To:	Bryce Taplin (Burbury Consulting)	**Date:**	12th Nov 2021
Cc:	Tim Alexander (Marine Solutions), Anahita Jungalwalla (ERA Planning)		
Project:	New Bridgewater Bridge		
From:	Colin Terry (Entura)		
Subject:	Comparison of 'Chosen Design' to Completed Assessment of Dredging and Reclamation, and Flood-prone Areas		

Dear Bryce,

As requested, we have reviewed the 'chosen design' provided to us on 25 October 2021 and have completed an analysis comparing it to the assessment we undertook as detailed in our report, Flood Hazard Report 8th Nov 2021 and Hydrodynamic Modelling 10th Nov 2021.

Our assessment was based on the reference design and the proposal description provided to us and included in the Major Project Impact Statement.

The 'chosen design' provided refines the extent of works and enables us to make comment regarding any changes we believe may be required to the identified potential impacts, proposed mitigations or the findings generally.

1. Summary

We have provided a summary of our comparison in the tables below.

1.1 Flood Hazard Report

Item	Current Assessment	'Chosen Design'
Potential Impacts	Increased flood levels upstream of bridge until existing bridge is removed Under capacity of existing Black Snake Rivulet infrastructure Flooding of low lying areas of new road near Granton	Potentially less flood effects upstream of bridge with bigger spans Potentially similar levels of flood risk as existing system near Granton
Proposed Mitigations	Removal of existing bridge and lifting of design levels above flood levels and/or protection works	Further modelling of final design and system required prior to construction
Findings and Conclusions	Removal of existing bridge will offset New Bridgewater Bridge and reclamation	Removal of existing bridge will probably offset New Bridgewater Bridge and reclamation

1.2 Hydrodynamic Modelling

Item	Current Assessment	'Chosen Design'
Potential Impacts	Plumes of sediment caused by construction and scouring around piers in main channel	Southern reclamation fill material uses cement to help stabilise soil, but there may be increase in water quality risk from as unbound soil moving through as groundwater (or over as surfacewater) from the final fill batter armouring/retaining wall compared to using rock fill NoFlood barrier will potentially help mitigation erosion but effectiveness unknown (especially local turbulence at edges with river, underflow of groundwater behind barrier and accidental impact that could rupture the bladder)
Proposed Mitigations	Limiting area and intensity of work Further assessment of scouring	Further detailed assessments required prior to construction and use of non-contaminated material in reclamation
Findings and Conclusions	Zinc levels away from works zone are below targets levels	Reclamation material has potential for an increase in water quality risk

1.3 Summary

In summary, we believe that the assessment we have completed (as outlined in our report), generally covers the expected impacts of the 'chosen design', noting that we have only visually assessed design drawings and reading the management plans without undertaking any further modelling, so this assessment is based purely on professional judgement.

The key differences from our assessment to the 'chosen design' are outlined, below.

- Nature of reclamation material and containment during construction, and potential flood risks from temporary works.

We recommend the following changes to our conclusions:

- Flood Hazard Report – add in executive summary at the end of dot 5 "and flood risks from temporary works"
- Hydrodynamic Modelling – add in executive summary in last sentence "reclamation that could leach into the river"

2. Introduction

During the preparation of our report, the Early Contractor Involvement (ECI) process was either yet to begin or was underway but not concluded. As a result, a 'chosen design' was not available for us to assess the impacts of and so we undertook an assessment of Flood Hazard Report and Hydrodynamic Modelling based on a modified version of reference design and the proposal description provided to us and included in the Major Project Impact Statement.

We understand that the reference design and the proposal description were developed to generally cover both of the tenderer design alignments and broadly the construction methods, and expected that the 'chosen design' will mostly accord with our assessment completed.

In particular, we expected to see a refinement of the alignment of the works (the size of intersections and the alignment over water were broader areas) and more detail on the construction methodology to be used.

This comparison has been completed to test these expectations and identify how well our assessment aligns with the 'chosen design'.

3. Background

The 'chosen design' was shared with us on 25 October 2021, and included selected plans, sections/elevations, renders and management plans.

In general, the 'chosen design' follows a design similar to the Reference Design. It:

- is a four-lane bridge crossing the River Derwent, with a posted speed limit of 80 km/h
- includes changes to the intersections at the southern and northern extents of the bridge to allow for grade separation
- includes a shared path as part of the crossing, connecting into the local surrounding network
- involves the demolition of selected buildings and structures as originally proposed.

The following is where the 'chosen design' differs from what we assessed.

- The alignment of the bridge. The alignment is more refined than was previously advised. In comparison to the Reference Design, the alignment is further east at the southern extent but similar at the northern extent.
- The extent of the intersection works. The extent of work is more refined than was previously advised. The layout of the intersections are generally similar to the reference design.
- The bridge type is confirmed. This includes the bridge pier spacing (typically 64 m) and number and type of piles.
- The extent of reclamation has reduced. A slightly larger area of reclaimed land was proposed and assessed as part of the MPIS.
- The content of the southern reclamation fill had been assumed to be for the most part (water quality) inert rock (similar to what is proposed for the northern reclamation), but the proposal is for a cement stablished soil protected during construction with a bladder coffer dam that rests on the river bed.
- Arrangement of the proposed drainage of Black Snake Rivulet culvert prior to and under the Brooker Highway differs to preliminary concept modelled in the Flood Hazard Report and it is unclear what design flows were or the proposal's performance in providing safe solution.
- Unclear whether new low-lying roads of southern interchange near Granton have been protected yet from current and climate affected river and sea storm flooding.

4. Potential Impacts

In our prior assessment, the potential impacts from the proposed development were identified as per the below list.

- Based on the assumed bridge structure (with 38 m pile group spacing without reclamation) there was an increased risk of flooding upstream of New Bridgewater Bridge from the reduced river flow area, until the existing bridge was removed which brought the risk back to a similar risk to the existing system.
- Based on the assumed reclamation there was a small increase in flood water levels and risk to some properties that would have been offset by the removal of the existing bridge.
- There was potential for inundation of part of the new road network on the low-lying parts of the southern approach if they weren't suitably lifted and/or protected from flooding and sea level rise.
- During construction, the works pose a potential water quality risk by creating turbid water as a plume of sediment moves away from the construction site on river currents and the tide. Within the sediment is the potential for other constituents such as zinc, which could pollute other areas of the river.
- After construction, the New Bridgewater Bridge structure has the potential for erosion and deposition processes to locally scour the main river channel during a large flood that would need to be considered in the bridge design.
- Flood flows from the Black Snake Rivulet and hillsides closer to the project land need to be collected and safely conveyed to the River Derwent, and existing infrastructure was needed upgrading.

In reviewing the 'chosen design' we have identified the following changes to impacts.

Impacts	**Change to impact**
River Derwent water quality during construction	The material used in the southern reclamation area and method of containment could increase the risk of poor water quality outcomes in an accidental breach of the containment, flash flooding washing surface material into the river, or leaching of unbound reclamation fill material as groundwater after containment system is removed, if not managed well.
Flood risks from temporary works	Damming part of the river flow (by placement of the linked barges) could increase flood risk, and temporary works that create significant obstructions to flow (even those downstream of the causeway as this is overtopped in some rarer floods) can increase water levels upstream, or downstream if barges move apart quickly during a flood.
Flood water level in low lying areas of Granton during serviceability flood	Potential risk of inundation to part of the new road network in southern interchange remains

As can be seen from the above table, the impacts are expected to be potentially higher to those assessed as part of the original assessment.

5. Proposed Mitigations

In our prior assessment, the proposed mitigations are identified as per the below list.

- Further flood and water quality modelling of the system with design once the design and construction methodology has been finalised to confirm impacts on surrounding people (community and workers)

and environment, and provide input to the design (e.g. flood levels and velocities) and construction approach, and whether offsets were required to due increases in flood risk from temporary works and final constructed form.

- Undertaking further design specific hydrological and hydraulic assessments as required, such as the 1:2000 AEP flow calculation and flow behaviour, and detailed scour calculations around the structure.
- Ensuring design safely conveys the Black Snake Rivulet to the River Derwent to avoid flood hazards from overland flow, and similarly on the northern side to capture surface water to protect the identified at risk houses for 1:100 AEP flood with future 2090 climate
- Lifting the design levels above the 1:100 AEP flood levels based on the future 2090 climate and / or protection works to achieve the same (or provision for future works in current design as part of an adaptative strategy to climate change)
- Ongoing maintenance and management of the system once constructed.

In reviewing the 'chosen design' we have identified the following changes to those mitigations.

Mitigations	**Change to mitigations**
Further modelling of water quality impacts in River Derwent	Understanding of potential leaching of the southern reclamation's concrete/soil fill
Further modelling of flood risks	Understanding of potential increase in short term flood risk from temporary works where they form a barrier to flood flows using storm rarity appropriate for temporary works commensurate with risks to upstream and downstream community and properties, and site works
Post construction monitoring	Confirmation of modelling of above points to acceptable levels

As can be seen from the above table, the mitigations are expected to be similar in approach to those assessed as part of the original assessment, just more detail is some new areas.

6. Findings and Conclusion

The choose design has been presented in a brief form and is still at an early stage of design. The general form and approach is similar to what had been assessed, with the largest differences related to construction methodology and the water quality and flood risks this could create. These matters will require further investigation prior to construction to ensure appropriate mitigation measures are included in the design and Construction Environmental Management Plan.

Kind Regards,

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Specialist Water Resources Engineer
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