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PROJECT

New Bridgewater Bridge Coastal Inundation Assessment

CLIENT

Department of State Growth

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ENGINEERING & PROJECT MANAGEMENT

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Figures

This report was prepared for the Department of State Growth for the purposes of preparation of the Major Project Impact Statement (MPIS) for the New Bridgewater Bridge. The report should be read in conjunction with the entire MPIS as well as any other referenced documents noted in the report.

The authors of this report, James Burbury is a Principal Engineer with over 20 years experience in the assessment, design and construction of marine and coastal infrastructure including ports, harbours, dredging, reclamation, navigation, coastal impact assessments, shoreline protection and wave studies. James has completed coastal erosion assessments around Tasmania for infrastructure projects as well as in accordance with the Tasmanian Interim Planning Scheme including site assessments of wave inundation and coastal erosion.

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1. Introduction

The Department of State Growth propose a replacement crossing of the River Derwent at Bridgewater, the New Bridgewater Bridge.

The project team are currently preparing the supporting documentation for approval of the new development under the "Major Projects" component of LUPAA.

This report has been prepared to address Assessment Criteria AC4.5, Coastal Inundation Hazard for the New Bridgewater Bridge Major Project.

Existing mapping prepared by the University of Tasmania for the Department of Premier and Cabinet in 2016 (accessed via ListMAP) shows areas within and adjacent to the project site which are at risk due to coastal inundation.

The nearby, adjacent areas (outside the project land), on the north bank of the river, are included in this report as they may be affected by the Project.

The basis of the findings and assessment are directly linked to the Entura (November 2021) New Bridgewater Bridge Flood Hazard Assessment Report included within the MPIS which assessed risks to inundation due to flood, sea level rise and tidal impacts of the site and surrounds.

An assessment of the local wave and storm surge impacts has been considered whilst recognising that the site is within an estuary and significantly upstream from the coast and influence of swell waves and significant wave induced events. This assessment included reviewing the impact of the New Bridgewater Bridge on the existing coastal inundation risk level for the site.

This report reviews the hazard areas identified in theList, on site inspections and results of the Entura assessment of the impact of flooding of littoral areas due to 1% AEP rainfall, storm surge and sea-level rise due to climate change. This report will assess whether the construction and utilisation of the New Bridgewater Bridge will affect the inundation hazard potential of the Project and adjacent areas in any material way, as well as the impact of inundation on the proposed development.

1.1 References

The following documentation has been referenced in the development of this assessment.

ID	Title	Author	Date
1	Assessment Criteria, New Bridgewater Bridge Major Project	Tasmanian Planning Commission	May 2021
2	Tasmanian Coastal Works Manual: A best practice management guide for changing coastlines	DPIPWE, & Tasmanian Government	Dec 2010
3	Tasmanian State Coastal Policy	Department of Premier and Cabinet, Tasmania	1996
4	LIST mapping www.thelist.tas.gov.au	Tasmanian Government	July 2021
5	CoastAdapt www.coastadapt.com.au	National Climate Change Adaption Research Facility	2016
6	New Bridgewater Bridge Flood Hazard Report	Entura	Aug 2021
7	Survey and Bathymetry Drawings EX 01 to 06	Burbury	Mar 2020

8	Derwent Flood Data Book	DPIPWE	May 2000
9	Coastal erosion susceptibility zone mapping for hazard band definition in Tasmania	Sharples et al	October 2013
10	Indicative Mapping of Tasmanian Coastal Vulnerability to Climate Change and Sea-Level Rise	Chris Sharples	May 2006
11	New Bridgewater Bridge, Coastal Erosion Hazard Report	Burbury	August 2021
12	State of the Derwent Estuary	Derwent Estuary Program	2015
13	Numerical Hydrodynamic Modelling of the Derwent Estuary	CSIRO	March 2005

1.2 Glossary

Annual Exceedance Probability (AEP). A measure of the likelihood (expressed as a probability) of a flood reaching or exceeding a particular magnitude. 1% AEP refers to a 1 in 100 year occurrence.

Australian Height Datum (AHD) is the mean sea level for 1972 at the tide gauges at Hobart. River level heights are benchmarked (marked point in a line of levels) to mean sea level.

Catchment. The land area that drains into a particular watercourse (river, stream or creek). It can be a natural topographic division of the landscape, although the underlying geological formations may alter the perceived catchment area suggested solely by topography (limestone caves are an example of this).

Cumec. The basic stream flow unit expressed as cubic metres per second (m3/s).

Discharge. The passage of flood flow volume with time. Discharge can be separated into direct runoff (overland flow, interflow and storm flow) and base flow (contributions of ground water spread out over longer periods of time).

Department means Department of State Growth as the proponent of the Project.

ECI means Early Contractor Involvement, process the Department is proceeding with the design and construction of the Project.

Existing Bridgewater Bridge means the existing bridge crossing the River Derwent incorporating rock causeway and steel bridge with mechanical lift span structure.

Extreme Flood. A rare and unusually severe flood that is greater in magnitude than the 1% AEP event.

Flood. Inundations of water over land as a result of overflow from rivers or the inflow of tide. Flood runoff results from short duration highly intense rainfall, long duration low intensity rainfall, snowmelt, failure of dam or levee system, or a combination of these conditions.

Flood Plain. Land which is covered by water when a river overflows its banks during flooding. The extent of the flood plain will normally be greater than the area covered in a 1% AEP event.

Hydraulics. The study of water flow in a river and across a flood plain and the evaluation of the river flow characteristics (ie river height and velocity).

Hydrology. A study of the rainfall-runoff process as it relates to the development of flooding and the derivation of hydrographs for given floods.

Highest Astronomical Tide (HAT) is the highest level of water that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions. It is deemed to be 0.86 metres above 0m AHD.

Inundation. The flooding of an area so that it is submerged or covered with water.

Lowest Astronomical Tide (LAT) is the lowest level of water that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions. It is deemed to be 0.83 metres below 0m AHD.

MAST means Marine and Safety, Tasmania.

MPIS means the Major Project Impact Statement.

New Bridgewater Bridge means the proposed new bridge crossing the River Derwent and described in the MPIS.

Project is a new river crossing (New Bridgewater Bridge) for motor vehicles between the Brooker Highway and Midland Highway, with connections to the Lyell Highway and other surrounding roads.

PSTR means Project Scope and Technical Requirements which forms part of the Contract and Specification requirements for the design, construction and commissioning of the Project.

ACRONYMS

BOM - Bureau of Meteorology

DPIPWE - Department of Primary Industries, Parks, Water and Environment

DPIF - Department of Primary Industry and Fisheries (replaced by DPIWE)

DPI - Department of Primary Industry (replaced by DPIF)

EMA - Emergency Management Australia

HEC - Hydro Electric Commission

PSTR – Project Scope and Technical Requirements (related to New Bridgewater Bridge)

RWSC - Rivers and Water Supply Commission

SES - State Emergency Service

2. Location

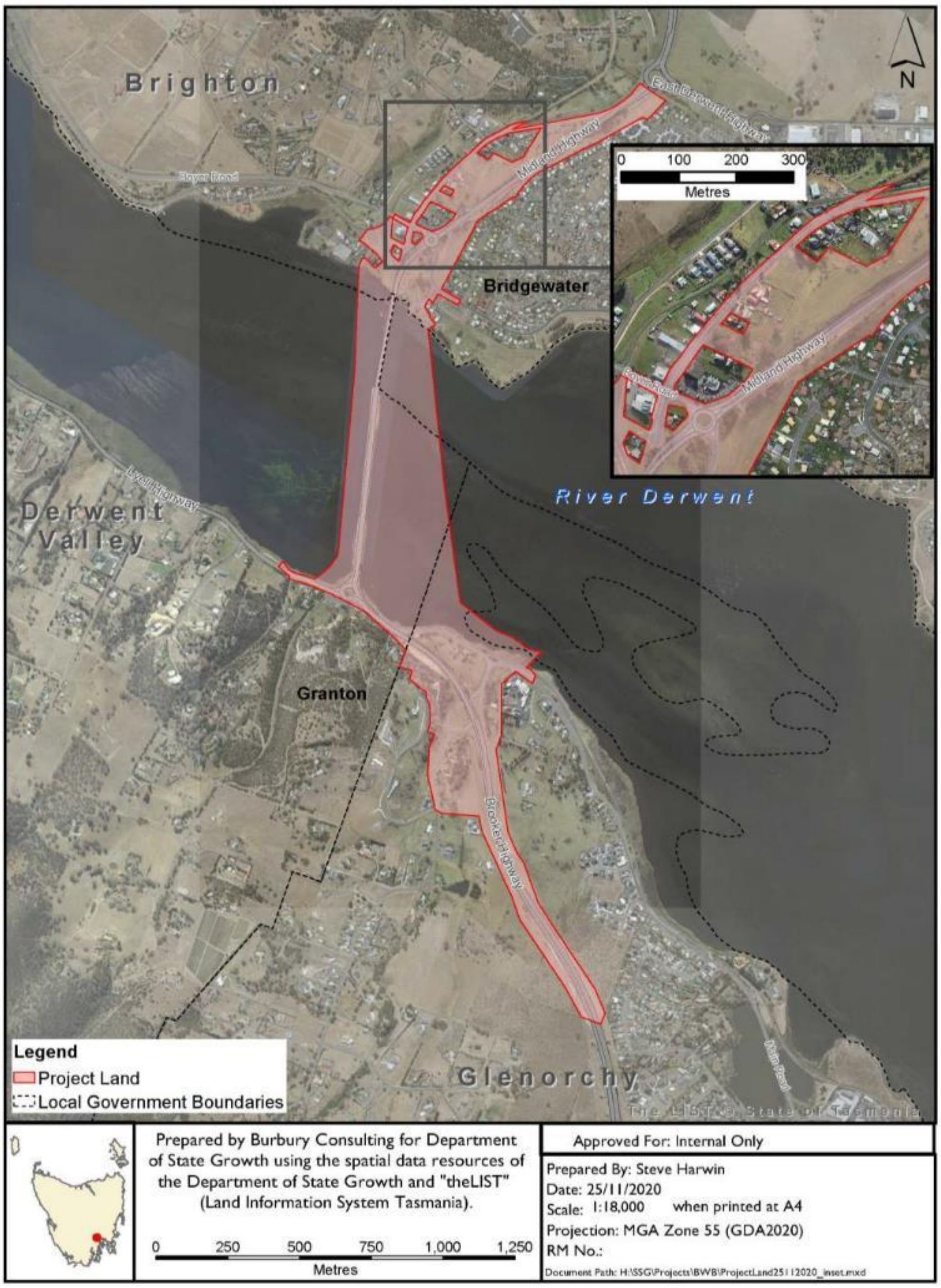
The River Derwent is the major freshwater inflow to the Derwent Estuary, a highly stratified, drowned river system. The Estuary extends over 52kms from the Iron Pot in Storm Bay inland to New Norfolk. Tidal influences are notable past New Norfolk up to *The Rocks* just downstream from Lawitta.

The New Bridgewater Bridge will be located downstream of the existing Bridgewater Bridge. Figures 1 & 2 show the location of the Project and its boundaries.

Details of the final design for New Bridgewater Bridge are pending completion of the Department's ECI process, however it is known that it will be situated downstream of the existing bridge, the existing bridge will be demolished and the constraints to navigation of the existing bridge removed.

Figure 1 – Location of the Project

Figure 2 – Project Land Extents



For the purpose of this investigation, the focus is the area between the southern bank of the River Derwent at Granton and the northern bank of the river at Bridgewater.

The proposed use as part of the project is for a new River Derwent crossing to replace the existing Bridgewater Bridge crossing. The zoning will predominately be 'Utilities' commensurate with the existing zoning of the land.

The design life of the new bridge will be 100 years, and the bridge will be part of the main road link between Hobart and northern Tasmania, open at all times.

A summary of the proposed works for the New Bridgewater Bridge is detailed in the MPIS for the extent of works and in general includes:

- A new four lane river crossing for vehicles from Granton to Bridgewater
- A new river crossing for pedestrian and cyclists
- A grade separation of the Lyell Highway and Black Snake Road Junctions at Granton and connecting ramps at Gunn Street and Old Main Road at Bridgewater
- Widening of the existing highway interchanges from two to four lanes
- Demolition of the existing Bridgewater Bridge structure.

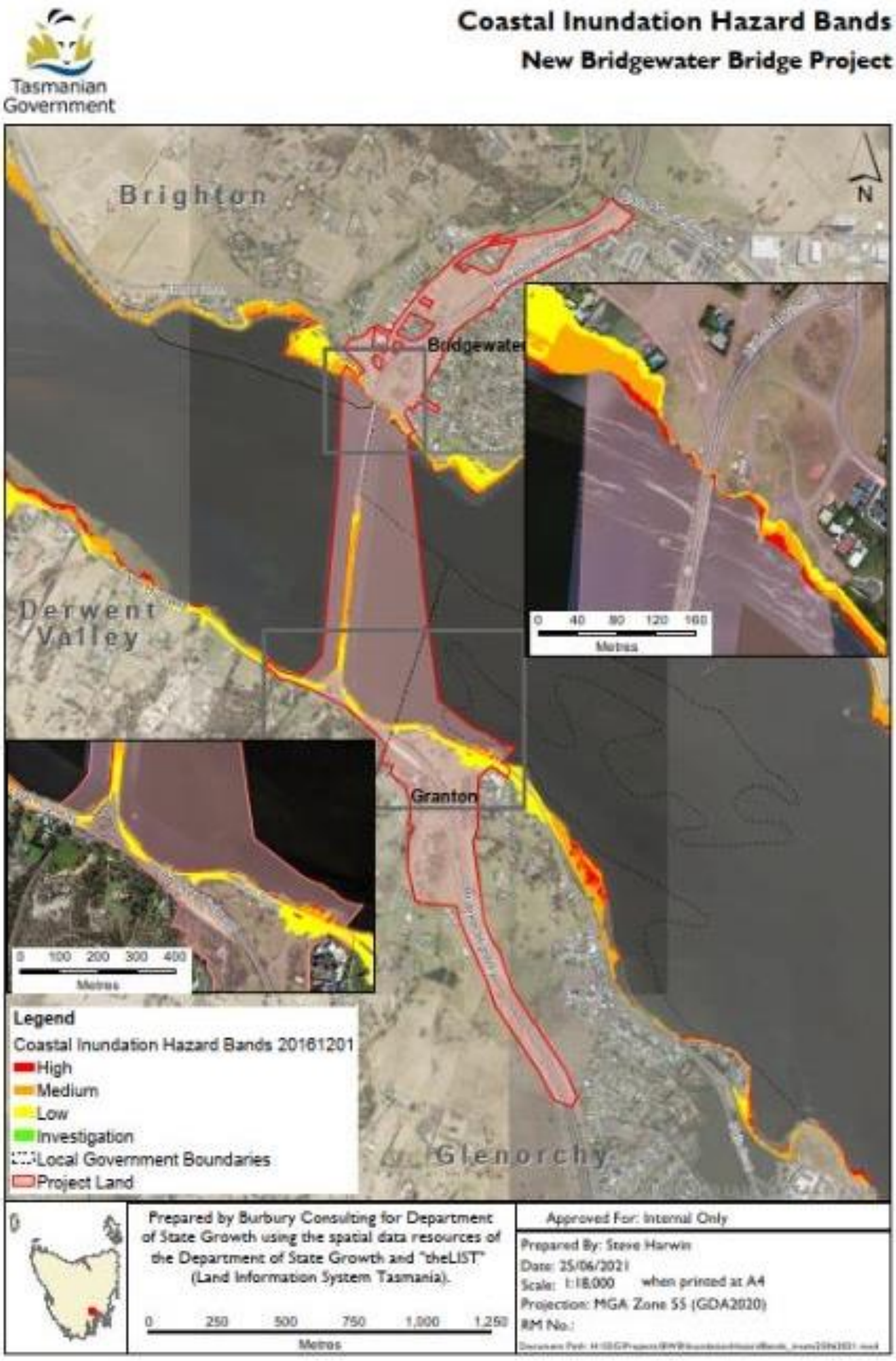
The marine and coastal works associated with the construction and operations include:

- Temporary works including access structures, hardstands and piled structures for the construction of the bridge substructure and superstructure
- Formation of new bridge abutments landside of the river (Granton and Bridgewater)
- Piling works within the waterways including concrete pile caps and piers
- Demolition of the existing bridge and rehabilitation of areas
- Land reclamation on coastal areas for construction access and temporary works
- Modifications to existing and creation of new stormwater infrastructure
- Barge and work boats for construction activities
- New load out ramps and structures for construction access from land to river.

3. Existing Site Inundation Mapping

Figure 3 below shows the coastal inundation mapping from theLIST of the existing Bridgewater Causeway and Bridge and Project extents. The immediate shoreline of the River Derwent as well as the existing Causeway are highlighted as risk of inundation due to storm surge and sea level rise.

Figure 3 – Project Site Coastal Erosion Extents



The mapping indicates that the Project extent is generally limited to risk of coastal inundation with localised areas to the south side of the river and to the east of the existing bridge, where the are is low-lying.

It is noted that the historic causeway is not expected to support any road traffic once the New Bridgewater Bridge is in operation. However, it may serve for recreational use. Whilst not highlighted in the coastal inundation map in Figure 3, it is the most vulnerable structure to inundation due to likely future flooding and over-topping.

On the southern shore of the river, west of the causeway, the A10 highway follows the riverbank at an approximate level of +2.4 metres AHD. To the east the main Brooker Highway will be redeveloped as part of the New Bridgewater Bridge project, but Main Road (a local access road) follows the shoreline at a level of +2.2 metres AHD.

At the northern side of the river, to the west of the existing bridge, there is a low-lying area which is privately owned and appears to be an abandoned hop farm (there are indications that development is planned). To the east is a boat ramp. This and the adjacent area are to be used, by the bridge contractor for marine access and laydown. Nearby housing, on Nielsen Esplanade, is above 3.8 metres AHD.

The areas along the riverbank, most at risk of inundation contain limited housing and other structures.

The impact of the construction has been assessed based on the corridor of works identified in Figure 2 and 3.

4. Existing Causeway and Bridge

4.1 General Observations

The existing Bridgewater Bridge and associated causeway is an important part of Tasmania's strategic National Highway transport network connecting Hobart with Launceston and the northern ports at Bell Bay, Devonport, and Burnie.

The existing Bridgewater Bridge was constructed in 1946, while the causeway was initially constructed in the 1830s and is Heritage Listed.

The existing Bridgewater Bridge has reached the end of its design life and the Department propose to replace the bridge with a new River Derwent crossing, the New Bridgewater Bridge.

The causeway was constructed by convict labour who quarried and carted sandstone by wheelbarrow to form the structure. It contains an estimated 1.8 million tonnes of stone and clay which was end tipped over mud flats to the edge of the natural deep-water channel. A considerable quantity of soft mud was displaced, and the causeway has been raised on several occasions due to settlement.

The causeway carries the Brooker Highway or A1, which here is a two-lane bitumen road plus an unused railway line. Except for limited parking hardstand there are small shoulders and an irregular slope to the water-level and riverbed, as shown on the photographs in figures 5 and 6.

As observed on site, the causeway has no actual slope protection, but has attained a stable profile of rock, gravel and reed beds.

On completion of the New Bridgewater Bridge, there may be an opportunity to convert the existing causeway to recreational space for public use.

Due to the low level of the road on the causeway, this area is subject to inundation risk and hence forms part of the justification for the New Bridgewater Bridge to maintain the future major road corridor and crossing of the River Derwent.

The impact of the Project on inundation is further explored in the following sections.

4.2 Coastal Assessment

The existing Bridgewater Bridge is positioned in a North-South alignment with Norwest and South-East waterway exposure to its West and East flanks respectively. Having a drowned riverbed composition, the waterway surrounding these two exposure zones is comprised of shallow mud-banks surrounding a moderately narrow navigable channel of approximately 0.5m and 5m Chart-Datum depths respectively.

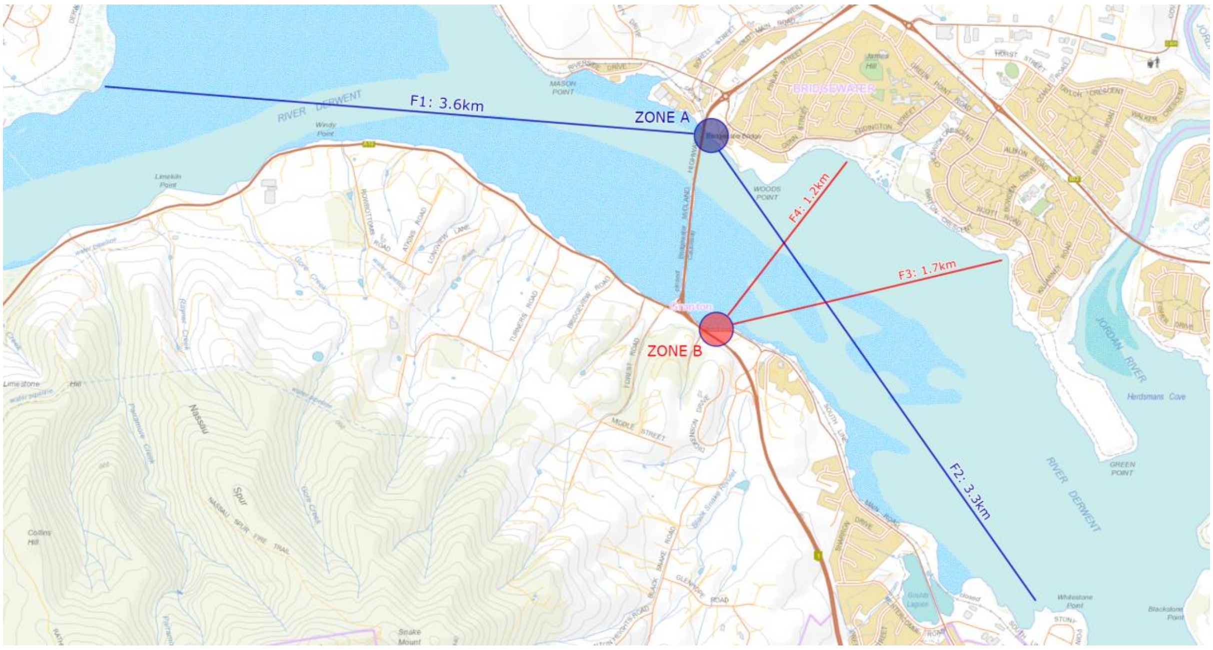
As highlighted in Figure 3 above, the existing causeway and northern and southern riverbanks are most exposed to coastal inundation risks through the low-level nature of those existing land forms.

For the purposes of assessing wave conditions and wave run-up from wind driven waves we have assessed the exposure of the Project Site as highlighted below.

To determine wind driven wave conditions of the existing site we have reviewed site wave climate, water depths, exposed zones (A and B below), tides and impacts of sea level rise on the wave magnitudes.

As highlighted, storm waves and extensive storm surge will not impact the site given the location of the site upstream of the coastal region.

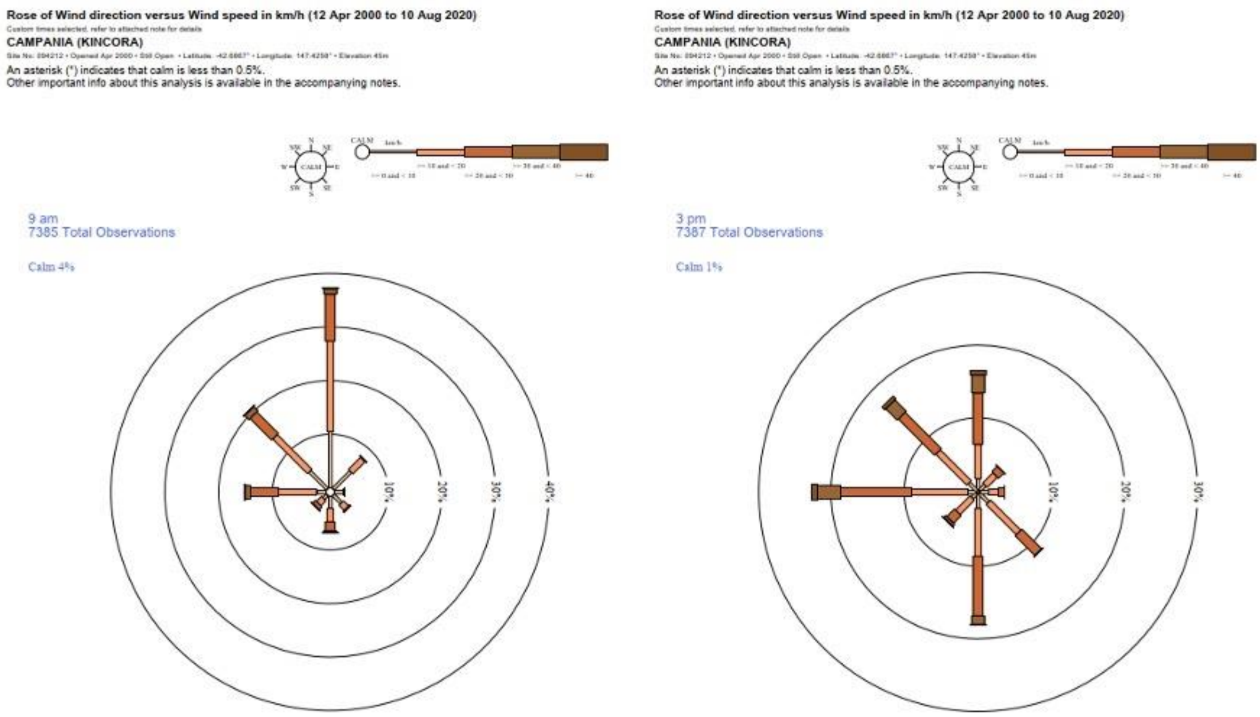
Figure 4 – Site Layout and Maximum Fetch Distances



4.2.1 Winds

The site primarily experiences winds in the north to west quadrants with some southerly sea breezes in the afternoon as per Figure 5.

Figure 5 – Historical Wind Roses for Campania (17 km away)



Gust wind speeds for the site were obtained from AS1170.2, with Terrain Category 1 as per recommendations in AS4997 – *Guidelines for the design of maritime structures.* The gusting wind speeds were modified to reflect an average hourly wind speed based on the guidelines given in section II -2 of the Coastal Engineering Manual.

These mean hourly wind speeds are shown below.

Table 4.1: AS 1170.2:2011 Wind Speeds

Scenario	*Affected Zone*	*Fetch*	*Direction*	*V_{av} (ARI:1)$_{adjusted}$ (m/s)*	*V_{av} (ARI:100)$_{adjusted}$ (m/s)*
F1	A	3.6	W	20.16	27.55
F2	A	3.3	SE	17.92	24.49
F3	B	1.7	ENE	17.92	24.49
F4	B	1.2	NNE	17.92	24.49

No shielding factors from the existing bridge structure have been applied to the wind values shown in the *F1* scenario. This represents a case where the existing bridge is demolished to allow for unimpeded vessel traffic.

The *F4* scenario is discounted from any further investigation as it represents a similar but less intense climate than that of the *F3* scenario although it may have a more direct wave direction to any shoreside proposed structural components of the New Bridgewater Bridge.

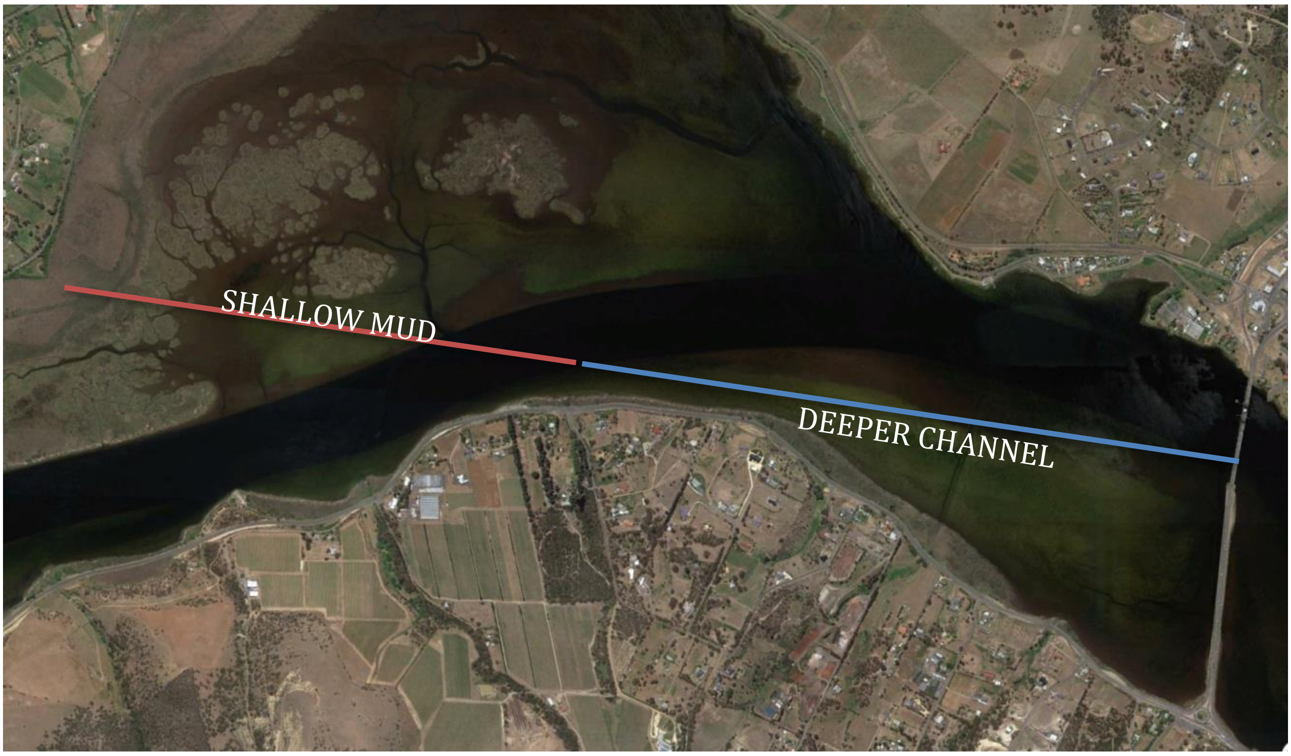
4.2.2 Water Depth

As detailed bathymetry was not available for the wider area of investigation, a range of average water depths from 0.5m to 2.5m was investigated. For scenarios F2, F3 and F4 (above) the cross sections associated with their fetch lines would show minimal sections of deep water, with most of the distance transiting shallow mud-banks and little variance in depths.

The assumption utilised in this analysis, that these developed waves could be represented as having an average water depth throughout their fetch distances may not accurately model the real-world wave. This issue is presented in **Error! Reference source not found.**, which shows that the scenario *F1* fetch line is split equally into shallow and deeper water sections (the navigable channel being relatively deep in comparison the to the surrounding shallow mud banks).

In the case of this latter scenario, the assumption that the shallow section (the onset of the fetch period) is where smaller capillary waves are formed and as such, they have an adequate wave height to water depth ratio to not significantly vary the resultant wave dimensions when using the average water depth method.

Figure 6:: Western Fetch Area with a Narrow Navigable Channel and Shallow Mud-Banks



For this analysis, the water depths are assumed as per **Error! Reference source not found.**, with the Highest Astronomical Tidal (HAT) selected as the worst-case analysis. High water levels are associated with large weather systems and large winds.

Table 4.2: Water Depths utilised in this Report

Location	Current HAT Depth (m)	Sea Level Rise (m)	100yr HAT Depth (m)
Mudbanks	1.50	0.85	2.35
Navigable Channel	7.00		7.85
F1	4.00		4.85
F2, F3	1.50		2.35

4.2.3 Tides

A detailed review of the river tidal dynamics was completed by CSIRO in March 2005 titled "Numerical Hydrodynamic Modelling of the Derwent Estuary".

The report presented results from development of a calibrated model of the tidal form of the estuary and confirmed the behaviour of the river in tide behaves as a salt wedge estuary with marine flow in the bottom waters directed upstream in the estuary and a freshwater surface flow heading downstream. The report identifies the difficulty of accurately modelling upstream of the Bridgewater Bridge site but results provided indicate an accurate assessment downstream.

The head of the salt wedge is located above Bridgewater under low environmental flows and then consequently pushed downstream in high environmental flow conditions.

The tide lag between Hobart and Bridgewater is nominally 50 minutes with a height variation highly subject to the environmental flows.

Tides for Hobart are referenced below, with the highest recorded tide for Hobart being 1.35m AHD (source: Tasports).

Table 4.3: Tides for Hobart Port

Tide State	AHD Reduced Level
Highest Astronomical Tide - HAT	0.860
Mean Higher High Water - MHHW	0.680
Mean Lower High Water - MLHW	0.170
Mean Sea Level (Actual) - MSL	0.050
Australian Height Datum - AHD83 (MSL 1972)	0.000 Datum
Mean Higher Low Water - MHLW	-0.070
Mean Lower Low Water - MLLW	-0.570
Indian Spring Low Water ISLW	-0.580
Chart Datum post 2006 -Lowest Astronomical Tide (LAT)	-0.830

4.2.4 Sea Level Rise

The planning scheme and Department of Premier and Cabinet references for sea level rise notes 0.2m increase by 2050 and 0.8m by 2100.

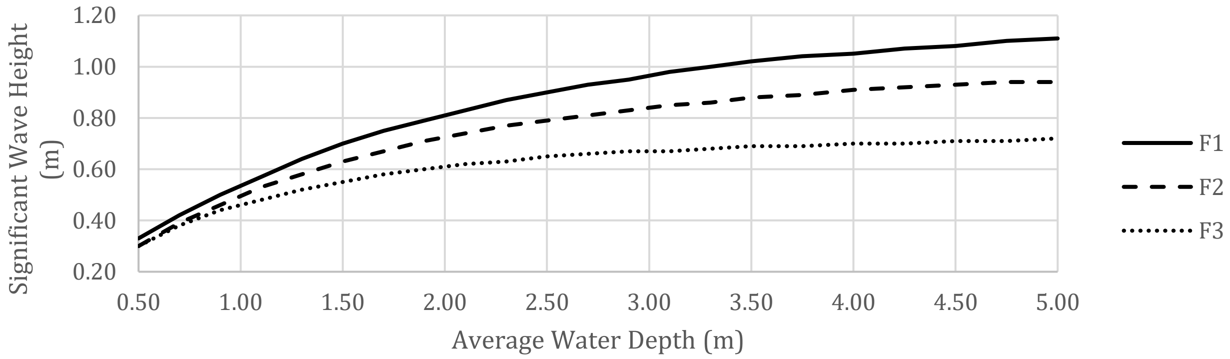
4.2.5 Wind Driven Waves

As described in **Error! Reference source not found.**, the F1, F2 and F3 scenarios extend straight-line distances of 3.6km, 3.3km and 1.7km respectively.

Using these fetch values along with wind speeds, and an average water depth for the wave to develop, a terminal fetch limited wind wave can be predicted at either side of the causeway.

Error! Reference source not found. show describes the relationship for the NW and SE wind waves to the water depths.

Figure 7: Wind Wave Heights for Different Fetch Scenarios in Relation to Average Water Depth



Wind setup due to local wind waves (based on the Coastal Engineering Manual) has been calculated at less than 0.1m for the above wave conditions.

Wave run-up based on Van Der Meers for the above is less than 0.2m for the 1% AEP 100 year design conditions.

4.2.6 Other Affecting Factors to Wave Climate

Flora

The Shore Protection Manual (1984) describes that "when waves travel across a shallow flooded area their initial heights and periods may increase, i.e., when the wind stress exceeds the frictional stress of the ground and vegetation underlying the shallow water. The initial wave heights may decay at other times when frictional stress exceeds wind stress".

This may have significant reductive impact on the wave heights as they travel across the shallow seagrass populations in all scenarios.

Figure 8: Shallow Flooded Area Frictional Curves

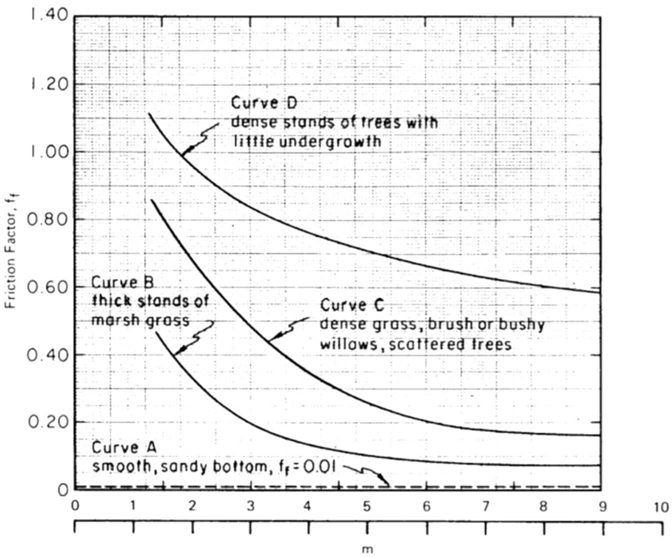
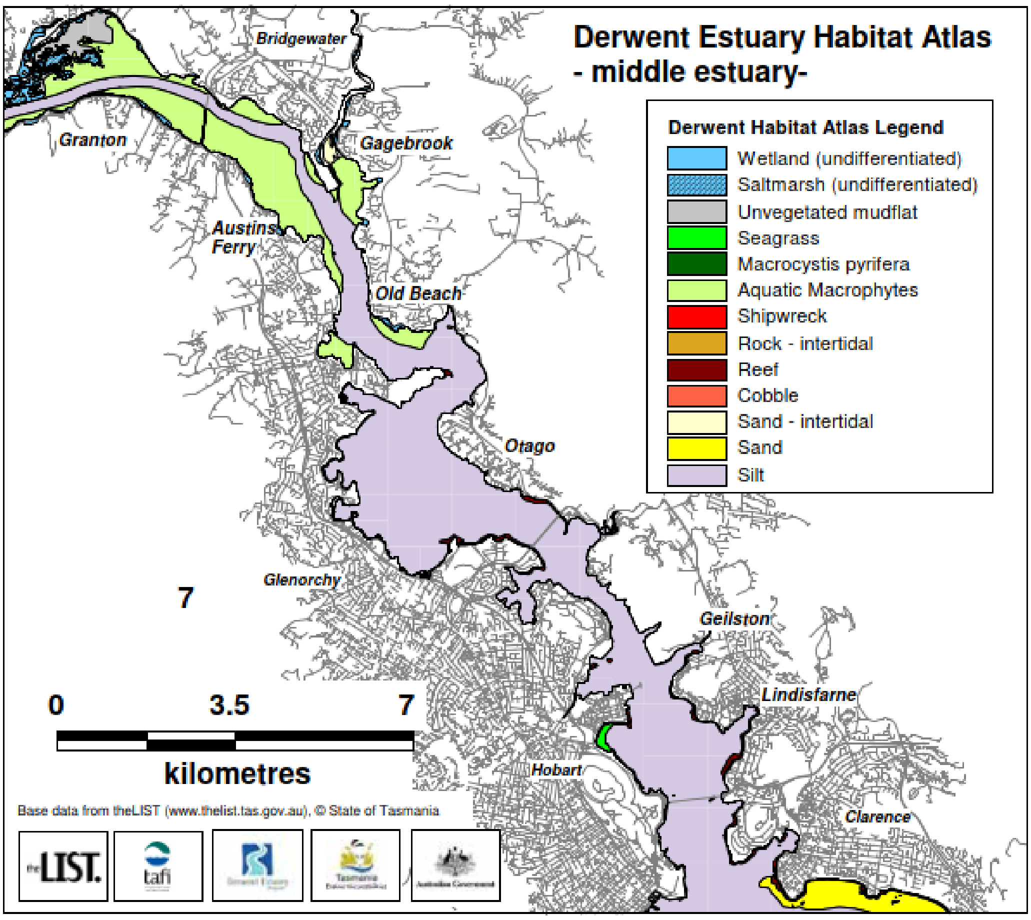


Figure 9: Derwent Estuary Seagrass Areas (Source: State of the Derwent Estuary 2015)



Wind wave conditions observed on site are consistent with the above, in that wind waves in line with the navigation channel remain in form and then dissipate within the mudflats and weed bed areas either side of the existing causeway and along the southern riverbank.

Siltation

As the sea level rives of the next 100 years, the mud banks and river bathymetry are not expected to remain stationary. Large flood events and changes in seasonal rainfall will ensure that the estuarine landscape will alter in accordance with time. This fact presents difficulty with a predictive wave model as the free-water above the riverbed is likely to change. Relating sea-level rise with water depth in the area is thus likely to be erroneous.

4.2.7 Coastal Summary

The wave climate in the area around the existing Bridgewater Bridge is significantly constrained by fetch, water depth, existing causeway and then shallow mudflats and seagrasses.

Analysis shows that minimal change (<100mm) to wave height in the area will result purely due to sea-level rise.

Water level changes at the site are influenced by tide, environmental flows, river dynamics, barometric pressure and local wind wave events.

A summary of the influence on water levels for Bridgewater are provided below:

Water Levels	**2021**	**2100**
HAT still water level, m AHD	0.86m AHD	1.66m AHD
Wave setup	0.1m	0.1m
Wave run-up elevations	0.2m	0.2m
HAT + wave setup + run-up	1.16m AHD	1.96m AHD
Recorded storm still water levels	1.36m AHD	2.16
1% AEP sea storm, Tasman Bridge	1.44m AHD	2.29m AHD
Entura Flood Model, downstream south bank: 10% AEP flood and 1% sea storm refer Appendix R and S	1.2m AHD	2.05m AHD
Entura Flood Model, downstream north bank: 10% AEP flood and 1% sea storm refer Appendix R and S	1.3m AHD	2.2m AHD
Brighton Council 1% AEP design flood level for Bridgewater (Tasmanian Planning Scheme)		2.6m AHD

The risk of shoreline inundation of the site is predominantly due to flooding and sea level rise and not wave induced storm surge or wave recession due wave erosion.

Modelling of the joint probability for sea storm and flooding is further detailed in the Entura Report.

5. New Bridgewater Bridge

Revised mapping of the Tasmanian Planning Scheme inundation and erosion risk hazard bands were applied to the proposed new Bridgewater Bridge design.

As presented in the following figures the proposed new Bridgewater Bridge extents are generally outside of the risk mapping areas highlighted for erosion and inundation other than small areas associated with the new interchange on the southern bank.

These areas are naturally low lying ground levels.

Figure 10 Coastal Erosion Hazard Band Mapping

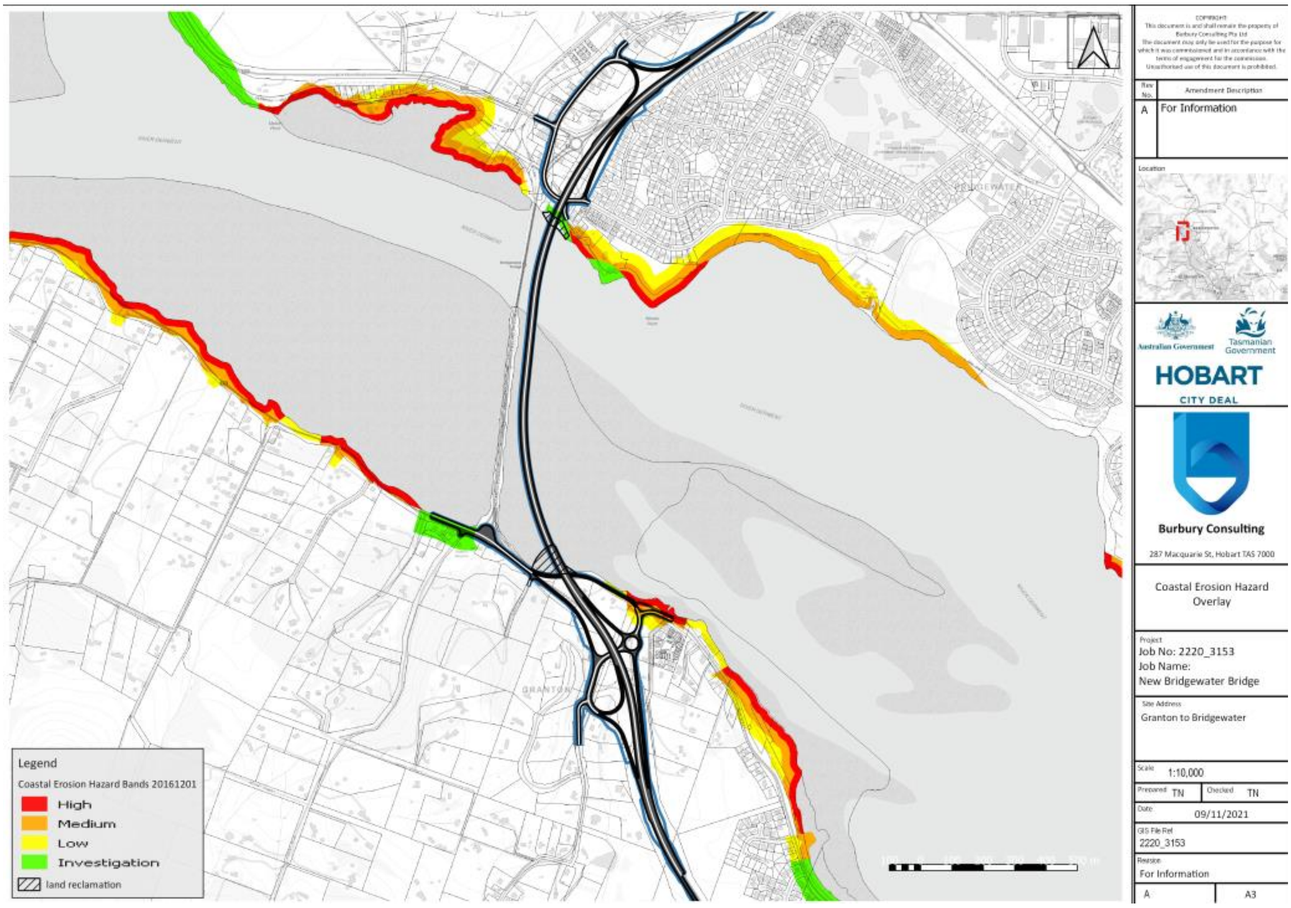
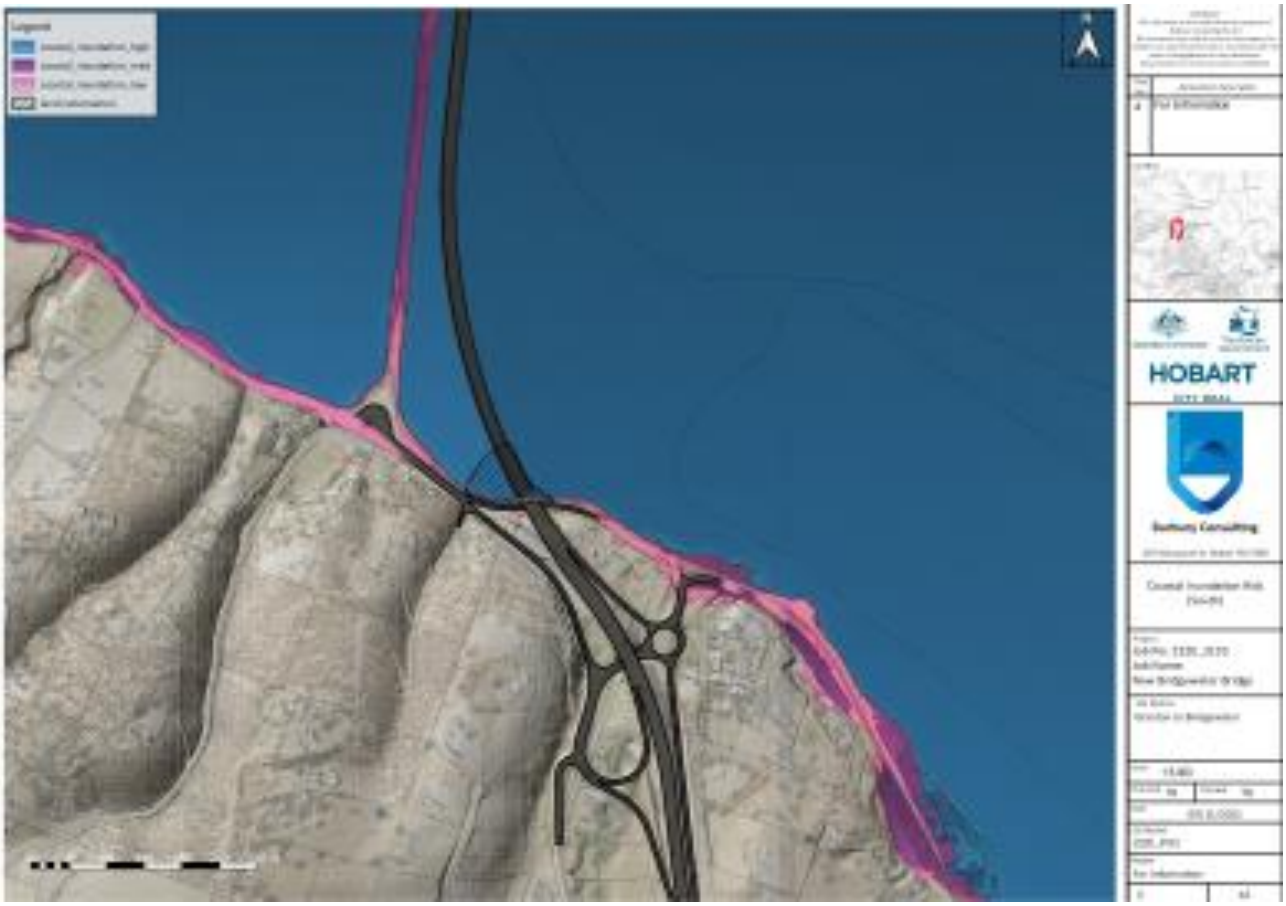


Figure 11 Coastal Inundation Hazard Band Mapping – Northern Shoreline

Figure 12 Coastal Inundation Hazard Band Mapping – Southern Shoreline



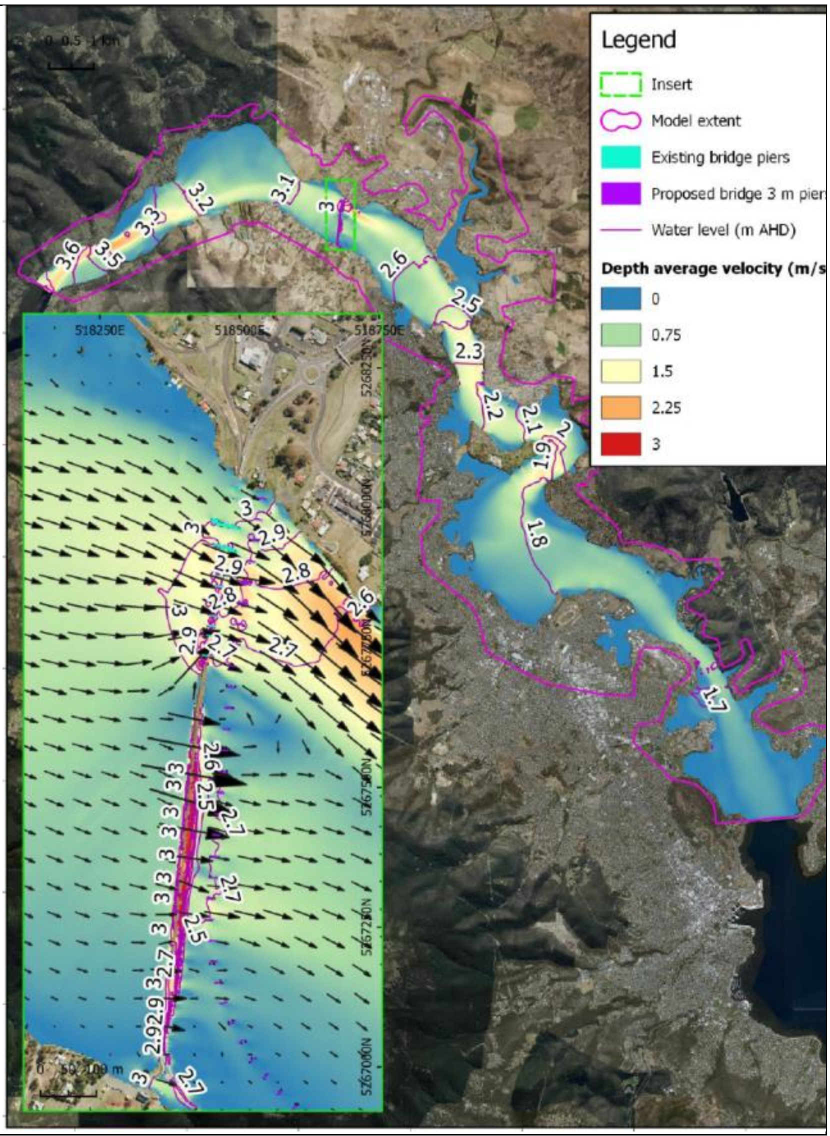
6. Flood Data

The River Derwent Flood Data Book by DPIPWE has recorded historical flood levels in the River Derwent utilising data from photographs and recorded levels. The last major flood was recorded in 1960 and records show water levels at the Norske Skog paper mill (12km upstream of Bridgewater) reached a level of +4.5 metres AHD. It is not specifically recorded whether the causeway at Bridgewater was over-topped.

It is unlikely that, if the main highway had been blocked, the event would not have been recorded. In 1964 the headwaters of the River Derwent were diverted to provide hydro-power and the catchment reduced to 8,920 square kilometres and an average of 15 cumecs diverted to the Poatina hydro scheme.

Flows in excess of 3,000 cumecs were recorded in the 1960 floods which were estimated to be due to rainfall exceeding the 1% AEP.

Figure 13 – Derwent River Catchment   Figure 14 - River Flows for 1% AEP Future Climate



The *Entura* report – Bridgewater Bridge Flood Hazard Report - is the primary source of flow and water level data for the Project. This report considered the option where the causeway would not be altered and can overflow in extreme conditions, which is the anticipated condition. The report evaluates the impact of the New Bridgewater Bridge on river and flood flows.

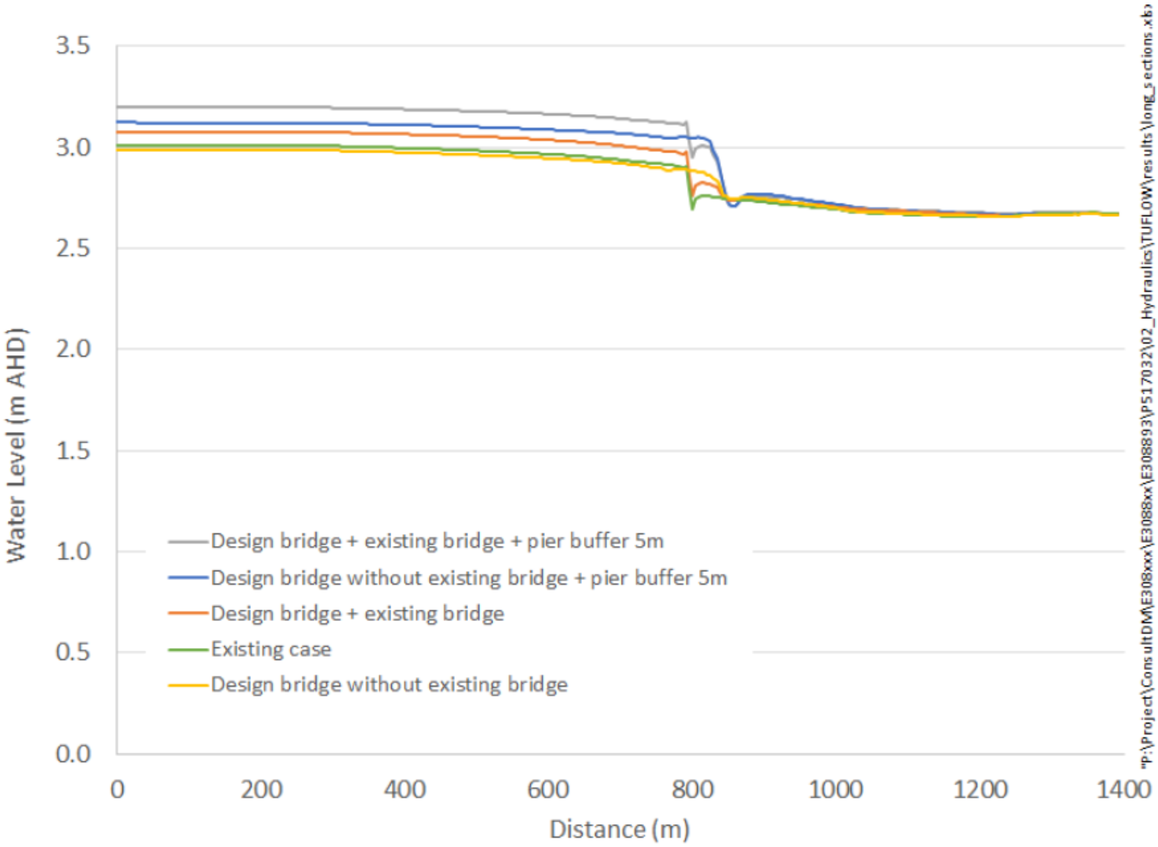
6.1 Flood Modelling

Entura were appointed to carry out computer modelling of the water levels and flows at the new bridge location and have prepared a report – The Bridgewater Bridge Flood Hazard Report.

The *Entura* report found that the modelling indicates that the existing causeway is overtopped for all modelled major design flood events. This means that the causeway will overtop in the design 1 in 100 year flood. This will become more frequent, within the design life of the proposed bridge, when climate change is expected to raise water levels by 0.8 metres and 20% more rain is predicted to fall.

For the AEP 1% water levels upstream are anticipated to cause overtopping of the causeway. As the causeway is not to be used for vehicle traffic after the new bridge is completed, future overtopping can be accepted however impacts on downstream erosion should be considered as outlined in the coastal erosion risk report.

Figure 15 – Design bridge sensitivity long sections (Entura)



Additional modelling has been carried out to assess the impact of the new works on the upstream water levels and these show a small, 0.07 metre rise in level while both the existing and new bridge structures remain in place. Following completion of the new bridge construction the existing bridge and approach is to be removed. Following this, upstream levels will fall by a marginal amount, due to the decrease in the number of piers and obstructions from the old bridge.

7. Review of Site-Specific Locations

7.1 General

The New Bridgewater Bridge will not lead to a worsening of the flow regime of the Derwent River, and consequent erosion. However the following Design Criteria, from the PSTR will have an impact:

- The design 1% AEP rainfall and flooding.
- The 20% rainfall increase due to climate change.
- The 0.85 metre climate change sea-level rise.
- Marine storm surge and wave run-up.

It should be noted that the 1% AEP flooding and storm surge are unlikely to coincide and were more appropriately modelled by Entura as 10% AEP flood combined with 1% sea storm state.

The locations of photographs in Section 10 are shown below in Figure

Figure 16 – Photograph Key Map

7.2 Upstream south bank

Photo A

This location carries the important A10 highway which is at a level of 2.5 metres AHD. From the *Entura* report the 1% AEP flood level is 2.19 metres AHD which is below the road level. Future climate change rises in water level will result in flooding, particularly if they coincide with high tides.

7.3 Downstream South Bank

Photo B

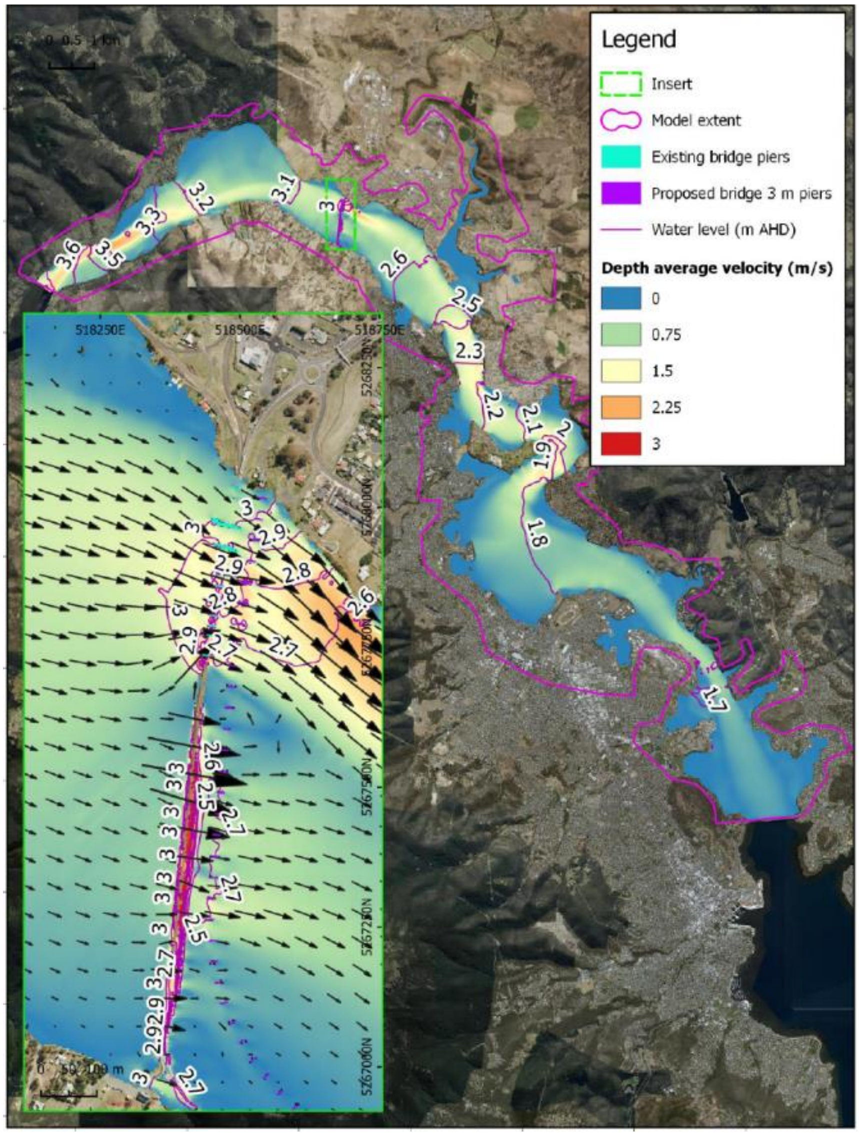
This location includes the existing A1 Highway and the local access road, "Main Road". The existing A1 Highway is to be replaced as part of the proposed New Bridgewater Bridge development and will be raised above present and future flood levels.

7.4 Upstream Causeway

Photo C

The causeway was built over soft sediments from the south bank of the river to the natural deep channel on the north side. Generally, depths on both sides of the causeway are between 0 and -1.0 metres AHD.

Figure 17 –River flows for 1% AEP, future climate (Entura)



The causeway is low-lying and has a lowest crest level of +1.5 metres AHD. While it was not over-topped in the 1960 floods, it will be subject to inundation after future climate change. Entura reports show 0.9 metres of inundation under 1% AEP and 1.6 metres after the 0.85 metre climate change rise.

Following construction of the new bridge the causeway will no longer be needed for road traffic, but will remain in place, particularly as it is a heritage listed structure. However it’s use will be for recreational use only and inundation and any consequent damage is not considered critical.

The New Bridgewater Bridge will not increase the risk of inundation to this area.

7.5 Downstream Causeway

Photo D

The eastern, downstream side of the causeway consists of a rubble beach with extensive reed beds. it was not inundated during the 1960 floods, though the Entura reports show 0.9 metres of inundation under 1% AEP and 1.6 metres after the 0.8 metre climate change rise.

Future inundation will not be affected by the construction or operation of the New Bridgewater Bridge.

7.6 Upstream North Bank

Photo E – View towards bridge from North Bank

The area shown in Photo E appears to be a derelict hop growing farm where there are indications that development is planned. Under existing conditions and 1% AEP flooding inundation of the above low-lying land and Riverside drive occurs. There are other residential properties to the South of Wallace Street and along Riverside Drive which will be subject to inundation under future design conditions.

The results indicate that there will be no increase in the risk of inundation after completion of the New Bridgewater Bridge and demolition of the existing bridge.

7.7 Downstream North Bank

Photo F

The photograph shows a typical waterside location. There do not appear to be any locations at risk of inundation as housing (left from the photograph) is above +3.8 metres AHD.

Photo G

The ramp and jetty shown above are well above water level and will not be affected by current flood levels. This facility is expected to be used by the New Bridgewater Bridge contractor for loading and unloading of construction materials to construct the bridge.

8. Summary and Conclusions

This report addresses the impact of the New Bridgewater Bridge on the inundation of nearby areas, including its construction and ongoing operation.

A review of the site coastal conditions including the influence of tide, wind waves, wave set up and wave runup was undertaken for the project site to assess the likely impact of the New Bridgewater Bridge on the existing and future risk of coastal inundation.

In addition a detailed flood model of the existing and proposed bridge was undertaken by Entura incorporating both 1% AEP flooding of the river in conjunction with highest astronomical tide and sea level rise as well as 10% AEP flooding with 1% AEP sea storm tail water levels.

Future flooding caused by 1% AEP events and exacerbated by climate change water-level and rain intensity increases, is expected to cause increased flooding throughout the Derwent Estuary and River system regardless of the development and has been assessed in detail in the Entura Reports. The 1% AEP produces significantly higher water levels than the sea storm event for both existing and future climates and hence will drive the risk of inundation for the project sites.

As outlined in the Entura Reports the proposed new Bridgewater Bridge will not alter the water levels and hence will not increase the risk for inundation from those events.

The recommendations from the Entura Report should be considered for any areas identified as at risk to future inundation due to flooding. Options may include design for adaptation (i.e. protection and/or raising of the design levels) to limit the requirements for removal or relocation in the event of increased sea levels.

Downstream water levels and consequent inundation are not affected by the Project.

Following completion of the New Bridgewater Bridge and removal of the existing structure there is likely to be a marginal decrease in water levels upstream and no measurable increase in inundation due to the construction or operation of the New Bridgewater Bridge.

The design of the New Bridgewater Bridge should include provision for water level rises anticipated due to climate change and, additionally, for flooding associated with 1% AEP events.