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PROJECT

New Bridgewater Bridge Coastal Erosion Assessment

CLIENT

Department of State Growth

DATE

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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 are James Burbury and review by Martin Scherzic. James is a Principal Engineer and has 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. Martin Schult is a Principal Geotechnical Engineer with over 30 years experience in geotechnical investigations, assessment and design. Martin has undertaken geotechnical assessments of the site with Burbury as part of the development of the reference design for the New Bridgewater Bridge Project.

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1. Introduction

The Department of State Growth (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 the *Land Use Planning Approvals Act 1993* (LUPAA).

This report has been prepared to address Assessment Criteria AC4.4, Coastal Erosion Hazard for the New Bridgewater Bridge Major Project.

The coastal erosion assessment is required to:

- Understand the geotechnical and coastal processes of the Project site.
- Present conclusions based on consideration of the proposed use and development that:
  - (i) determine whether the use or development is likely to cause or contribute to the occurrence of coastal erosion on the project land, adjacent land or public infrastructure;
  - (ii) determine whether the use or development can achieve and maintain a tolerable risk from a coastal erosion event in 2100 for the intended life of the use or development, having regard to:
    - a. the nature, intensity and duration of the use;
    - b. the type, form and duration of any development;
    - c. the likely change in the risk across the intended life of the use or development;
    - d. the ability to adapt to a change in the level of risk;
    - e. the ability to maintain access to utilities and services;
    - f. the need for specific coastal erosion reduction or protection measures on the project land;
    - g. the need for coastal erosion reduction or protection measures beyond the boundary of the project land; and
    - h. any coastal erosion management plan in place for the project land or adjacent land;
  - (iii) include any advice relating to the ongoing management of the use or development; and
  - (iv) determine whether the use or development is located on an actively mobile landform within the coastal zone.

An extensive geotechnical investigation of the site was commissioned by State Growth for the New Bridgewater Bridge Project and undertaken by pitt&sherry (2020). In addition, extensive marine sediment sampling and contamination testing was completed as part of the project investigations (Marine Solutions and pitt&sherry) which provides a thorough understanding of the geotechnical conditions of the Project Land and surrounds.

Coastal erosion hazard mapping prepared by the University of Tasmania for the Department of Premier and Cabinet in 2016 (accessed via ListMAP) indicates areas within and adjacent to the Project Land which are at risk due to erosion (shown in Figure 3 below). These areas have been reviewed on site as well as in the context of responding to the above risk review of coastal erosion with respect to both construction and operations.

This report reviews the impact of erosion of littoral areas due to 1% AEP rainfall, storm surge coastal processes 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 hazard potential of the project on adjacent areas in any material way, as well as the coastal erosion impact of 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
10	Coastal Hazards in Tasmania, Summary Report of Coastal Hazards Technical Report	Department of Premier and Cabinet, Tasmania	December 2016
11	Guidelines for Developing a Coastal Hazard Assessment	Vic Govt	Aug 2017
12	New Bridgewater Bridge, Coastal Inundation Hazard Report	Burbury	August 2021
13	Bridgewater Bridge Replacement Project Geotechnical Factual Report	Pitt&sherry	November 2020
14	Bridgewater Bridge Geotechnical Investigations	Pitt&sherry	November 2020
15	Bridgewater Bridge Project Geoheritage Impact Assessment	ERA Planning and Environment	August 2021

1.2 Glossary

Annual Exceedance Probability (AEP) A measure of the likelihood (expressed as a probability) of a flood or wind event 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).

State Growth 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. Emergency Management Australia River Derwent Flood Data Book

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.

2. Project Site

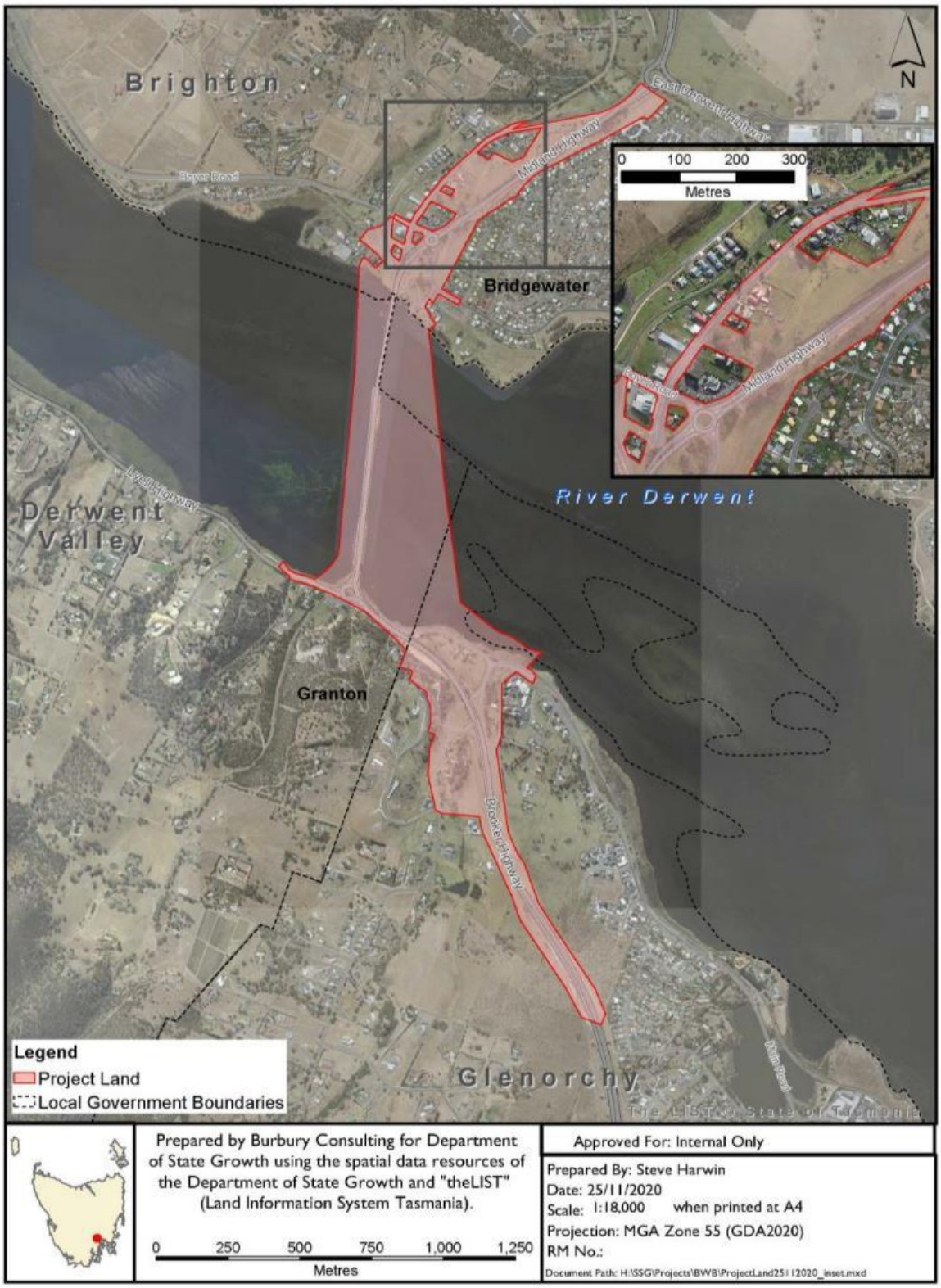
The River Derwent is the major freshwater inflow to the Derwent Estuary, a highly stratified, drowned river system. The Estuary extends over 52kms from the Iron Pot in Storm Bay inland to New Norfolk. Tidal influences are notable past New Norfolk up to *The Rocks* just downstream from Lawitta.

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 (the Project Land).

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 the following elements.

- 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 the following works.

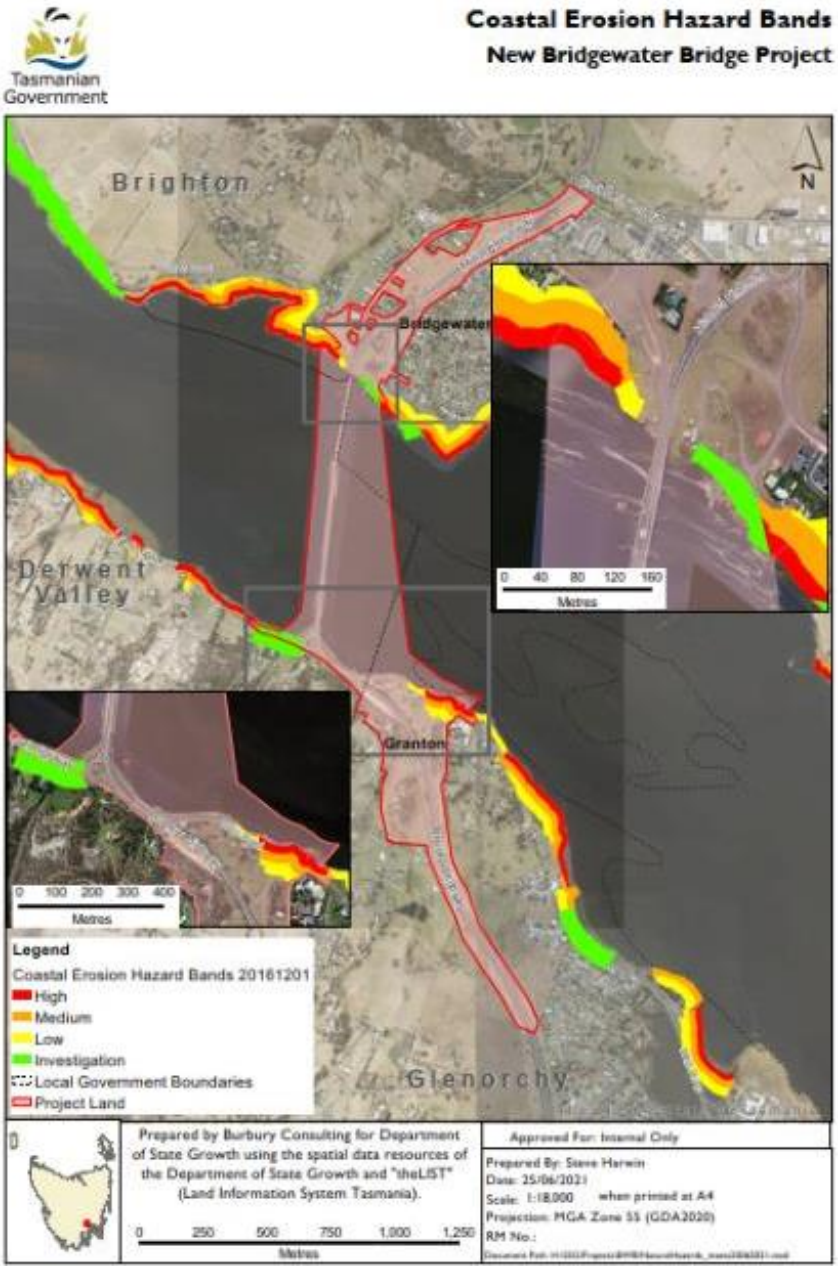
- Temporary works including access structures, hardstands and piled structures for the construction of the bridge substructure and superstructure.
- Formation of new bridge abutments landside of the river (Granton and Bridgewater).
- Piling works within the waterways including concrete pile caps and 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 Coastal Conditions

As an upper estuary, the site within the Project Land is generally less exposed to coastal processes of wind waves, swell waves, tide, storm surge and currents and more exposed to flood and inundation from flooding.

Figures 3, below, shows the erosion mapping from LIST of the existing Bridgewater Causeway and Bridge and Project extents. The mapping of erosion hazard bands was developed to provide an indication of the risks to communities from natural hazards (coastal erosion, recession, inundation and landslide). The assessment generally combines reviews of the existing natural landform levels, coastal shoreline geotechnical and river geomorphology and natural hazards.

Figure 3 – Project Site Coastal Erosion Extents



The mapping indicates that the Project Land is generally limited to risk of coastal erosion with localised risk areas to the south side of the river and to the east of the existing bridge, where there is a low-lying area and exposed shorelines on the northern bank consisting of clayey-gravelly shores prone to slumping and progressive erosion (theList, Coastal Vulnerability Layer).

The River Derwent is naturally deeper to the north and the fetch from the south west is largest hence those areas mapped on the northern bank from theList in Figure 3 are considered to be at risk from storm erosion and natural recession. The risk of erosion of the river bank to flooding between the causeway and the northern bank is also a key consideration of the site.

The southern riverbank (Granton) is well protected from wind driven waves and flooding due to the causeway from the north and the shallow.

The existing causeway is not currently mapped as being at risk of coastal erosion but is at risk of inundation. It is understood that on completion of the New Bridgewater Bridge the existing Bridgewater Bridge and causeway is not expected to support any vehicular traffic. However, it may serve for pedestrian access and recreational use.

The risk of impact and exposure of the area to coastal erosion during the construction has been assessed based on the corridor of works identified in Figure 3. This will be generally limited to existing natural risks to erosion as well as increased impact from temporary works and higher intensity of marine vessel traffic.

3.1 Coastal Dunes

The proposed New Bridgewater Bridge will not be constructed on any form of coastal dune.

The site is a river estuary and no primary frontal dune exists on the shorelines as well as no evidence on site or through historical aerial photographs of sediment accretion and recession due to long term coastal processes.

As highlighted in the geoheritage, geotechnical and aquatic site assessment reports within the MPIS, the causeway provides a sedimentation barrier for river and tidal flows resulting in large mudflats with submerged vegetation.

The causeway provides a barrier to tide, flood and wave action.

3.2 Wind and Wave Effects

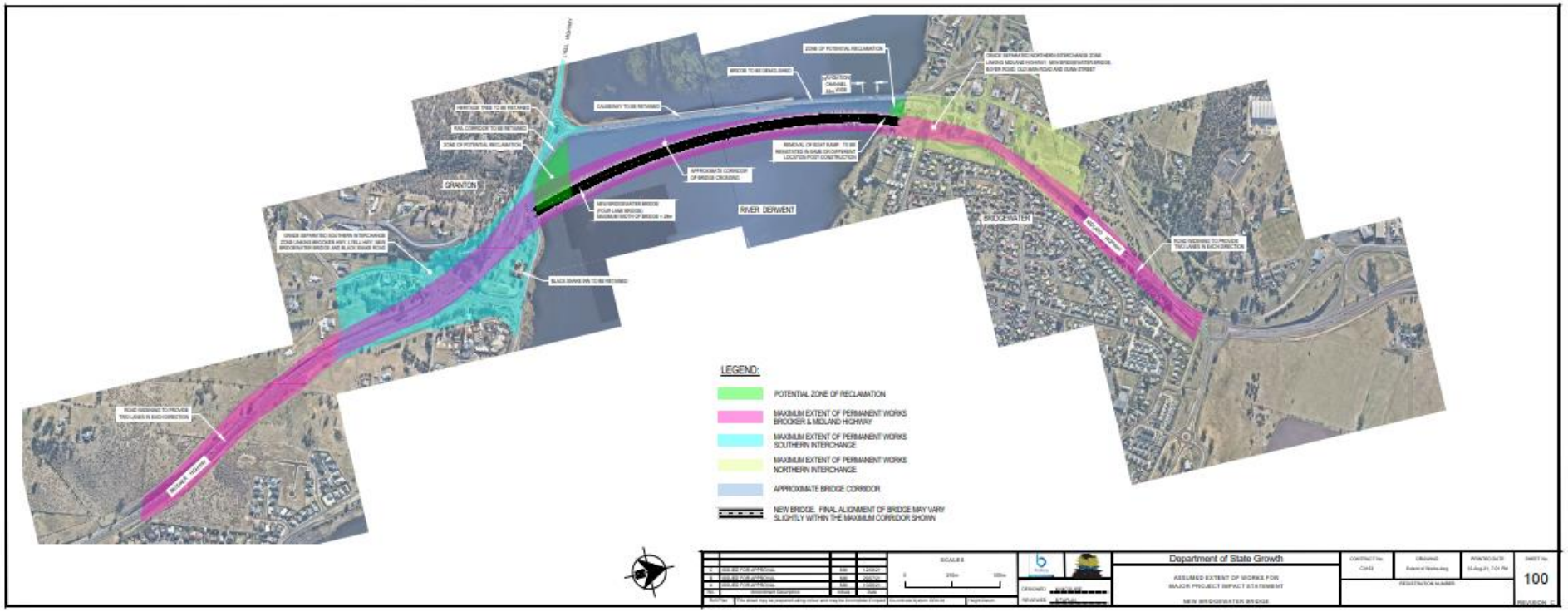
The river, in this location, is protected from swell waves and the site is only exposed to wind generated waves or vessel waves passing through the main navigation channel.

The maximum fetch of open deep water to the southwest of the Project site is approximately 2 kilometres. If a sustained wind from that direction is maintained, coinciding with a high tide and elevated water levels, then the existing river banks are exposed to wind wave erosion. This is evident from our site inspection of the river banks on the northern side and downstream face of the causeway (refer photos further in this report).

The riverbanks appear stable under the current scenario and there is no evidence of recent erosion. Changes in water levels due to climate change will result in greater levels of embankment and river exposure which may require remedial measures to protect residential and other property. This is a function of future climate conditions and not due to the development of the New Bridgewater Bridge.

The New Bridgewater Bridge piers, piles and pile caps that are constructed within the waterway downstream of the causeway (as highlighted in Figure 4) will act as a wave energy dissipator to waves from the south.

Figure 4 – Nominal Bridge Footprint within Project Extents



4. Flood Impacts on Erosion

Entura (August 2021) have completed an extensive assessment of the 1 per cent AEP flood hazard arising from construction and operation of the New Bridgewater Bridge.

During construction and prior to the demolition of the existing bridge, water levels are predicted to rise by 0.07 metres (Entura, August 2021) which will cause a modest increase in current flows in the event of a flood. However, following demolition of the existing bridge, there will be no increase in current flows or erosion due to the New Bridgewater Bridge.

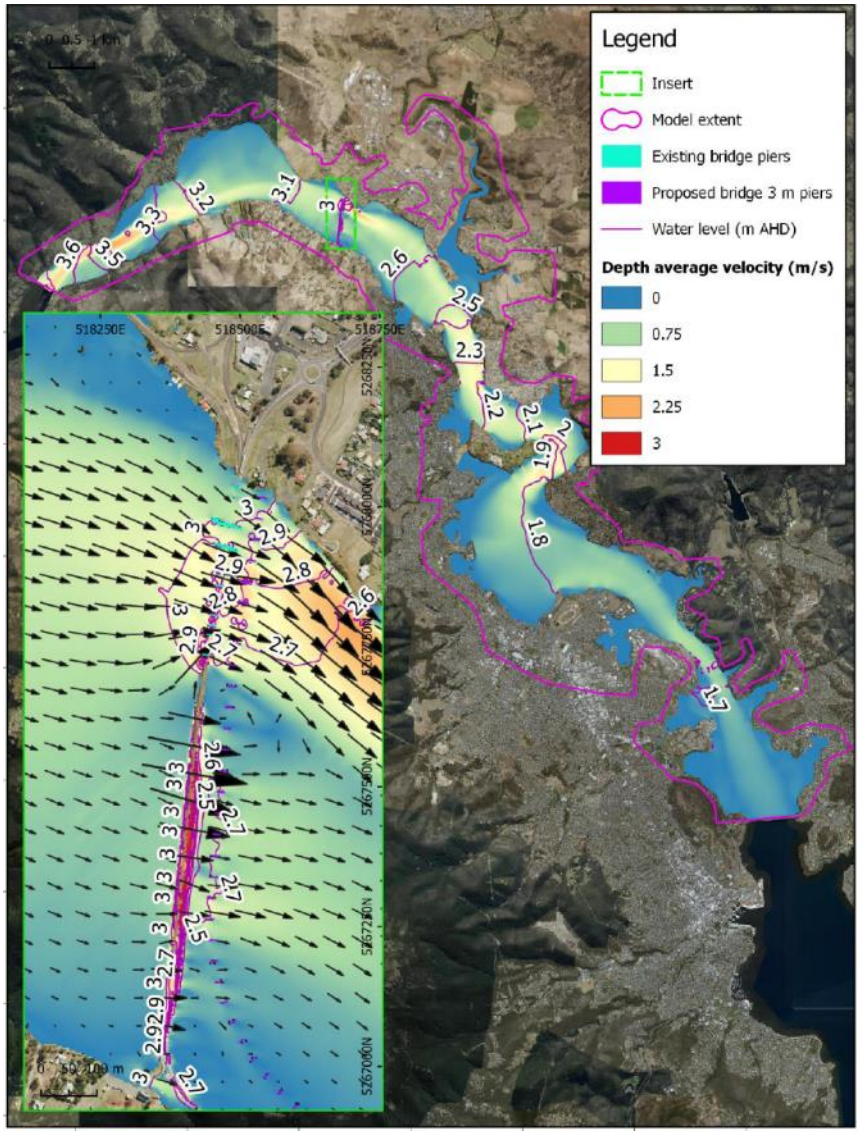
The River Derwent Flood Data Book by the Department of Primary Industries, Parks, Water and the Environment (DPIPWE) has recorded historical flood levels in the River Derwent utilising data from photographs and recorded levels. The last major flood was recorded in 1960 and records show water levels at the Norske Skog paper mill (12 km 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 5 – Derwent River Catchment

Figure 6 - River Flows for 1% AEP Future Climate



It is believed that the causeway has not been over-topped even in the extreme 1960 floods, but is expected to do so during the design life of the New Bridgewater Bridge with increased of sea levels.

A flow of 3,100 cumecs was recorded, in 1960, at Macquarie Plains, some 25-30 kilometres upstream, which is considered equivalent to the future climate 1% AEP flow of 4,240 cumecs at Bridgewater. As the causeway will remain in place it will continue to obstruct the river flow. This means that the accelerated flows at the location of the existing bridge will continue.

5. Site Geotechnical Review

The Causeway was originally constructed with 1.8 million m^3 of quarried rock and clay and has been raised on a number of occasions since formation in response to localized settlement. As shown in photograph A the visible surface is a mixture of rubble, gravel and reed beds. The bulk of the causeway is considered to be well-compacted and reasonably resistant to erosion, particularly at high tides and with future sea level rises.

On the south bank the slopes of the shoreline appear similar to the causeway and this would be logical as the roads (Main Road, Brooker Highway and Lyell Highway) are constructed on reclaimed land.

The northern riverbanks appear to be in a more natural state, with mostly a stable profile. Close to Nielsen Parade there is some additional rubble protection, indicated by the presence of angular rock fragments.

The southern existing bridge abutment shows indications of settlement. Following demolition of the existing bridge, the abutments may be subject to erosion and consequent failure in the event of a major flood event. This will form part of the bridge demolition, removal and rehabilitation plan.

Excluding the existing causeway and bridge, the Project Land is generally undisturbed and in natural form.

New structures proposed for the New Bridgewater Bridge include the following.

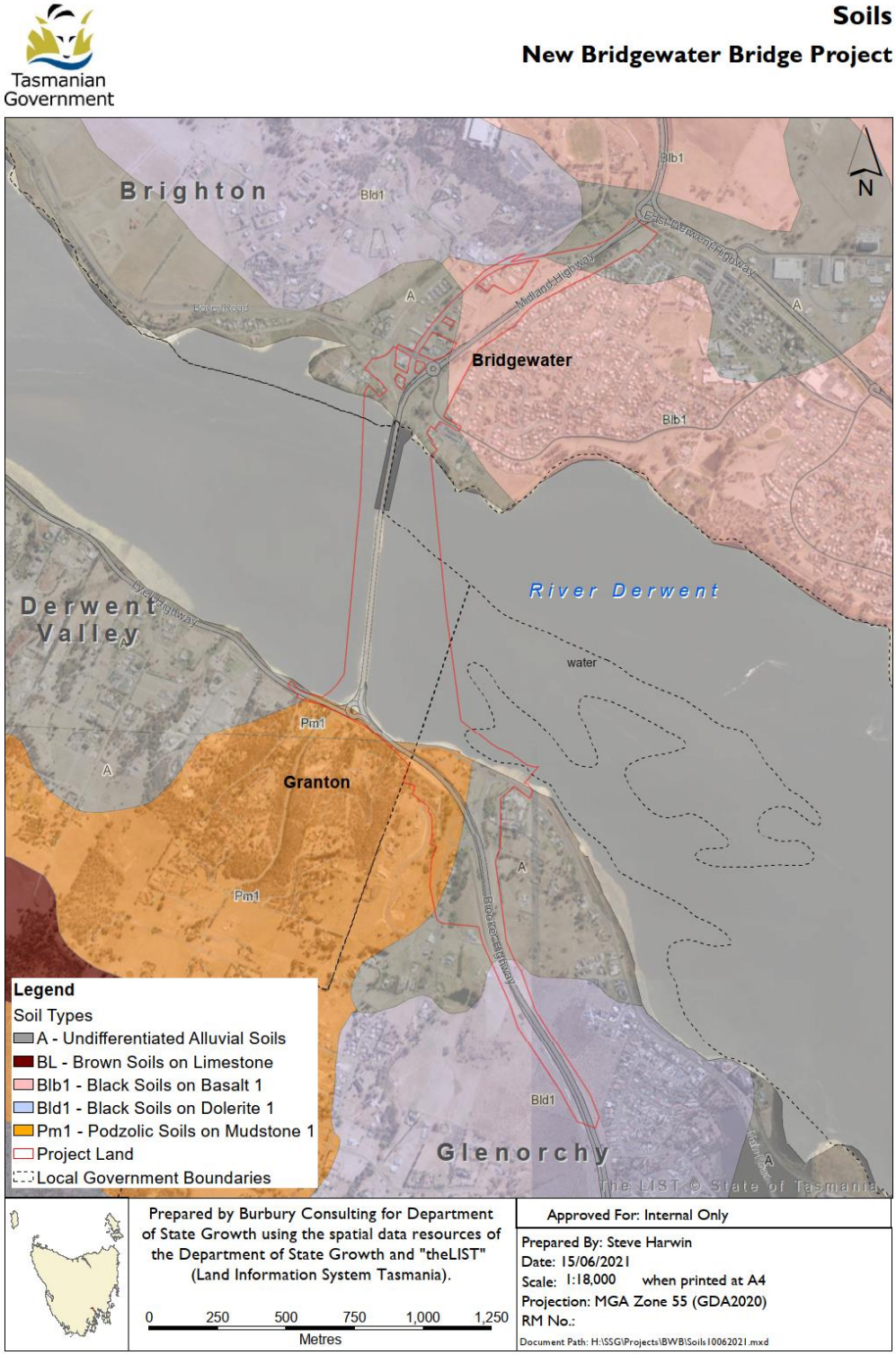
- Bridge piers within the River Derwent.
- New bridge abutments on either shore banks.
- New shoreside work platforms for construction access.
- Temporary works structures installed for the duration of the construction works only and removed at the completion of the works.

The structures will be designed to support themselves within the natural environment with the bridge supported on driven piles and connections to the existing roadways through shoreside abutments and earthworks for roads and junctions.

The New Bridgewater Bridge structure will not be impacted by sea level rise in that the design for the bridge and new roads will all be founded above extreme water levels including sea level rise impacts.

The existing causeway and low lying roads will still be subject to increased risks of sea level rise and subsequent inundation from flooding which are existing risks of the current road and river crossing. The rehabilitation of the existing bridge removal will need to be considerate to the future use of the causeway and future mitigations of the site may require additional shore protection in response to sea level rise. These are not immediate risk management strategies but commonly considered as mitigation and management for adaptation.

Figure 7 - Project Site Soils Mapping



6. Risk of Erosion of Site

6.1 General

The Causeway may be subjected to fast-flowing currents in two ways:

- When overtopped by flooding.
- At its' northern end where the flow is concentrated through the causeway and river bank.

The southern riverbank is in a shallow and slow flowing area and while it will be subject to flooding in the future, adjacent current flows are low and erosion is not expected to be of concern.

The northern bank is subject to flooding and faster currents and parts of the shoreline are low-lying.

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

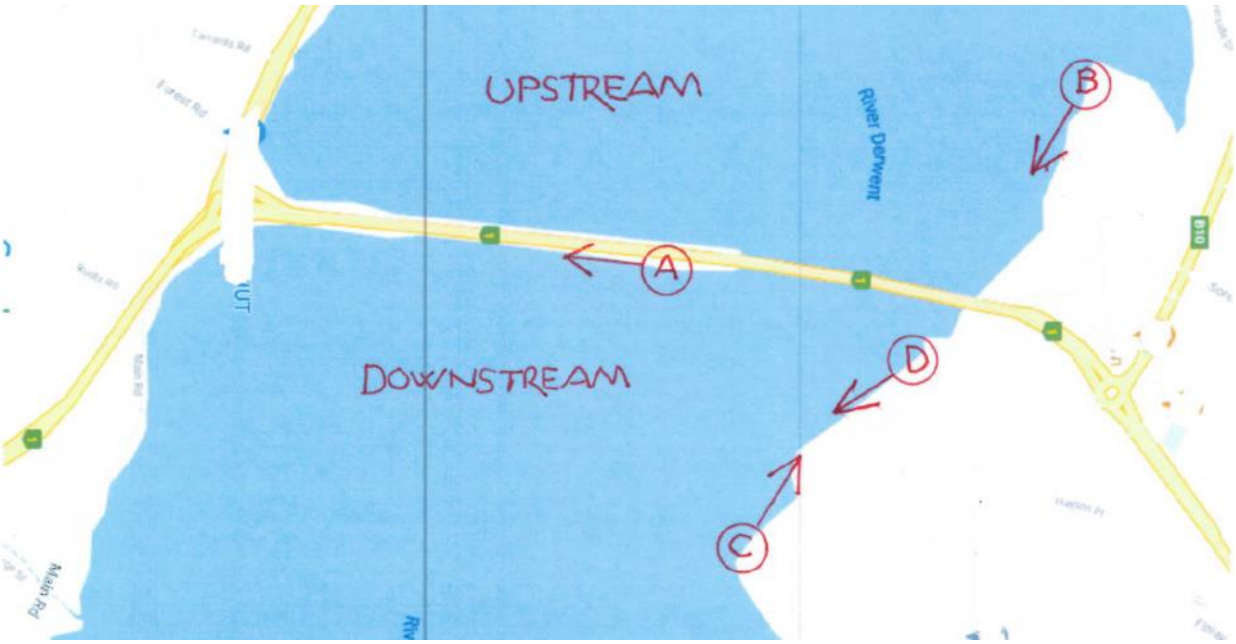
- The possible rainfall increase due to climate change including the design 1% AEP rainfall and resultant flooding.
- The expected sea-level rise of 0.8 metres due to climate change.
- Marine storm surge.

None of the above are factors introduced by the new bridge.

It should be noted that the 1% AEP flooding and storm surge are unlikely to coincide and that a report completed by Entura, *New Bridgewater Bridge Flood Hazard Report, 2021*, considers that event.

Locations of photographs referred to in this Section are shown in Figure 9 below:

Figure 8 – Plan showing Location of Photographs



6.2 Causeway Over-topping

Photograph A – Downstream side of Causeway, Looking South

Entura (2021) predicts overtopping of the causeway in a 1% AEP flood and a differential level in excess of 0.5 metres, with associated velocities of up to 2.9 metres/sec.

This is likely to cause erosion of the downstream embankment and, in the case of extended or repeated flooding, may lead to a breach.

In any case construction of the New Bridgewater Bridge will not exacerbate the possible erosion as flow velocities will not be increased after completion of the New Bridgewater Bridge and demolition of the existing bridge.

6.3 Upstream North bank

Photograph B – North Bank, Looking East

6.4 Downstream North Bank

Photograph C – North Bank, Looking West

Photograph D – North Bank, Looking East

Flow is accelerated in this location and, due to the restriction in the river from the Causeway, currents of up to 6 knots are predicted. In conjunction with the raised levels due to inundation some erosion is to be anticipated under the future climate scenario.

The erosion in this area will not be exacerbated by the New Bridgewater Bridge, once the existing bridge has been demolished. However further measures are likely to be necessary to mitigate erosion of the riverbank in this location due to climate change.

7. Summary and Conclusions

This assessment reviewed the impact of the New Bridgewater Bridge and its' construction on the coastal erosion of the Project Land and nearby areas of the River Derwent.

Future flooding caused by 1% AEP events will be exacerbated by climate change water-level and rain intensity increases. These are expected to cause increased flooding throughout the Derwent Estuary and River Derwent, but it should be noted that these are pre-existing conditions that will occur even without the new bridge.

Because of this, regardless of the proposed new bridge, future coastal control and mitigation measures may be required in localised areas as adaptation measures that may be impacted from sea level rise and increased flooding impacts but these events will not be increased due to the Project.

Following demolition of the existing bridge, water levels and consequent river flow velocities will not be impacted by the Project.

Our assessment of the site coastal hazards and the proposed infrastructure associated with the New Bridgewater Bridge concludes that there will be no measurable increase risk in erosion of the coastal areas the planned works are constructed on or adjacent to due to the construction or operation of the New Bridgewater Bridge for the intended design life.

The risk to the existing causeway and old bridge abutments may increase with sea level rise and greater exposure to inundation, wave erosion and flood erosion effects. Shore protection structures such as placement of boulders, managed vegetation and backfilling to exposed areas can be an appropriate adaption measure in the future when sea levels increase however this should be considered in conjunction with the wider region for management controls. The adaptation will not increase the risk or change the risk from the proposed New Bridgewater Bridge structures.

An adaptation management plan to sea level rise of the existing causeway and shoreline abutment areas should be considered as part of the rehabilitation plan for the site.

Any new shoreline reclamation or building pads constructed into the waterways should be armoured with appropriate rock protection to minimse the risk of erosion within from waves, stormwater or flooding.

Temporary structures for the construction of the bridge should be designed for the site coastal conditions.