COASTAL VULNERABILITY ASSESSMENT

1 Hayfield Place,
Bridgewater

CLIENT

Multi-Res Builders

June 2022

Updated: February 2025

Tables

Figures

DOCUMENT CONTROL

Title	Version	Date	Author	Reviewed By
Coastal Vulnerability Assessment: Nielsen Esplanade, Bridgewater, Tasmania	Version 1	November 2017	Kris Taylor	JP Cumming
Coastal Vulnerability Assessment: 14 Nielsen Esplanade, Bridgewater, Tasmania	Version 2	November 2021	J Traynor	JP Cumming
Coastal Vulnerability Assessment: 1 Hayfield Place, Bridgewater, Tasmania	Version 3	February 2022	J Traynor	JP Cumming
Coastal Vulnerability Assessment: 1 Hayfield Place, Bridgewater, Tasmania	Version 4	June 2022	J Traynor	JP Cumming
Coastal Vulnerability Assessment: 1 Hayfield Place, Bridgewater, Tasmania	Version 5	February 2025	V Gupta	JP Cumming

Executive Summary

Geo-Environmental Solutions Pty Ltd (GES) were contracted by Prime Design to prepare a coastal vulnerability assessment for a proposed works at Bridgewater, Tasmania. The project area consists of a single cadastral title (CT 176642/3) located at 1 Hayfield Pl Bridgewater 7030. (The Site).

An application to conduct construction works has triggered the assessment in accordance with the Tasmania Planning Scheme (TPS) – Brighton City Council and following of the Director's Determination for Coastal Erosion and Inundation areas which provides building requirements for building and demolition work in coastal erosion and inundation hazard areas.

The proposed works involve multiple units of varying sizes, along with a new driveway, located within low coastal inundation and low to medium coastal erosion overlays, as per the Tasmanian Planning Scheme for Brighton Council.

A coastal erosion and inundation assessment has been conducted for the site area which involved an assessment of coastline hydrodynamics and erosion processes.

GES has conducted a site assessment to evaluate the potential risks of sea level rise associated with the proposed constructions. It has been determined that, based on the 2100 high emissions scenario (1% Annual Exceedance Probability), stillwater levels could rise up to 2.46meters above Australian Height Datum (AHD). The proposed finished floor levels for the proposed development should be designed above the flood level with 300mm free board. The habitable finished floor level of the proposed units within a coastal inundation overlay must be constructed at or above ***2.6 m AHD*** in accordance with the TPS – Brighton Council in Table C11.1 Minimum Level for the Coastal Inundation Low Hazard Area.

The site investigation has identified the presence of clay material, which is susceptible to erosion. However, most of the material on the site is not prone to erosion. The more resilient layers above the clay will provide significant protection, preventing excessive erosion of the underlying clays.

Rubble fill present around the existing residence will also provide considerable resilience, however whilst it is low lying, it will be vulnerable to wave runup. Shoreline recession and wave runup has been determined for the site based on a 2100 scenario which allows time for the site to be fully developed and for the projected life of the use. Based upon the current assessment the proposal represents a tolerable risk from coastal erosion for the life of the development and use.

List of Abbreviations

AHD(83)	Australian Height Datum
AEP	Annual Exceedance Probability
CEM	Coastal Engineering Model
CEHC	Coastal Erosion Hazards Code
CIHC	Coastal Inundation Hazards Code
DCP	Dynamic Cone Penetrometer
DEM	Digital Elevation Model
DPAC	Department of Premier and Cabinet
ERMP	Erosion Risk Management plan
GES	Geo-Environmental Solutions Pty Ltd
GIS	Geographical Information System
IPCC	Intergovernmental Panel on Climate Change
TPS	Tasmania Planning Scheme
LiDAR	Light Detection And Ranging
LIST	Land and Information System, Tasmania
MRT	Mineral Resources Tasmania
NCCOE	National Committee on Coastal and Ocean Engineering
SB	Soil Bore
SPM	Shoreline Protection Manual
SSP	Surf Similarity Parameter
SWAN	Simulating Waves Nearshore
TAFI	Tasmanian Aquiculture and Fisheries Institute
WRL	Water Research Laboratory (University of New South Wales)

1 Introduction

Geo-Environmental Solutions Pty Ltd (GES) were contracted by Prime Design to prepare a coastal vulnerability assessment for a proposed works at Bridgewater, Tasmania. The project area consists of a single cadastral title (CT 176642/3) located at 1 Hayfield Pl Bridgewater 7030. (The Site).

An application to conduct construction works has triggered the assessment in accordance with the Tasmania Planning Scheme (TPS) – Brighton City Council and following of the Director's Determination for Coastal Erosion and Inundation areas which provides building requirements for building and demolition work in coastal erosion and inundation hazard areas.

GES have undertaken this assessment using available scientific literature and datasets. Estimations are determined by approximation with appropriate regional information applied where appropriate to site specific information. Data collection and site-specific modelling was undertaken in assessment of the site

2 Objectives

The objective of the site investigation is to:

- Identify which codes need to be addressed in terms of coastal vulnerability and identify the performance criteria relevant to the project which need addressing;
- Conduct a literature review of all geological, geomorphologic, hydrodynamic information and any erosion or inundation assessments which are relevant to the site;
- Review hydrodynamic assessments of the local area to determine projected sea level rise, storm tides and site-specific hydrodynamic conditions and where applicable, GES's site-specific soil investigation findings;
- Conduct a detailed erosion assessment of site erosion vulnerability in terms of long-term beach recession and short-term storm erosion.
- Conduct a site risk assessment for the proposed development ensuring relevant performance criteria are addressed; and
- Where applicable, provide recommendations on methods and design approach to reduce inundation and erosion impact.

3 Site Details

3.1 Project Area Land Title

The land studied in this report is defined by the following title reference:

- CT 176642/3 (1 Hayfield Place)

This parcel of land is referred to as the 'Site' and/or the 'Project Area' in this report.

3.2 Project Area Regional Coastal Setting

The Project Area is located on Woods Point on the banks of Derwent River about 20km north of Hobart (Figure 1). The site is subject to the following hydraulic influences:

- Wind fetch across the river Derwent from the west, southwest and the south and the following:
    - Wave setup; and
    - Wave run-up
- Sea level rise;
- Tides and associated water currents; and
- Fluvial flooding.

3.2.1 Proposed works

The project site spans approximately 1.88 hectares and is currently vacant land block. The proposed development includes the construction of various types of units, along with a new driveway access from Gunn Street.

The proposed development site has an elevation range of approx. 2.5 m to 4 m AHD. The site's elevation varies, along the southern portion of the site at 2-2.5m AHD (Australian Height Datum) and rising to 4m AHD towards the northwest and northeast side of the boundary. The contours for the site were exported from Greater Hobart 2013 Lidar data using Qgis software.

Plans for the proposed works have been provided to GES from the Prime Design (Project No: PD23113-01, Dated: 21/06/2024). The plans are presented in Figure 2.

Figure 1   Location of the Project Area

GENERAL NOTES:
- CHECK & VERIFY ALL DIMENSIONS & LEVELS ON SITE
- WRITTEN DIMENSIONS TO TAKE PREFERENCE OVER SCALED
- ALL WORK TO BE STRICTLY IN ACCORDANCE WITH NCC 2022, ALL S.A.A. CODES & LOCAL AUTHORITY BY-LAWS
- ALL DIMENSIONS INDICATED ARE FRAME TO FRAME AND DO NOT ALLOW FOR WALL LININGS
- CONFIRM ALL FLOOR AREAS
- ALL PLUMBING WORKS TO BE STRICTLY IN ACCORDANCE WITH A.S. 3500, NCC 2022 & APPROVED BY COUNCIL INSPECTOR
- BUILDER/PLUMBER TO ENSURE ADEQUATE FALL TO SITE CONNECTION POINTS IN ACCORDANCE WITH A.S. 3500 FOR STORMWATER AND SEWER BEFORE CONSTRUCTION COMMENCES
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE ENGINEER'S STRUCTURAL DRAWINGS
- ALL WINDOWS AND GLAZING TO COMPLY WITH A.S. 1288 & A.S. 2047
- ALL SET OUT OF BUILDINGS & STRUCTURES TO BE CARRIED OUT BY A REGISTERED LAND SURVEYOR AND CHECKED PRIOR TO CONSTRUCTION
- IF CONSTRUCTION OF THE DESIGN IN THIS SET OF DRAWINGS DIFFER FROM THE DESIGN AND DETAIL IN THESE AND ANY ASSOCIATED DOCUMENTS BUILDER AND OWNER ARE TO NOTIFY DESIGNER
- BUILDER'S RESPONSIBILITY TO COMPLY WITH ALL PLANNING CONDITIONS
- BUILDER TO HAVE STAMPED BUILDING APPROVAL DRAWINGS AND PERMITS PRIOR TO COMMENCEMENT OF CONSTRUCTION
- CONSTRUCTION TO COMPLY WITH AS 3959, READ IN CONJUNCTION WITH BUSHFIRE ATTACK LEVEL (BAL) ASSESSMENT REPORT.

IMPORTANT NOTE:
DRAWINGS CAN BE READ IN BLACK & WHITE, HOWEVER ARE BEST PRINTED IN FULL COLOUR FOR OPTIMUM CLARITY. A COLOUR COPY SHOULD BE RETAINED ON SITE AT ALL TIMES FOR CONTRACTORS COMPLETING WORKS.

NOTE: DIMENSIONED BOUNDARY OFFSETS TO THE PROPOSED BUILDING ARE TO THE EXTERNAL CLADDING U.N.O.

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Shop 9, 105-111 Main Road, Moonah Hobart 7009
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info@primedesigntas.com.au primedesigntas.com.au

Project: PROPOSED RESIDENTIAL DEVELOPMENT 1 HAYFIELD PLACE, BRIDGEWATER
Client name: CENTACARE EVOLVE HOUSING
Drawing: SITE PLAN
Drafted by: Author
Approved by: Approver
Date: 21-06-2024
Scale: 1 : 500@A1
Project/Drawing no: PD23113 -01
Revision: 06
Accredited building practitioner: Frank Geskus -No CC246A

Figure 2 Site Plan

4 Planning

4.1 *Australian Building Code Board*

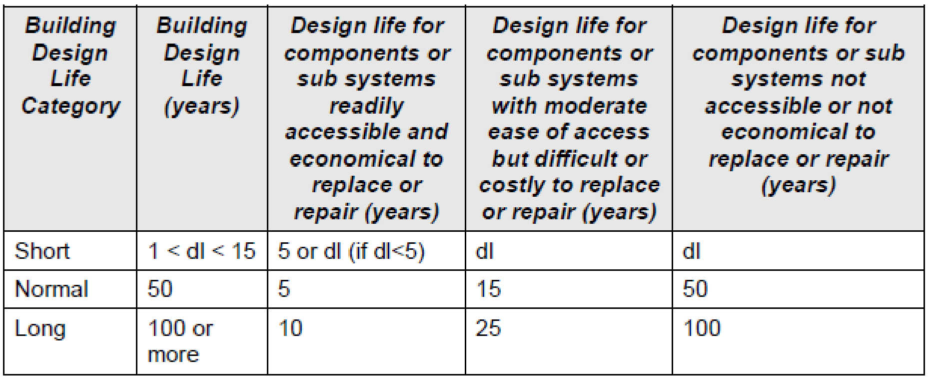
This report presents a summary of the overall site risk to coastal erosion and inundation processes. This assessment has been conducted for the year 2080 which is representative of a ‘normal’ 50-year building design life category plus considerable leeway given to allowance for construction time (ABCB 2015).

Per the Australian Building Code Board (ABCB 2015), when addressing building minimum design life:

> *‘The design life of buildings should be taken as ‘Normal” for all building importance categories unless otherwise stated.’*

As per Table 3-1, the building design life is 50 years for a normal building.

Table 3-1 Design life of building and plumbing installations and their components



Building Design Life Category	***Building Design Life (years)***	***Design life for components or sub systems readily accessible and economical to replace or repair (years)***	***Design life for components or sub systems with moderate ease of access but difficult or costly to replace or repair (years)***	***Design life for components or sub systems not accessible or not economical to replace or repair (years)***
Short	1 < dl < 15	5 or dl (if dl<5)	dl	dl
Normal	50	5	15	50
Long	100 or more	10	25	100

Note: Design Life (dl) in years

4.2 *The Tasmanian Building Regulations 2016*

Division 4 - Coastal erosion. Section 58. Works in coastal erosion hazard areas

(1) A person must not perform work in a coastal erosion hazard area unless he or she is authorised to do so under the Act.

(2) If a person intends to perform work in an investigation area of a coastal erosion hazard area, the person must, before performing the work, ensure that the land is classified in accordance with the coastal erosion determination (a) as being an acceptable risk;

(3) A responsible person for work being performed in a coastal erosion hazard area must ensure that the work is being performed in accordance with the Act and the coastal erosion determination.

(4) A person performing work in a coastal erosion hazard area must ensure that the work complies with the Act and the coastal erosion determination.

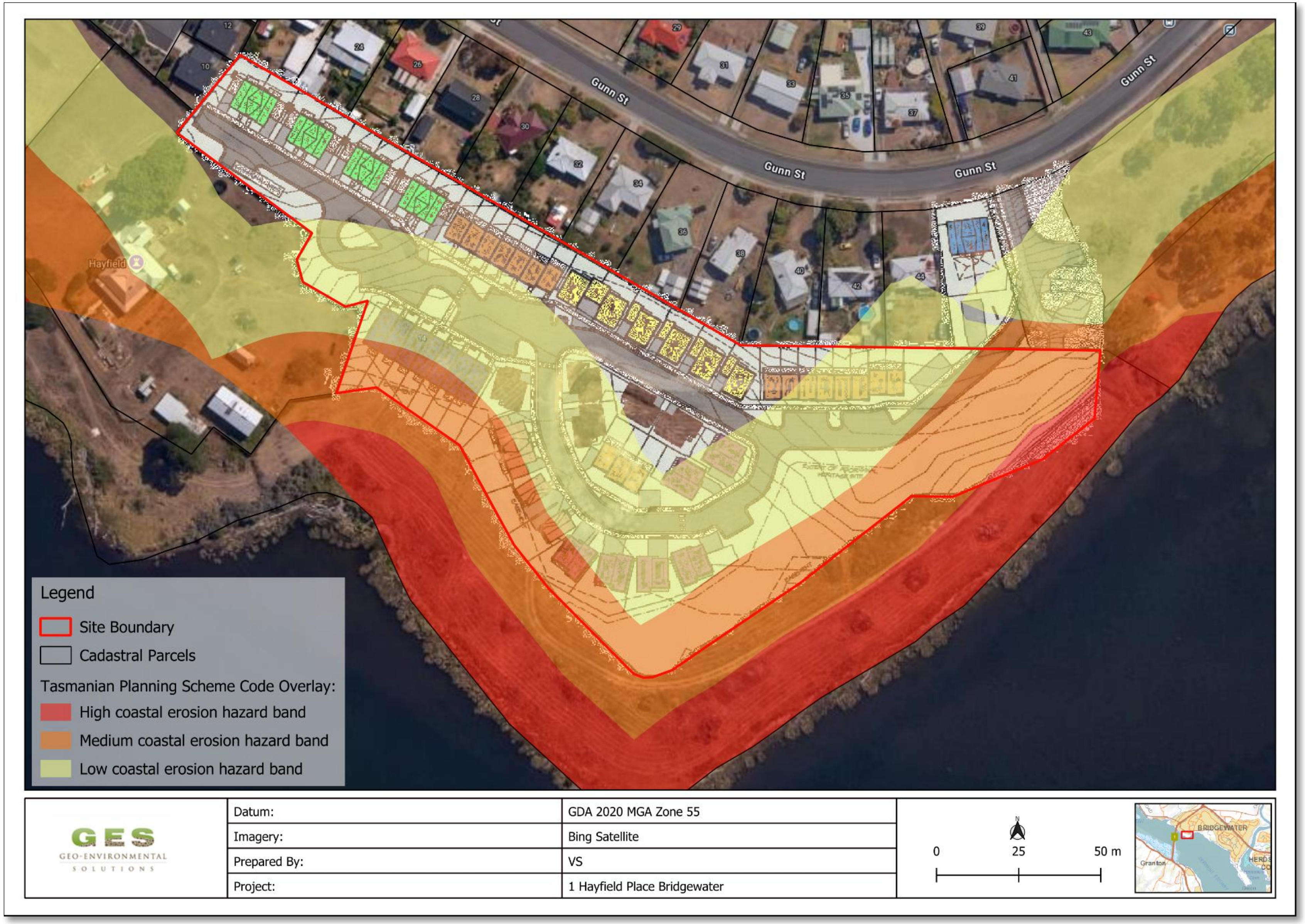
4.3 *Planning Scheme Overlays*

4.3.1 Coastal Erosion Hazards Code (CEHC) Overlay

A portion of the site is within the low (yellow) and the medium (orange) Coastal Erosion Hazards Code (CEHC) overlay (Figure 3).

4.3.2 Coastal Inundation Hazards Code (CIHC) Overlay

The site is within the low (yellow) Coastal Inundation Hazards Code (CIHC) overlay (Figure 4).



Datum:	GDA 2020 MGA Zone 55
Imagery:	Bing Satellite
Prepared By:	VS
Project:	1 Hayfield Place Bridgewater

Figure 3 CEHC Overlay near the Site (The LIST)

Figure 4 CIHC Overlay near the Site (The List)

4.4 Development and Works Acceptable Solutions

Where applicable, the need for further performance criteria compliance is summarised in Appendix 2.

4.4.1 Coastal Erosion Hazards Code (CEHC)

Given that part of the development resides in the CEHC area, and there are no acceptable solutions for buildings and works in a CEHC area, the C10.6.1 P1 performance criteria will need to be addressed.

4.4.2 Coastal Inundation Hazards Code (CIHC)

Given that part of the development resides in the CIHC area, and there are no acceptable solutions for buildings and works in a CIHC area, the C11.6.1 P1 performance criteria will need to be addressed.

As per Tasmanian Planning Scheme – Brighton Council requirements for the minimum level of the habitable rooms finished floor for the site in Bridgwater the 1% AEP flood level for 2100 with freeboard is defined at ***2.6 m AHD.***

4.5 Performance Criteria

The following performance criteria need to be addressed:

- C10.6.1 P1.1
- C11.6.1 P1.1

5 Desktop Site Assessment

5.1 Previous studies

5.1.1 Smartlines

'Smartline mapping has primarily been used in the creation of the hazard band overlays' in terms of classifying the shoreline into one of three types' (Sharples et. al. 2013):

- Unconsolidated soft sediments – sand, mud, gravels. Comprise of very loose clasts which generally show very little or no induration or lithification and are thus very susceptible to erosion;
- Soft rock substrates – semi lithified sediments and deeply weathered bedrock including Tertiary aged cohesive clay sediments, soft mudstone sequences and well podsolised Pleistocene sands. These are cohesive enough to form cliffs; and
- Platforms, sloping ramps or vertical cliffs of hard well lithified bedrock.

According to Smartlines, the site is classified as comprising of:

- Moderately to steep slopping soft bedrock
- Soft bedrock with or without soil – both backshore proximal and backshore distal
- Geology comprising or semi lithified undeformed clastic sediments (dominantly siliceous);
- A muddy coastal re-entrant muddy shoreline.

5.1.2 The LIST – Shoreline Classification

The LIST classifies the site in terms of one or a few the following coastal vulnerability substrates:

- Rocky shores;
- Soft Shores;
- Clayey Shores;
- Unclassified Shores

The following are defined at the site based on these layers:

- Soft Shore - Muddy shores backed by harder bedrock – limited potential vulnerability to erosion, depending on backshore bedrock type;
- Clayey Shore - Sloping clayey-gravelly shores – prone to slumping and / or progressive erosion

5.1.3 The LIST – Costal Erosion Component

Site low hazard band - Recession (S3) to 2100 Low hazard zone (sheltered soft sed. shore) - to possible natural recession limit

Site medium hazard band - Recession (S3) to 2050 Med hazard zone (sheltered soft sed. shore) - to possible natural recession limit

5.2 Site Geology

To assist in determination of the vulnerability of the site to erosion from coastal processes, it is important to determine the geological and geomorphological characteristics of the site in Bridgwater.

Geological mapping of surface geology is available from Mineral Resources Tasmania. Based on the MRT 1:25,000 scale geology map ‘New Norfolk”, indicates the site is underlain by Undifferentiated Quaternary sediments.

- Map Unit: Qpad - Older alluvium of river terrace, predominantly dolerite derived

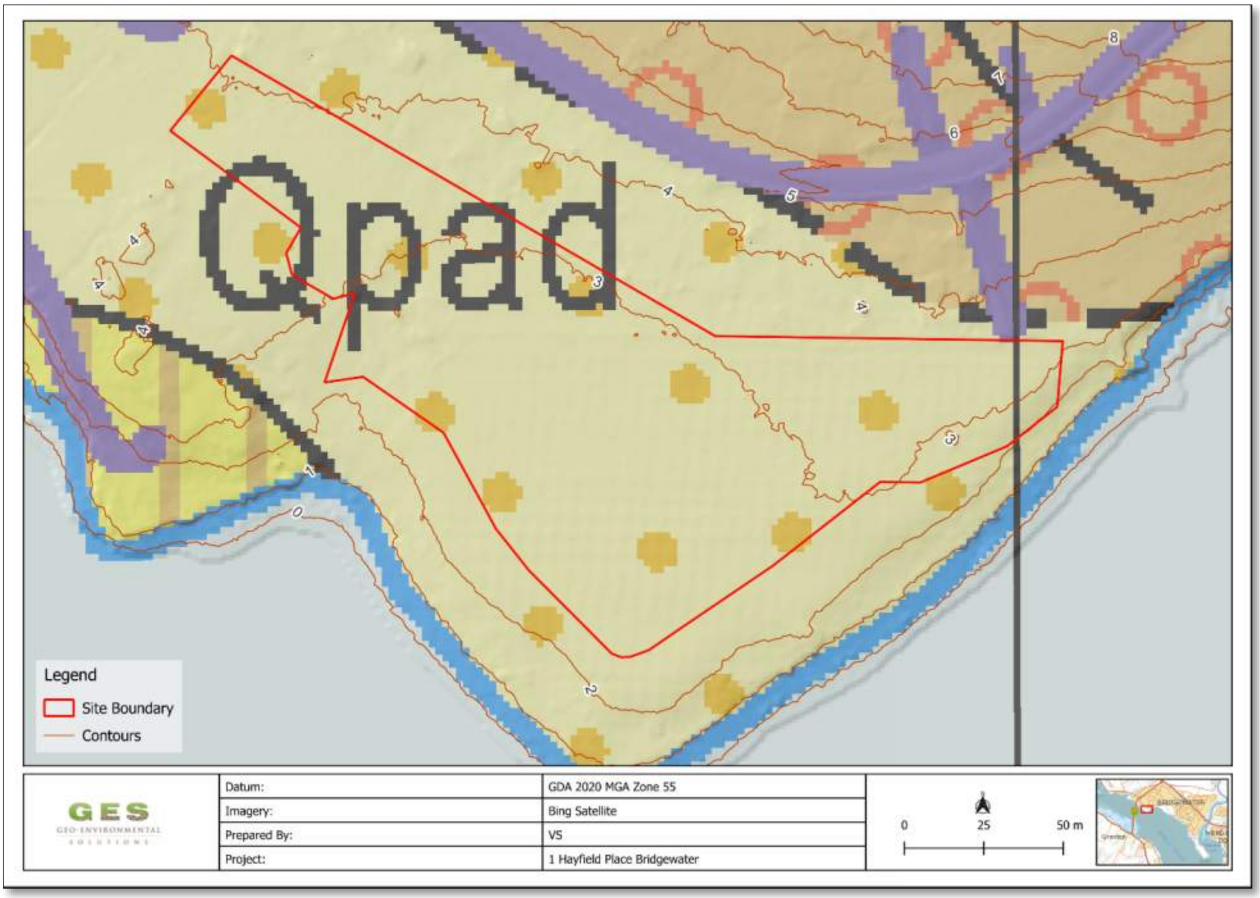


Figure 5 – Geology near the Project Area

6 Site Field Investigation

6.1 Site Walkover

GES has conducted the site visit to observe the current site conditions. Plate 1 & Plate 5 illustrate the site coastal boundary. Most of the shoreline was observed to be lined with well-rounded basalt rock ranging in size from sand through to boulders (Plate 4 & Plate 2). The typical rock size is in the order of 100 to 150 mm diameter. Across the majority of the site similar sized cobbles are mixed within and beneath sandy soils.

More angular and larger rock material is apparent on the western shoreline which is inferred to have been put in place to protect the embankment from eroding (Plate 4 & Plate 5). There are signs of erosion on the western margins of the site where boulder armouring has been placed to protect the fill material along the margins of Nielsen Parade.

There are signs of debris along the shoreline which is inferred to have been emplaced during the particularly large flood events which occurred in June and July 2016 (Plate 3).

Plate 1 Coastline Sediment Investigation

Plate 2 Natural and Placed Shoreline Armouring On the Shoreline

Plate 3 Debris Deposited on the Shoreline Berm (looking south)

Plate 4 Natural and Placed Shoreline Armouring on the Shoreline

Plate 5 Fill Placed In Embankment Alongside Nielsen Parade

Plate 6 Natural Gravel & Cobbles at the Site are Evidence of a River Terrace

6.2 *Site Soil Assessment*

Figure 6 illustrates the soil investigation bores drilled at the site to assess the costal erosion hazard. Soil bore logs are presented in Appendix 3.

Basalt bedrock was encountered in all site boreholes at 1.0 (BH9 & BH15) to greater than 2.4 m (BH1, BH2 & BH5) below ground surface (BGS). The bedrock profile is inferred to mound at 2.0 m AHD beneath Nielsen Esplanade with a similar contour to the surface topography along the shoreline to the west of the site and dipping to the northeast to the north near BH1 & BH2.

The basalt is mantled by Clayey GRAVELS which outcrops along the shoreline along the length of the site.

Between all the boreholes, the surface of the Clayey GRAVELS varies by approximately 0.8 m (ranging from 1.2 m to 2.0 m AHD). The Clayey GRAVELS are very dense and are bound within a cohesive clay matrix.

High plasticity CLAY is thickest on the northern site of the site and overlies Clayey GRAVELS which are inferred to have a thickness of up to 2.2 m between BH1 and BH2 (between 1.3 and 3.6 m AHD). The clay pinches out towards the shoreline along the length of the site. The CLAY therefore underlies the upper shoreline profile (between o and 2.0 m AHD) along the majority of the site.

Most of the site is mantled with a gravel and cobble armouring to typical thicknesses in the order of 200 mm which is continuous to the shoreline. The cobbles are expected to have formed the river terrace at a time when the Derwent River had a larger flow before dams were constructed in the upper catchments and possibly before the river was diverted through the narrow passage forming the Bridgewater Bridge.

Clay sediment erosion scour is apparent at approximately 1.0 m AHD.

Figure 6 Site Borehole Layout – Coastal Erosion Hazard Investigation

Plate 7 Typical Soil Profile Within the Central East Part of the Site.

Plate 8 Typical Soil Profile Near the Shoreline (BH4)

6.3 Site Geomorphology Observations

The following can be summarised from the erosion assessment:

- Cobbles and gravels distributed across most of the site indicative of an historical higher energy regime with significantly greater inundation levels than present;
- Although riverine inundation is not considered in the Tasmanian Planning Scheme – Brighton Council for this part of the Derwent River, consideration will be given to combined fluvial, and storm tide processes;
- An observed rocky beach gradient of 4° is apparent in the shoreline swash platform. This shoreline gradient steepens to an embankment at approximately 1.0 m AHD elevation. At this point, it is observed that there is scour of the clay soil profile (Plate 9 & Plate 10). Clearly, the shoreline armouring is not providing tidal scour protection from erosion at this point, and will continue to recede into the future;
- Continual erosion of the shoreline escarpment is expected to occur along a 4° gradient from the current shoreline. Cobbles and gravel will slump onto the swash platform as the clay material is eroded out from underneath and will add to the existing armouring blanket along the shoreline will assist in attenuating wave runup energy.   As sea levels rise, the shoreline will recede, however the erosion and cobble distribution profile will be maintained at a consistent 4° gradient. There comes

a point where the 4° profile will meet the surface of the site which is determined approximately 45 to 50 m from the present-day coastline on the eastern side of the site;

- The erosion gradient is expected to be considerably steeper on the coastal side of the existing residence where rubble fill has been placed. In these areas, the rubble appears to have been placed directly over the top of erosion resilient gravel which is not expected to erode, at least by 2100. Moreover, the rubble will greatly attenuate rave runup levels in this part of the site;
- Given that only very minor rubble material has been placed on the coastal side of the roundabout, this part of the shoreline is expected to recede. The basalt bedrock underneath the roundabout will limit the erosion extent. This part of the site will erode up to 65 m by 2100 unless armouring is placed on the shoreline; and
- Wave runup modelling (based on the evolving shoreline properties) can be conducted to determine at what point the shoreline will recede for different locations and based on different timeframes;
- During the site visit and soil investigation, it was confirmed that the site is underlain by basalt rock at a depth ranging from 1.0 meters to 2.4 meters below ground surface (mbgs). The foundations for the proposed units should be anchored in the bedrock

Plate 9 Escarpment Scour on the Southern Side of the Site

Plate 10 Escarpment Scour on the Southern Side of the Site Eroding Underlying Clay and Exposing Cobbles Mantling the Surface of the Site. The former site armouring is forming present day swash platform as the encampment recedes.

7 Hydrology Assessment

7.1 Previous Studies

GES are not aware of any second pass assessments that have been conducted near the site.

7.2 Scope of Works

GES have conducted a site specific hydrodynamic assessment. The following assessment scope of works has been adopted for the site:

- Identify inundation potential in terms of 1% AEP riverine inundation. This involves understanding past fluvial flooding conditions and future fluvial inundation conditions;
- To identify short term still water levels based on site specific 1% Annual Exceedance Probability (AEP) astronomical tide, barometric low (storm), wind setup and river inundation conditions for different parts of the shoreline;
- Determine site specific wave conditions at the site based on methods outlined in the Shoreline Protection Manual SPM (1984) and the Coastal Engineering Model (CEM 2008) which will provide site specific information on site wave conditions;
- Assess the attenuation of wave runup on the shoreline based on the site erosion model (development of a cobble and rubble armouring surface over the shoreline);
- Assess how changing hydrodynamic conditions including water currents at the site will impact on the proposed development with implications for site stability and flooding for a given time; and
- Provide a comprehensive risk assessment addressing all performance criteria and providing recommendations where applicable.

7.3 Site Flooding History

The River Derwent Flood Data Book (Fallon, Fuller, & Graham, 2000) indicated that a 1 in 150-year flood event occurred on the Derwent River on the 23rd of April 1960. At the Grafton Service Station, inundation levels reached 2.5 m AHD.

Other that general dam storage, the only major diversion of yield from the Derwent catchment occurred in 1964, when the combined yields from the catchments of the Ouse River and Liawenee (area 267 km^2) and the Shannon River at Miena (which includes Great Lake, catchment area 399 km2) were diverted northward through Poatina into the South Esk drainage (Davies and Kalish 1994).

Since the diversion, there has been an overall decrease in higher discharge frequencies. It therefore appears that some factors peculiar to the Derwent catchment have significantly reduced flood frequencies at discharges greater than 200 m3 s-' and consequently the incidence of flushing flows required for the estuary (Thompson and Godfery 1985).

Based on a 10-day flood event, 1% AEP floods are determined to have reduced by approximately 75% (Figure 6). General flow rates identified in Figure 6 will have minimal effect on present day conditions near the site and projected to 2100 given the influence of the broad Derwent River Estuary.

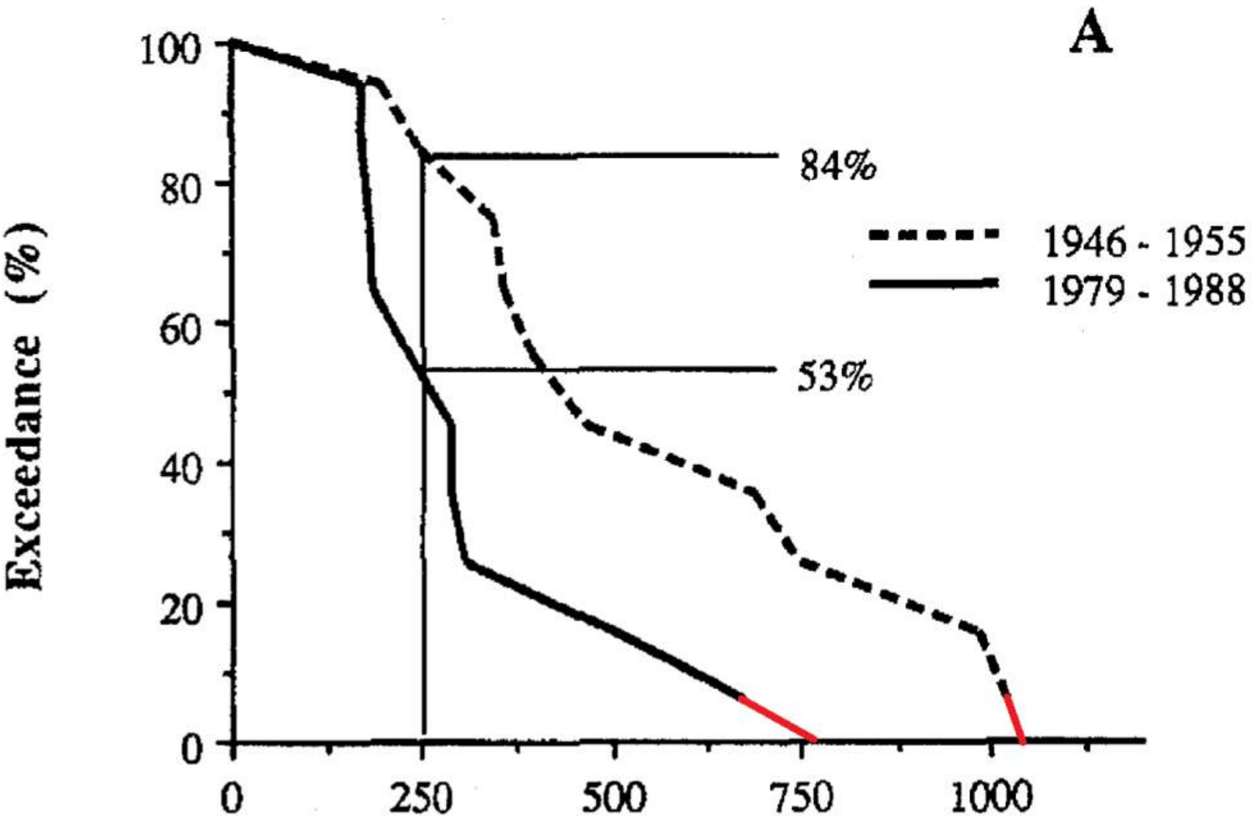


Figure 6 Flood Exceedance Curve for the Derwent River Based on a 10-day Flood Event (m3/seconds)

7.4 Site Baseline Water Levels

7.4.1 Storm Tide

Storm tide events may be defined in terms of the culmination of astronomical tide and storm surge events. Maximum storm tide inundation levels have been adopted for the site based on a 1% AEP that an inundation event will occur. Storm tide levels are obtained from the inundation hazard tables.

The storm tide level adopted for the site is 1.36 m AHD.

7.4.2 Sea Level Rise

The TPS (2021) has adopted the following sea level rise estimates based DPAC projections with reference to a 2010 baseline:

- 0.2 m rise by 2050; and
- 0.8 m rise by 2100.

Based on these figures, sea level elevations presented in Table 1 are applied to the site. 2100 projections are used reference the design life of the proposed structures.

Table 1 Present Day & Projected Inundation Levels for 2100 based on DPAC (2012) estimates.

DPAC (2012) Sea Levels	Present	2080 DPAC	2100 DPAC
Sea Levels (m AHD)	0.12	0.58	0.80

7.4.3 Fluvial Inundation Levels

Based on the flood study conducted by The Hydro Electric Commission (1993), the 1:100-year AEP flood level near the site will not exceed the storm tide inundation level. A fluvial inundation level influence if therefore not applicable for the site (Figure 7).

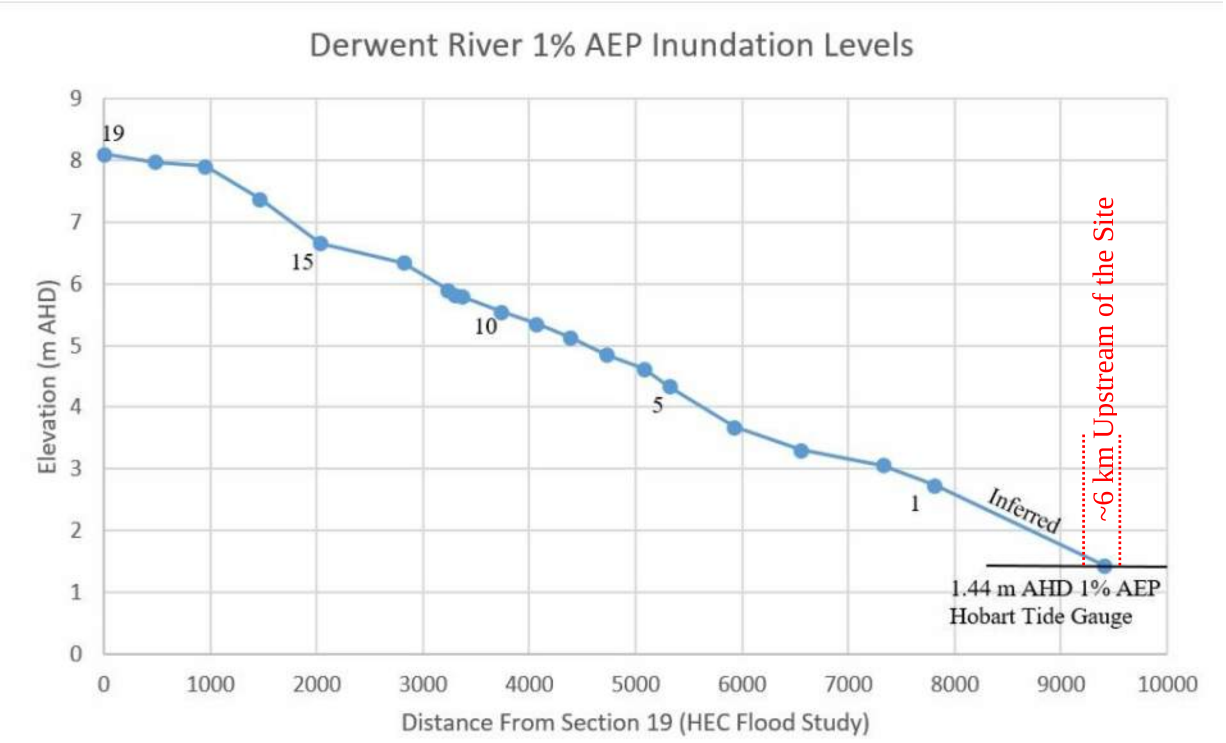


Figure 7 Derwent River 1:100 AEP Inundation Levels (HEC)

7.4.4 Stillwater Levels

The effects of storm tide may be combined with sea levels projections to provide baseline water levels (reported in m AHD) which are referred to as still water level. The still-water levels adopted for the site is based on 1% AEP storm tides and 2100 DPAC (2012) estimates (Table 2).

Table 2 Summary of Site Stillwater Levels for Present Day & Projected 2100 Inundation Levels based on DPAC (2012) estimates & 1% AEP Fluvial Levels

Stillwater Elevations	**2100 DPAC**
DPAC (2012) Sea Levels (m AHD)	0.80
Tidal Influence & Barometric Low Influence (m)	1.36
Wind Setup (m)	0.10
Fluvial (m)	0.20
Summary (m AHD)	2.46

7.5 Site Hydrodynamics

Coastal process hydrodynamics were assessed at the site. Information collected is used to assist in interpreting site specific:

- Maximum site inundation levels;
- Effects of storm inundation levels on site erosion; and
- Longer term recession trends.

Without consideration of site hydrodynamic wave models, these potential hazards cannot be addressed. Depending on the planning requirements and the level of site risk, this information may or may not have not have been utilised in the site inundation and/or erosion model. It is recognised however, that a site specific coastal processes study is imperative in any coastal vulnerability assessment which seeks to identify the potential hazards and potential risks to assets and life.

7.5.1 Methods

Some of the information obtained for the models is extracted directly from the TPS (2021) inundation level tables. Other information has been collected from historical models such as Simulating Waves Nearshore (SWAN) significant offshore swell wave height models (Carley *et. al.* 2008). The wind fetch wave model has been developed based on the CEM (2008) and SPM (1984) formulations which interpret site bathymetry, topography and wind speeds. Radials used to interpret wind wave conditions are presented in Appendix 3.

Hydrodynamic risks are measured in terms of 1% AEP events. Site specific processes considered in this section include but are not limited to the following (some of which are detailed in Figure 8):

- Wave runup;
- Wave setup; and
- Wind setup.

A 300-mm freeboard value has been adopted by the TPS (2021) to account to for the Tasmanian Building Act 2000 regulations. Site hydrodynamic factors are included within this 300-mm freeboard zone which essentially defines any hydrodynamic inundation processes which are above the adopted still water levels. The 300-mm value will tend to overestimate inundation levels at some sites and underestimate inundation levels at other sites.

Given that hydrodynamic processes are largely site specific, GES develop hydrodynamic models for the specific sites of interest which are based on the following information:

- Tasmanian Aquaculture and Fisheries Information (TAFI) bathymetry data,
- Formulations in the CEM (2008), the SPM (1984) and ;
- Local wind conditions (AS/NZS 1170.2:2011).

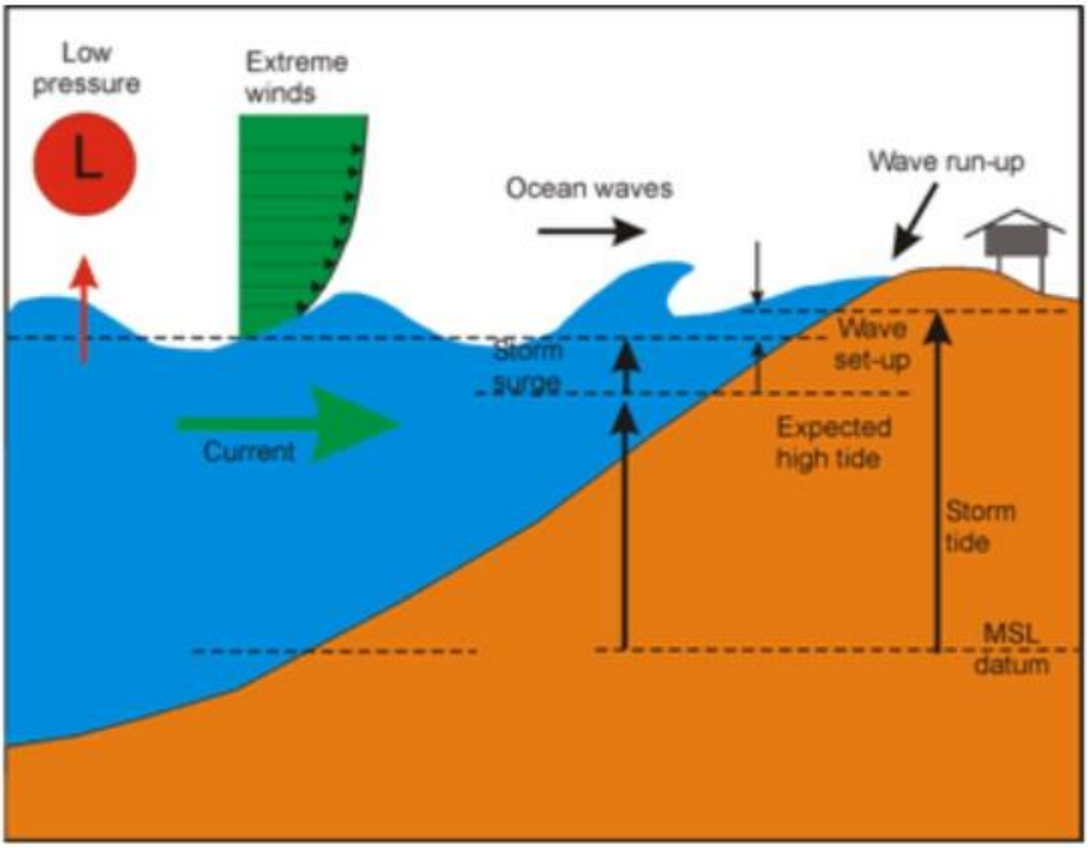


Figure 8 Hydrodynamic Parameters Associated with Storm Surge Events

As wind setup, wave setup and wave runup normally occur simultaneously during storm surge events, these components are combined with extreme tide and storm surge predictions to provide maximum inundation levels for the site. Wave models have been generated for the site to define the site-specific hazards.

7.5.2 Site Wave Conditions

Table 3 provides a summary of the dominant waves intercepting the site.

Table 3 Summary of Dominant Waves Intercepting the Site

Wave Details	Local Wind Fetch	Local Wind Fetch	Local Wind Fetch
Direction	Southeast	West	South
Wave Height (m)	0.6	0.7	0.4
Period (s)	2.4	2.3	1.8
Approach Angle	0	45	0

7.5.3 Dominant Wave Characteristics

The most dominant wave originates from a south easterly wind wave (summarised in Table 4).

Table 4 Details of the Dominant Wave Intercepting the Site

Wave Position	Parameter	Value	Value	Value
Nearshore	Origin	Local Wind Fetch	Local Wind Fetch	Local Wind Fetch
	Direction	Southeast	West	South
	Approach Angle	0	45	0
	Nearshore Wave Height (m)	0.6	0.7	0.4
	Period (s)	2.4	2.3	1.8
Breaking	Breaker Height (m)	0.6	0.6	0.4
	Breaking Depth (m)	1.0	0.8	0.6
	Breaking Angle	0	30	0
	Nearshore Gradient (%)	1.3	5.0	1.5

7.6 Site Inundation Levels

Table 5, Table 6 & Table 7 presents a summary of the site inundation levels based on 1% AEP still water, wave run-up (based on Ru 2%) and wave setup inundation levels for 2100 DPAC scenarios. All wave run-up levels are based on projected changes in water level across the embankment profile to account for wave steepening.

Table 5 Site Coastal Inundation Levels for the Eastern Coastal Boundary Based on 2080 1% AEP Scenario

1% AEP Inundation Levels (m AHD)	2080 DPAC	2100 DPAC
Still Water Elevations Including Wind Setup	2.24	2.55
Wave Setup Elevation	2.35	2.66
R2% Wave Runup Elevations Based on a South Easterly Wind (Van Der Meer 1992)*	2.41	2.66

*Wave Runup Based on Reduction Factors

Table 6 Site Coastal Inundation Levels for the Western Coastal Boundary Based on 2080 1% AEP Scenario

1% AEP Inundation Levels (m AHD)	2080 DPAC	2100 DPAC
Still Water Elevations Including Wind Setup	2.24	2.55
Wave Setup Elevation	2.35	2.66
R2% Wave Runup Elevations Based on a Westerly Wind (Van Der Meer 1992)*	2.62	2.92

*Wave Runup Based on Reduction Factors

Table 7 Site Coastal Inundation Levels for the Central Coastal Boundary Based on 2080 1% AEP Scenario

1% AEP Inundation Levels (m AHD)	2080 DPAC	2100 DPAC
Still Water Elevations Including Wind Setup	2.24	2.55
Wave Setup Elevation	2.35	2.66
R2% Wave Runup Elevations Based on a Southerly Wind (Van Der Meer 1992)*	2.29	2.59

*Wave Runup Based on Reduction Factors

7.7 Overland Flow

Overland flow paths are an important and fundamental component of the stormwater drainage system. Brighton Council provided a draft catchment management plan which identifies potential possible flooding due to the low-lying land in the proposed development area (Figure 9). GES would recommend that this be addressed in a stormwater management plan which would be able to demonstrate that the proposed development will not adversely impact on flooding to upstream, downstream, or adjacent properties, or create nuisance ponding on other properties. The stormwater management plan and associated drainage design must be prepared by a suitably qualified civil or hydraulic engineer.

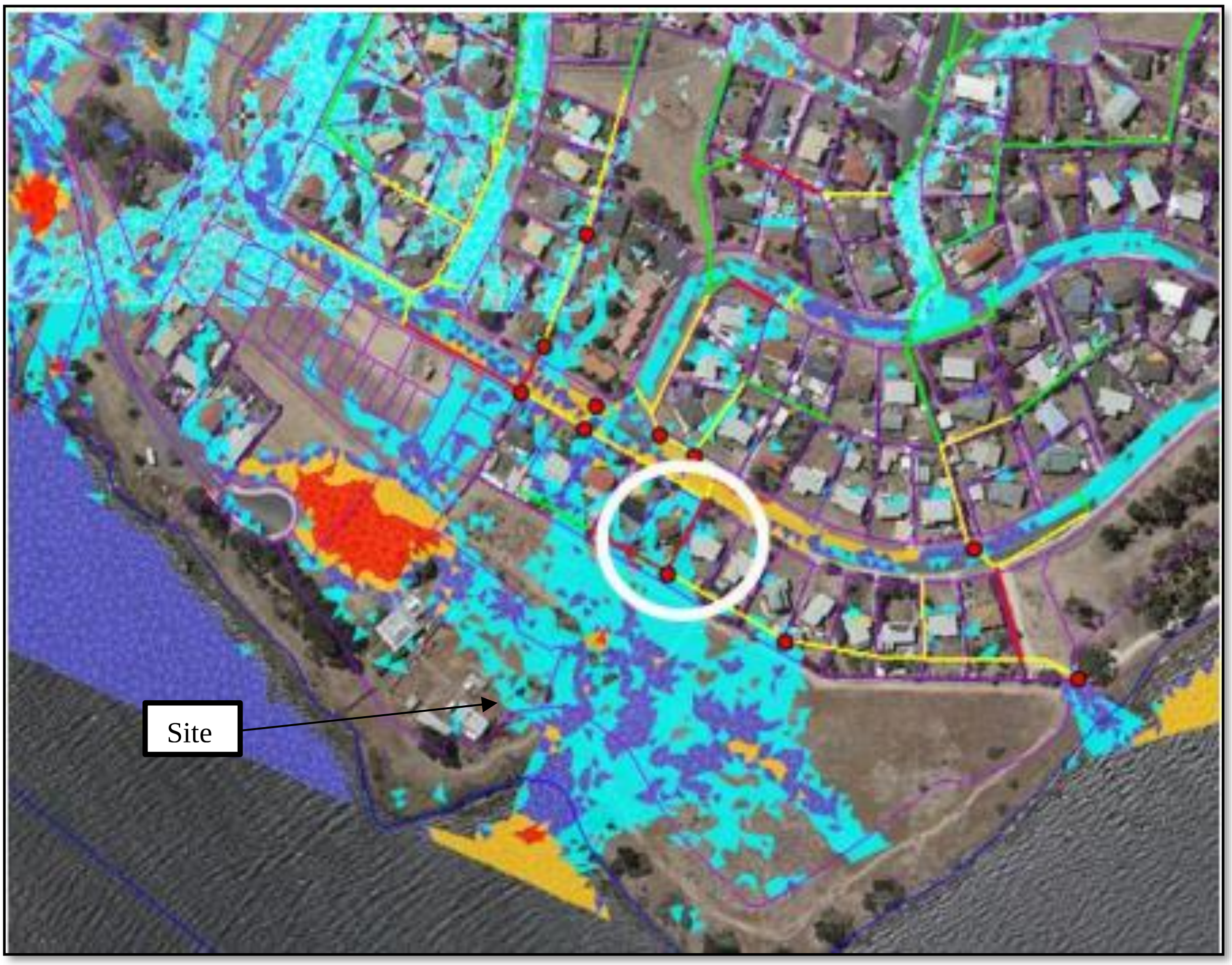


Figure 9 Overland flow path draft (Source: Brighton Council)

8 Coastal Erosion Assessment

8.1 Scope of Works

Table 8.presents a summary of the various methods adopted by GES to identify erosion hazards in vulnerable coastal zones.

Table 8 Summary of Assessment Approaches for Identify Site Erosion Hazards

Investigative Approach	Investigation Details	Typical Application
Short Term Site Historical Aerial Imaging	Assess historical short term shoreline positions relative to known storm events to forward project sediment storm erosion demand.	Used where Tasmarc surveys are not available or there is no previous storm erosion modelling done for the site.
Storm Erosion Demand	Conduct a detailed assessment of site storm erosion vulnerability due to coastal processes as well as available geological and geomorphological information	Where site is in an inferred to be in an erosion hazard zone and where the proposed development building cannot be founded on a stable foundation.
Shoreline Recession Model	Development of a long term shoreline recession model based on projected DPAC (2012) sea level rise scenarios and using calculated closure depths and various Bruun Rule formulations (1988)	Where site is in an inferred to be in an erosion hazard zone and where the proposed development building cannot be founded on a stable foundation.
Stable Foundation Zones	Development of a cross section through the site detailing zone of reduced foundation capacity and the stable foundation zone through Nielsen et. al. (1992) methods	Where site is in an inferred to be in an erosion hazard zone and where the proposed development building cannot be founded on a stable foundation.

8.2 Aerial Imagery Recession Assessment

The coastline positions from 19 separate historical aerial images dating back to 2005 were compared with historical sea level measurements (Church & White 2011) and projected 2050 and 2100 sea levels as outlined.

Findings from the assessment are presented in Table 9.

Table 9 Summary of Coastline Recession Analysis

Variable	Value
Recession Profile ID	Point
2050 & 2100 sea level rise planning allowance adopted given 2010 baseline (DPAC 2016)	0.23 & 0.85 m
Confidence In Relationship (R^2)	0.27
Computer Generated Bruun Rule Relationship (horizontal recession per metre sea level rise)	30
Manually Inferred Recession Trend (Bruun Rule Relationship)	No Adjustment
Adopted Bruun Rule Relationship	**30**
Projected 2050 Horizontal Recession Relative to Geoscience Australia LIDAR	**8m**
Projected 2100 Horizontal Recession Relative to Geoscience Australia LIDAR	**25m**

A coastline recession of 25 m horizontal is recommended for the site by 2100 based on the 2008 LIDAR Survey

8.3 Storm Erosion Demand Assessment

A storm erosion demand of 3 m3/m is recommended for the site.

8.4 Stable Foundation Zone

As the proposed structures are not located within the zone of reduced foundation capacity, the foundations should be designed to account for the AS2870 site classification.

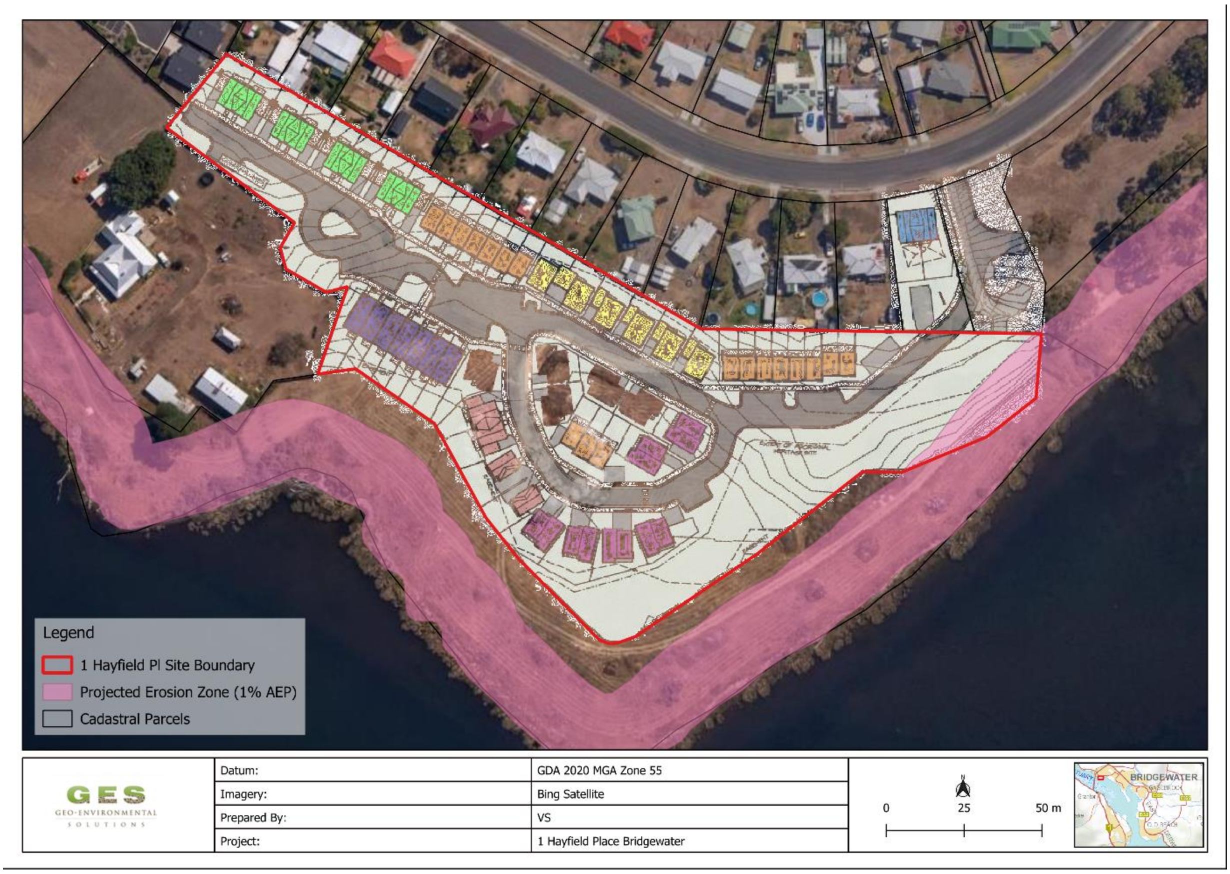


Figure 10 Summary of Projected 2100 Erosion Conditions with Proposed Development Footprints

8.5 Summary

The following can be concluded from the coastal erosion assessment (Figure 10):

- It is established that up to 25 m of coastline recession may be expected by 2100
- The proposed structures are not located within the zone of reduced foundation capacity
- The risk to the proposed buildings and use is tolerable for the life of the proposed use

9 Risk Assessment

Qualitative risk assessment criteria have been developed to identify key risks that may arise from building works in areas that are vulnerable to erosion or inundation hazards.

The criteria are based on a risk assessment matrix consistent with Australian Standard AS4360 on Risk Management (AS4360). The qualitative assessment of risk severity and likelihood (Appendix 3) are used to help provide a qualitative risk assessment based upon the coastal vulnerability assessment completed for the site.

GES has established from the qualitative risk assessment that the level of risk is within the lowest bounds and the proposed development works at the site are acceptable.

10 Conclusions and Recommendations

Based on the detailed site assessment conducted by GES, the potential risks of sea level rise and coastal erosion associated with the proposed construction have been thoroughly evaluated. It has been determined that, under the 2100 high emissions scenario (1% Annual Exceedance Probability), stillwater levels could rise up to 2.46 meters above Australian Height Datum (AHD). To mitigate this, the finished floor level of the proposed units must be constructed at or above 2.6 m AHD, in line with the Tasmanian Planning Scheme for Brighton Council. The site assessment also reveals that erosion risks are limited by a scour gradient of 4° along the eastern coastal boundary, rubble fill armouring along the shoreline, and a basalt bedrock mound beneath the western part of the site. The capacity for further erosion is constrained to no more than 25 meters. Additionally, the proposed development lies within a stable foundation zone, and the risk of coastal erosion over the expected life of the development (until 2100) is deemed tolerable. No specific management measures are required to mitigate coastal erosion at the site. However, a stormwater management plan and appropriate engineering design are essential to manage potential overland flows and stormwater generated by the development.

11 References

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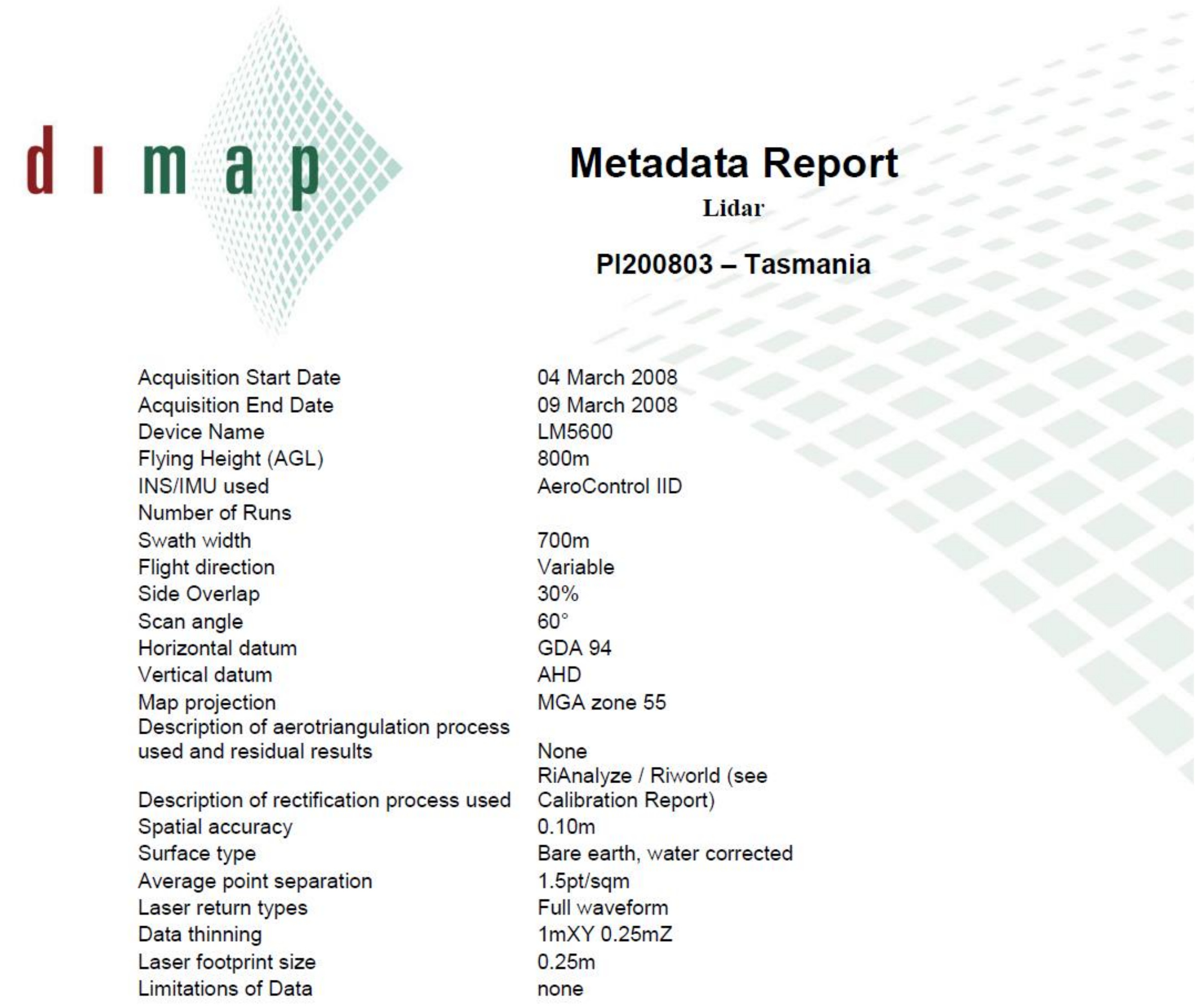
Appendix 1 LIDAR Metadata Report



dimap

Metadata Report

Lidar

PI200803 – Tasmania

Acquisition Start Date	04 March 2008
Acquisition End Date	09 March 2008
Device Name	LM5600
Flying Height (AGL)	800m
INS/IMU used	AeroControl IID
Number of Runs	
Swath width	700m
Flight direction	Variable
Side Overlap	30%
Scan angle	60°
Horizontal datum	GDA 94
Vertical datum	AHD
Map projection	MGA zone 55
Description of aerotriangulation process used and residual results	None
Description of rectification process used	RiAnalyze / Riworld (see Calibration Report)
Spatial accuracy	0.10m
Surface type	Bare earth, water corrected
Average point separation	1.5pt/sqm
Laser return types	Full waveform
Data thinning	1mXY 0.25mZ
Laser footprint size	0.25m
Limitations of Data	none

Appendix 2 Acceptable Solutions

Coastal Erosion Hazard Code (CEHC) Areas

Standard	**Code**	**Acceptable Solution**		**Performance Criteria**
Development	C10.6.1 Buildings & Works	A1	No Acceptable solution	P1.1 P1.2

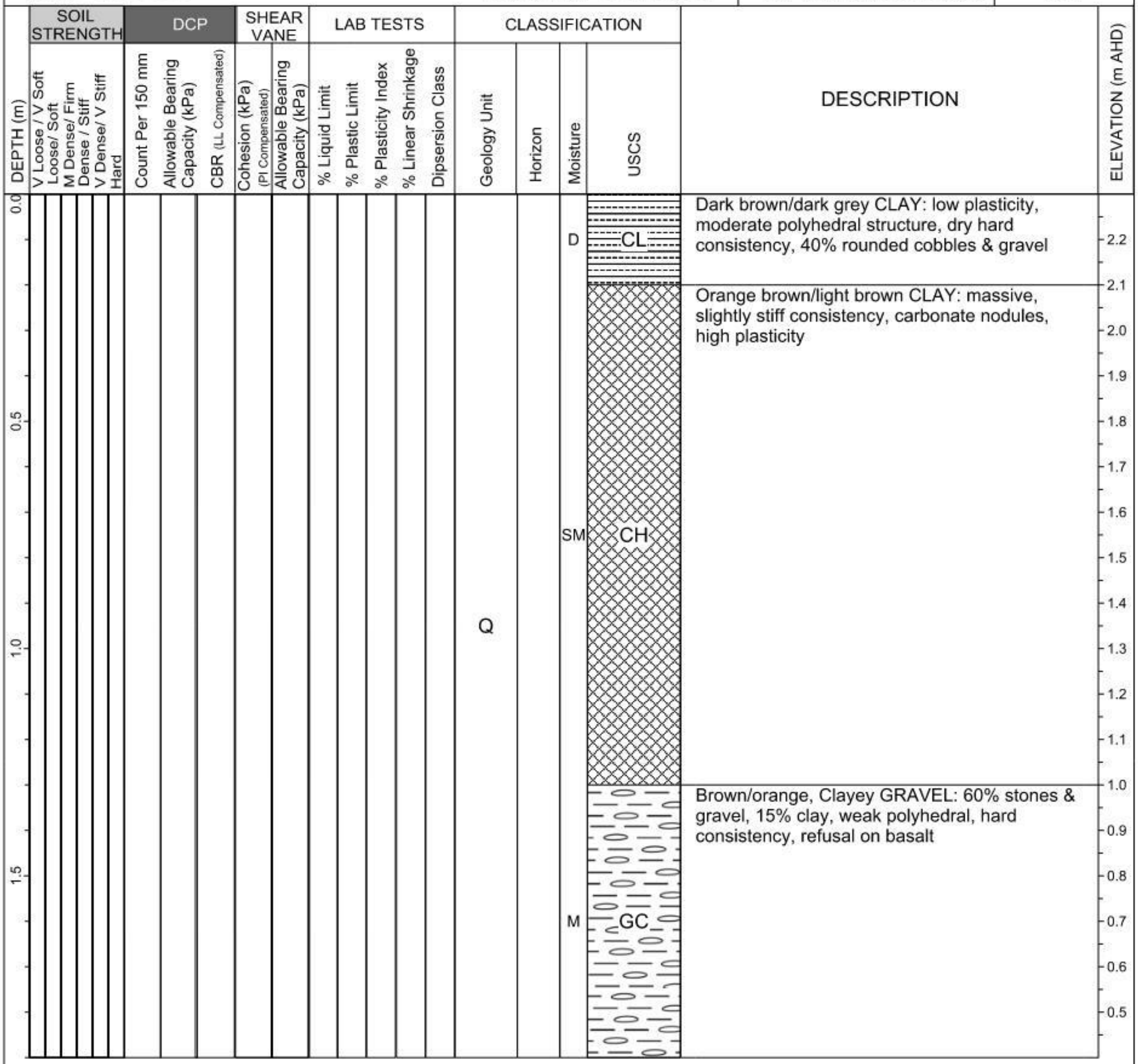
Coastal Inundation Hazard Code (CIHC) Areas

Standard	**Code**	**Acceptable Solution**		**Performance Criteria**
Development	C11.6.1 Buildings & Works	A1	No Acceptable solution	P1.1 P1.2

Appendix 3 Bore Hole Logs

GEO-ENVIRONMENTAL SOLUTIONS

PROJECT: 1 Hayfield Place		**Log of: BH1**	
CLIENT: **Multi-Res Builders**		EASTING (GDA94):	**518995.1**
LOCATION: **Bridgewater**		NORTHING (GDA94):	**5267819.9**
CONTRACTOR:	**Geo-Environmental Solutions**	ELEVATION (m AHD):	**2.3**
DRILLING METHOD:	**Direct Push Core**	TOTAL DEPTH (m):	**1.9**
DRILLING INTERVAL:	**0-1.0m**	NATURAL GROUND (m):	**0**
DATE: **3/10/2021**	LOGGED BY: **G Mcdonald**	DEPTH WATER STRUCK (m):	**NA**



Dark brown/dark grey CLAY: low plasticity, moderate polyhedral structure, dry hard consistency, 40% rounded cobbles & gravel

Orange brown/light brown CLAY: massive, slightly stiff consistency, carbonate nodules, high plasticity

Brown/orange, Clayey GRAVEL: 60% stones & gravel, 15% clay, weak polyhedral, hard consistency, refusal on basalt

VIRONMENTAL SOLUTIONS - 29 KIRKSWAY PLACE, BATTERY POINT 7004- T: 03 6223 1839 | Page 1 of 1

GEO-ENVIRONMENTAL SOLUTIONS

PROJECT:
1 Hayfield Place

Log of: BH2

CLIENT: **Multi-Res Builders**		EASTING (GDA94):	**518946.5**
LOCATION: **Bridgewater**		NORTHING (GDA94):	**5267778.7**
CONTRACTOR:	**Geo-Environmental Solutions**	ELEVATION (m AHD):	**2.1**
DRILLING METHOD:	**Direct Push Core**	TOTAL DEPTH (m):	**1.6**
DRILLING INTERVAL:	**0-1.0m**	NATURAL GROUND (m):	**0**
DATE: **3/10/2021**	LOGGED BY: **G Mcdonald**	DEPTH WATER STRUCK (m):	**NA**

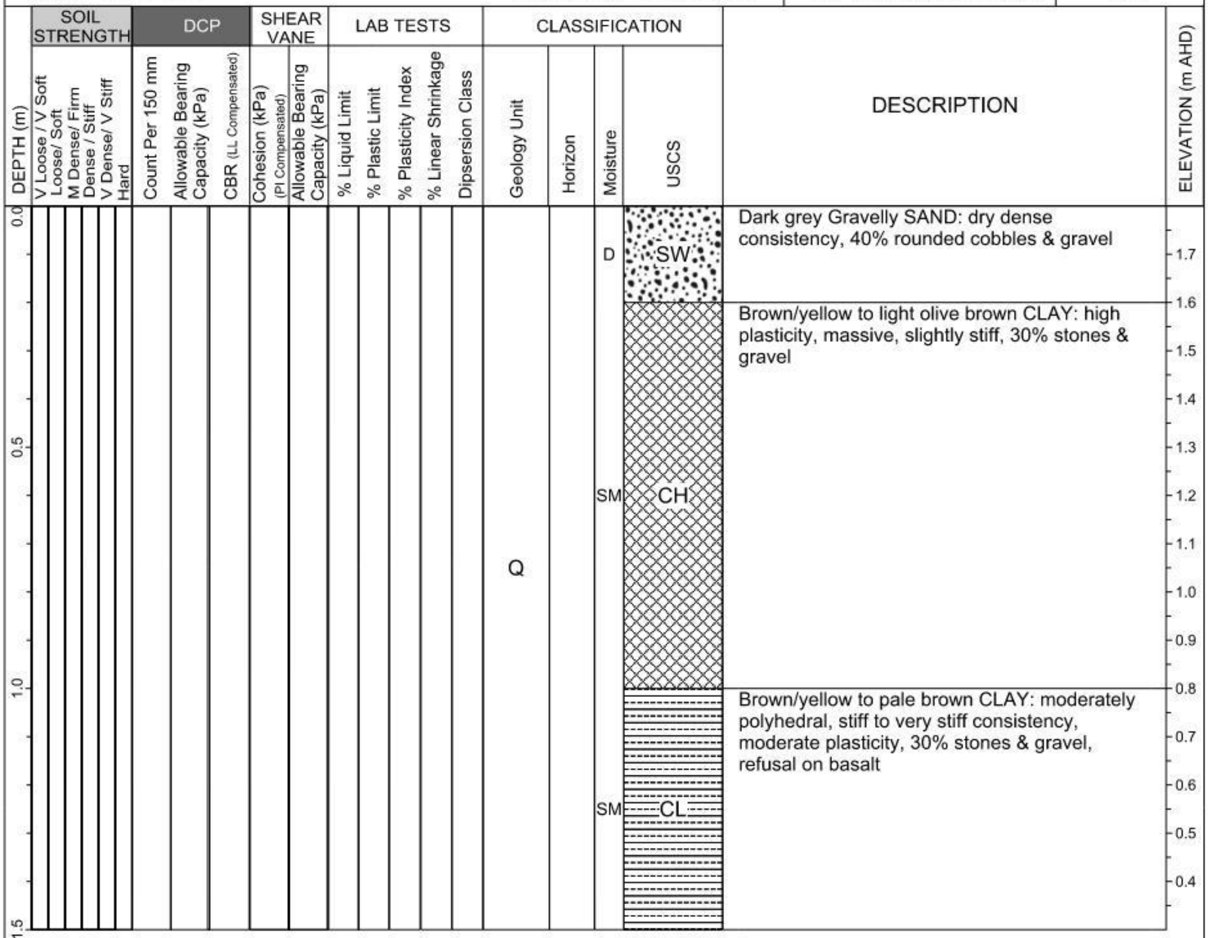
DEPTH (m)	SOIL STRENGTH V Loose / V Soft Loose/ Soft M Dense/ Firm Dense / Stiff V Dense/ V Stiff Hard	DCP Count Per 150 mm	DCP Allowable Bearing Capacity (kPa)	DCP CBR (LL Compensated)	SHEAR VANE Cohesion (kPa) (PI Compensated)	SHEAR VANE Allowable Bearing Capacity (kPa)	LAB TESTS % Liquid Limit	LAB TESTS % Plastic Limit	LAB TESTS % Plasticity Index	LAB TESTS % Linear Shrinkage	LAB TESTS Dipsersion Class	CLASSIFICATION Geology Unit	CLASSIFICATION Horizon	CLASSIFICATION Moisture	CLASSIFICATION USCS	DESCRIPTION	ELEVATION (m AHD)
0.0												Q		D	SW	Dark grey Gravelly SAND: dry dense consistency, 40% rounde cobbles & gravel	2.0
														SM	CH	Brown/yellow to light olive brown CLAY: high plasticity, massive, slightly stiff, 40% stones & gravel	1.9
														M	GC	Brown/orange, Clayey GRAVEL: 60% stones & gravel, 15% clay, weak polyhedral, hard consistency, refusal on basalt	0.6

DEPTH (m): 0.0, 0.5, 1.0, 1.5

ELEVATION (m AHD): 2.0, 1.9, 1.8, 1.7, 1.6, 1.5, 1.4, 1.3, 1.2, 1.1, 1.0, 0.9, 0.8, 0.7, 0.6

GEO-ENVIRONMENTAL SOLUTIONS

PROJECT: 1 Hayfield Place		**Log of:**	**BH3**
CLIENT: **Multi-Res Builders**		EASTING (GDA94):	**518898.7**
LOCATION: **Bridgewater**		NORTHING (GDA94):	**5267743.8**
CONTRACTOR:	**Geo-Environmental Solutions**	ELEVATION (m AHD):	**1.8**
DRILLING METHOD:	**Direct Push Core**	TOTAL DEPTH (m):	**1.5**
DRILLING INTERVAL:	**0-1.0m**	NATURAL GROUND (m):	**0**
DATE: **3/10/2021**	LOGGED BY: **G Mcdonald**	DEPTH WATER STRUCK (m):	**NA**



Moisture	USCS	DESCRIPTION
D	SW	Dark grey Gravelly SAND: dry dense consistency, 40% rounded cobbles & gravel
SM	CH	Brown/yellow to light olive brown CLAY: high plasticity, massive, slightly stiff, 30% stones & gravel
SM	CL	Brown/yellow to pale brown CLAY: moderately polyhedral, stiff to very stiff consistency, moderate plasticity, 30% stones & gravel, refusal on basalt

Geology Unit: Q

GEO-ENVIRONMENTAL SOLUTIONS

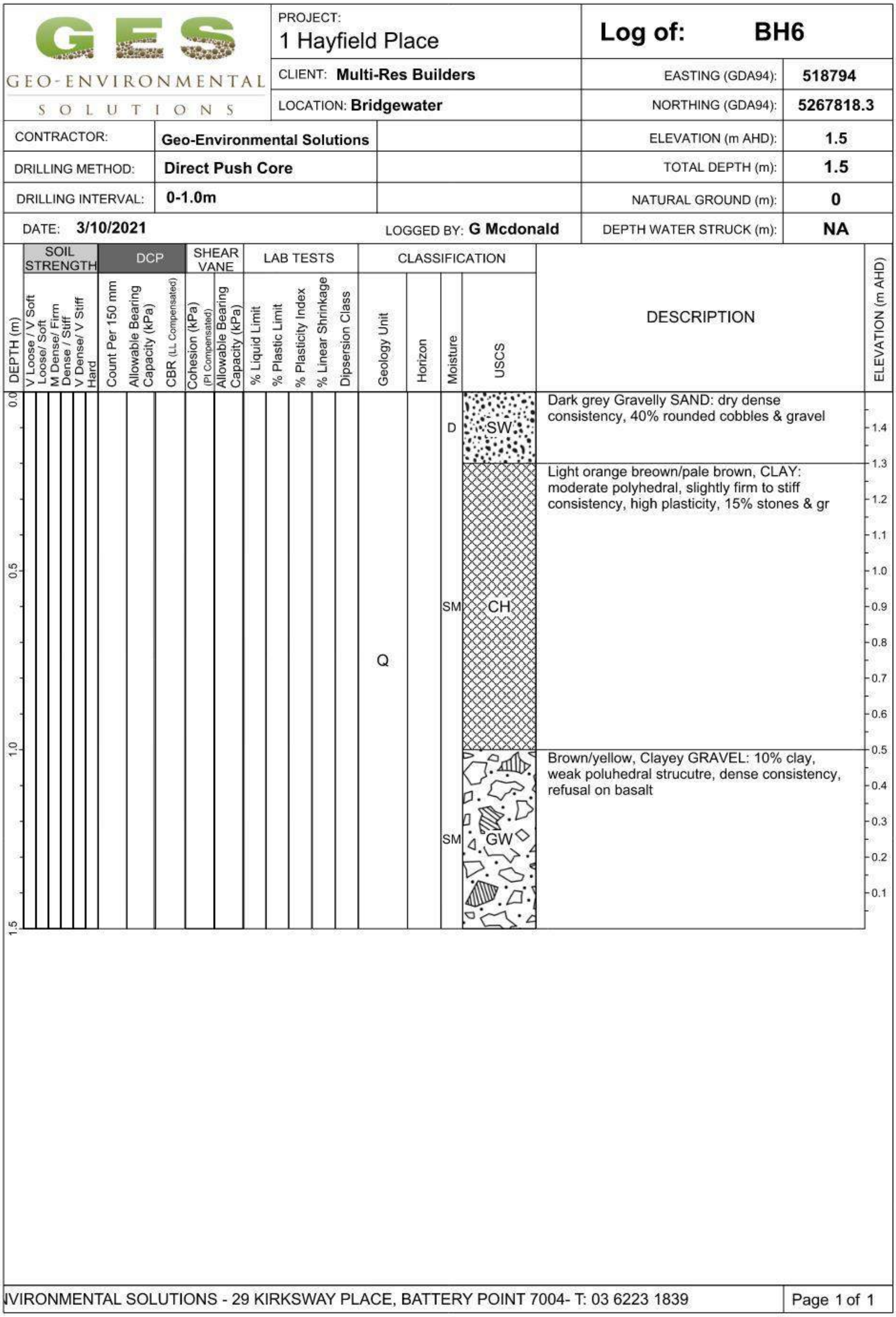
PROJECT: 1 Hayfield Place		**Log of: BH4**	
CLIENT: **Multi-Res Builders**		EASTING (GDA94):	**518852.1**
LOCATION: **Bridgewater**		NORTHING (GDA94):	**5267749.8**
CONTRACTOR:	**Geo-Environmental Solutions**	ELEVATION (m AHD):	**1.4**
DRILLING METHOD:	**Direct Push Core**	TOTAL DEPTH (m):	**1**
DRILLING INTERVAL:	**0-1.0m**	NATURAL GROUND (m):	**0**
DATE: **3/10/2021**	LOGGED BY: **G Mcdonald**	DEPTH WATER STRUCK (m):	**NA**

	SOIL STRENGTH						DCP			SHEAR VANE		LAB TESTS					CLASSIFICATION					
DEPTH (m)	V Loose / V Soft	Loose/ Soft	M Dense/ Firm	Dense / Stiff	V Dense/ V Stiff	Hard	Count Per 150 mm	Allowable Bearing Capacity (kPa)	CBR (LL Compensated)	Cohesion (kPa) (PI Compensated)	Allowable Bearing Capacity (kPa)	% Liquid Limit	% Plastic Limit	% Plasticity Index	% Linear Shrinkage	Dipsersion Class	Geology Unit	Horizon	Moisture	USCS	DESCRIPTION	ELEVATION (m AHD)
0.0																			D	SW	Dark grey Gravelly SAND: dry dense consistency, 40% rounded cobbles & gravel	1.4
																					Brown/yellow to light olive brown CLAY: high plasticity, massive, slightly stiff, 30% stones & gravel	1.3
																						1.2
																						1.1
																						1.0
0.5																	Q		SM	CH		0.9
																						0.8
																						0.7
																						0.6
																			SM	CL	Brown/yellow to pale brown CLAY: moderately polyhedral, stiff to very stiff consistency, moderate plasticity, 30% stones & gravel, refusal on basalt	0.5
1.0																						

GEO-ENVIRONMENTAL SOLUTIONS

PROJECT: 1 Hayfield Place		**Log of: BH5**	
CLIENT: **Multi-Res Builders**		EASTING (GDA94):	**518816.9**
LOCATION: **Bridgewater**		NORTHING (GDA94):	**5267787.5**
CONTRACTOR:	**Geo-Environmental Solutions**	ELEVATION (m AHD):	**1.5**
DRILLING METHOD:	**Direct Push Core**	TOTAL DEPTH (m):	**1.6**
DRILLING INTERVAL:	**0-1.0m**	NATURAL GROUND (m):	**0**
DATE: **3/10/2021**	LOGGED BY: **G Mcdonald**	DEPTH WATER STRUCK (m):	**NA**

	SOIL STRENGTH	DCP			SHEAR VANE		LAB TESTS					CLASSIFICATION					
DEPTH (m)	V Loose / V Soft Loose/ Soft M Dense/ Firm Dense / Stiff V Dense/ V Stiff Hard	Count Per 150 mm	Allowable Bearing Capacity (kPa)	CBR (LL Compensated)	Cohesion (kPa) (PI Compensated)	Allowable Bearing Capacity (kPa)	% Liquid Limit	% Plastic Limit	% Plasticity Index	% Linear Shrinkage	Dipsersion Class	Geology Unit	Horizon	Moisture	USCS	DESCRIPTION	ELEVATION (m AHD)
0.0												Q		D	SW	Dark grey Gravelly SAND: dry dense consistency, 40% rounded cobbles & gravel	1.4 1.3 1.2
0.5 1.0														SM	CH	Brown/yellow to light olive brown CLAY: high plasticity, massive, slightly stiff, 30% stones & gravel	1.1 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2
1.5														SM	CL	Brown/yellow to pale brown CLAY: moderately polyhedral, stiff to very stiff consistency, moderate plasticity, 30% stones & gravel, refusal on basalt	0.1 0.0



GEO-ENVIRONMENTAL SOLUTIONS

PROJECT: 1 Hayfield Place

Log of: BH6

CLIENT: **Multi-Res Builders**

LOCATION: **Bridgewater**

EASTING (GDA94): **518794**

NORTHING (GDA94): **5267818.3**

CONTRACTOR: **Geo-Environmental Solutions**

ELEVATION (m AHD): **1.5**

DRILLING METHOD: **Direct Push Core**

TOTAL DEPTH (m): **1.5**

DRILLING INTERVAL: **0-1.0m**

NATURAL GROUND (m): **0**

DATE: **3/10/2021**

LOGGED BY: **G Mcdonald**

DEPTH WATER STRUCK (m): **NA**

DEPTH (m)	SOIL STRENGTH: V Loose / V Soft, Loose/ Soft, M Dense/ Firm, Dense / Stiff, V Dense/ V Stiff, Hard	DCP: Count Per 150 mm	DCP: Allowable Bearing Capacity (kPa)	DCP: CBR (LL Compensated)	SHEAR VANE: Cohesion (kPa) (PI Compensated)	SHEAR VANE: Allowable Bearing Capacity (kPa)	LAB TESTS: % Liquid Limit	LAB TESTS: % Plastic Limit	LAB TESTS: % Plasticity Index	LAB TESTS: % Linear Shrinkage	LAB TESTS: Dipsersion Class	CLASSIFICATION: Geology Unit	CLASSIFICATION: Horizon	CLASSIFICATION: Moisture	CLASSIFICATION: USCS	DESCRIPTION	ELEVATION (m AHD)
0.0														D	SW	Dark grey Gravelly SAND: dry dense consistency, 40% rounded cobbles & gravel	1.4
0.5												Q		SM	CH	Light orange breown/pale brown, CLAY: moderate polyhedral, slightly firm to stiff consistency, high plasticity, 15% stones & gr	1.3
1.0														SM	GW	Brown/yellow, Clayey GRAVEL: 10% clay, weak poluhedral strucutre, dense consistency, refusal on basalt	0.5

IVIRONMENTAL SOLUTIONS - 29 KIRKSWAY PLACE, BATTERY POINT 7004- T: 03 6223 1839

Page 1 of 1

GEO-ENVIRONMENTAL
SOLUTIONS

PROJECT:
1 Hayfield Place

Log of: BH7

CLIENT:	**Multi-Res Builders**	EASTING (GDA94):	**518892.5**
LOCATION:	**Bridgewater**	NORTHING (GDA94):	**5267793.5**
CONTRACTOR:	**Geo-Environmental Solutions**	ELEVATION (m AHD):	**2.7**
DRILLING METHOD:	**Direct Push Core**	TOTAL DEPTH (m):	**1.65**
DRILLING INTERVAL:	**0-1.0m**	NATURAL GROUND (m):	**0**
DATE: **3/10/2021**	LOGGED BY: **G Mcdonald**	DEPTH WATER STRUCK (m):	**NA**

	SOIL STRENGTH						DCP			SHEAR VANE		LAB TESTS					CLASSIFICATION					
DEPTH (m)	V Loose / V Soft	Loose/ Soft	M Dense/ Firm	Dense / Stiff	V Dense/ V Stiff	Hard	Count Per 150 mm	Allowable Bearing Capacity (kPa)	CBR (LL Compensated)	Cohesion (kPa) (PI Compensated)	Allowable Bearing Capacity (kPa)	% Liquid Limit	% Plastic Limit	% Plasticity Index	% Linear Shrinkage	Dipsersion Class	Geology Unit	Horizon	Moisture	USCS	DESCRIPTION	ELEVATION (m AHD)
0.0																			D	SC	Dark brown Clayey SAND: stiff, 10% clay, weak polyhedral structure, 15% stones and gravels	2.6 2.5
0.5																			SM	CH	Dark orange/brown CLAY: high plasticity, weak polyhedral strucutre, stiff to very stiff, 40% rounded cobbles & gravels at 0.4 m	2.4 2.3 2.2 2.1
1.0 1.5																	Q		SM	GC	Olive yellow, clayey GRAVEL: 10% clay, weak polyhedral structure, dense consistency, 80% stones and gravels. Refusal on bedrock	2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1

NVIRONMENTAL SOLUTIONS - 29 KIRKSWAY PLACE, BATTERY POINT 7004- T: 03 6223 1839 | Page 1 of 1

GES
GEO-ENVIRONMENTAL SOLUTIONS

PROJECT: 1 Hayfield Place		**Log of: BH8**	
CLIENT: **Multi-Res Builders**		EASTING (GDA94):	**518833.3**
LOCATION: **Bridgewater**		NORTHING (GDA94):	**5267816.2**
CONTRACTOR:	**Geo-Environmental Solutions**	ELEVATION (m AHD):	**2.5**
DRILLING METHOD:	**Direct Push Core**	TOTAL DEPTH (m):	**1.7**
DRILLING INTERVAL:	**0-1.0m**	NATURAL GROUND (m):	**0**
DATE: **3/10/2021**	LOGGED BY: **G Mcdonald**	DEPTH WATER STRUCK (m):	**NA**

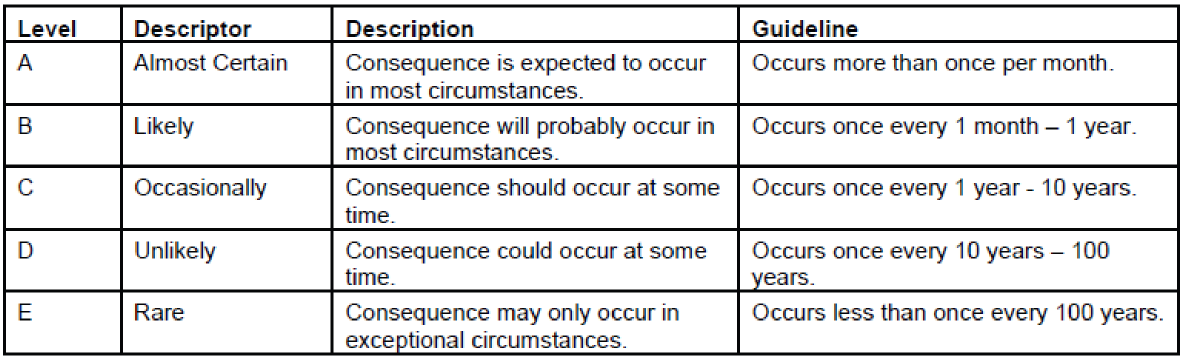
	SOIL STRENGTH						DCP			SHEAR VANE		LAB TESTS					CLASSIFICATION					
DEPTH (m)	V Loose / V Soft	Loose/ Soft	M Dense/ Firm	Dense / Stiff	V Dense/ V Stiff	Hard	Count Per 150 mm	Allowable Bearing Capacity (kPa)	CBR (LL Compensated)	Cohesion (kPa) (PI Compensated)	Allowable Bearing Capacity (kPa)	% Liquid Limit	% Plastic Limit	% Plasticity Index	% Linear Shrinkage	Dipsersion Class	Geology Unit	Horizon	Moisture	USCS	DESCRIPTION	ELEVATION (m AHD)
0.0																			D	SC	Dark brown Clayey SAND: stiff, 10% clay, weak polyhedral strucutre, 15% stones and gravels	2.4 2.3 2.2
0.5																			SM	CH	Brown CLAY: polyhedral structure, stiff to very stiff, high plasticity, 40% rounded cobbles and gravel	2.1 2.0 1.9 1.8 1.7
1.0 1.5																	Q		SM	GC	Dark orange/brown GRAVEL: dense consistency, stiff to very stiff, 60% stones, 10% rounded gravels at the base. Refusal on bedrock	1.6 1.5 1.4 1.3 1.2 1.1 1.0 0.9

Appendix 4 Quantitative Risk Assessment Tables

Consequence Index

Consequence	**Details - Storm Erosion and Inundation**	**Details – Waterways and Coastal Protection**
Catastrophic	Loss of life, loss of significant environmental values due to a pollution event where there is not likely to be recovery in the foreseeable future.	Very serious environmental effects with impairment of ecosystem function. Long term, widespread effects on significant environment (eg. RAMSAR Wetland)
Major	Extensive injuries. Complete structural failure of development, destruction of significant property and infrastructure, significant environmental damage requiring remediation with a long-term recovery time.	Serious environmental impact effects with some impairment of ecosystem function. Relatively widespread medium-long term impacts.
Moderate	Treatment required, significant building or infrastructure damage i.e. loss of minor outbuildings such as car ports, garages and the like. Replacement of significant property components. linings, hard paved surfaces, cladding, flooring. Moderate environmental damage with a short-term natural or remedial recovery time.	Moderate effects on biological or physical environment (air, water) but not affecting ecosystem function. Moderate short term widespread impacts (e.g. significant spills)
Minor	Medium loss – repair of outbuildings and repair and minor replacement of building components of buildings. Replacement of floor/window coverings, some furniture through seepage (where applicable). Minor environmental damage easily remediated.	Minor effects on biological or physical environment. Minor short-term damage to small area of limited significance.
Insignificant	No injury, low loss – no replacement of habitable building components, some remediation of garden beds, gravel driveways etc. Environment can naturally withstand and recover without remediation. Inundation of the site, but ground based access is still readily available and habitable buildings are not inundated, including incorporated garages.	Limited damage to minimal area of low significance.

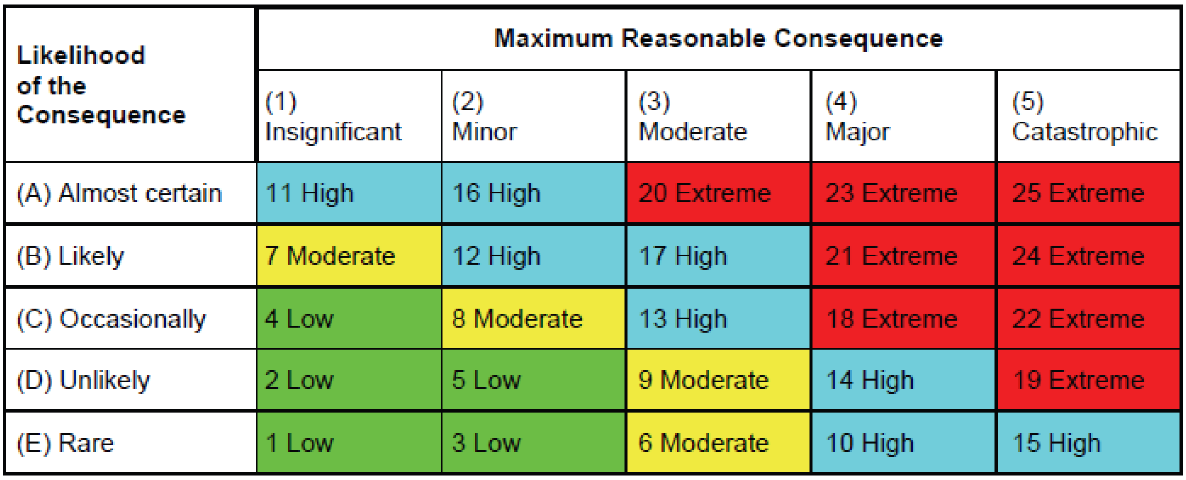
Likelihood Index



Level	**Descriptor**	**Description**	**Guideline**
A	Almost Certain	Consequence is expected to occur in most circumstances.	Occurs more than once per month.
B	Likely	Consequence will probably occur in most circumstances.	Occurs once every 1 month – 1 year.
C	Occasionally	Consequence should occur at some time.	Occurs once every 1 year - 10 years.
D	Unlikely	Consequence could occur at some time.	Occurs once every 10 years – 100 years.
E	Rare	Consequence may only occur in exceptional circumstances.	Occurs less than once every 100 years.

Source: AS/NZS 4360:2004 Risk Management

Qualitative Risk Matrix



Likelihood of the Consequence	**Maximum Reasonable Consequence**				
	(1) Insignificant	(2) Minor	(3) Moderate	(4) Major	(5) Catastrophic
(A) Almost certain	11 High	16 High	20 Extreme	23 Extreme	25 Extreme
(B) Likely	7 Moderate	12 High	17 High	21 Extreme	24 Extreme
(C) Occasionally	4 Low	8 Moderate	13 High	18 Extreme	22 Extreme
(D) Unlikely	2 Low	5 Low	9 Moderate	14 High	19 Extreme
(E) Rare	1 Low	3 Low	6 Moderate	10 High	15 High

Source: AS/NZS 4360:2004 Risk Management

Appendix 5 Quantitative Risk Assessment

BUILDING AND WORKS WITHIN A COASTAL EROSION HAZARD AREA

Performance Criteria C10.6.1 P1.1 **Buildings and works, within a coastal erosion hazard area must have a tolerable risk, having regard to:**	**Relevance**	**Management Options**	**Preliminary Risk Assessment (where relevant)**			**Further Assessment Required**
			Consequence	**Likelihood**	**Risk**	
(a) whether any increase in the level of risk from coastal erosion requires any specific hazard reduction or protection measures;	The building structure is beyond the modelled 2100 1% AEP erosion hazard area		Minor (2)	Unlikely (D)	Low (5)	No
(b) any advice from a State authority, regulated entity or a council; and	N/A		Minor (2)	Unlikely (D)	Low (5)	No
(c) the advice contained in a coastal erosion hazard report.			Insignificant (1)	Rare (E)	Low (1)	No
Performance Criteria C10.6.1 P1.2 **A coastal erosion hazard report demonstrates that:**						
(a) the building and works:						
(i) do not cause or contribute to any coastal erosion on the site, on adjacent land or public infrastructure; and	The building structure is beyond the modelled 2100 1% AEP erosion hazard area		Minor (2)	Rare (E)	Low (3)	No
(ii) can achieve and maintain a tolerable risk from a coastal erosion event in 2100 for the intended life of the use without requiring any specific coastal erosion protection works;	Risk low and tolerable no works required		Minor (2)	Unlikely (D)	Low (3)	No
(b) buildings and works are not located on actively mobile landforms, unless for engineering or remediation works to protect land, property and human life	Site not actively mobile landform		Insignificant (1)	Rare (E)	Low (1)	No

BUILDING AND WORKS WITHIN A COASTAL INUNDATION HAZARD AREA

Performance Criteria C11.6.1 P1.1 **Buildings and works, within a coastal inundation hazard area, can achieve and maintain a tolerable risk from coastal inundation, having regard to:**	**Relevance**	**Management Options**	**Preliminary Risk Assessment (where relevant)**			**Further Assessment Required**
			Consequence	**Likelihood**	**Risk**	
a) whether any increase in the level of risk from coastal inundation requires any specific hazard reduction or protection measures;	The building structure is beyond the modelled 2100 1% AEP inundation hazard area	The finished floor level of the proposed units must be constructed at or above 2.6 m AHD	Minor (2)	Unlikely (D)	Low (5)	No
b) any advice from a State authority, regulated entity or a council; and	N/A		Minor (2)	Unlikely (D)	Low (5)	No
c) the advice contained in a coastal inundation hazard report.						No
Performance Criteria C11.6.1 P1.2 **A coastal inundation hazard report also demonstrates that the building or works:**						
a) do not cause or contribute to coastal inundation on the site, on adjacent land or public infrastructure; and	Proposed development will not impose any additional risk from coastal inundation zone. Stormwater needs to be assessed overland flows in the local area has been predicted.	Stormwater Management Plan is required and must include overland flow paths	Minor (2)	Unlikely (D)	Low (5)	YES
b) can achieve and maintain a tolerable risk from a 1% annual exceedance probability coastal inundation event in 2100 for the intended life of the use without requiring any specific coastal inundation protection works.	The development can achieve and maintain a tolerable level of risk to typical 50 year life of building as modelled for a 2100 1% AEP event		Minor (2)	Rare (E)	Low (3)	No

GEO-Environmental Solutions
29 Kirksway Place, Battery Point
Tasmania 7004
Phone: 03 62231839

17 December 2024

Natural Values Assessment – Waterway and Coastal Protection Area

Project area - 1 Hayfield Place Bridgewater 7030

PID: 9163759

C/T: 176642/3

The following report is intended to demonstrate compliance with Code C7.0 (Waterways and Coastal Protection Area) of the Tasmania Planning Scheme – Brighton Council.

The proposal is for a new unit's development on the above address as shown on the attached site plan. The proposed site is in close proximity to the shore of the Derwent River and therefore triggers Code C7.0 of the Tasmania Planning Scheme – Brighton which requires compliance with the standards outlined at C7.6.1 for Buildings and Works.

Table 1. Extract of Tasmania planning scheme C7.6.1 Buildings and Works

P1.1 Buildings and works within a waterway and coastal protection area must avoid or minimise adverse impacts on natural assets, having regard to:	
Performance Criteria	Comment / Compliance
(a) impacts caused by erosion, siltation, sedimentation and runoff;	Any proposed development works should only be approved with an appropriate, site specific soil and water management plan to reduce the risk of environmental harm and erosion. The site should regularly maintain and progressively stabilised through vegetation and landscaping to reduce the potential for erosion.
(b) impacts on riparian or littoral vegetation;	No riparian or littoral vegetation is present on the site
(c) maintaining natural streambank and streambed condition, where it exists;	No works proposed in streambank
(d) impacts on in-stream natural habitat, such as fallen logs, bank overhangs, rocks and trailing vegetation;	The in-stream natural habitat will not be disturbed under the current proposal.
(e) the need to avoid significantly impeding natural flow and drainage;	The watercourse is well defined, the proposed works area is located well away from the watercourse

(f) the need to maintain fish passage, where known to exist;	n/a
(g) the need to avoid land filling of wetlands;	No wetlands are located at the project area.
(h) the need to group new facilities with existing facilities, where reasonably practical;	The project area is a vacant land lot which doesn't have any existing facilities on site.
(i) minimising cut and fill;	There is only a minimal proposed cut/fill for the site required the proposed units.
(j) building design that responds to the particular size, shape, contours or slope of the land;	The proposed development works are strategically positioned to accommodate multiple units with a low impact to the natural values. The proposed unit's placement allows for efficient site development, minimizing the need for unnecessary excavations, while ensuring convenient access from Hayfield Place.
(k) minimising impacts on coastal processes, including sand movement and wave action;	n/a
(l) minimising the need for future works for the protection of natural assets, infrastructure and property;	No further works required other than regular maintenance.
(m) the environmental best practice guidelines in the Wetlands and Waterways Works Manual; and	All works should be undertaken in compliance with the 'Wetlands and Waterways Works Manual' (DPIWE, 2003).
(n) the guidelines in the Tasmanian Coastal Works Manual.	All proposed works should be following the guidelines of the Tasmania Coastal Works Manual.

A2.

Acceptable Solutions	Comment / Compliance
Building and works within a Future Coastal Refugia Area must be within a building area on a plan of subdivision approved under this planning scheme.	No development will occur within a Future Coastal Refugia Area

A3.

Acceptable Solutions	Comment / Compliance
Development within a waterway and coastal protection area or a future coastal refugia area must not involve a new stormwater point discharge into a watercourse, wetland or lake.	No new stormwater discharge points are proposed to watercourse, wetland or lake. The proposed dwelling will be connected to an existing stormwater and sewage line.

A4.

Dredging or reclamation must not occur within a waterway and coastal protection area or a future coastal refugia area	
Acceptable Solutions	Comment / Compliance
Dredging or reclamation must not occur within a waterway and coastal protection area or a future coastal refugia area.	There is no proposed dredging or reclamation on the site.

A5.

<table>
<tr><td colspan="2">Coastal protection works or watercourse erosion or inundation protection works must not occur within a waterway and coastal protection area or a future coastal refugia area.</td></tr>
<tr><td>Acceptable Solutions</td><td>Comment / Compliance</td></tr>
<tr><td>Coastal protection works or watercourse erosion or inundation protection works must not occur within a waterway and coastal protection area or a future coastal refugia area.</td><td>No coastal protection works, or waterway erosion or inundation protection works are proposed within the Waterway and Coastal Protection Area or a future coastal refugia area. If such activities are to be undertaken, then they must be designed by a suitably qualified person to minimise adverse impacts on natural coastal processes.</td></tr>
</table>

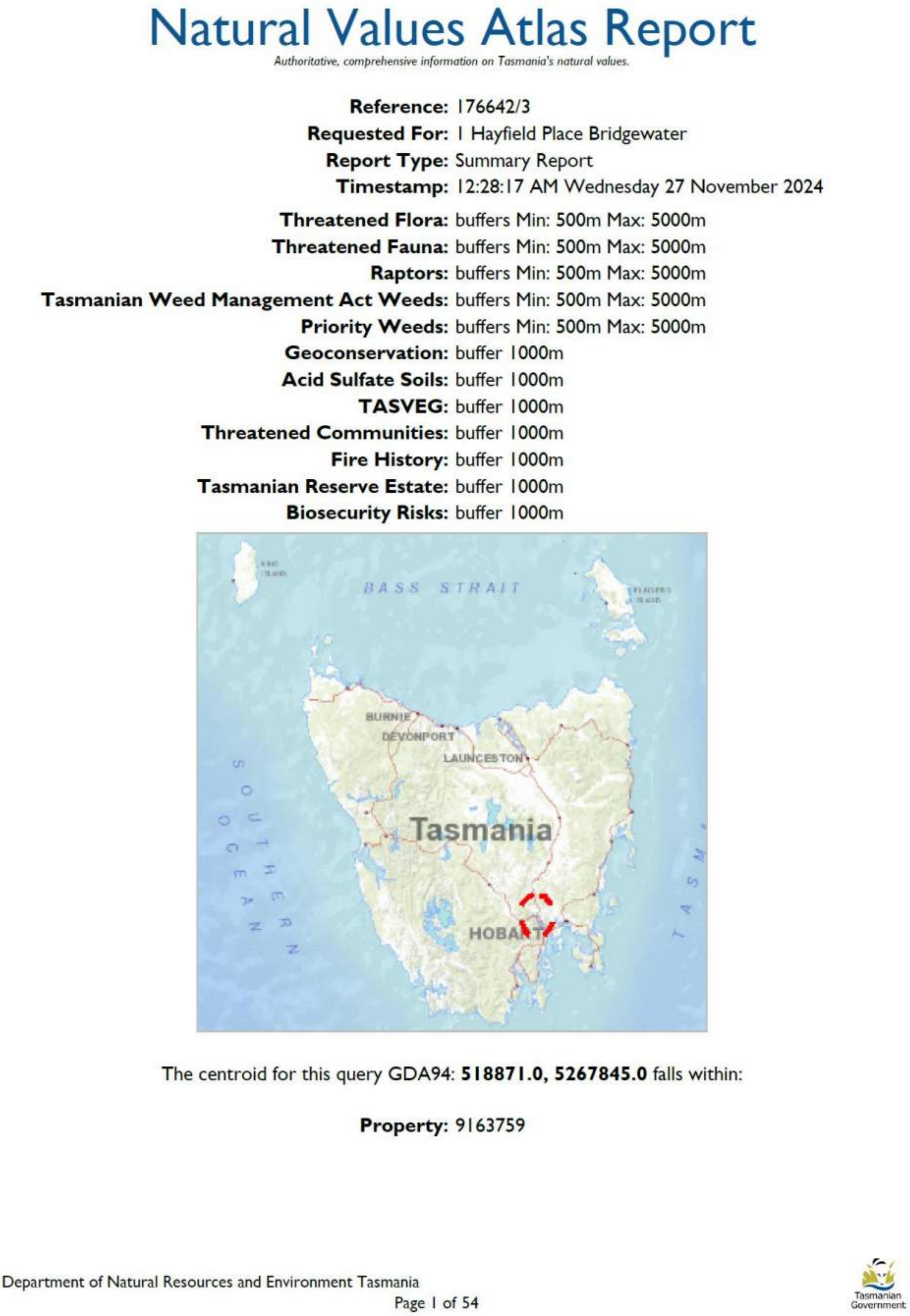
The attachment in Appendix 2 shows the proposed works and the WCP overlay of the project area. The assessment has been completed based on the site plan (refer to Appendix 3). The Integrated Conservation Value for the waterway has been identified as LOW (NVA report run on the 27/11/2024). Table 1 associated figures and plan demonstrate compliance with the performance criteria of section C7.6.1 of Tasmanian Planning Scheme – Brighton Council.

In considering the objectives of the Code 7 it is anticipated that there will be no unnecessary or unacceptable impacts on natural values as a result of the proposed dwelling and that any future development that is facilitated by the proposed dwelling is unlikely to lead to unnecessary or unacceptable impacts on natural values.

Dr John Paul Cumming B.Agr.Sc (hons) PhD CPSS GAICD

Environmental and Engineering Soil Scientist

Appendix 1. Natural Value Report



Natural Values Atlas Report

Authoritative, comprehensive information on Tasmania's natural values.

Reference: 176642/3
Requested For: 1 Hayfield Place Bridgewater
Report Type: Summary Report
Timestamp: 12:28:17 AM Wednesday 27 November 2024

Threatened Flora: buffers Min: 500m Max: 5000m
Threatened Fauna: buffers Min: 500m Max: 5000m
Raptors: buffers Min: 500m Max: 5000m
Tasmanian Weed Management Act Weeds: buffers Min: 500m Max: 5000m
Priority Weeds: buffers Min: 500m Max: 5000m
Geoconservation: buffer 1000m
Acid Sulfate Soils: buffer 1000m
TASVEG: buffer 1000m
Threatened Communities: buffer 1000m
Fire History: buffer 1000m
Tasmanian Reserve Estate: buffer 1000m
Biosecurity Risks: buffer 1000m

The centroid for this query GDA94: **518871.0, 5267845.0** falls within:

Property: 9163759

Department of Natural Resources and Environment Tasmania
Page 1 of 54

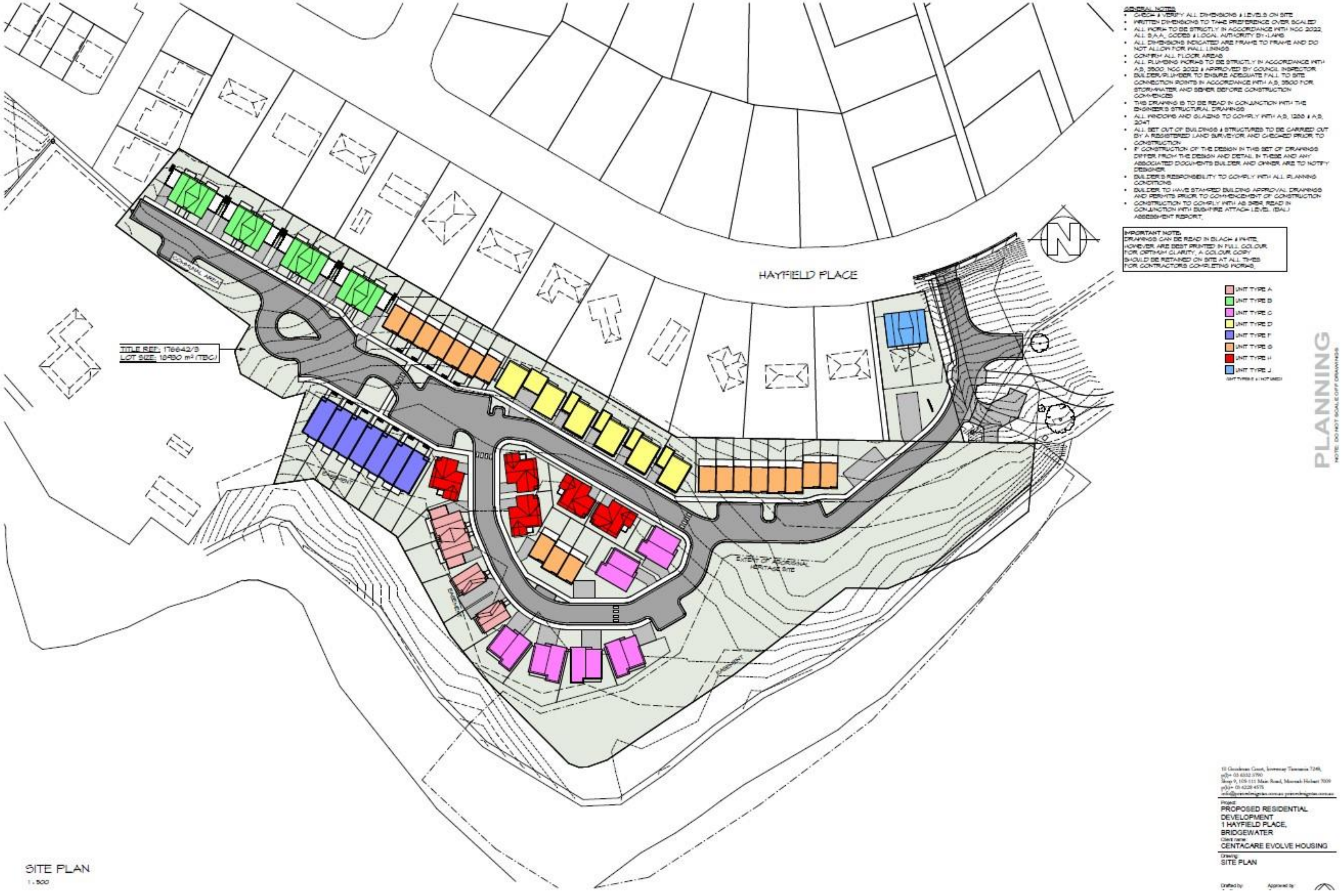
Tasmanian Government

Front cover of NVA report (full report available on request).

Appendix 2. Tasmanian Planning Scheme Overlays

Datum:	GDA 2020 MGA Zone 55
Imagery:	Bing Satellite
Prepared By:	VS
Project:	1 Hayfield Place Bridgewater

Appendix 3. Site Plan



GENERAL NOTES:
- CHECK & VERIFY ALL DIMENSIONS & LEVELS ON SITE
- WRITTEN DIMENSIONS TO TAKE PREFERENCE OVER SCALED
- ALL WORK TO BE STRICTLY IN ACCORDANCE WITH NCC 2022, ALL S.A.A. CODES & LOCAL AUTHORITY BY-LAWS
- ALL DIMENSIONS INDICATED ARE FRAME TO FRAME AND DO NOT ALLOW FOR WALL LININGS
- CONFIRM ALL FLOOR AREAS
- ALL PLUMBING WORKS TO BE STRICTLY IN ACCORDANCE WITH A.S. 3500, NCC 2022 & APPROVED BY COUNCIL INSPECTOR
- BUILDER/PLUMBER TO ENSURE ADEQUATE FALL TO SITE CONNECTION POINTS IN ACCORDANCE WITH A.S. 3500 FOR STORMWATER AND SEWER BEFORE CONSTRUCTION COMMENCES
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE ENGINEER'S STRUCTURAL DRAWINGS
- ALL WINDOWS AND GLAZING TO COMPLY WITH A.S. 1288 & A.S. 2047
- ALL SET OUT OF BUILDINGS & STRUCTURES TO BE CARRIED OUT BY A REGISTERED LAND SURVEYOR AND CHECKED PRIOR TO CONSTRUCTION
- IF CONSTRUCTION OF THE DESIGN IN THIS SET OF DRAWINGS DIFFER FROM THE DESIGN AND DETAIL IN THESE AND ANY ASSOCIATED DOCUMENTS BUILDER AND OWNER ARE TO NOTIFY DESIGNER
- BUILDER'S RESPONSIBILITY TO COMPLY WITH ALL PLANNING CONDITIONS
- BUILDER TO HAVE STAMPED BUILDING APPROVAL DRAWINGS AND PERMITS PRIOR TO COMMENCEMENT OF CONSTRUCTION
- CONSTRUCTION TO COMPLY WITH AS 3959, READ IN CONJUNCTION WITH BUSHFIRE ATTACK LEVEL (BAL) ASSESSMENT REPORT.

IMPORTANT NOTE:
DRAWINGS CAN BE READ IN BLACK & WHITE,
HOWEVER ARE BEST PRINTED IN FULL COLOUR
FOR OPTIMUM CLARITY, A COLOUR COPY
SHOULD BE RETAINED ON SITE AT ALL TIMES
FOR CONTRACTORS COMPLETING WORKS.

- 🟥 UNIT TYPE A
- 🟩 UNIT TYPE B
- 🟪 UNIT TYPE C
- 🟨 UNIT TYPE D
- 🟦 UNIT TYPE F
- 🟧 UNIT TYPE G
- 🟥 UNIT TYPE H
- 🟦 UNIT TYPE J

(UNIT TYPES E & I NOT USED)

10 Goodman Court, Invermay Tasmania 7248,
p(l)+ 03 6332 3790
Shop 9, 105-111 Main Road, Moonah Hobart 7009
p(h)+ 03 6228 4575

Project:
PROPOSED RESIDENTIAL DEVELOPMENT
1 HAYFIELD PLACE,
BRIDGEWATER
Client name:
CENTACARE EVOLVE HOUSING
Drawing:
SITE PLAN

Drafted by: Approved by:

Prepared for:
Centacare Evolve Housing

1 Hayfield Place Unit Development

FLOOD INUNDATION REPORT

Project Number: FE_24038
First Release: 18 September 2024

flüssig
Engineers

L4/ 116 BATHURST ST
HOBART TASMANIA 7000
ABN: 16 639 276 181

Document Information

Title	*Client*	*Document Number*	*Project Manager*
Unit Development Redevelopment Flood Inundation Report	**Centacare** **Evolve Housing**	FE_24038	Max W. Möller *Principal Hydraulic Engineer*

Document Initial Revision

REVISION 00	Staff Name	Signature	Date
Prepared by	Max W. Moller ***Principal Hydraulic Engineer***		09/09/2024
Prepared by	Ash Perera ***Senior Hydraulic Engineer***		09/09/2024
GIS Mapping	Damon Heather ***GIS Specialist***		09/09/2024
Reviewed by	Christine Keane ***Senior Water Resources Analyst***		09/09/2024
Reviewed by	John Holmes ***Senior Engineer***		15/09/2024
Authorised by	Max W. Möller ***Principal Hydraulic Engineer***		17/09/2024

Rev No.	Description	Prepared by	Authorised by	Date
00	DRAFT for Client Comments	MM	MM	18.09.2024
01	Final	MM	MM	05.11.2024

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ABBREVIATIONS AND ACRONYMS

Abbreviation/ Acronym	Description
AEP	Annual Exceedance Probability
ARF	Areal Reduction Factor reduces the design rainfall as the catchment area increases
AVM	Average Variability Method uses a representative design rainfall temporal pattern per duration
BoM	The Australian Bureau of Meteorology
CFD	Computational Fluid Dynamics
CL	Continuing Loss (mm/hr)
DV	Product of depth and velocity (m^2/s)
FSL	Full Supply Level
BC	Brighton Council
GSAM	Generalised South Australia Method estimates PMP rainfall for durations equal or longer than 24 hours appropriate to the South East of Australia
GSDM	Generalised Short-Duration Method estimates PMP rainfall for durations equal to or shorter than 6 hours
HAT	Highest Astronomical Tide (mAHD)
IFD	Intensity Frequency Duration refers to statistics on design rainfall
IL	Initial Loss (mm)
IWL	Initial Water Level describing the first water level during a stormwater model simulation
k_C	Catchment routing parameter used in the rainfall-runoff model
PMF	Probable Maximum Flood is the theoretical largest discharge combining the most saturated catchment conditions with the largest rainfall (PMP) (m^2/s)
PMP	Probable Maximum Precipitation is the theoretical largest rainfall (mm)
Q	Discharge (m^3/s)
RCP	Representative Concentration Pathways are scenarios of future greenhouse gas trajectories
RFFE	Regional Flood Frequency Estimate
SLR	Sea Level Rise (m)

1. Introduction

Centacare Evolve Housing has engaged the services of **Flüssig Engineers** to conduct a site-specific Flood Hazard Report for the Unit Development project located at 1 Hayfield Place, Bridgewater, within the jurisdiction of the Brighton Council municipality. The objective of this report is to assess the flood characteristics in both existing conditions and post-development scenarios, specifically considering the 1% Annual Exceedance Probability (AEP) along with climate change rainfall increase for 2100 and induced River Derwent's storm surge level at 2.30 mAHD. This evaluation is crucial for informing the development process.

1.1 Development

The proposed 58 Unit development. The current lot at No 1 Hayfield Place, Bridgewater has an approximately area of 18,800 m^2. This proposed Unit development triggers the Coastal Inundation Hazard Code as the development falls within Brighton Council low coastal inundation hazard band.

1.2 Objectives and Scope

This flood analysis has been written to meet the standards of the Tasmanian Planning Scheme (TPS) – Brighton, with the intent of understanding the development risk with respect to riverine flooding. The objectives of this study are:

- This study is assessed against a 1% Annual Exceedance Probability (AEP) storm, incorporating the effects of climate change, characterised by an increase in rainfall intensity and the associated storm surge for the 1% AEP.
- Undertake a comparative analysis of flooding between pre- and post-development scenarios. This involves assessing how the proposed development aligns with established standards and criteria. The potential consequences of the planned development on the risk of flooding for adjacent land, structures, and infrastructure will be assessed. This evaluation encompasses various factors, including frequency, extent, depth, velocity, and floor levels.
- Provide recommendations for flood mitigation strategies applicable to the potential future development, wherever deemed appropriate. These suggestions aim to enhance the resilience of the development in the face of potential flood hazards. Any measures or design features intended to control inundation and mitigate risk, along with the subsequent impact on the overall risk level, will be evaluated and considered.

Through addressing these objectives, this study aims to contribute valuable insights and information to support informed decision-making in accordance with the regulatory framework outlined in the Tasmanian Planning Scheme.

1.3 Limitations

This investigation is constrained by the defined objectives set forth by our clients, the accessibility and dependability of available data, and includes the following considerations:

- The flood model is specifically tailored to a worst-case scenario, encompassing a 1% Annual Exceedance Probability (AEP) in combination with the effects of climate change (CC) plus sea level rising during a temporal design storm.
- All model parameters have been extrapolated from best practice manuals and relevant studies within the area, ensuring alignment with established methodologies.
- Any data supplied by the client or governmental bodies for the purposes of this study is assumed to be fit for its intended purpose. However, it should be noted that a comprehensive accuracy check has been conducted on the provided data.

- The study is expressly designed to assess the impact of the new development on flooding behaviour within the specified area. Caution is advised against using this study as a comprehensive flood analysis beyond the designated scope without additional assessment.

These limitations are integral to the study's context and should be taken into consideration when interpreting the findings and applying them in decision-making processes.

2. Flood History and Model Build

2.1 Flood History

The Bridgewater, Tasmania, has a long and significant history marked by its strategic location and infrastructure developments, which have also influenced its flooding history.

The town's origins date back to the early 19th century when it became a key crossing point over the Derwent River. In 1830, construction began on the Bridgewater Causeway, a monumental project carried out by convicts. This causeway, completed in 1836, was crucial for connecting Hobart to Launceston and facilitating transportation and trade in the region. The first bridge was constructed in 1849 to complement the causeway, with subsequent bridges built to improve the infrastructure, including the notable lift bridge completed in 1946 (Bridgewater Bridge Project) (Aussie Towns).

In recent years, flood management and mitigation efforts have been a priority, especially with the construction of a new Bridgewater Bridge, which started in October 2022. This project aims to enhance the safety and reliability of the crossing, addressing some of the flood-related challenges faced by the older infrastructure (Bridgewater Bridge Project).

2.2 Overview of Catchment

The proposed unit development at Lot 1 Hayfield Place in Bridgewater is significantly influenced by both riverine and overland flood inundation, which together shape the hydrological dynamics of the study site. The proximity of the River Derwent, located just over 40 metres from the site, plays a central role in the flood risk profile of the area.

The River Derwent is a major river system in Tasmania, originating in the Central Highlands and flowing southeast through a diverse landscape, eventually reaching the ocean at Storm Bay. This extensive journey through rugged terrain results in a river system with varied hydrological characteristics that influence flooding patterns along its banks. The contributing catchment area of the River Derwent is vast, spanning approximately 10,200 square kilometres, as depicted in Figure 1. This large catchment size means that significant rainfall events or snowmelt in the upper reaches of the catchment can result in substantial riverine flooding downstream, including in the area around Lot 1 Hayfield Place.

The proximity of the River Derwent to the study site means that during high-flow events, such as those associated with a 1% Annual Exceedance Probability (AEP) flood or a coincidental storm surge, there is a considerable risk of riverine floodwaters encroaching upon Lot 1. The river's close location amplifies the potential for flooding, particularly when combined with localised overland flow paths, creating a complex hydrological scenario that needs careful consideration in flood risk assessments for the proposed development.

Lot 1 Hayfield Place is also positioned within an immediate catchment area of approximately 30 hectares, which significantly impacts its flood risk profile. This immediate catchment comprises a network of streets, urban surfaces, and natural depressions that all contribute to overland flow during rainfall events. The lot receives inflow from various overland flow paths that originate from the surrounding catchment, particularly during periods of intense rainfall when the capacity of local stormwater systems may be exceeded.

The topography of the immediate catchment is such that water from higher elevations and adjacent streets, including Hayfield Place, Brighton Road, Derwent Avenue, Eddington Street, and Gagebrook Road, flows downhill towards Lot 1. These overland flow paths are critical as they direct runoff from impervious surfaces, driveways, and natural drainage lines towards the lower-lying areas of the lot. This inflow converges at Lot 1 and subsequently moves towards the River Derwent, as shown in Figure 2, which provides a detailed representation of the immediate catchment area.

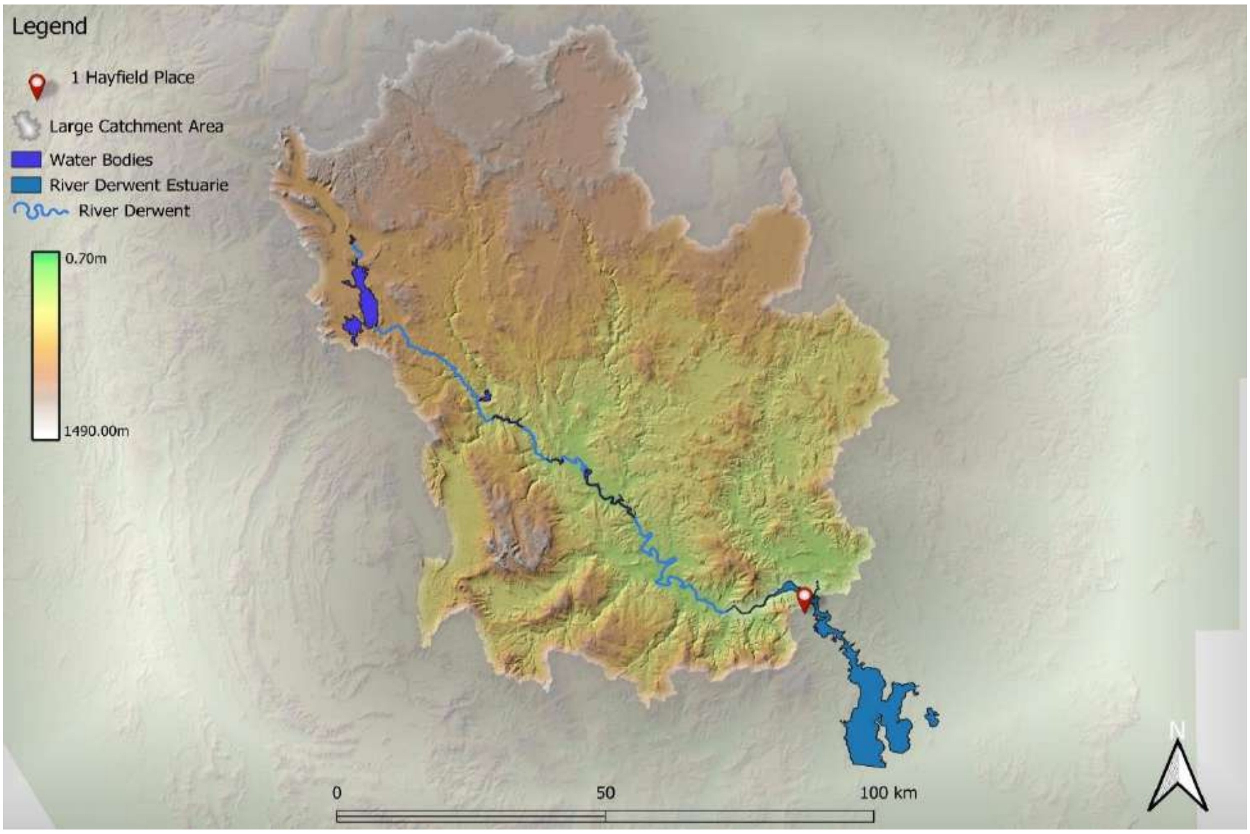

Figure 1. Full Contributing Catchment, Unit Development, Bridgewater

Figure 2. Immediate Catchment, Unit Development, Bridgewater

2.3 Previous Studies

Flüssig Engineers acknowledge the previous hydrological and flood studies conducted for the River Derwent. The principal preceding studies relevant to this investigation are as follows:

- Tasmanian Strategic Flood Map Derwent Study Area Model Calibration Final Report (WMAWater 2023)
- New Bridgewater Bridge Flood Hazard Report (Entura 2021)

2.4 Hydrology

Flüssig Engineers have adopted the results from the Council's accepted New Bridgewater Bridge Flood Hazard Report (Entura 2021) as hydrograph inflow points at the River Derwent, with the immediately local urban contributing catchment were modelled as a refined rain on gride area. Refer to Figure 3 for inflow points and sea level rise boundary condition's locations.

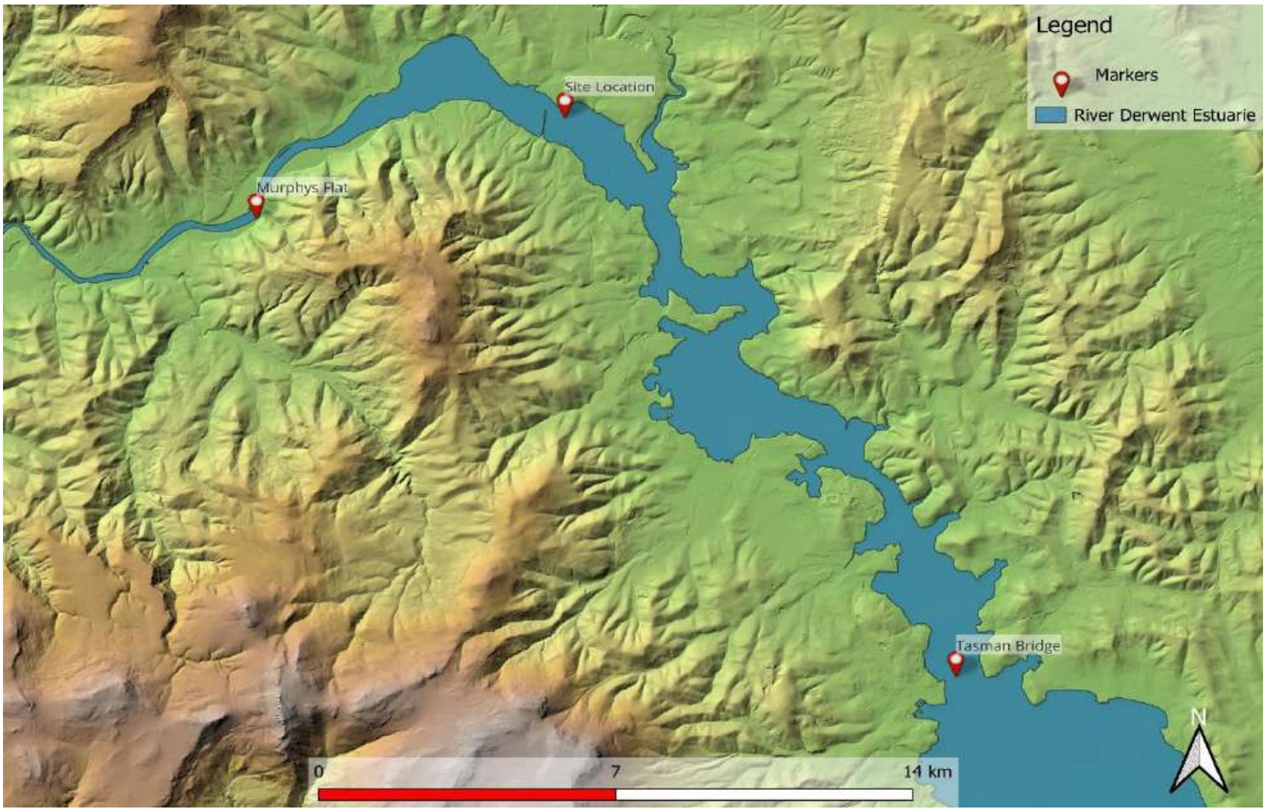

Figure 3. Inflow Points Boundary Conditions Location, Unit Development, Bridgewater.

Table 1 states the adopted hydrological parameters for immediate catchment rain on grid modelling for the development area, the RAFTS catchment. the adopted initial and continuous rainfall loses values were conservatively adopted from best practices and from Australian Rainfall & Runoff Revision Project 6 Loss Models for Catchment Simulation – Urban Catchments Stage 2 Report.

Table 1. Parameters for RAFTS catchment

Rain on Grid Area (ha)	Initial Loss Perv/imp (mm/ hr)	Continuing Loss Perv/imp (mm/hr)	Manning's N pervious	Manning's N impervious	Non-linearity factor
30	5/1	1.0/0.0	0.045	0.02	-0.285

2.4.1 Design Rainfall Event

In Figure 4, the box and whisker plot visually represent the output generated by the model run. The results show that the 1% Annual Exceedance Probability (AEP) 305-minute storm with temporal pattern

6 emerged as the most severe in terms of median storm characteristics. This particular storm event was selected as the worst-case scenario for further integration into the hydraulic model.

The utilisation of this specific storm pattern ensures a comprehensive assessment of the system's response under conditions representing a high level of hydrological stress, thereby enhancing the model's ability to simulate and address extreme weather scenarios.

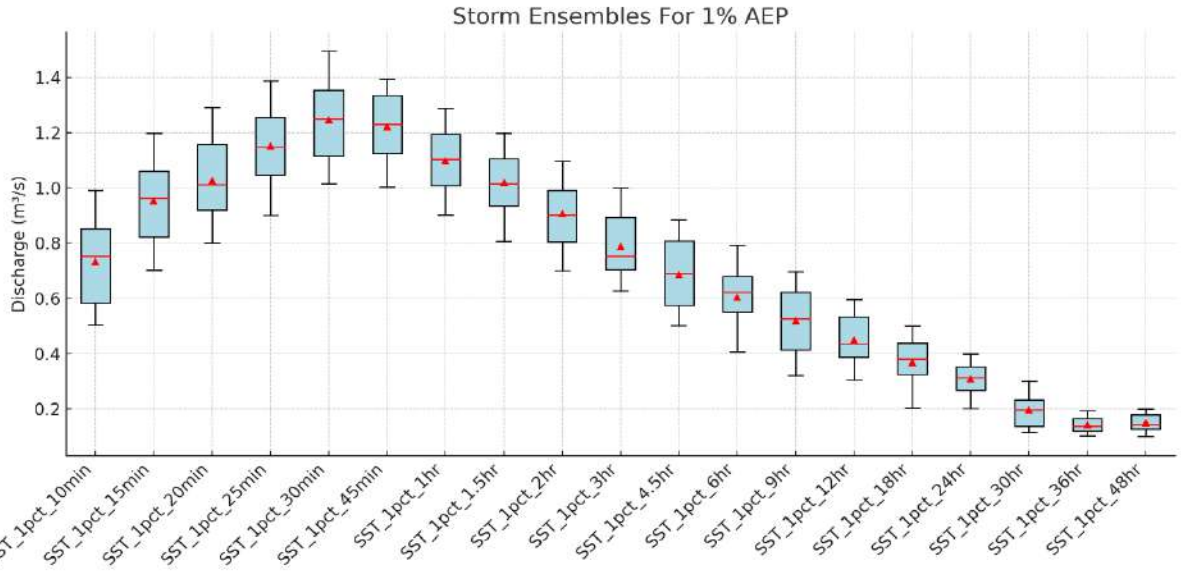

Figure 4. 1% AEP Flood Event Model, Box and Whisker Plot

2.4.2 Climate Change

As per ARR 2019 Guidelines, for an increase in rainfall due to climate change at 2100, it is recommended the use of RCP 8.5. However, ARR 2019 recommends that this figure be used in lieu of more local data being available.

The base scenario of the Climate Futures Tasmania (2010) study was revised following the ARR 2019 Australasia Climate Change study (undertaken by the University of Tasmania), resulting in the original increase in rainfall be increased to 24.0%.

Table 2 shows the ARR 8.5 increase compared to the revised increase of 24% that has been adopted by Brighton Council and therefore used within the model.

Table 2. Climate Change Increases

Catchment	CFT increase @ 2090	ARR 8.5 increase @ 2090
Lower Derwent	14.6%	24%

2.4.3 Calibration/Validation

This immediate catchment has no stream gauge to calibrate the model against a real-world storm event. Similarly, there is little historical information available, and limited available past flood analysis undertaken to validate against the flows obtained in the model. A Regional Flood Frequency Estimation model (RFFE) has been used to calibrate our rain on grid rainfall estimation. The RFFE values are listed in Table 3 below.

Table 3. Regional Flood Frequency Estimation model (RFFE) v/s Flussig Result.

AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)	Flussig Discharge (m^3/s)
50	0.0500	0.0200	0.100	0.071
20	0.0800	0.0400	0.180	0.910
10	0.120	0.0500	0.290	0.144

5	0.150	0.0500	0.450	0.168
2	0.210	0.0500	0.760	0.254
1	0.360	0.0500	1.090	**0.475**

Input Data	
Date/Time	2024-09-09 15:30
Catchment Name	Bridgewater
Latitude (Outlet)	-42.742
Longitude (Outlet)	147.231
Latitude (Centroid)	-42.722
Longitude (Centroid)	147.25
Catchment Area (km^2)	0.3
Distance to Nearest Gauged Catchment (km)	23.51
50% AEP 6 Hour Rainfall Intensity (mm/h)	4.205361
2% AEP 6 Hour Rainfall Intensity (mm/h)	8.927339
Rainfall Intensity Source (User/Auto)	Auto
Region	Tasmania
Region Version	RFFE Model 2016 v1
Region Source (User/Auto)	Auto
Shape Factor	4.95*
Interpolation Method	Natural Neighbour
Bias Correction Value	0.22

2.5 Hydraulics

2.5.1 Survey

The 2D surface model was taken from a combination of Greater Hobart LiDAR 2013-DEM-GRID (Geoscience Australia) and Aldanmark Consulting Engineering 3D TIN to create a 1m and 0.25m cell size DEM. For the purposes of this report, 1.0 m cells are enough to capture accurate flow paths. The DEM with hill shading can be seen below (Figure 5).

Hydraulic structures are included as either 1D or 2D structures throughout the model, where 1D structures exists a 1D/2D link is provided to allow flow to transition to and from the 2D surface.

Figure 5. 1.0m DEM (Hill shade) of Lot Area

2.5.2 Pipes and pits

Pipes and pits were modelled as 1D underground network within the catchment model included the outfall discharge at the River Derwent. Pipe and pit data was supplied by Brighton Council for inclusion in the model. Underground pipes were connected via 1D/2D connected pits. Pits adopted an inlet flow limitation based off a double grated pit depth/flow curve.

2.5.3 Key Structures

Key infrastructure elements on the site consist of an established causeway, which has been incorporated into the model, utilises a modelled Digital Elevation Model (DEM) with the integration of impervious wall in Infoworks ICM model. This encompasses both the existing Bridgewater causeway and Bridgwater bridge existing and new pier structures under construction within its framework, ensuring comprehensive representation and analysis within the model's scope building.

2.5.4 Roads

Roads often form the basis for overland flow in high frequency events, however the kerb and channel are not always picked up by DEM surface. To correct for the drainage lines, mesh polygons were used to delineate road corridors with the roads being incorporated a z-line along the gutter to ensure the kerb invert is represent in the mesh.

In our Digital Elevation Model (DEM), a "z-line" refers to a line representing a constant elevation or contour line. These lines connect the existing kerb points of equal elevation on the terrain surface, with maximum of 100mm from invert to top of kerb, allowing for visualisation of the terrain's shape and elevation changes.

2.5.5 Buildings

Specifically, residential houses and commercial buildings were integrated into the DEM by elevating the corresponding grid cells representing these structures by a standardised height of 0.3 meters above the natural ground surface. Subsequently, the re-sampled grids were utilised to establish the Infoworks ICM model, thus forming a foundational framework for the subsequent analysis and simulation of flood dynamics.

This method allows for flow through the building if the flood levels/ pressure become great enough. The aim is to mimic flow through passageways such as doors, windows, and hallways.

2.5.6 Boundary Conditions

Infoworks ICM operates as a single use software, streamlining the hydrology and hydraulic modelling processes within a unified framework. This feature eliminates the necessity for separate inflow boundary conditions, as the hydrology model seamlessly integrates with the hydraulic model through a 1D or 2D link.

It's crucial to note that the catchment into the Unit development site is subject to riverine and tidal influence. To account for this coincidental storm events, a boundary inflow conditions is established approximately 6.5 kms upstream the River Derwent, at Murphys Flat Bend, allowing for the interaction between riverine and coastal waters.

The downstream boundary of the InfoWorks ICM model extends to the Tasman Bridge. To define this boundary, the Storm Surge Peak Tide Level (SSPTL) was set at 2.30 AHD for the 1% AEP + CC scenario in the River Derwent.

The choice of the 1% AEP Storm Surge Peak Tide Level (SSPTL) over the Sea Level Rise Peak Tide Level (SLRPTL) was carefully considered, as it offers a more realistic implementation during major storm events over the development's lifespan. The model run was adjusted to reflect climate change, with the incorporation of the Storm Surge Peak Tide Level (SSPTL) as the sea boundary in the study. Furthermore, various coincidental scenarios involving storm surge and riverine flooding were simulated, including:

- 1% AEP rainfall + CC + 1% SSPTL (used in the hydrological and hydraulic model)
- 1% AEP rainfall + CC + 1% SLRPTL.

Table 4. Flow Discharge Input

Inflow Point Name	Entura Peak Flow 1% AEP + CC (m³/s)	Flussig Peak Flow 1% AEP + CC (m³/s)
Murphys Flat	4,240	4,300
Boundary Name	**Entura SS 1% AEP - (m AHD)**	**Flussig SS 1% AEP - (m AHD)**
Tasman Bridge	2.29	2.30

2.5.7 Roughness (Manning's n)

Proposed structures were set to the finished surface level as shown on design drawings PD-23113. Figure 6 shows the adopted Manning values for the hydraulic model for the study site and the full catchment area.

The model grid's roughness and equivalent Manning's n values were derived from land use data. The specific values utilised are outlined in Table 6 provided below. These parameters have proven effective in previous flood mapping projects undertaken in Tasmania.

Table 5. Manning's Coefficients (ARR 2019)

Land type	Roughness, Manning's M	Equivalent Manning's 'n' (1/Roughness)
Built up areas	8	0.125
Open space	28	0.025
Waterways	33	0.029
Roads	55	0.013
Houses/Buildings Roof	56	0.010

Figure 6. Manning's n derived polygon for the 2D hydraulic model.

3. Model Results

3.1 Pre-Development Scenario

As shown in Figure 7, the pre-development scenario for the proposed unit development at No1 Hayfield Place in Bridgewater has been carefully modelled to assess potential flood impacts under a combination of riverine and storm surge events. The analysis considers a 1% Annual Exceedance Probability (AEP) flood event, a projected 24% increase in rainfall due to climate change (CC), and a 1% Storm Surge Peak Tide Level (SSPTL). These conditions represent a coincidental event where both riverine flooding from the River Derwent and a storm surge intersect, producing a comprehensive results of flood risk in the area.

Upon detailed examination of the pre-development model results, it is evident that the primary source of inundation at the site arises from the River Derwent. Under the combined riverine and storm surge scenario, floodwaters predominantly follow the natural channel of the river.

The modelling indicates that floodwaters from the River Derwent can spill over during peak events, leading to widespread shallow flooding across the site. This floodwater originates not only from the river itself but also from a combination of localised runoff and storm surge effects, which collectively contribute to the extent of flooding experienced on the site.

Furthermore, the local catchment immediately surrounding No1 Hayfield Place adds another layer to the flood dynamics observed. The terrain and topographical features of the site facilitate the movement of shallow, slow-moving water from the surrounding catchment towards the River Derwent. This localised runoff is particularly evident in lower sections of the site, where it flows gradually across the land, eventually converging with the larger body of floodwater moving from the river. The convergence of these two sources of flooding riverine and localised runoff creates a complex interaction that increases the overall inundation depth and coverage across the lot.

3.2 Post-development Scenario

The proposed development, encompassing new residential units and an internal road network, has been assessed with regard to its impact on flood depth and hazard categorisation. The analysis indicates that, overall, the site has retained its pre-development hazard levels, with no significant changes in flood behaviour for most areas. However, a localised increase in hazard has been observed along the rear boundaries of Units 31, 32, and 33.

The minor change in hazard classification at the rear of these units is primarily attributed to the excavation approach, which has altered the natural flow paths and affected overland water behaviour in this area. Specifically, the excavation has created slight depressions near the rear boundaries, which restricts the free movement of water towards natural drainage outlets, such as the River Derwent.

As a result, these minor depressions have led to water pooling during peak flow events, increasing flood depths slightly beyond the original levels for these specific locations. This change has shifted the hazard category at the rear of those Units from their original lower classifications to category H2, indicating a marginal increase in flood risk.

For the remainder of the development site, the impact on flood depth and hazard remains consistent with pre-development conditions, with no changes observed in other areas. The confined impact to these specific boundaries suggests that the overall site design is largely effective in maintaining natural drainage and flood safety.

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Figure 7. Pre-Development 1% AEP + CC + SLR 2090 Depth

Figure 8. Post-Development 1% AEP + CC + SLR 2090 Depth

3.3 Displacement of Overland Flow on Third Party Property

Upon careful analysis of Figure 8, which portrays the post-development conditions incorporating the proposed redevelopment works and new structures, we discern subtle shifts in flood depths within the lot boundaries surrounding the existing structures compared to the pre-development scenario illustrated in Figure 7. Furthermore, the outcomes indicate minor modifications in the hazard rating extent within the property boundary.

A more detailed examination of the proposed works areas reveals minimal alterations in flood depth and extent, the associated works pose no risk to the property or any existing or future structures resulting from the proposed development. Significantly, no observable changes are noted on other surrounding properties.

3.4 Development Effects on Flooding

Below are Figure 9, which present the discharge hydrograph originating from the property boundary at the cross-sectional result line at Bridgewater Road, showcasing overland flow discharge and velocity from the development area. These graphs have been captured within the model for both pre- and post-development scenarios, including runs for the 1% Annual Exceedance Probability (AEP), and merged into a comprehensive graph format. The purpose is to visually highlight the changes in net discharge resulting from the proposed development.

3.5 Development Effects on Stormwater Discharge

A slight increase in discharge is observed, rising from 0.13 m^3/s pre-development to 0.16 m^3/s post-development, along with a small decrease in velocity from 0.19 m/s to 0.13 m/s. This increase in discharge is due to the addition of new impervious areas, which define the flow path that previously moved freely across the existing land. The minor decrease in velocity is likely due to the proposed units and driveway, which may slightly obstruct flow.

These changes have minimal impact on flow dynamics and do not raise risk ratings for nearby properties or infrastructure. Figure 9 shows a small increase in flood depth within the development area, with a slight rise from pre- to post-development stages. This is due to the proposed structures and driveway, but it does not increase risk ratings for surrounding properties or infrastructure.

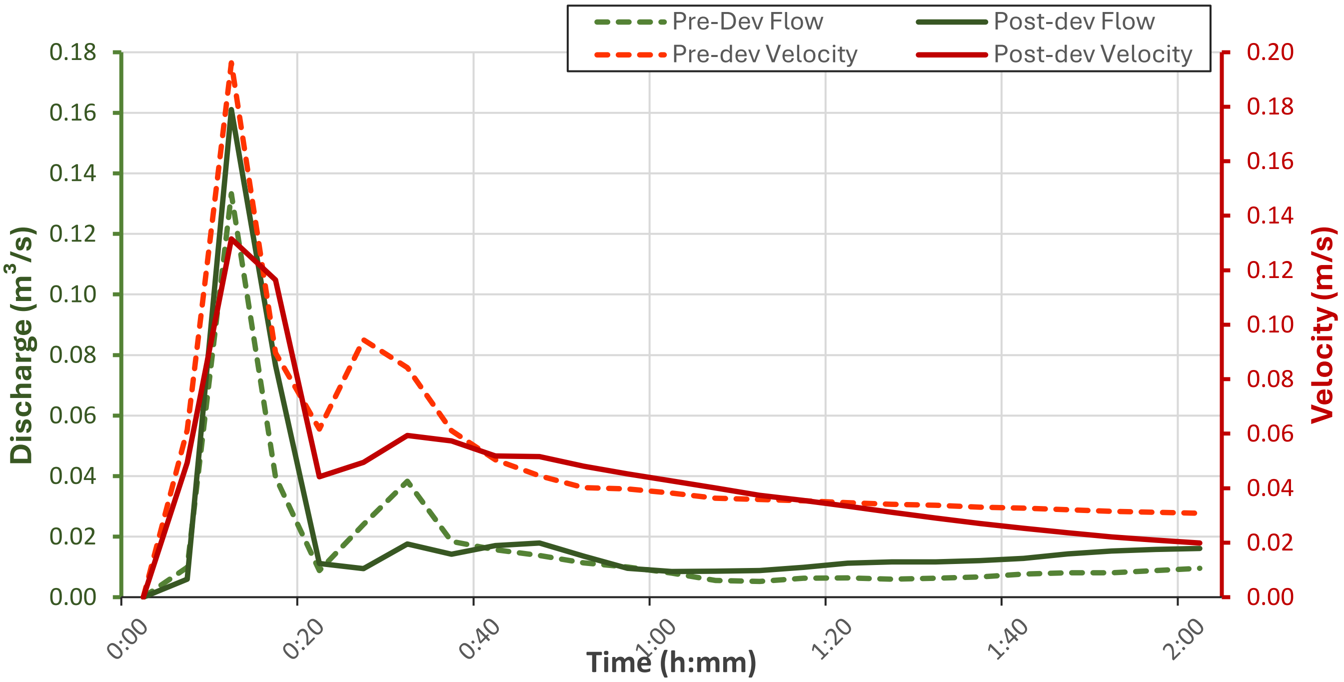

Figure 9. Pre and Post Development Flow and Velocity 1% AEP + CC + SLR 2090.

4. Flood Hazard

Before the proposed unit development at Lot 1 Hayfield Place, an assessment of the existing site conditions indicated that the area earmarked for new structures could be susceptible to flooding under certain conditions. Modelling of the pre-development scenario revealed that the site could experience flood inundation with depths reaching up to 0.13 metres and flow velocities of up to 0.20 metres per second during a 1% Annual Exceedance Probability (AEP) flood event, factoring in climate change projections.

Based on the hazard rating system provided in the Australian Flood Resilience and Design Handbook, these conditions fall within the H1 hazard rating category. As depicted in APPENDIX A - Hazard Maps, an H1 rating represents the lowest hazard band, suggesting that the flood conditions are generally safe for people, vehicles, and buildings. Under this classification, the water depths and flow velocities are low enough to present minimal risk of injury or damage. The associated static and dynamic forces are sufficiently low, allowing individuals to safely navigate the affected area without significant concerns regarding stability or safety.

Following the proposed development, which involves the construction of new units and alterations to the surrounding site layout, a re-evaluation of the flood hazard was carried out to assess how these changes would influence flood behaviour. The post-development modelling scenario indicates a continuation in the flood hazard category of H1, with a small portion at the rear of Unit 31, 32 and 33 experiencing a flood depth increasing by up to 0.32 metres. For a detailed description of hazard categories, please refer to Figure 10.

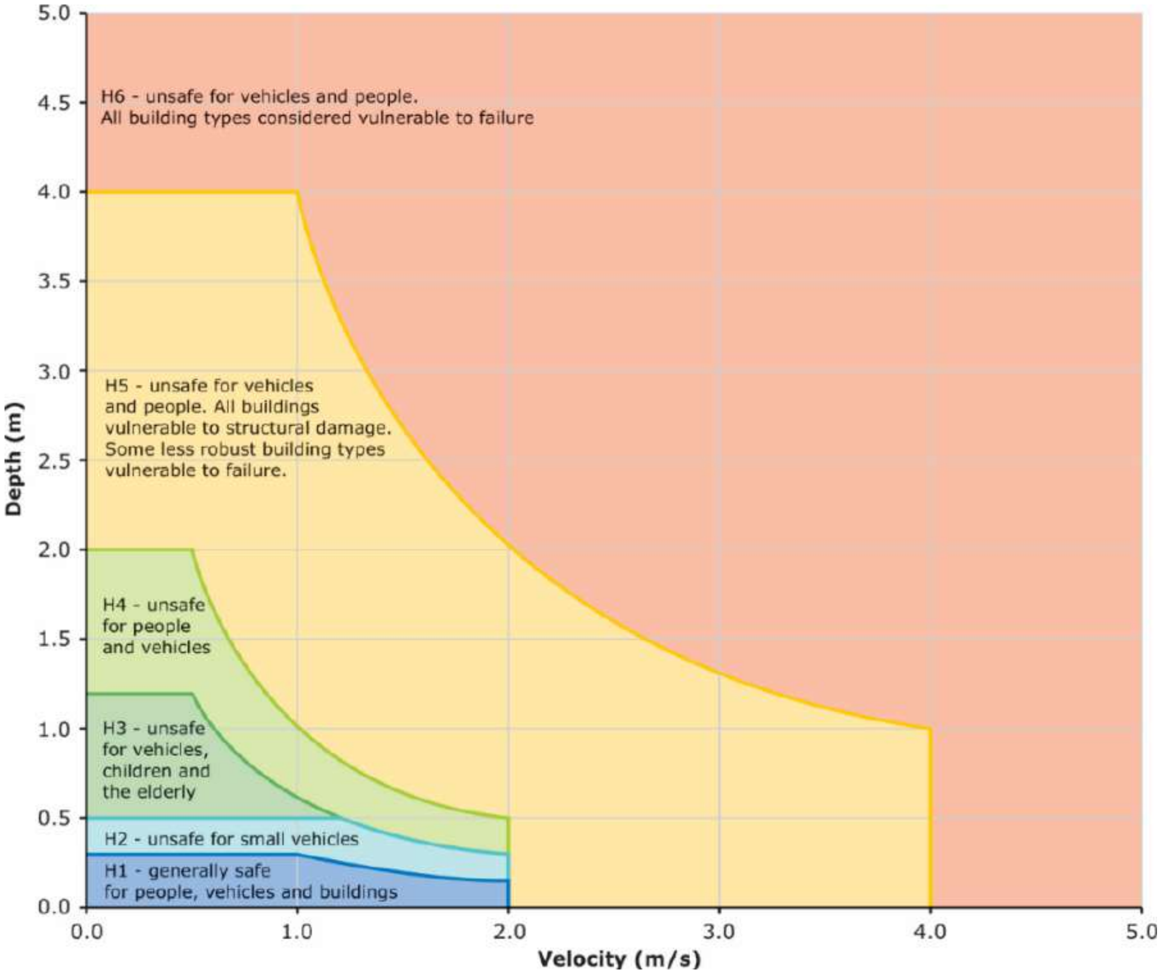

Figure 10. Hazard Categories Australian Disaster and Resilience Handbook

4.1 Tolerable Risk

Most of the proposed unit development at Lot 1 Hayfield Place is exposed to shallow, slow-moving floodplain flows, especially during a 1% Annual Exceedance Probability (AEP) flood event, compounded by the effects of projected climate change. Hydraulic modelling shows that most of the surrounding area falls under a low hazard rating (H1) in such conditions.

According to Australian floodplain management guidelines, an H1 hazard rating indicates that the flooding in this area is generally safe for people and would likely result in minimal property damage. However, there are still important risks associated with shallow inundation. The primary concerns in these conditions include the potential for erosion of unprotected soils and ground surfaces, as well as the movement of debris that could accumulate or be carried by floodwaters.

4.2 New Habitable Building

To meet the performance criteria of the Building Regulations S.54, the construction of a new units is required to have a habitable floor level >300mm above the >1% AEP + CC flood level. The proposed units must meet this regulation as shown in Table 6. (The floor level >1% AEP + CC flood level + 300mm does not apply for non-habitable areas).

Table 6. Habitable floor construction levels of proposed units.

Unit No	1% AEP +CC flood level (mAHD)	Minimum Floor Level required (mAHD)	Unit No	1% AEP +CC flood level (mAHD)	Minimum Floor Level required (mAHD)
1A -1B	5.15	5.45	**29**	3.90	4.20
2	3.30	3.60	**30**	3.90	4.20
3	3.30	3.60	**31**	3.16	3.46
4	3.33	3.63	**32**	3.16	3.46
5	3.21	3.51	**33**	3.16	3.46
6	3.22	3.52	**34**	3.16	3.46
7	3.20	3.50	**35**	3.19	3.49
8	3.17	3.47	**36**	3.19	3.49
9	3.10	3.40	**37**	3.19	3.49
10	3.05	3.35	**38**	3.00	3.30
11	3.08	3.38	**39**	2.80	3.10
12	3.15	3.45	**40**	2.80	3.10
13	3.13	3.43	**41**	2.80	3.10
14	3.21	3.51	**42**	2.80	3.10
15	3.22	3.52	**43**	2.80	3.10
16	3.27	3.57	**44**	2.80	3.10
17	3.36	3.66	**45**	2.80	3.10
18	3.37	3.67	**46**	2.80	3.10
19	3.39	3.69	**47**	2.90	3.20
20	3.42	3.72	**48**	2.90	3.20
21	3.43	3.73	**49**	2.90	3.20
22	3.45	3.75	**50**	2.90	3.20
23	3.46	3.76	**51**	2.90	3.20
24	3.50	3.80	**52**	2.90	3.20
25	3.70	4.00	**53**	2.90	3.20
26	3.79	4.09	**54**	2.90	3.20
27	3.80	4.10	**55**	2.90	3.20
28	3.80	4.10			

Table 7. Tasmanian Planning Scheme – Brighton summary C11.6.1

C11.6.1 Buildings and works, excluding coastal protection works, within a coastal inundation hazard area			
Objectives: **That:** **a) building and works, excluding coastal protection works, within a coastal inundation hazard area, can achieve and maintain a tolerable risk from coastal inundation; and** **b) buildings and works do not increase the risk from coastal inundation to adjacent land and public infrastructure.**			
Performance Criteria			
P1.1		**P1.1**	
Buildings and works, excluding coastal protection works, within a coastal inundation hazard area must have a tolerable risk, having regard to:		Response from flood report	
(a)	whether any increase in the level of risk from coastal inundation requires any specific hazard reduction or protection measures;	(a)	The proposed unit development and internal driveway footprint are outside the Coastal Inundation Hazard areas.
(b)	any advice from a State authority, regulated entity or a council; and	(b)	N/A
(c)	the advice contained in a coastal inundation hazard report.	(c)	Refer to this report and recommendations.
P1.2		**P1.2**	
A coastal inundation hazard report also demonstrates that the building or works:		Response from flood report	
(a)	do not cause or contribute to coastal inundation on the site, on adjacent land or public infrastructure; and	(a)	The inclusion of the proposed development ensures that there will be no occurrence or contribution to coastal inundation on the site, adjacent land, or public infrastructure.
(b)	can achieve and maintain a tolerable risk from a 1% annual exceedance probability coastal inundation event in 2100 for the intended life of the use without requiring any specific coastal inundation protection works.	(b)	The proposed development does not necessitate any specific coastal inundation protection works for the for the 1% AEP + climate change + storm surge event at 2100

Table 8. Tasmanian Planning Scheme – Brighton summary C12.5.1

C12.5.1 Uses within a flood prone hazard area			
Objectives: That a habitable building can achieve and maintain a tolerable risk from flood			
Performance Criteria			
P1.1		**P1.1**	
A change of use that, converts a non-habitable building to a habitable building, or a use involving a new habitable room within an existing building, within a flood-prone hazard area must have a tolerable risk, having regard to:		Response from flood report	
(a)	the location of the building;	(a)	Proposed unit development lays within a shallow, slow-moving flood inundation area. Entrances and designated parking spaces are situated in an area away from inundated areas.
(b)	the advice in a flood hazard report;	(b)	Assuming recommendations of this report are implemented, no additional flood protection measures required for the life expectancy of the building.
(c)	any advice from a state authority, regulated entity or a council;	(c)	N/A
P1.2		**P1.2**	
A flood hazard report also demonstrates that:		Response from flood report	
(a)	any increase in the level of risk from flood does not require any specific hazard reduction or protection measures;	(a)	There is no increase in level of risk from pre-development scenario.
(b)	the use can achieve and maintain a tolerable risk from a 1% annual exceedance probability flood event for the intended life of the use without requiring any flood protection measures	(b)	Maximum hazard rating at the proposed development is H1 in the pre and post-development scenario.

Table 9. Tasmanian Planning Scheme – Brighton summary C12.6.1

C12.6.1 Building and works within a flood prone area			
Objective: (a) building and works within a flood-prone hazard area can achieve and maintain a tolerable risk from flood; and, (b) buildings and works do not increase the risk from flood to adjacent land and public infrastructure.			
Performance Criteria			
P1.1		**P1.1**	
Buildings and works within a flood-prone hazard area must achieve and maintain a tolerable risk from a flood, having regard to:		Response from flood report	
(a)	the type, form, scale and intended duration of the development;	(a)	Proposed unit development and hardstand areas.
(b)	whether any increase in the level of risk from flood requires any specific hazard reduction or protection measures;	(b)	Assuming recommendations of this report are implemented, no additional flood protection measures required for the life expectancy of a habitable building.
(c)	any advice from a State authority, regulated entity or a council; and	(c)	N/A
(d)	the advice contained in a flood hazard report.	(d)	Flood report and recommendations provided within.
Performance Criteria			
P1.2		**P1.2**	
A flood hazard report also demonstrates that the building and works:		Response from Flood Report	
(a)	do not cause or contribute to flood on the site, on adjacent land or public infrastructure; and	(a)	A small increase to flow and marginal decrease in velocity from proposed development.
(b)	can achieve and maintain a tolerable risk from a 1% annual exceedance probability flood event for the intended life of the use without requiring any flood protection measures.	(b)	With the recommendations of this report the proposed site and development would be likely to achieve a tolerable risk to the 1% AEP storm event for the life expectancy of the building.

5. Conclusion

The Flood Hazard Report for the existing Unit Development, in Bridgewater re-development site has reviewed the potential future flood scenario. The following conclusions were derived in this report:

1. A comparison of the pre- and post-development peak flows for the 1% AEP plus climate change event and 1% AEP Storm Surge, shows that there is no displacement of flood waters on neighbouring private properties.
2. Peak discharge from the site slightly increases between pre- and post-development flood scenarios.
3. Peak flood depths don’t increase between pre- and post-development flood scenarios. Except from a small area at rear boundary of Unit 31,32 and 33.
4. Hazard from flooding in the area remained at **H1** from the pre-development to the post-development scenarios, except from a small area of **H2** at Unit 31,32 and 33.

6. Recommendations

Flüssig Engineers therefore recommends the following engineering design be adopted for the development and future use to ensure the works meets the Flood Impact Code:

1. The future driveway should incorporate features such as pits, culverts, or other drainage solutions that allow water to move freely and efficiently from the Crescent area to the river. This design will help minimise water accumulation and reduce flood risk, ensuring the safe passage of vehicles and pedestrians during a flood event.
2. To further enhance flood resilience, it is recommended that the proposed units have the minimum finish floor level as per table 6. The current placement of the units is allowing the overland flow path to pass almost unrestricted through the development area. This approach not only reduces the risk of flooding to the buildings themselves but also ensures that the flow of water is not obstructed.
3. All future proposed structures within the flood extent not shown within this report will require a separate design and report addressing their impacts.

As outlined in the Flood Inundation Report, it is confirmed that the proposed development does meet the current acceptable standards and performance criteria set forth in the Tasmanian Planning Scheme's Coastal Inundation Hazard and Flood Prone Areas Codes.

7. Limitations

Flüssig Engineers was commissioned by **Centacare Evolve Housing,** to conduct a comprehensive site-specific Flood Hazard Report for the Unit Development re-development project, located in Bridgewater, in accordance with the Tasmanian Planning Scheme Launceston Local Provision Schedule – Flood Impact. The study was deemed appropriate for its intended purpose at the time of execution. However, in the event that conditions at the site undergo any changes, it is imperative that the report be reassessed in light of such alterations.

The utilisation of this report is restricted to its entirety and may not be fragmented or employed to support objectives other than those explicitly delineated within, unless specific written consent for deviation is obtained from Flüssig Engineers. It is crucial to adhere to the stipulated purposes to maintain the report's integrity and relevance.

Flüssig Engineers explicitly disclaims any responsibility for the accuracy of third-party documents provided for the sole purpose of this Flood Hazard Report. Any reliance on external documents is at the sole risk and discretion of the parties involved in the utilisation of this comprehensive report.

8. References

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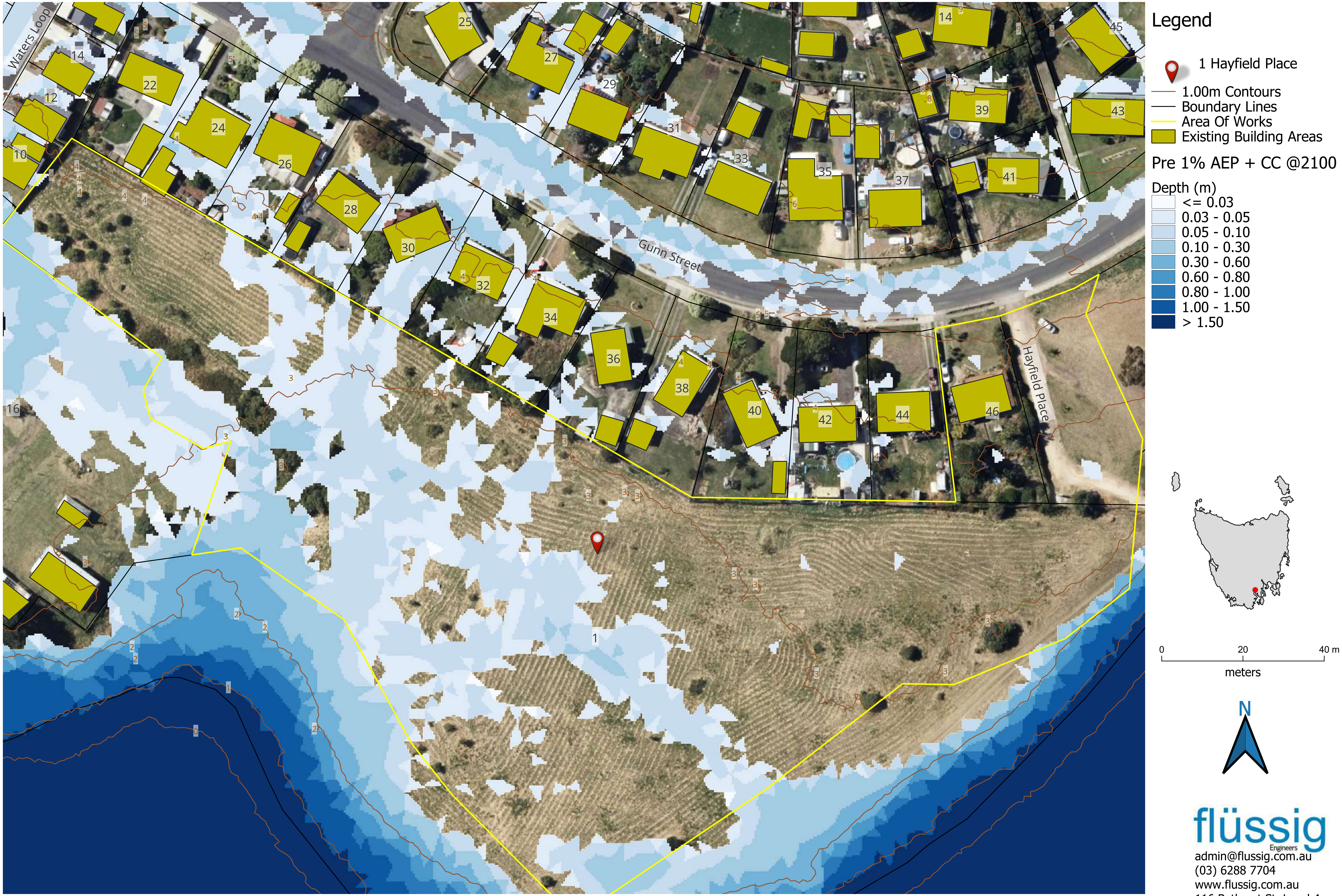
Appendices

Appendix A: Flood Study Maps

PRE 1% AEP + CC @2100



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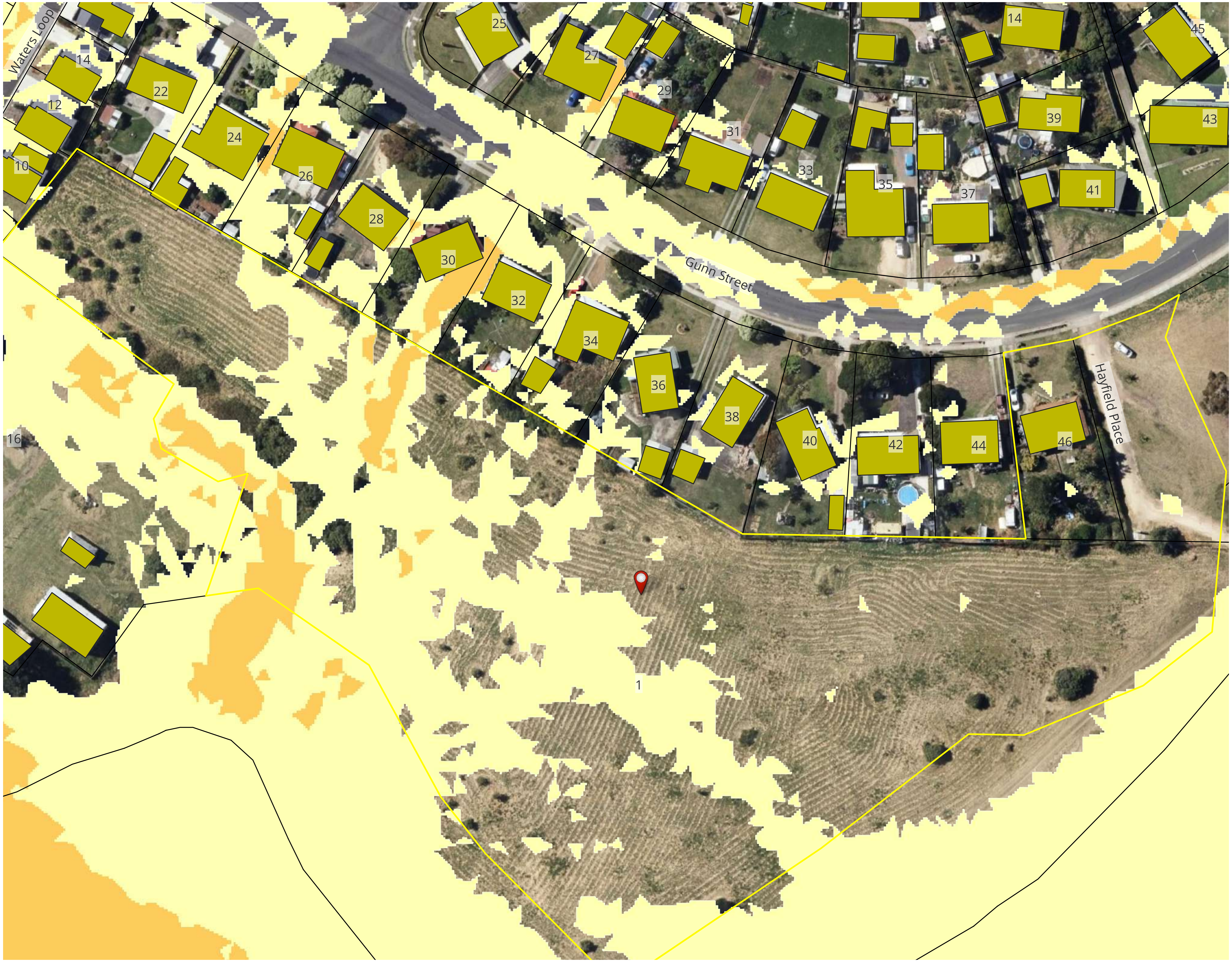
- 18-09-2024 - Flussig Engineers   Map CRS: GDA2020 / MGA zone 55   EPSG:7855

PRE 1% AEP + CC @2100



Legend

📍 1 Hayfield Place

— Boundary Lines

— Area Of Works

▨ Existing Building Areas

Pre 1% AEP + CC @2100

Velocity (m/s)

- 🟨 <= 0.50
- 🟨 0.50 - 1.00
- 🟧 1.00 - 1.50
- 🟥 1.50 - 2.00
- 🟥 > 2.00

0 20 40 m

meters

N

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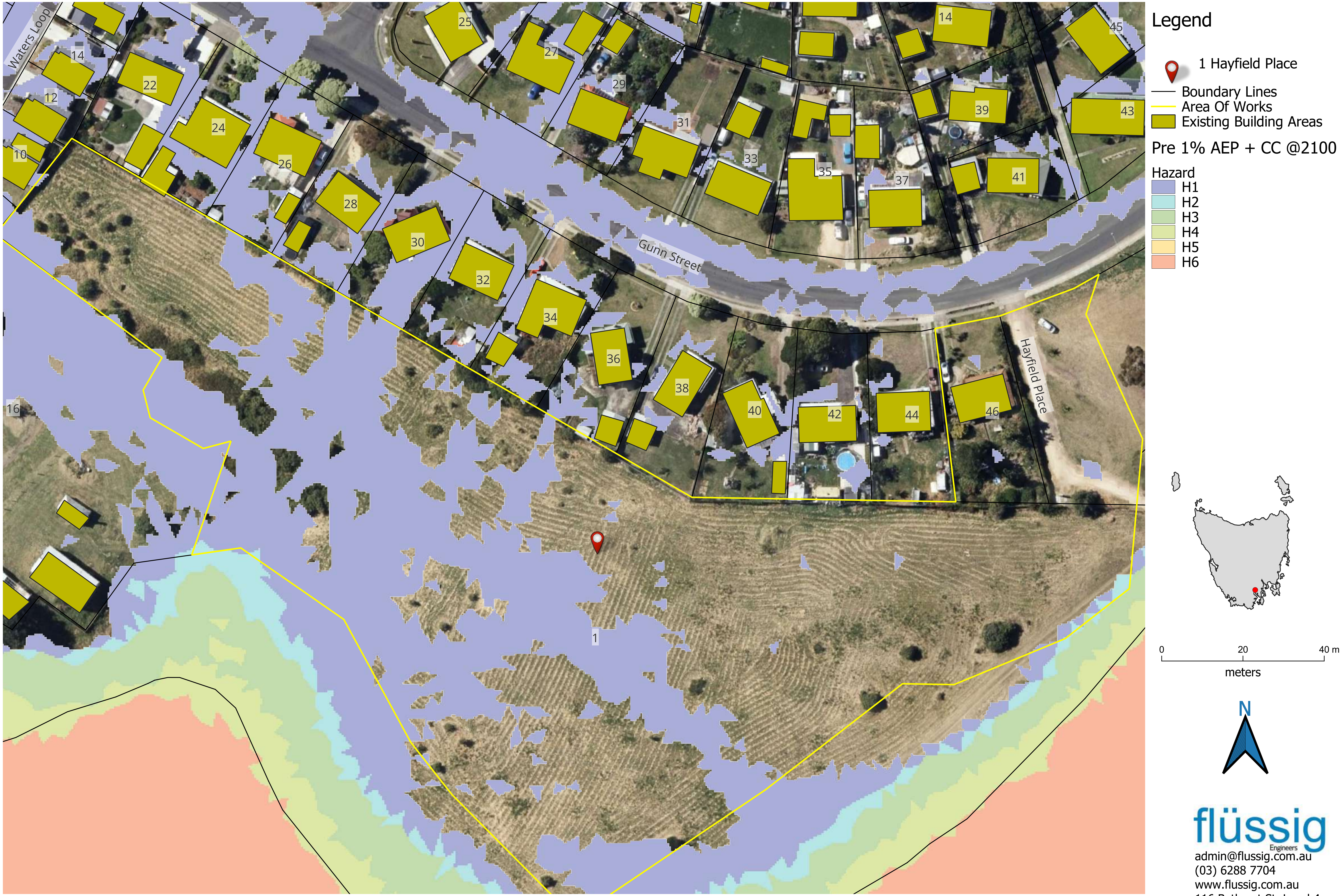
PRE 1% AEP + CC @2100



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POST 1% AEP + CC @2100

Legend

📍 1 Hayfield Place
1.00m Contours
Boundary Lines
Area Of Works
🟩 Proposed Units
▨ Proposed Road

Post 1% AEP + CC @2100

Depth (m)
<= 0.03
0.03 - 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
1.00 - 1.50
> 1.50

0 30 60 m
meters

N

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POST 1% AEP + CC @2100

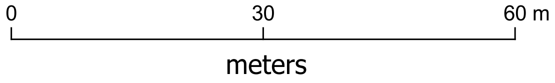
Legend

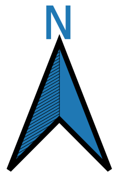
📍 1 Hayfield Place
— Boundary Lines
— Area Of Works
🟩 Proposed Units
⬜ Proposed Road

Post 1% AEP + CC @2100

Velocity (m/s)

🟨 <= 0.50
🟧 0.50 - 1.00
🟧 1.00 - 1.50
🟥 1.50 - 2.00
🟥 > 2.00





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POST 1% AEP + CC @2100

Legend

📍 1 Hayfield Place
— Boundary Lines
— Area Of Works
🟩 Proposed Units
■ Proposed Road

Post 1% AEP + CC @2100

Hazard
■ H1
■ H2
■ H3
■ H4
■ H5
■ H6

0 30 60 m
meters

N

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Appendix C: Coastal Inundation Declaration.

Coastal Hazards Report Declaration

Section 1: About the practitioner and methodology

1.1 Practitioner details

Lead / coordinating consultant name (must be an individual)	Max Moller
Academic Qualification/s	*Bachelor of Engineering.* *Post Graduated Certificate in Hydraulic Services Design.* Introduction to Coastal Processes and Coastal Engineering *FIEAust, EngExec, CPEng, NER, APEC Engineer, IntPE(Aus)*
Relevant Experience	20 + years of undertaking various Riverine and Coastal inundation Studies that meets the requirements of current legislation.
Business name and address	Flussig Engineers – 4/116 Bathurst Street, Hobart, 7000
Contact phone number	0431 080 279
Email address	max@flussig.com.au
Signature	
Date	18/09/2024

Supporting consultant name (must be an individual)	Max Moller
Academic Qualification/s	*Bachelor of Engineering.* *Post Graduated Certificate in Hydraulic Services Design.* Introduction to Coastal Processes and Coastal Engineering *FIEAust, EngExec, CPEng, NER, APEC Engineer, IntPE(Aus)*

Relevant Experience	20+ years of undertaking various Riverine and Coastal inundation Studies that meets the requirements of current legislation.
Business address	Flussig Engineers – 4/116 Bathurst Street, Hobart, 7000
Contact phone number	0431 080 279
Email address	max@flussig.com.au
Signature	
Date	18/09/20234

Professional Indemnity

- Insured Company: Flussig Engineers
- Insurance Period: 17/10/22 to 17/10/23
- Amount: $10,000.000.00

1.2 Methodology

The Methodology adopted for the 61 Mannata Street, Lauderdale Coastal Inundation study has been prepared in accordance with the *Tasmanian Planning Scheme 2020*, *Building Act 2016* and regulation 51 and *Director Determination - Coastal Inundation Hazard Areas 2021.*

Section 2: Conclusions about the proposal

Likelihood of the proposed use or development to cause or contribute to the occurrence of coastal erosion and/or coastal inundation on the site or adjacent land[1]

According to the Flussig Engineers Study 2024 - the proposed unit development at No1 Hayfield Place, Bridgewater does not cause or contribute to the occurrence of coastal inundation on the site or adjacent land is proposed fill is constrcuted.

Can the proposed use or development achieve and maintain a tolerable risk for the intended life of the use or development, having regard to:

the nature, intensity and duration of the use	The intended future use of the proposed lots are as a habitable class 1a building does not affect its risk for the life of a class 1a building.
the type, form and duration of any development	Under the recommendations of this study the future class 1a building can withstand a tolerable risk to coastal inundation for the life of a class 1a building (50 years).
the likely change in the risk across the intended life of the use or development	Coastal inundation was assessed to include changes up to the year 2100, the intended life of the building puts the dwelling life at the year 2071. Therefore, the building should be able to maintain its risk status for its expected life. Changes to current future climate estimates may change the coastal inundation however given the very low risk currently experienced it is unlikely to have a detrimental effect.

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the ability to adapt to a change in the level of risk	Given the extent of inundation risk to the proposed development areas, any future building it is highly probable to be able to adapt to any additional inundation.
the ability to maintain access to utilities and services	Given the extent of inundation risk to the proposed fill area and future building it is highly probable it will be able to maintain access to utilities and services for its intended life.
the need for specific coastal erosion or coastal inundation hazard reduction or protection measures on the site[3]	No specific protection measures required.
the need for coastal erosion or coastal inundation reduction or protection measures beyond the boundary of the site[3]	No broader scale protection measures required.
any coastal erosion or coastal inundation management plan in place for the site or adjacent land[3]	No specific inundation measurement plan required.

Any advice relating to the ongoing management of the use or development

Assuming future development meets current building code structures no ongoing management is required.

Is the use or development located on an actively mobile landform within the coastal zone?[2]

☐ Yes ☒ No

Conclusions relating to any matter specifically required by Performance Criteria in the Coastal Erosion Hazard Code (C10.5 – C10.7) or the Coastal Inundation Hazard Code (C11.5 – C11.7)

Under the Tasmanian Planning Scheme, the proposed development can meet all performance criteria under C11.6.1 Buildings and works, excluding coastal protection works, within a coastal inundation hazard area.

Site/ job number **FE_24038_No1 Hayfield Place, Coastal Inundation Report**

RISKS OF THE DEVELOPMENT IMPACTING ON EXISTING FLOOD BEHAVIOUR

Pre-Development Risk Identification (1% AEP + CC + SS)			**Post-Development**				**Recommendations**			
				Risk with no Treatment				**Risk following recommended treatment**		
Risk Ref No	**Risk Type** **A - Asset** **P - Project** **F - Financial** **S - Safety**	**Risk Description**	**Conclusions derived from report for the post development scenario**	**Likelihood**	**Consequence**	**Risk Level**	**Treatment**	**Likelihood**	**Consequence**	**Risk Level**
P1	A, F, S	Whether the use or development is likely to cause or contribute to coastal inundation on the site or on adjacent land;.	No increased displacement of flood waters observed in flood model. No treatment recommended.	Rare	Minor	Low	none required	Rare	Insignificant	Low
P3	A, F, S	To whether the use or development can achieve and maintain a tolerable risk for the intended life of the use or development, having regard to the nature, intensity and duration of the use (a)	The development will achieve and maintain a tolerable risk if the recommendations specified in the report are applied.	Rare	Minor	Low	none required	Rare	Insignificant	Low
P4	A, S	To whether the use or development can achieve and maintain a tolerable risk for the intended life of the use or development, having regard to the type, form and duration of any development (b)	The development will achieve and maintain a tolerable risk if the recommendations specified in the report are applied.	Rare	Minor	Low	none required	Rare	Insignificant	Low
P5	A,S	To whether the use or development can achieve and maintain a tolerable risk for the intended life of the use or development, having regard to the likely change in the risk across the intended life of the use or development (c)	The development will achieve and maintain a tolerable risk if the recommendations specified in the report are applied.	Rare	Minor	Low	none required	Rare	Insignificant	Low
P6	A, F, S	To whether the use or development can achieve and maintain a tolerable risk for the intended life of the use or development, having regard to the ability to adapt to a change in the level of risk (d)	The development will achieve and maintain a tolerable risk if the correct fill material and proposed levels and construction methods specified in the report are applied.	Rare	Minor	Low	should major climate estimates show increase risk to surrounding properties current coastal modelling should be updated to refelct new information.	Rare	Insignificant	Low
P7	A, F, S	To whether the use or development can achieve and maintain a tolerable risk for the intended life of the use or development, having regard to the ability to maintain access to utilities and services (e)	The development will achieve and maintain a tolerable risk including access to utilities and services.	Rare	Minor	Low	none required	Rare	Insignificant	Low
P8	A, F, S	To whether the use or development can achieve and maintain a tolerable risk for the intended life of the use or development, having regard to the need for specific coastal inundation hazard reduction or protection measures on the site (f)	The development will achieve and maintain a tolerable risk without the need for specific coastal reduction or protection measures on the site.	Rare	Minor	Low	none required	Rare	Insignificant	Low

Site/ job number

FE_24038_ No1 Hayfield Place Coastal Inundation Report

RISKS OF FLOOD BEHAVIOUR ON THE DEVELOPMENT POST CONSTRUCTION

	Risk Identification (1% AEP + CC + SS)				
			Risk with no Treatment		
Risk Ref No	Risk Type A - Asset P - Project F - Financial S - Safety	Risk Description	Likelihood	Consequence	Risk Level
D1	A	There is a risk that during a coastal inundation flood event, excessive flow could result in back flow of treatment devices (inc. stormwater and sewer).	Possible	Minor	Medium
D2	S	There is a risk to personal safety when during a coastal inundation flood event, people may become trapped in the vehicles during a storm event inside the lot boundary.	Possible	Minor	Medium
D3	A, F	There is a risk that the flow of a coastal inundation flood event could result in damage to the proposed development due to flood water depth, velocity and debris.	Possible	Minor	Medium
D4	A, S	There is a risk the flow of a coastal inundation flood event could pose a risk to assets and personal safety of the inhabitants of the development.	Possible	Minor	Medium

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