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Inundation, Beach Erosion and Recession Study for Wollongong Coastal Management Program

Technical Modelling Report

Final

12 November 2025

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Prepared by	Alexandra Maskell BSc (Hons) MPhil PhD Senior Coastal Modeller Andrew Fielding BSc (Hons) PGCert Senior Environmental Analyst Jayden Kachel BSc BMarSc Environmental Analyst
Reviewed by	Alexandra Maskell BSc (Hons) MPhil PhD Senior Coastal Modeller Daniel Rodger BSc, MEng, PGDip, PGCert, CPEng, CMarEng Director
Authorised by	Daniel Rodger BSc, MEng, PGDip, PGCert, CPEng, CMarEng Director

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JBP Project Manager	Alexandra Maskell
Address	Level 1, 150 Charlotte Street, Brisbane City, 4000
JBP Project Code	2024s0621

This report describes work commissioned by Salients on behalf of City of Wollongong, by an instruction dated 18 April 2024. The Client's representative for the contract was David Wainwright of Salients. Jayden Kachel, Ravi Sukhadiya, Alexandra Maskell, Andrew Fielding and Daniel Rodger of JB Pacific carried out this work.

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Abbreviations

AEP	Average Exceedance Probability
AR6	Assessment Report 6
ARI	Average Recurrence Interval
C3S	Copernicus Climate Change Service
CM	Coastal Management
CMP	Coastal Management Program
CMIP6	Coupled Model Intercomparison Project 6
COWCLIP	Coordinated Ocean Wave Climate Project
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEA	Digital Earth Australia
DoC	Depth of Closure
ECL	East Coast Low
ECMWF	European Centre for Medium-Range Weather Forecasts
ESL	Extreme Sea Level
EurOtop	European Wave Overtopping Manual
GCM	Global Climate Models
H_s	Significant Wave Height
H_{max}	Maximum Wave Height
HHWSS	Higher High Water Spring Solstice
ICOLL	Intermittently Closed and Open Lake and Lagoon
IPCC	Intergovernmental Panel on Climate Change
JBP	Jeremy Benn Pacific (JB Pacific)
LiDAR	Light Detection and Ranging
mAHD	metres above Australian Height Datum
NN2	Neural Network 2
NSW	New South Wales
OEH	Office of Environment and Heritage
SLR	Sea-level Rise
SSP	Shared Socioeconomic Pathway
STR	Subtropical Ridge
T_p	Wave Period
ZRFC	Zone of Reduced Foundation Capacity
ZSA	Zone of Slope Adjustment
ZWI	Zone of Wave Impact

Executive Summary

New coastal hazard mapping for the Wollongong Coastline has been prepared for tidal inundation, coastal inundation, beach erosion and shoreline recession. These maps support the development of the Wollongong Coastal Management Program (CMP), which is being prepared by Wollongong City Council under the requirements of the Coastal Management Act 2016 (CM Act) and its associated Coastal Management Manual (NSW Government, 2018). The creation of hazard maps provides information for a subsequent risk assessment and planning that will consider coastal infrastructure, and both natural and built assets.

Tidal inundation hazard maps

Tidal inundation is the inundation of land by tidal action under average meteorological conditions. Two mapping approaches were used; (i) where existing flood-focussed hydrodynamic models were available, those have been repurposed to simulate tides entering creeks and estuaries, and (ii) along the open coast, and inside estuaries where no model was available, inundation was based on a “bathtub” mapping approach. A simulation library has been developed in 0.1m increments for tide levels between 1.10 to 1.80 mAHD, with a single additional scenario of 2.9 mAHD representing a low likelihood sea level rise scenario by 2125.

Coastal inundation mapping

Coastal inundation mapping accounts for storm surge, closed entrance effects, and wave actions including runup and overtopping. Two approaches have been used; (i) the repurposed hydrodynamic models were used to simulate storm surges entering creeks and estuaries, including potential wave overtopping of structures and low dune crests, and (ii) along the open coast, seaward of the dune crest, or inside estuaries where no pre-existing hydrodynamic model was available, mapping considered extreme sea levels (including an allowance for sea level rise for some scenarios) plus wave effects calculated using analytical equations. These have also been applied using the “bathtub” mapping approach.

Coastal inundation mapping has been completed for up to three storm return periods: typically, the 63% Annual Exceedance Probability (AEP), 5% AEP and 1% AEP events for present day and future planning horizons (+20y, +50y, +100yr).

Future coastal inundation scenarios include an allowance for sea level rise following the SSP5-8.5 medium confidence projection. This includes some scenarios using the mean and higher probability levels within that projection (e.g. 50% & 95% chance of not being exceeded).

Beach erosion and recession mapping

Beach erosion is the loss of beach material by wave action, tidal currents, littoral currents, or wind over a short timeframe; either resulting from a storm, consecutive storms, or a period of coincident events. Coastal recession is a longer-term loss of beach material, leading to the continued landward movement of the shoreline.

A probabilistic erosion and recession framework has been adopted. That framework uses a mixture of statistical, evidence-driven and modelled components. Mapped erosion hazard zones include short-term storm demand, historic recession, future sea level rise induced recession, and a zone of reduced foundational capacity. Site-specific adjustments are made based on the local geological setting, commonly informed by geotechnical survey data. Maps include three probabilities (63% AEP, 5% AEP and 1% AEP) events for present day and future planning horizons (+20y, +50y, +100yr).

1 Introduction

This technical report supports the development of the Wollongong Coastal Management Program (CMP) and includes hazard mapping for tidal inundation, coastal inundation, beach erosion and shoreline recession. The CMP is being prepared by Wollongong City Council under the requirements of the Coastal Management Act 2016 (CM Act) and its associated Coastal Management Manual (NSW Government, 2018). The aim of this report is to quantify local coastal hazards within the study area shown in Figure 1-1. It should be read in conjunction with the full range of CMP reports developed by Salients and Tetra Tech Coffey.

This report includes the following sections:

- Section 2: Background and available data
- Section 3: Tidal inundation
- Section 4: Coastal inundation
- Section 5: Coastal erosion & recession

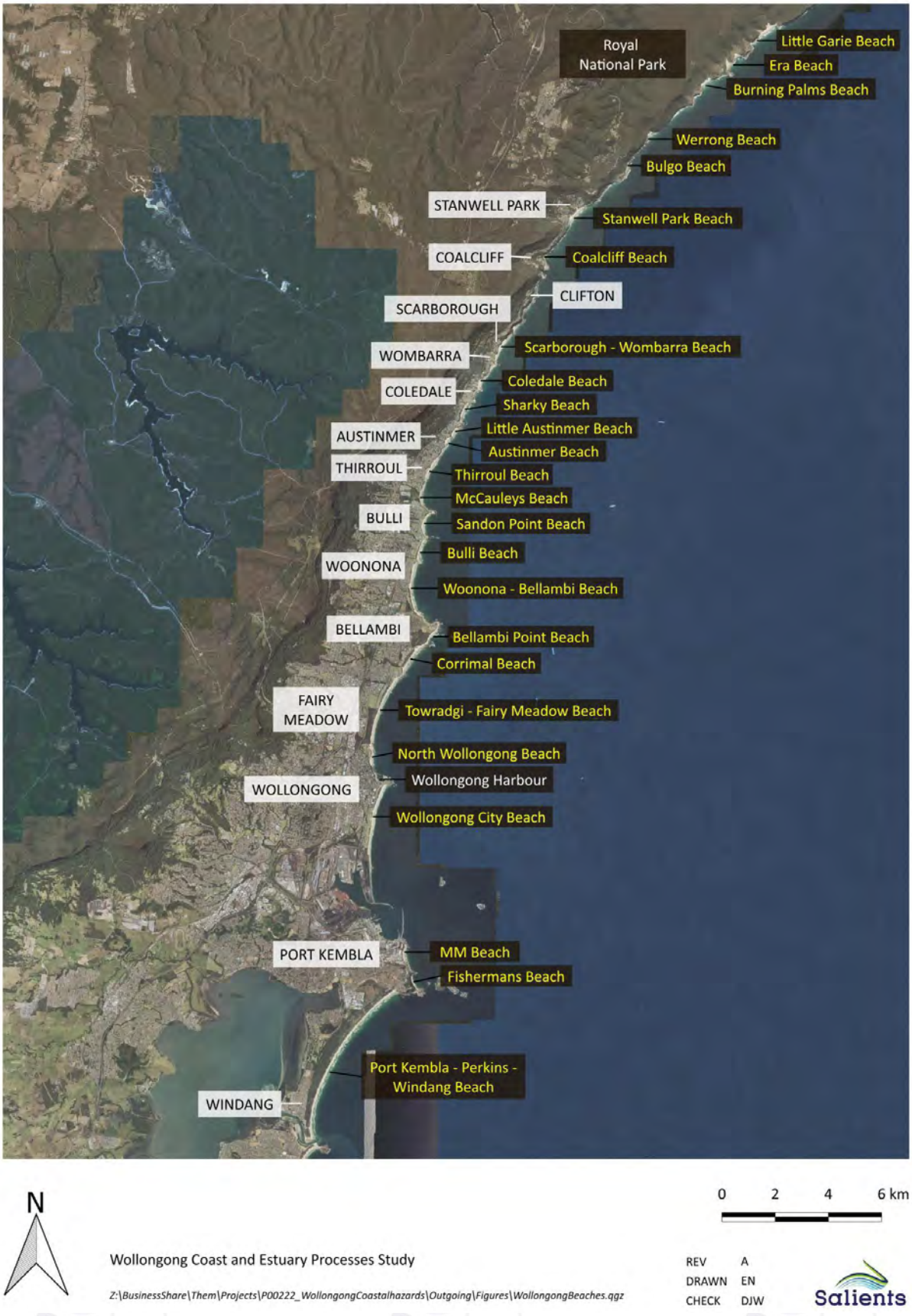


Figure 1-1: Location map (Salients, 2024).

2 Background & Available Data

2.1 Approach

The hazard mapping approach described throughout this report has been developed in line with a range of frameworks and guidelines published by the NSW government, which are summarised in this section. Hazard maps have used a combination of state-wide and local scale data, which build on to the initial work undertaken within the Wollongong CMP Stage 1 and Stage 2 projects. This report should therefore be read in conjunction with the material presented in the following documents:

- Stage 1 report:
    - Wollongong Scoping Study (Salients, 2023)
- Stage 2 reports:
    - Wollongong Coastal Management Program – Stage 2 Coastal and Estuary Processes Study 2025 (Salients, 2025a), including Addendum A: Sea-level rise.
    - Coastal Cliff and Slope Instability Hazard Study (Tetra Tech Coffey, 2025)
    - Coastal Entrance and Estuarine Foreshore Erosion Hazard Study (Salients, 2025b)

2.2 Common datums

Clear definitions of datums and naming conventions are essential for reducing uncertainty in any coastal study. The definitions used throughout this report are listed below.

- All vertical elevations are relative to the Australian Height Datum (AHD), which approximates mean sea level at present.
- Winds and waves are designated by the direction they come from. Both a south-easterly wind and wave originate from the southeast.
- Currents are designated by the direction in which they are going. A northerly current is flowing from south to north.
- Longshore sediment transport is the movement of sand parallel to a beach. When standing on a beach facing the ocean, the convention is typically that 'leftward' directed transport is considered negative. This can cause confusion along Australia's east coast, which has a large northward transport rate (therefore a negative rate). In this report the direction of any transport is stated to avoid confusion.
- When referencing changes to a beach profile, a negative shoreline change indicates landward movements (erosion, recession) and positive shoreline change indicates a seaward movement (accretion).

Likewise, coastal hazards may be defined in terms of a likelihood or event frequency. Standard industry practice is to use statistical definitions, based on an Annual Exceedance Probability (AEP), however many existing studies reference the Average Recurrence Interval (ARI) terminology. For events rarer than 5% AEP, the relationship between AEP and ARI is straightforward, where AEP = 1 / ARI. For more common events, more complex equations are required. The key return periods used throughout this report are:

- 1% AEP = 100-year ARI
- 5% AEP = 20-year ARI
- 63% AEP = 1-year ARI

2.3 Common data

A range of common datasets have been used for the tidal inundation, coastal inundation, beach erosion and shoreline recession hazard mapping. This includes:

- Background to coastal processes (all hazards)
- Beach names and boundaries (coastal inundation, beach erosion)
- Observations from the 2016 East Coast Low event (coastal inundation, beach erosion)
- Elevation data (all hazards)
- Hydrodynamic models (tidal inundation, coastal inundation)
- Extreme sea levels (tidal inundation, coastal inundation, beach erosion)
- Sea-level rise estimates (tidal inundation, coastal inundation, beach erosion)
- Wave estimates (coastal inundation, beach erosion)

2.3.1 Background to coastal processes

The Wollongong CMP Stage 1 and Stage 2 projects include a range of information on coastal processes that is important to the hazard maps developed within this technical report. These reports provide background information and description of available datasets relating to:

- Sea-level rise
- Beach morphological descriptions
- Local beach evolution processes
- Longshore sediment transport processes
- Rocky reef mapping

2.3.2 Beach names and boundaries

A common dataset of beach names has been used throughout the report for the coastal erosion and recession assessments. This is designed to avoid ambiguity, e.g. the northern end of Windang Beach is also known locally as Port Kembla Beach however a discrete boundary is not available.

The Wollongong coastline was discretised into headlands, estuary, and beach units. Beaches are referenced based on their local names, e.g. Wollongong Beach, and, where greater detail is needed split into units typically split around creek mouths and protected corners adjacent to headlands. A list of beach units used within specific calculations are shown in Table 2-1 and Figure 2-1.

Table 2-1: Beaches used within erosion and recession calculations

Beach name	Beach unit	Other common names/descriptor
Windang Beach	Windang1	-
Windang Beach	Windang2	-
Windang Beach	Windang3	Perkins Beach
Windang Beach	Windang4	Port Kembla Beach
Fishermans Beach	Fishermans1	-
MM Beach	MMBeach1	-
MM Beach	MMBeach2	North Beach
Wollongong City Beach	WollongongCity1	-
Wollongong City Beach	WollongongCity2	Wollongong Beach
Wollongong City Beach	WollongongCity3	Wollongong Beach
Brighton Beach	Brighton1	Cove Beach/Harbour
North Beach	North1	-
North Beach	North2	North Wollongong Beach
Fairy Meadow Beach	FairyMeadow2	-
Towradgi Beach	Towradgi1	-
Towradgi Beach	Towradgi3	-
Corrimal Beach	Corrimal1	-
Corrimal Beach	Corrimal2	Bellambi Lake
Corrimal Beach	Corrimal3	-
Bellambi Beach	Bellambi1	Bellambi Point
Bellambi Beach	Bellambi3	-
Bellambi Beach	Bellambi4	-
Bellambi Beach	Bellambi6	-
Woonona Beach	Woonona1	-
Woonona Beach	Woonona2	-
Bulli Beach	Bulli1	Collins Creek
Bulli Beach	Bulli2	-
Bulli Beach	Bulli3	Whartons Creek
Bulli Beach	Bulli4	Bulli Rockpool
Sandon Point Beach	Sandon1	-

Beach name	Beach unit	Other common names/descriptor
Sandon Point Beach	Sandon2	Slacky Creek
Sandon Point Beach	Sandon3	-
McCauleys Beach	McCauleys1	-
McCauleys Beach	McCauleys2	Woodlands/Hewitt Creek
McCauleys Beach	McCauleys3	-
Thirroul Beach	Thirroul1	-
Thirroul Beach	Thirroul2	Flanagans Creek
Thirroul Beach	Thirroul3	-
Austinmer Beach	Austinmer3	-
Austinmer Beach	Austinmer5	Little Austinmer Beach
Sharky Beach	Sharky1	Headland Beach
Sharky Beach	Sharky2	-
Sharky Beach	Sharky3	-
Coledale Beach	Coledale2	-
Coledale Beach	Coledale4	-
Coledale Beach	Coledale6	-
Wombarra Beach	Wombarra1	-
Scarborough Beach	Scarborough1	Horse Creek
Scarborough Beach	Scarborough2	-
Coalcliff Beach	Coalcliff1	-
Coalcliff Beach	Coalcliff2	-
Stanwell Park Beach	Stanwell1	-
Bulgo Beach	Bulgo1	Stanwell Tops Lookout
Bulgo Beach	Bulgo2	-
Bulgo Beach	Bulgo3	-
Werrong Beach	Werrong2	-
Burning Palms Beach	BurningPalms2	-
Era Beach	Era2	-
Era Beach	Era5	-
Little Garie Beach	LittleGarie3	-



Figure 2-1: Location of beach units.

2.3.3 Observations from the 2016 East Coast Low event

Observations from the 2016 East Coast Low (ECL) storm event have been used in coastal inundation mapping (observed wave runup) and erosion mapping (observed erosion). This uses several datasets and event summaries, including:

- Conference presentations on the East Coast Low in Wollongong (Beardsmore et al. 2016).
- Other conference presentations on the event (Burston et al. 2016).
- Profile and erosion data provided by Council[1] and Louis et al. (2016).

A description of the event is provided below, with specific review of wave runup and erosion estimates included in their respective assessments.

The 2016 East Coast Low, moved across NSW on 3 – 4 June 2016. Gale force north-easterly winds blew over a long fetch with peak gusts reaching 100-120 km/hr. Alongside heavy rains, strong north-easterly winds and large ocean waves, the event coincided with spring tide. This resulted in widespread erosion along the NSW coastline.

Burston et al. (2016) analysed regional water levels and wave conditions for the event. The peak water level occurred during the evening high tide on the 5th June for most sites, with elevated water levels persisting for three consecutive tide cycles. In Sydney the maximum tidal residual was 0.34m, with 0.20m recorded at high tide, while Batemans Bay recorded 0.56m, with 0.24m at high tide. These values are not considered particularly extreme, with an ARI between 2.5 to 20 years. The occurrence of the ECL coincided with a Winter Solstice Spring Tide (Louis et al., 2016). Louis et al. notes that the highest tidal peak was observed at Sydney with a water level of 1.29 mAHD, with the tidal peak at Eden of similar level (1.21 mAHD) although occurred one tidal period later.

Louis et al. (2016) estimated that the storm peak passed through Port Kembla between 15:00 hours and 16:00 hours on June 5th. The authors note that wave data from Port Kembla was limited due to signal interference, with no data captured between 10:00 on the June 4th to 17:00 hours of June 5th. This makes it unlikely that peak wave conditions of the event were recorded at Port Kembla. The largest waves recorded at Port Kembla were at 23:00 hours on the June 5th with a significant wave height (Hs) of 5.8 m, maximum wave height (H_{max}) of 11.1 m, and a storm average wave period (Tp) of 13.5 s, with an average wave direction of east (estimated 2-year ARI). At Sydney and Eden (located to the north and south of Port Kembla), the records cover the entire storm duration:

- Eden recorded the largest waves of the event, reaching a peak Hs of 8.5 m at 04:00 hours on the 6th, equivalent to an ARI of 1:30 years (ignoring direction). With an average direction of east-northeast.
- Sydney recorded a moderate Hs of 6.5 m at the peak of the ECL corresponding to about a 1:2 years ARI (ignoring direction).

1 Data provided by Council as a spreadsheet: "PGMonitoring_Allcalcs2Nov_combined130317"

The 2016 June event created the largest waves recorded in the northeast to east quadrant from Eden to Sydney. Most storm events along this stretch of coast come from southeast to southwest. This meant that areas that are normally sheltered at the central to southern end of beaches were exposed and suffered severe damage. Beardsmore et al. (2016) documented erosion along the NSW south coast, including the Wollongong coastline, noting that there were lower impacts at protected northern ends of beaches.

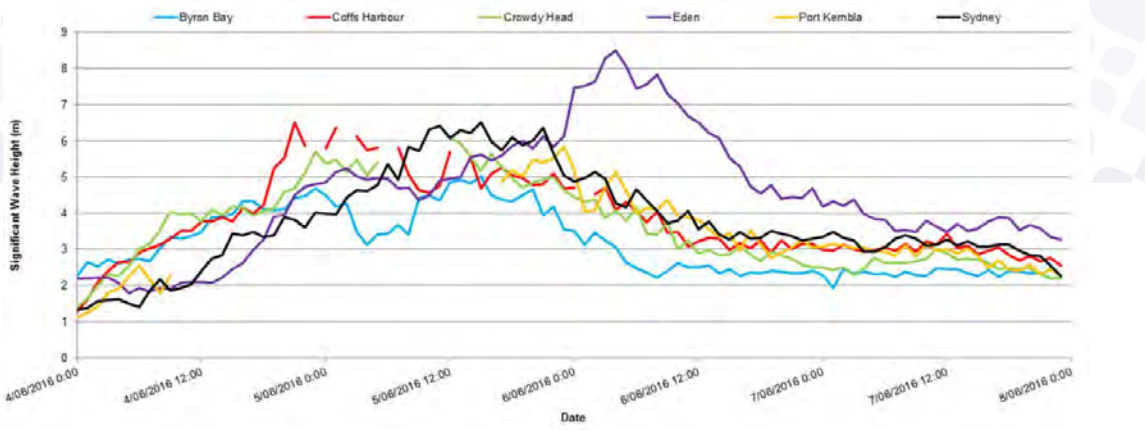


Figure 2-2: Hourly significant wave heights recorded at each of MHL's offshore Waverider buoys, 4th to 7th June 2016 (Louis et al. 2016).

2.3.4 Elevation data

Elevation data has been used for all hazard mapping. A variety of elevation datasets have been adopted for use within this study, shown in Table 2-2. This includes Light Detection and Ranging (LiDAR) data, combined NSW Marine LiDAR Topo-Bathy 2018[2] which includes shallow water bathymetry, and beach cross section information from the NSW Beach Profile Database.

Table 2-2: Elevation data used in this study.

Name	Year/s	Source
5m NSW Marine LiDAR Topo-Bathy	2018	https://datasets.seed.nsw.gov.au/dataset/marine-lidar-topo-bathy-2018
1m NSW LiDAR	2013 & 2021	https://elevation.fsdf.org.au/
NSW Beach Profile Database	1951 - 2023	http://www.nswbpd.wrl.unsw.edu.au/photogrammetry/

2.3.5 Hydrodynamic models

Tidal inundation and coastal inundation mapping have been supported by the use of existing hydrodynamic models. This has used existing hydrodynamic models originally developed for flood studies which have been repurposed for new coastal simulations.

2 NSW Marine LiDAR Topo-Bathy 2018 Data Quality Statement

Available models use the TUFLOW hydraulic engine with their extent shown in Figure 2-3, having been developed for the following flood studies:

- Hewitts Creek Flood Study (2019)
- Collins Creek Flood Study (2019)
- Towradgi Creek Flood Study (2019)
- Fairy & Cabbage Tree Creeks Flood Study (2020)
- Wollongong City Flood Study (2019)
- Allans Creek Flood Study (2019)

Note: For the purposes of this study, the Wollongong City Flood Study and Allans Creek Flood Study hydrodynamic models have been amalgamated into a single domain. Further information to support the hydrodynamic changes implemented within this study can be found in Appendix A.

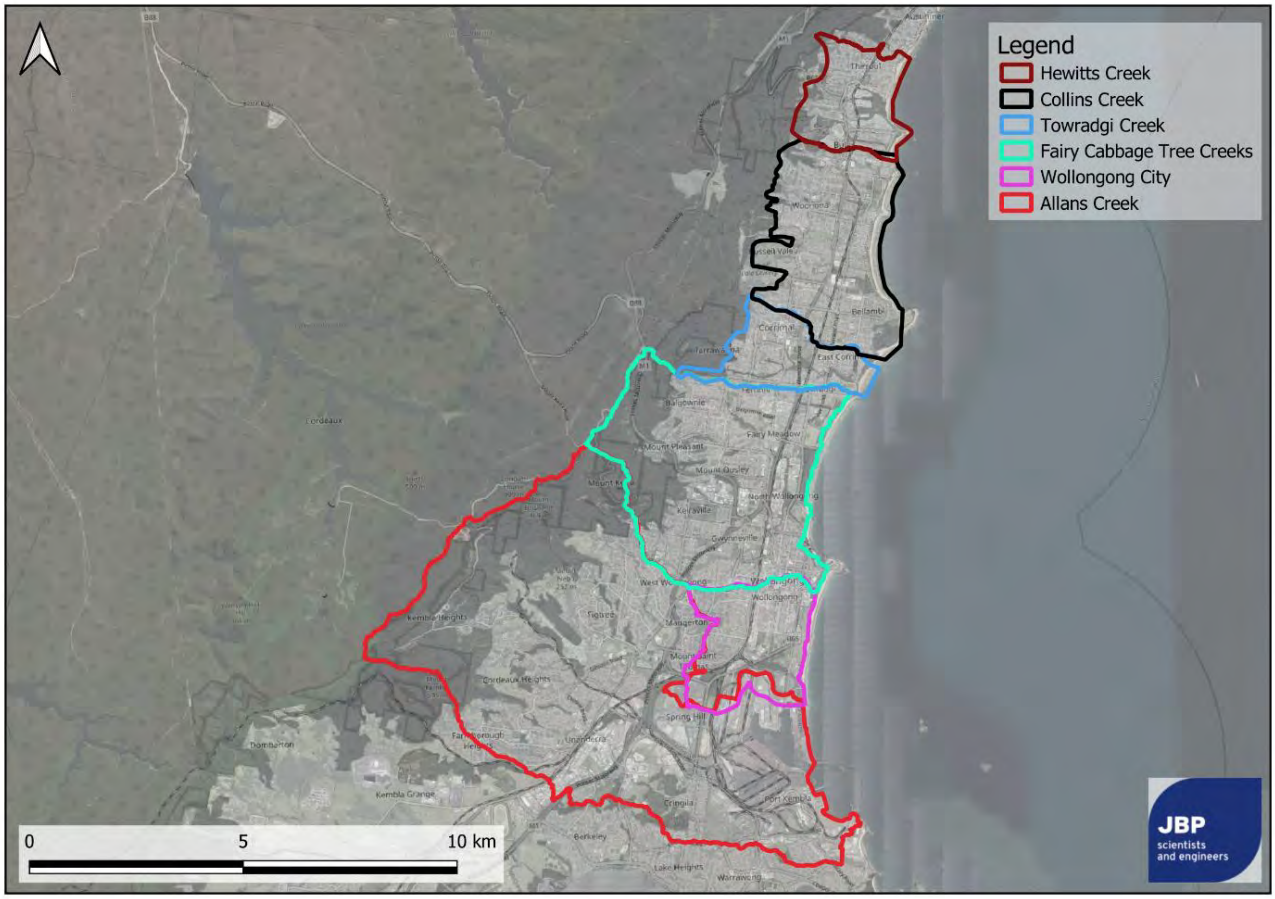


Figure 2-3: Extent of the available TUFLOW models across the study area.

2.3.6 Extreme sea levels

Extreme sea levels (ESLs) are used for coastal inundation and coastal erosion hazard mapping. These are based on published estimates for the open coast and NSW government guidance on selecting ESLs in estuaries.

For the open coast, a literature review was undertaken on published estimates and analysis of the Fort Denison tide gauge, which has been operational since 1867, with reliable monthly mean water levels from 1886 and hourly water levels from 1914. Due to its proximity, approximately 80 kilometres south, Wollongong experiences similar tidal patterns making the Fort Denison data applicable. Available ESLs were reviewed for Fort Denison from:

- Floodplain Risk Management Toolkit (OEH, 2015),
- A review undertaken by MHL in 2018 ("NSW Extreme Ocean Water Levels")
- “Fort Denison sea level rise vulnerability study” By Watson and Lord (2008)
- "Determining Extreme Still Water Levels for Design and Planning Purposes Incorporating Sea-level rise: Sydney, Australia” by Watson (2022).

Table 2-3 shows the ESL estimates from all sources. The comparison shows a difference of 50mm for the 100-year ARI 'present-day event', which is considered to have negligible impact on inundation extents. It is noted that the provided ARI estimates are based on historical data up to the publication dates of the respective studies. NSW government studies have been used in preference, based on most recent value. This uses MHL 2018 for the 20-year and 100-year value, and OEH 2015 for the 1-year. These have been increased to account for small SLR changes since their publication (detailed below).

Table 2-3: Extreme sea levels for the open coast, Fort Denison tide gauge.

Likelihood			Extreme Sea Levels (mAHD)		
ARI (years)	AEP	MHL (2018)	OEH (2015)	Watson & Lord (2008)	Watson (2022)
1	63%	-	**1.25***	1.24	1.24
20	5%	**1.35***	1.40	1.38	1.41
100	1%	**1.42***	1.45	1.44	1.47
*Denotes adopted value for open coast					

Coastal inundation mapping within estuaries has considered the influence of wave and entrance effects following the guidance provided by OEH (2015). This guidance categorises three types of entrance. Allans Creek is considered an open coast type A (Tidal Embayment) entrance condition and therefore the open coast water level is applied at the Allans Creek model boundary. Fairy/Cabbage Tree Creeks, Towradgi Creek, Collins Creek and Hewitts Creek are all considered Type C Intermittently Closed and Open Lake or Lagoons (ICOLLs), where:

- Entrance Type C (ICOLL) 20-year ARI (5% AEP): 2.35 mAHD
- Entrance Type C (ICOLL) 100-year ARI (1% AEP): 2.55 mAHD

Therefore, for all other TUFLOW models the Type C water levels are applied at the model boundary.

Note OEH (2015) does not provide closed entrance values for a 1-year event, with an open coast level used instead.

All ESLs for the open coast and ICOLLs have been updated to account for SLR estimates since their published date. Since the 2018 MHL report, sea levels have risen at an average rate of approximately 4 mm per year (DCCEEW, 2021; CSIRO, 2020). To reflect present day conditions an adjustment of +0.03 m has been applied to the original ESLs (calculated as 0.004 mm/year x 7.5 years). Table 2-4 presents the updated ESL used in this study for the open coast and ICOLLs.

Table 2-4: Present day extreme sea levels (adapted from OEH 2015 and MHL 2018).

Waterway Entrance Type	1-year ARI (63% AEP) ESL (mAHD)	20-year ARI (5% AEP) ESL (mAHD)	100-year ARI (1% AEP) ESL (mAHD)
Open Coast	1.28	1.38	1.45
Creeks and ICOLLS covered by hydrodynamic modelling	1.28	2.38	2.58

2.3.7 Sea-level rise (SLR)

SLR estimates have been used in all hazard mapping. Background information on SLR assumptions is produced in Salients Consulting (2025), Addendum A: Sea-level rise. Table 2-5 shows the sea-level rise estimates used for this study.

Table 2-5: Mean Sea Level - SLR projections (SSP5-8.5) for Wollongong Coastal Hazard Studies (mAHD)

Year	% chance won't be exceeded				
	5%	17%	50%	83%	95%
2045	0.15	0.18	0.23	0.29	0.35
2075	0.33	0.39	0.50	0.65	0.79
2125	0.65	0.78	1.10	1.54	1.89

2.3.8 Wave conditions

Wave conditions are used within coastal inundation and erosion hazard mapping where:

- The coastal inundation hydrodynamic model incorporates extreme wave overtopping
- The coastal inundation bathtub-based mapping approach incorporates extreme wave runup
- The erosion hazard mapping considered extreme wave conditions to develop the wave exposure factor.

Long-term wave conditions have been extracted from the NSW Nearshore Wave Tool[3] and developed into a Multivariate Dataset for use in wave overtopping or runup calculations.

The NSW Nearshore Wave Tool was developed by Baird Australia for the NSW Government. It includes a long-term nearshore hindcast that uses a wave transformation tool based on the third-generation spectral wind-wave model WAVEWATCH III forced with atmospheric conditions from the ERA5 global reanalysis dataset prepared by the European Centre for Medium-Range Weather Forecasts (ECMWF) in association with the Copernicus Climate Change Service (C3S). The model is based on three nested regular grids, stepping from global (1° resolution), Australia (0.25° resolution), to south-east Australia region (0.05°) – and an irregular mesh covering the nearshore NSW study area, reaching 100 m resolution at 10 m water depth. Wave conditions have been extracted at the 10 m depth contour for selected nearshore points along the Wollongong coastline. Initial assessment showed little difference (order of centimetres) in significant wave heights (Hs) along the 10 m depth contour.

A multivariate dataset was developed using storm event parameters (Hs, Tp and Direction) for Hs greater than 2m. A univariate distribution was fit to each parameter. A Gaussian copula method was then applied to create multivariate distributions. This was used to generate 10,000 years' worth of simulated storm conditions. The developed multivariate dataset has been used in wave overtopping (Section 4.3.1) and wave runup (Section 4.4.1) calculations.

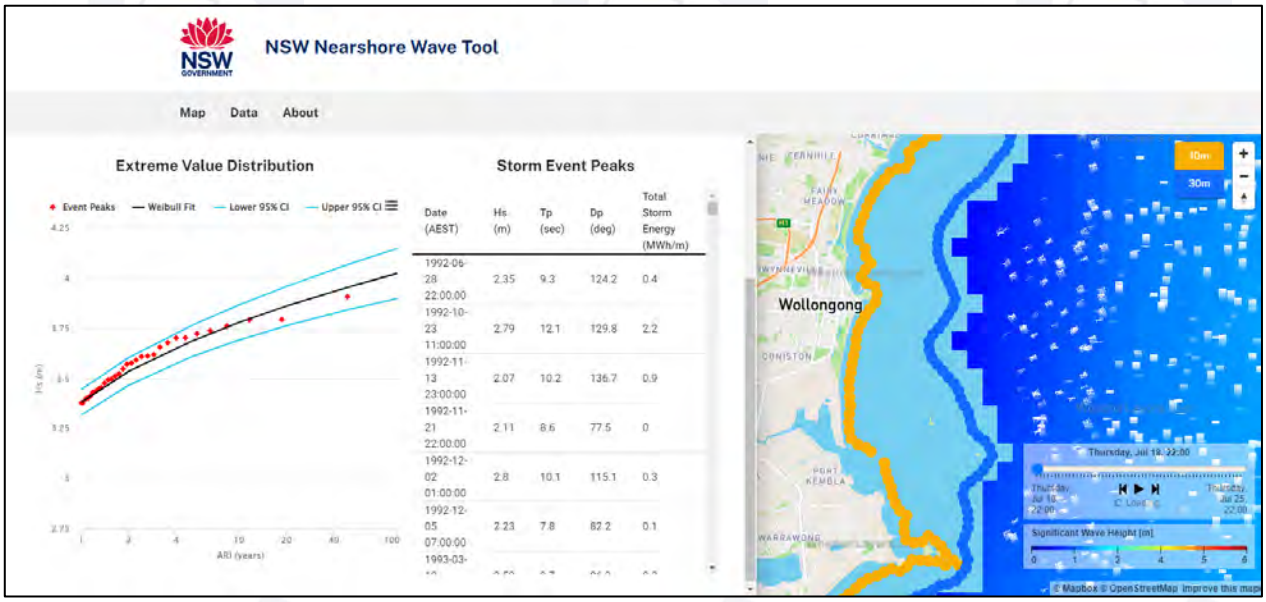


Figure 2-4: Screenshot of NSW nearshore wave tool.

3 Baird Australia (2017) NSW Coastal Wave Model - State Wide Nearshore Wave Transformation Tool. Accessed via the NSW Nearshore Wave Tool webpage: https://nearshore.waves.nsw.gov.au/home/forecast

3 Tidal inundation

3.1 Methodology

Tidal inundation is the inundation of land by tidal action under average meteorological conditions and the incursion of sea water onto low lying land that is not normally inundated, during a high sea level event such as a king tide combined with long term SLR.

Two approaches have been adopted for production of the tidal inundation maps.

- Where existing hydrodynamic models are available for the harbour and creeks, they have been used to simulate the open coast tide conditions.
- Along the open coast in areas without a hydrodynamic model, inundation is based on a bathtub mapping approach.

The two mapping approaches are shown in the flow chart in Figure 3-2.

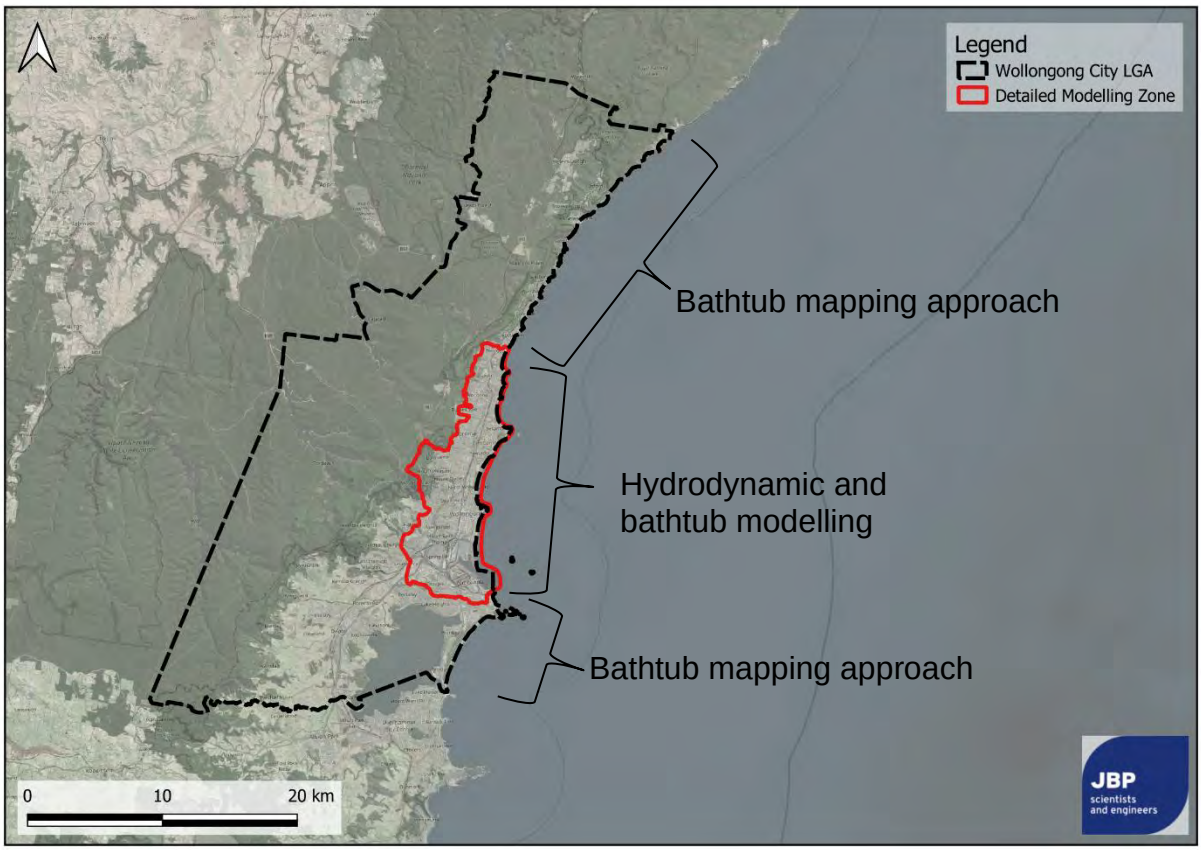


Figure 3-1: Wollongong Coastal Hazard Study - study area and modelling zones.

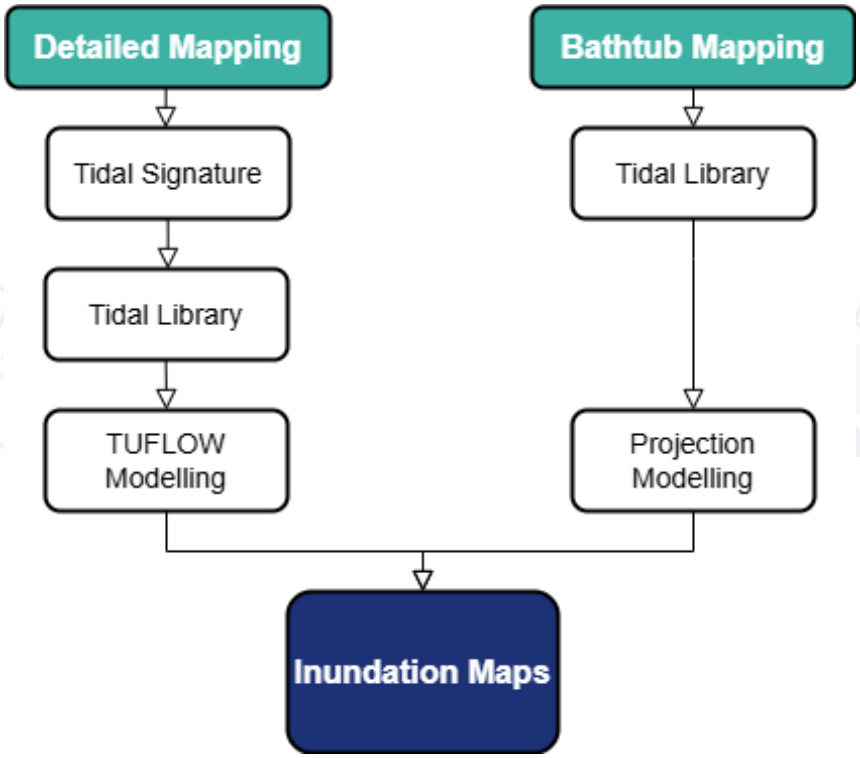


Figure 3-2: Schematic of overall tidal inundation mapping approach.

3.2 Tidal maps

A simulation library has been developed in 0.1m increments for tide levels between 1.10 to 1.80 mAHD, with a single additional scenario of 2.9 mAHD (see Table 3-1). This spans the present day Higher High Water Spring Solstice (HHWSS) tide of 1.1 mAHD and can be used to reflect a range of future SLR scenarios. By adopting a library of events at 0.1m intervals, future SLR maps will fall with ±5 cm of a modelled scenario. The 2.9 mAHD scenario represents the 95th percentile HHWSS for the year 2125, providing an unlikely scenario for future sea level conditions. Other low-confidence AR6 projections may result in higher sea levels than the adopted figure, with the possibility of 3.5 to 4 m of SLR over the next 100 years.

The adoption of a “simulation library” approach is advantageous as it remains independent of any sea-level rise projection that may be adopted for planning or risk analysis. Should Council’s selected projection be updated, potentially triggered when new information is published by the Intergovernmental Panel on Climate Change (IPCC), results would be readily available from the simulation library with no more than 5cm in error from any chosen amount of sea level rise. Therefore, suitable simulation results for a selected probability of sea level rise could be extracted from the simulation library results to examine risks at a selected future time, without requiring new model simulations to be executed.

Table 3-1: Simulation library events.

Normalised MSL (mAHD)	HHWSS Peak Tide Level (mAHD)	Example Equivalent SSP5-8.5 Medium Confidence Projection
0.10	1.10	Present Day
0.20	1.20	2045 – 50th Percentile
0.30	1.30	↓ ↓ ↓
0.40	1.40	↓ ↓ ↓
0.50	1.50	↓ ↓ ↓
0.60	1.60	↓ ↓ ↓
0.70	1.70	↓ ↓ ↓
0.80	1.80	2075 - 95th Percentile
1.90	2.90	2125 - 95th Percentile

3.3 Hydrodynamic modelling

Tidal inundation and coastal inundation mapping have used repurposed hydrodynamic models for creeks and estuaries. These have been repurposed from their flood-focus to a coastal-focus using the adjustments described in Appendix A.

Hydrodynamic modelling has applied a HHWSS tide signature. This is based on 'design' hourly water level data provided within the NSW Coastal Management Toolkit[4], for areas south of Crowdy Head. This tidal signature was scaled so the peak HHWSS water levels match the simulation library tide levels (Figure 3-3). Four full tide cycles have been extracted from this data for use within the hydrodynamic model covering a 50-hour period. This captures two high tides before the HHWSS occurs and one high tide after, allowing for water to propagate inland and flush through the systems between peak events.

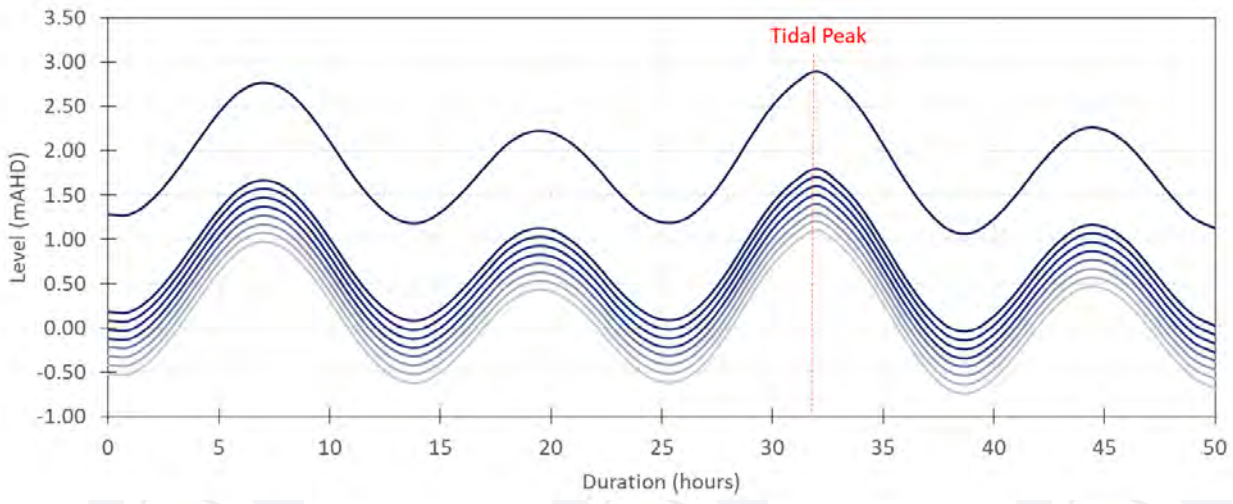


Figure 3-3: Adopted tidal signatures across the simulation library for use within the hydrodynamic models.

4 NSW Government (2024) Coastal management toolkit. Dataset: 'Hourly water level data to support using the Guide (XLS 48KB)'.

3.4 Bathtub mapping

A water level projection (bathtub) mapping approach has been used in areas not covered by hydrodynamic models. This approach creates inundation depths as the difference between water level and ground elevation. The bathtub mapping uses the 5m resolution NSW Marine LiDAR Topo-Bathy data, which is compared against the maximum HHWSS water levels for any event in the simulation library. Post processing has removed isolated regions (topographic depressions) where there is no surface connectivity to the coastline at the projected water level. The outputs have also been resampled down to 2.5m resolution grid to align with the repurposed hydrodynamic model output data.

3.5 Merged tidal inundation maps

The hydrodynamic model maps and bathtub maps have been merged into single tidal inundation maps for each tide level in the simulation period. A snapshot of the composite mapping outputs at Towradgi Creek is shown in Figure 3-4. A subset of the full spatial data is printed in Appendix B1, showing HHWSS inundation at 1.1, 1.4, 1.8 and 2.9 mAHD.

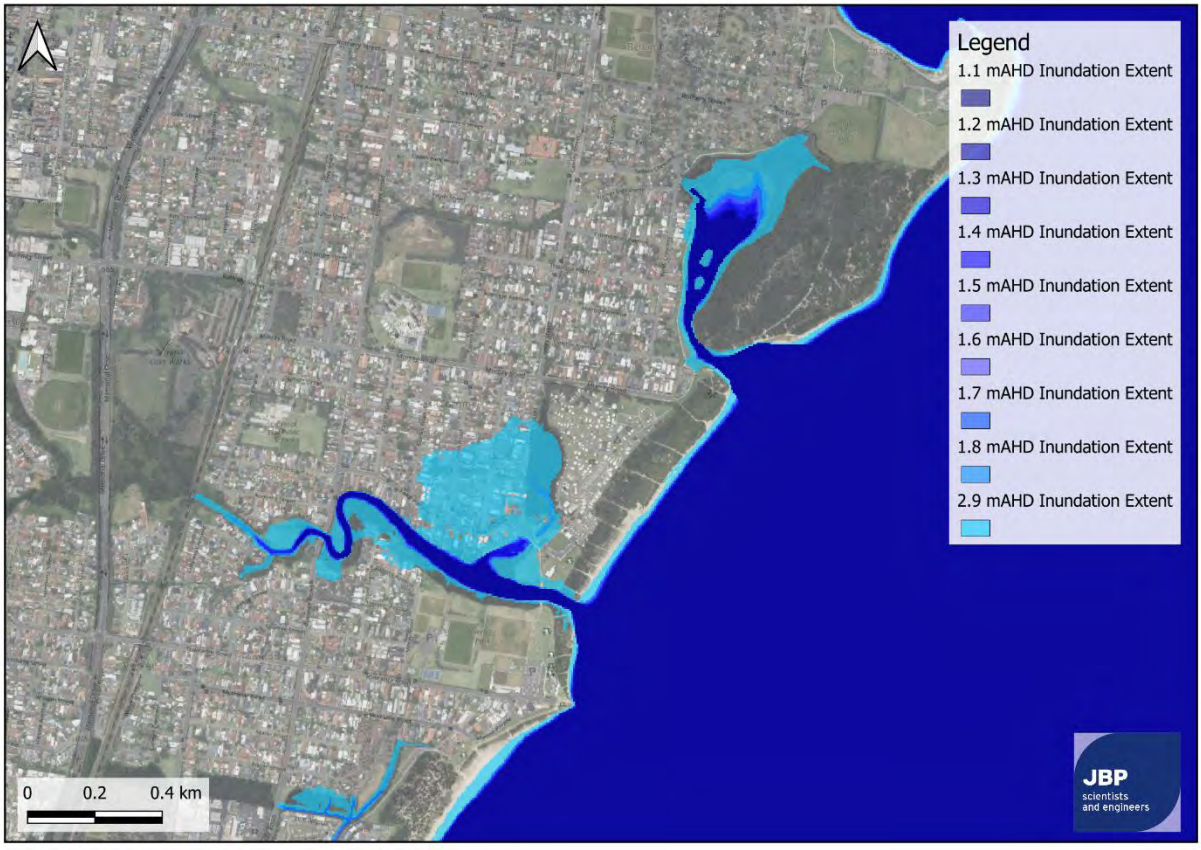


Figure 3-4: Tidal Inundation at Towradgi Creek for the modelled simulation library.

4 Coastal inundation

4.1 Methodology

Coastal inundation mapping accounts for additional processes including storm surges, closed entrance effects, and wave action including wave overtopping. Two approaches have been adopted:

- The repurposed hydrodynamic models were used to simulate storm surges entering creeks and estuaries, including potential wave overtopping of structures and low-lying dunes. The Allans Creek model (Port Kembla harbour) uses open coast extreme sea levels, with other creek models using adjusted entrance conditions based on the OEH (2015) Floodplain Risk Management Guide. These models focus on hydrodynamics within the creek mouth (i.e. inland/upstream of any partially blocked entrances) and consequently their results have only been used 'landward' of the entrance and dune systems.
- Along the open coast, seaward of the dune crest, or in areas without a hydrodynamic model, coastal inundation mapping uses extreme sea level plus wave runup effects calculated using analytical equations. These have been applied using a bathtub mapping approach.

An overview of the coastal inundation mapping approach is provided within the flow chart in Figure 4-1. A schematic showing how hydrodynamic model maps and wave runup maps have been split along the dune crest is shown in Figure 4-2.

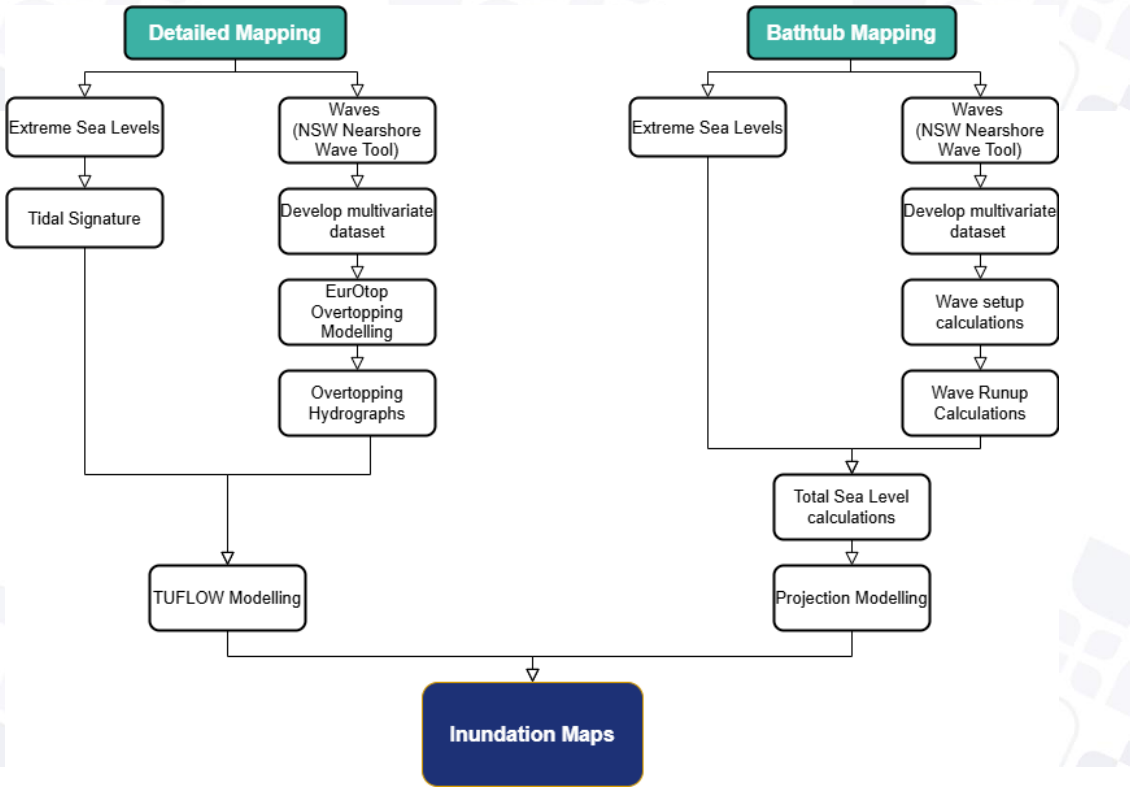


Figure 4-1: Schematic of overall tidal inundation mapping approach.

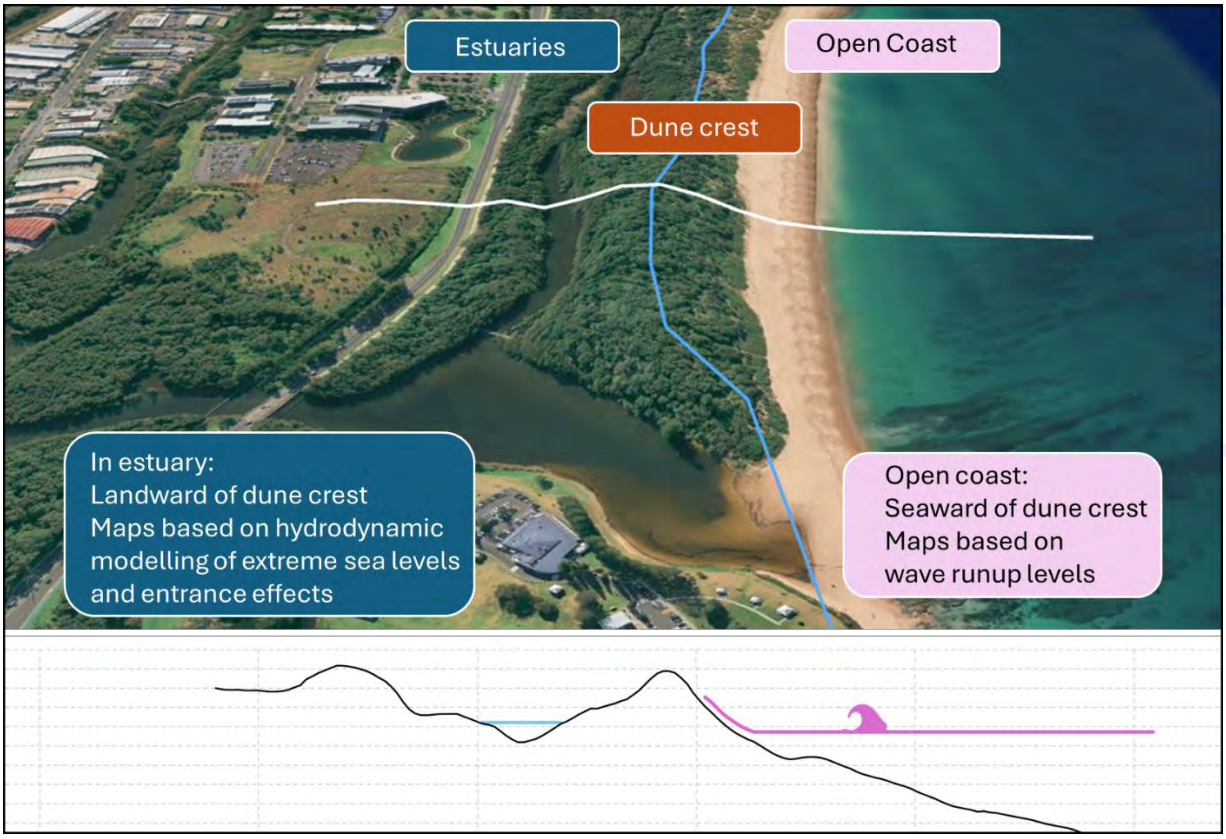


Figure 4-2: Schematic of hydrodynamic model mapping outputs and wave runup mapping outputs split along the dune crest.

4.2 Coastal inundation maps

A specific set of coastal inundation maps have been produced, listed in Table 4-1. Coastal inundation mapping has been completed for up to three return period events for present day and future planning horizons (+20y, +50y, +100yr). Future horizons follow the SSP5-8.5 medium confidence projection. This includes some scenarios using the mean and higher probability estimates (e.g. 50% & 95% chance it won't be exceeded). ESL (open coast or ICOLLs) and SLR projections are based on the levels described in Section 2.3, which are presented in Table 4-2 and Table 4-3.

Table 4-1: Proposed model scenarios for coastal inundation mapping.

Year	Extreme water levels & coincident overtopping (AEP)	SLR probabilities
2025	5%	n/a
2045	63%, 5% and 1%	50% & 95%
2075	63%, 5% and 1%	50% & 95%
2125	63%, 5% and 1%	95%

Table 4-2: Extreme sea levels and entrance conditions for coastal inundation mapping, based on 95th percentile SLR projections.

Year	Condition*	SLR percentile	Extreme water levels (mAHD)		
			63% AEP	5% AEP	1% AEP
2025	ESL	-	-	1.38	-
2045	ESL	95th	1.44	1.54	1.61
2075	ESL	95th	1.89	1.99	2.06
2125	ESL	95th	2.98	3.08	3.15
2025	ICOLL	-	-	2.35	-
2045	ICOLL	95th	1.44	2.55	2.75
2075	ICOLL	95th	1.89	2.99	3.19
2125	ICOLL	95th	2.98	4.08	4.28
ESL: Extreme sea levels for the open coast Creek: ICOLL levels based on entrance condition type C (OEH 2015)					

Table 4-3: Extreme sea levels and entrance conditions for coastal inundation mapping, based on 50th percentile SLR projections.

Year	Condition*	SLR percentile	Extreme water levels (mAHD)		
			63% AEP	5% AEP	1% AEP
2025	ESL	-	-	1.38	-
2045	ESL	50th	1.39	1.49	1.56
2075	ESL	50th	1.66	1.76	1.83
2125	ESL	50th	-	-	-
2025	ICOLL	-	-	2.35	-
2045	ICOLL	50th	1.39	2.49	2.69
2075	ICOLL	50th	1.66	2.76	2.96
2125	ICOLL	50th	-	-	-
ESL: Extreme sea levels for the open coast Creek: ICOLL levels based on entrance condition type C (OEH 2015)					

4.3 Hydrodynamic modelling

Hydrodynamic modelling uses the repurposed hydrodynamic models to simulate storm surges entering creeks and estuaries, including potential wave overtopping of structures of low-lying dunes.

Simulations use the normalised tidal signature developed for tidal inundation modelling (see Section 3.3). A triangular storm surge hydrograph was applied over a 72-hour window to represent the dynamic interaction between storm surge events and tides. The triangular shape was selected as a simplified representation of the surge. The 72-hour duration was informed by an analysis of historical storm events recorded at the Port Kembla tide gauge, which provided a basis for defining the timing and magnitude of the surge (Figure 4-3).

Additional inputs into the hydrodynamic models include wave overtopping (Section 4.3.1).

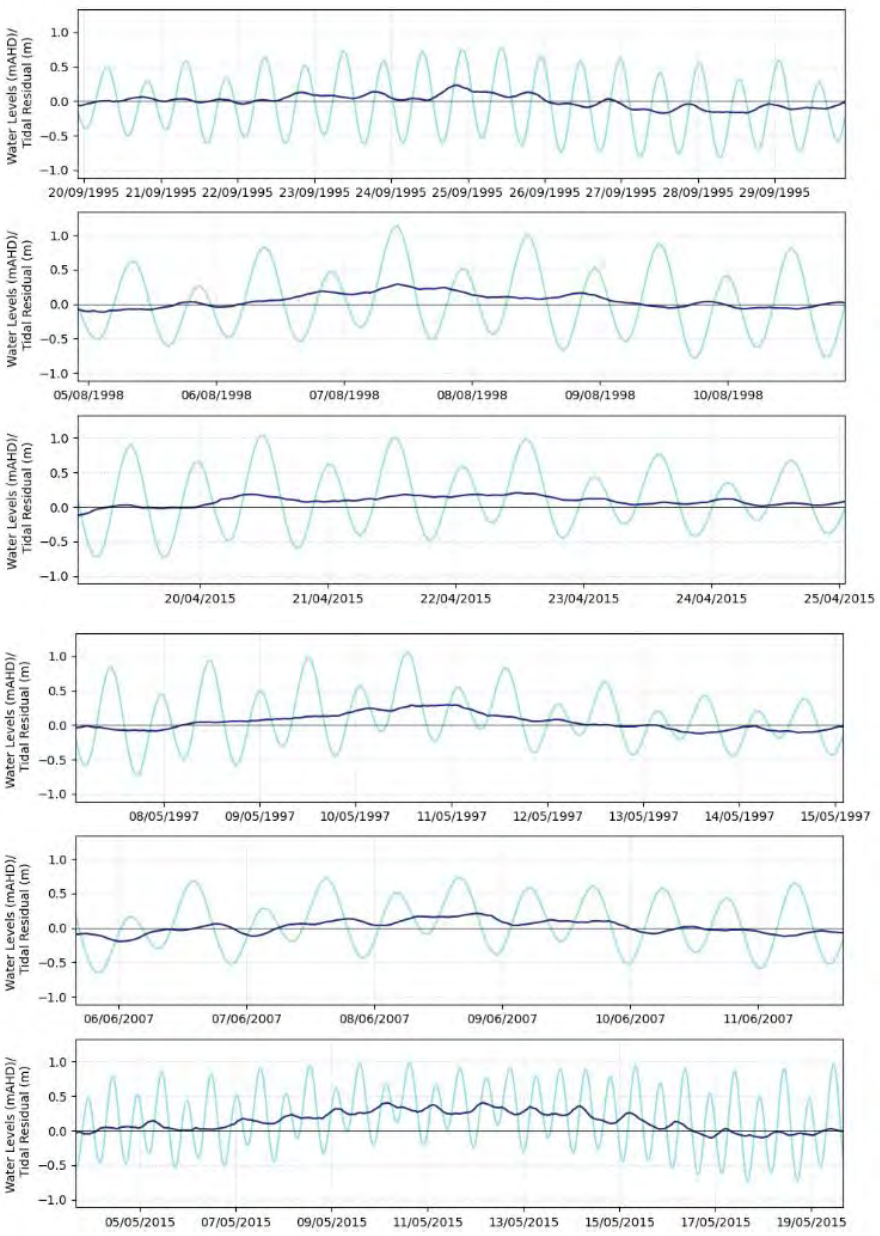


Figure 4-3: Observed tide and residual of selected storms from Port Kembla tide gauge.

4.3.1 Wave overtopping

The incorporation of wave overtopping within the hydrodynamic models required five steps:

1. Division of frontage
2. Schematisation
3. Calculation of peak overtopping rates
4. Overtopping validation for structures (4A) and dunes (4B)
5. Overtopping hydrographs

4.3.1.1 Overtopping step 1. Division of frontage

Locations within the hydrodynamic model extents with a wave overtopping risk were divided into discrete sections based on changes in crest level, structure geometry, orientation, or

other clear changes in characteristic of the frontage (see example low dune sections in Figure 4-4). Areas with low crest levels outside of the hydrodynamic model extents consider wave effects using setup and wave runup calculations, described in Section 4.4.1.

Table 4-4 shows the number of identified wave overtopping sections for each hydrodynamic model. Overtopping was only applied where it may result in inundation risk. Sections were schematised using LiDAR data and aerial imagery. The North Wollongong seawall was schematised as per supplied design drawings.

Table 4-4: Number of overtopping sections related to each model.

TUFLOW Model	Number of OT sections	Defence structure type
Hewitts Creek	3	Wall
Collins Creek	3	Armoured rock, beach dune
Allans Creek	3	Tetrapod block, beach dune
Fairy Cabbage Tree Creeks	4	Seawall, stepped revetment, beach dune
Towradgi Creek	0	-

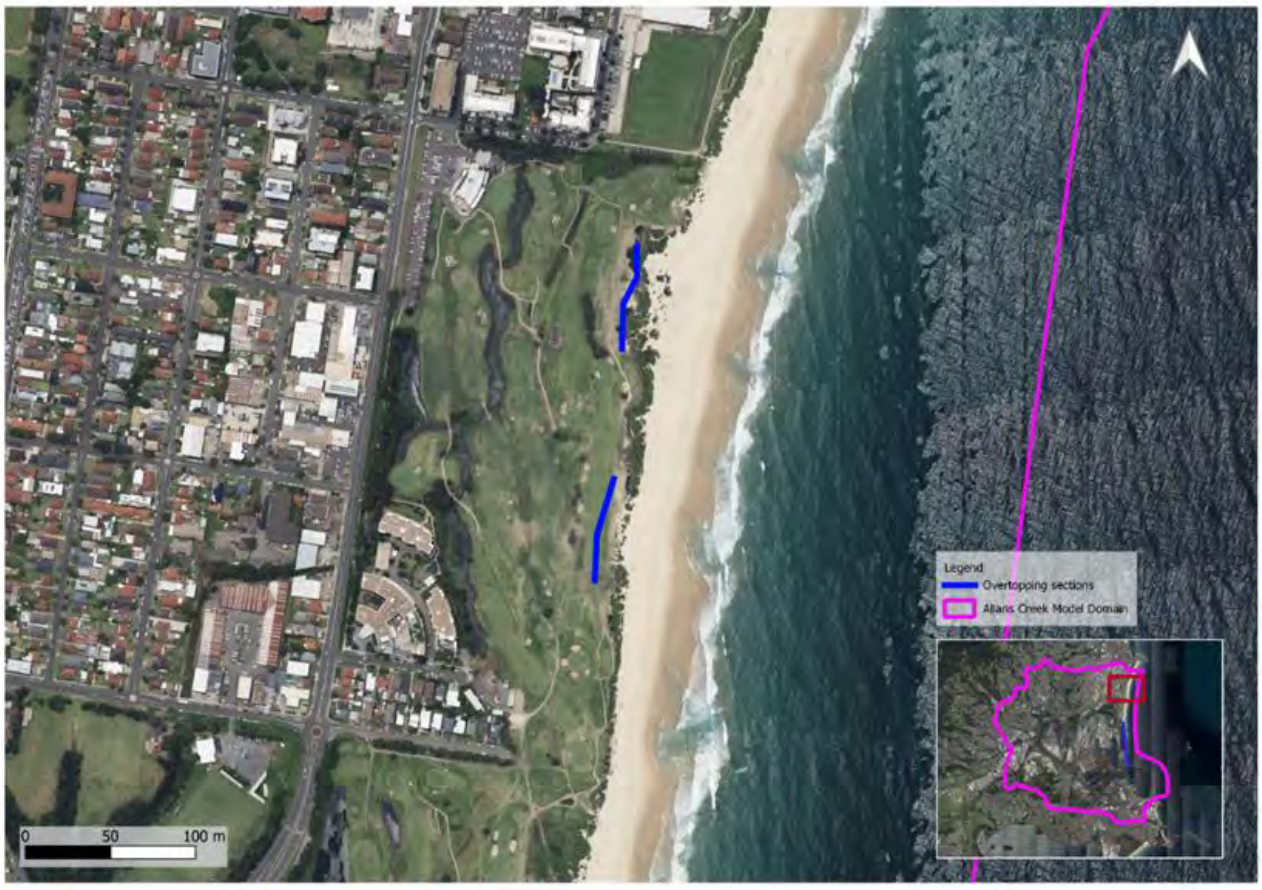


Figure 4-4: Identified dunes (blue) with wave overtopping risk at Wollongong Golf Club (Allans Creek Model).

4.3.1.2 Overtopping step 2. Schematisation

Wave overtopping estimates have been calculated using the methods outlined within the industry standard European Wave Overtopping Manual (EurOtop)[5]. This manual includes three different methods and associated guidelines for the prediction of wave overtopping for different structure types. For this study, both the empirical equations and Neural Network approach (NN2) were used. Example schematisations are shown in Figure 4-5 and Figure 4-6. An allowance has been made for possible toe lowering during storm events with a depleted beach toe of -1 mAHD used. It is assumed all schematisations remain unchanged throughout the assessment period. A simple, empirical, approach has been undertaken for dunes at risk of overtopping. This approach requires the following assumption: 1) that during a storm, a beach will erode such that that a near vertical, saturated scarp will form, and 2) this saturated scarp would behave like an impermeable seawall. Based on these assumptions, wave overtopping volumes can then be calculated using the EurOtop manual (2018) equation for a vertical seawall.

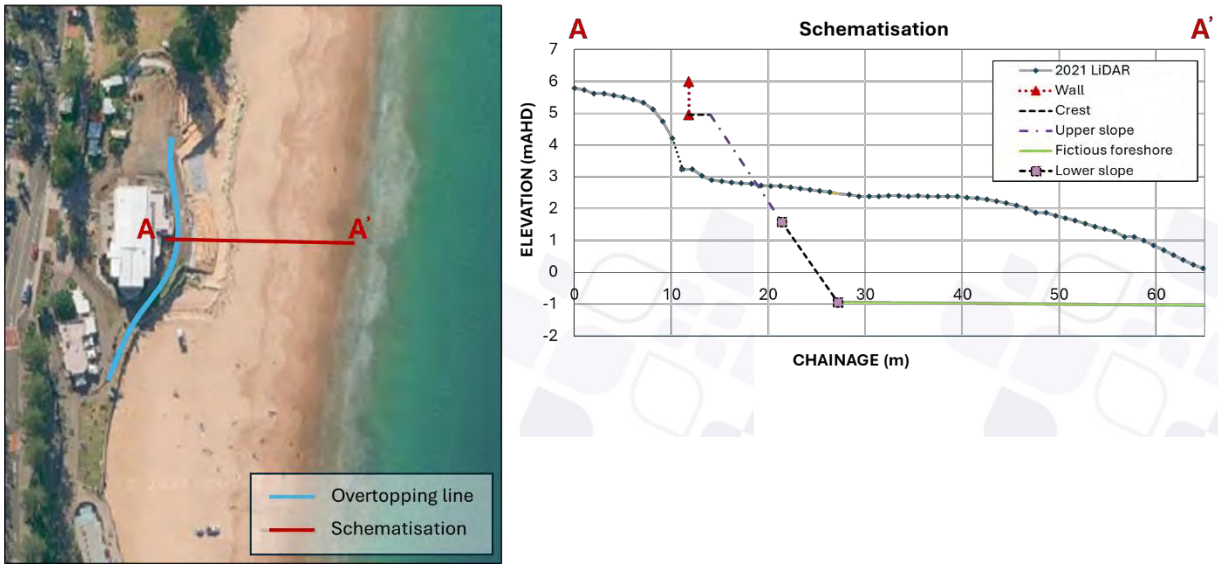


Figure 4-5: Overtopping schematisation and section for new North Wollongong seawall.

5 EurOtop (2018) “Manual on Wave Overtopping of Sea Defences and Related Structures an Overtopping Manual Largely Based on European Research, but for Worldwide Application”

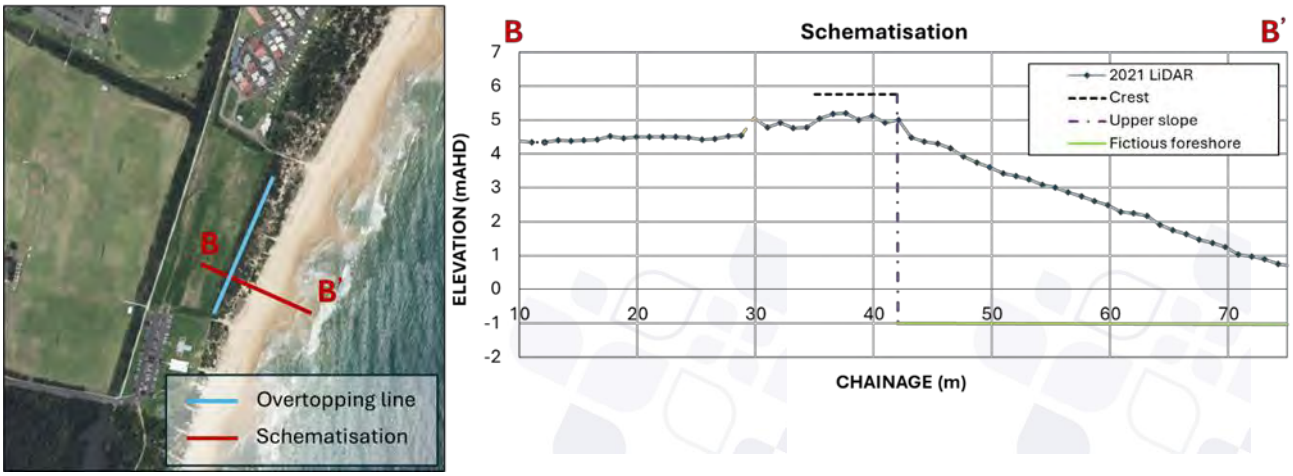


Figure 4-6: Overtopping schematisation and section for eroded dune north of Fairy Meadow SLSC (Overtopping section - FCT01).

4.3.1.3 Overtopping step 3. Calculation of peak overtopping rates

Both empirical equations and the Neural Network have been used to derive peak overtopping discharge rate, expressed in terms of metres cubed per second, per metre length of defence ($m^3/s/m$). This is converted to litres/s/m for simpler visualisation of results. Mean overtopping discharges were calculated for each event in the 10,000-year multivariate wave dataset (see Section 2.3.8) with return period estimates assigned to each overtopping rate. This followed the approach whereby the overtopping rate is ranked (1 - i) and each event assigned a return period following:

$$RP_i = \frac{N_y}{i}$$

Where N_y is the number of years the dataset represents (10,000 years).

4.3.1.4 Overtopping step 4A. Overtopping validation hard structures

Evaluating the performance of wave overtopping models relies on good quality observed data from a storm that produced wave overtopping, which rarely exists. A formal quantitative evaluation of the performance of overtopping models is therefore not feasible in this particular study, and a more qualitative approach has been taken.

Wave overtopping rates from the June 2016 ECL have been captured on camera at the Wollongong Breakwater[6]. In the 32s video, three waves are observed breaking over the breakwater and one over the vertical wall adjacent to the carpark, with the higher rate of overtopping per wave observed at the breakwater.

6 Zac Mckenzie (2016) “Huge waves hit Wollongong during major Australian storm”, video available on newsflare.com. Accessed 18 March 2025 from: https://www.newsflare.com/video/74508/huge-waves-hit-wollongong-during-major-australian-storm

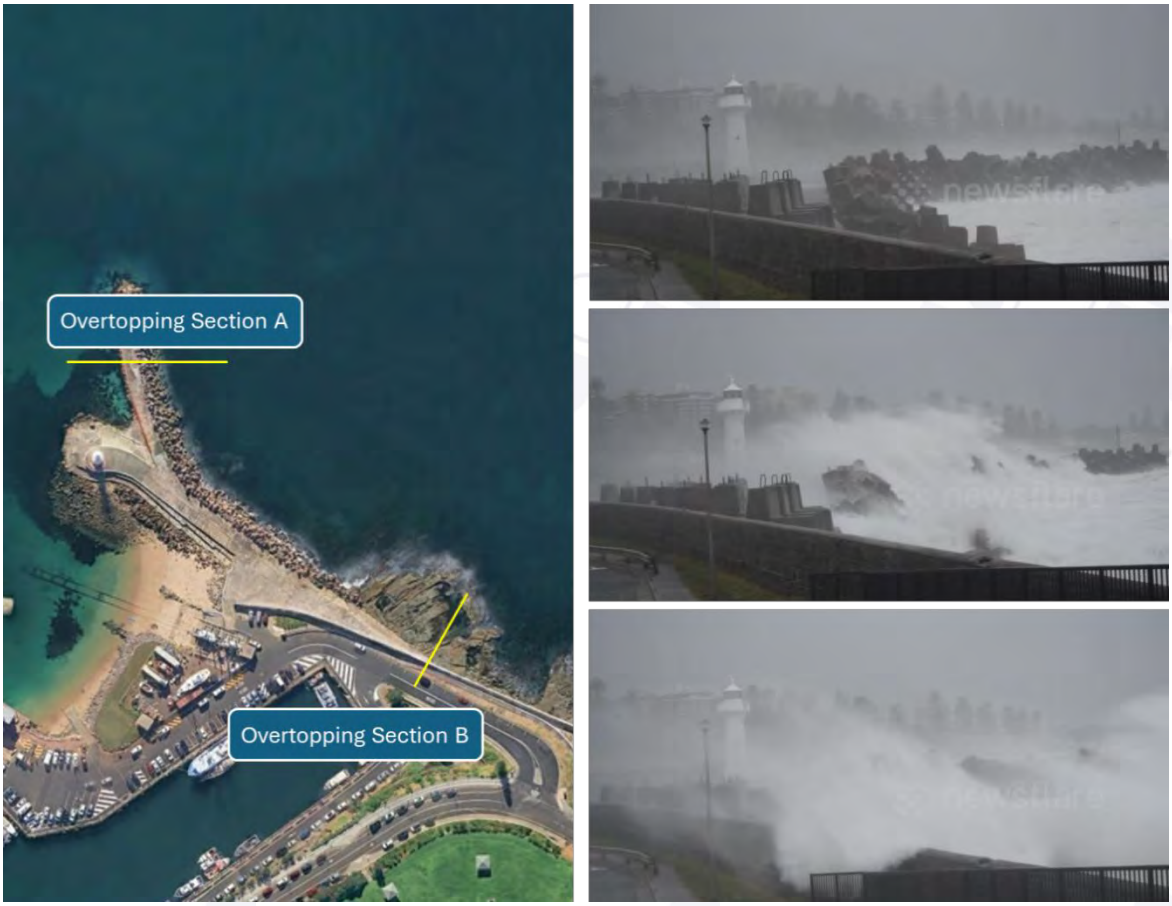


Figure 4-7: Validation locations for observed 2016 overtopping

A degree of judgement has been used to consider the overtopping rates that could have been expected during peak conditions. This has compared the observed conditions against tolerable overtopping volumes suggested in the EurOtop Manual. This suggests:

- The breakwater (Section A) is likely to have overtopping rates exceeding >200 l/s/m, which is the threshold able to cause damage. All waves in the video overtop the structure significantly, with water ejected tens of metres in the air.
- The vertical wall (Section B) is more difficult. Only one wave overtopped the vertical wall, which fell within ~1m of the structure. It does not appear to be a dangerous environment, therefore low rates of overtopping are expected, i.e. well below 10 l/s/m which is a commonly referenced limit for trained staff, and potentially below 1 l/s/m which is a common limit for pedestrians.

Both overtopping sections were schematised and wave overtopping calculated in the NN and empirically. The results show 223 l/s/m overtopping for the breakwater (Section A), which supports observations. For the vertical wall, the NN returns 0.2 l/s/m, which is considered low but suitably close to the observed values.

This validation exercise supports the use of the NN model in calculating peak overtopping rates.

4.3.1.5 Overtopping step 4B. Overtopping validation dunes

A 1D XBeach numerical model has been used to test the validity of using EurOtop to estimate overwash flood risk of natural systems. Numerical process-based models like XBeach are not suitable for probabilistic modelling due to computational limitations, hence they are used for validation. The beach profile for overtopping section FCT01, shown in Figure 4-8a, was modelled in XBeach for the 2125 1% AEP event. Both a storm profile and semi-accreted beach profile were modelled. Results are shown in Figure 4-8b with a comparison to the EurOtop vertical equation (assumes a vertical scarp). Rates are the same order of magnitude, however, XBeach consistently estimates larger overtopping rates at the dune crest for the 1% AEP event. The degree of uncertainty in calculating overtopping rates can vary by a factor of 2-10, influenced by slight variations in wave forcing, water levels and beach profile to that forecast or measured at a different location[7]. Given the inherent uncertainty in overtopping calculations and the long simulation times of the XBeach model, the simpler EurOtop vertical equation was used to derive overtopping rates for the coastal inundation models.

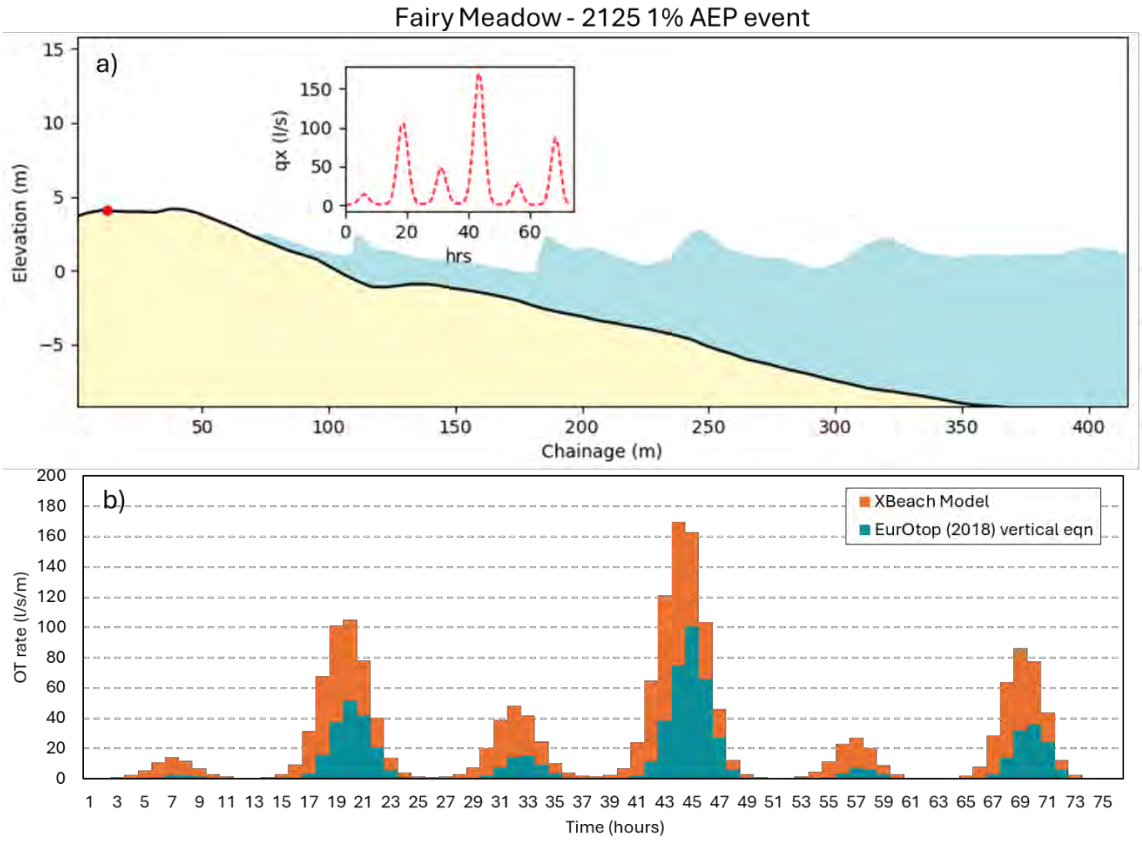


Figure 4-8: a) XBeach model for FCT01 with overtopping hydrograph for 2125 1% AEP; b) plot showing overtopping hydrograph comparison with EurOtop-derived rates.

7 Stokes, K., Poate, T., Masselink, G., Brown, J., & Yelland, M. (2022). Sources of uncertainty in coastal overtopping forecasts. Presented at the EuroSea Workshop 1.

4.3.1.6 Overtopping step 5. Overtopping hydrographs

Peak overtopping rates have been converted into a time-varying overtopping discharge using the tidal and storm surge signature described in Section 3.3. The overtopping discharge is added to the landward side of the dune or coastal defence crest, as shown in the schematic in Figure 4-9, which then flow landwards into the hydrodynamic model domain. An example of overtopping discharge rates over a design storm (hydrographs) are shown in Figure 4-10 for Wollongong Golf Club dune (WG01).

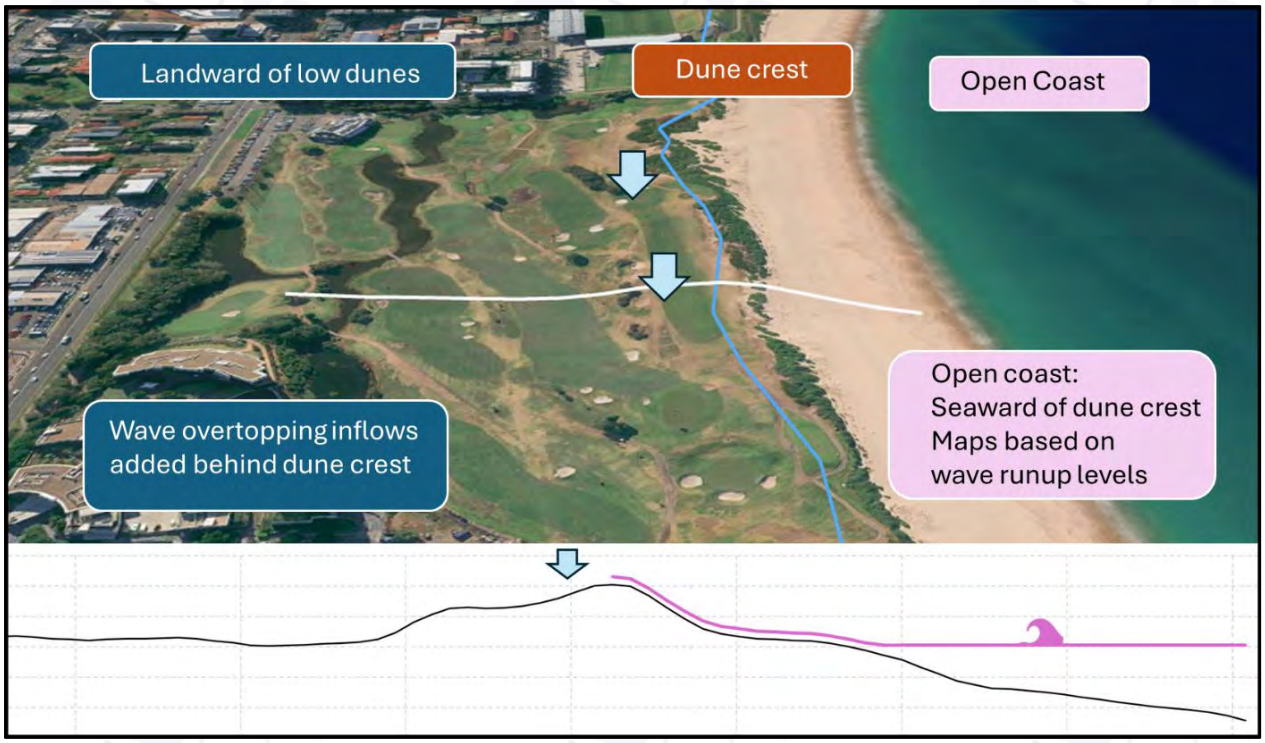


Figure 4-9: Schematic of wave overtopping inputs being used in hydrodynamic models behind areas of high wave runup

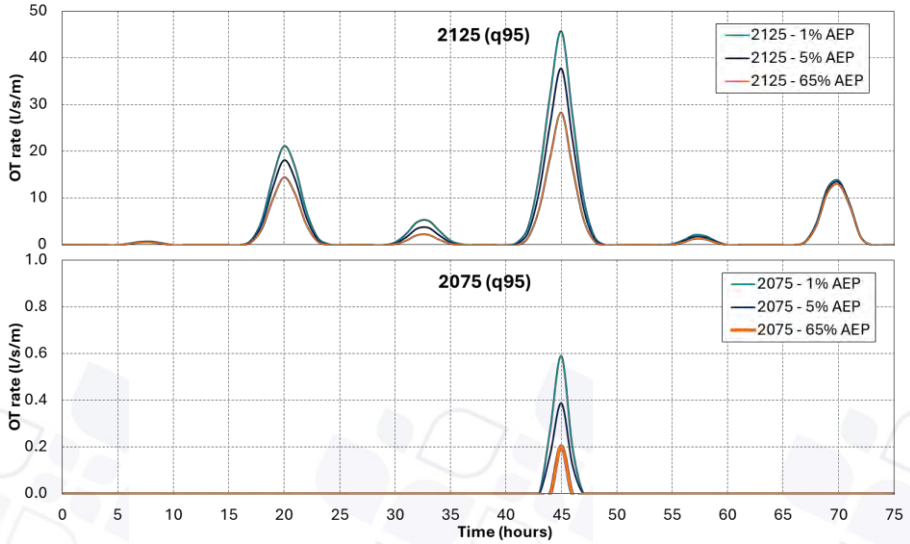


Figure 4-10: Example overtopping hydrographs for overtopping section WG01 (Wollongong Golf Club) – Empirical EurOtop equation rates.

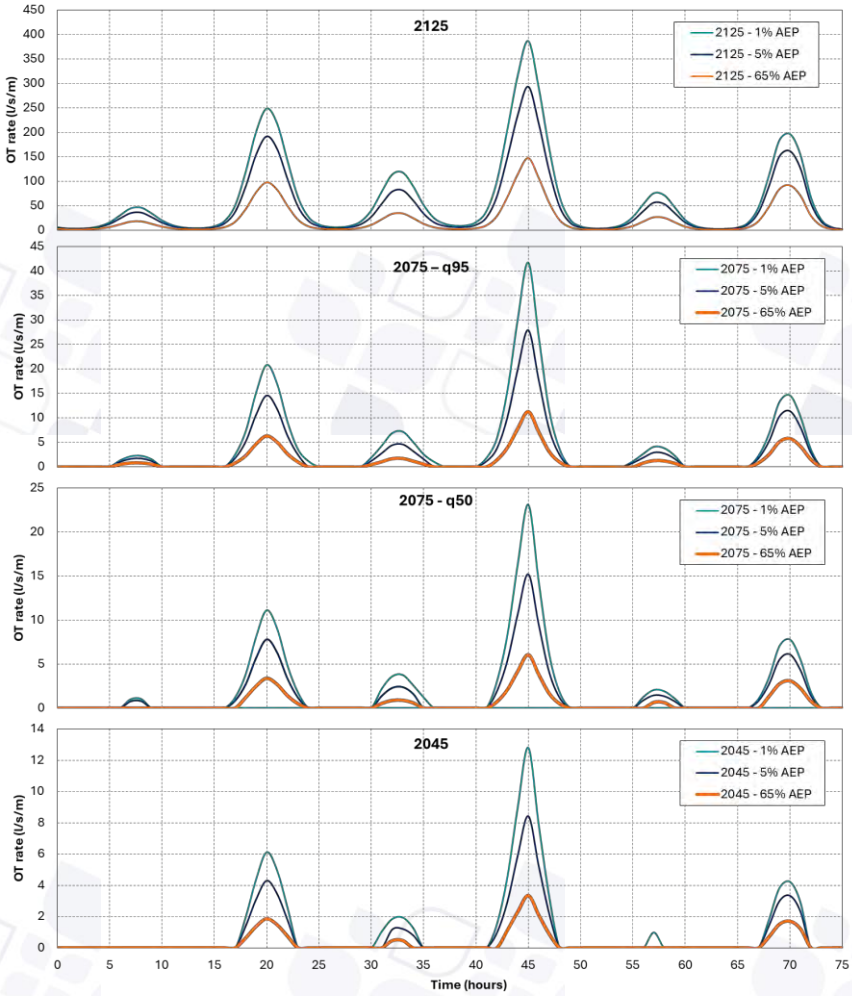


Figure 4-11: Example overtopping hydrographs for overtopping section new North Wollongong Seawall – NN2 rates.

4.4 Bathtub mapping

A water level projection (bathtub) mapping approach has been used in areas not covered by hydrodynamic models. This includes areas south of Port Kembla, north of Flanagans Creek, and along the frontal dune adjacent to creeks covered by hydrodynamic models.

The projected water level is a combination of total sea level, wave setup, and wave runup.

4.4.1 Wave runup

If waves reach the shoreline any residual energy may intermittently run up and down the beach face, known as wave runup. The result is that waves can reach elevations higher than the underlying ESL, which will depend on the wave conditions and shoreline characteristics, particularly slope.

Wave runup is measured as a vertical height above the still water level. It is most commonly represented by one of two values: R_{max} and $R_{2\%}$

- R_{max} is the maximum elevation obtained by a single runup event within a specific time period.
- $R_{2\%}$ is the runup elevation that is exceeded by only 2% of incoming waves within a specific time period. Meaning 98% of waves will have a runup below this level.

In coastal engineering, $R_{2\%}$ is widely used as industry standard because it strikes a balance between adequate protection with cost-effectiveness. It is considered to provide an acceptable level of risk in design, accounting for significant events but not the most extreme. The $R_{2\%}$ was recommended and approved for use in this study.

Wave runup has been calculated along each beach unit using the MM2 "model of models" empirical formula presented by Atkinson et al. (2017)[8]. This was derived for the south-east Australian coastline, whereby:

$$R_{2\%} = 0.92 \tan\beta \sqrt{H_s L_p} + 0.16 H_s$$

Where *Hs* is the deep-water significant wave height, *Lp* is the peak period deep water wavelength, and β is beach slope.

The greatest uncertainty in calculating wave runup is beach slope, which will vary both spatially and temporally. To incorporate uncertainty, transects were cut every 50 m along each beach unit and beach slope estimated using available sources, including but not limited to 1m NSW LiDAR, NSW beach profile database, and the beach-face slope dataset by Vos et al (2022)[9]. This approach has been validated for five beaches based on debris lines surveyed after the 2016 storm (see Section 2.3.3 for an event summary) which typically showed runup extending above 4.5 to 5.0 mAHD.

Validation calculations for four of five beaches show wave runup levels within 0.3 m of observed values. The outlier is Windang Beach unit 4 (Port Kembla beach) where calculations expect 5.5 mAHD runup, yet only 3.8 mAHD was observed. The difference is attributed to the ECL bringing north easterly waves meaning the northern part of Windang Beach would be more protected by Red Point and Five Islands so would have experienced smaller waves than measured at the WaveRider Buoy.

A secondary check was undertaken at Towradgi Beach using a 1D XBeach model. Initially peak wave conditions were extracted from the nearest NSW Nearshore Wave Toolbox wave point (peak Hs = 3.96, Tp = 13.2), however runup estimates were ~1 m lower than observations. Instead, peak observed conditions from the Port Kembla WaveRider Buoy were applied at the boundary (peak Hs = 5.83 m, Tp = 13.5s; NB: Port Kembla waverider did not capture the full ECL event). Results are shown in Figure 4-12, with a maximum modelled runup of 5.48 mAHD and R2% of 4.89 mAHD. The modelled maximum runup is approximately 20 cm higher than the measured wrack marks.

8 Atkinson, Power, Moura, Hammond, Callaghan, Baldock (2017) "Assessment of runup predictions by empirical models on non-truncated beaches on the south-east Australian coast". School of Civil Engineering, University of Queensland, St Lucia

9 Vos, K., Deng, W., Harley, M. D., Turner, I. L., and Splinter, K. D. M. (2002). Beach-face slope dataset for Australia, Earth Syst. Sci. Data, 14, 1345–1357, https://doi.org/10.5194/essd-14-1345-2022.

Given the accuracy for most beaches, and a tendency for slight overestimation against observed values, the Atkinson runup formula with calculated average beach slopes was considered suitable for the hazard mapping and continued for all open coast beaches.

A probabilistic assessment of runup (R2%) values was conducted using the Atkinson formula. A gaussian distribution was fit to each beach unit to represent the observed variation in beach elevation data. An example for Bulli Beach is shown in Figure 4-13 and Table 4-6. From this, 1,000 random beach slope values were generated for each beach unit based and combined with the corresponding full simulated 10,000-year wave dataset. Runup (R2%) values were computed for the combined datasets (Figure 4-14).

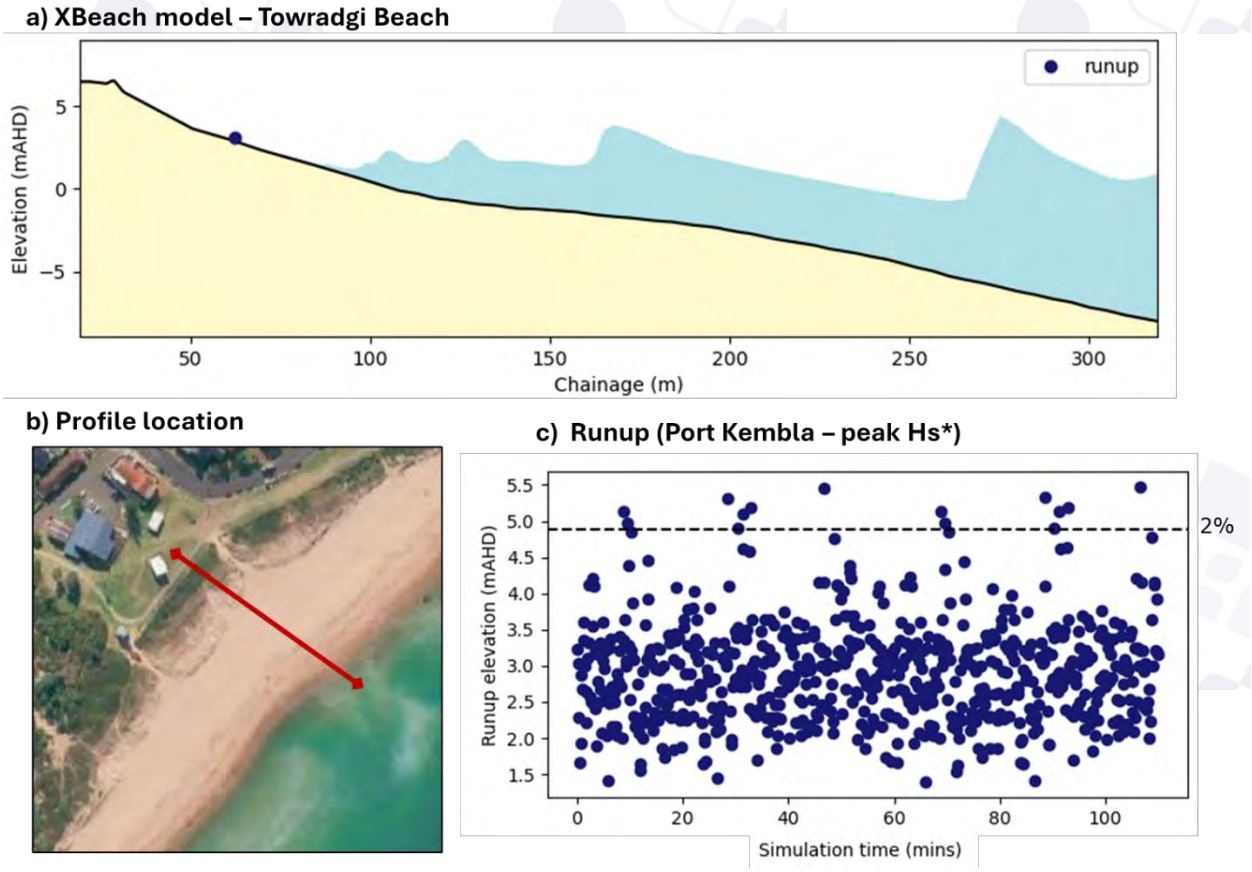
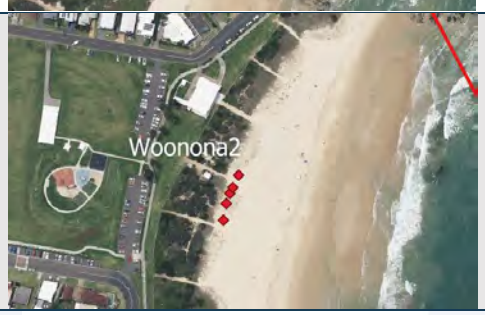


Figure 4-12: a) 1D XBeach model of Towradgi beach (Beach profile - May 2016 survey, City of Wollongong); b) map of profile location; c) simulated runup using Port Kembla observed peak wave conditions. * Port Kembla WaveRider Buoy did not capture the full ECL event.

Table 4-5: Wave runup validation against 2016 ECL storm.

Wave runup levels (mAHD)	Image of surveyed debris lines
Unit: Windang Beach 4 (Port Kembla Beach) Measured: 3.77 mAHD Calculated: 5.48 mAHD Difference: 1.71 m	
Unit: Wollongong City 2 (Wollongong Beach) Measured: 5.21 mAHD Calculated: 5.52 mAHD Difference: 0.31 m	
Unit: Towradgi 1 (Towradgi Beach) Measured: 5.26 mAHD Calculated:5.52 mAHD Difference: 0.26 m	
Unit: Corrimal 4 (Corrimal Beach) Measured: 4.98 mAHD Calculated: 5.03 mAHD Difference: 0.05 m	
Unit: Woonona 2 (Woonona) Measured: 4.46 mAHD Calculated: 4.77 mAHD Difference: 0.31 m	

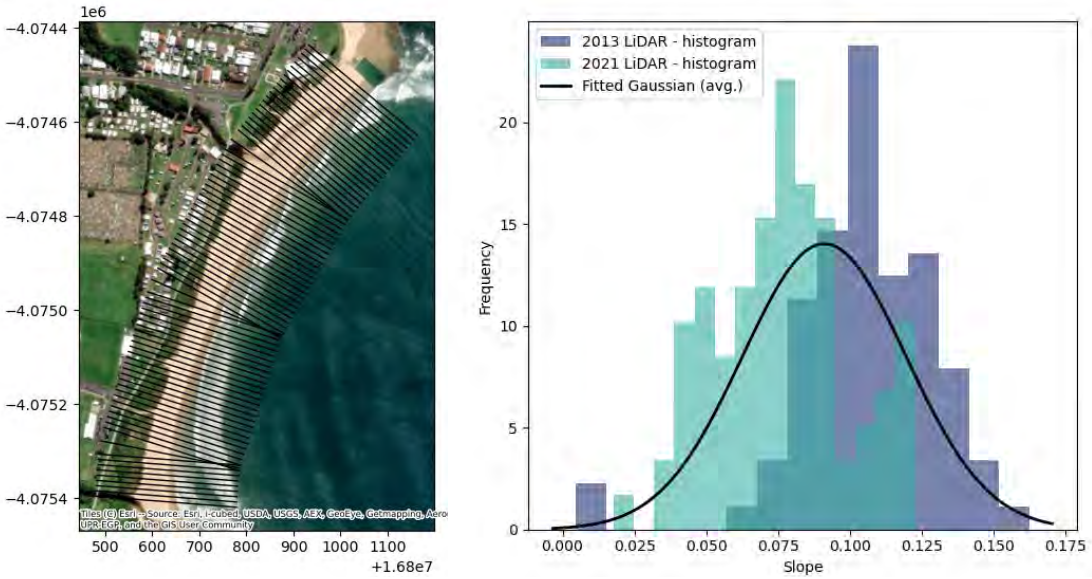


Figure 4-13: Gaussian fit of beach slopes at Bulli Beach (2013 and 2021 1m LiDAR).

Table 4-6: Example Beach slope analysis for Bulli Beach.

	2013 LiDAR (50m transects)	2021 LiDAR (50m transects)	Australia Beach Slope Database (Vos et al 2022)	NSW Beach Profile Database	This study (avg)
Transects	84	84	10	16	-
Mean	0.110	0.084	0.061	0.070	0.096
St Dev	0.031	0.024	0.007	0.028	0.031

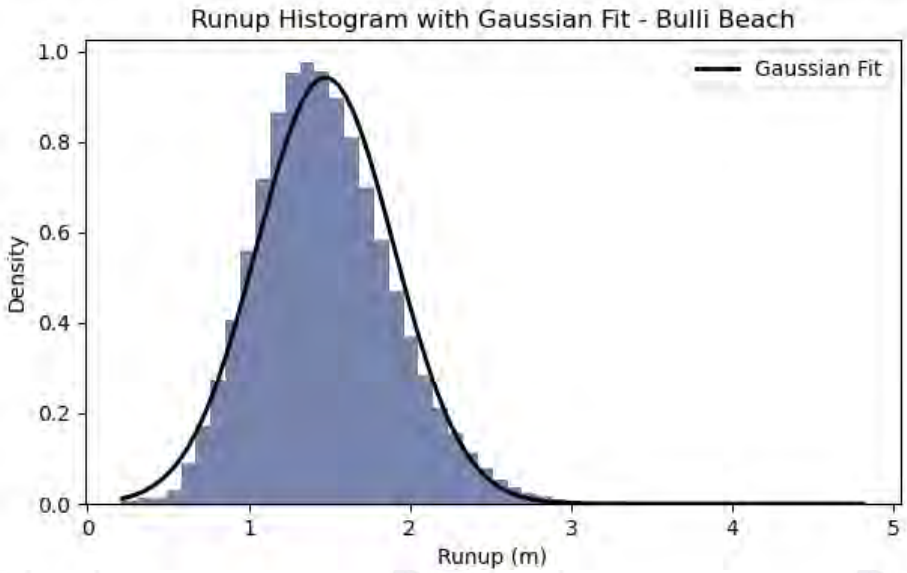


Figure 4-14: Calculated probabilistic runup distribution for Bulli Beach.

4.4.2 Uncertainties and overestimations

Bathtub modelling is a common, very simplified approach to mapping coastal inundation. The bathtub model simply "fills" the land up to a set level. It is very easy to implement; however, uncertainties and overestimations can arise due to the oversimplification of hydrological connectivity, neglect of flow dynamics and accuracy of topographic data.

If combined water level (sea level + wave setup + wave runup) is higher than the beach crest or dune, the bathtub model assumes that everything inland of that crest and below the set height gets flooded, no matter the actual processes or barriers. Ideally these regions would be covered by a process-based hydrodynamic model such as TUFLOW.

Flanagans Creek is a transition between the existing TUFLOW models and bathtub mapping. Figure 4-15 shows the combined inundation maps with the bathtub only mapping inset. These maps highlight the potential overestimation of flood extents/depths to the north of Flanagans Creek where bathtub modelling is used. As discussed above, bathtub mapping with wave effects overestimates extent when inundation extends beyond the beach, giving more conservative outputs.

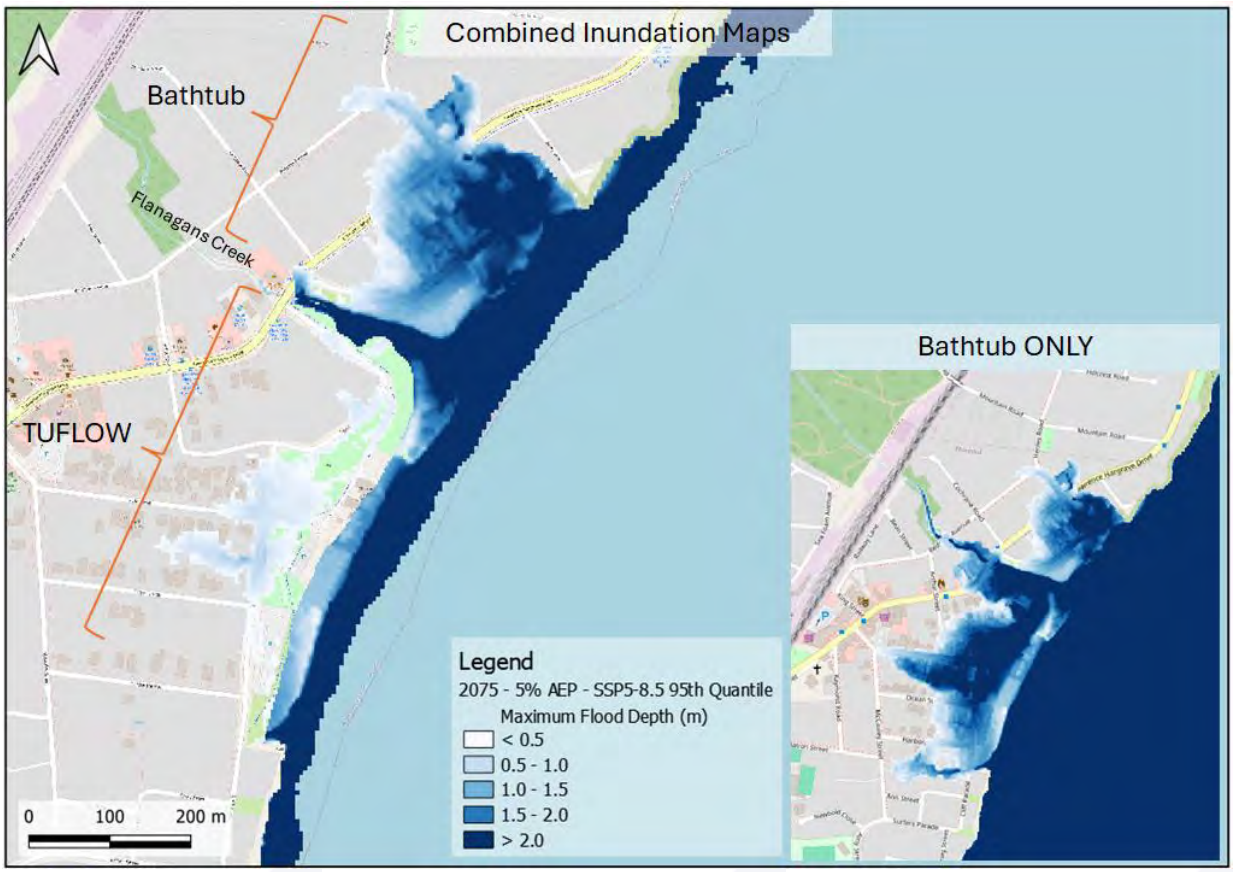


Figure 4-15: Combined inundation map showing transition at Flanagans Creek from TUFLOW mapping to bathtub mapping. Inset: bathtub mapping only.

4.5 Merged coastal inundation maps

The hydrodynamic model maps and bathtub maps have been merged into single coastal inundation maps for each return period. This follows the approach described in Section 4.1 where entrance effects mapped using hydrodynamic models are used ‘landward’ of the creek entrance and dune crest, and wave runup levels mapped using a bathtub approach are used along the open coast. A snapshot of the composite mapping outputs for Bulli Beach and Whartons Creek is shown in Figure 4-16. A subset of the full spatial mapping data is printed in Appendix B2, showing a present day 5% AEP coastal event, and 1% AEP events in 2045, 2075 and 2125.



Figure 4-16: Coastal inundation mapping outputs at Bulli Beach and Whartons Creek for 2125 - 1% AEP – SSP5-8.5 95th Quantile event.

5 Coastal erosion & recession

5.1 Overview

Beach erosion and recession hazards are interrelated. Beach erosion is the loss of beach material by wave action, tidal currents, littoral currents, or wind over a short timeframe, either due to a storm, consecutive storms, or a period of coincident events. Coastal recession is similar in that it involves the loss of beach material; however, this is over a longer timeframe, leading to the continued landward movement of the shoreline.

This coastal erosion and recession assessment incorporates local-scale data, regional wave modelling, future climate scenarios and erosion mapping for the open coastline. Beach-scale erosion maps have been developed based on analysis of local data, medium-term satellite data and NSW Beach Profile Database. The potential erosion prone zone, including allowances for a zone of reduced foundation capacity, historic recession and future sea-level rise induced recession has been calculated using a probabilistic framework, which was developed to balance level of detail, number of beaches being assessed, available time and local processes.

5.2 Beach units and transects

The beaches have been subdivided into units (see Section 2.3.2). For each unit, a series of representative beach transects (also referred to as beach profiles) have been extracted from available data sources (e.g. Figure 5-1). Using a series of transects, rather than a single representative profile, accounts for variability in the landward terrain elevation. Relying on a single profile would risk overestimating or underestimating erosion extents in areas with significant topographic variation. Elevation profiles were extracted from the NSW Beach Profile Database and 2021 1m LiDAR. The most accreted profiles were recorded in 2023. Where beaches are covered by the NSW Beach Profile Database the 2023 observations are used as the representative accreted profiles, otherwise 2021 is used. The accreted profiles have a greater volume of sand on the beach but also a more landward position of the 0m AHD contour compared to more depleted profiles. Therefore, by using these accreted profiles the erosion zones will start further landward but there will be more volume to erode over a smaller area. Where a beach was not covered by the NSW Beach Profile Database, 2021 1m LiDAR has been used. Where transects cross a creek, i.e. Fairy Creek, these have been removed, and the coastal erosion zones are interpolated across (Figure 5-2). This is because there is a large degree of uncertainty in how they will evolve in the future. Details on the number of transects used within each unit as well as their locations can be visualised in Appendix C.

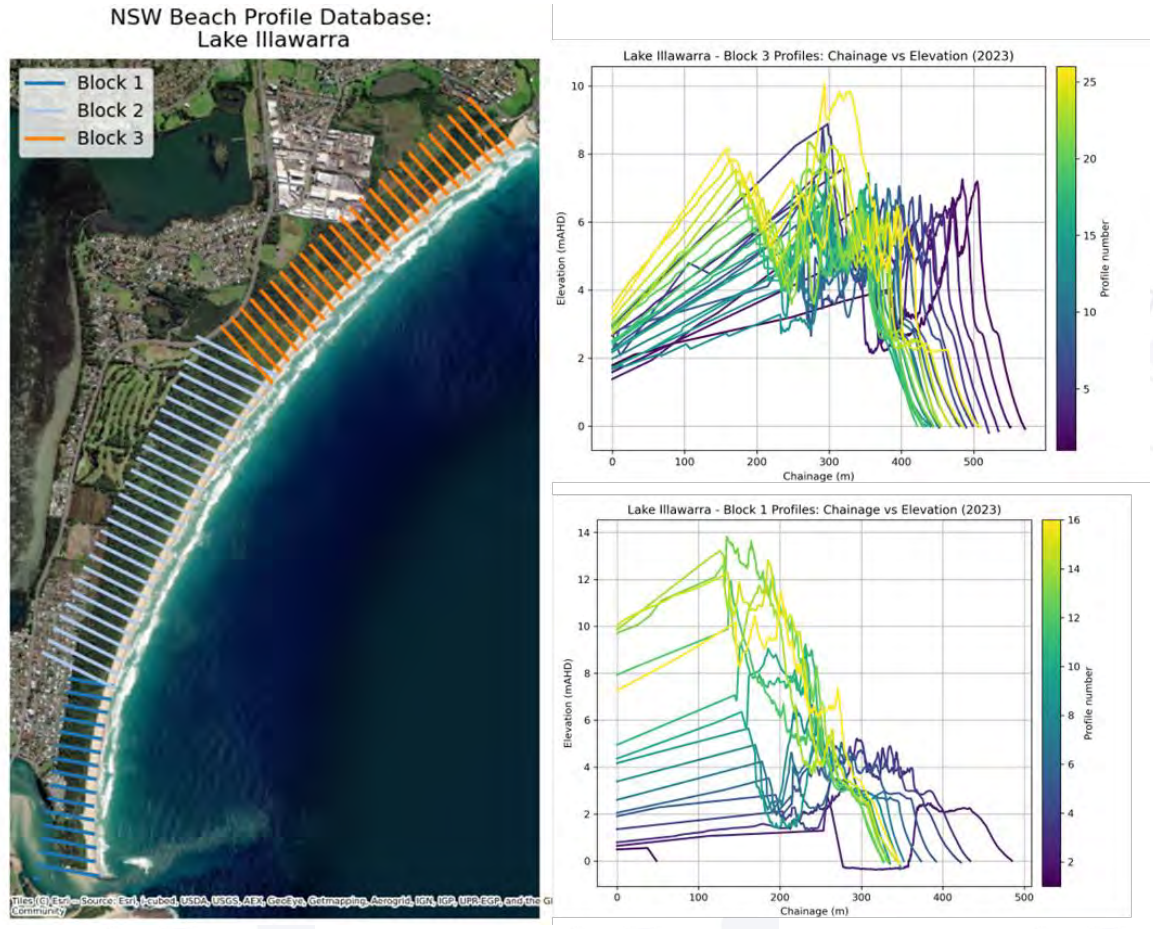


Figure 5-1: 2023 Lake Illawarra/Windang Beach transects taken from the NSW Beach Profile Database.



Figure 5-2: Map showing higher density transect spacing and region of interpolation across Fairy Creek entrance.

5.3 Methodology

The Coastal Management Manual, which guides the preparation of a CMP and hazard maps, does not specify a required methodology to estimate erosion hazards. However, several analysis methods have been presented by the NSW State Government that can be followed to develop increasingly detailed maps ranging from simple proximity analysis to the regional-scale modelling techniques developed by Kinsela et al (2017). The latter moves towards a probabilistic framework. The advantage of a probabilistic framework is that it can account for uncertainties in a range of key drivers, such as SLR, storm intensity, changing sediment transport rates, and natural variability in model inputs such as retreat rates and erosion volumes. These uncertainties and variability necessitate a probabilistic model (Figure 5-3) rather than a deterministic single result model. Probabilistic models generate a range of possible shoreline positions with associated probabilities.

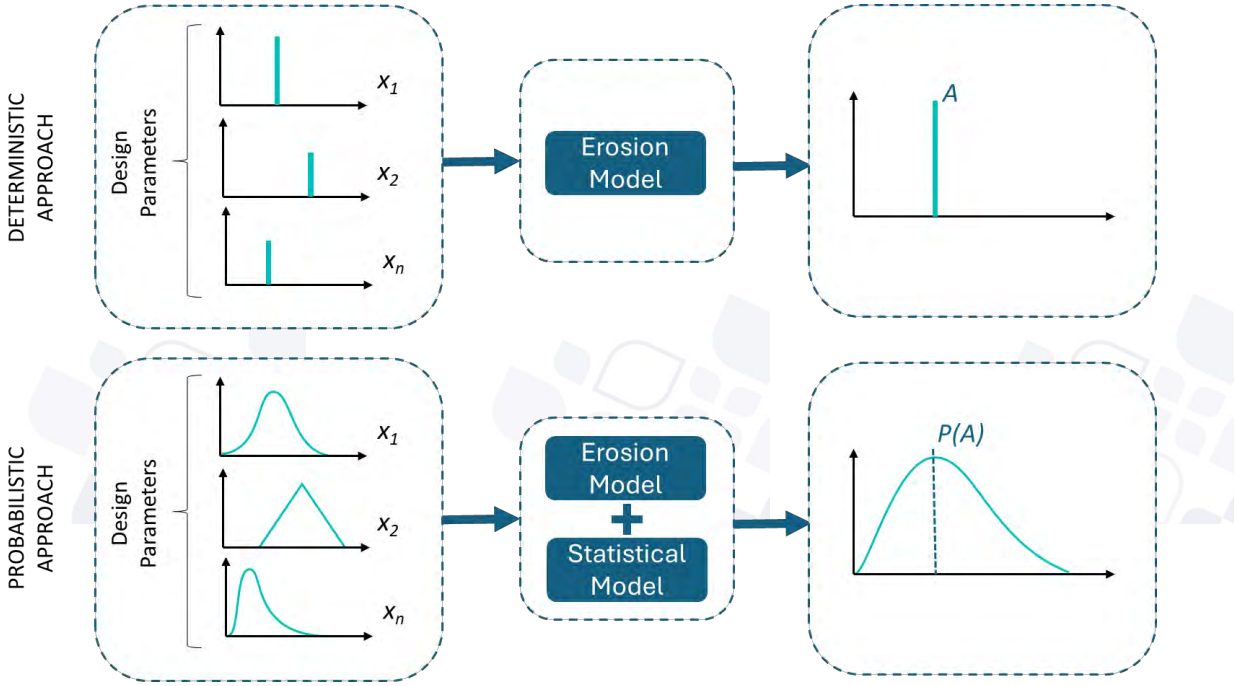


Figure 5-3: Deterministic versus probabilistic approach.

For this study, 12 scenarios have been modelled:

- 4 x time horizons: present day, +20 (2045), +50 (2075), +100 (2125)
- 3 x probabilities of occurrence: 63%, 5%, 1%
- 1 x SLR scenario: SSP5-8.5 climate pathway

In coastal erosion modelling, the setback line identifies a future position of the shoreline, often defined by a selected probability of erosion occurring by a target year (incorporating both beach erosion and recession). The corresponding hazard zone is the area between the present-day shoreline and this setback line. Within the analysis presented here,

potential hazard zones are inclusive of short-term storm demand, historic recession, future SLR induced recession, and a zone of reduced foundational capacity, which have been derived based on the outputs of a probabilistic framework. Site-specific adjustments are made for each component based on local geological setting, geotechnical survey data (Tetra Tech Coffey, 2025), exposure to waves, seafloor composition and topography (i.e. underlying bedrock, clifftop position, nearshore rocky reefs). The approach has been developed to balance level of detail, number of beaches being assessed, computational demand and local processes.

In a standard, stationary framework, the return period and annual probability of occurrence are inversed. However, in a probabilistic model, the hazard zone/setback line is determined by combining several stochastic components, each with its own uncertainty. As a result, in any given year the setback line reflects the cumulative probability that the shoreline will have retreated to a specific threshold by that time. The hazard zone, therefore, represents the likelihood that any location within that area will be affected by erosion over the chosen planning period. This cumulative exceedance probability is not the same as AEPs, which represent the chance of exceedance in a single year due to a discrete event.

The probabilistic framework considered four statistical, evidence-driven or modelled components, described in the following Sections:

1. Storm (event-based) erosion. See Section 5.4
2. Historic recession rate. See Section 5.5
3. Changes in future recession rate due to wave climate variability was evaluated but not used, as described in Section 5.6
4. Sea-level rise impacts. See Section 5.7 and Table 2-5

The statistical approach used to combine each component within a probabilistic model is described in Section 5.8.

5.4 Component 1: Event-based erosion due to storms (V)

This component considers the magnitude of present-day short-term erosion, also known as the short-term storm demand. It refers to the volume of sand removed from the beach by a single event or closely grouped series of coastal storms. A probabilistic distribution for each beach unit has been developed by combining:

- Design erosion volume gamma probability density function (Section 5.4.1)
- An exposure factor, which considers the relative protection of each beach unit (Section 5.4.2).
- Bedrock control, which considers underlying geology and geotechnical data of a beach (Section 5.4.3).

An assessment of projected future storm intensity found that the predicted changes were insufficient to justify modifying the design erosion volumes for future planning horizons (See Section 5.6).

5.4.1 Design erosion volumes: gamma probability distribution

Short-term storm demands for each beach are based on the empirical relationship for open coast and sheltered areas established for NSW coastlines by Gordon (1987). This relationship was further parameterised into a gamma probability density function by Kinsela et al. (2017):

$$\Gamma(k,\theta) \equiv Gamma(v, 3, 30.5) \text{ for } 1 \leq v \leq 350$$

Kinsela et al., applied their coastal erosion hazard model to Windang Beach showing the derived present-day gamma distribution of potential short-term erosion, V. In Kinsela's model, the beach change volumes that were exceeded by 50%, 10%, and 1% of samples were 83, 167, and 255 m^3/m, respectively.

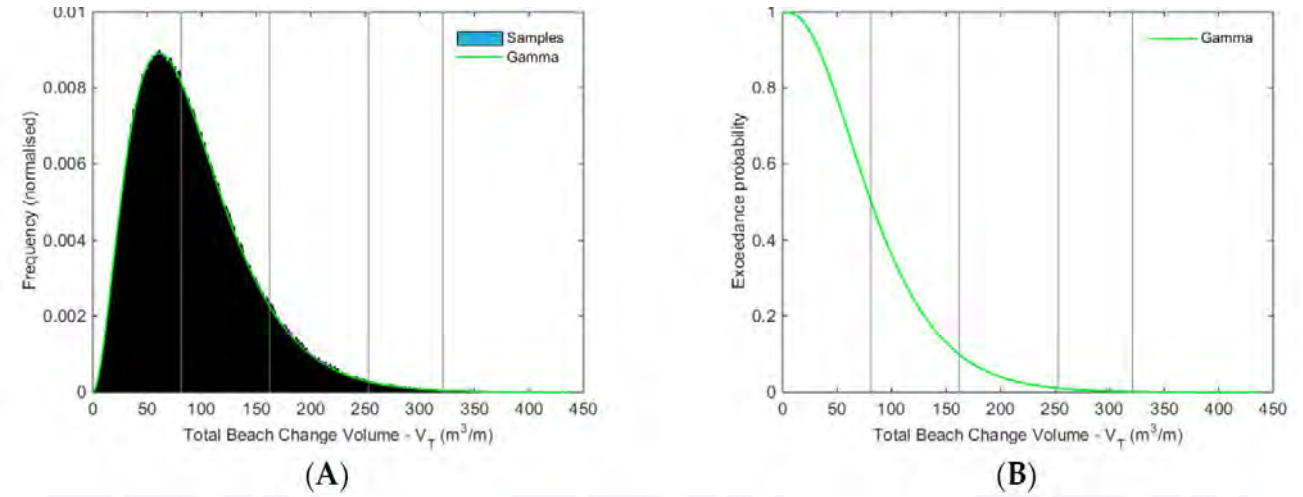


Figure 5-4: Model forecasts of beach volume change for Windang Beach for the present day (Kinsela et al. 2017).

For this study, a fully exposed, open coast, 1% exceedance storm erosion volume of 250 m^3/m has been used. To account for differences in local protection (e.g. headlands, reefs, rock platforms), an exposure factor is applied to each beach (see Section 5.4.2 for details on deriving the exposure factor). This factor adjusts the calculations to better reflect the actual erosion risk, by scaling the gamma distribution based on the exposed or sheltered nature of each beach.

5.4.2 Exposure factor

The generic "maximum" 100-year erosion volumes for the open coast used in this study are 250 m^3/m. Where beaches are not fully exposed (e.g. those protected by headlands or rocky reefs), the gamma probability distribution has been scaled. Wave conditions from the NSW nearshore toolbox extracted at 10 m depth were insufficiently close the shoreline to show the variation in wave climate due to headlands, etc. Therefore, adjustments to the short-term erosion volume were made through three exposure factors that consider offshore conditions, headland protection and nearshore protection. Where:

Short-term Erosion Volume = (Offshore Waves × Headland Protection × Nearshore Protection) × Gordon Design Volume

- **Offshore Wave Factor**: The Wollongong continental shelf is considered relatively narrow and steep. This narrowness means that swell waves can approach the coast without being significantly affected by bottom friction, meaning that relatively large waves are present near the coastline. The relative magnitude of nearshore waves originating from different directions was considered a potential influence on beach erosion and was introduced as the initial scaling factor. For each beach, the 1% AEP wave height was extracted at the 10 m contour using data from the NSW Nearshore Wave Toolbox. These values were then normalized, with the largest recorded wave across all Wollongong beaches given a score of 1 (E.g. Little Garie Beach 1% Hs = 4.4m), and subsequent waves at other beaches given a smaller score (e.g. Windang Beach 1% Hs = 3.9, was given a score of 0.89). These scores scaled the maximum wave height within each unit to give a factor.

- **Headland Protection Factor:** Wollongong's beaches are highly embayed by rocky headlands, platforms and reefs. This factor considers the degree of protection from headlands that will reduce the wave conditions from a depth of 10 mAHD (depth of waves extracted from NSW Nearshore Wave Toolbox) on approach to the beaches. The Headland Protection factor has used the following schema: 1 (open coast), 0.9 (protected by one headland, 0.8 (protected by two headlands), with other values used based on coastal engineering judgment.

- **Nearshore Protection Factor**: Along the Wollongong coast, nearshore rocky features, located between the low water level and approximately 10 mAHD depth, offer protection to beaches by dissipating wave energy. This factor considers the degree of protection from nearshore reefs and rock platforms that will reduce the wave conditions from a depth of 10 mAHD (depth of waves extracted from NSW Nearshore Wave Toolbox) on approach to the beaches. These natural formations can influence coastal processes by increasing bed roughness, dissipating wave energy, and reducing storm erosion. To account for these effects, a Nearshore Exposure Factor is derived from nearshore reef coverage using the NSW Seabed Landforms Classification Toolset (Linklater et al, 2023) and aerial imagery, based on the percentage of rocky features in front of the beach. The Nearshore Exposure Factor is expressed as the inverse of the portion of reef present. A value of 1 indicates no influence from nearshore rocky features.

The bounds used for each scaling factor are presented in Table 5-1.

Table 5-1: Limits applied to each exposure factor.

Exposure factor	Upper limit (%)	Lower limit (%)
Offshore wave factor	100	95
Headland protection factor	100	70
Nearshore protection factor	100	20
Resulting 1% Volumes (m^3/m)		
Example - average score	250 m^3/m (100%)	100 m^3/m (40%)*

*Geotechnical analysis to be included as a final consideration

These independent factors are multiplied to derive a single overall adjustment factor. Beaches with large incoming waves, wide open exposure and no rocky reefs score close to 100%, meaning they will be close to adopting the full distribution. For example, Figure 5-5, Windang beach has a near fully open coast short-term erosion rate of 223 m^3/m. In contrast, Brighton Beach (inside Wollongong Harbour) has a low exposure factor resulting in a short-term erosion volume of 71 m^3/m. Similarly, Fishermans Beach and Wombarra Beach have low-moderate exposure with short term erosion rate of around 120-160 m^3/m. For beaches with less sand volume available than the calculated storm erosion demand, the demand has been truncated to only reflect the loss of available sand.

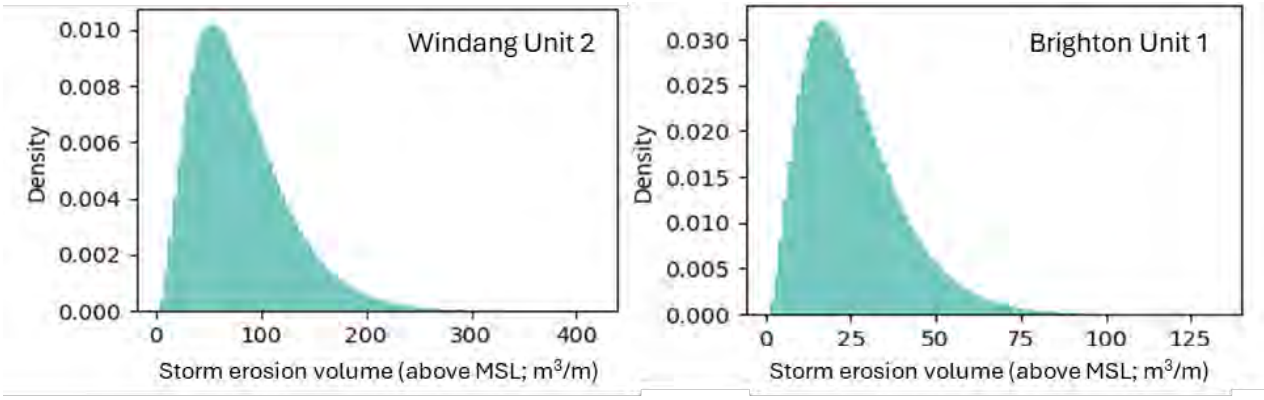


Figure 5-5: Scaled storm erosion distribution. Windang Unit 2 (left), Brighton Unit 1 (right).

5.4.3 Bedrock control

Several northern beaches in Wollongong are perched on bedrock, backed by steep escarpment and have a limited offshore sand supply. At these locations, there is a limited volume of sandy beach to erode before exposing underlying bedrock or semi-consolidated to consolidated escarpment material.

To the North, at Werrong, Era and Burning Palms, sandy beaches are backed by an escarpment formed of the Hawkesbury Sandstone, with slopes covered by vegetated debris deposits of colluvium. Further south, from Coalcliff to Austinmer, the beaches are backed by sandstone, siltstone, shale and coal of the Illawarra Coal Measures (Flentje, 2009). From North Beach to Fishermans Beach, the beaches are backed by the Budgong sandstone (Wollongong – Port Hacking 1:100,000 Geological Map). Geological

characteristics such as these significantly limit potential erosion rates and the total sand volumes that can be lost during erosional events.

Where data sources are available, geotechnical reports, geological maps and site imagery have been used to estimate bedrock location and elevation (Figure 5-6). However, data sources are limited, and where there is uncertainty, a conservative approach has been adopted (i.e. tending to assume less influence of bedrock). A shapefile layer documenting areas where bedrock is likely to limit erosion has been compiled from borehole data and geological maps. This shapefile is used in post-processing to trim predicted erosion zones, so they do not extend beyond documented geological limits. The datasets used for each beach unit are described in Appendix C.

For each beach unit, the volume of available sand above 0 mAHD has been estimated from the accreted beach profiles. In addition, the back beach transition from marine sand to another source, e.g. colluvium deposits, rocky escarpment/bedrock, etc, as illustrated in Figure 5-6, has been estimated from the above sources. The storm erosion demand for each beach unit was reviewed based on an upper estimate of sand availability. If the modelled storm demand exceeds available sand supply, the gamma distribution is truncated such that for any given extreme event storm erosion does not exceed sand availability (see Figure 5-7).

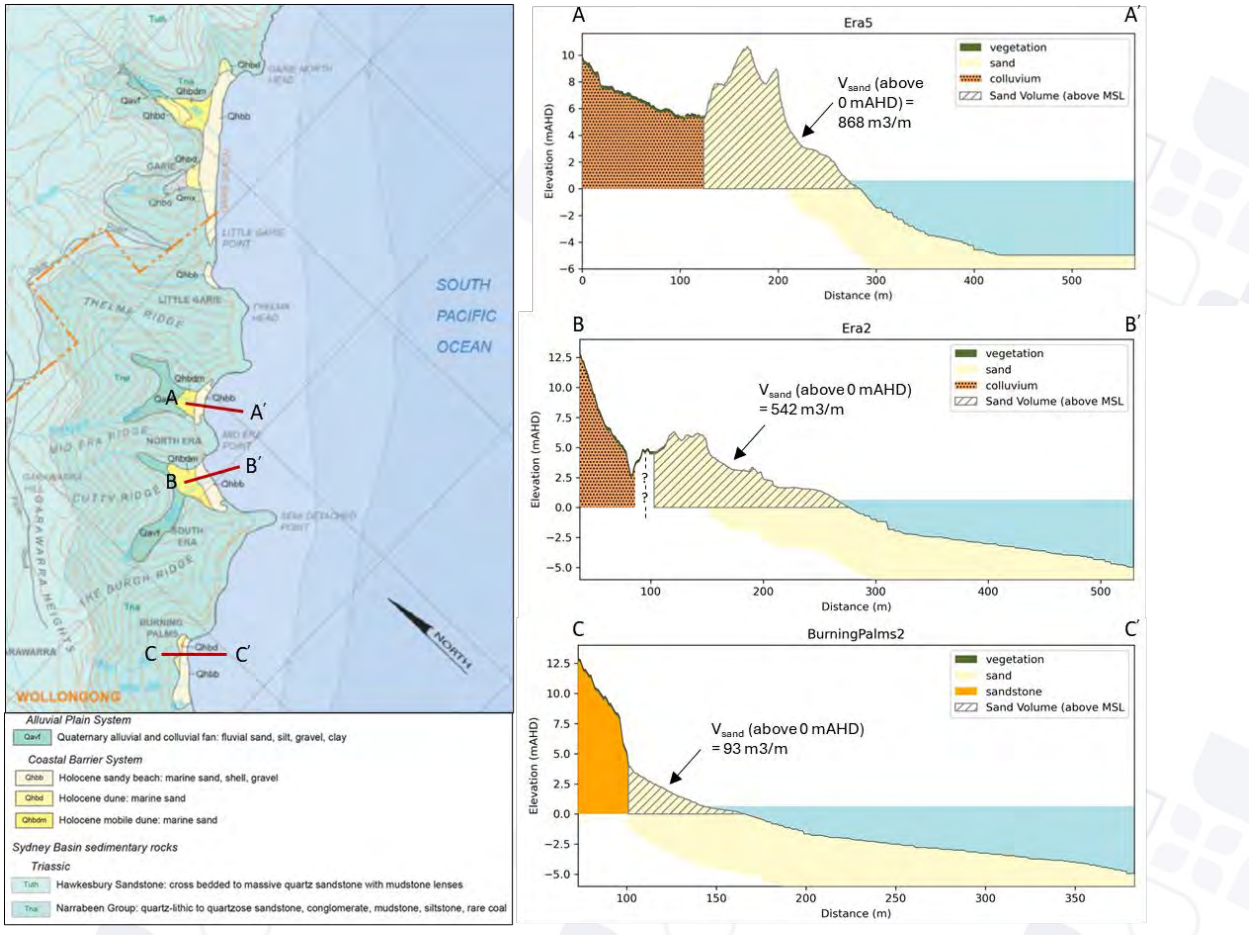


Figure 5-6: Example of beach transects and sand volume calculation for Era Beach (A-A', B-B') and Burning Palms Beach (C-C').

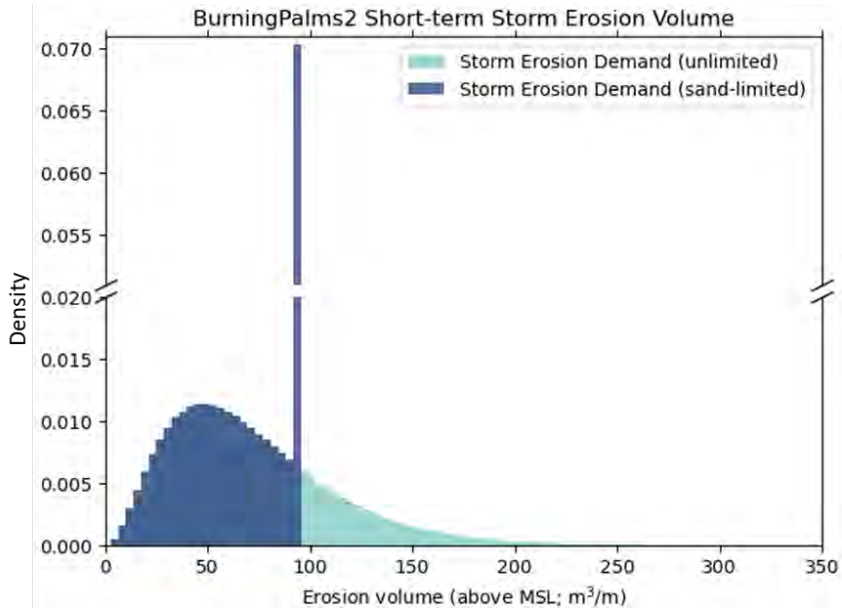


Figure 5-7: Unlimited and limited gamma distribution for storm erosion demand based on available sand volume above 0 mAHD for Burning Palms unit 2 (cross section C-C' in Figure 5-6).

5.4.4 Design volume checks against the Wollongong 2016 East Coast Low event and 2010 Coastal Zone Study

A review of the suitability of the final storm erosion volumes for the Wollongong coastline has been performed using recorded erosion from the 2016 storm event, discussed in the section below.

The 2016 East Coast Low (ECL) storm event is described in Section 2.3.3. Erosion volumes for this event were produced by the Wollongong City Council and summarised in Beardsmore et al. (2016). The analysis, shown visually in Figure 5-8, compares pre- and post-storm profiles to estimated volume changes above 0 mAHD. The largest erosion occurred at open coast beaches (e.g. Coniston), while lower erosion was observed at the protected northern ends of beaches. The 2016 storm event was unusual in that winds and waves were easterly in direction at Wollongong, rather than the more standard south to southeast that generally accompanies storm events. Figure 5-8 shows the beach volume changes, with notable areas including:

- Coniston: 165 m^3/m
- Fairy Meadow: 105 m^3/m
- Woonona north: 163 m^3/m
- Bulli north: 26 m^3/m
- Towradgi: 31 m^3/m

Analysis of the wave and ESL return periods by Louis et al. (2016) suggest the 2016 storm event was moderate. Neglecting the unusual direction, water levels were above a 2-year event and wave heights around a 30-year event. Open coast erosion of up to 165 m^3/m aligns with a 10- to 20-year erosion event based on the Gordon distribution. Whilst a 1:1

relationship between offshore forcing and onshore response is not expected, the comparable magnitudes between both components supports the continued use of the Gordon estimates for Wollongong.

The Wollongong coastline includes both open, wave-exposed beaches and smaller, sheltered embayments protected by headlands. Depending on the orientation of a beach and surrounding features, some sections are protected from southeast storms, while others are more sheltered from northeast events. As a result, the amount of erosion observed along each beach and between beaches can vary significantly, depending on the direction and characteristics of individual storms. This is consistent with the range of observations from the 2016 storm event.

An additional comparison has been made against the design volumes presented in the 2010 Wollongong Coastal Zone Study (Cardno Lawson Treloar, 2010). At the time the study was completed, there was no appropriate erosion records to validate storm demand modelling. The storm erosion demands presented were based on uncalibrated models. A review shows many of the 100-year erosion volumes from the 2010 study are similar to the 2016 ECL event, which has an estimated return period of up to 30-years (see Table 5-2). Examples include:

- Coniston beach: up to 186 m^3/m (100-year value from 2010 study) with 165 m^3/m observed during the 2016 storm event
- Corrimal beach: 85 m^3/m (100-year value from 2010 study) with up to 98 m^3/m observed during the 2016 storm event
- Woonona beach: 147 m^3/m (100-year value from 2010 study) with up to 163 m^3/m observed during the 2016 storm event

It is noted that at some localities, e.g. Windang North, Towradgi North, Sandon and Thirroul, the 100-year erosion volumes from the 2010 study exceed those observed during the 2016 storm event. Interestingly, the modelled setback lines at some beaches are not substantially different compared to the present study. This outcome largely reflects the choice of representative beach profiles. In the 2010 study, a more depleted profile was adopted, which can produce similar setback lines despite indicating smaller erosion volumes.

The 2016 storm event, which is estimated to have a return period of up to 30 years, resulted in significant erosion volumes along the more exposed sections of the beach. This suggests that the 2010 Wollongong Coastal Zone Study may have underestimated the potential erosion hazard along the Wollongong Coast. However, it is important to note that these impacts can vary significantly depending on factors such as the accretion state of the beach, the relative sheltering of different locations and variations in wave direction. It is recommended that post-storm surveys be undertaken following larger storms to allow further refinement of storm erosion volumes.

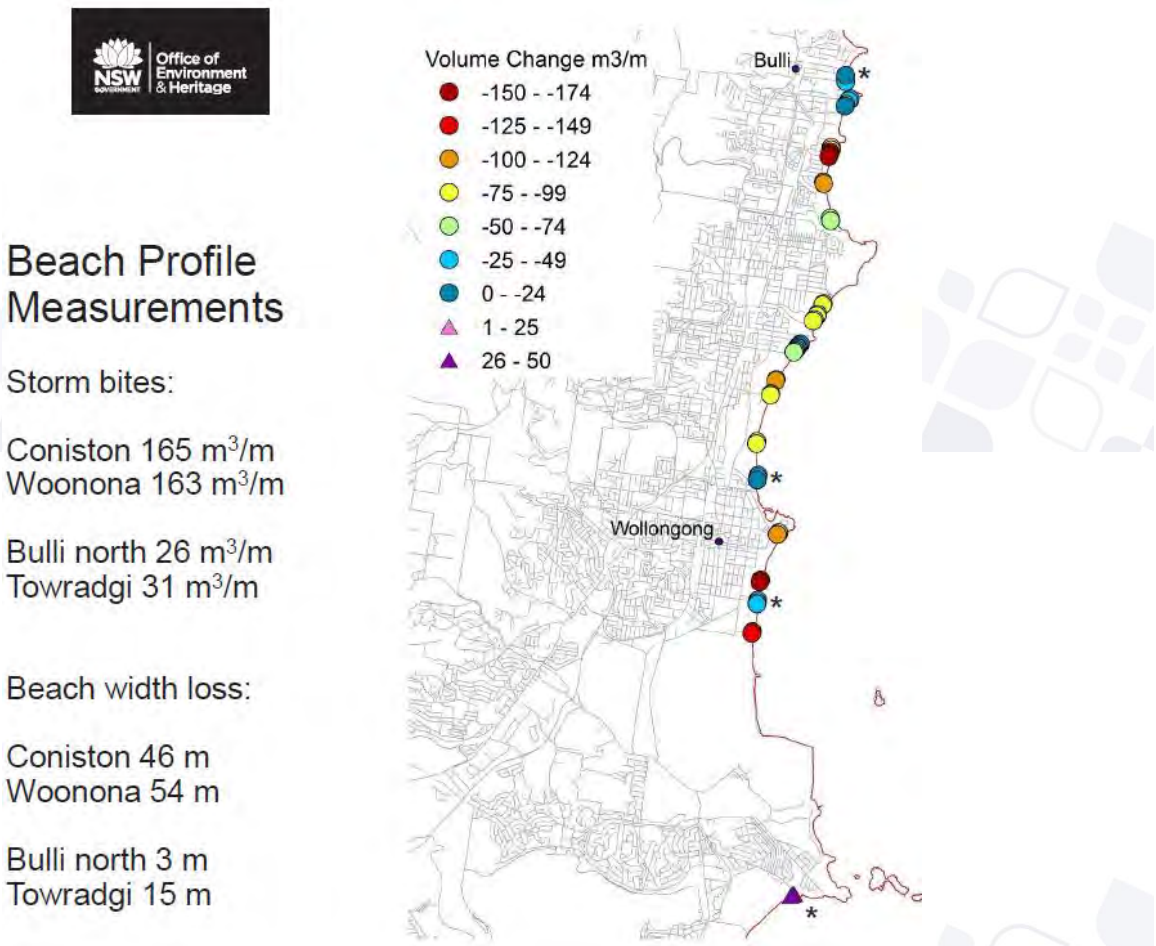


Figure 5-8: Beach volume change (above 0 mAHD) for 2016 ECL event (Source: Beardsmore et al., 2016).

Table 5-2: Comparison of the scaled 100-year ARI storm demand from the 2010 Coastal Zone Study and the 2016 ECL storm bites presented in Beardsmore et al. (2016).

Location	Locality descriptor	2016 ECL (m3/m) Beardsmore et al. (2016)	100-yr storm demand (m3/m) 2010 Coastal Zone Study	100-yr storm demand (m3/m) This Study
Windang / Perkins South	NE-SW orientation North Windang – protected from NE to E conditions by headland (exposed to SE and S)	35 - 73	165.5	200.9
Coniston	NNE-SSW orientation Central - exposed North - protected from NE conditions by headland	158 - 165	110 – 186	222

Location	Locality descriptor	2016 ECL (m3/m) Beardsmore et al. (2016)	100-yr storm demand (m3/m) 2010 Coastal Zone Study	100-yr storm demand (m3/m) This Study
Towradgi North	NE-SW orientation Some protection from reef in ENE conditions (exposed to E and SE)	31 - 46	162	225.5
Corrimal	NE-SW orientation Some protection from nearshore reef to S and E (exposed to SE)	77 - 98	85	223.6
Woonona Central	N-S orientation Some protection from headlands to NNE and SSE conditions (exposed to E)	150 - 163	147	224.4
Woonona North	N-S orientation Some protection from headland to north and nearshore reef to east (exposed to SE)	84 - 129	83	224.4
Sandon	NNE-SSW orientation Embayment bounded by headlands and reef (central exposed to E)	24 - 55	76 – 120	182.2
Thirroul	NE-SW orientation Some protection in the north by nearshore reef. No protection central. (exposed to E and SE)	26-106	184	210-223

5.5 Component 2: Historical shore-normal recession rate (q_x)

Historical records, including aerial imagery, satellite data, and previous studies, indicate that overall, the Wollongong shoreline has been relatively stable over recent geological times with some areas showing accretion, whilst others are receding.

Historic rates of shore-normal recession for this study have been derived from the Geoscience Australia (GA) Digital Earth Australia (DEA) Coastline dataset to provide a more representative assessment. The DEA Coastlines dataset covers the whole of Australia's coastlines dating back to 1988. It utilises sub-pixel waterline extraction from publicly available satellite data in combination with a pixel-based tidal modelling to estimate the annual mean sea level location along the coast and the rate of change of shoreline positions.

The DEA dataset is used in preference to other available data sources because it provides continuous spatial coverage, higher temporal frequency, and consistent data collection, enabling a more accurate representation of medium-term shoreline trends.

Rates of change are aggregated along a beach unit using multiple transects, which gives a mean and standard deviation for each beach unit. For the probabilistic approach, a Gaussian distribution is fitted to each beach unit using its mean and standard deviation, allowing for statistical sampling and analysis of shoreline change variability. Validation of the DEA coastlines by Geoscience Australia gave a statistical bias in annual rates of 0.08 m / year (Bishop-Taylor et al, 2021). Therefore, for this work, if the yearly mean rate of change is less than 0.1 m it is considered within the noise range of the observations, and a value of 0 m is used – in other words no “long-term” retreat rate is applied. Where a rate of change has varied significantly over time, the more recent trend will be analysed. For example, adjacent to the Illawarra breakwater (see Section 5.5.1) where since it’s construction the beach has been accreting; or McCauleys Beach which in recent years has seen reduced retreat rates because the sand that used to exist is no longer there.

Non-linear scaling factor

As a beach evolves, it is moving towards an equilibrium state where sediment inputs/outputs can begin to balance. The latest coastal literature addresses this through new research on a ‘non-linear evolution rate’ that would consider a diminishing recession rate as a beach nears equilibrium (Hunt et al., 2023). However, given the relatively small magnitude of Wollongong coastal recession, the uncertainty in implementing this non-linear scaling factor was not considered to have an overall benefit to the project and could cause ambiguity in this component of the erosion and recession assessment. The only exception being Windang Unit 1, adjacent the Illawarra Breakwater, where the current rate of accretion is expected to decrease as it reaches equilibrium. For this unit a non-linear scaling factor has been applied with the assumption that by the 2075 planning horizon, the planform profile will near equilibrium.

5.5.1 Impact of Lake Illawarra breakwater

The northern breakwater at Lake Illawarra is a significant anthropogenic factor that has influenced sediment dynamics and shoreline morphology along the adjacent beach areas. Historic recession rates for this section of coastline (Windang Beach unit 1 and 2) have been calculated using data from 2007 onwards, following completion of the breakwater. The current rates indicate that the beach is still accreting, this rate is expected to decrease as the planform profile nears equilibrium. As such a non-linear scaling factor is applied to Windang Unit 1.

5.5.2 Coledale Avenue

This investigation has focused on erosion rates of soft sediment and has therefore excluded headland and cliff erosion from analysis. One exception to this is Coledale Avenue, a location where erosion has been reported. As Figure 5-9 shows, the beach is intermittent allowing the unconsolidated cliff to be exposed to wave action. The DEA erosion estimates did not reflect erosion rates in this area and; therefore, to reflect the known risk, the long-term erosion rate was calculated manually by mapping cliff top position using aerial imagery (Figure 5-9). Between 2010 and 2024, the average recession rate of this frontage was 0.04 m/year. This has been used in the statistical model for Coledale Unit 2.



Figure 5-9: Coledale cliff erosion rates from 2010 to 2024.

5.5.3 Long-term erosion volumes

Historic erosion rates (m/yr) were converted to shoreline retreat distances (m) for each epoch and beach unit. These distances were then used to estimate long-term erosion volumes by assuming a simple triangular cross-shore profile (Figure 5-10). See Appendix C

for historic rates, projected long-term erosion distances and corresponding volumes for each beach unit.

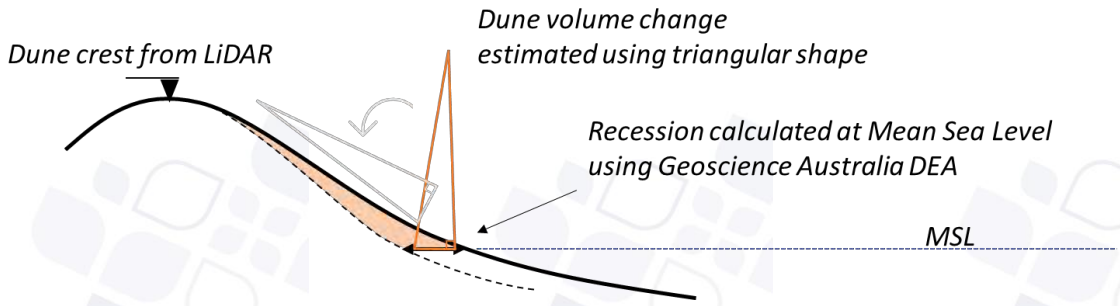


Figure 5-10: Schematic cross shore profile illustrating calculation of long-term erosion volumes.

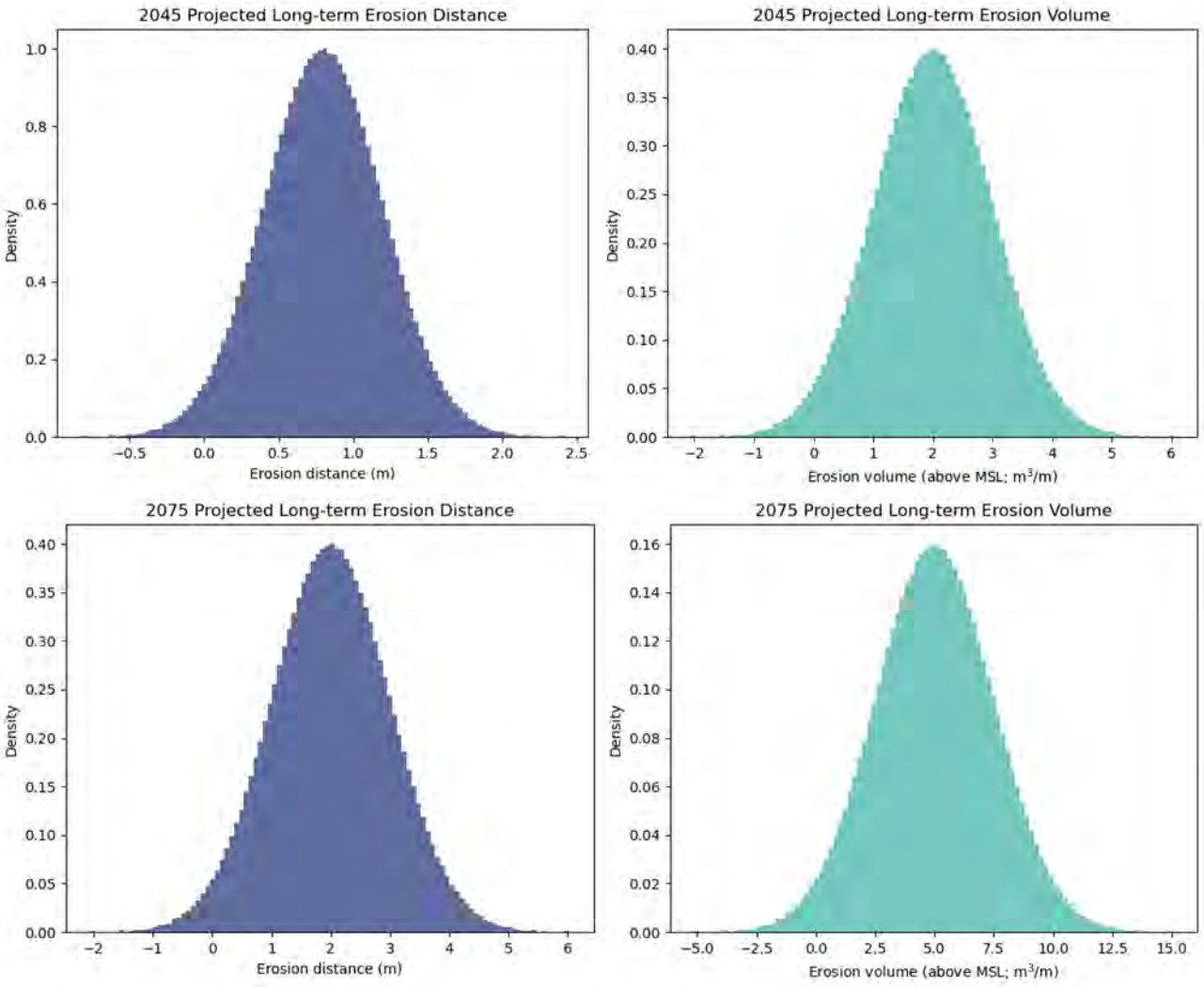


Figure 5-11: Projected long-term erosion distances (left) and volumes (right) for a representative cross section in Coledale unit 2. Top: 2045; Bottom: 2075.

5.6 Component 3: Changes in future wave climate and sediment transport (q_y)

Future changes to wave conditions may alter the sediment transport and future recession patterns. The magnitude of this change has been considered in relation to the evolutionary processes of the Wollongong Beaches and the expected changes in Longshore Sediment Transport (LST). Based on the reviews below, no adjustments have been made to future recession rates.

The Coastal Processes Study (Salients, 2025) provides a full description of beach evolution processes and is summarised here. The Wollongong coastline is predominantly rocky and considered "sand-starved," with minimal new sediment supply. The existing sediment originates from the Holocene and Pleistocene periods and is continuously reworked along the immediate shoreline. LST is limited due to the compartmentalized nature of the beaches and the lack of significant sediment input from the catchment, alongshore transport, or offshore sources. Because sediment along this coastline is primarily reworked rather than driven by LST processes, LST-based approaches are not suitable for predicting future changes to long-term recession rates.

A second review has been undertaken to consider how extreme waves are projected to change in the future. Along the coast of NSW, it is well established that the main drivers for projected changes in waves are the poleward shift of the high-pressure subtropical ridge (STR) and reduction in ECLs (Drosdowsky, 2005; Kent et al., 2013; Grose et al., 2021). Historical and future wave climate projections for Wollongong (Figure 5-12) have been assessed using the latest publicly available global wave modelling results, derived from seven of the CMIP6 Global Climate Models (GCMs), shown in Table 5-3 (Meucci et al., 2021; Meucci et al., 2023).

Archived outputs have been sourced from: https://data-cbr.csiro.au/thredds/catalog/catch_all/oa-cmip6-wave/UniMelb-CSIRO_CMIP6_projections/catalog.html

Table 5-3: List of Global Climate Models (GCMs) used in forcing the available global wind-wave simulations, and general applicability to NSW.

GCM Model	Contributor	Applicability to NSW
ACCESS-CM2	CSIRO, Bureau of Meteorology	Highly applicable -- tailored for Australian climate conditions.
AWI-CM	Alfred Wegener Institute (AWI)	Limited -- focuses more on polar and oceanic processes.
CMCC-CM2	Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC)	Moderate -- not specifically calibrated for Australia.
EC-EARTH3	EC-Earth Consortium	Moderate -- European focus.
IPSL-CM6A	Institut Pierre-Simon Laplace (IPSL)	Moderate -- not specifically calibrated for Australia.
KIOST-ECM	Korea Institute of Ocean Science and Technology (KIOST)	Limited -- developed for East Asian climate.
MPI-ESM1	Max Planck Institute for Meteorology (MPI-M)	Moderate -- not specifically calibrated for Australia.

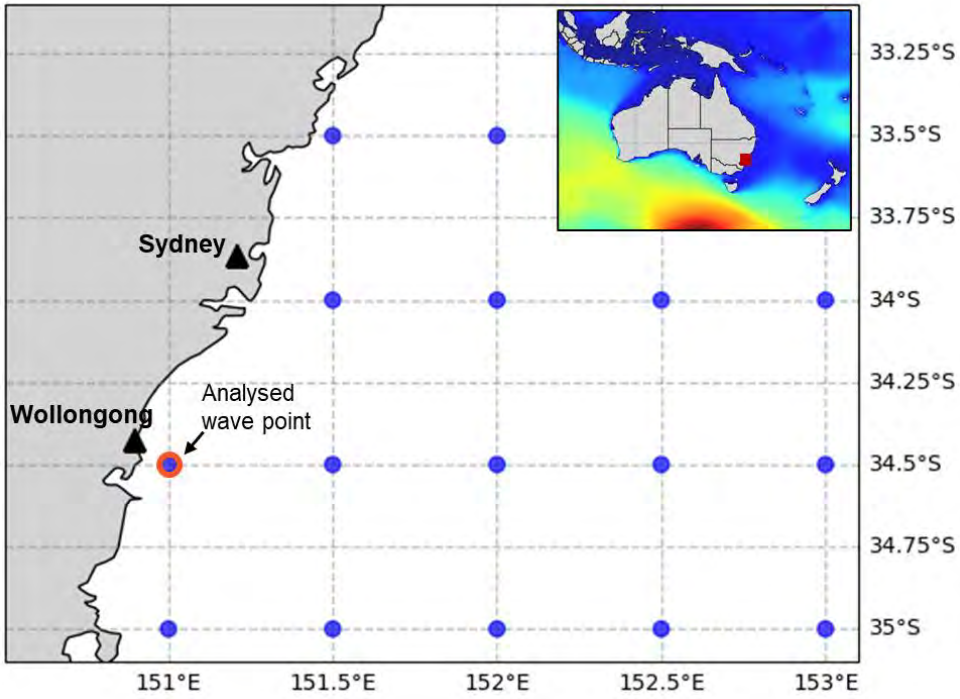


Figure 5-12: Map of wave climate ensemble grid showing analysed wave point location

Statistics are derived from the 3-hourly outputs to analyse extreme wave climate trends off the coast of Wollongong. Traditional statistics, i.e. means, have not been calculated, because these wind-wave models are a limited subset of the larger GCM ensemble and therefore further investigation into model biases would be required. Instead, individual model results are presented here to show general trends.

Figure 5-13 plots independent storm wave events (Hs > 3m) for each model across three time periods: historical from 1979-2014, mid-century from 2026-2046, and end-of-century from 2081-2101.

To better understand changes in numbers of storm events and other key wave climate conditions, storm events with a peak significant wave height (Hs) greater than 3 metres (approximately top 5%) have been analysed. Table 5-4 shows the percentage change in mean wave direction (Dir) and peak wave period (Tp) from historical to end of 21 century time periods. There is variability across the different GCMs, primarily due to in how each model represents the movement of the STR. Despite this variability, the ensemble results generally indicate minimal changes in wave direction and period for extreme wave events. Interestingly, the projections suggest a potential decrease in the frequency of extreme storm events along the Wollongong coastline, with most models predicting fewer storms exceeding 3 m in wave height by 2100.

Consistent with this, the Australian Bureau of Meteorology notes that most global climate models, project a southward shifting of the STR, leading to a reduction in the strength and frequency of cold fronts for NSW.

Given this variability, no adjustments have been made to future recession rates due to future wave conditions.

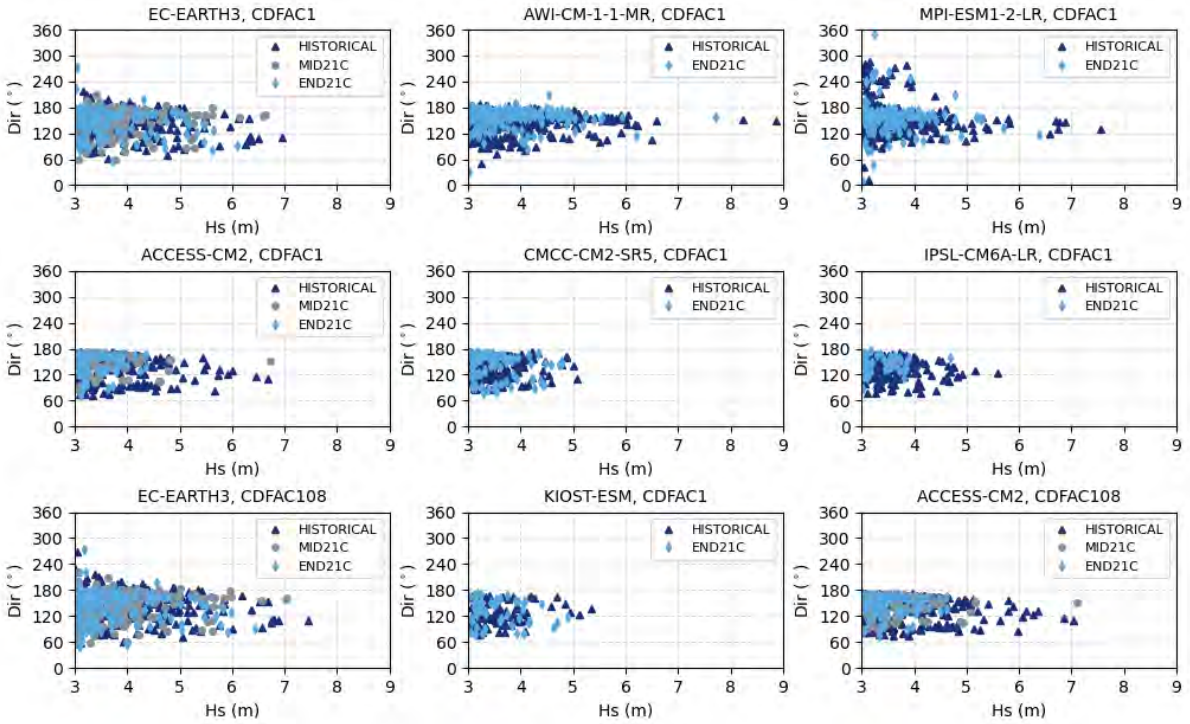


Figure 5-13: Independent storm wave events for historical (1979-2014), mid-century (2026-2046), and end-of-century (2081-2101). NB: Only the ACCESS-CM2 and EC-EARTH results have mid-century results. CDFAC – Wind drag coefficient.

Table 5-4: Changes in storm events and wave climate conditions for storm events with a peak significant wave height (Hs) greater than 3 m.

GCM	Wind Friction Factor	Percentage Change (Historical to End of 21 Century)		
		Mean Dir (Hs > 3 m)	Mean Tp (Hs > 3 m)	Avg number events/year (Hs > 3 m)
ACCESS-CM2	CDFAC1	4.60%	-1.70%	-45%
ACCESS-CM2	CDFAC108	3.50%	-1.70%	-46%
AWI-CM-1-1-MR	CDFAC1	5.30%	2.50%	4%
CMCC-CM2-SR5	CDFAC1	1.10%	-0.20%	-3%
EC-EARTH3	CDFAC1	-1.90%	2.60%	-28%
EC-EARTH3	CDFAC108	-3.10%	1.90%	-26%
IPSL-CM6A-LR	CDFAC1	6.20%	1.20%	-56%
KIOST-ESM	CDFAC1	-0.60%	-1.30%	4%
MPI-ESM1-2-LR	CDFAC1	0.20%	6.50%	2%

5.7 Component 4: Shoreline changes due to erosion from changes in sea level (S)

A consequence of SLR is that future recession rates will not reflect past conditions. This is commonly linked to the principles described by Bruun (1962), who found that when sea levels rise, the equilibrium beach profile will move upward and landward. At geological timescales, it is reasonable to expect that coastal processes have sufficient time to maintain relative beach and dune heights during shore-normal coastline translation. However, for the rates of sea level change projected over the next century, the coastal change is considered to consist of a loss of sand from the upper beach profile with redistribution and deposition within the nearshore to balance the sediment budget.

The Bruun rule concept is applied to all sandy beaches where a beach has sufficient nearshore sediment supply. In applying the Bruun Rule, it is assumed that at all beaches the upper profile will adjust to rising sea levels by landward retreat, even if sediment is constrained by hard substrate or platform edges. Whilst this offered a degree of conservatism it avoids underestimating risk.

A summary of Bruun-concept models has been described within Shand (2013), shown in Figure 5-14. Our framework uses a volumetric shoreface model, similar to the concept shown in Figure 5-14 (d). This does not assume barrier roll-over or landward retreat.

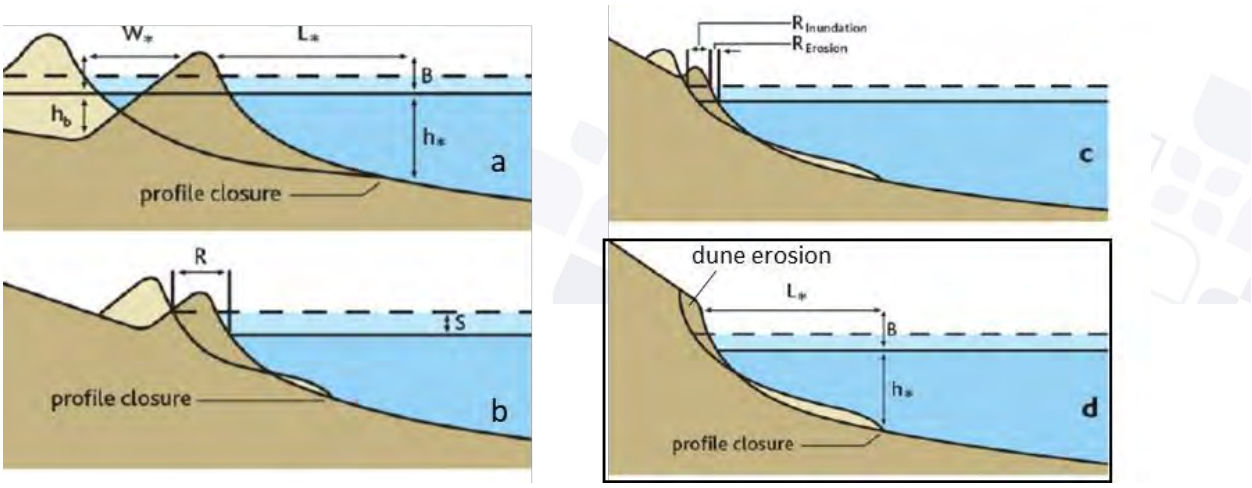


Figure 5-14: Schematic diagrams of the Bruun model modes of shoreline response after Cowell (2001).

Shoreline change due to SLR was calculated using the Bruun Rule:

$$Recession\ due\ to\ sea\ level\ rise = \frac{SLR}{\left(\frac{h+B}{W}\right)}$$

Whereby the following inputs are required:

- Sea-level rise to projected epoch (SLR)
- Depth of closure (*h*)

- Width of active profile (*W*); horizontal distance between the dune toe and the depth of closure.
- Berm height (*B*)

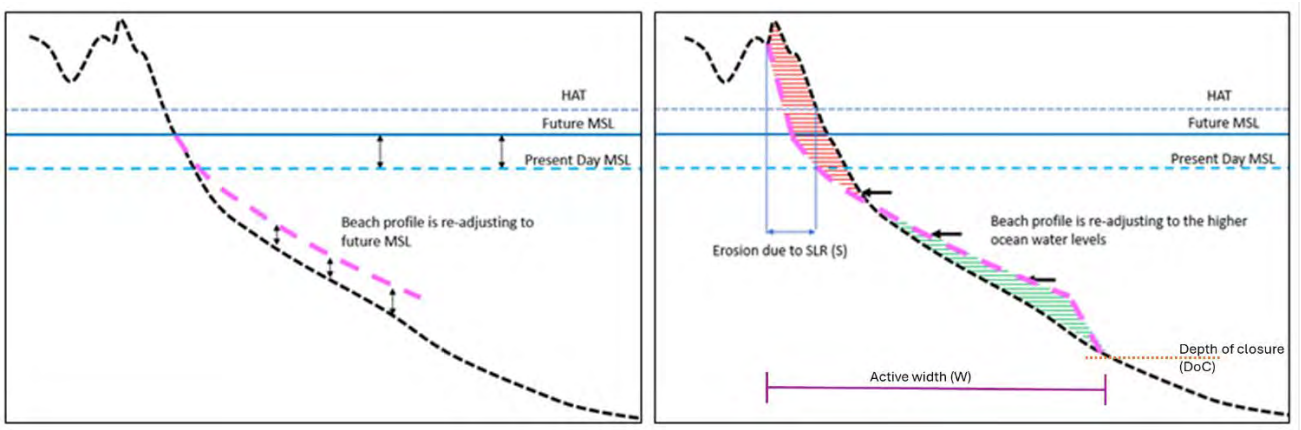


Figure 5-15: Schematisation of erosion-deposition volume balance due to sea level rise.

The Bruun Rule is a simple and widely used model that provides an easily explainable and replicable approach for estimating shoreline recession estimates due to SLR. It has several well-known limitations particularly when applied to complex coastlines such as Wollongong. It assumes uniform beach profiles, excludes longshore sediment transport, and cannot account for complex coastal geomorphology. As a result, the model often produces conservative estimates, this however, is advantageous for planning setbacks and identifying coastal erosion risk zones. Despite these limitations, it remains a useful tool due to its transparency and minimal data requirements. Additionally, it can be easily incorporated into probabilistic assessments to estimate a range of possible erosion outcomes.

A probabilistic approach has been taken to project shoreline change so that uncertainty from different data sources is considered in the calculations.

Sea Level Rise

For each future planning horizon, a triangular probability distribution was constructed to represent the possible SLR outcomes, based on the IPCC SSP5-8.5 scenario. In this distribution the 5th percentile was set as the minimum value, the 50th percentile as the most likely and the 95th percentile as the maximum value (see Figure 5-16). This approach allows a range of plausible scenarios to be considered, weighted by their likelihood according to the IPCC projection.

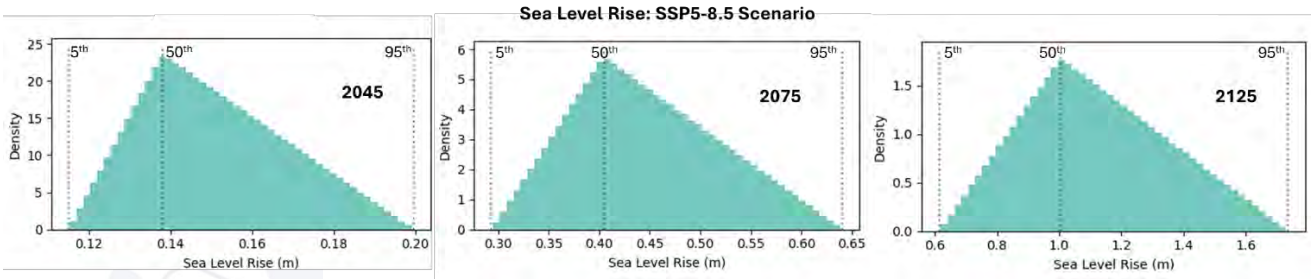


Figure 5-16: Triangular sea level rise distributions for each epoch based on IPCC SSP5-8.5 scenario.

Depth of Closure

In the Bruun rule, the depth of closure (DoC) is used to define the most seaward limit of the active profile. In simpler terms, it is the water depth beyond which there is no significant change/movement in the seabed, i.e. erosion or accretion of sand. DoC is not static and can change with extreme events or long-term climate (e.g. SLR). It can vary laterally due to differences in geology, wave exposure, etc.

For this study, a DoC has been assigned to each beach unit per epoch. This has been adapted from Hallermeier's (1981) inner shoal zone limit. For each beach, Hallermeirer's limit has been scaled for a beach's planform orientation, embayment and depth of nearshore rock layers to reflect the complex interactions between shoreline response and nearshore rocky reefs that are common along the NSW coastline. The following sources were used to inform this: NSW Seabed Landforms Classification Toolset (Linklater et al, 2023), aerial imagery, and profile transects extended to depth of -20 m AHD (NSW Topo-Bathy dataset).

Table 5-5 presents the typical DoC depths used for this study. The DoC varies depending on the timescale on which sediment changes are considered, i.e. in a single year only the upper part of the profile may be mobilised, while over longer timescales, rare extreme events are more likely to occur, reworking sediment at greater depths. Hence DoC increases for projections into the future.

It is important to note that the presence and depth of seabed landforms, such as rocky reefs, vary between beaches and have a significant impact on the actual DoC at each unit. While Table 5-5 provides typical values for the region, further site-specific alterations are undertaken. For some beaches the presence of rocky reefs and lacking offshore sand supplies will physically limit sediment movement, effectively truncating the DoC regardless of the timescale considered. For example, at Austinmer beach units 1 and 4 a rocky reef is exposed from -5 m AHD with no sand located offshore of this depth. As a result, it is not possible for the DoC to increase with time at these locations, and a single DoC of 5 m is used for these units.

Each beach unit was assessed individually, and the corresponding DoC values, accounting for any such truncations, are provided in Appendix C. Figure 5-17 shows examples of beaches where different seabed landforms have resulted in different DoCs being adopted.

Table 5-5: Typical depth of closure values seaward from the 0 mAHD contour used in this study.

Seabed Landform	Depth of Closure (m)			
	2025	2045	2075	2125
Open Coast	10	12	14	19
Perched Beach (nearshore rocky reef)	8	10	12	14
Significant Seabed Landforms	Depth limited based on rock platform depth at each beach			

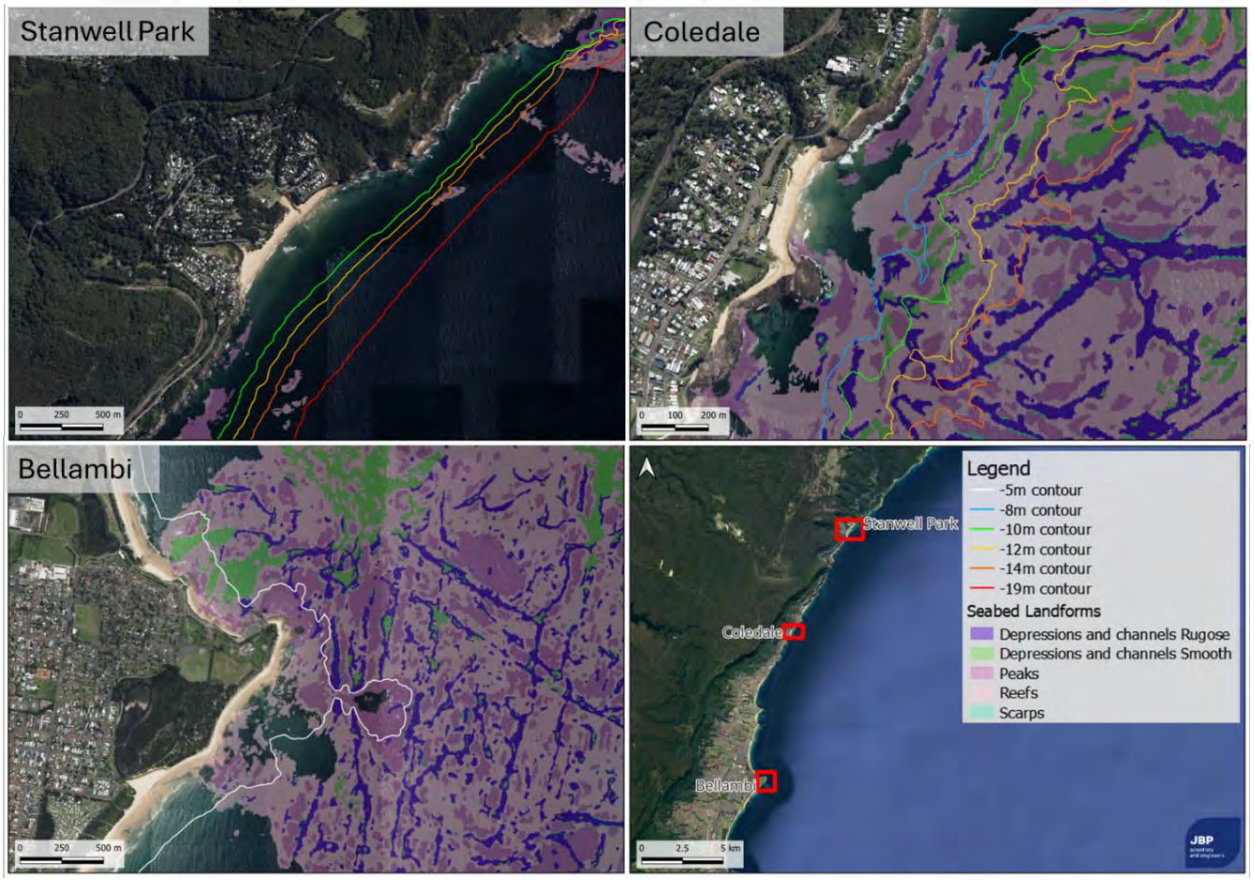


Figure 5-17: Locations where different Depth of Closure has been adopted. Top Left – Stanwell Park (Open Coast), Top Right – Coledale (Perched Beach), Bottom Left – Bellambi Beach/Point (Significant Seabed Landforms), Bottom Right – Beach locations.

Recession due to SLR

For each beach and epoch, the range of possible shoreline recession distances due to SLR was modelled by randomly sampling a triangular distribution of SLR values 10,000 times. For each sample, shoreline retreat was calculated using the Bruun Rule and expressed as a horizontal distance. These distances were then converted to erosion volumes by assuming a simplified triangular cross-shore profile. The resulting set of 10,000 volume estimates were used to construct a probability density function, representing the range and likelihood of potential erosion outcomes (Figure 5-18).

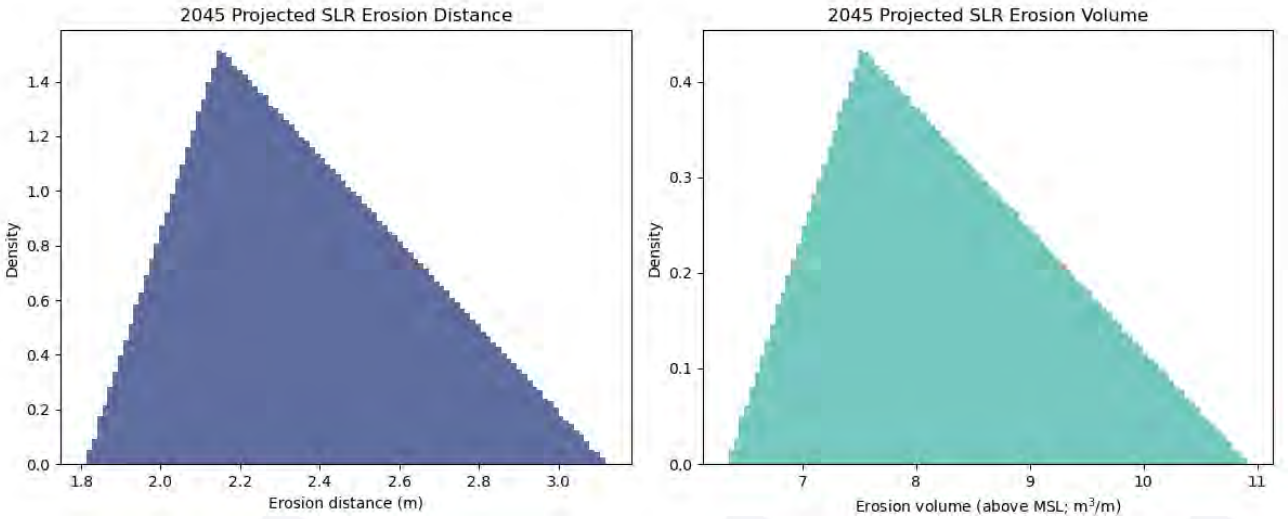


Figure 5-18: Potential shoreline recession (left) and erosion volumes (right) by 2045 for a representative transect in Bellambi beach unit 1.

5.8 Statistical model

Each of the components of erosion and recession hazard is represented as a probability distribution. The type of distribution for each component is described below:

- Event-based erosion due to storm + probabilistic exposure factor (V): gamma distribution.
- Shore-normal recession rate (q_x) + non-linear terms and local factors: normal distribution.
- Recession changes due to future wave climate and alongshore sediment flux (q_y): triangular distribution.
- Shoreline changes due to sea level change (S): triangular distribution.
- ZSA + ZRFC (Section 5.8.1 and 5.8.2)

Tabulated components for each beach unit are provided in Appendix C.

Through random sampling from each of the above distributions using the equation below, a complete erosion and recession distribution has been developed for each beach, at each planning period.

$$E_T = q_x N(1 + q_y) + S + V$$

Where E_T is the total erosion and recession hazard volume. This is repeated 10,000 times to produce a distribution of E_T, from which the total erosion for probability can be extracted for any probability (e.g. 1%). This process was then repeated for each beach per planning horizon.

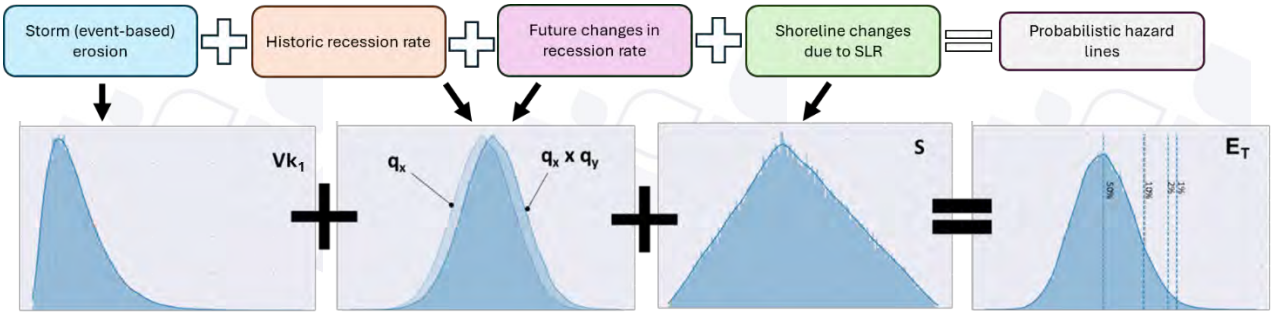


Figure 5-19: Derivation of total erosion and recession hazard (E_T) exceedances.

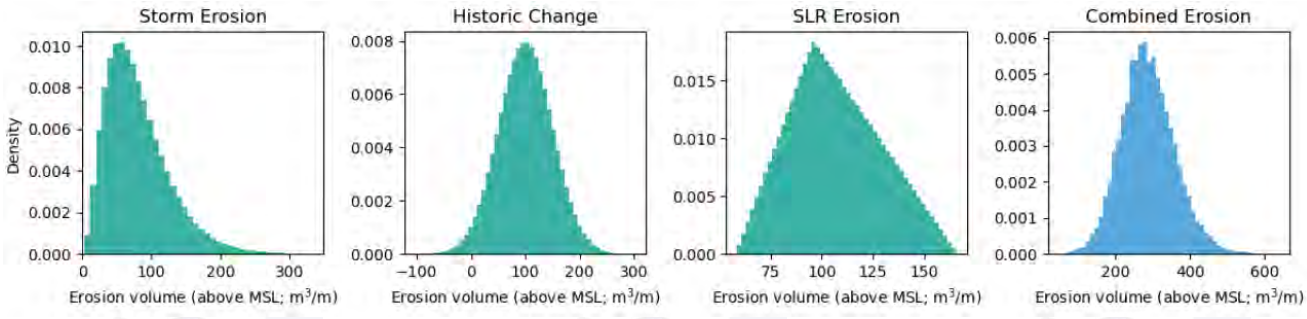


Figure 5-20: Example statistical model outputs for Windang Unit 3 for planning horizon 2125.

5.8.1 Calculating zone of coastal erosion hazard

A series of representative beach transects are then used to convert the erosion volume to an erosion distance (Section 2.3.2). These profiles represent a semi-accreted to accreted beach state. Manual checks have been made with available beach profile data to validate the representative profiles.

To account for dune slumping following encroachment into pre-existing dune morphology, this post-processing uses an allowance that is proportionate to the crest level of the dune erosion escarpment and the angle of repose of the substrate material. This is called the Zone of Slope Adjustment (ZSA).

It is noted that for Coledale2, where erosion extends into semi-consolidated material, the ZSA is not applied. This is because the ZSA is only applicable for unconsolidated sands.

5.8.2 Zone of reduced foundational capacity

A final addition to the coastal erosion hazard zones is the Zone of Reduced Foundational Capacity (ZRFC). The ZRFC is a zone that may experience geotechnical instability behind the slumped eroded dune and incorporates a standard geotechnical engineering factor of

safety (1.5). This is a well-established and accepted step for erosion mapping in NSW. In line with NSW State guidance the ZRFC will be calculated following the schema of Nielsen, Lord & Poulos (1992) using the following parameters for sandy beaches:

- Scour level of -1 mAHD*
- Nominal swash zone up to 2 mAHD.
- Angle of repose for dune sand (i): 34˚
- Safe angle of repose of dune sand (α): 24˚

*If a beach unit is underlain by bedrock shallower than -1 mAHD, the scour level is adjusted accordingly. For example, this applies to McCauleys Unit 1 and Austinmer Unit 5 (Little Austinmer) where a scour level of 0 mAHD is applied.

Representative cross sections for each beach unit were used to determine the relationship between storm demand, erosion distances and projection of the zone of reduced foundation capacity. An example for Windang unit 2 is shown in Figure 5-21.

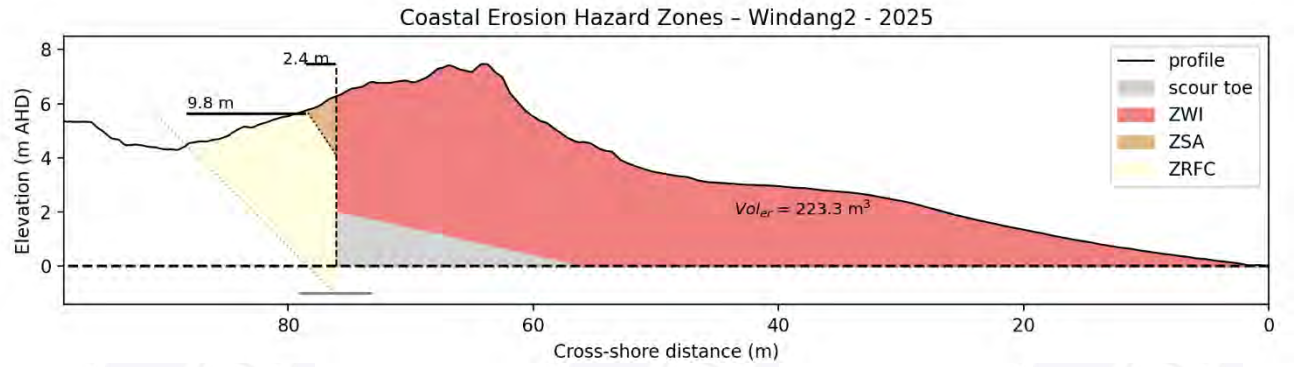


Figure 5-21: Calculated Zone of Reduced Foundation Capacity (ZRFC) for a 1% probability present day event, Windang unit 2. ZWI – zone of wave impact; ZSA – zone of slope adjustment.

Along sections of the Wollongong coastline, storms can completely erode the beach, exposing a scarp which is not composed of sand. Along the northern beaches, debris deposits of colluvium often form the back of beaches. In other locations, such as McCauleys, the beaches are backed by clay and silt deposits. Colluvium has an angle of repose typically ranging between 34° and 37°, with the safe angle of repose usually less than 27° with conservative estimates between 20° to 25° (Turner, 1996). The angle of repose for clay and silt deposits can be very variable, ranging between 15° to 40°, depending on moisture content and compaction. In the absence of local geotechnical testing, an angle of repose of 34° is applied to beaches backed by silt/clay deposits.

Where beaches are predicted to lose all sand during a storm and the beach is backed by colluvium, the following parameters are used to calculate the ZRFC:

- Angle of repose for colluvium (i): 37˚
- Safe angle of repose of colluvium (α): 24˚

Where beaches are predicted to lose all sand during a storm and the beach is backed by clay and silt, the following parameters are used to calculate the ZRFC:

- Safe angle of repose of clay and silt (α): 34˚

This is on the upper end of the range but in lieu of geotechnical testing, is taken as the default. By choosing a higher angle of repose the zone of reduced foundational capacity will be relatively smaller than a lower angle.

An exception has been made at Coledale2, where site photos show the eroding colluvium material at a higher angle of repose. For this site, engineering judgment has been applied and an angle of repose of 50˚ (similar to wet clay) has been used to calculate ZRFC.

Where the ZRFC intersects cliff tops or bedrock above 2 m AHD, the zone has been truncated in the GIS maps as the method above is not applicable for hard rock.

5.9 Cliff erosion

Along the sections of the Wollongong coastline, the calculated erosion values often exceed the available sediment present on a beach. Where predicted erosion distances intersect a cliff scarp comprised of hard lithified material (e.g. sandstone), erosion of soft sediment ceases, and it is assumed no further erosion takes place. Cliff scarps have been determined using the top-of-cliff spatial data provided by Tetra Tech Coffey[10] and a geotechnical compendium of borehole and survey data (compiled by Salients). The top-of-cliff points and bedrock levels have been used as a landward boundary where erosion distances have been truncated. These adjustments assist in limiting the erosion estimates to reflect the natural limitations imposed by the underlying geological structure of the cliffs.



Figure 5-22: Map showing data at Coledale Unit 2 (left) and Stanwell Park (right) that has gone into developing the “Erodible Limit Polygon” which has been used to limit erosion distances. Where annotated boreholes have intersected bedrock at noted depth (mAHD).

10 Tetra Tech Coffey (2025). Coastal Hazard Studies for Wollongong Coast: Coastal Cliff Instability Study. Report No NTLGE340999-AE

5.10 Mapping

The total erosion and recession volume has been converted to a linear distance for each beach unit. This is calculated based on the available sand in the dune profile above the 0 mAHD contour. The linear distance is then mapped landwards from approximately the 0 mAHD contour to represent the potential erosion and recession zone for each return period and planning horizon. To reduce local variability and improve interpretability, a moving average has been applied to smooth the erosion distances along each beach unit.

Any beach unit classified as a headland has been removed from the mapping due to its geological composition, as the estimated erosion rates were calculated for unconsolidated sediment. Unlike beaches, headlands consist of more lithified material and will erode at a significantly slower and less predictable rate. For the purposes of the mapping, the erosion distances from adjacent beaches have been extended into adjoining headland units where the beach edge overlaps into these units. This was undertaken to ensure the eroded profile is represented across the full length of each beach and to avoid the visual impression that the sandy beach edges, where units join, are non-erodible. This approach maintains continuity in the mapped erosion distances while ensuring that true headland features remain excluded from the analysis.

Where erosion zones cross a creek, i.e. Fairy Creek, the coastal erosion zones are interpolated across (Figure 5-24). This is because there is a large degree of uncertainty in how creek entrances will evolve in the future.

Mapped erosion and recession zones are clipped to a non-erodible polygon layer which was developed using bedrock levels and geological mapping from the following sources:

- Geotechnical data collected as part of this CMP by Tetra Tech Coffey
- Geological Survey of New South Wales 1:100 000 and 1:25 000 Coastal Quaternary Geology Map Series (Troedson, 2016)
- Geotechnical reports and borehole data held by Council.

Non-erodible regions were nominally defined as where bedrock is exposed, where bedrock is above ~2 mAHD, or where topography is sufficiently steep to indicate bedrock is near the surface.

The erosion and recession mapping represents an undefended scenario, i.e. without seawalls. This allows the benefits of seawalls to be quantified based on the value of land, assets, and infrastructure within their protection. Estimating their zone of protection requires an understanding of the design characteristics, estimated end-of-life, condition, and maintenance regime, which is not known for all assets. A simplified approach has been undertaken to produce a spatial dataset that indicates “defended” areas, whereby any hazard landward of an identified structure has been removed from the erosion and recession maps. This assumes that all identified structures and in good condition and working as intended. Table 5-6 provides the location of defence structures considered in the defended mapping.

Table 5-6: Structure locations of defences used in ‘defended’ area

Structure Type	Unit	Latitude	Longitude
Seawall	Austinmer 3	-34.306	150.935
Breakwall	Bellambi 2	-34.368	150.929
Seawall	Bellambi 2	-34.368	150.928
Ocean Pool Wall	Bellambi 3	-34.366	150.924
Seawall	Bellambi 3	-34.366	150.924
Seawall	Bellambi 4	-34.366	150.923
Seawall	Brighton 1	-34.421	150.907
Seawall	Brighton 1	-34.421	150.907
Seawall	Brighton 1	-34.419	150.903
Seawall	Clifton 2	-34.246	150.977
Geotextile Wall	Coalcliff 1	-34.245	150.977
Seawall	Coledale 6	-34.288	150.948
Seawall	Coledale 7	-34.280	150.956
Seawall	Fishermans 1	-34.492	150.919
Lake Illawarra Breakwater	Windang 1	-34.542	150.875
Seawall	McCauleys 3	-34.323	150.925
Seawall	McCauleys 3	-34.320	150.926
Seawall	North 2	-34.415	150.901
Reno Mattress Seawall	North 2	-34.413	150.902
Seawall	Sandon 1	-34.338	150.925
Surf Club Seawall	Sandon 3	-34.331	150.928
Seawall	Thirroul 1	-34.318	150.927
Seawall	Thirroul 1	-34.317	150.928
Seawall	Thirroul 1	-34.318	150.927
Seawall	Thirroul 1	-34.319	150.926
Ocean Pool Wall	Towradgi 2	-34.386	150.915
Seawall	Towradgi 2	-34.386	150.915
Seawall	Windang 5	-34.492	150.909
Breakwall	Wollongong City 3	-34.420	150.907
Seawall	Wollongong City 3	-34.421	150.909

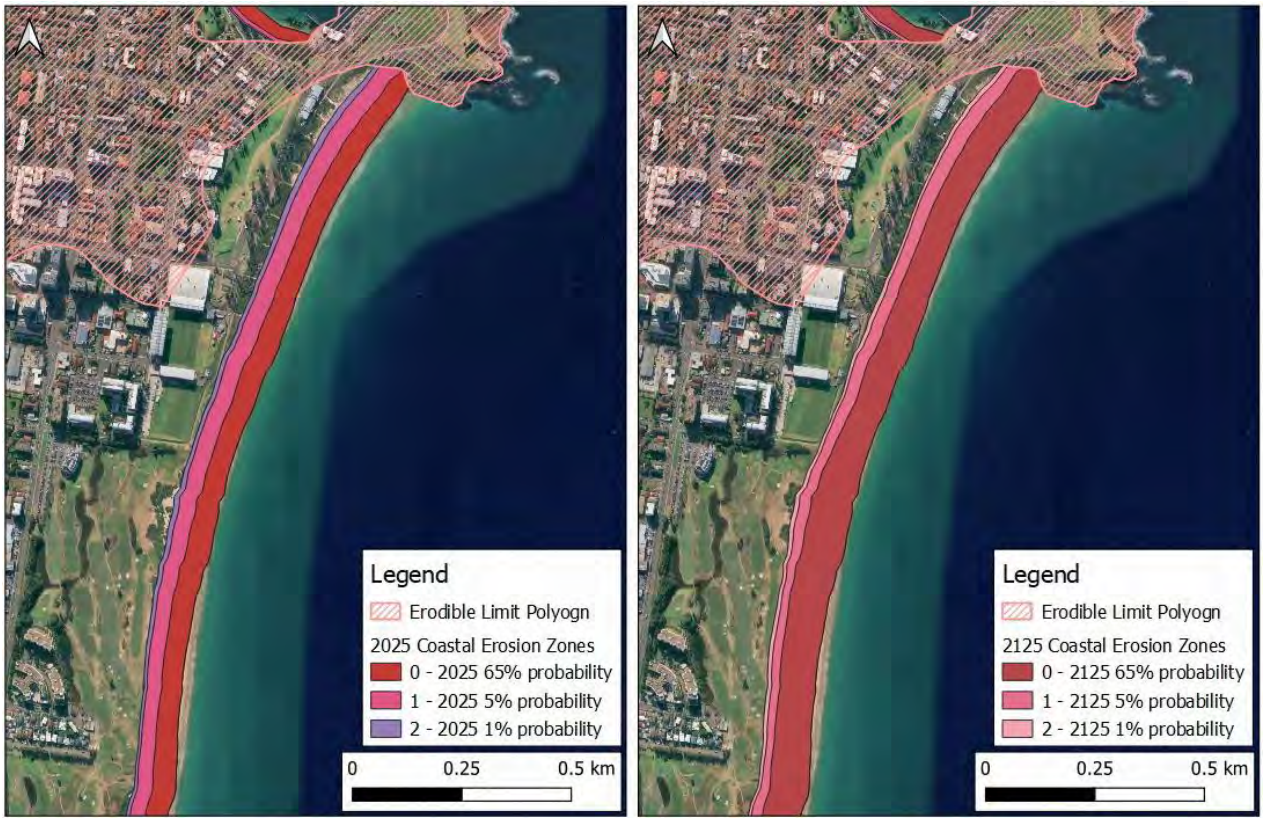


Figure 5-23: Coastal erosion zone maps for north Wollongong City beaches in 2025 and 2125.

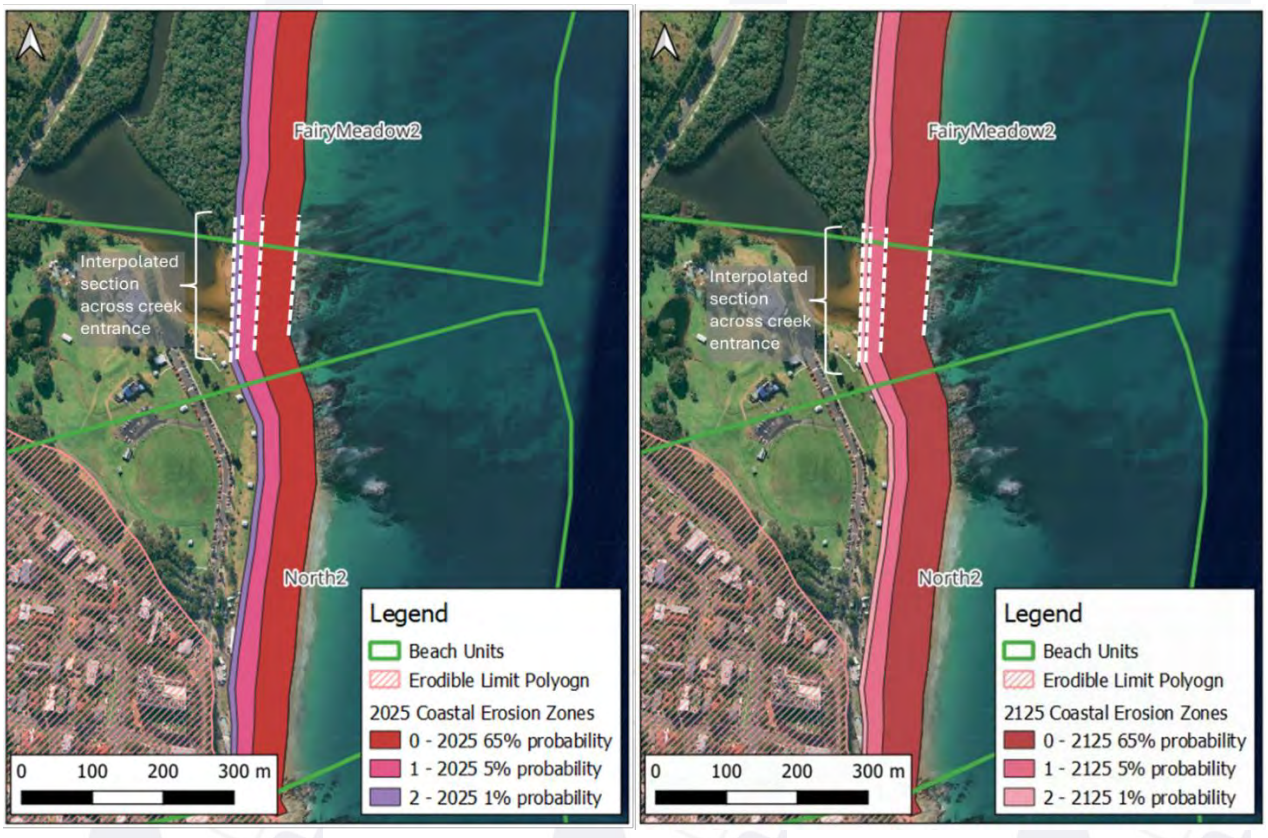


Figure 5-24: Coastal erosion zone maps for Fairy Creek in 2025 and 2125 showing interpolation across creek entrance.

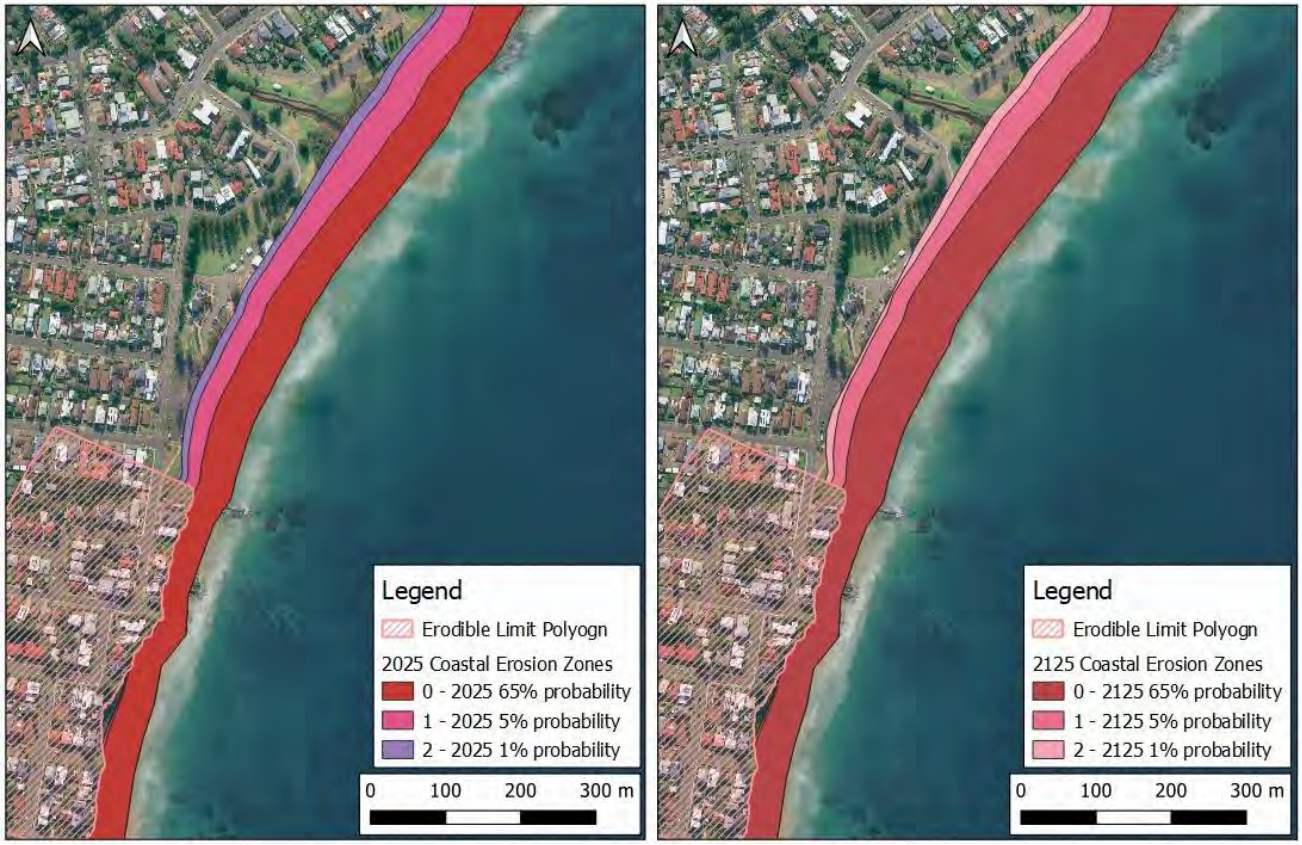


Figure 5-25: Coastal erosion zone maps for Thirroul beach in 2025 and 2125.

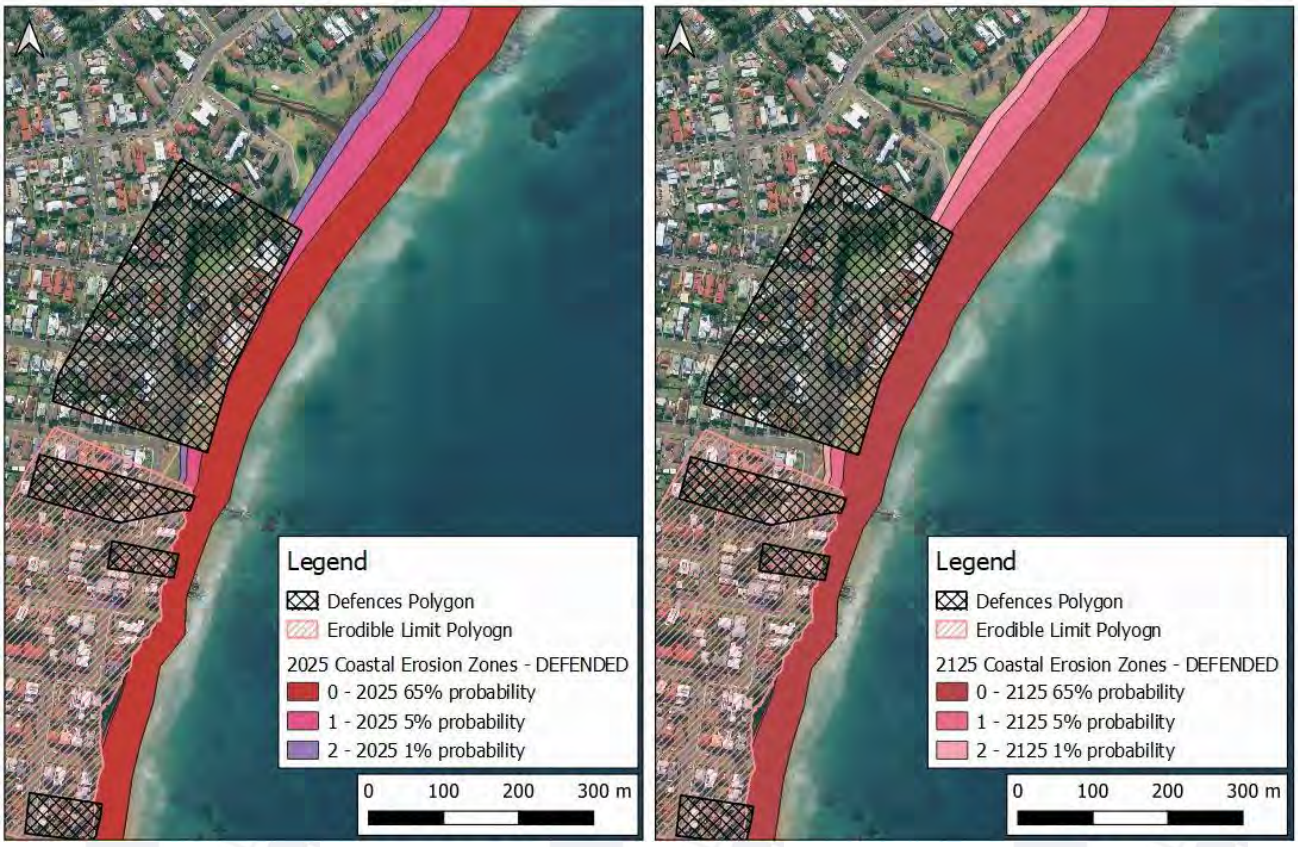


Figure 5-26: Defended coastal erosion zone maps for Thirroul beach in 2025 and 2125.

5.11 Uncertainty and the Probabilistic Approach

Uncertainty is an inherent part of projecting future coastal erosion hazard zones. Key sources of uncertainty include the magnitude and rate of future sea level rise, potential changes to long-term shoreline recession rates, how beach profiles may respond to evolving wave and water level conditions, model limitations and resolution of available datasets, among other factors. These uncertainties introduce a degree of variability into any projection of future coastal change. Some relate to incomplete knowledge or model limitations, others to natural randomness such as changing meteorological and oceanographic forcing conditions.

To reflect these uncertainties, a probabilistic approach is used to estimate a range of plausible outcomes rather than a single deterministic scenario. However, even with probabilistic methods, it is important to note that the resulting hazard zones depend on assumptions and input distributions that are themselves uncertain.

For each component—such as sea level rise, long-term recession, and storm-induced erosion—probability distributions are developed based on available data and current best practice.

These component distributions are then combined using probabilistic techniques resulting in an integrated range of coastal erosion values and their associated probabilities. Importantly, the 1% probability coastal erosion hazard zone is not simply the sum of the 1% values for sea level rise, long-term recession, and storm erosion. Instead, it reflects the joint probability of extreme conditions across all components occurring together, providing a more statistically valid estimate of rare but plausible outcomes. The 1% hazard zone is the landward limit that has only a 1 in 100 chance of being reached or exceeded by erosion in each planning timeframe, considering key processes and their uncertainties.

The greatest uncertainty arguably comes from the assumption of what the beach state will be prior to a storm event, i.e. accreted, depleted, somewhere in between. This has not been integrated into the probabilistic modelling here but may be worth considering in future updates.

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A Appendix A – Hydrodynamic modelling updates

The repurposing from flood-focussed to coastal-focussed models for this study required a range of adjustments as described below.

The original models have been developed to simulate fluvial and pluvial processes (e.g. water levels resulting from rainfall) and do not have a coastal focus. They have been through a rigorous calibration and validation process which is well documented. After adjustments, the repurposed models have been used to simulate tide and extreme sea level conditions, and the fluvial and pluvial processes removed. Therefore, results cannot be compared between the initial and repurposed models as they have not been run for the same purpose.

A.1 Merging models

Following discussion with Council a decision was made to merge the Wollongong City and Allans Creek hydrodynamic models to provide a more accurate representation of coastal and tidal dynamics, particularly during extreme events.

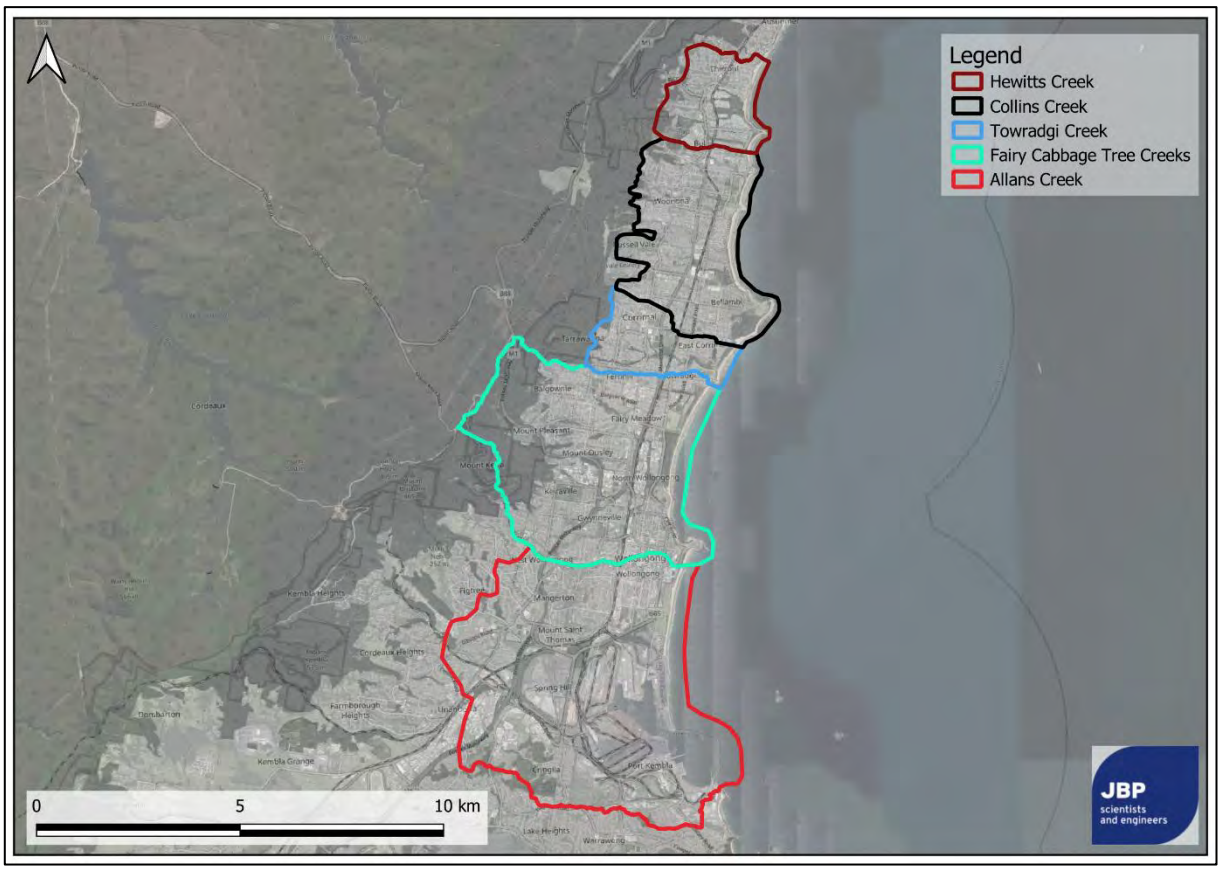
The merged model retains the name "Allans Creek" for consistency and ease of future updates.

This integration enhances the ability to capture overtopping along Wollongong City Beach, where flows from the beach are directed into the Wollongong Model Domain and subsequently exit through the Allans Creek Domain, including via the Gurungaty Waterway at the entrance to Port Kembla. This approach resolves the cross-boundary flow issues identified in both models, improving the overall accuracy of inundation predictions.

A.2 Code layer & boundary adjustments

To implement tidal boundaries in the models, the code layers were extended approximately 100 meters seaward. Within this extended modelling region, the model parameters have been configured as best as possible to match those of the original model build. Some of the model domains have also been reduced in extent on the landward side to improve run time efficiencies where appropriate as the land is not subject to tidal or coastal inundation.

Of note, the Hewitts Creek model domain has been extended in the north at Flanagan’s Creek where the original hydraulic model boundary was constrained to the crossing at Lawrence Hargrave Drive.



Appendix Figure A-1: Revised model domains for the detailed hydrodynamic models being adopted for this study.

A.3 Intertidal DEM integration

NSW Marine LiDAR Topo-Bathy 2018 data has been adopted into all of the hydrodynamic models as they were originally developed with a smaller domain that doesn't capture the open coastline.

Note: For the merged Allans Creek model through Port Kembla a fixed bed level of -3 mAHD was adopted within the inner port. This aligns with the previous modelling setup and removes some poor triangulated data within the Topo-Bathy data. Sensitivity testing was conducted on this, testing implementation of lower bed levels, and it was found to have no tangible impact on the inundation extents (<1.5cm difference). As a result, for consistency with the original model adopted for this study, the -3 mAHD bed level was retained for the final modelling.

A.4 Entrance conditions

The modelling of Intermittently Closed and Open Lake and Lagoons (ICOLLs) will be influenced by the water level boundary conditions and the entrance elevation.

Water level boundaries have used the values published within OEH (2015) "Floodplain Risk Management Guide. Modelling the Interaction of Catchment Flooding and Oceanic

Inundation in Coastal Waterways". This uses a Type C boundary, reflecting ICOLL conditions. These will propagate from the open boundary towards the ICOLL entrance.

The entrances across the study area were assumed to be open, allowing for maximum tidal propagation. This is necessary as the representation of closed or partially closed ICOLL berms within the hydrodynamic model means that tidal ingression into the creeks becomes more limited. The extent to which creeks will be opened has been informed by the coastal processes assessments being undertaken by Salients as part of the wider project program.

Appendix Table A-1 shows the representative bed levels that have been adopted for each of the ICOLL entrances that have been modified within the detailed mapping study. These entrance condition levels have been developed in conjunction with the recently released NSW Water Level Frequency Distribution Analysis report (MHL, 2025). This document is the most recent probability analysis of water levels in the region. Minimum bed elevations have been defined based on the lowest recorded water levels at the ICOLL entrances; this was assumed representative of the lowest elevation to which the entrance berm would scour (adding for +0.1-0.2 m allowing for superelevation of water levels inside the entrances). This analysis typically resulted in berm elevations around mean sea level as can be observed in Appendix Table A-1.

It should be noted that at some sites the lowest water level recorded in the MHL 2025 report is different to that published online as the figures are yet to be updated.

Appendix Table A-1: List of ICOLL modification locations within the detailed hydrodynamic models and their respective elevations.

Location Name	Minimum Bed Elevation	Method
Fairy Creek	0 mAHD	Fixed Elevation
Towradgi Creek	-0.1 mAHD	Graduated Profile
Bellambi Lagoon	0 mAHD	Fixed Elevation
Bellambi Gully	0.4 mAHD	Graduated Profile
Collins Creek	0 mAHD	Graduated Profile
Whartons Creek	0 mAHD	Graduated Profile
Slacky Creek	0.6 mAHD	Graduated Profile
Woodlands Creek	0 mAHD	Fixed Elevation
Hewitts Creek	0 mAHD	Graduated Profile
Flanagans Creek	0 mAHD	Fixed Elevation

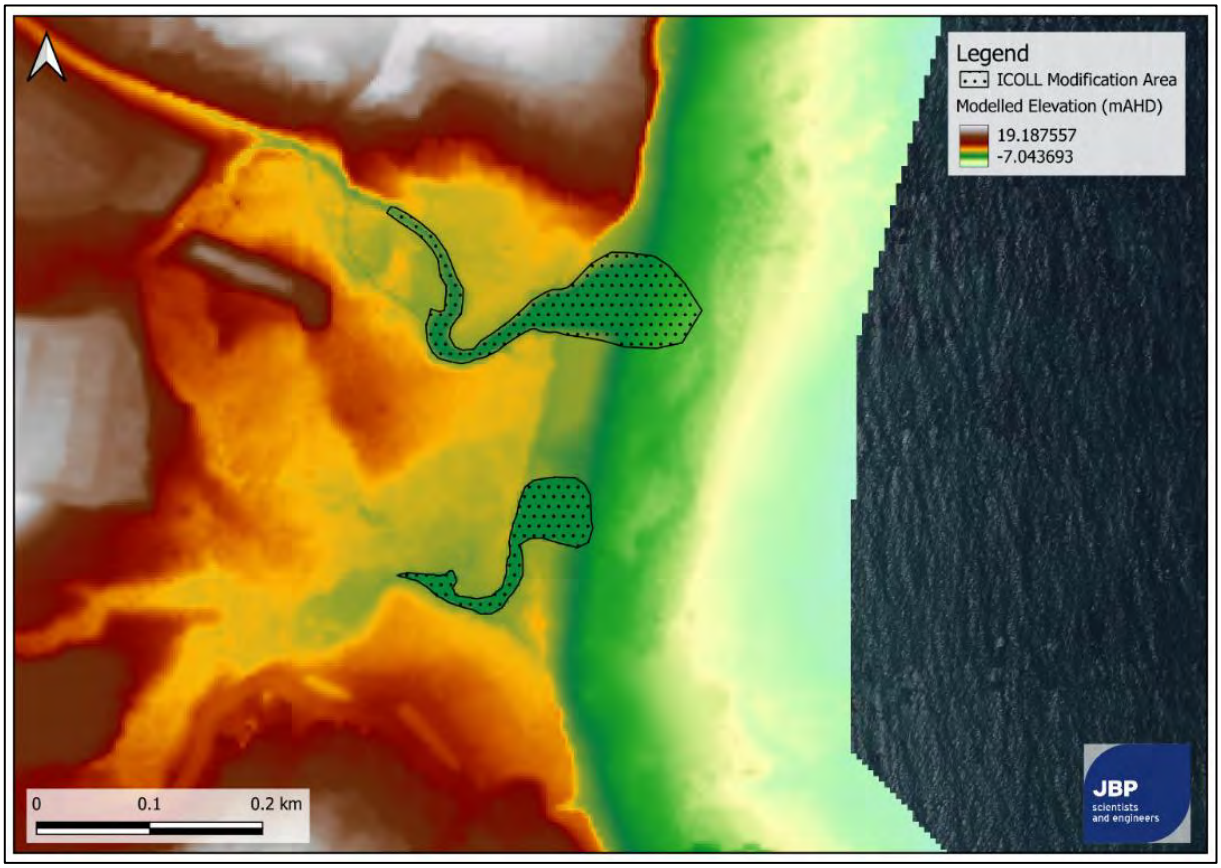
The two methods for modifying the bathymetric data are described as follows:

- Fixed Elevation – A mask polygon has been applied over the ICOLL berm and all elevation values within the region have been lowered to the minimum bed elevation.
- Graduated Profile – Due to the presence of bathymetric survey data, more refined adjustments to the bed elevations at the berm are achievable, have been

enforced at the centre of the ICOLL berm and blended into neighbouring bathymetric values more seamlessly.

Existing survey data captured in 2005 was used in addition to the NSW TopoBathy data for Hewitts Creek and Towradgi Creek. The surveyed elevations were deemed representative when compared with the newer 5m TopoBathy data.

For Fairy Creek, although survey data captured the ICOLL berm, the crest has been lowered as per Appendix Table A-1 with the modification boundaries blended into the survey data and NSW TopoBathy data. Some additional cleaning of the bathymetric data has been completed in attempt to more seamlessly represent the bed level of the lagoons behind the berms. An example of this can be seen for Hewitts Creek in Appendix Figure A-2 where the ICOLL berm has been removed and the lagoon representation lowered to match survey records.



Appendix Figure A-2: ICOLL berm modifications within the TUFLOW hydrodynamic model for Hewitts Creek.

It should be noted that in areas lacking specific survey records, the DEM data may not accurately represent the true bed level. This can limit the accuracy of inundation modelling within these systems.

A.5 Hydraulic structures

The representation of large structures (culverts and bridges) from the original modelling has been retained. These are predominately enforced using gully lines or flow constrictions. The sub-surface stormwater network within all the models has mostly been removed due to underlying errors (i.e. pit elevations above ground level) and would require reasonable effort to address which was not within the remit of this project. Where significant structures not captured in the original modelling are present and data is unavailable, approximate dimensions and elevation values have been derived from reviews of openly available aerial imagery.

It is assumed that the drainage channel depths are represented correctly in the original models. This may have an impact on conveyance and resulting flood extents. An example of these additional structures includes those shown in Appendix Figure A-3 along Flanagans Creek in the region where the model domain has been extended inland to allow propagation beyond Lawrence Hargrave Drive (section A.2). Other locations where several assets have been added include those within the Allans Creek model around Port Kembla however it is noted that mapping in this region, although hydrologically relevant, is not considered part of the assessment.



Appendix Figure A-3: Additional modelled structures in the Hewitts Creek hydrodynamic model domain along Flanagans Creek.

A.6 Standardised model structure

For ease of use, some of the models which were originally developed using MapInfo format data have been converted to GIS (Shapefile) format models.

Furthermore, all the hydrodynamic models have been translated into Geocentric Datum of Australia 2020 (GDA2020) projection. The GDA2020 is Australia's new national datum which replaces GDA94. GDA2020 is of higher accuracy than GDA94, aligns more closely with GPS and GNSS positioning services and supports nationally consistent datasets, free of the known distortions of GDA94.

All the hydrodynamic models adopted for use in this study have been re-structured and developed with a uniform structure that makes modifications more seamless. This will also be run on the latest version of TUFLOW (Version 2023-03-AE). This helps to alleviate some of the nuances of model development adopted by different consultants across the study area and allows for more consistent feature and boundary representation across all models.

A.7 Model resolution

For consistency in reporting, all models have been run at 5m cell resolution. This resolution was adopted as it provides uniformity in outputs enabling more seamless integration. The model domains have also been oriented orthogonally and snapped to the nearest 5m cell increment within the GDA2020 projection.

Although some of the models adopted from the flood study were modelled at a higher resolution initially, the requirement to produce a continuous output across all hydrodynamic models would result in the need for resampling to a uniform resolution, irrespective of whether this was done at the modelling or post processing stage of the assessment.

A.8 Other adjustments

Given their prior validation, calibration, and adoption by council, further efforts to improve the models have been limited. Despite this, during the review of these models, some sub-optimal or erroneous data configurations were identified, which could potentially affect the quality of the repurposed tidal models.

For example, initial checks often reported that the Flow Constriction Layers (2d_lfcsh) are lower than the ground level suggesting erroneous implementation during model setup however this may be a symptom of different parameter configurations in more recent versions of TUFLOW since the implementation of 2d_bg features in 2022.

Where such issues posed a significant risk to the accuracy of the tidal configurations, minor adjustments have been made to ensure reliable outcomes for this project.

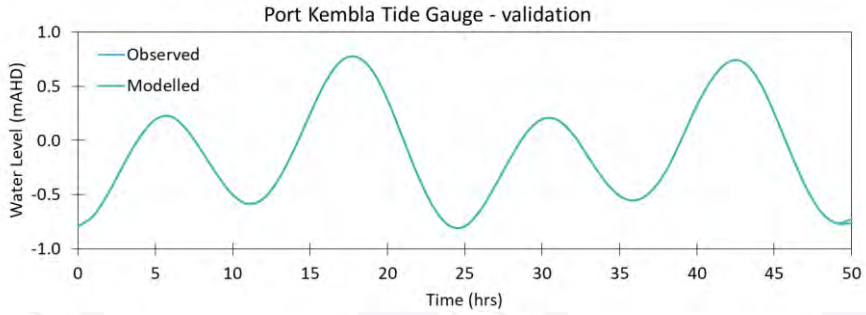
A.9 Model Validation

Fairy Creek, Towradgi Creek and Port Kembla water level gauges were all initially considered for model validation. However, both Fairy and Towradgi Creeks have ICOLL entrances. Accurate calibration of a model using gauges within an ICOLL requires precise

information on berm elevation at the time of gauge reading, as the berm exerts a controlling influence on the exchange of water between the river and the ocean. Without reliable berm level data, it becomes difficult to calibrate the model, because discrepancies may be due either to model performance or to differences in actual versus assumed berm conditions.

Furthermore, in the hydraulic modelling, the berm is artificially lowered to the full scour level—i.e., where maximum flow occurs. This is a distinctly different configuration than would be present for much of the historical gauge record, which would reflect a variety of berm conditions. As a result, using Fairy or Towradgi Creek gauges for calibration would not reliably improve model accuracy under the chosen modelling scenario.

In contrast, the Port Kembla gauge, location within the harbour, has no such issues. It was used to validate the Allans Creek model and confirm propagation of the boundary conditions into the model domain. The Allans Creek model was run for a 50-hour period, using observed tidal data from Port Kembla gauge, simulating the period from 05:00 26 December 2019 to 07:00 28 December 2019. Model results showed a Root Mean Squared Error (RMSE) of 0.001 between the observed and simulated data indicating that the hydraulic model was performing proficiently.



Appendix Figure A-4: Observed and Modelled data at Port Kembla Tide Gauge

B Appendix B – Tidal and Coastal Inundation Mapping

This appendix has been supplied as a separate item alongside this report. The appendix comprises of a suite of PDF files for each of the modelled epochs and events.

B.1 Tidal Inundation Maps

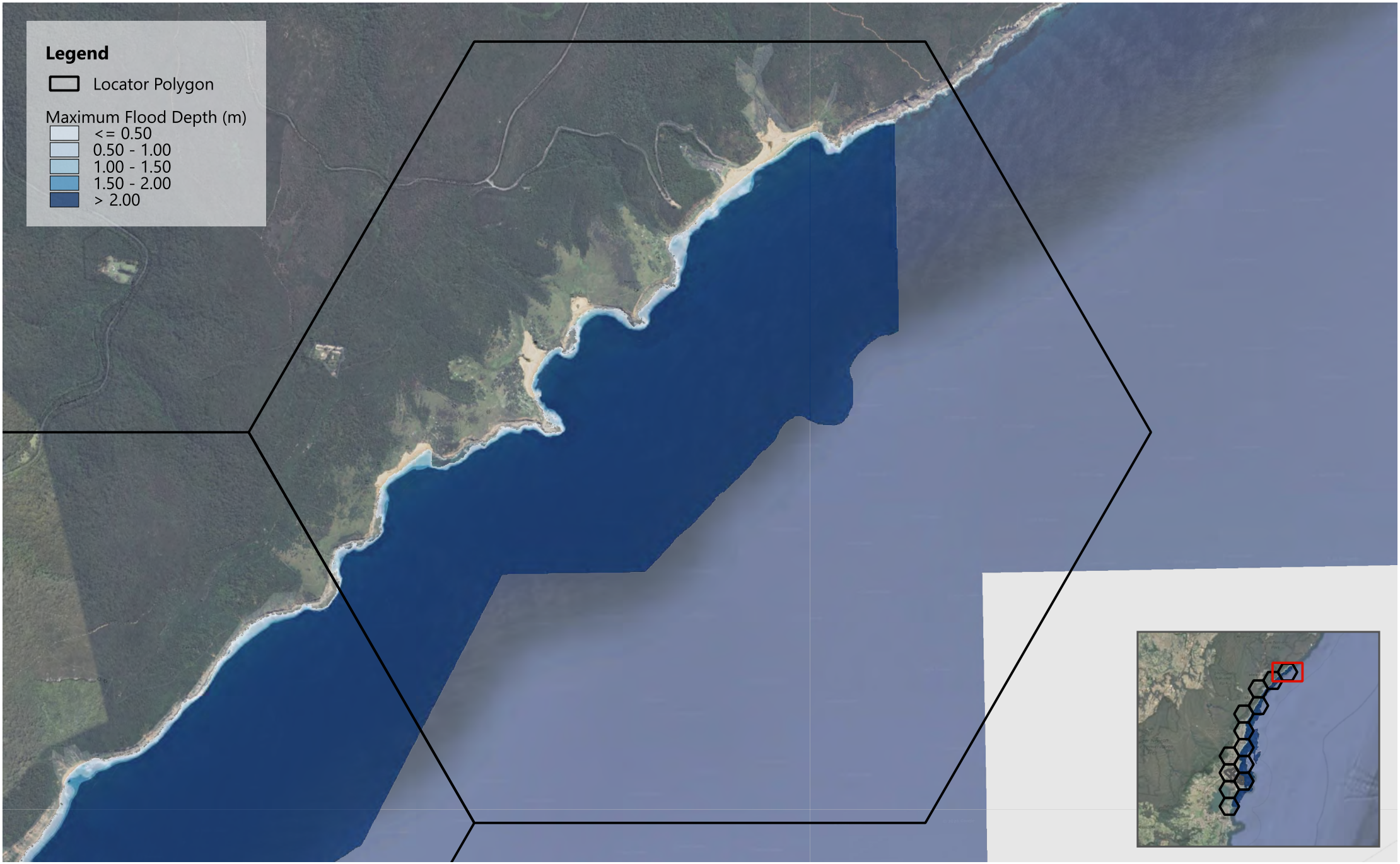
The following Tidal Inundation mapping has been included:

- HHWSS 1.1 m AHD
- HHWSS 1.4 m AHD
- HHWSS 1.8 m AHD
- HHWSS 2.9 m AHD

B.2 Coastal Inundation Maps

The following Coastal Inundation mapping has been included:

- 2025 5% AEP
- 2045 1% AEP - SLR SSP5-8.5 95th percentile
- 2075 1% AEP - SLR SSP5-8.5 95th percentile
- 2125 1% AEP - SLR SSP5-8.5 95th percentile



Map Scale

0 0.5 1 km

Wollongong Coastal Hazard Study: Tidal Inundation Mapping HHWSS @ 1.1mAHD - Present Day Grid ID: 1

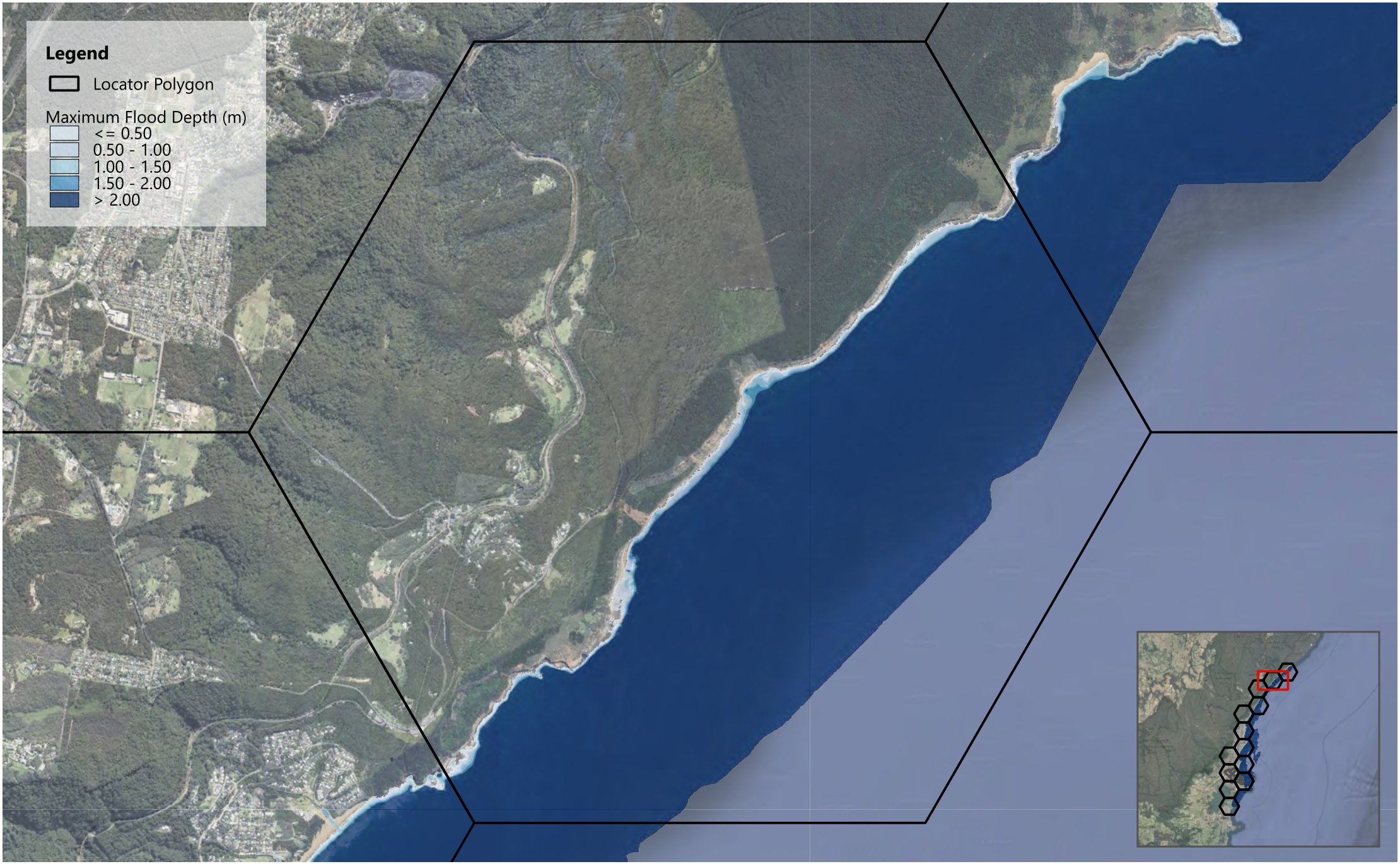
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Map Scale

0 0.5 1 km

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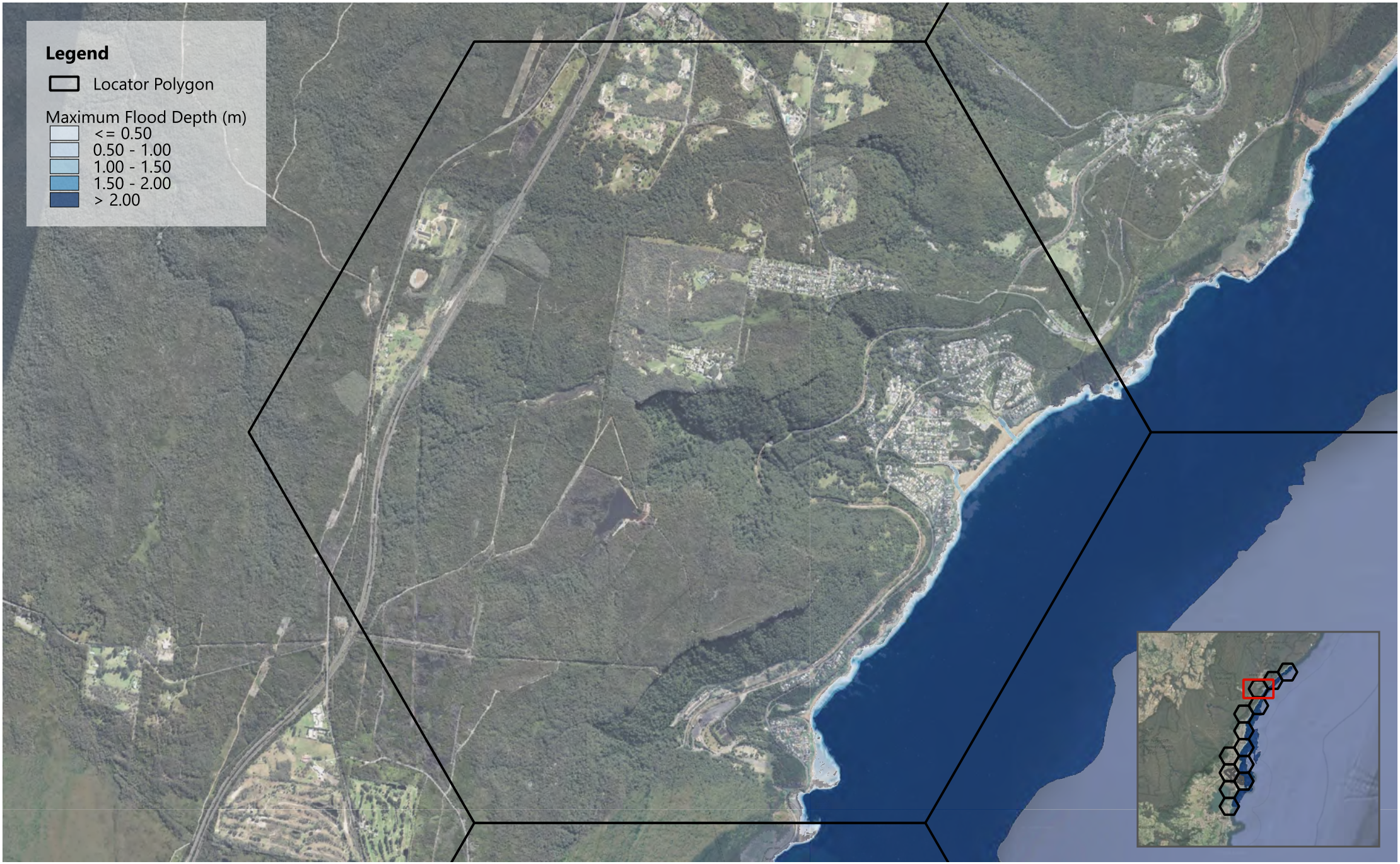
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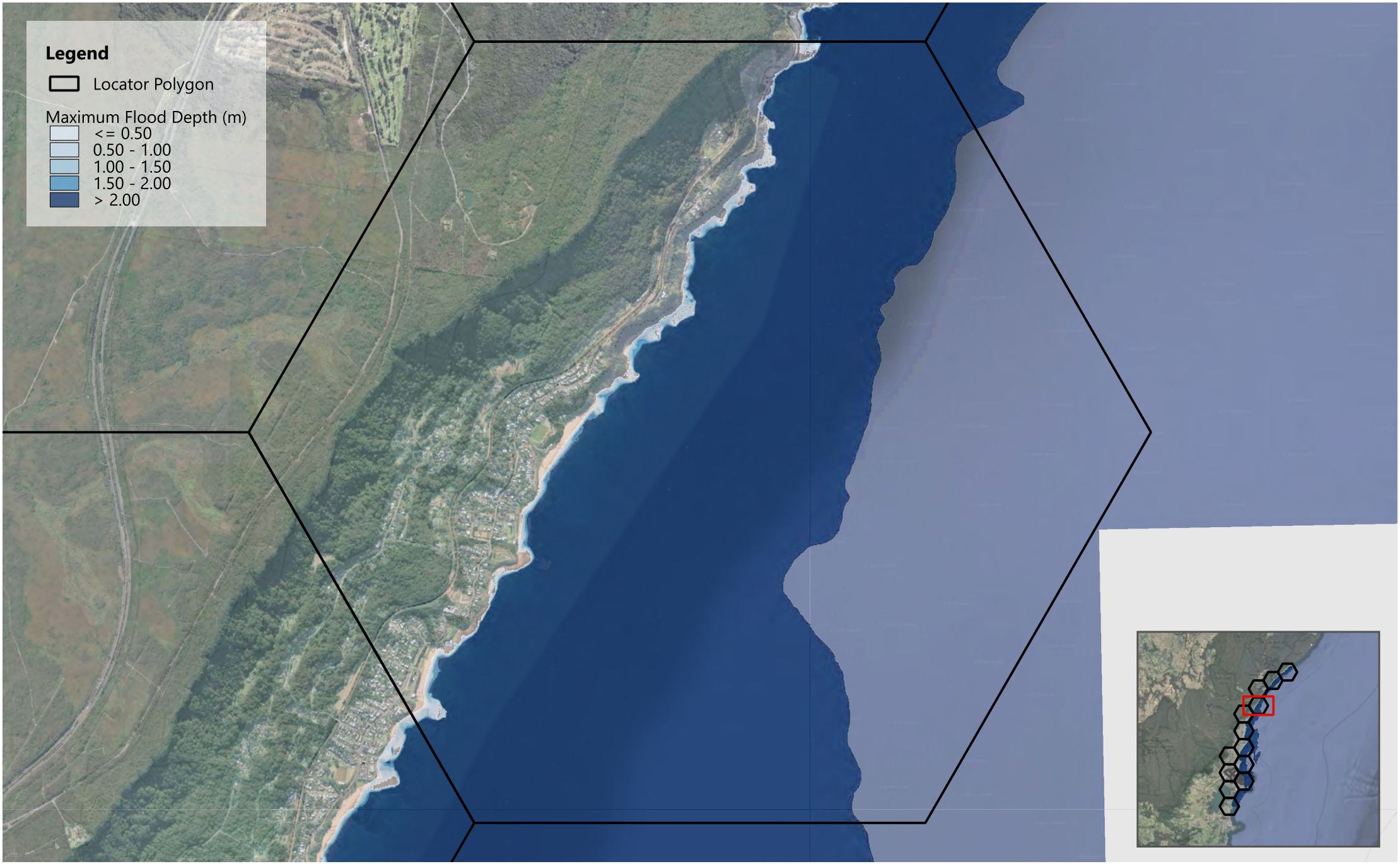
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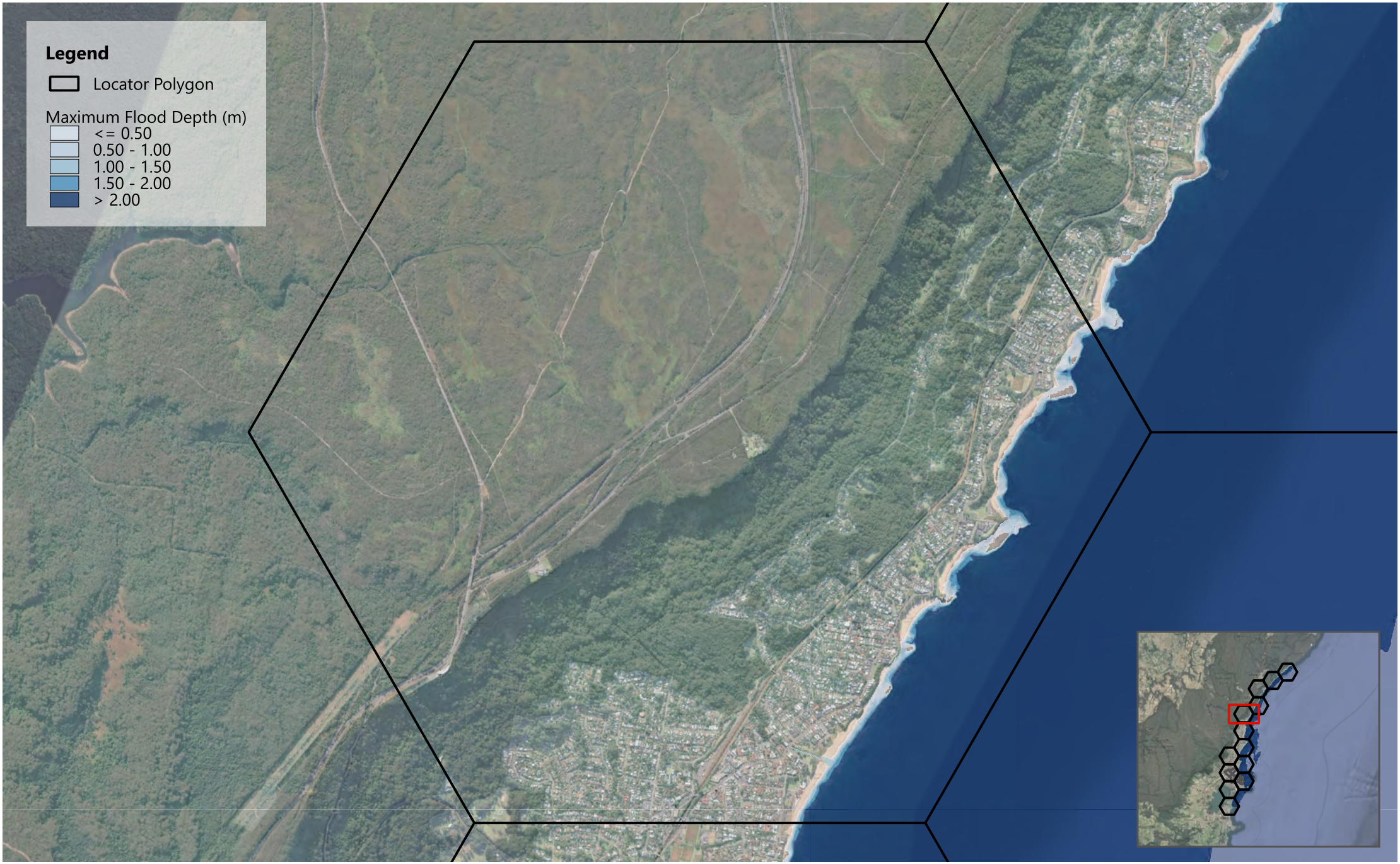
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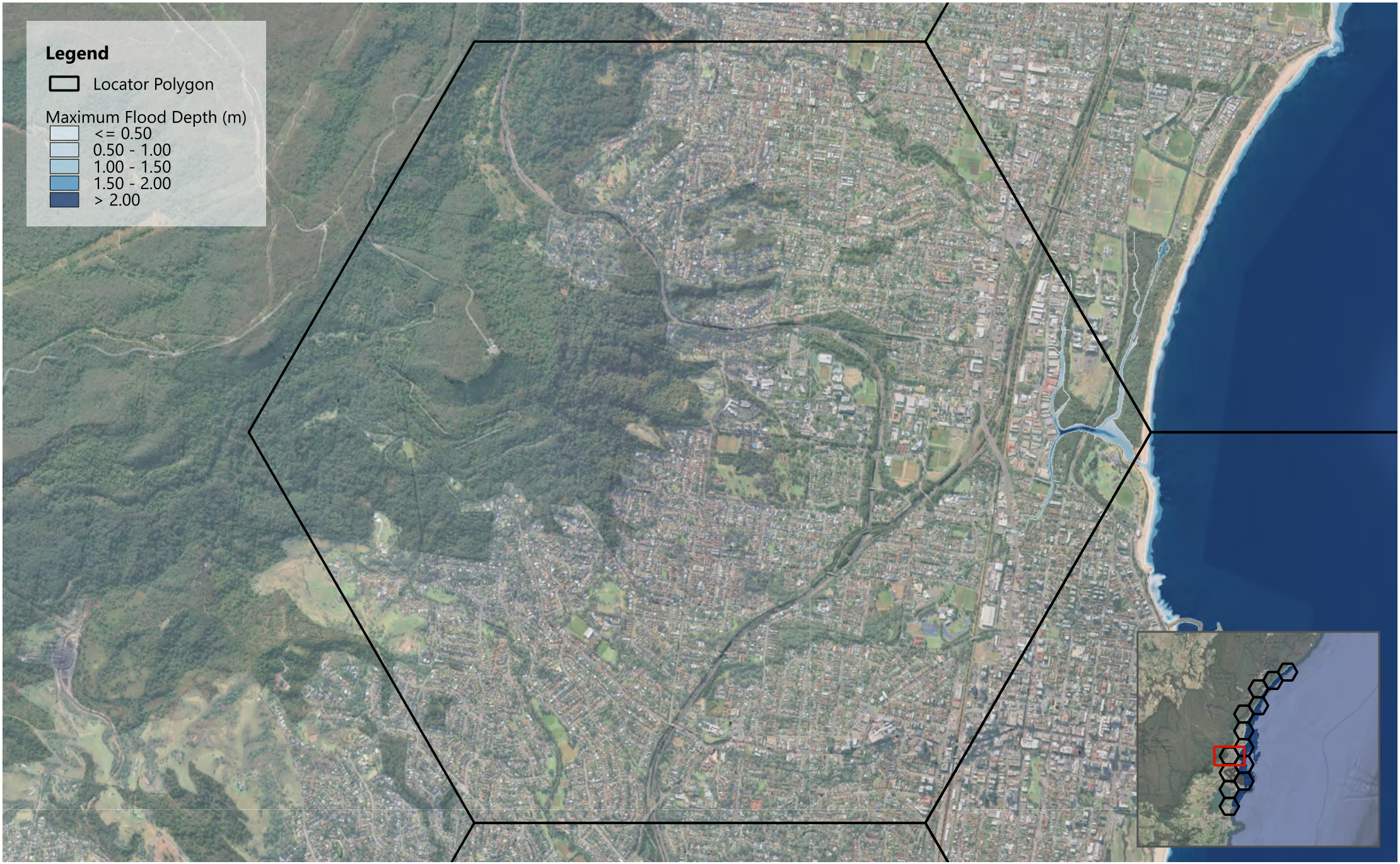
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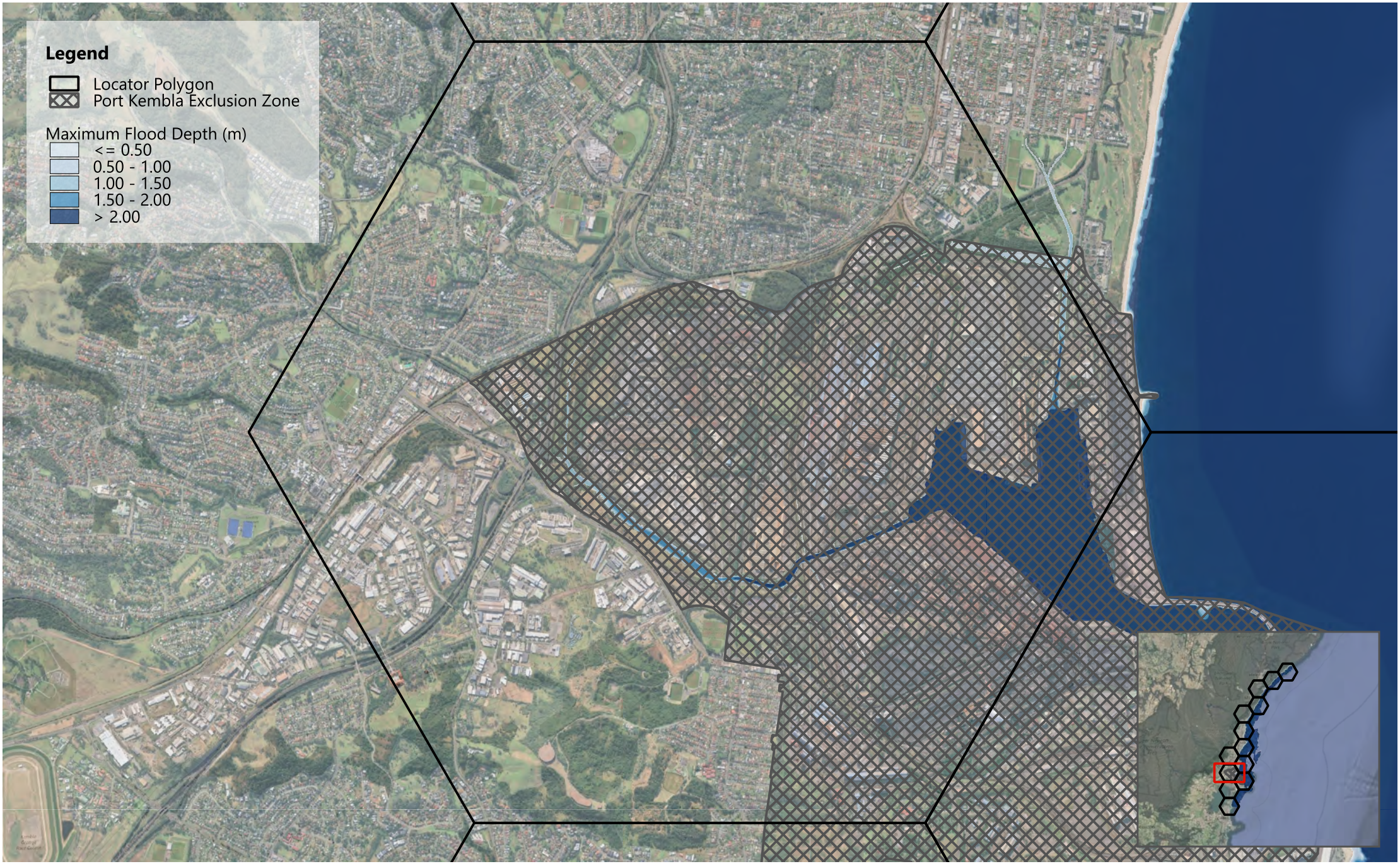
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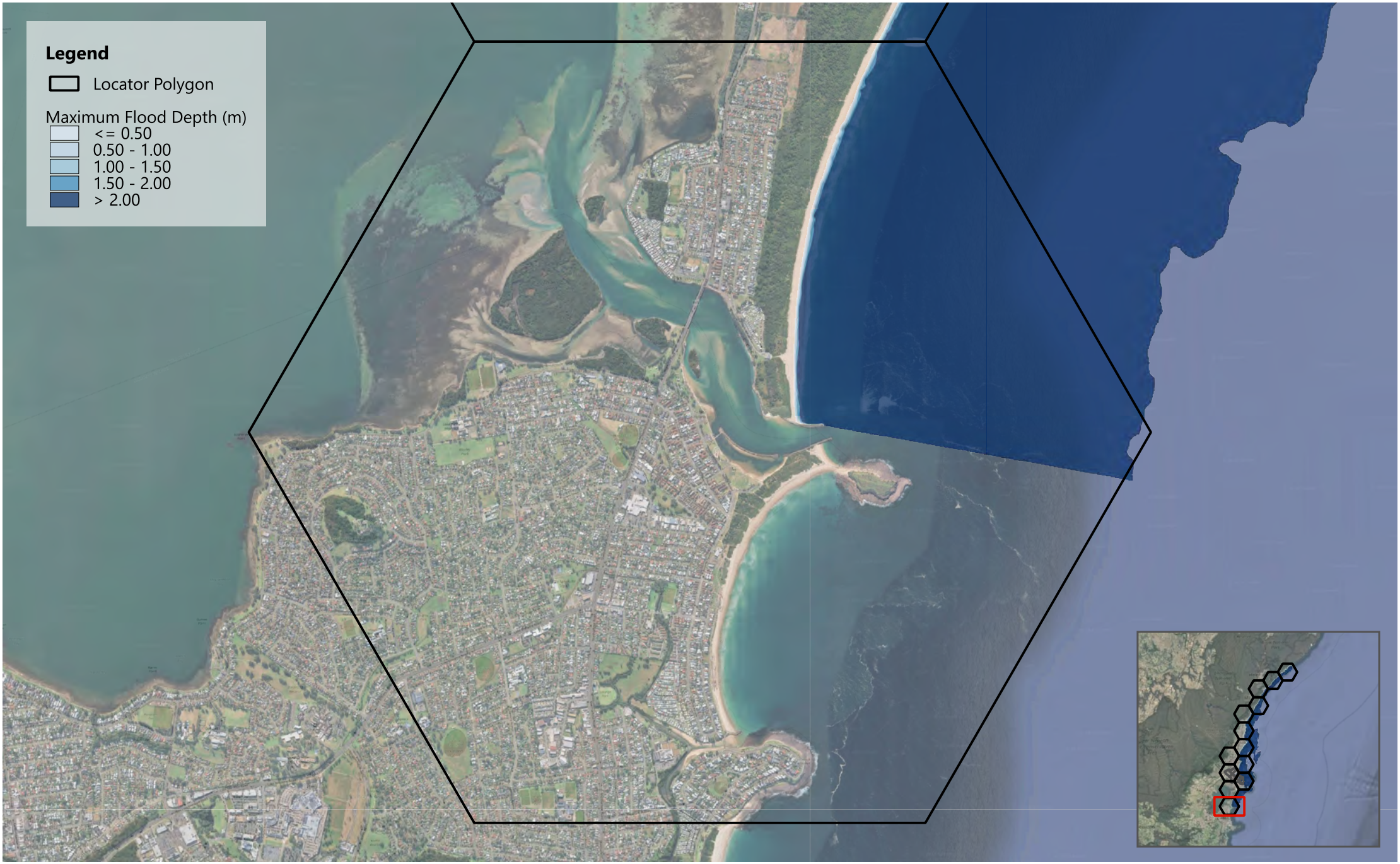
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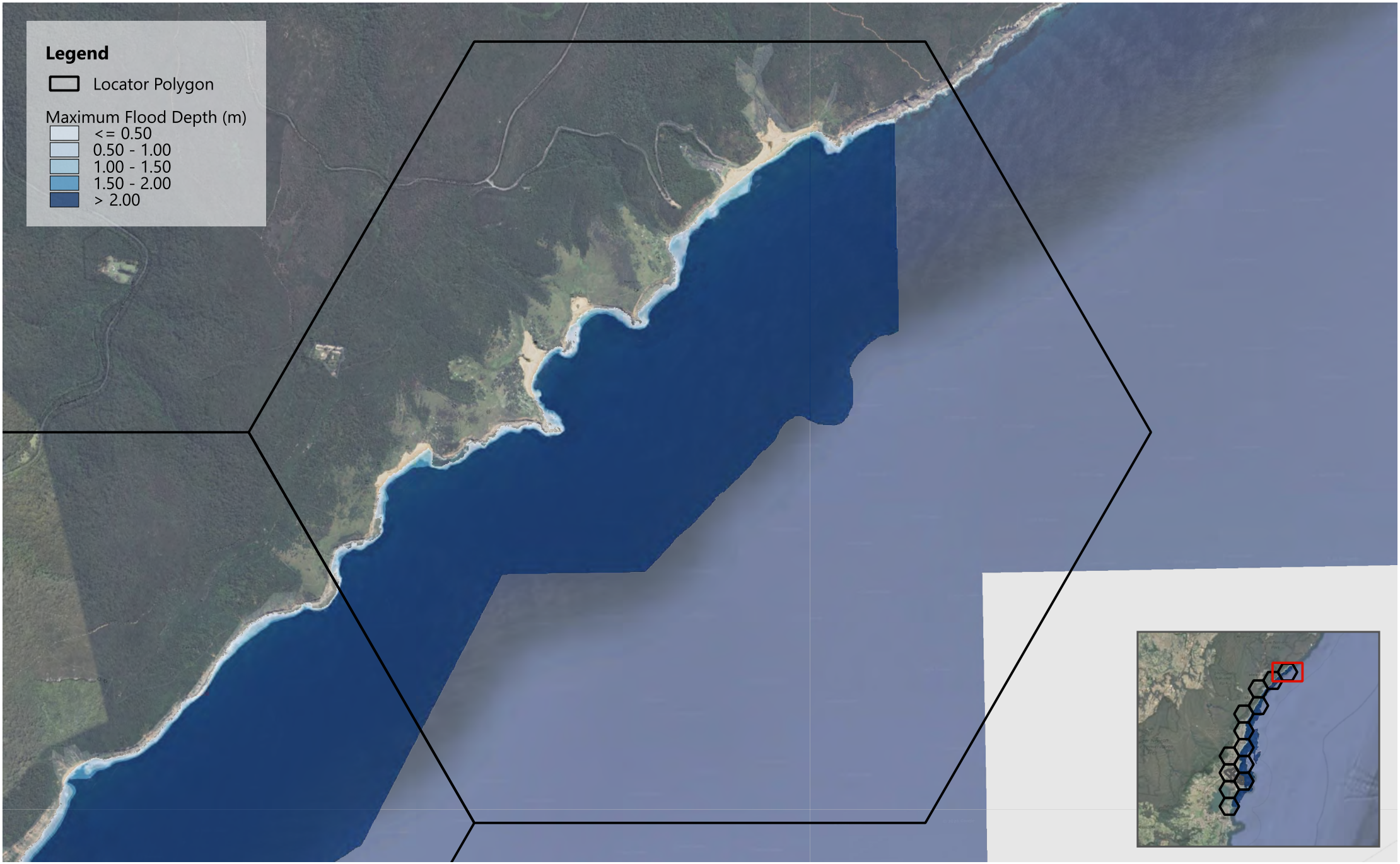
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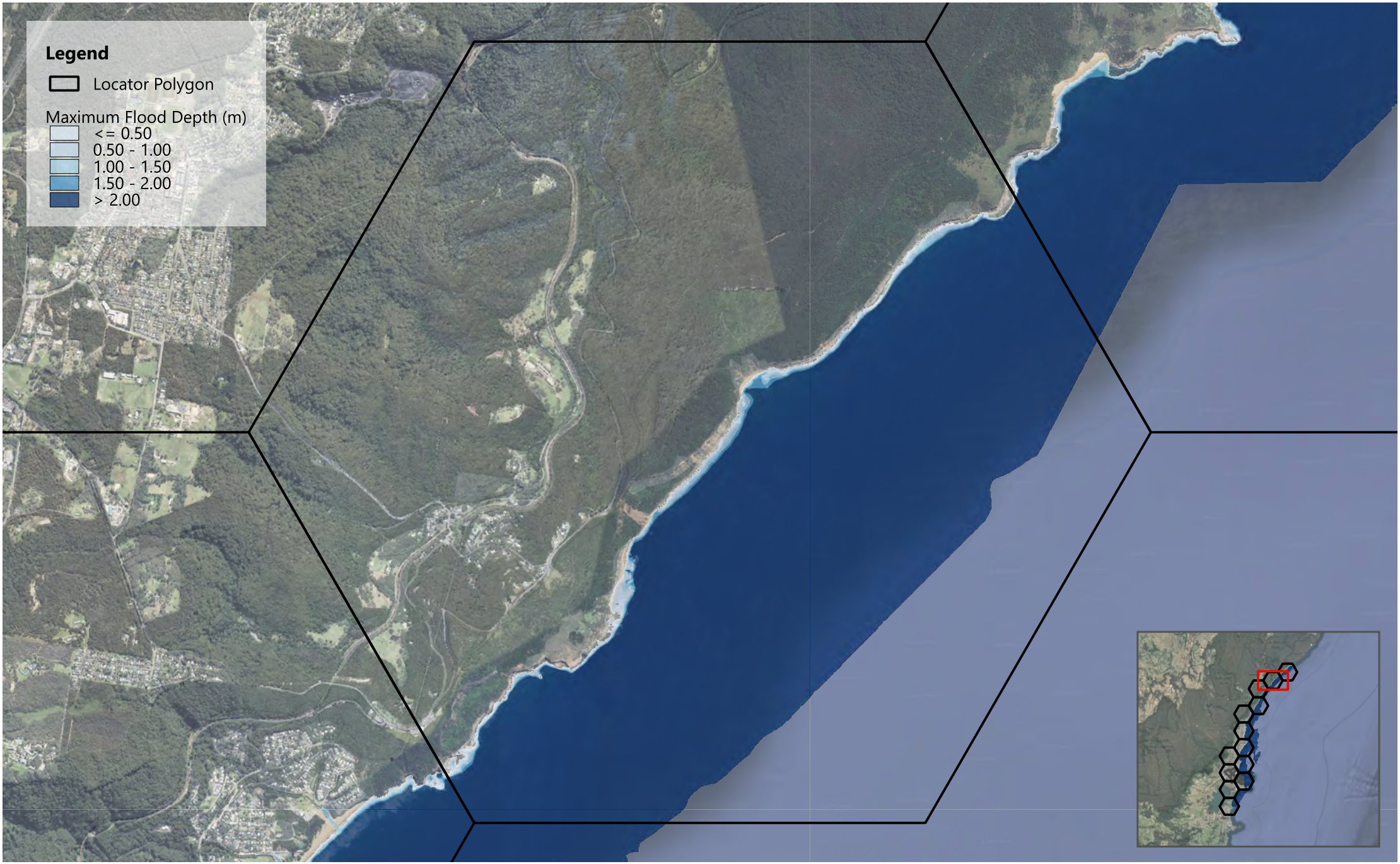
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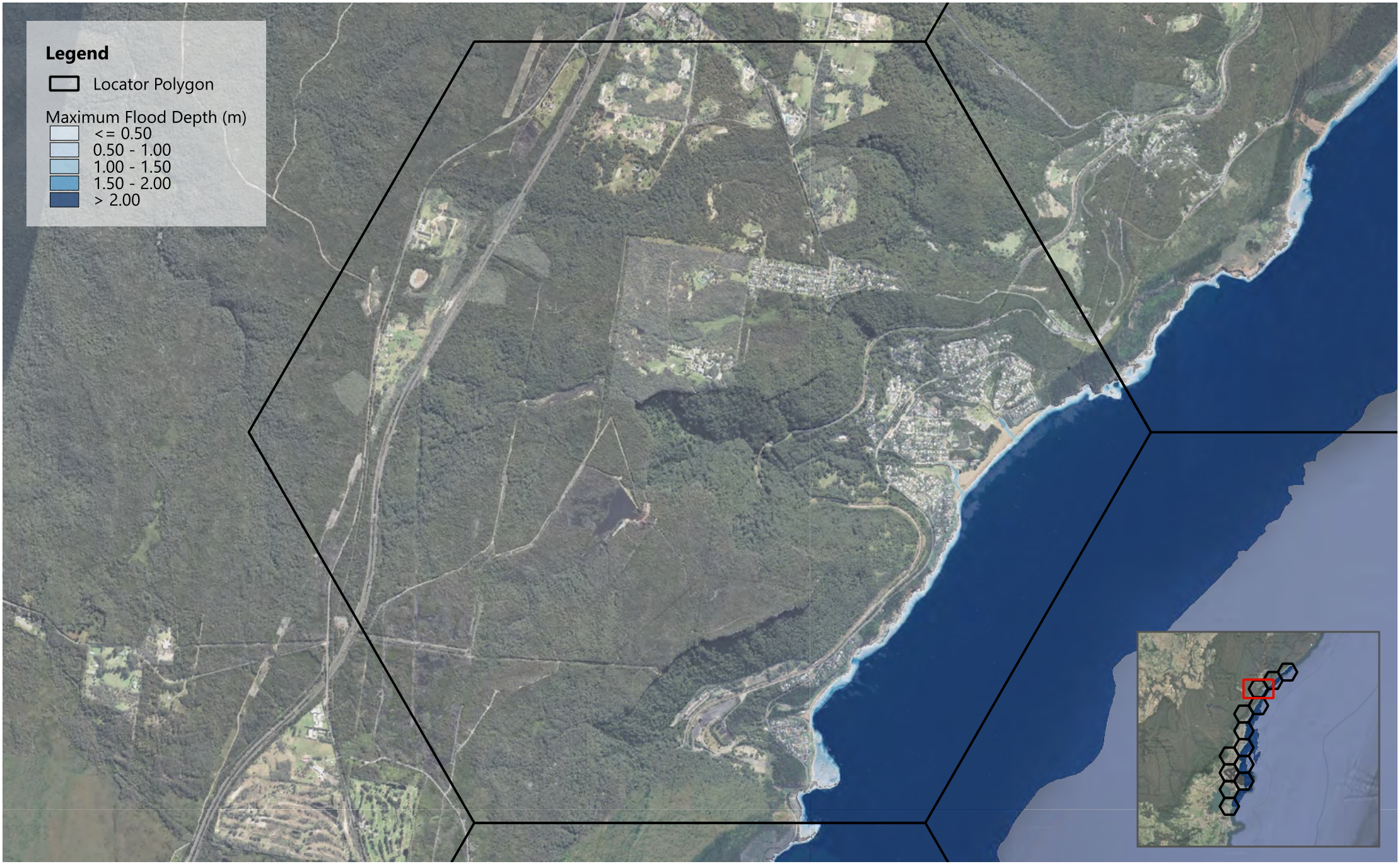
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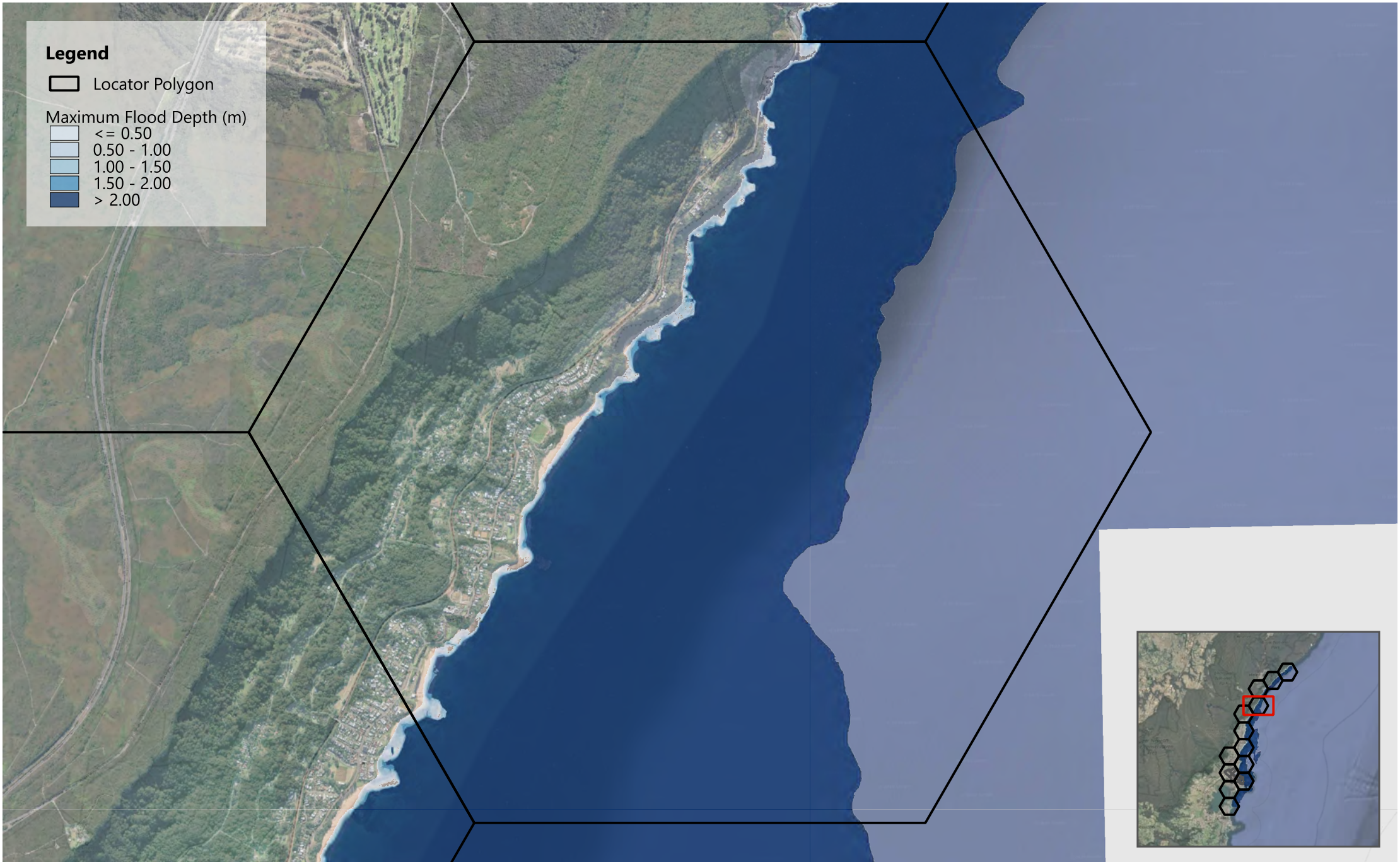
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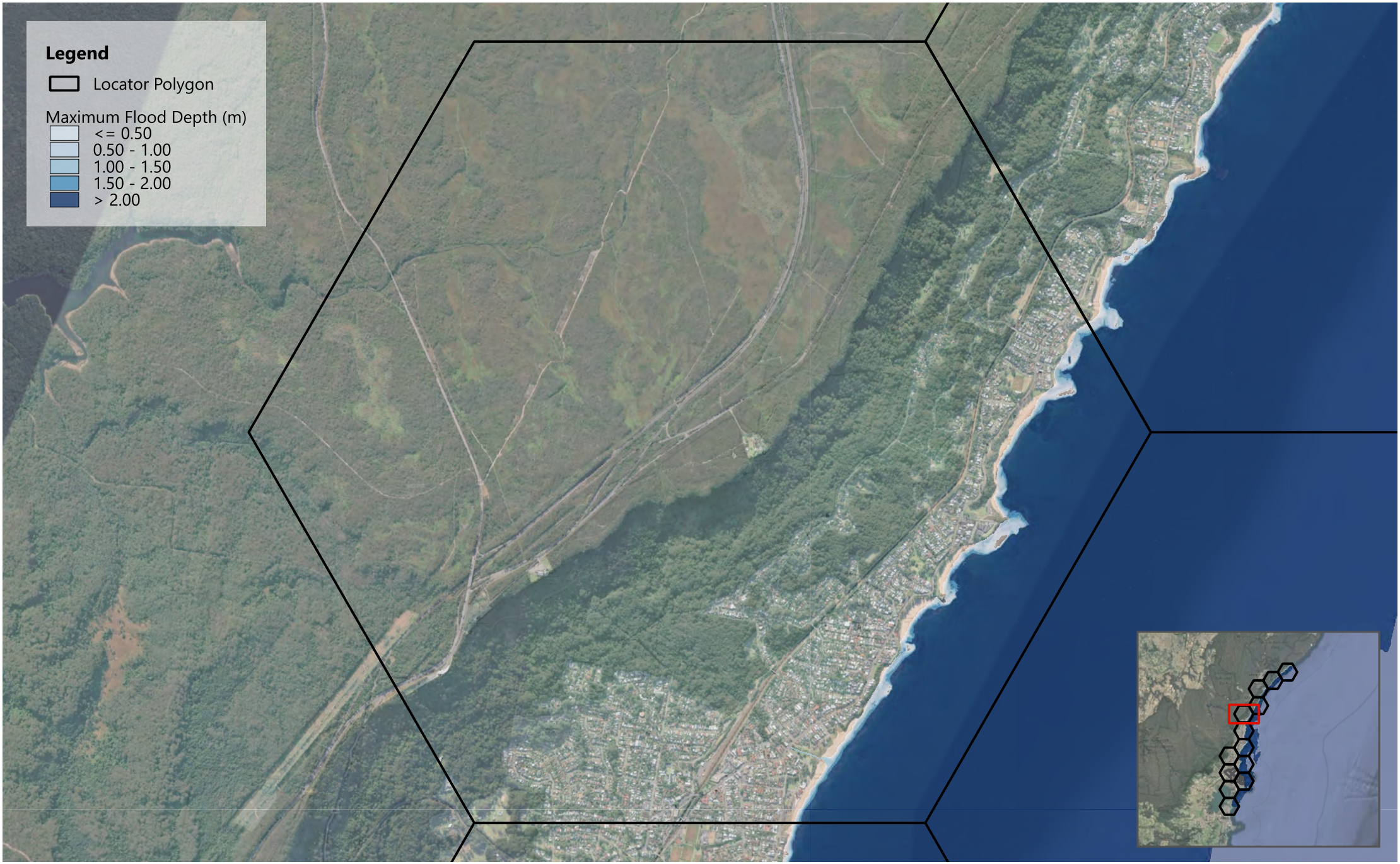
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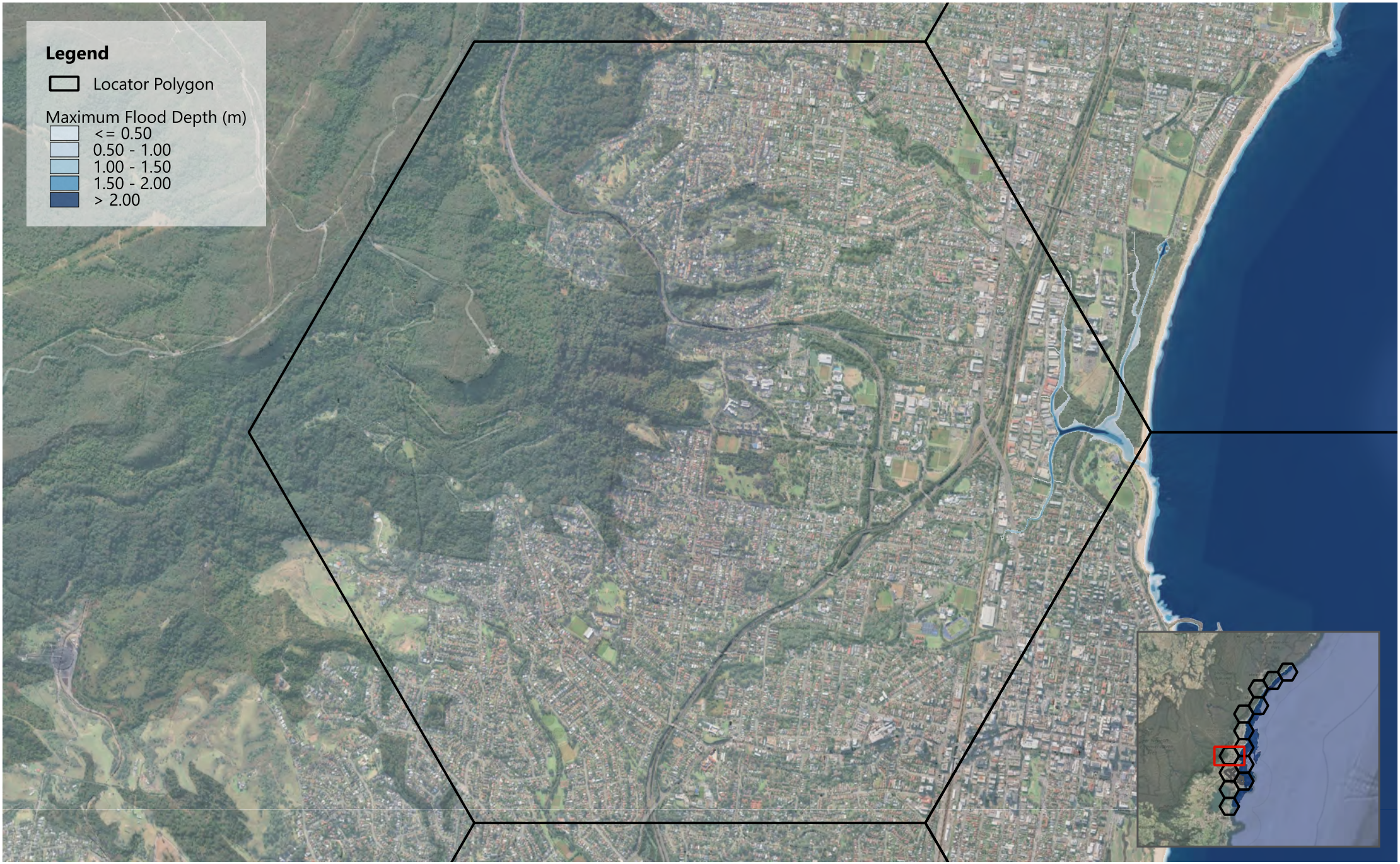
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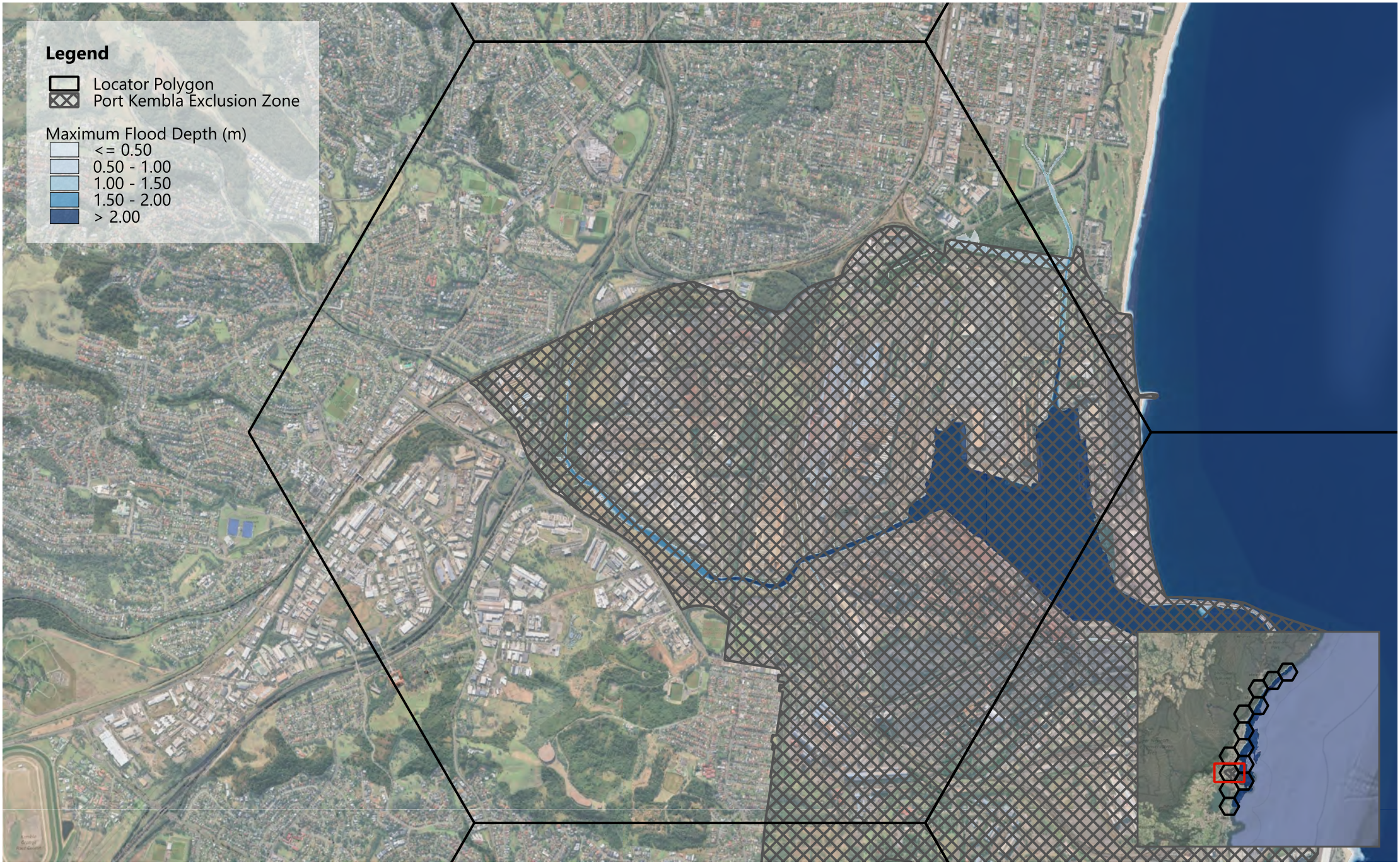
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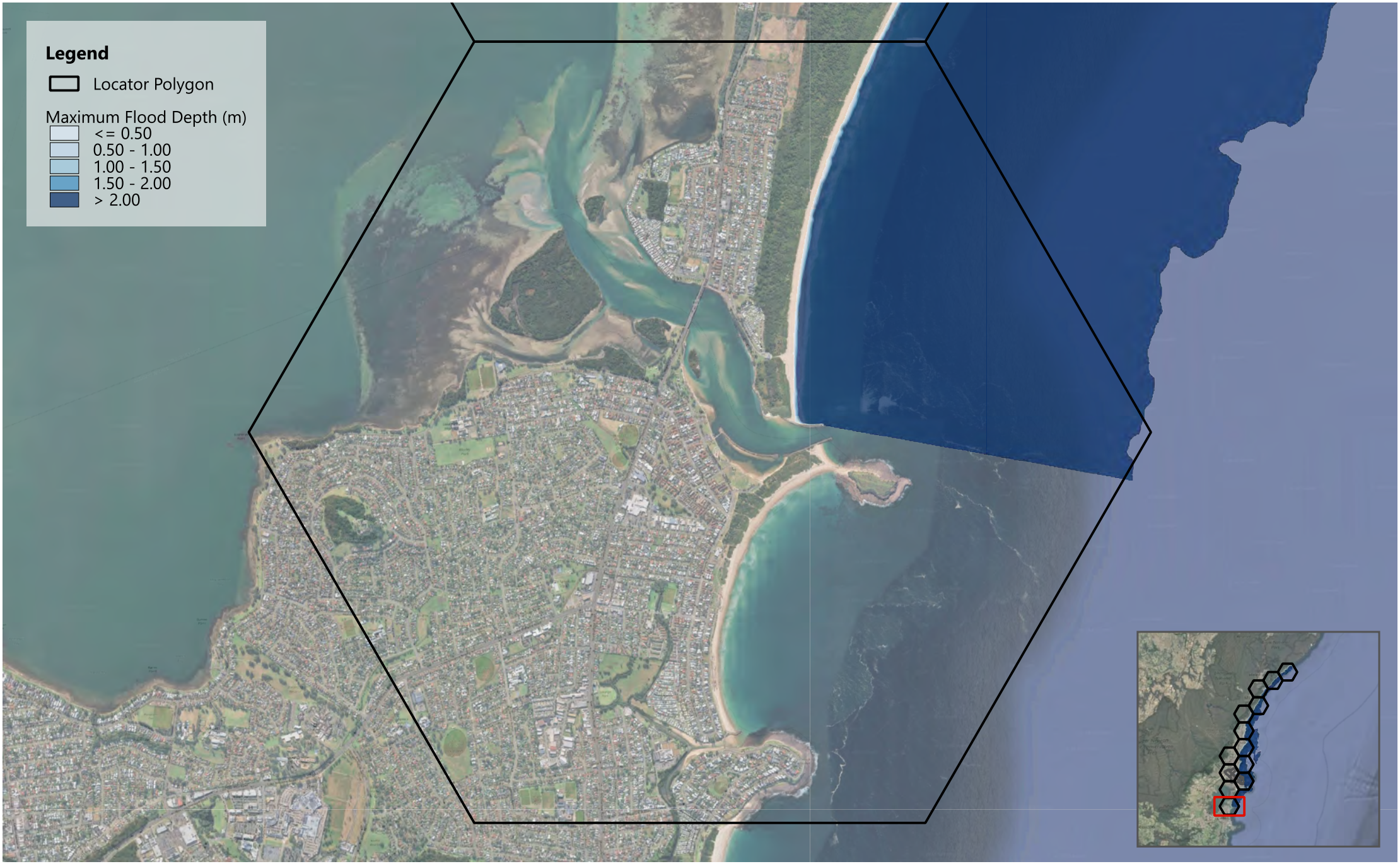
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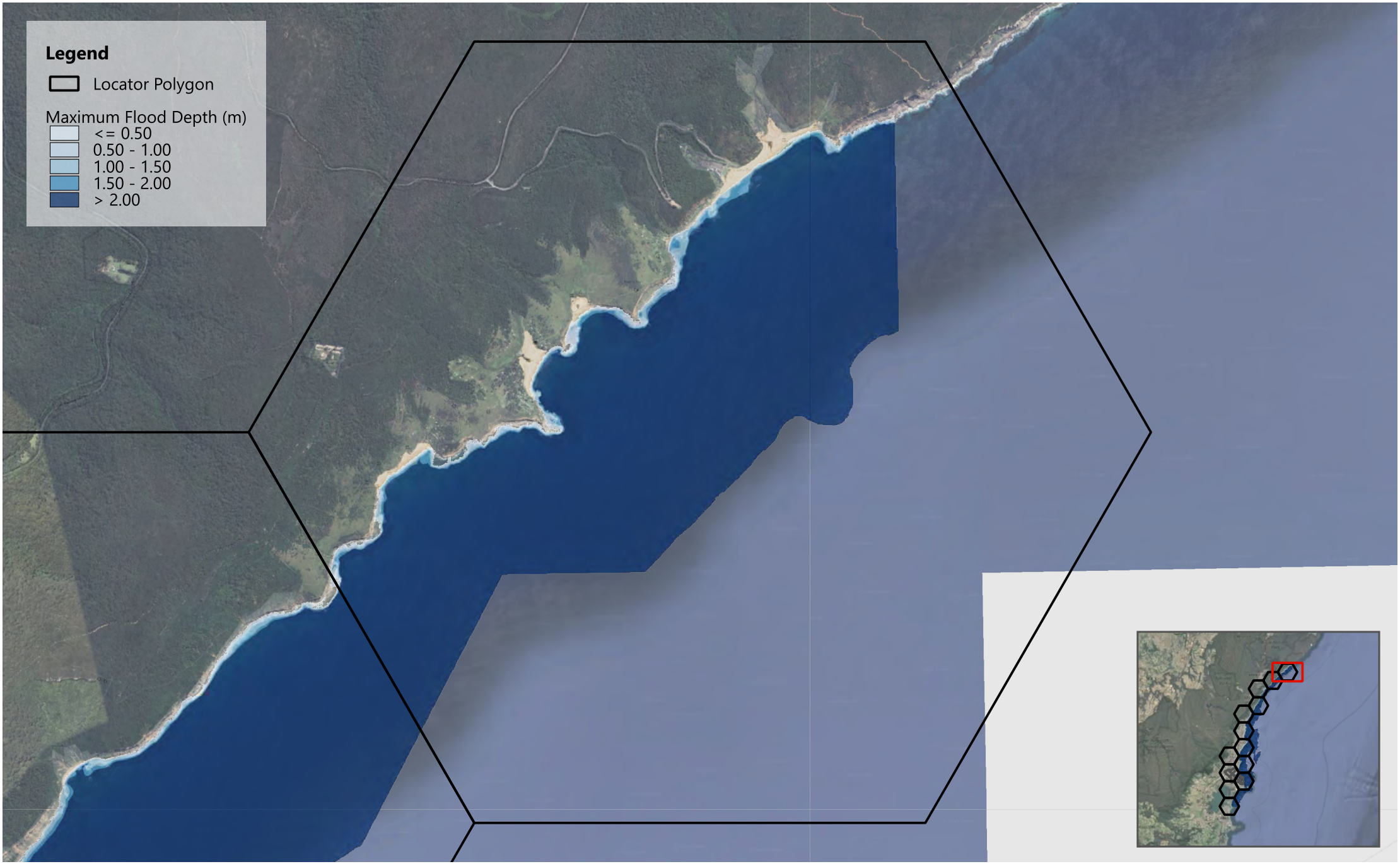
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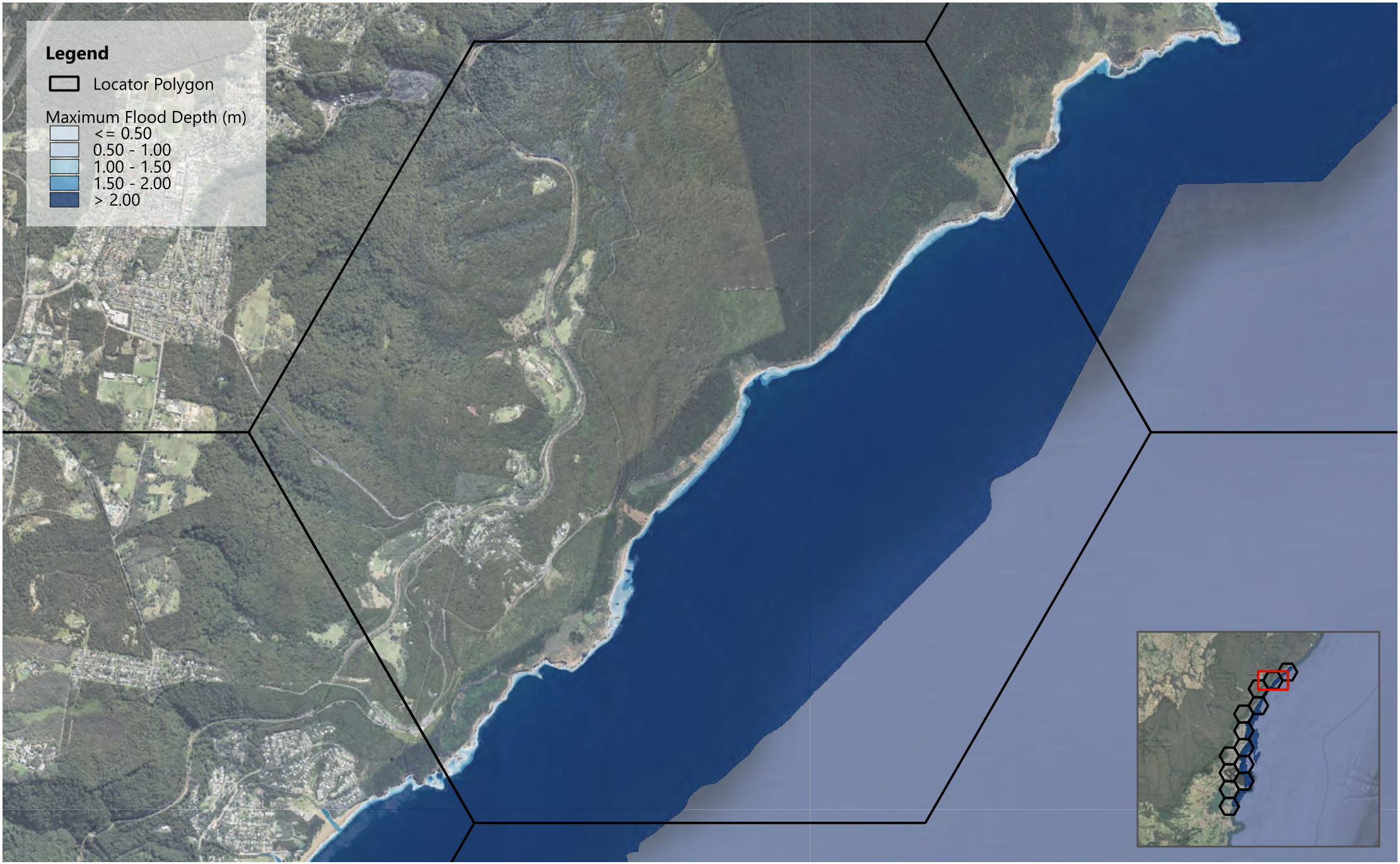
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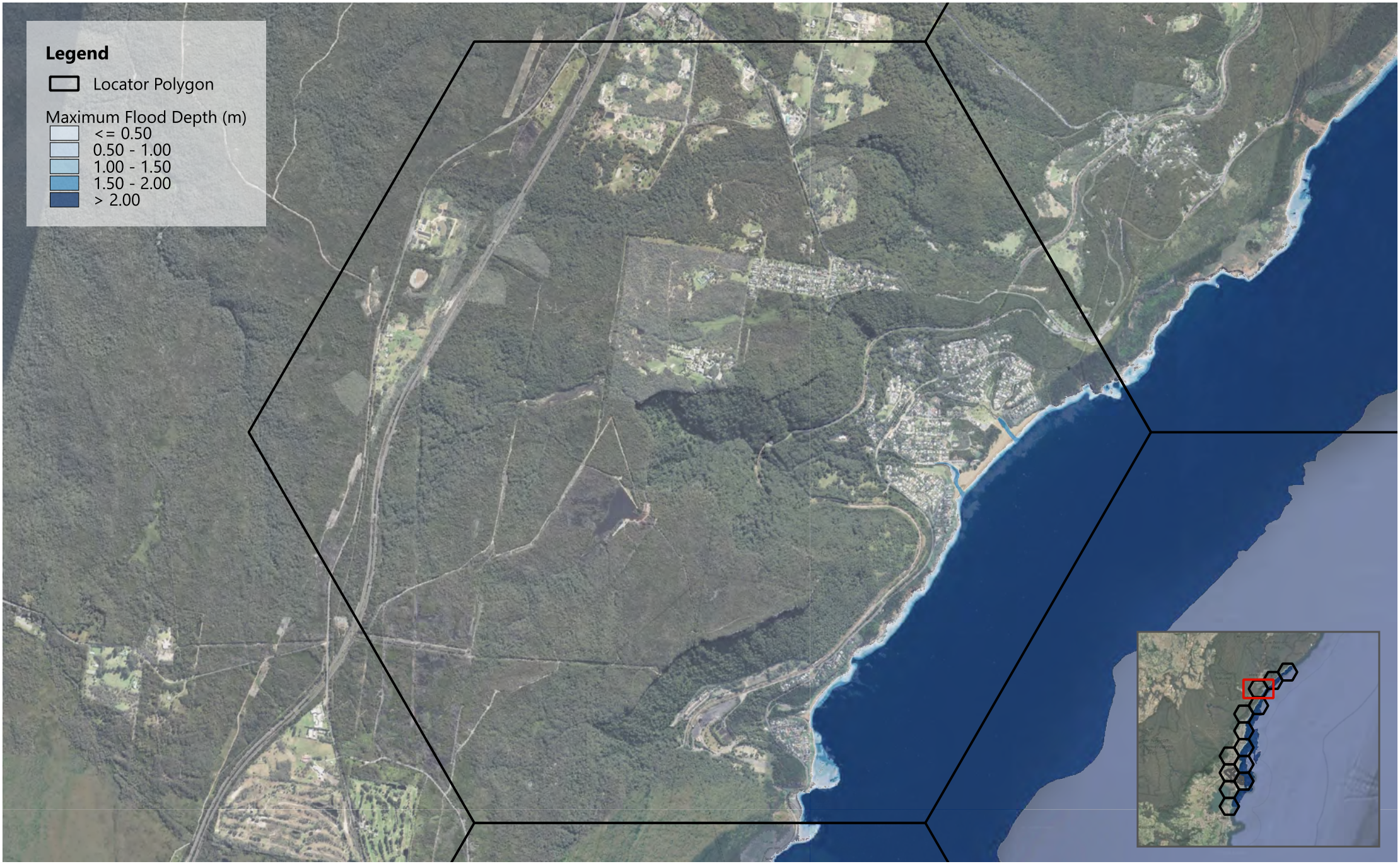
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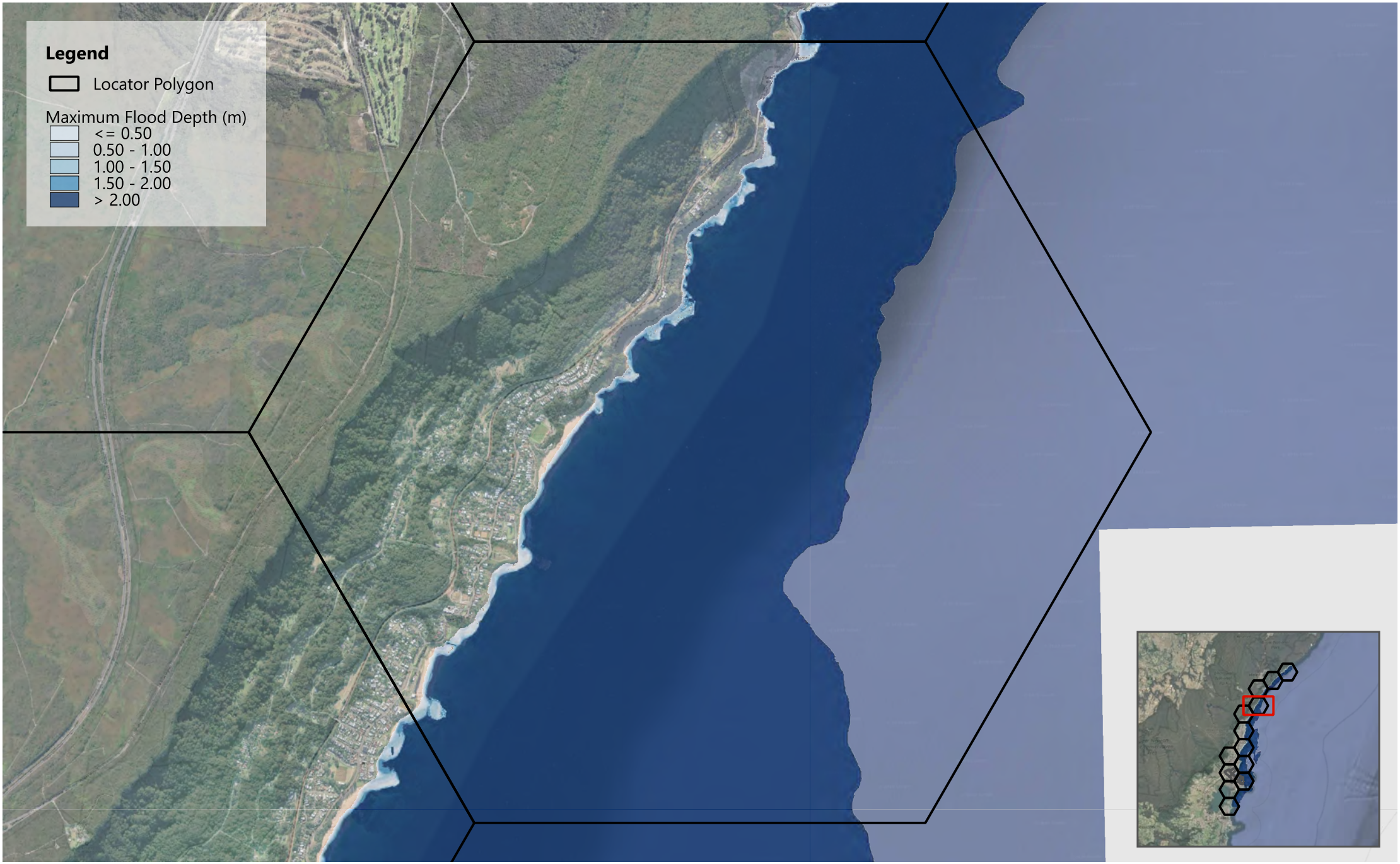
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Wollongong Coastal Hazard Study: Tidal Inundation Mapping HHWSS @ 1.8mAHD - 0.7m SLR Grid ID: 3

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Grid ID: 4

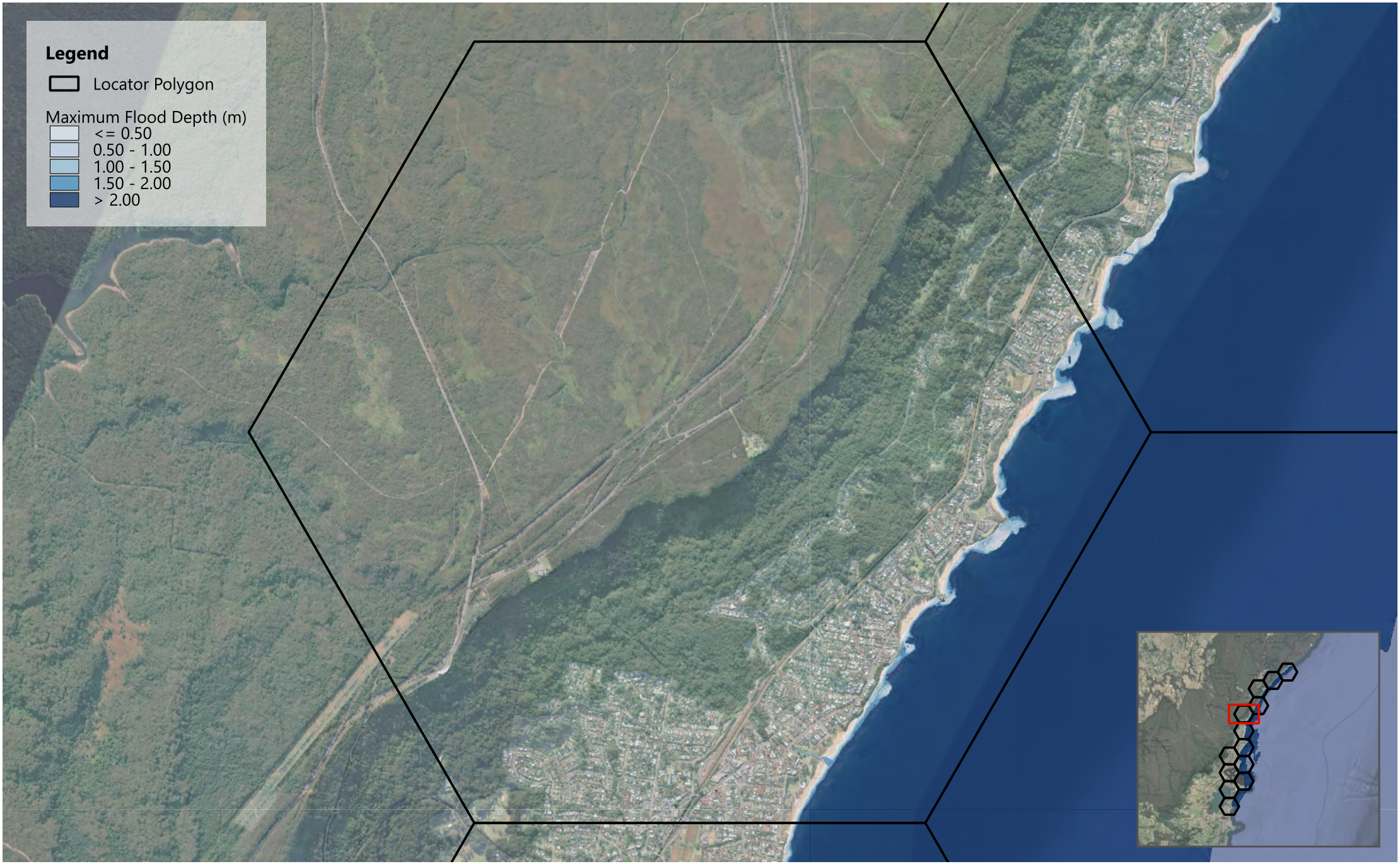
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Wollongong Coastal Hazard Study:
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HHWSS @ 1.8mAHD - 0.7m SLR
Grid ID: 5

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Map Scale

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Wollongong Coastal Hazard Study: Tidal Inundation Mapping HHWSS @ 1.8mAHD - 0.7m SLR Grid ID: 6

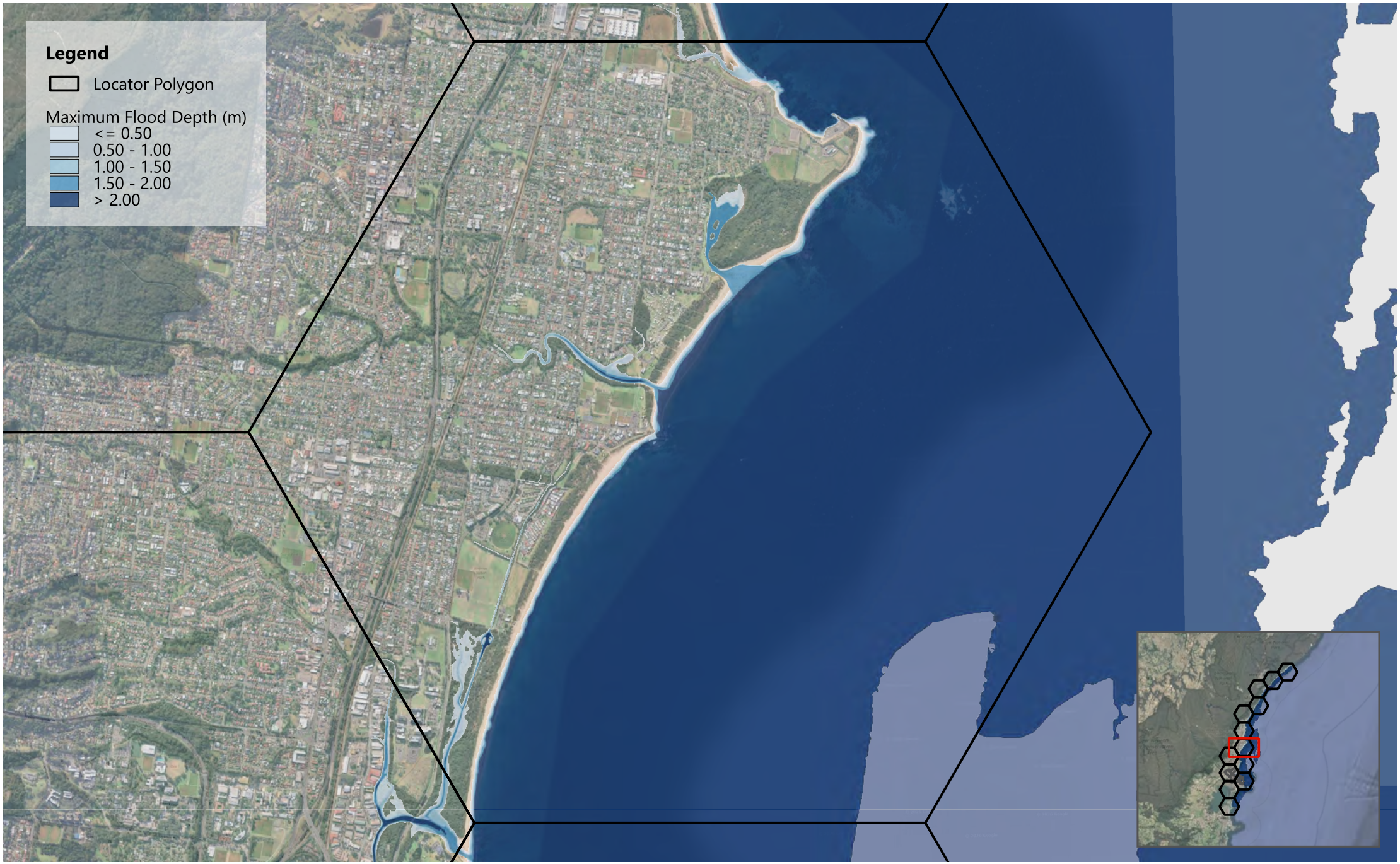
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Map Scale

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Wollongong Coastal Hazard Study:
Tidal Inundation Mapping
HHWSS @ 1.8mAHD - 0.7m SLR
Grid ID: 9

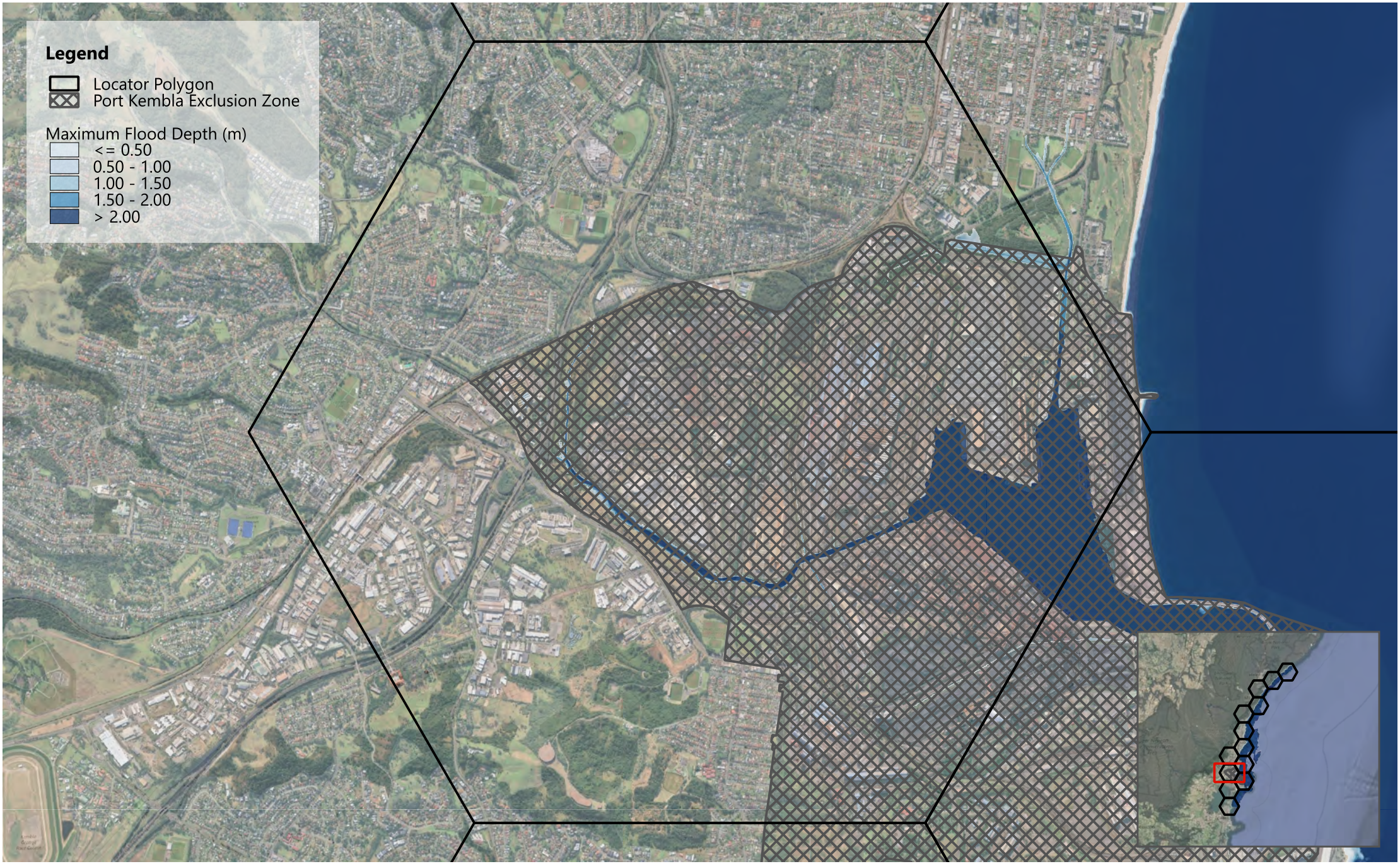
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Wollongong Coastal Hazard Study: Tidal Inundation Mapping HHWSS @ 1.8mAHD - 0.7m SLR Grid ID: 10

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Wollongong Coastal Hazard Study:
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Wollongong Coastal Hazard Study: Tidal Inundation Mapping HHWSS @ 1.8mAHD - 0.7m SLR Grid ID: 12

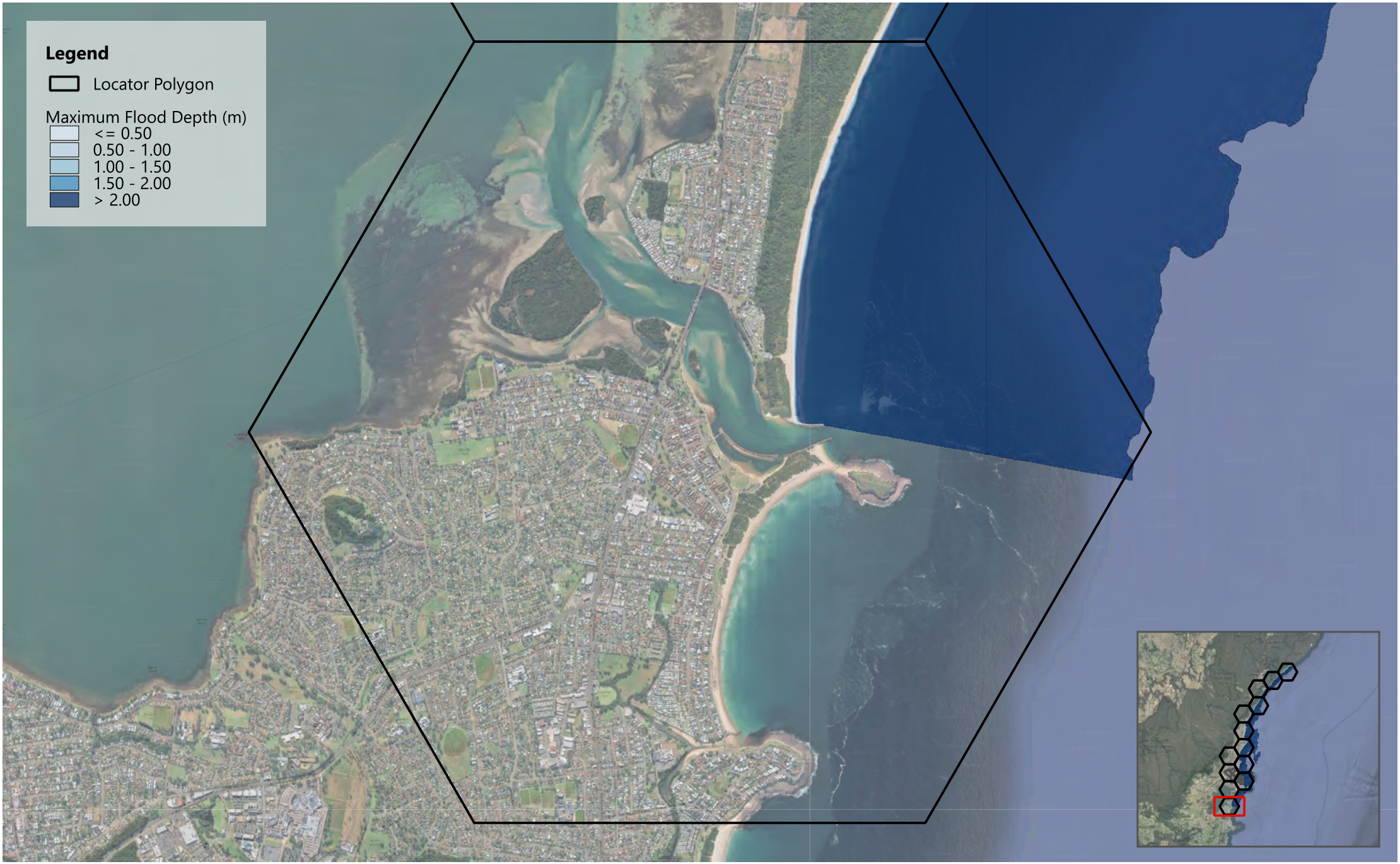
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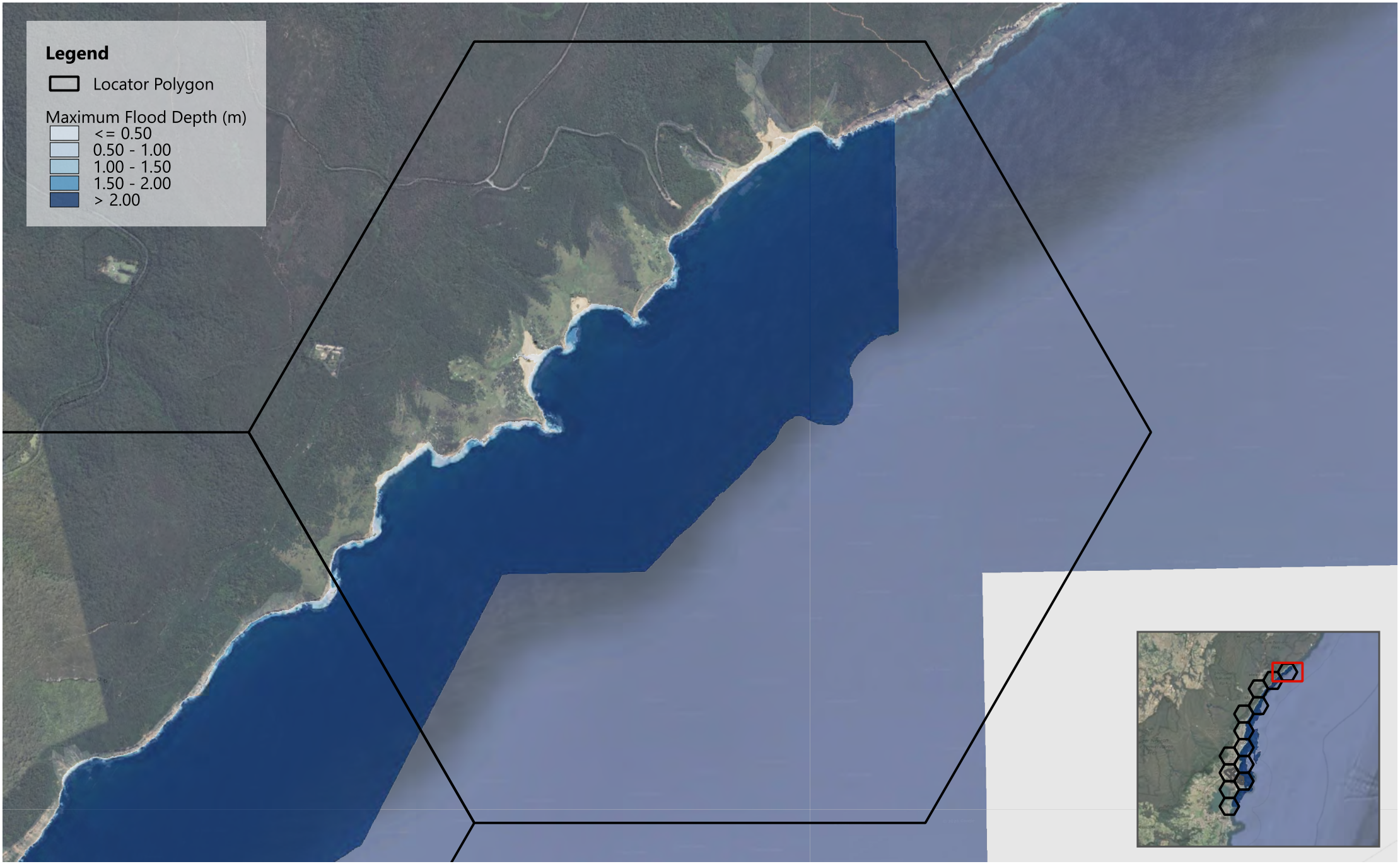
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Wollongong Coastal Hazard Study: Tidal Inundation Mapping HHWSS @ 2.9mAHD - 1.8m SLR Grid ID: 1

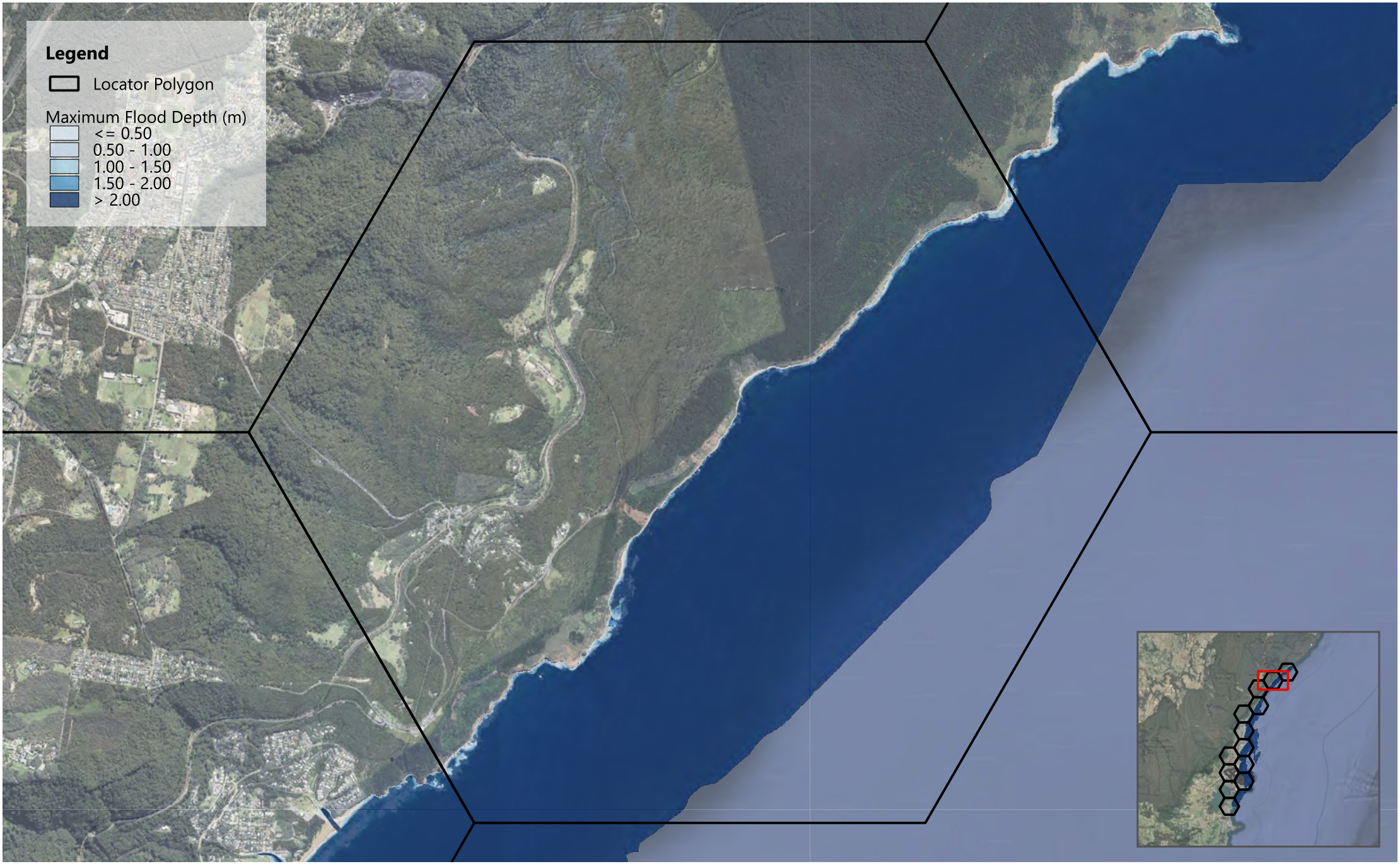
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Wollongong Coastal Hazard Study:
Tidal Inundation Mapping
HHWSS @ 2.9mAHD - 1.8m SLR
Grid ID: 2

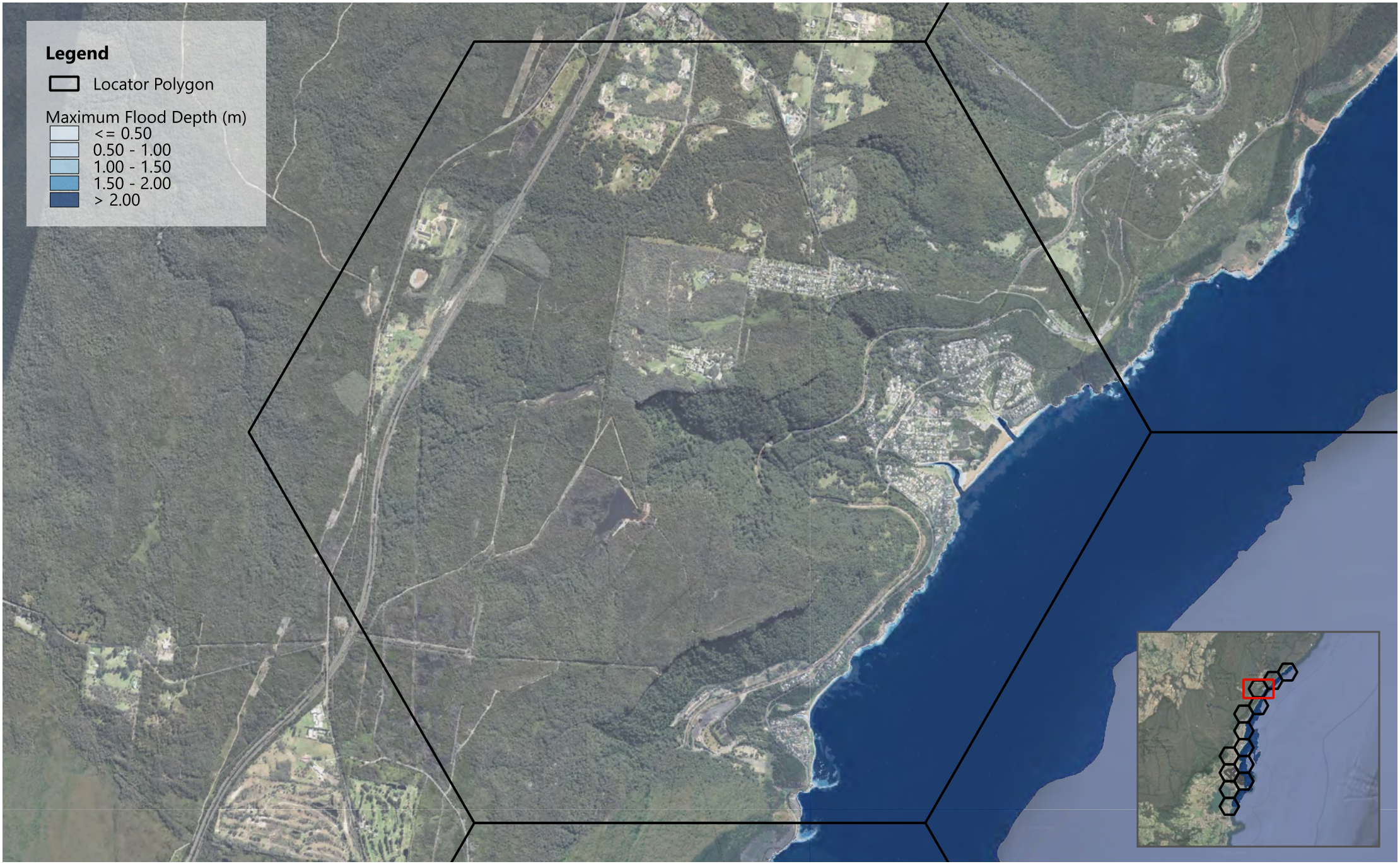
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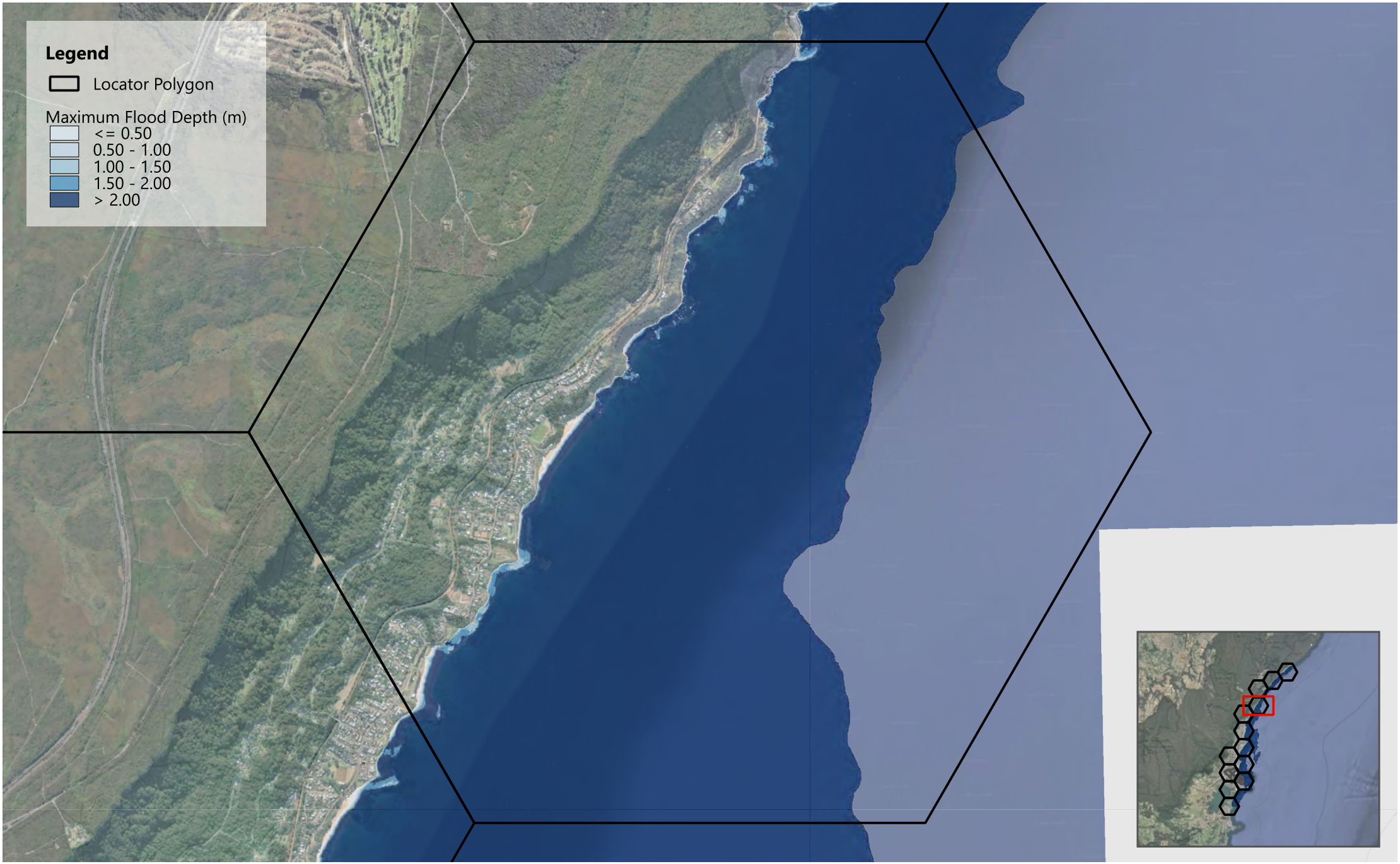
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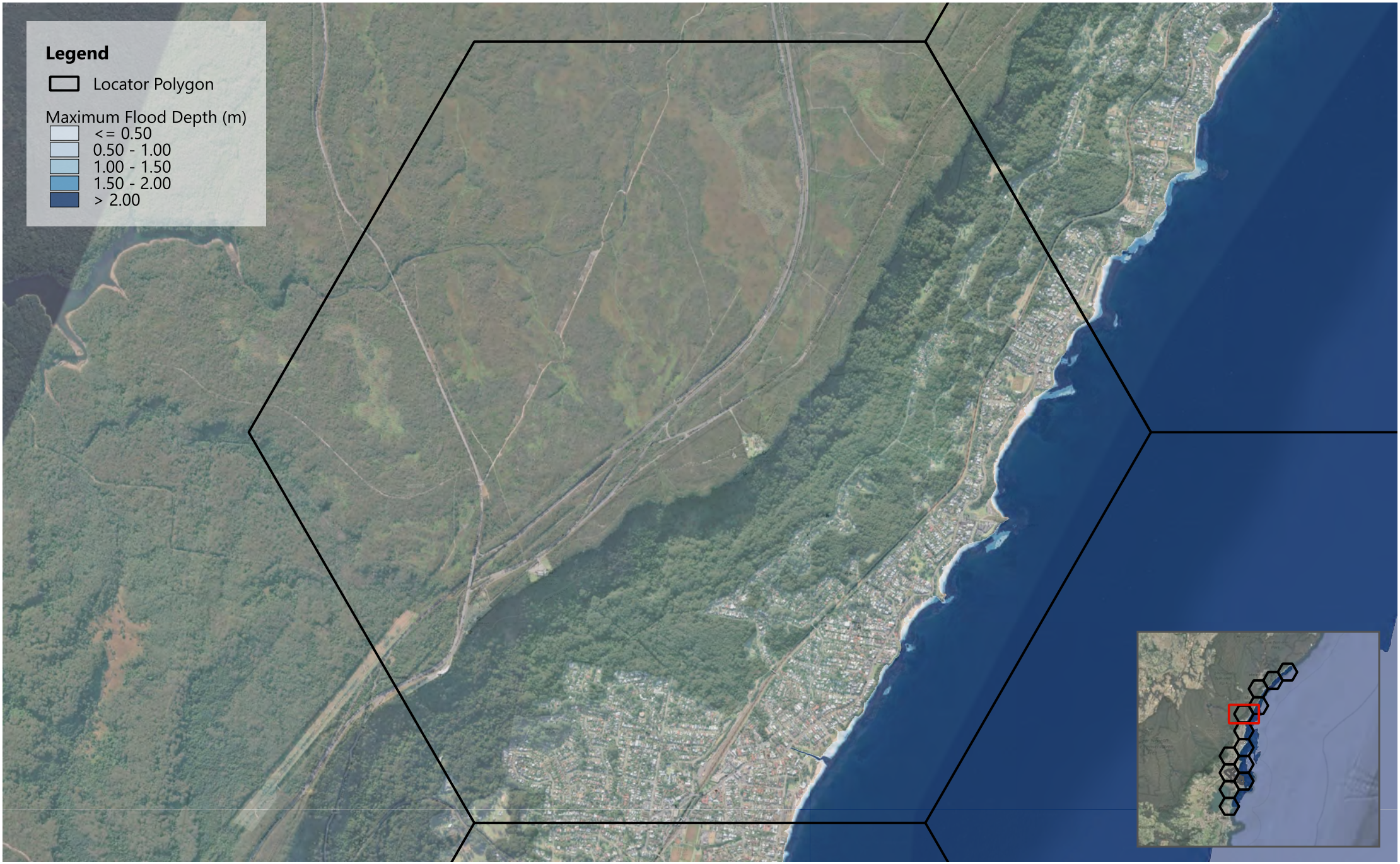
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Wollongong Coastal Hazard Study:
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Wollongong Coastal Hazard Study: Tidal Inundation Mapping HHWSS @ 2.9mAHD - 1.8m SLR Grid ID: 5

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Wollongong Coastal Hazard Study: Tidal Inundation Mapping HHWSS @ 2.9mAHD - 1.8m SLR Grid ID: 6

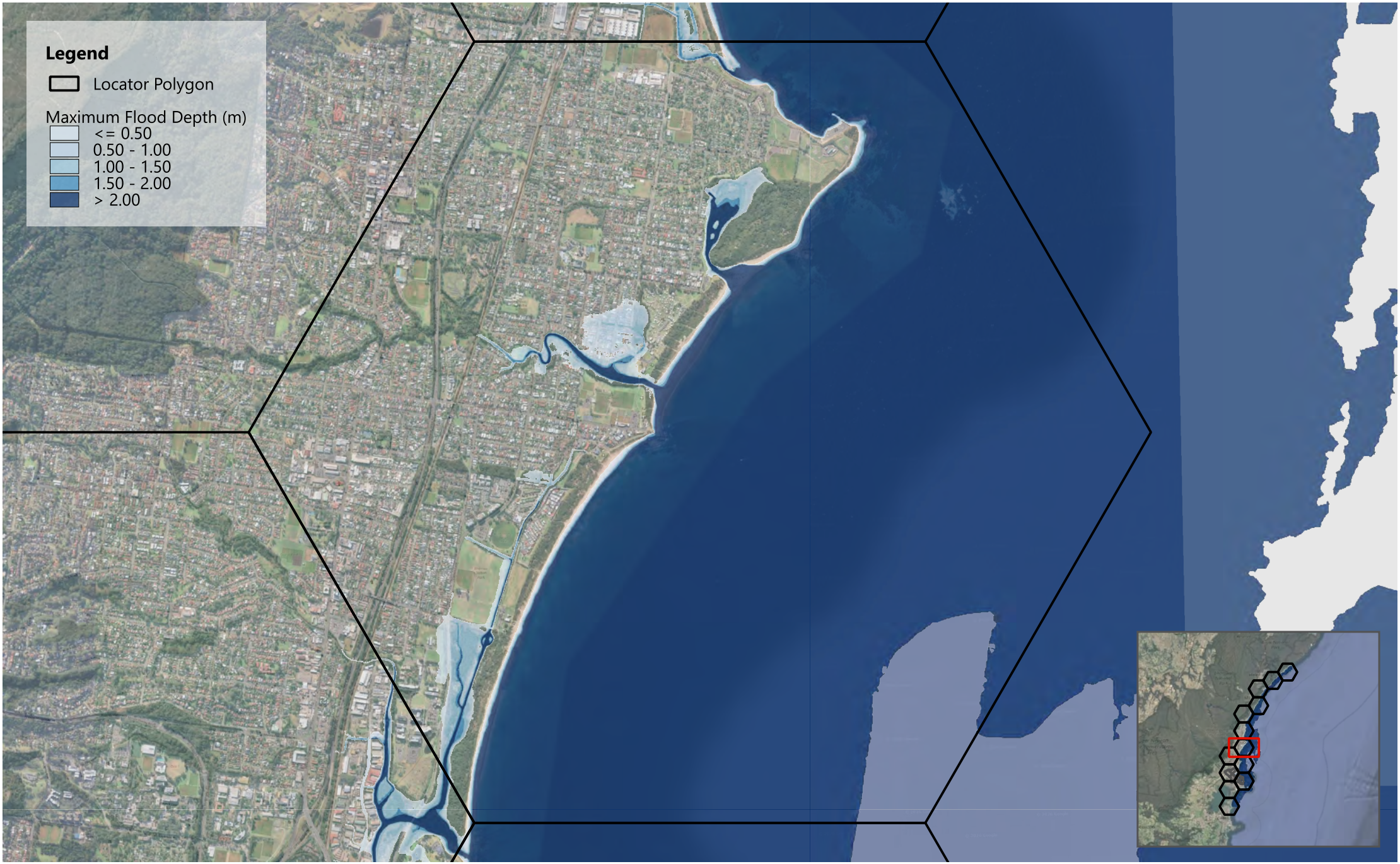
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Wollongong Coastal Hazard Study: Tidal Inundation Mapping HHWSS @ 2.9mAHD - 1.8m SLR Grid ID: 7

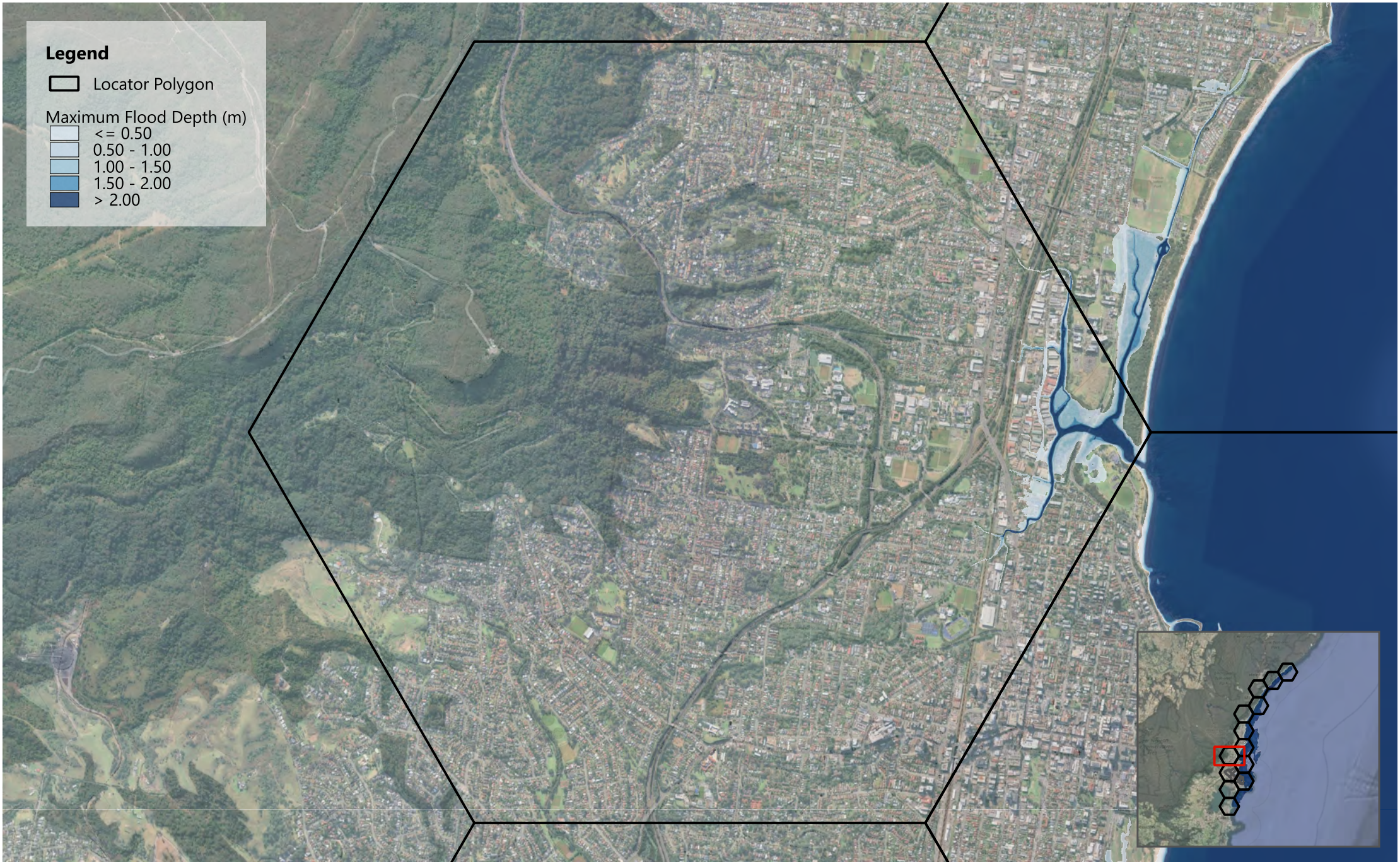
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Wollongong Coastal Hazard Study:
Tidal Inundation Mapping
HHWSS @ 2.9mAHD - 1.8m SLR
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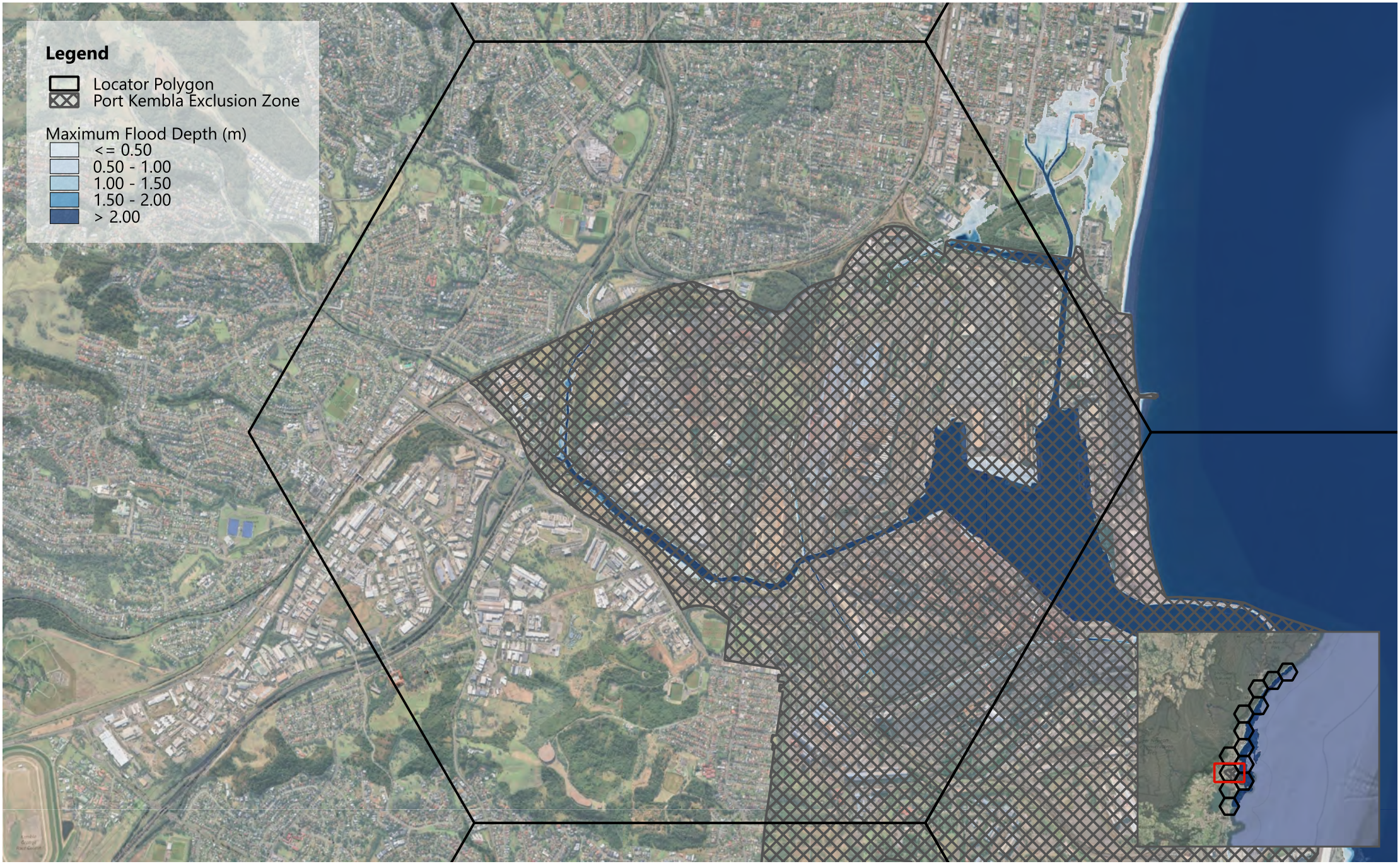
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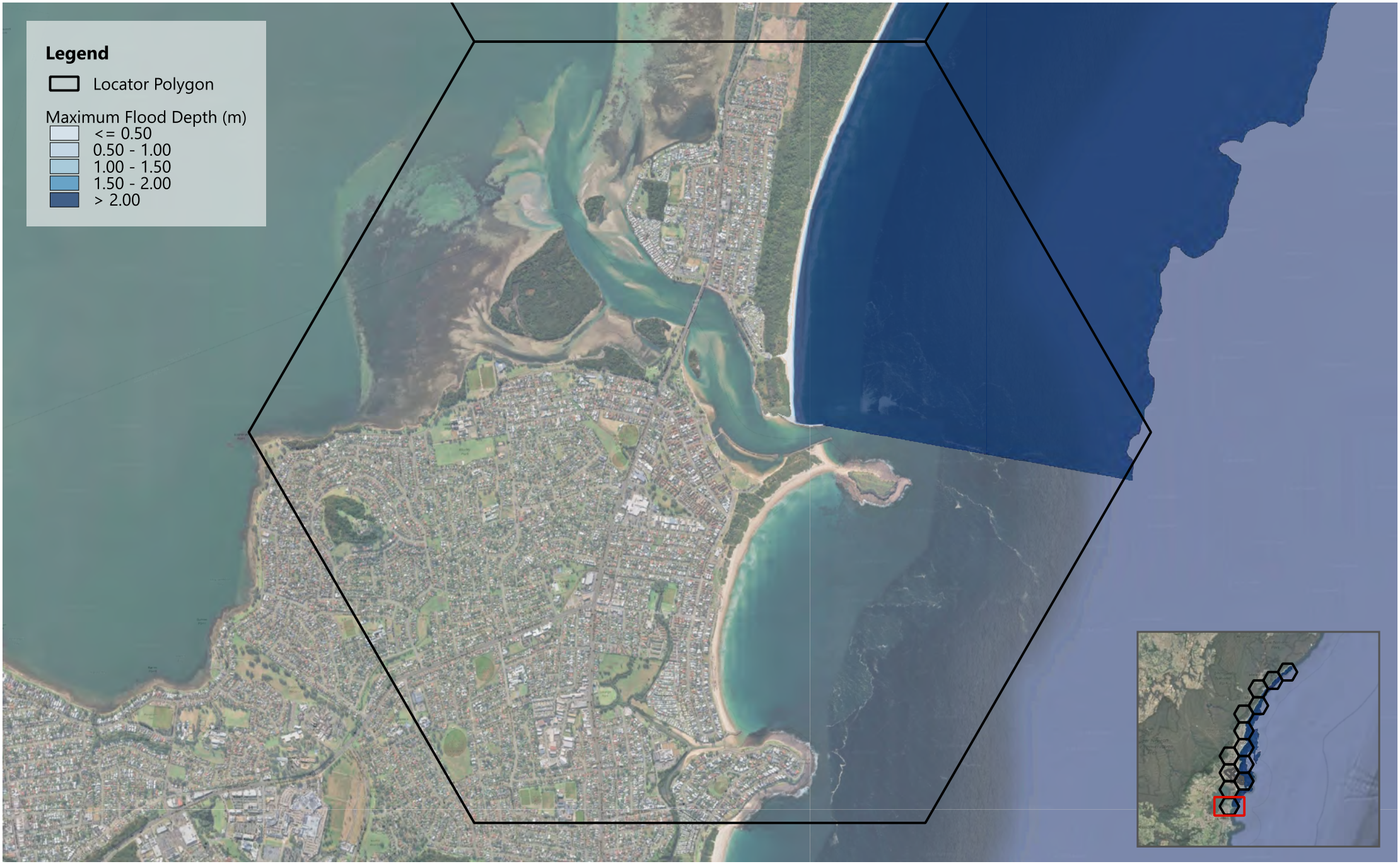
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Map Scale

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Wollongong Coastal Hazard Study: Tidal Inundation Mapping HHWSS @ 2.9mAHD - 1.8m SLR Grid ID: 13

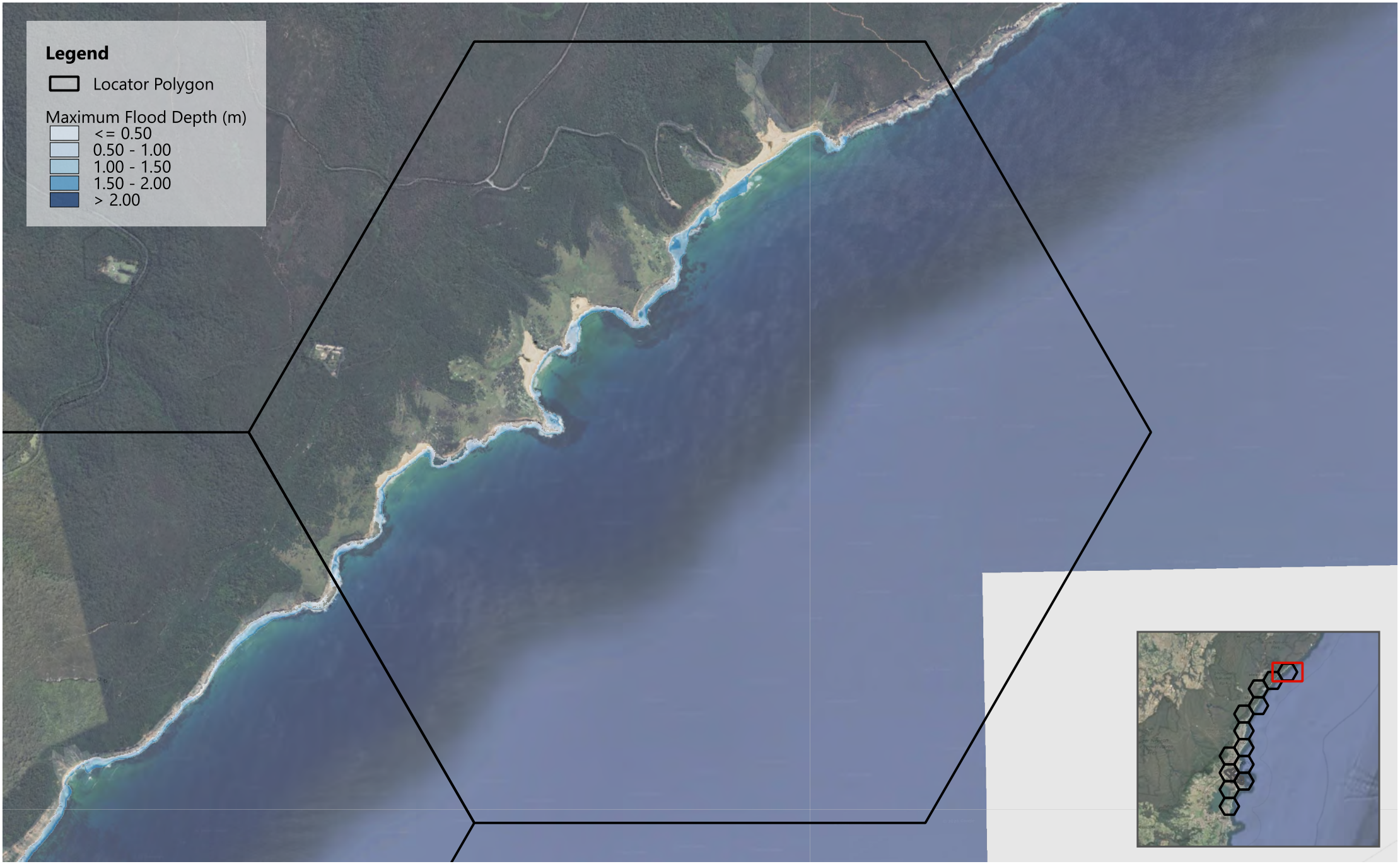
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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2025 - 5% AEP - Present Day Grid ID: 1

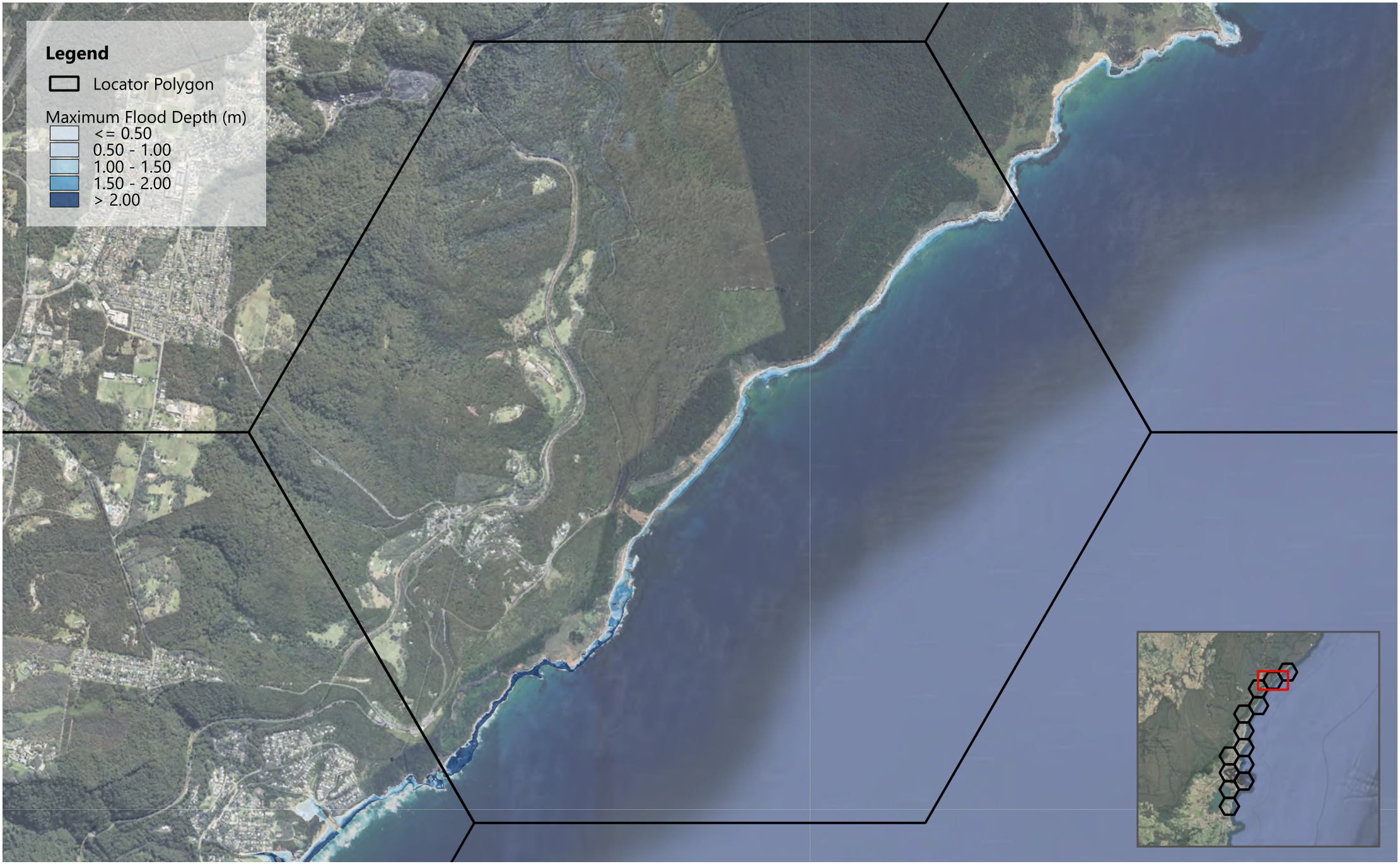
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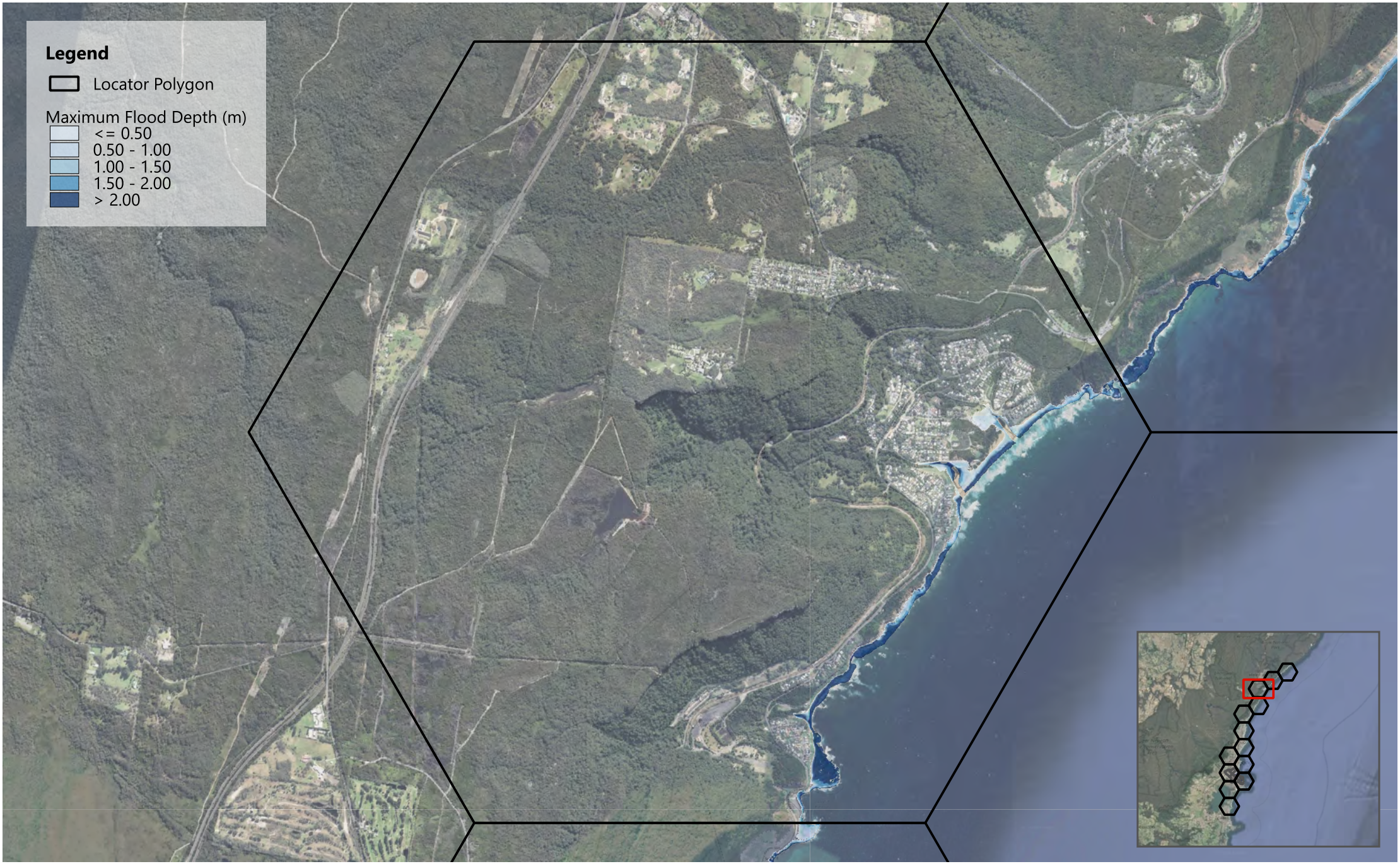
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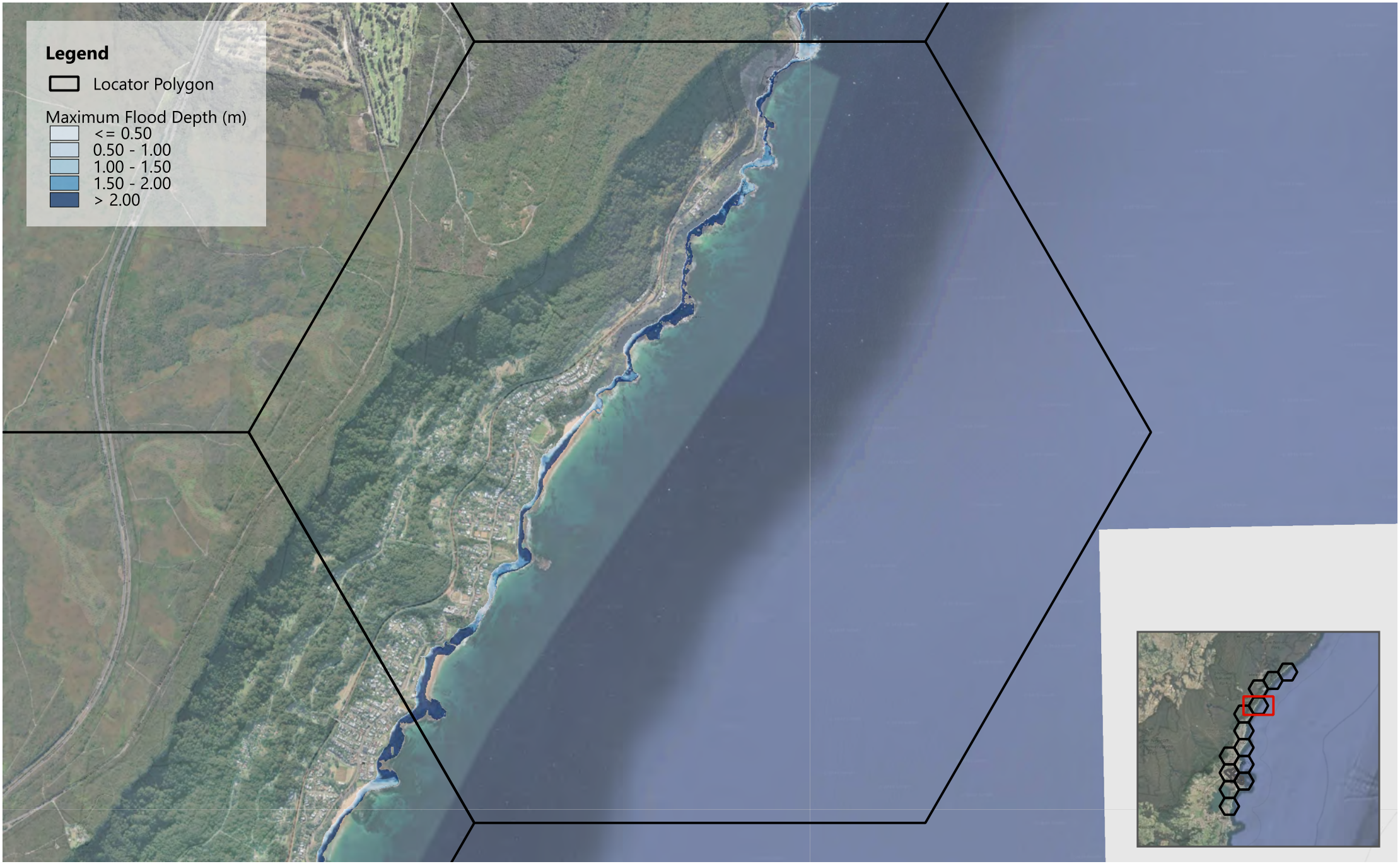
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Coastal Inundation Mapping
2025 - 5% AEP - Present Day
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Coastal Inundation Mapping
2025 - 5% AEP - Present Day
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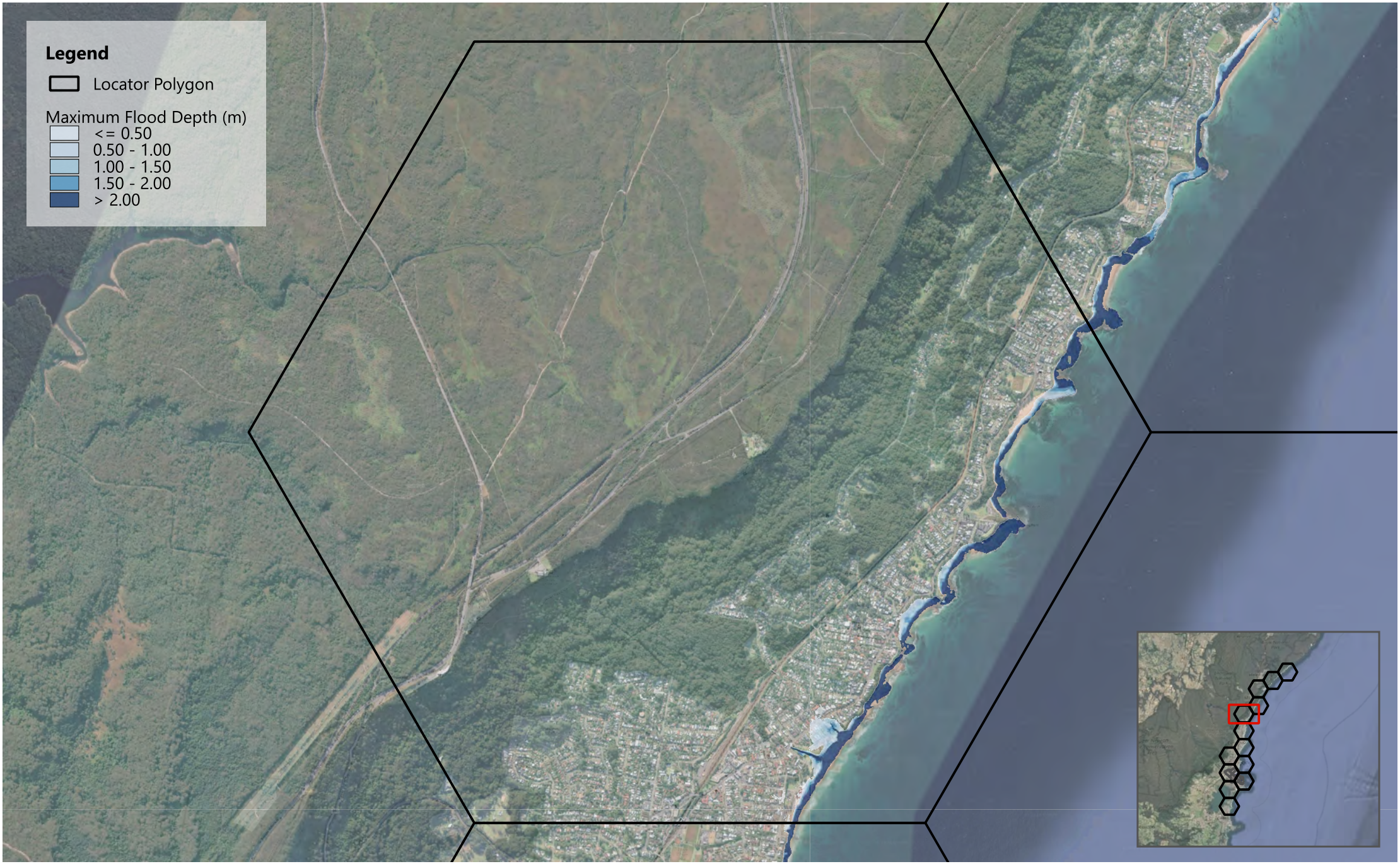
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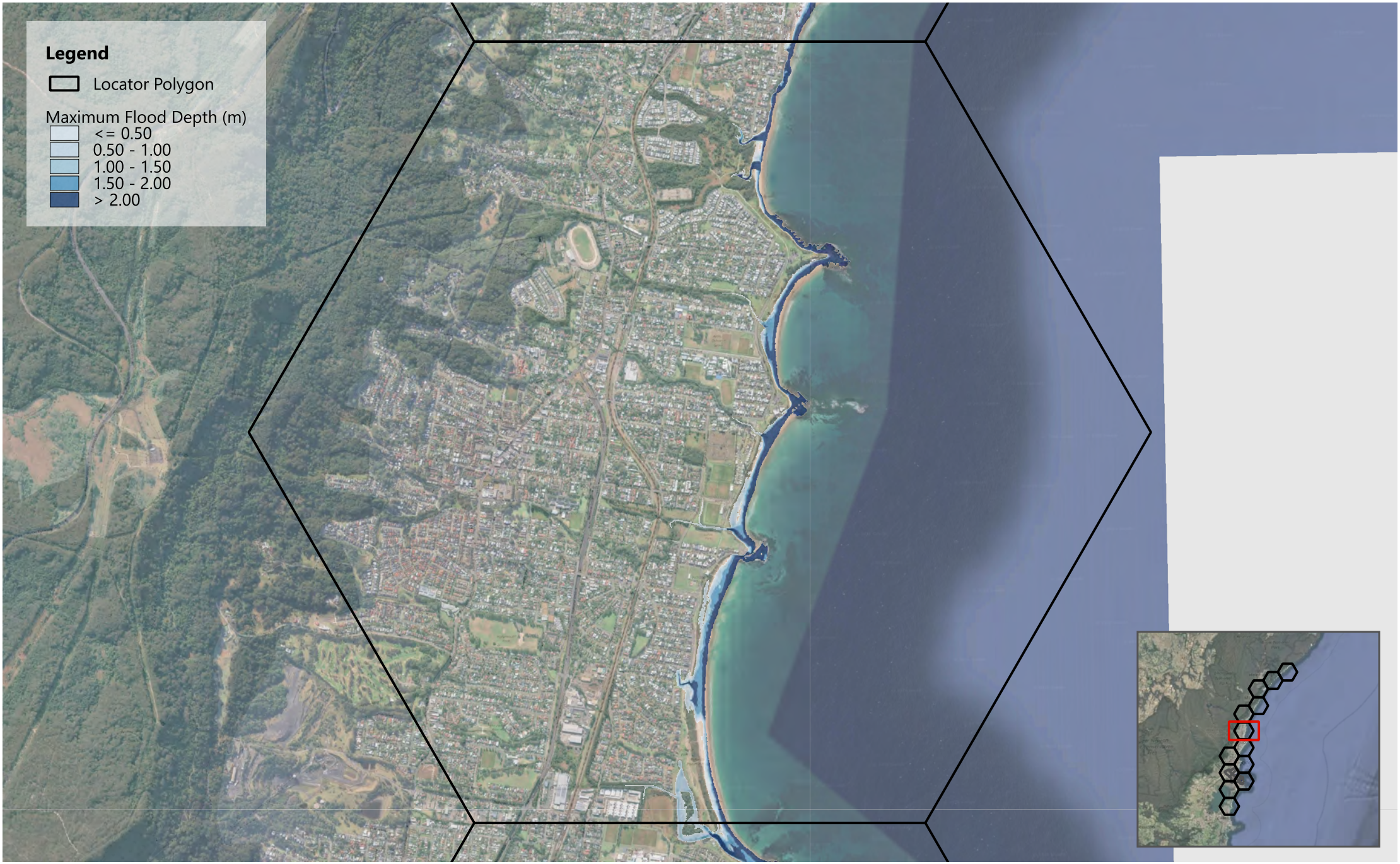
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Wollongong Coastal Hazard Study:
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Map Scale

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Wollongong Coastal Hazard Study:
Coastal Inundation Mapping
2025 - 5% AEP - Present Day
Grid ID: 6

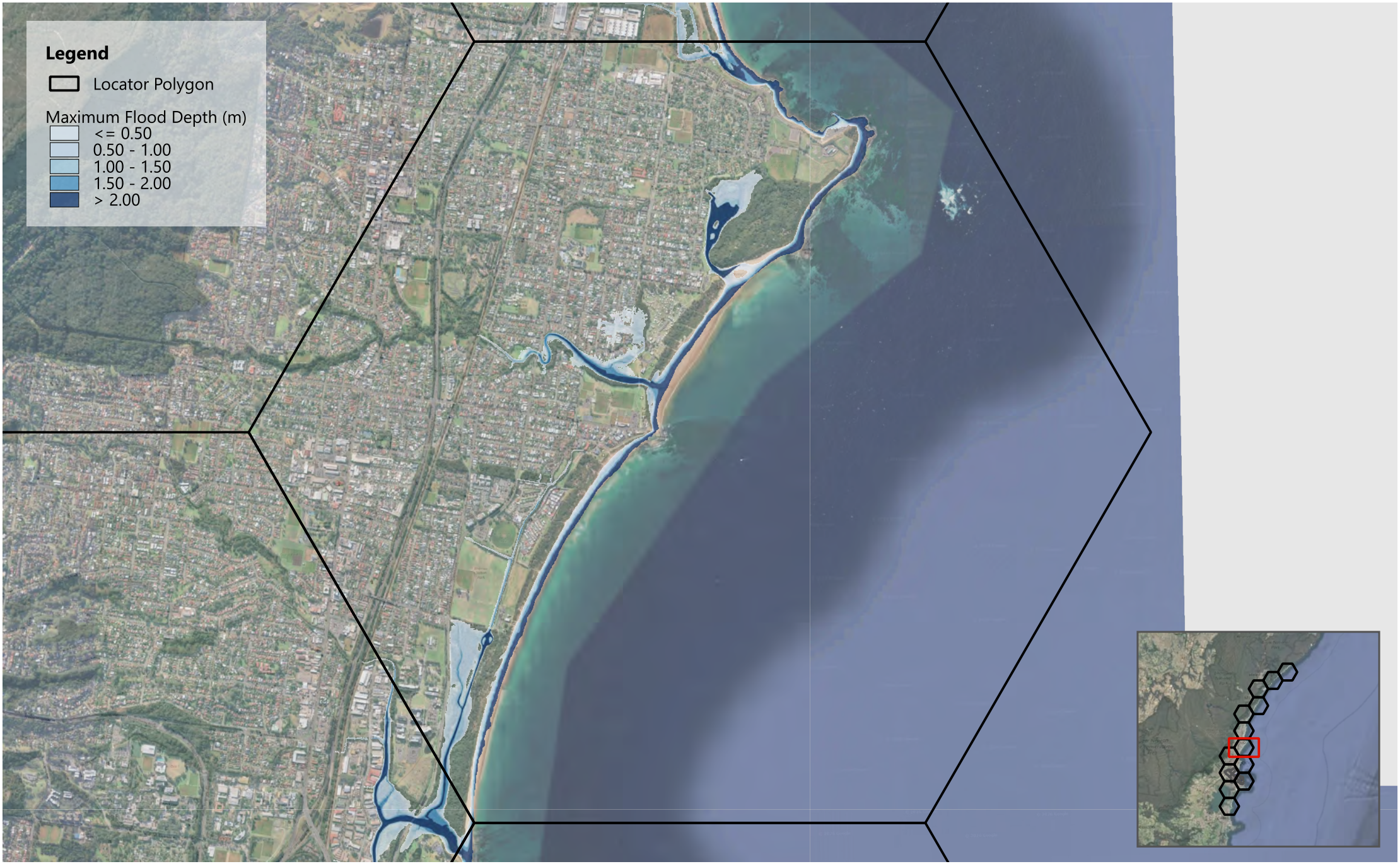
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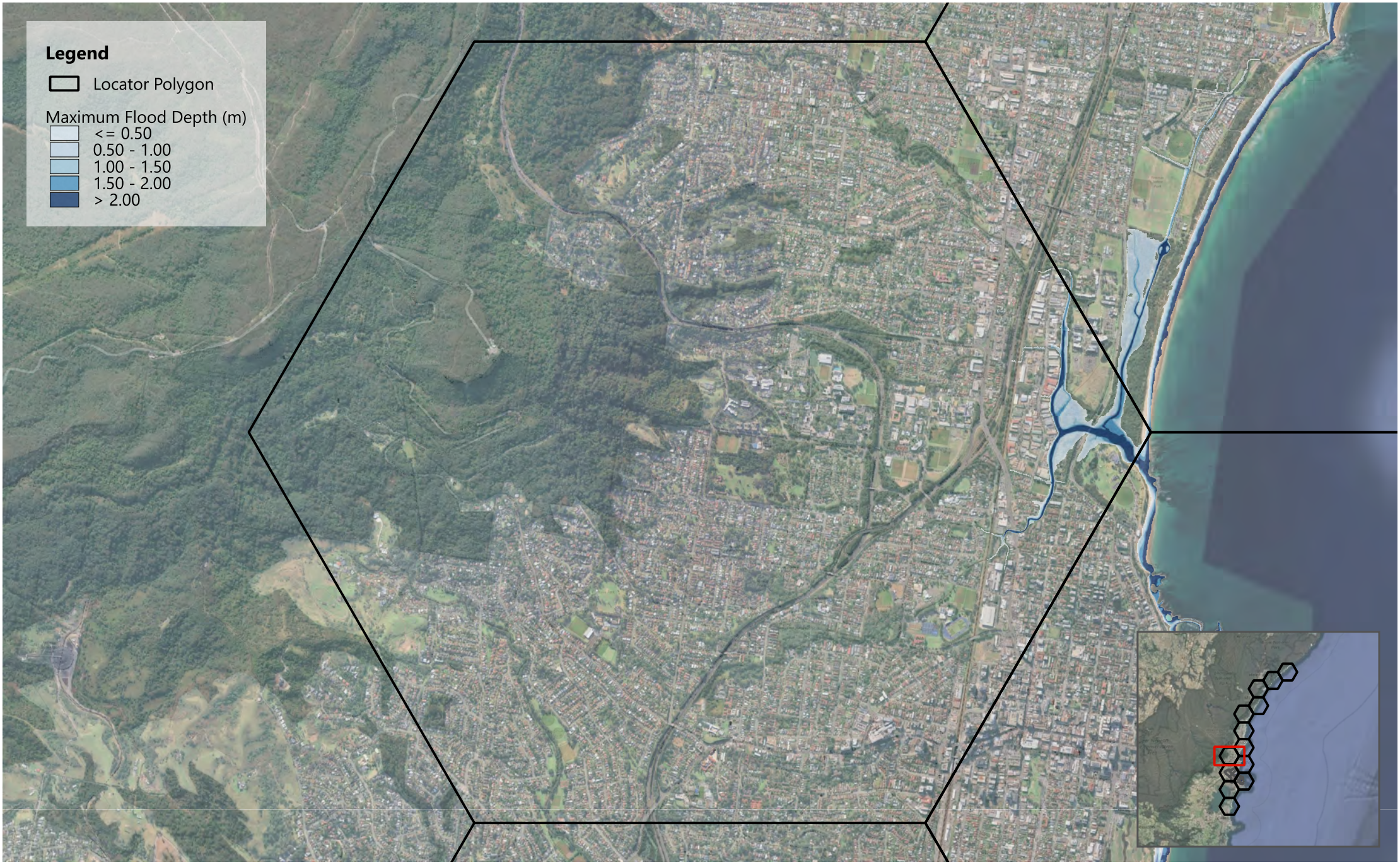
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Map Scale

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Wollongong Coastal Hazard Study:
Coastal Inundation Mapping
2025 - 5% AEP - Present Day
Grid ID: 9

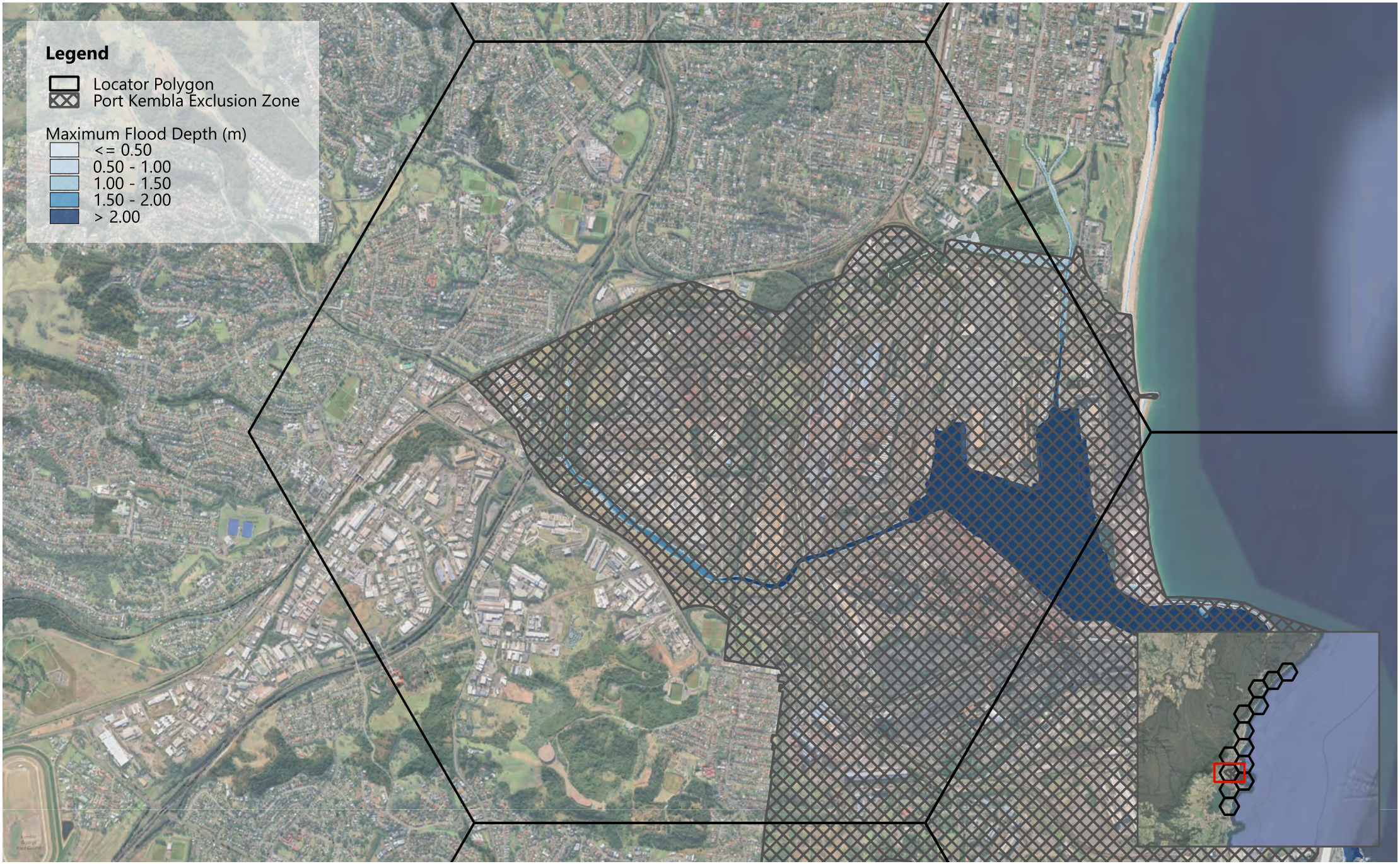
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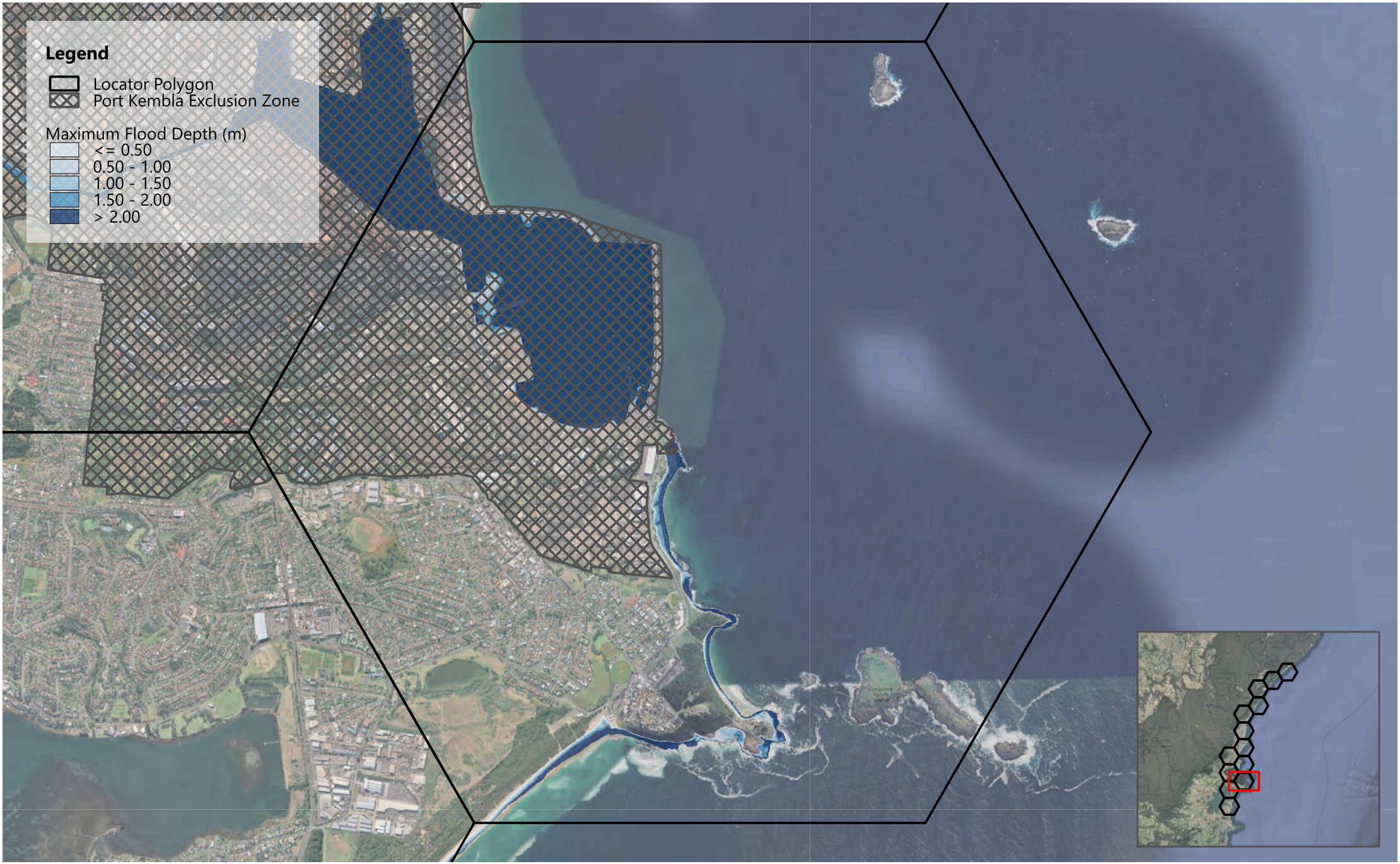
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2025 - 5% AEP - Present Day
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Map Scale

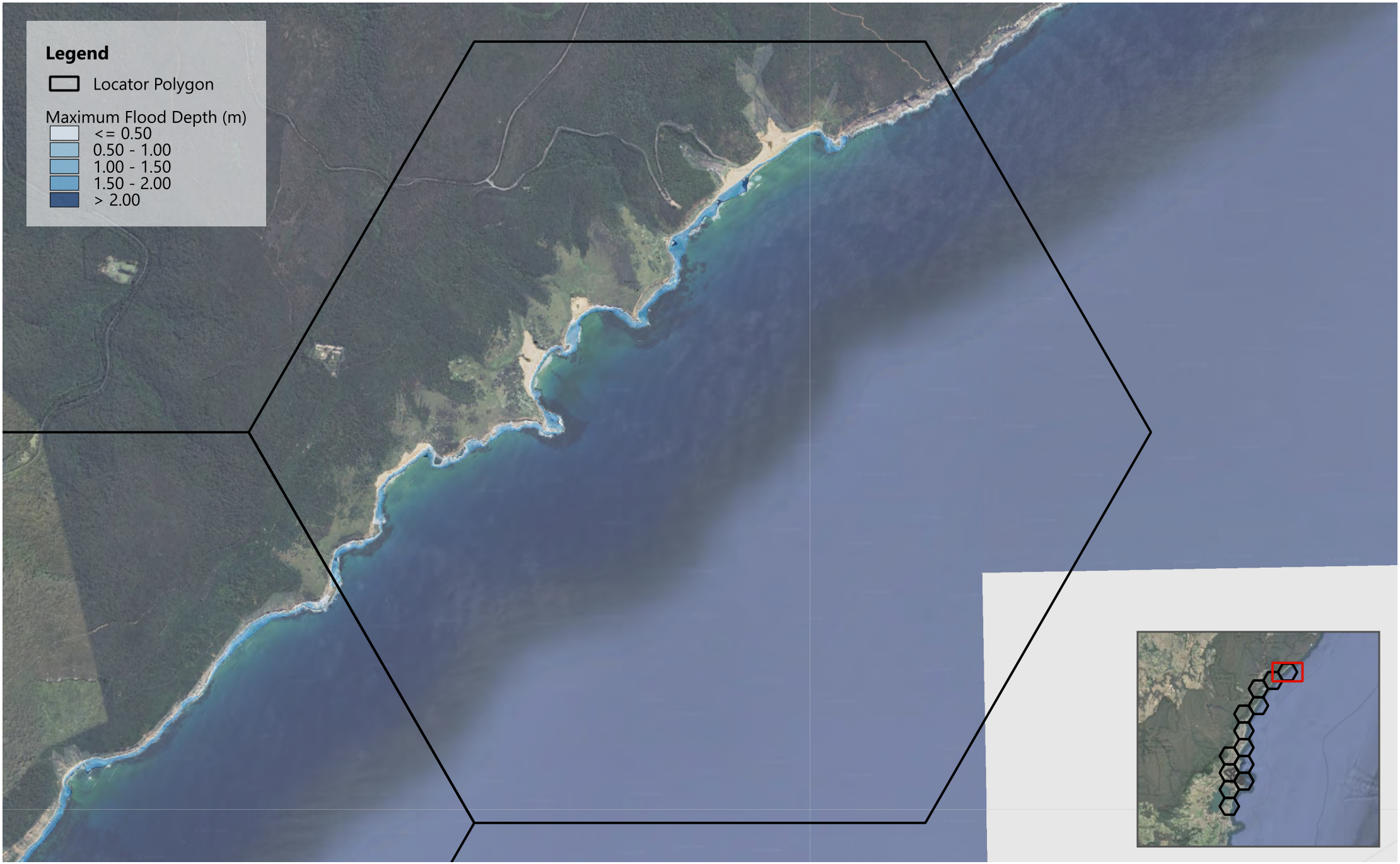
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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2025 - 5% AEP - Present Day Grid ID: 13

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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2045 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 1

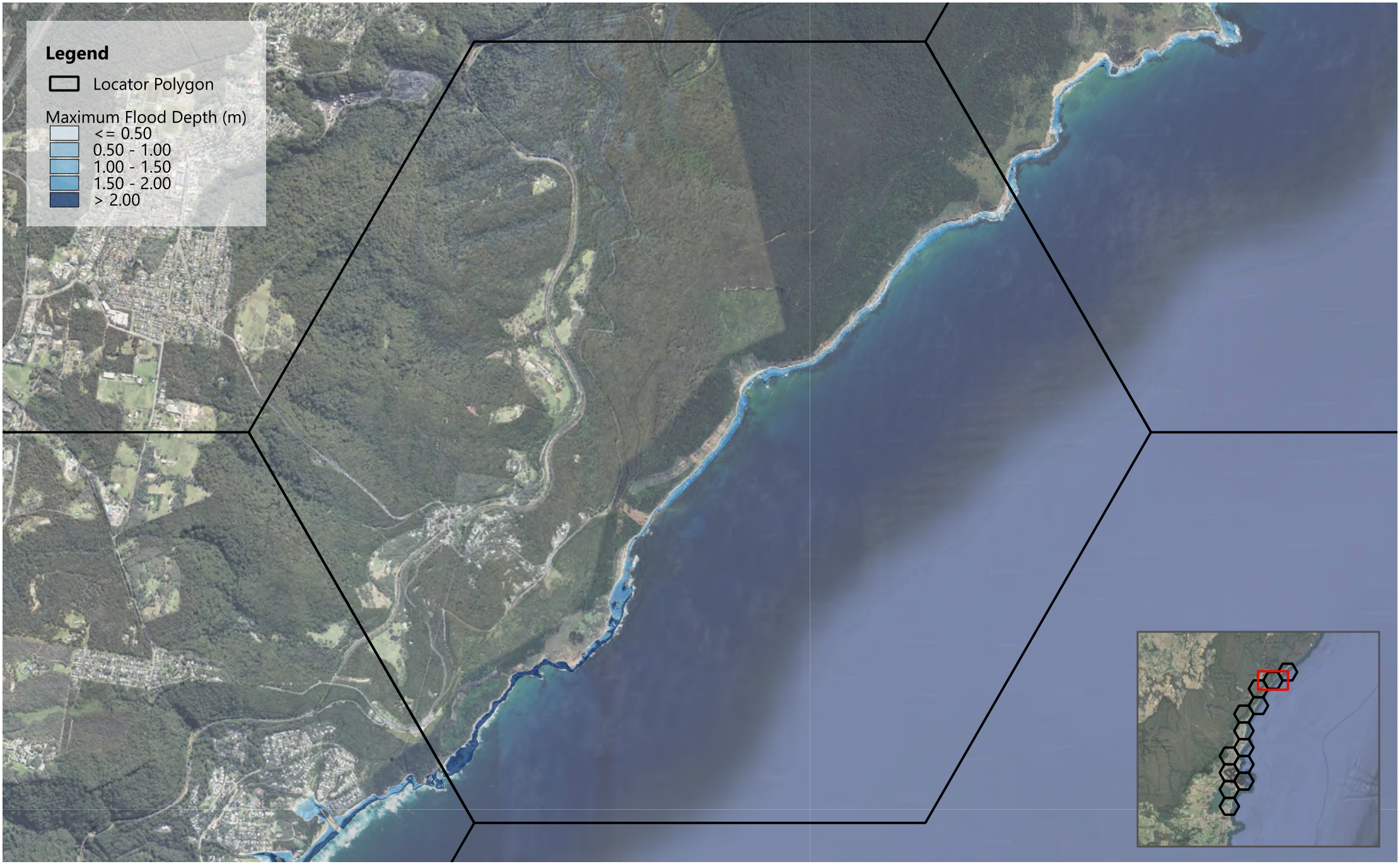
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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2045 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 2

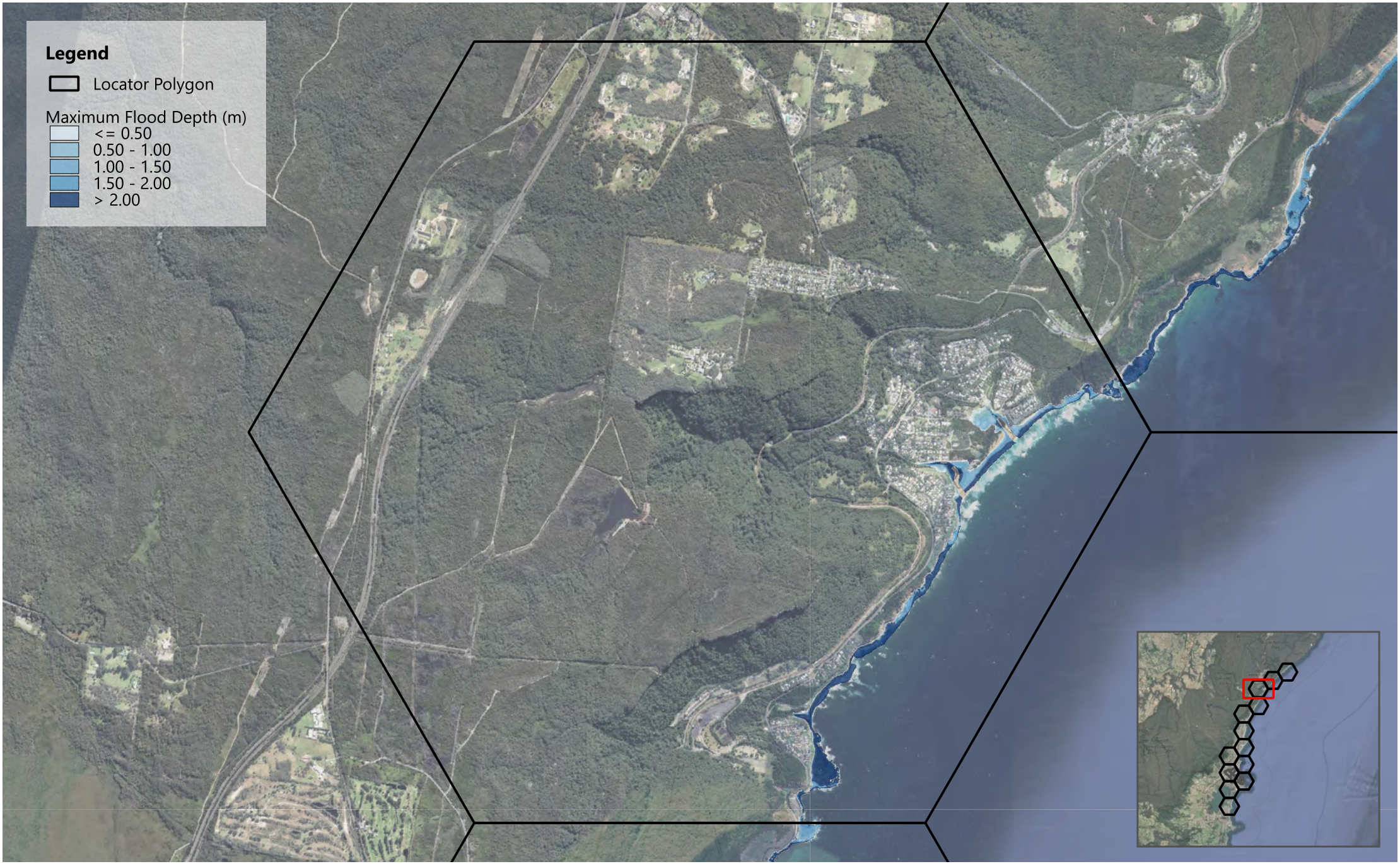
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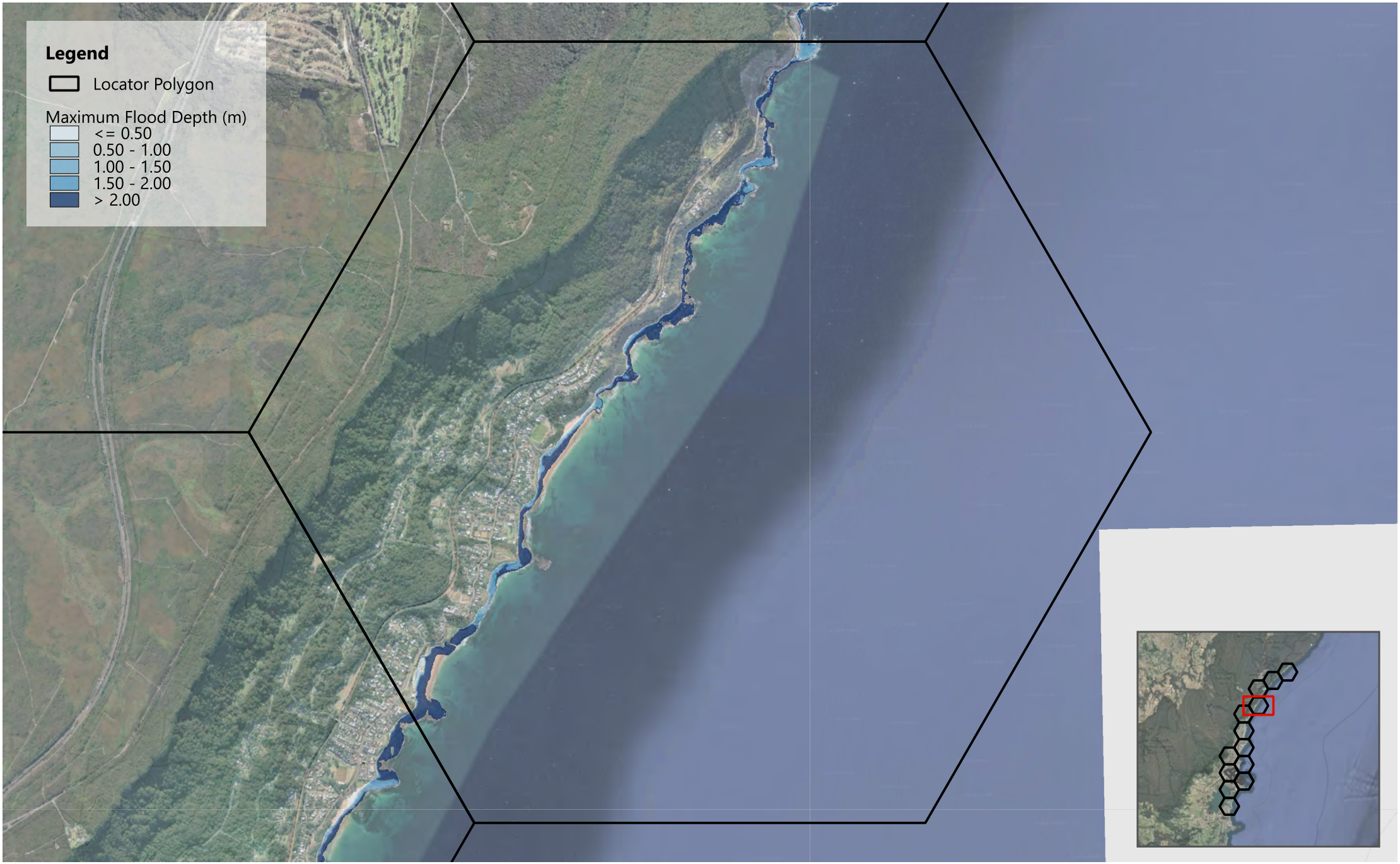
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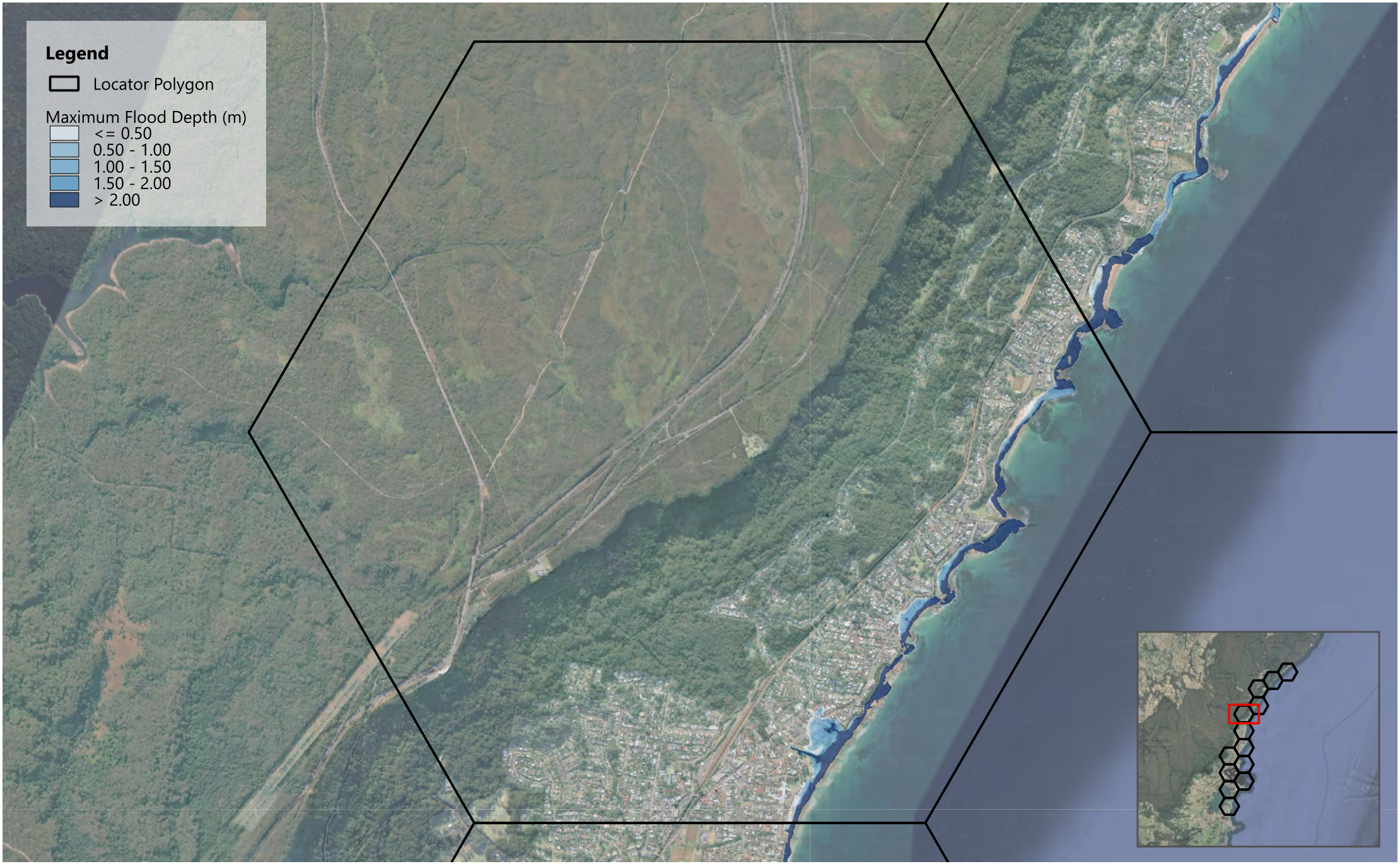
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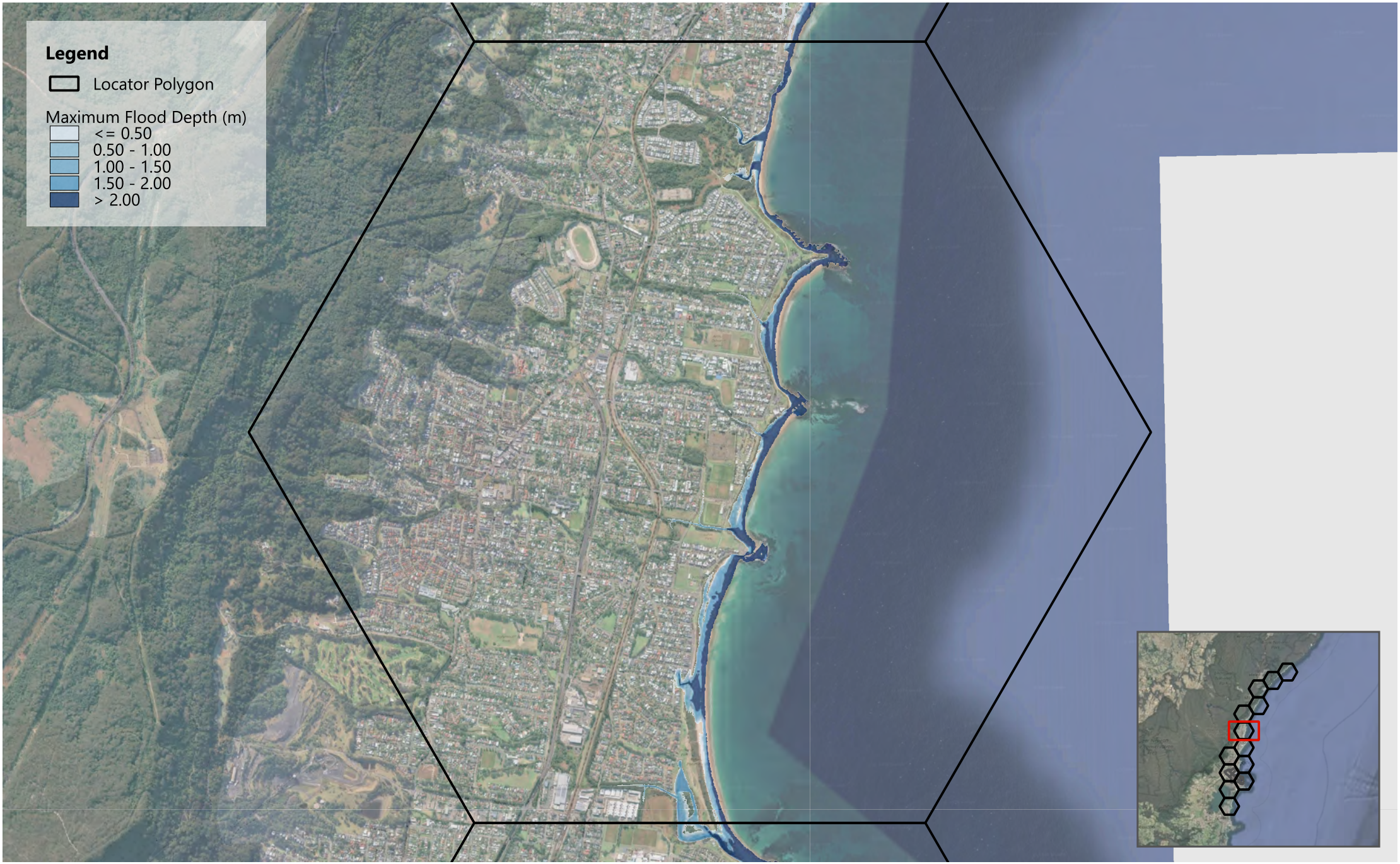
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Wollongong Coastal Hazard Study:
Coastal Inundation Mapping
2045 - 1% AEP - SSP5-8.5 95th Quantile
Grid ID: 5

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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2045 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 6

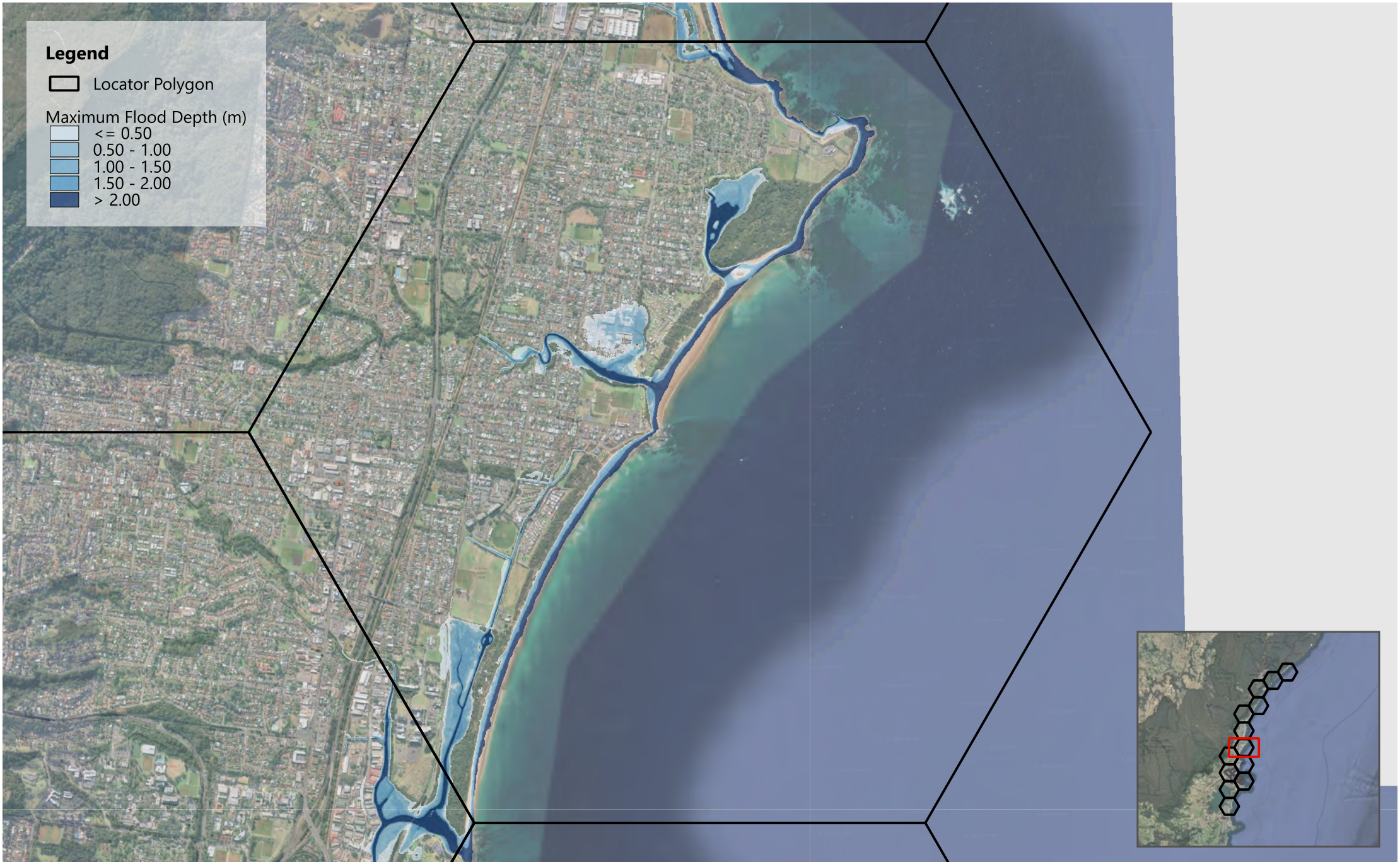
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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2045 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 7

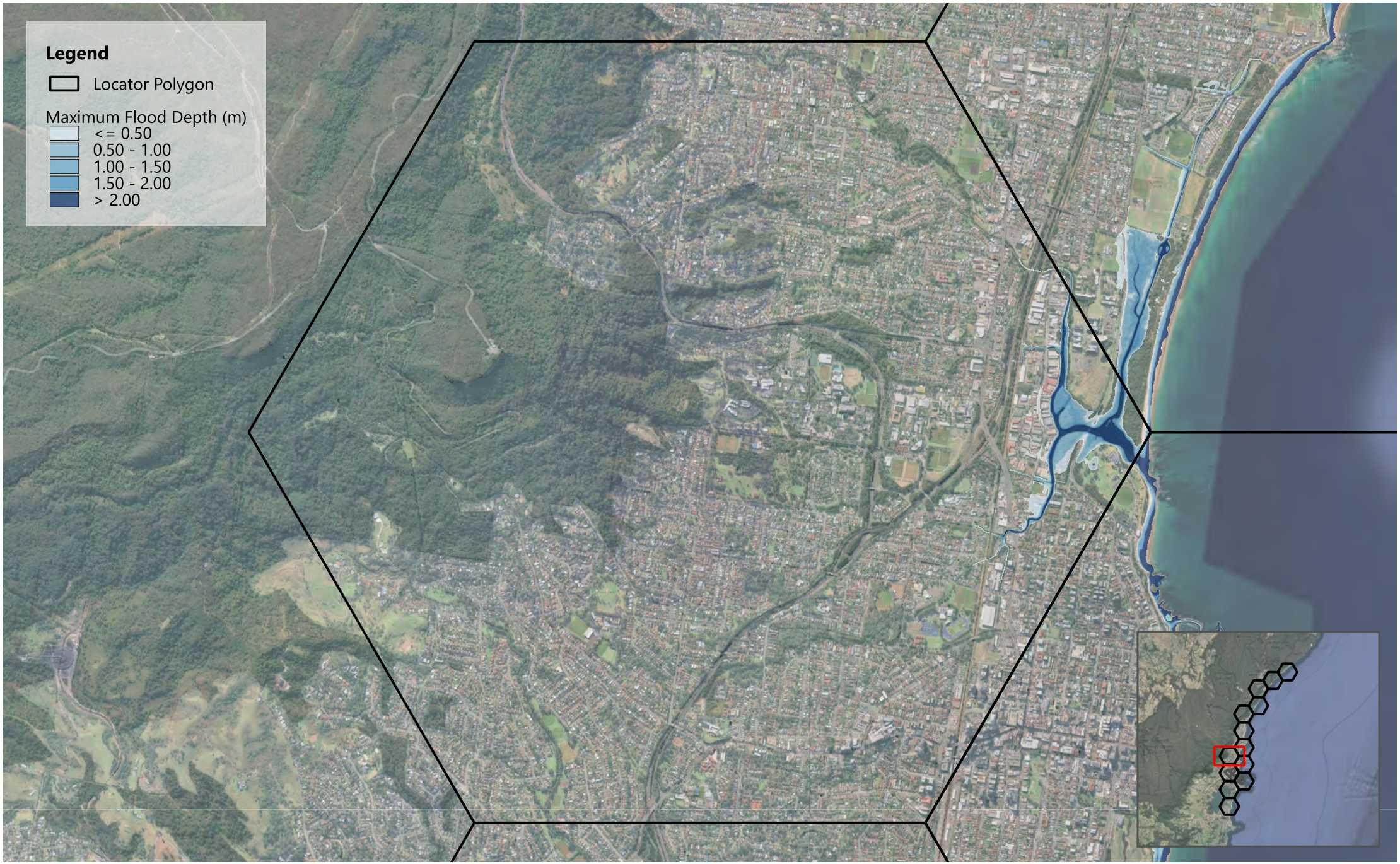
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Wollongong Coastal Hazard Study:
Coastal Inundation Mapping
2045 - 1% AEP - SSP5-8.5 95th Quantile
Grid ID: 9

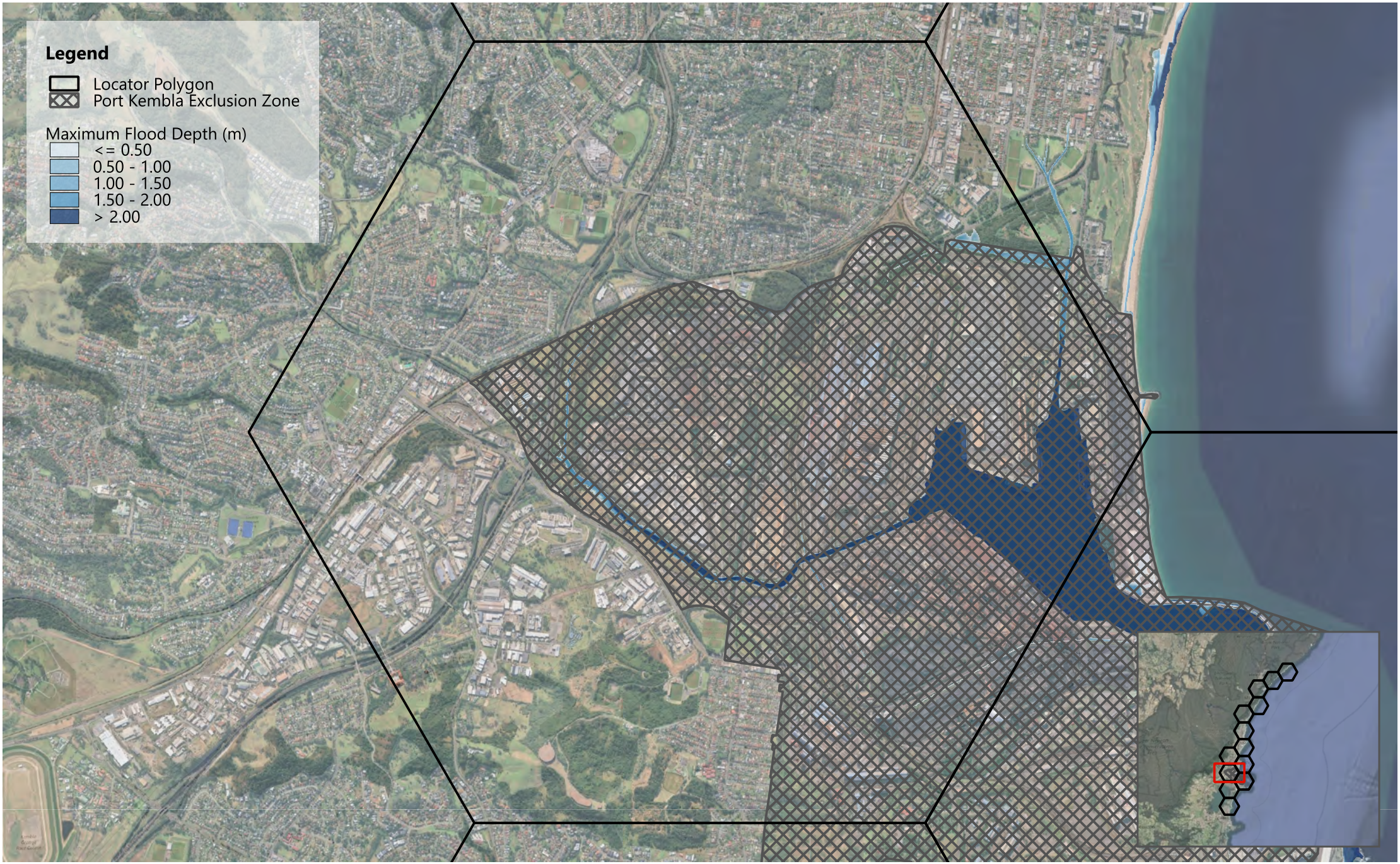
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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2045 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 10

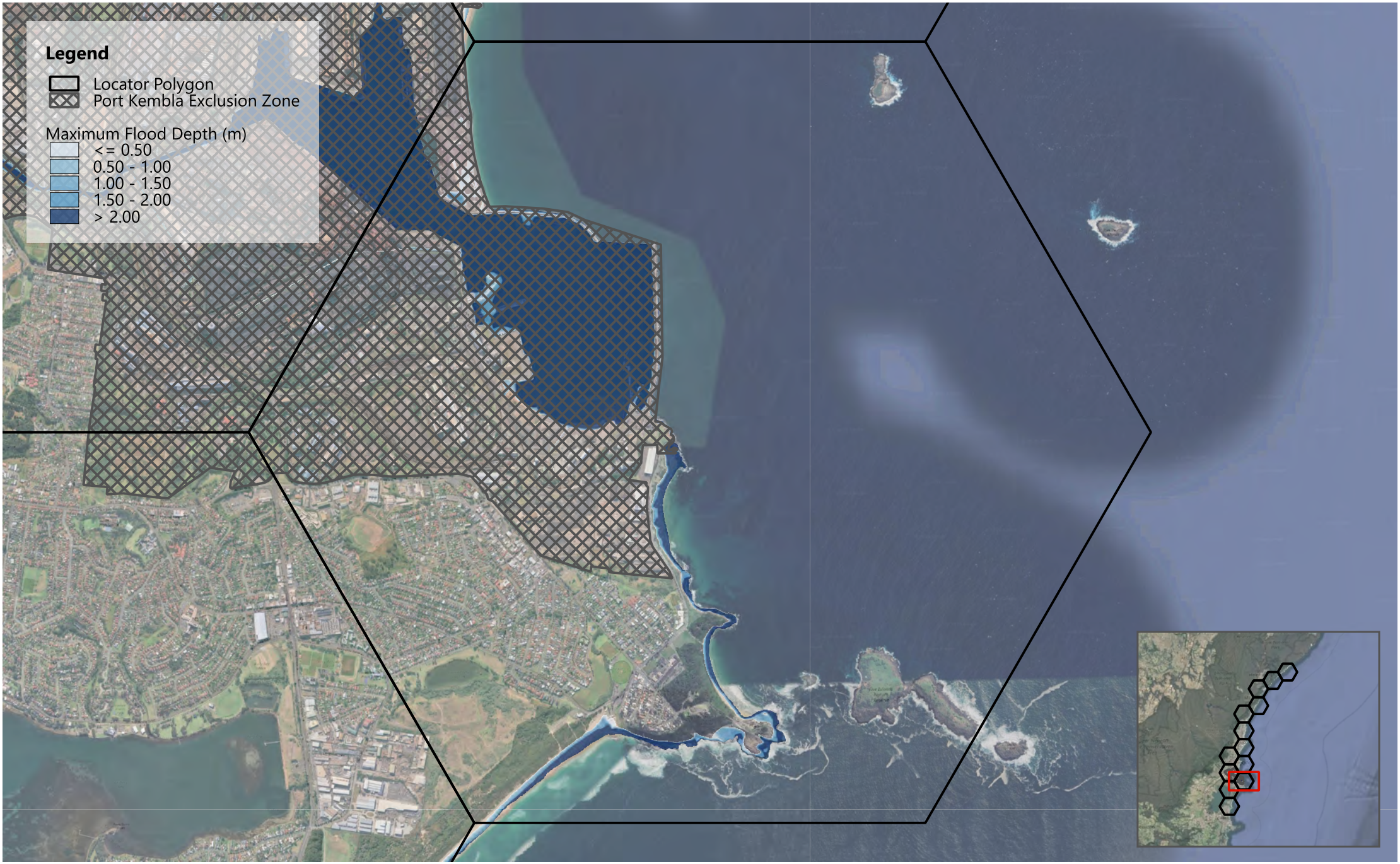
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Wollongong Coastal Hazard Study:
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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2045 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 12

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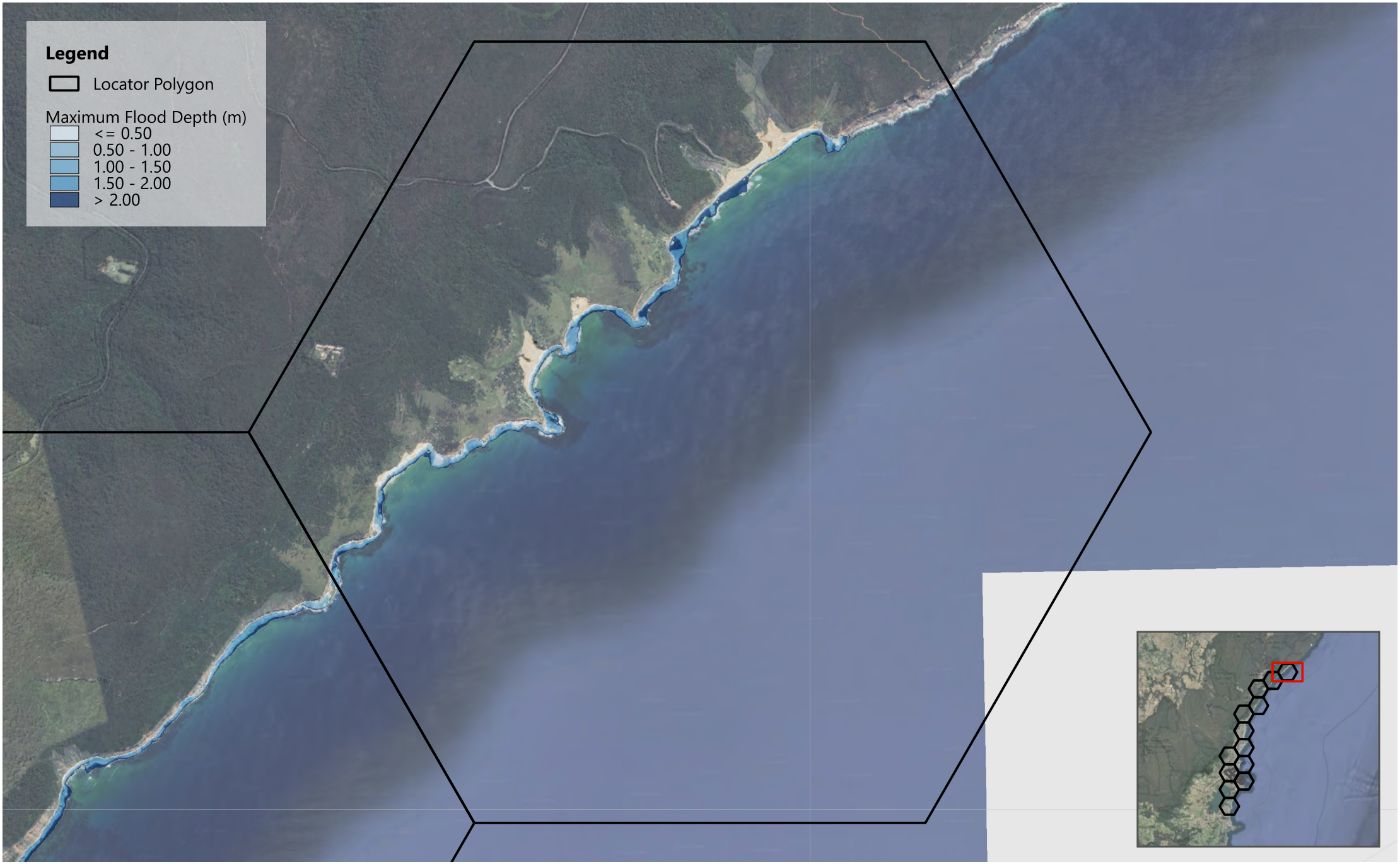
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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2075 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 1

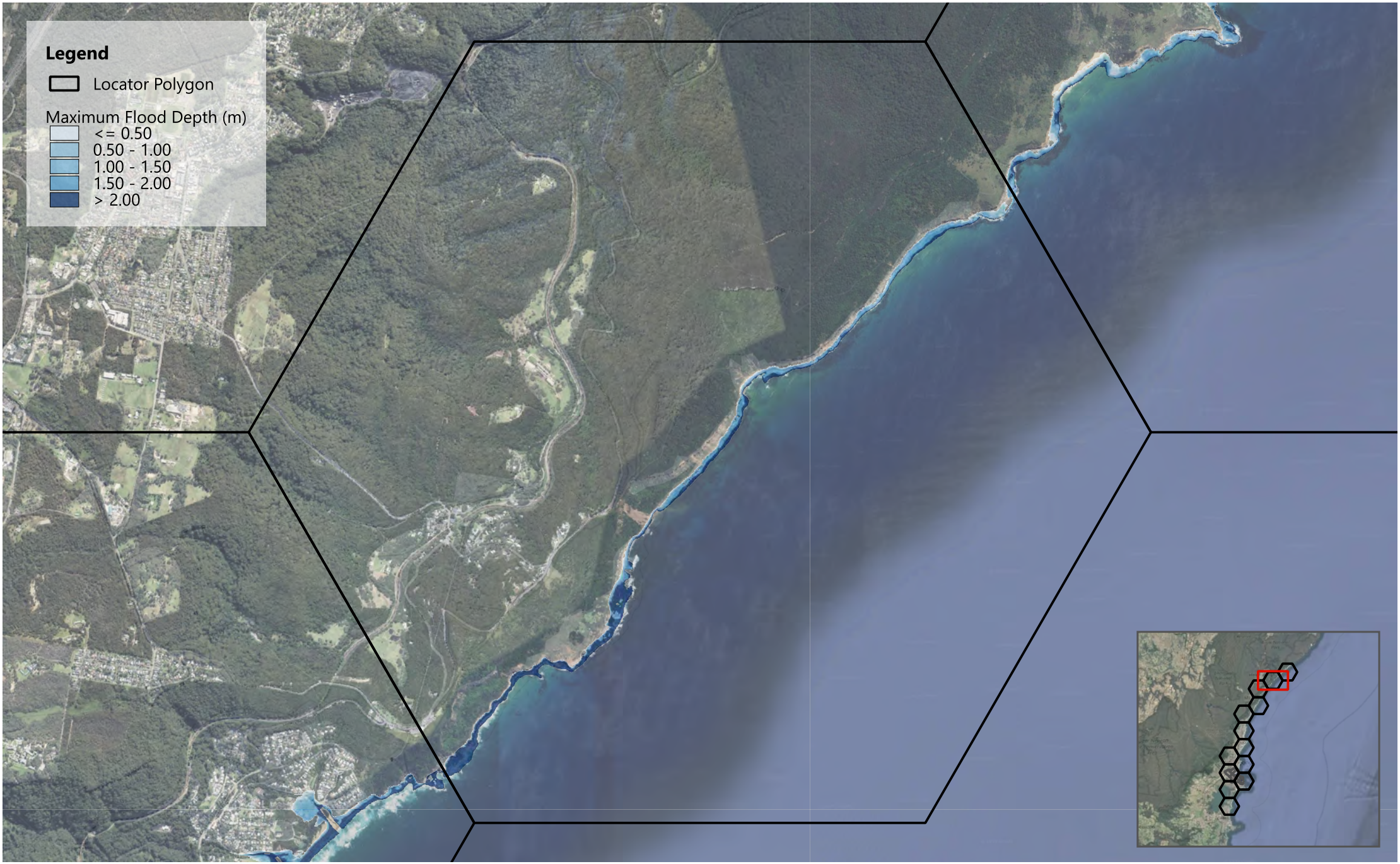
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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2075 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 2

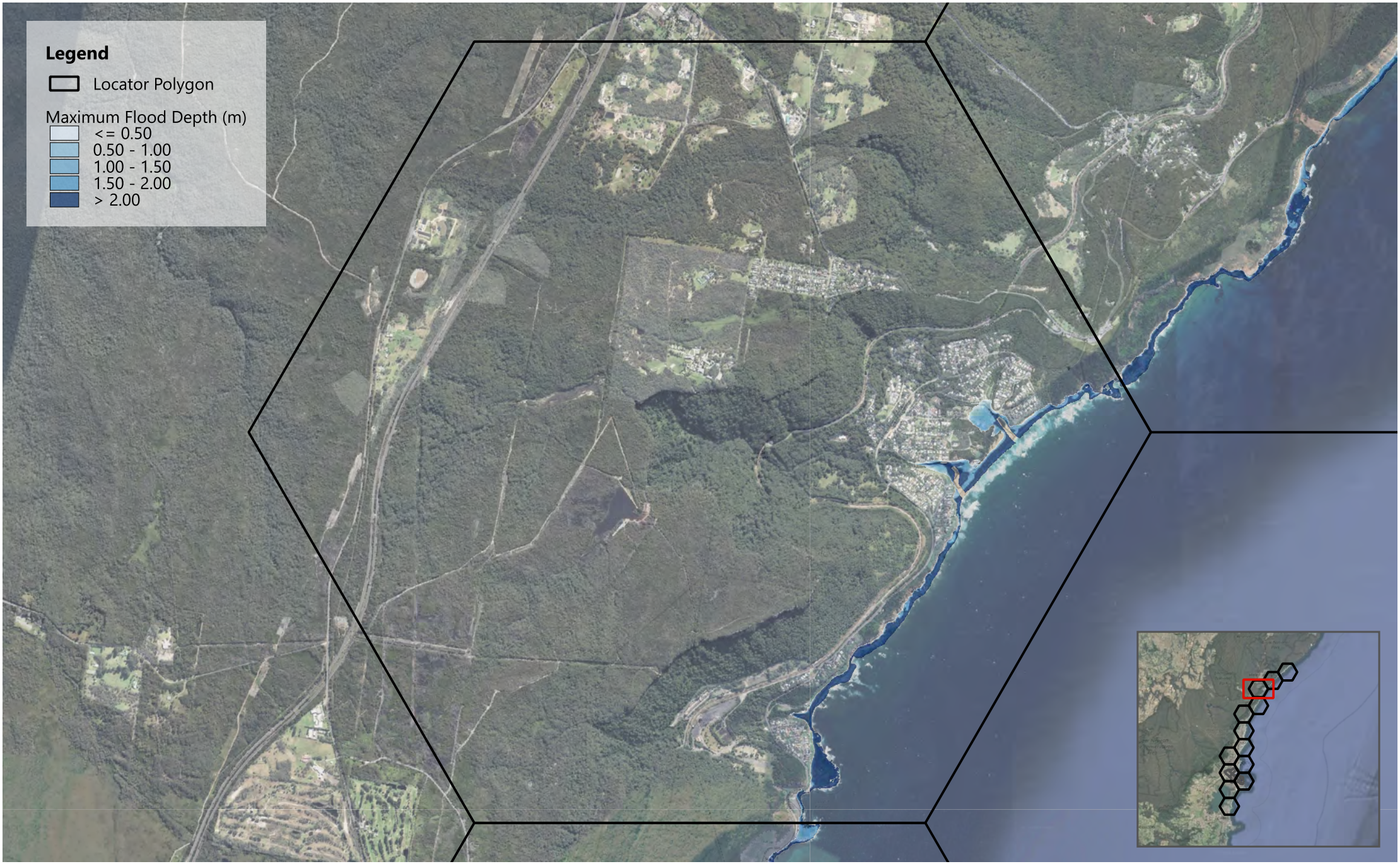
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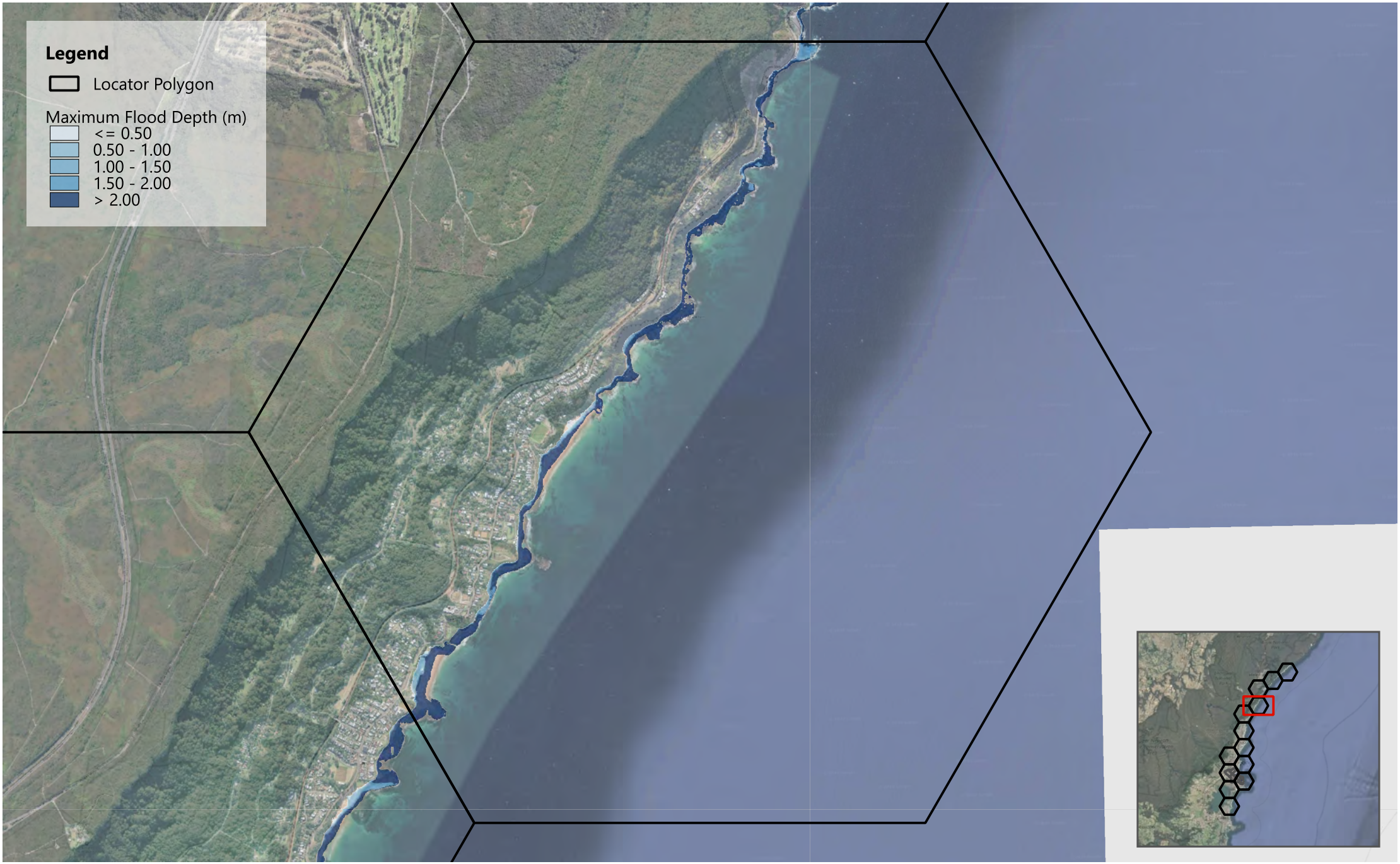
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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2075 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 3

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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2075 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 4

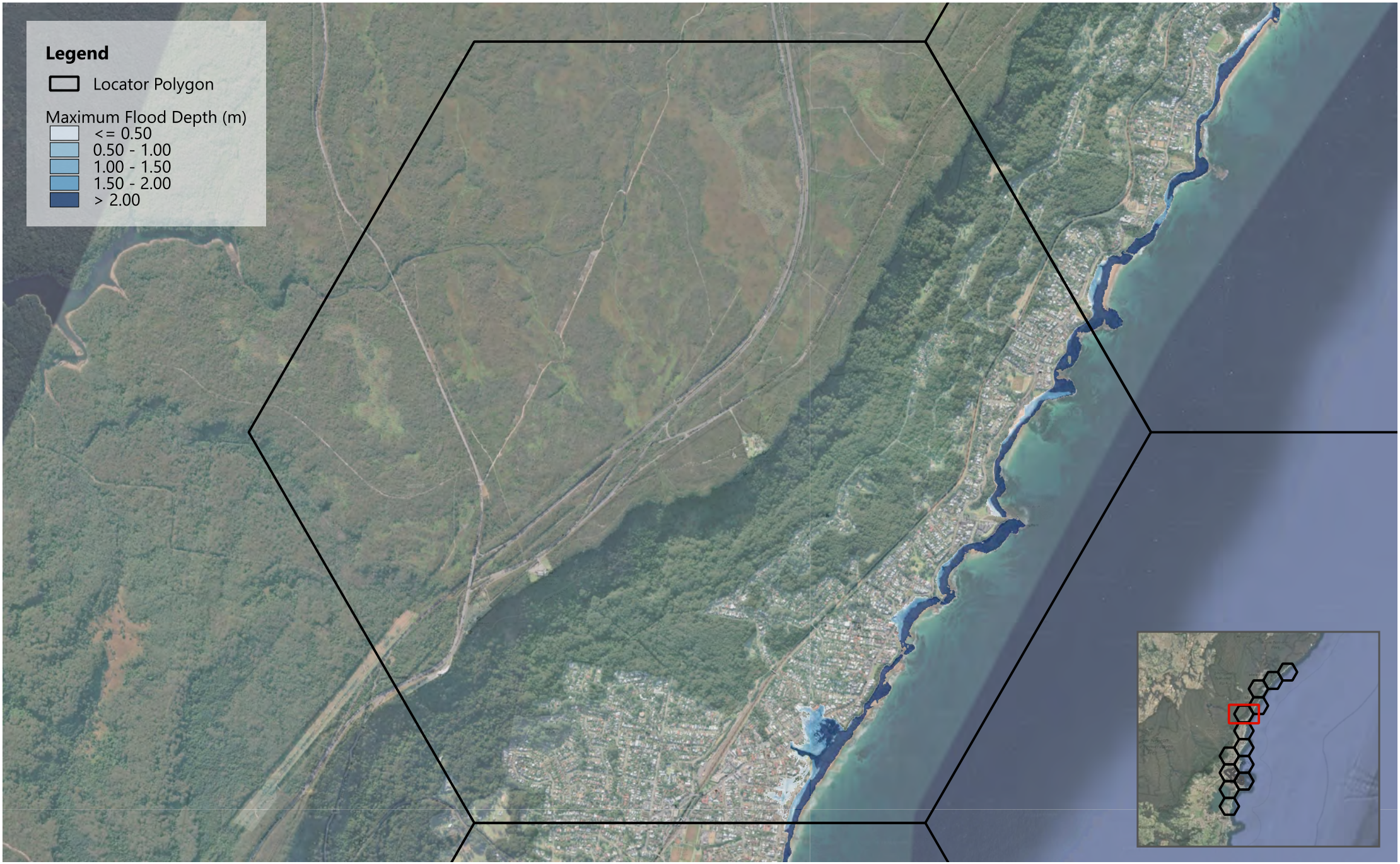
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Wollongong Coastal Hazard Study:
Coastal Inundation Mapping
2075 - 1% AEP - SSP5-8.5 95th Quantile
Grid ID: 5

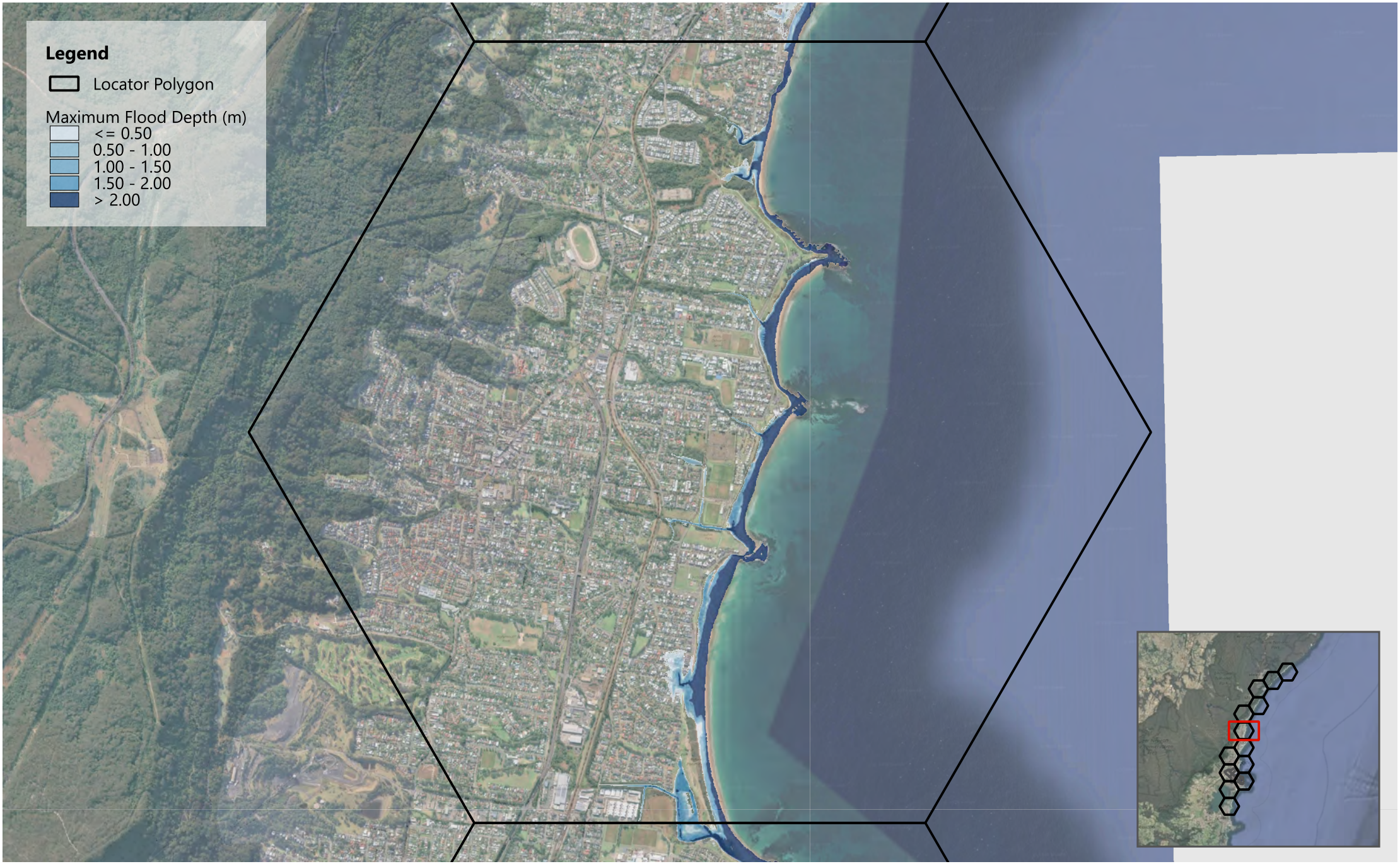
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Wollongong Coastal Hazard Study:
Coastal Inundation Mapping
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Grid ID: 6

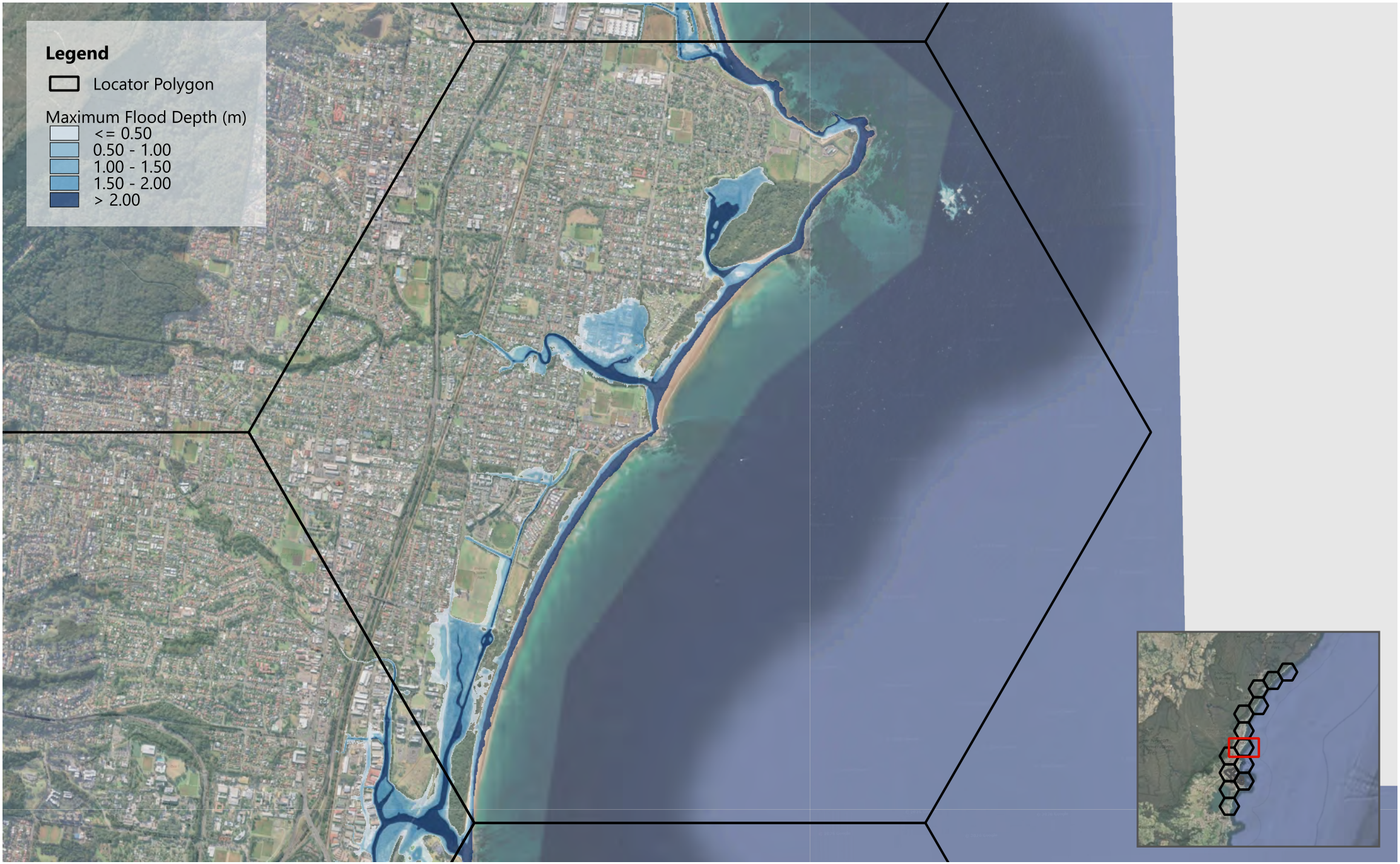
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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2075 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 7

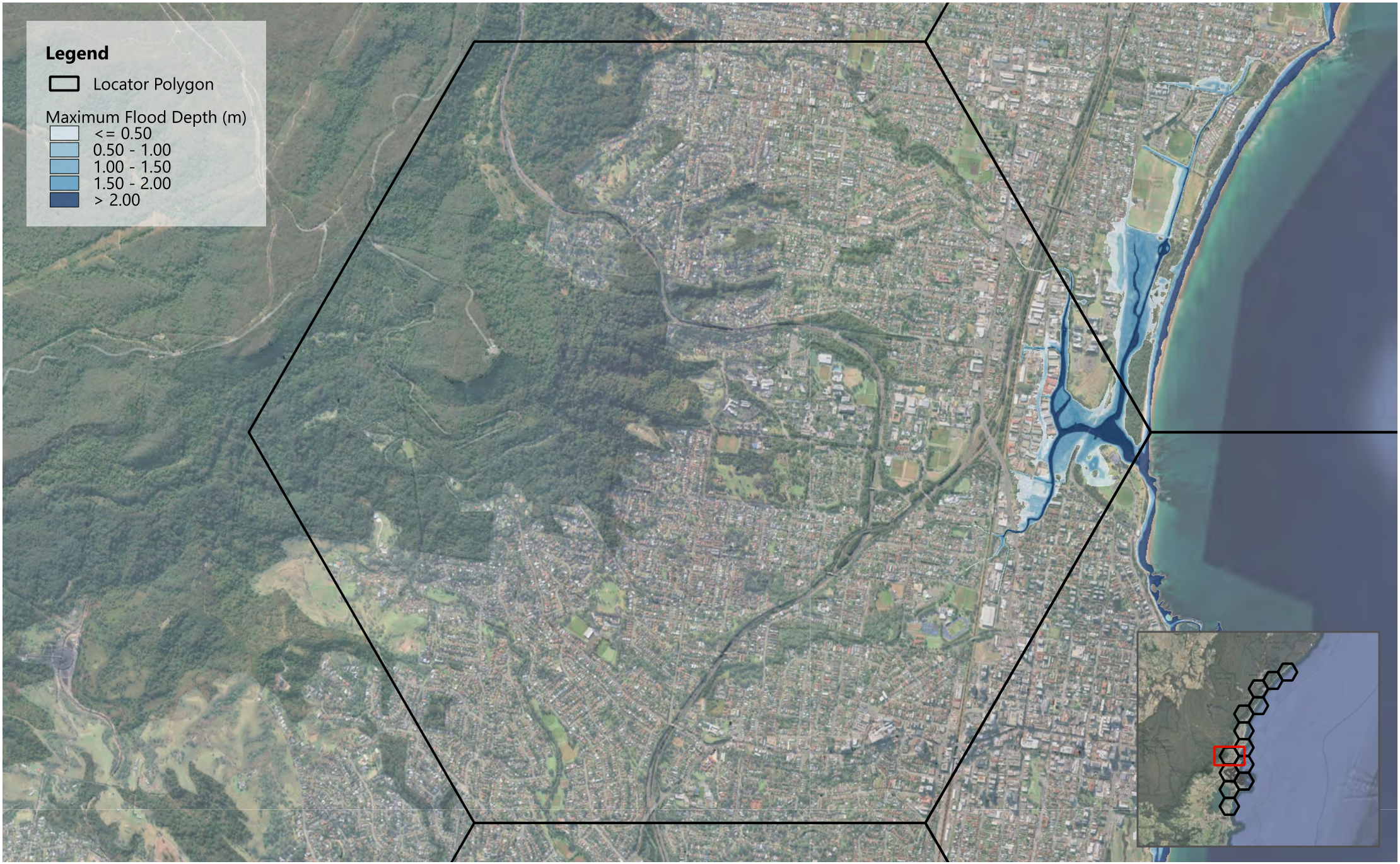
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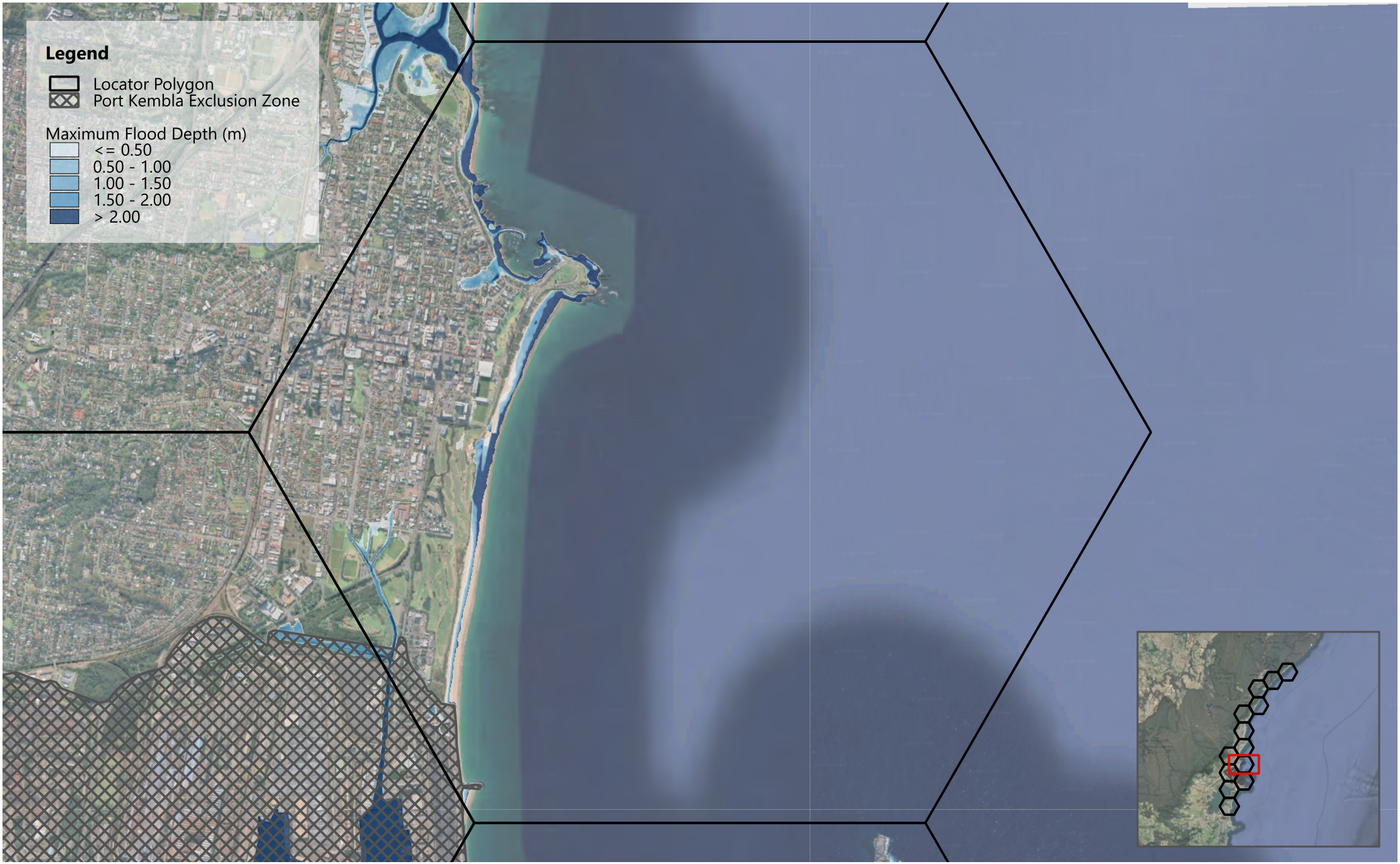
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Wollongong Coastal Hazard Study:
Coastal Inundation Mapping
2075 - 1% AEP - SSP5-8.5 95th Quantile
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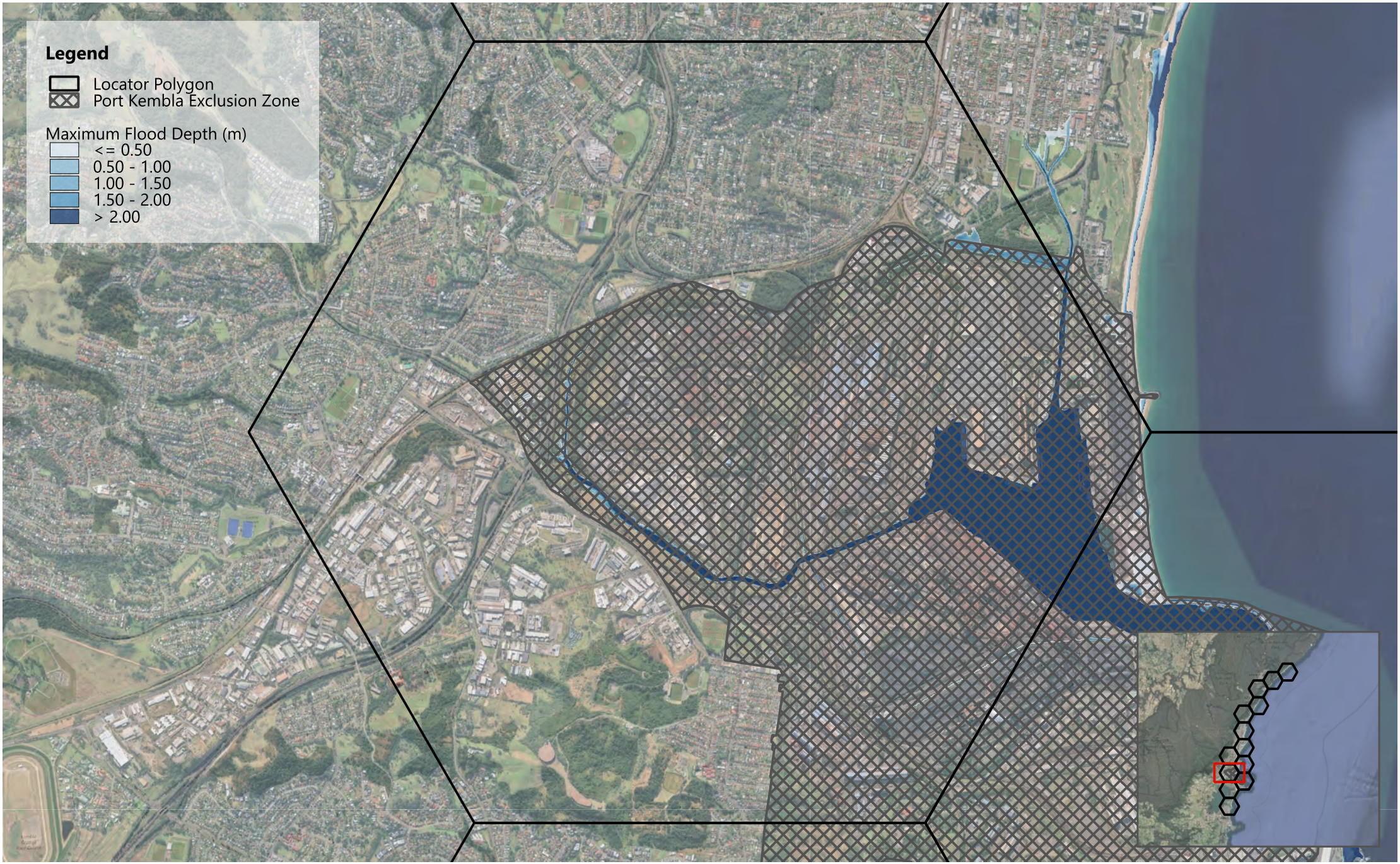
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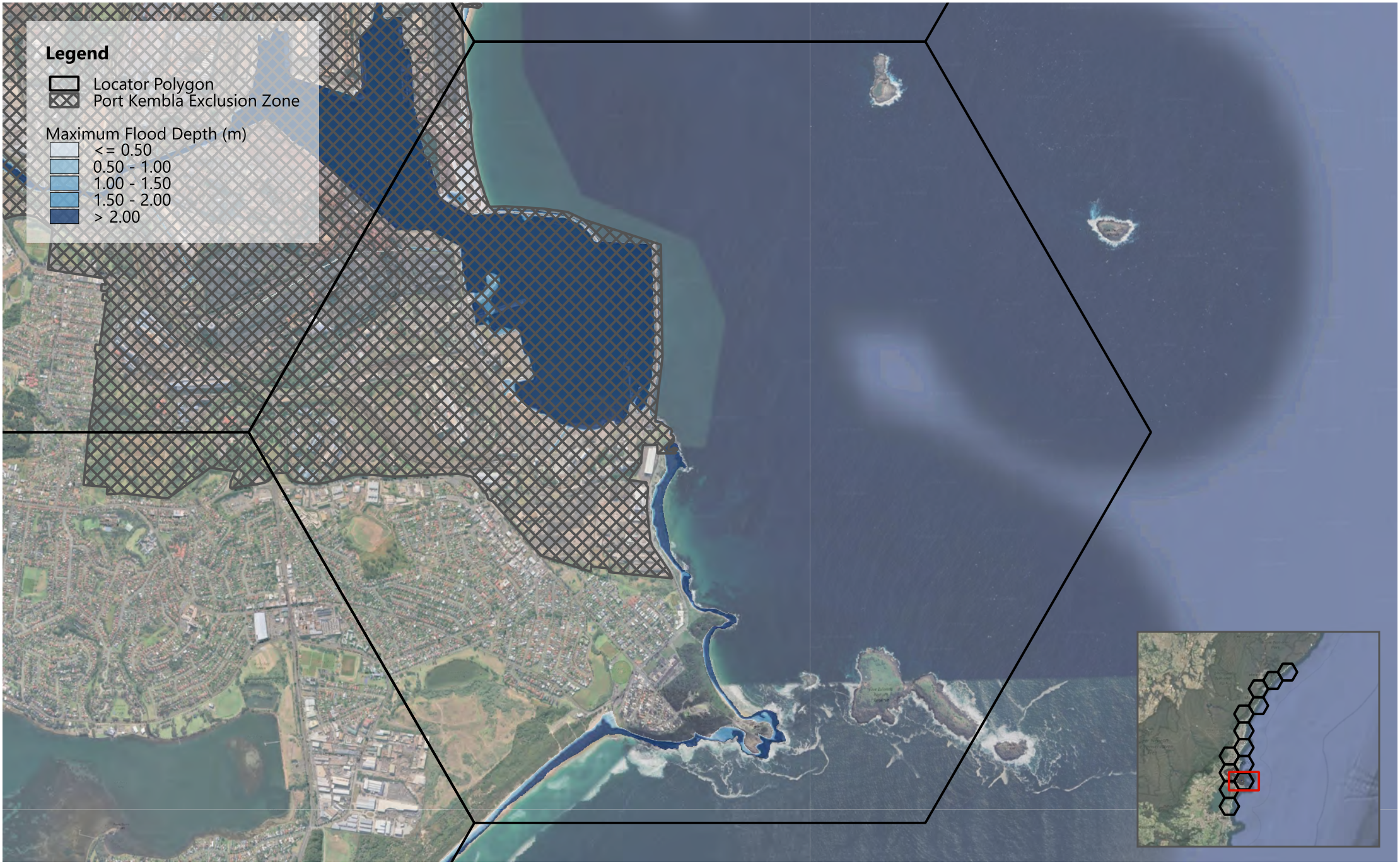
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Wollongong Coastal Hazard Study:
Coastal Inundation Mapping
2075 - 1% AEP - SSP5-8.5 95th Quantile
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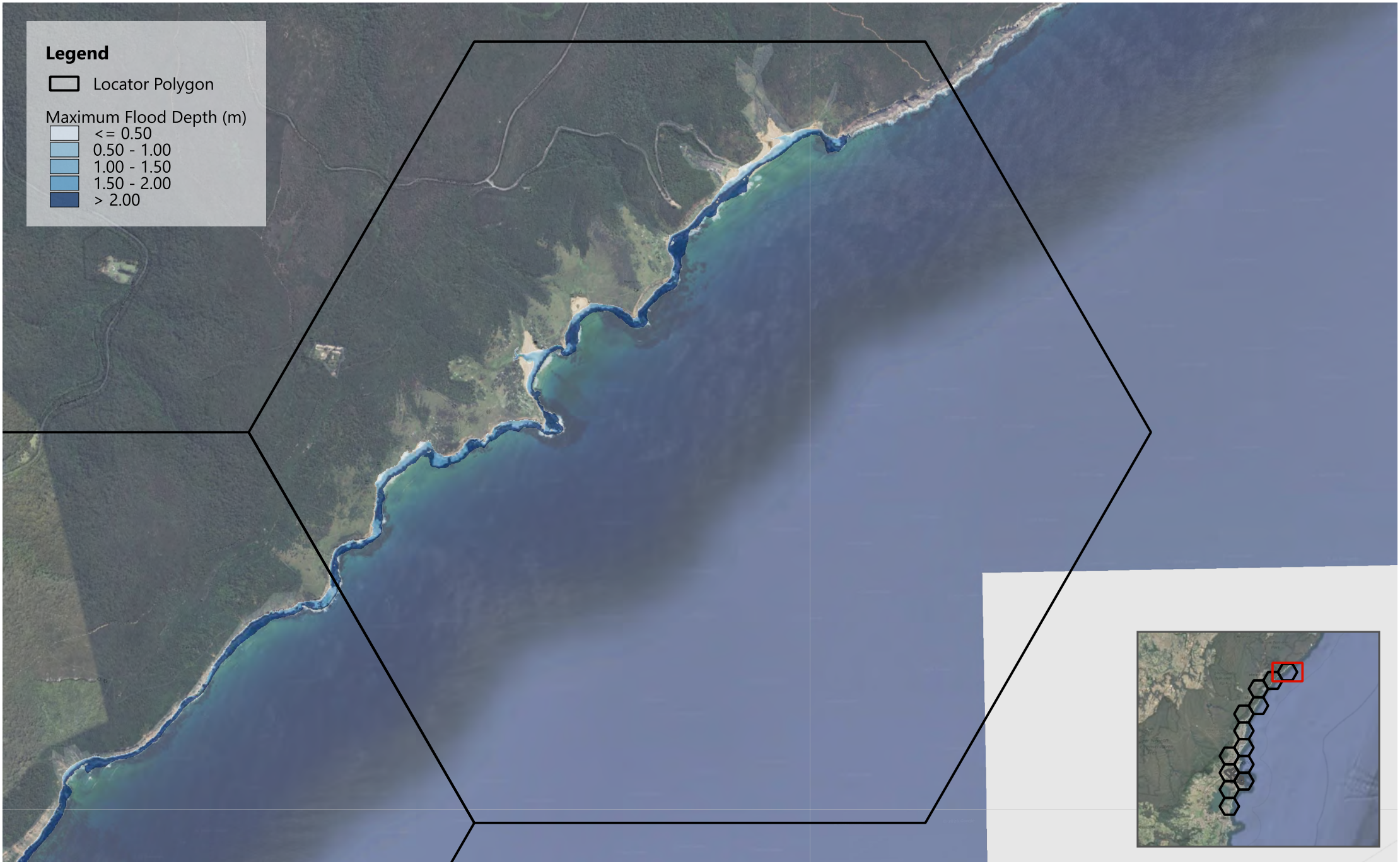
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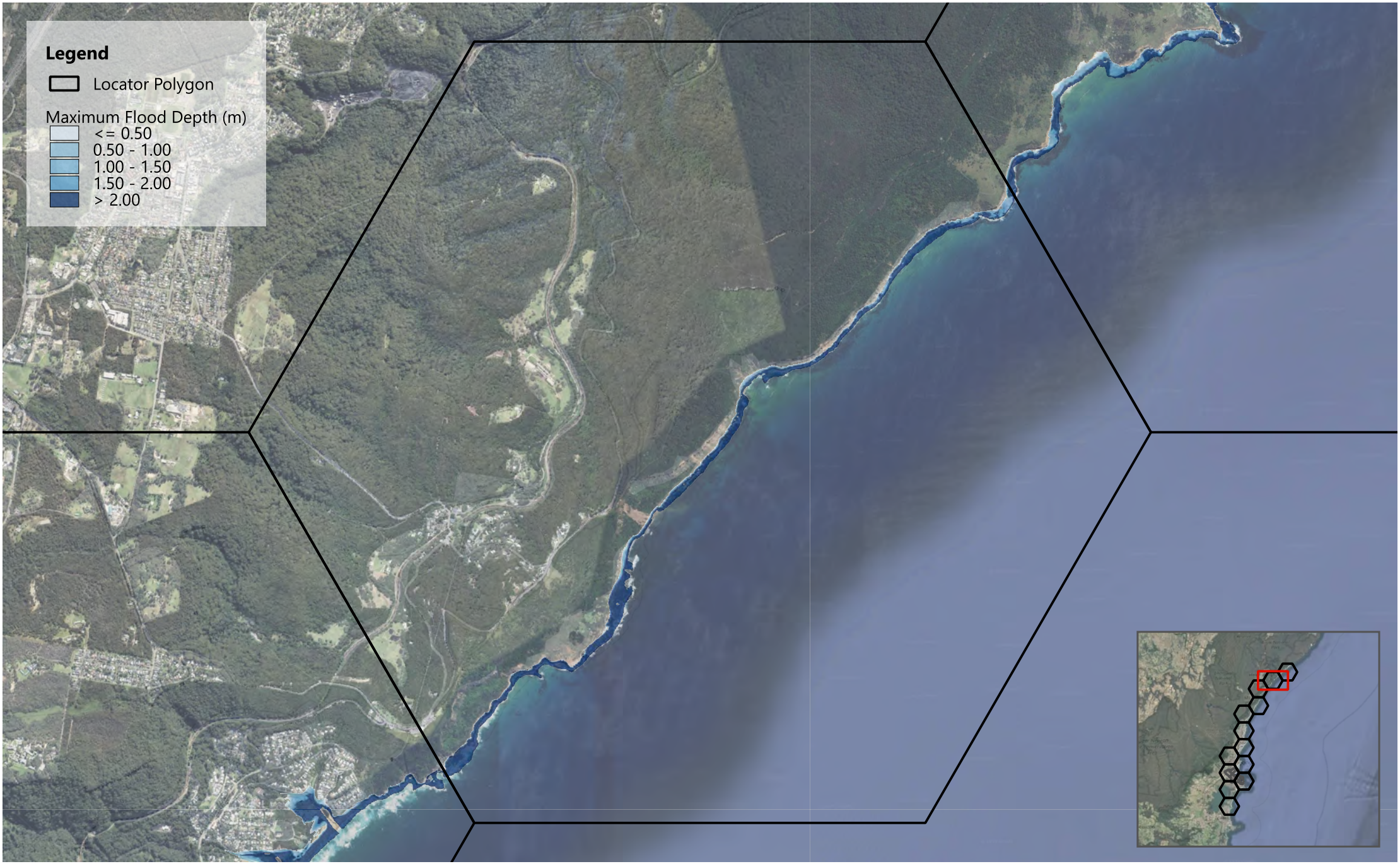
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Coastal Inundation Mapping
2125 - 1% AEP - SSP5-8.5 95th Quantile
Grid ID: 1

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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2125 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 2

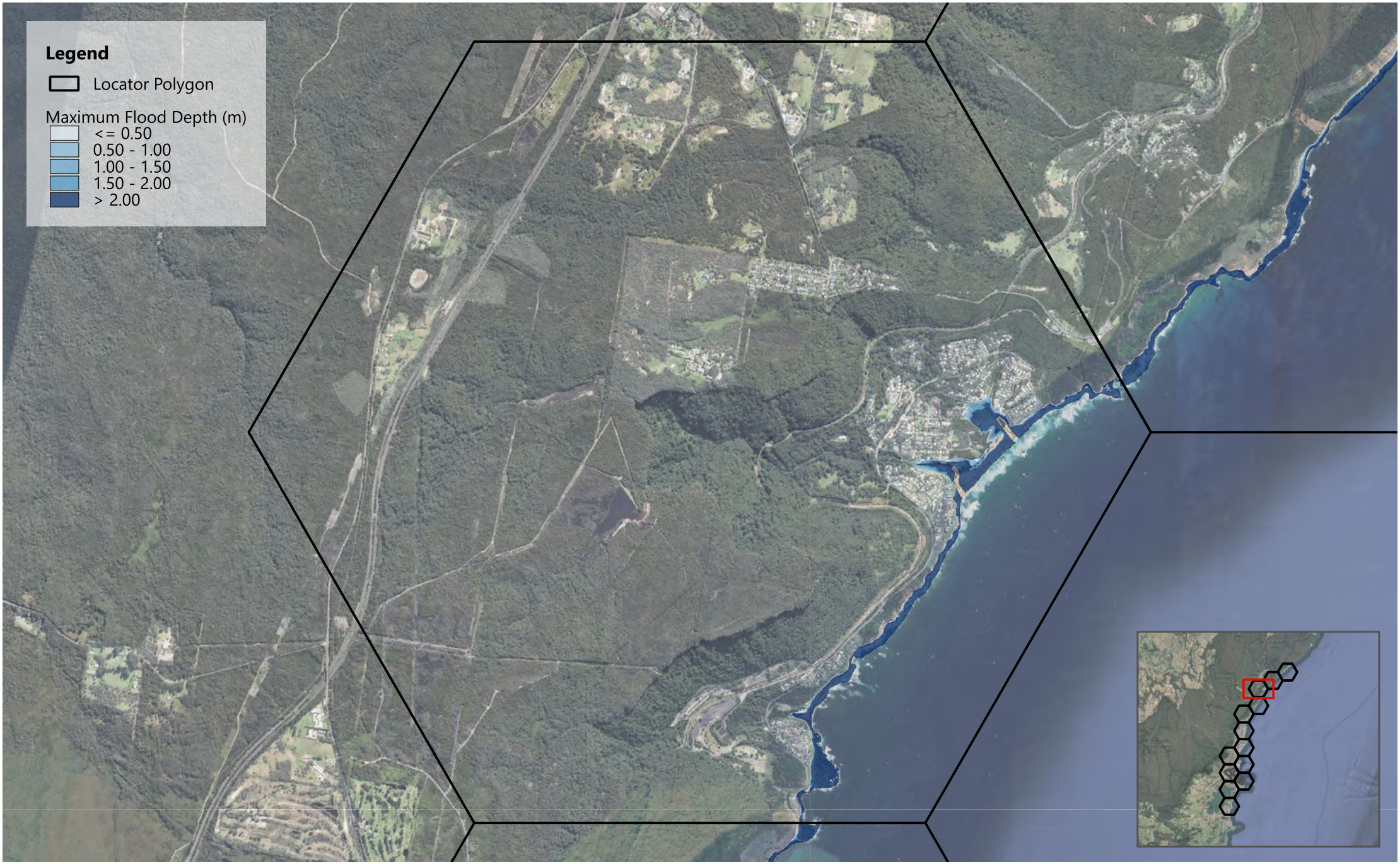
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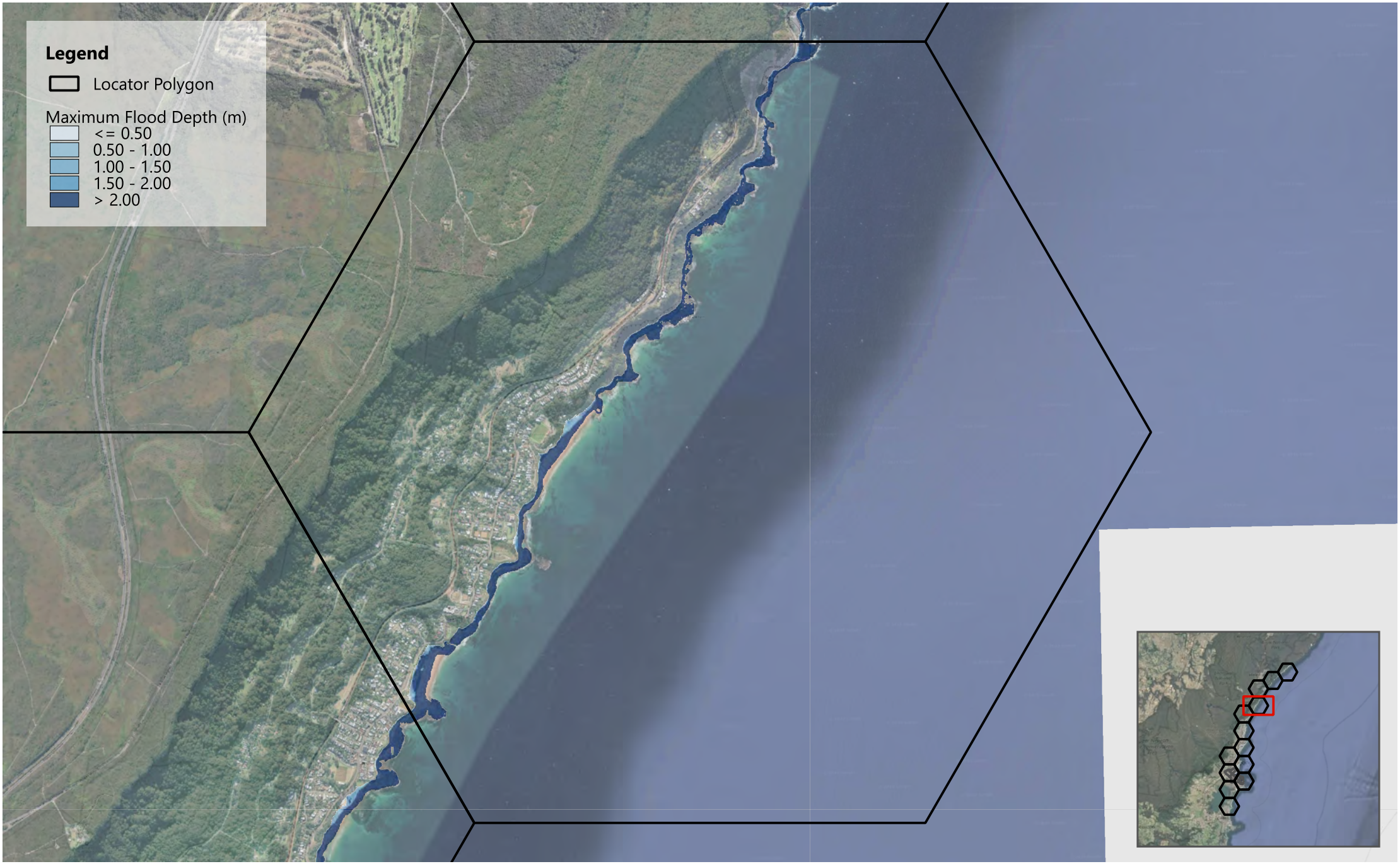
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Map Scale

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Wollongong Coastal Hazard Study: Coastal Inundation Mapping

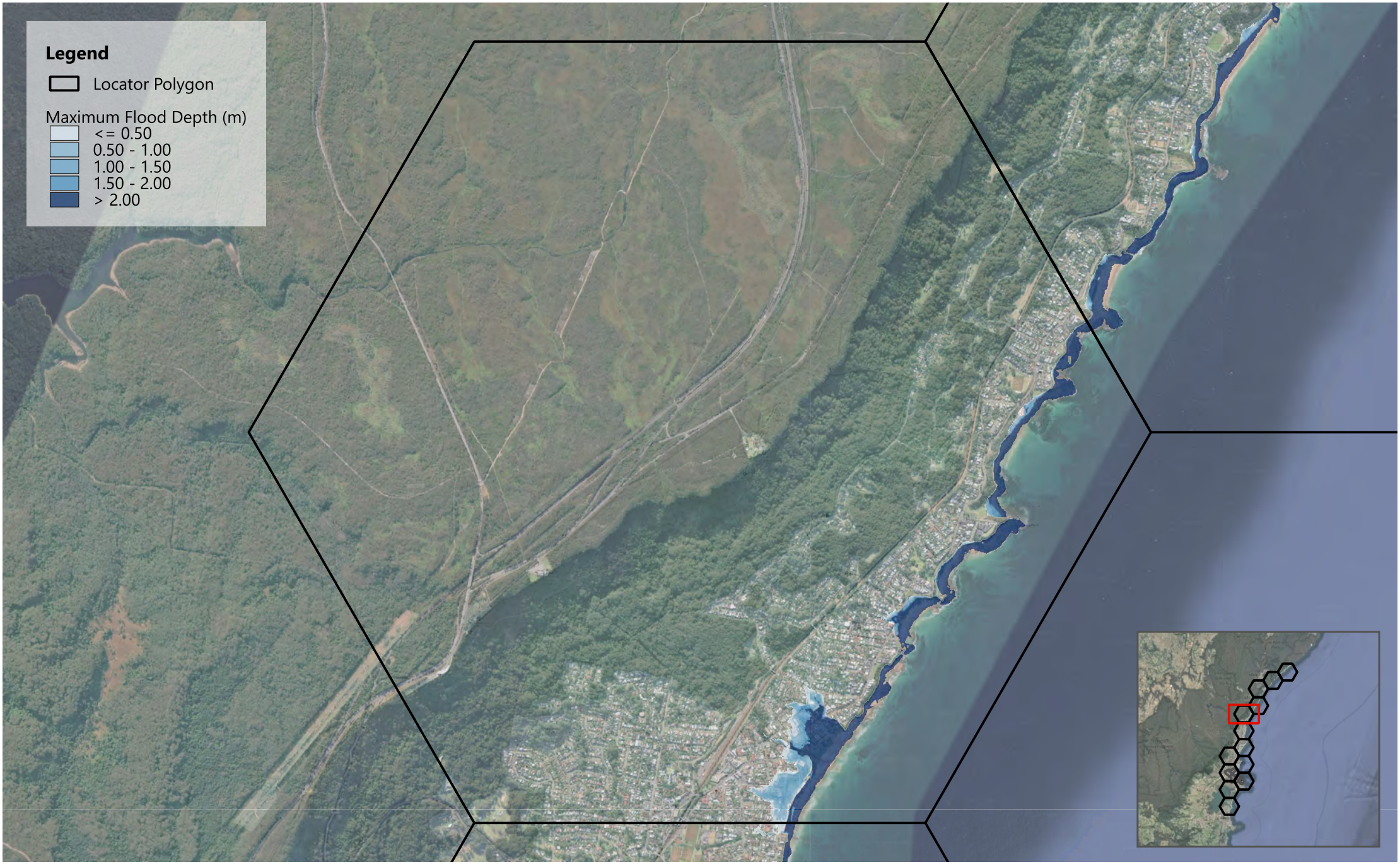
2125 - 1% AEP - SSP5-8.5 95th Quantile

Grid ID: 4

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Map Scale

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Wollongong Coastal Hazard Study:
Coastal Inundation Mapping
2125 - 1% AEP - SSP5-8.5 95th Quantile
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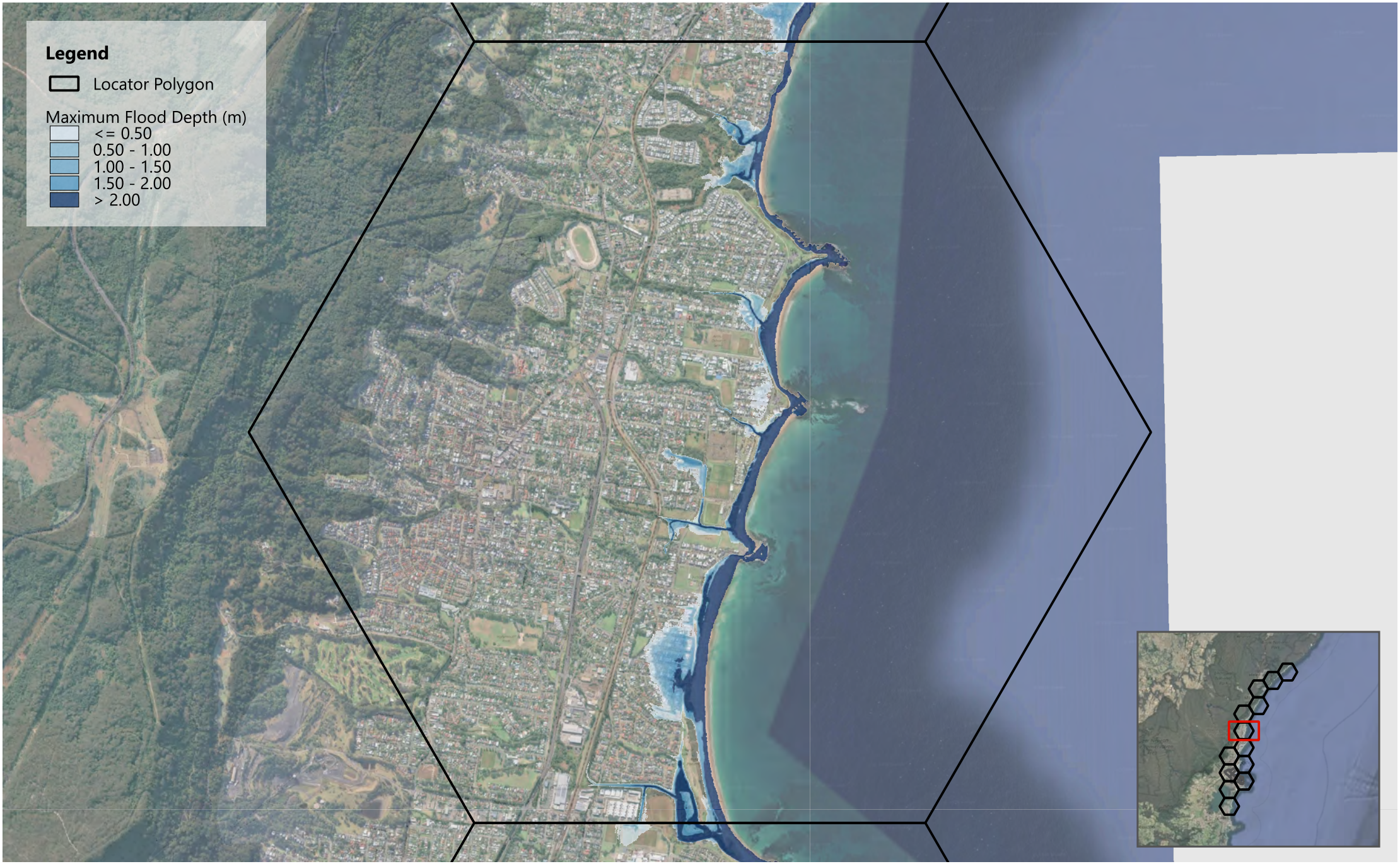
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Map Scale

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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2125 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 6

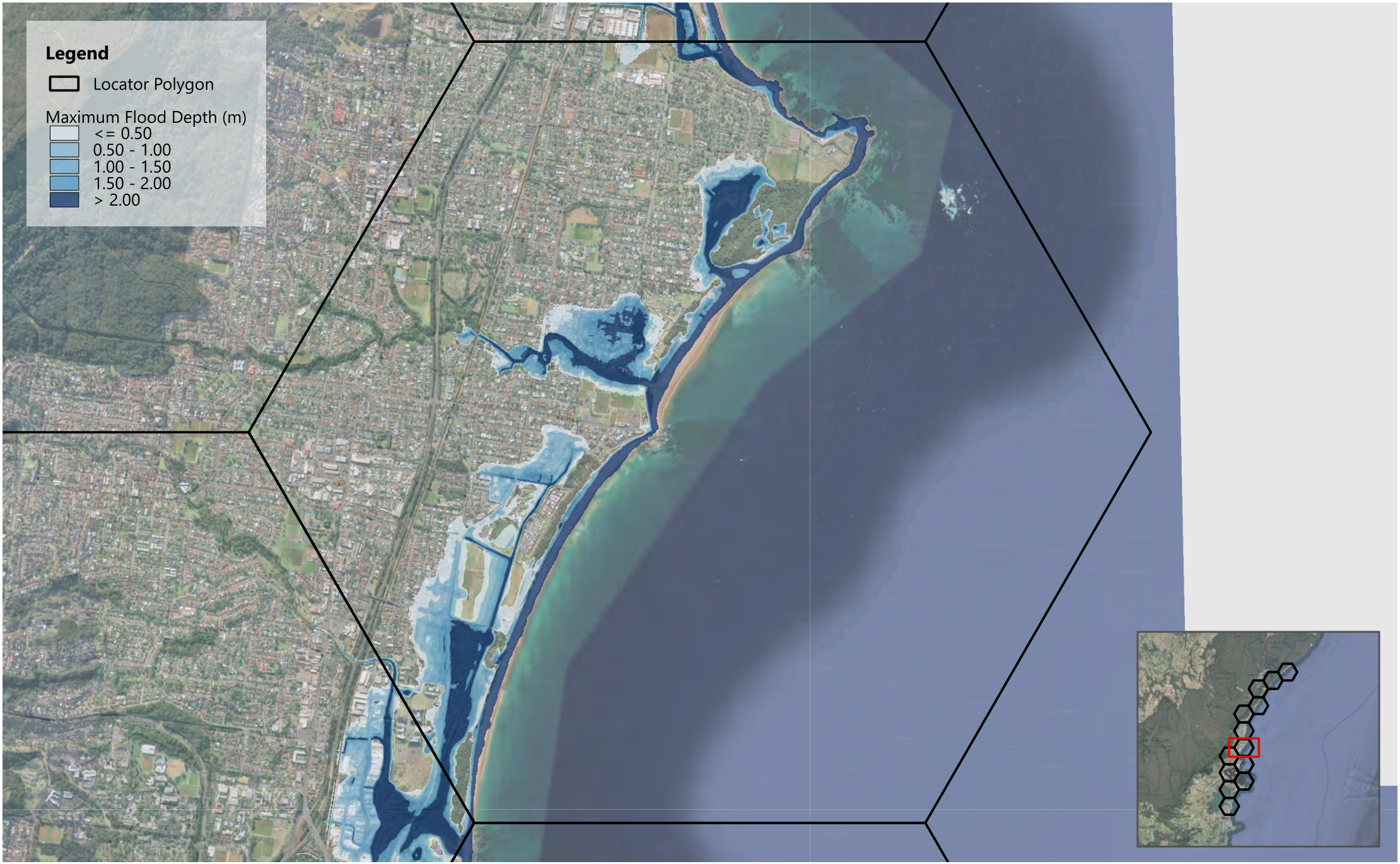
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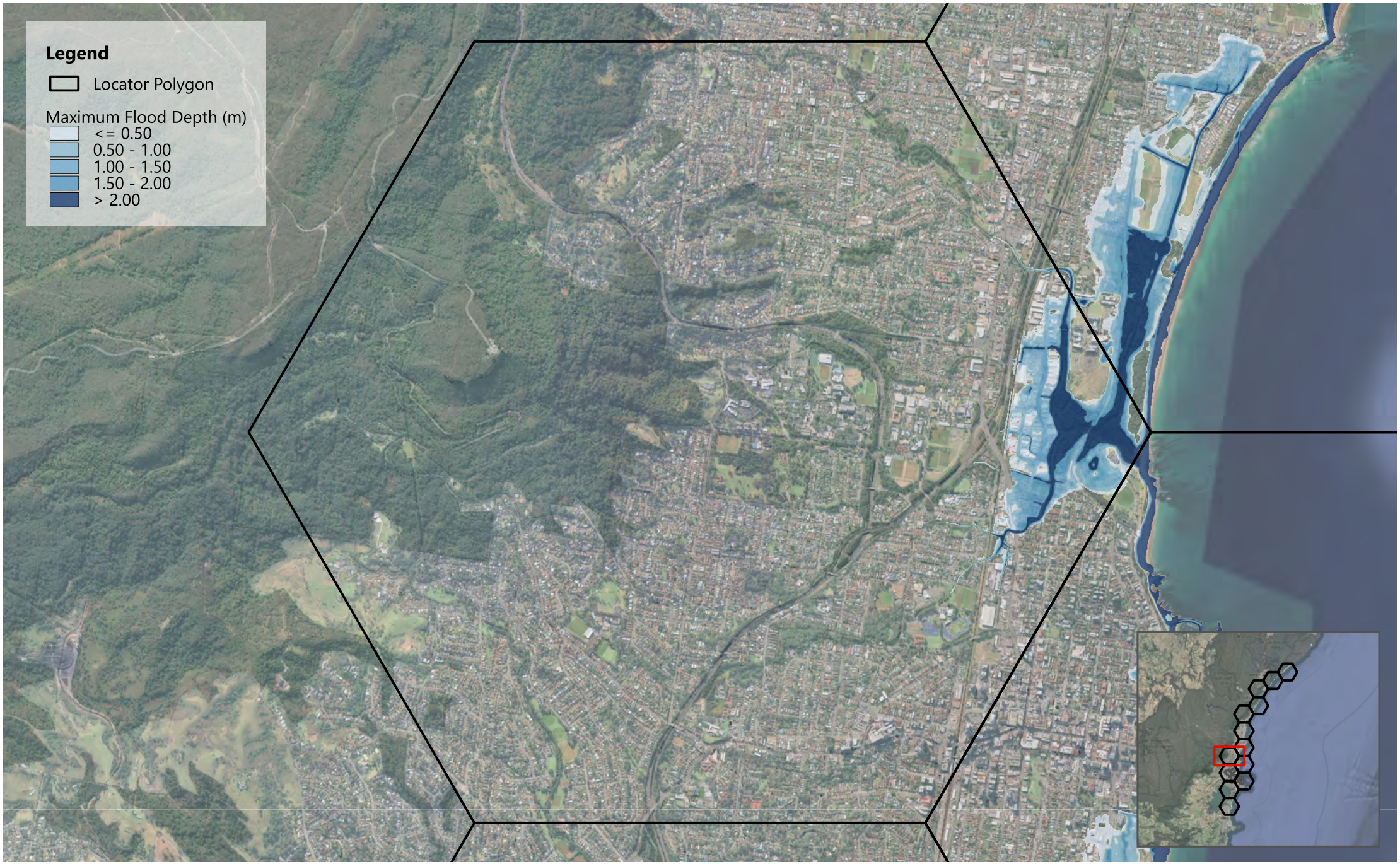
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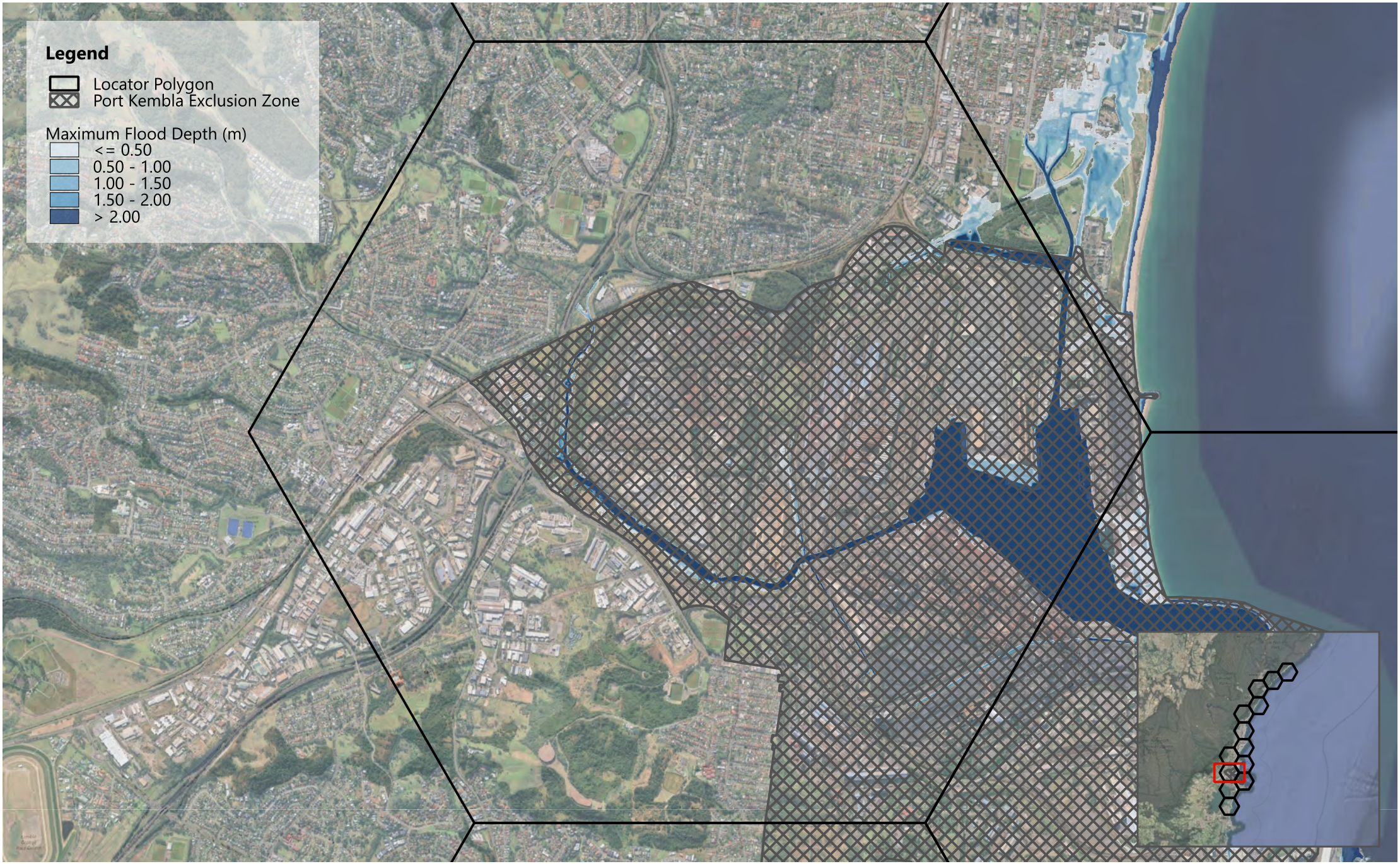
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Map Scale

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Wollongong Coastal Hazard Study: Coastal Inundation Mapping 2125 - 1% AEP - SSP5-8.5 95th Quantile Grid ID: 13

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C Appendix C – Beach Units and Statistical Model Results

This appendix has been supplied as a separate item alongside this report.

C.1 Statistical Model

The statistical model presented here combines erosion volumes from multiple contributing processes—storm demand, long-term retreat, and sea level rise—into a single, combined erosion volume distribution. This is achieved through a Monte Carlo-based probabilistic convolution of the individual volume distributions associated with each process.

This approach is a simplified but effective way to estimate erosion outcomes, allowing the interacting and cumulative effects of multiple erosion drivers to be accounted for within a unified probabilistic framework.

The 1%, 5%, and 63% probability values shown in the results represent specific quantiles from the combined erosion volume distribution. These values indicate the total projected erosion volumes that have a corresponding chance of being exceeded.

Importantly, the long-term erosion and sea level rise values listed alongside each combined probability in the table are not standalone probability estimates. Instead, they represent the individual component volumes that, together with storm demand, sum to the total erosion volume for that given probability level. Since multiple combinations can result in the same total probability, the values shown reflect a simplified case aligned with a representative storm demand.

The 1%, 5% and 63% probability values for the storm demand, as applied along the Wollongong Coast correspond to the 1%, 5% and 63% AEP storm demand volumes for the Immediate (2025) timeframe.

Note: The values presented here represent the potential erosion and recession unconstrained by any bedrock and are therefore not necessarily representative of the final mapped outputs. When converting erosion volumes into mapped extents, the results are constrained by underlying bedrock, which limits the actual extent of the hazard shown on final maps in some locations.

C.1.1 Number of transects per beach unit

Beach Unit	Number of Transects
Windang1	15
Windang2	26
Windang3	19
Windang4	9
Fishermans1	16
MMBeach1	9
MMBeach2	16
WollongongCity1	13
WollongongCity2	74
WollongongCity3	49
Brighton1	16
North1	1
North2	13
FairyMeadow2	34
Towradgi1	22
Towradgi3	3
Corrimal1	18
Corrimal2	12
Corrimal3	16
Bellambi1	17
Bellambi3	21
Bellambi4	5
Bellambi5	4
Bellambi6	15
Woonona1	6
Woonona2	17
Bulli1	3
Bulli2	11
Bulli3	5
Bulli4	7
Sandon1	6
Sandon2	3
Sandon3	9
McCauleys1	6
McCauleys2	10
McCauleys3	9
Thirroul1	19
Thirroul2	6
Thirroul3	7
Austinmer3	7
Austinmer5	19
Sharky1	9
Sharky2	13
Sharky3	11
Coledale2	9
Coledale4	7
Coledale6	10

Beach Unit	Number of Transects
Wombarra1	10
Scarborough1	6
Scarborough2	11
Coalcliff1	9
Coalcliff2	4
Stanwell1	17
Bulgo1	5
Bulgo2	3
Bulgo3	6
Werrong2	7
BurningPalms2	15
Era2	20
Era5	20
LittleGarie3	17

C.1.2 Table of statistical model inputs

Beach Unit	Unit Type	Av Shoreline Change (m/yr)	St.Dev. Shoreline Change	100-yr Hs (m)	Wave Exposure Factor	Headland Protection	Headland Protection Factor	% Reef Cover	Nearshore Protection Factor	Combined Exposure Factor	Design Storm Volume	Crest Height (m)	DoC 2025 (mAHD)	DoC 2025 width (m)
Windang1	Beach	0.3	0.2	3.93	0.893	Open	1.0	0.0	1.0	0.893	223	4.5	10	418
Windang2	Beach	0.0	0.0	3.93	0.893	Open	1.0	0.0	1.0	0.893	223	6	10	352
Windang3	Beach	-0.4	0.2	3.93	0.893	Open	1.0	0.0	1.0	0.893	223	5	10	370
Windang4	Beach	0.0	0.0	3.93	0.893	Partially Protected	0.9	0.0	1.0	0.804	201	5.5	10	422
Windang5	Headland	n/a	n/a	3.93	0.893	Partially Protected	0.9	0.0	1.0	0.804	n/a	n/a	0	n/a
Fishermans1	Beach	0.0	0.0	3.90	0.887	Partially Protected	0.7	0.0	1.0	0.621	155	2.5	10	479
Fishermans2	Rocky Beach	n/a	n/a	3.90	0.887	Partially Protected	0.9	0.4	0.6	0.479	n/a	n/a	0	n/a
MMBeach1	Beach	-0.1	0.1	3.93	0.893	Open	1.0	0.2	0.8	0.714	179	2	8	622
MMBeach2	Beach	0.0	0.0	3.93	0.893	Open	1.0	0.1	0.9	0.804	201	4	8	334
WollongongCity1	Beach	0.0	0.0	3.94	0.896	Open	1.0	0.0	1.0	0.896	224	6.5	10	294
WollongongCity2	Beach	0.0	0.0	3.92	0.891	Open	1.0	0.0	1.0	0.891	223	7	10	236
WollongongCity3	Beach	0.0	0.0	3.90	0.886		1.0	0.0	1.0	0.886	222	7.5	10	198
WollongongCity4	Headland	n/a	n/a	3.91	0.889	Open	1.0	0.0	1.0	0.880	n/a	n/a	0	n/a
Brighton1	Beach	-0.1	0.1	3.92	0.890	Protected	0.4	0.2	0.8	0.285	71	3.2	5	130
North1	Beach	0.0	0.0	3.99	0.906	Partially Protected	0.9	0.1	0.9	0.734	183	2.5	8	587
North2	Beach	0.0	0.0	3.99	0.906	Open	1.0	0.1	0.9	0.815	204	4.5	8	426
FairyMeadow1	Estuary	0.0	0.0	3.91	0.888	Open	1.0	0.0	1.0	0.888	222	1.5	5	138

Beach Unit	DoC 2045 (mAHD)	DoC 2045 width (m)	DoC 2075 (mAHD)	DoC 2075 width (m)	DoC 2125 (mAHD)	DoC 2125 width (m)	Sand Limited?	Length to Escarpment (m)	Scour Level (m)	Erodable Volume abv 0 mAHD	Notes
Windang1	12	670	14	951	19	1397			-1	380	Post 2007 mean recession due to training wall construction
Windang2	12	437	14	532	19	930			-1	688	Post 2007 mean recession due to training wall construction
Windang3	12	452	14	552	19	939			-1	547	
Windang4	12	527	14	650	19	987			-1	488	
Windang5	0	n/a	0	n/a	0	n/a			-1		Headland
Fishermans1	12	583	14	671	14	671	Yes	158	-1	45	Borehole- depth to rock 1.05m at 38.95 elevation Cliff top from Tetra Tech Defended by revetment
Fishermans2	0	n/a	0	n/a	0	n/a			-1		
MMBeach1	10	761	12	833	14	902			-1	185	Cliff top from Tetra Tech
MMBeach2	10	771	12	844	14	987			-1	226	Cliff top from Tetra Tech
WollongongCity1	12	351	14	427	19	816			-1	490	
WollongongCity2	12	311	14	744	19	1029			-1	653	Siltstone from Boreholes Limited by Quarternary Map - Sandstone
WollongongCity3	12	275	14	319	19	485			-1	819	
WollongongCity4	0	n/a	0	n/a	0	n/a			-1		Headland
Brighton1	5	130	5	130	5	130	Yes	105	-1	56	Quarternary Map - Sandstone Landforms dataset suggests benthic protection Defended by revetment
North1	10	692	12	733	14	752	Yes	44	-1	60	Sandstone from Boreholes Quarternary Map - Sandstone Cliff top from Tetratec Rock platform visible Defended by revetment
North2	5	153	5	153	5	153			-1	500	Sandstone and Siltstone from Boreholes Quarternary Map - Sandstone Cliff top from Tetratec Defended by revetment
FairyMeadow1	5	138	5	138	5	138			-1	41	Sandstone from Boreholes Landforms dataset suggests benthic protection Rock platform visible

Beach Unit	Unit Type	Av Shoreline Change (m/yr)	St.Dev. Shoreline Change	100-yr Hs (m)	Wave Exposure Factor	Headland Protection	Headland Protection Factor	% Reef Cover	Nearshore Protection Factor	Combined Exposure Factor	Design Storm Volume	Crest Height (m)	DoC 2025 (mAHD)	DoC 2025 width (m)
FairyMeadow2	Beach	0.0	0.0	3.91	0.888	Open	1.0	0.0	1.0	0.888	222	4	10	313
Towradgi1	Beach	0.0	0.0	3.97	0.902	Open	1.0	0.0	1.0	0.902	226	6	10	346
Towradgi2	Headland	n/a	n/a	3.97	0.902	Open	1.0	0.1	0.9	0.821	n/a	n/a	5	191
Towradgi3	Beach	0.0	0.0	3.97	0.902	Open	1.0	0.2	0.8	0.722	180	6	8	361
Towradgi4	Estuary	0.0	0.0	3.97	0.902	Open	1.0	0.0	1.0	0.902	226	3	8	332
Corrimal1	Beach	0.0	0.0	3.94	0.895	Open	1.0	0.0	1.0	0.895	224	7	8	434
Corrimal2	Estuary	0.4	0.2	3.94	0.895	Open	1.0	0.0	1.0	0.895	224	2.5	8	350
Corrimal3	Beach	0.0	0.0	3.94	0.895	Open	1.0	0.0	1.0	0.895	224	6.5	5	437
Bellambi1	Beach	0.3	0.2	3.94	0.895	Open	1.0	0.2	0.8	0.716	179	7	8	288
Bellambi2	Headland	n/a	n/a	3.94	0.895	Open	1.0	0.5	0.5	0.447	n/a	4	5	269
Bellambi3	Beach	-0.2	0.1	3.87	0.880	Partially Protected	0.8	0.3	0.7	0.493	123	4.5	5	350
Bellambi4	Beach	0.0	0.0	3.87	0.880	Partially Protected	0.9	0.1	0.9	0.713	178	4	5	298
Bellambi5	Estuary	0.0	0.0	3.87	0.880	Partially Protected	0.9	0.0	1.0	0.792	210	4	5	146
Bellambi6	Beach	0.1	0.1	3.87	0.880	Open	1.0	0.0	1.0	0.880	220	5	8	224
Woonona1	Beach	0.0	0.0	3.95	0.898	Open	1.0	0.0	1.0	0.898	224	5.5	8	255
Woonona2	Beach	0.0	0.0	3.95	0.898	Open	1.0	0.0	1.0	0.898	224	5.5	8	213
Woonona3	Headland	n/a	n/a	3.95	0.898	Open	1.0	0.0	1.0	0.898	n/a	n/a	5	198
Bulli1	Estuary	0.0	0.0	3.97	0.902	Partially Protected	0.9	0.0	1.0	0.812	203	5.5	8	302

Beach Unit	DoC 2045 (mAHD)	DoC 2045 width (m)	DoC 2075 (mAHD)	DoC 2075 width (m)	DoC 2125 (mAHD)	DoC 2125 width (m)	Sand Limited?	Length to Escarpment (m)	Scour Level (m)	Erodable Volume abv 0 mAHD	Notes
FairyMeadow2	12	392	14	489	19	767			-1	423	
Towradgi1	12	450	14	483	19	1066			-1	603	Geotechnical and Geophysical Survey - Tetra Tech
Towradgi2	5	191	5	191	5	191			-1		Headland
Towradgi3	10	696	12	800	14	843			-1	623	Landforms dataset suggests benthic protection Rock platform visible
Towradgi4	10	474	12	766	14	878			-1	308	
Corrimal1	10	617	12	773	14	915			-1	889	Boreholes- Sandstone Quarternary Map - Shale
Corrimal2	10	711	12	740	14	777			-1	292	Quarternary Map - Shale
Corrimal3	6	481	7	525	10	691			-1	779	Quarternary Map - Shale Landforms dataset suggests benthic protection Rock platform visible
Bellambi1	10	319	10	319	10	319			-1	900	Landforms dataset suggests benthic protection Rock platform visible
Bellambi2	5	269	5	269	5	269			-1		Headland
Bellambi3	6	404	7	459	10	604	Yes	89	0	80	Boreholes - Claystone Quarternary Map - Shale Defended by revetment
Bellambi4	6	361	7	424	8	487			-1	101	Quarternary Map - Shale Landforms dataset suggests benthic protection Defended by revetment
Bellambi5	6	211	7	277	8	342			-1	206	Quarternary Map - Shale
Bellambi6	10	326	12	521	14	695			-1	677	Boreholes - Weathered Sandstone Quarternary Map - Shale
Woonona1	10	376	12	564	14	692			-1	158	
Woonona2	10	281	12	546	14	623			-1	376	Cliff top from Tetra Tech Quarternary Map - Shale Geotechnical and Geophysical Survey - Tetra Tech
Woonona3	6	263	7	329	10	432			-1		Headland
Bulli1	10	392	12	474	14	614			-1	304	

Beach Unit	Unit Type	Av Shoreline Change (m/yr)	St.Dev. Shoreline Change	100-yr Hs (m)	Wave Exposure Factor	Headland Protection	Headland Protection Factor	% Reef Cover	Nearshore Protection Factor	Combined Exposure Factor	Design Storm Volume	Crest Height (m)	DoC 2025 (mAHD)	DoC 2025 width (m)
Bulli2	Beach	0.0	0.0	3.97	0.902	Open	1.0	0.0	1.0	0.902	225	5.5	8	277
Bulli3	Beach	0.0	0.0	3.97	0.902	Open	1.0	0.0	1.0	0.902	225	5	8	632
Bulli4	Beach	0.0	0.0	3.97	0.902	Open	1.0	0.0	0.7	0.631	158	5	5	139
Sandon1	Beach	0.0	0.0	4.01	0.911	Partially Protected	0.8	0.0	1.0	0.729	182	5	8	474
Sandon2	Estuary	-0.2	0.1	4.01	0.911	Partially Protected	0.8	0.0	1.0	0.729	182	5	8	481
Sandon3	Beach	0.0	0.1	4.01	0.911	Partially Protected	0.8	0.0	1.0	0.729	182	6	8	259
Sandon4	Headland	n/a	n/a	4.01	0.911	Open	1.0	0.0	1.0	0.911	n/a	n/a	5	123
McCauleys1	Beach	-0.3	0.1	3.92	0.891	Partially Protected	0.9	0.1	0.9	0.722	180	2.5	5	145
McCauleys2	Estuary	-0.3	0.2	3.92	0.891	Open	1.0	0.1	1.0	0.847	212	2.4	8	306
McCauleys3	Beach	-0.2	0.1	3.92	0.891	Open	1.0	0.0	1.0	0.891	223	2.7	5	169
Thirroul1	Beach	-0.3	0.2	3.90	0.886	Open	1.0	0.0	1.0	0.886	222	4	8	370
Thirroul2	Estuary	-0.4	0.2	3.90	0.886	Open	1.0	0.0	1.0	0.860	215	3.4	5	161

Beach Unit	DoC 2045 (mAHD)	DoC 2045 width (m)	DoC 2075 (mAHD)	DoC 2075 width (m)	DoC 2125 (mAHD)	DoC 2125 width (m)	Sand Limited?	Length to Escarpment (m)	Scour Level (m)	Erodable Volume abv 0 mAHD	Notes
Bulli2	10	366	12	441	14	558			0	238	Boreholes - Assumed rock Quarternary Map - Shale
Bulli3	10	643	12	776	14	814			-1	107	Boreholes - Sandstone
Bulli4	6	251	7	363	10	538			0	120	Cliff top from Tetra Tech Quarternary Map - Shale Landforms dataset suggests benthic protection Defended by revetment
Sandon1	10	524	10	524	10	524			-1	122	Cliff top from Tetra Tech Defended by revetment Geotechnical and Geophysical Survey - Tetra Tech
Sandon2	10	536	10	536	10	536			-1	216	Quarternary Map - Shale
Sandon3	10	288	10	288	10	288			-1	216	Boreholes- Weathered Sandstone Cliff top from Tetra Tech Quarternary Map - Shale Defended by revetment
Sandon4	5	123	5	123	5	123			-1		Headland
McCauleys1	6	193	7	241	10	436	Yes	46	0	15	Cliff top from Tetra Tech Quarternary Map - Shale Landforms dataset suggests benthic protection
McCauleys2	10	546	12	850	14	1159			-1	246	Headland
McCauleys3	6	195	7	220	10	338	Yes	39	-1	52	Boreholes - Sandstone Cliff top from Tetra Tech Quarternary Map - Shale Landforms dataset suggests benthic protection Defended by revetment Geotechnical and Geophysical Survey - Tetra Tech
Thirroul1	10	399	12	463	12	463			-1	343	Boreholes - Sandstone Cliff top from Tetra Tech Quarternary Map - Shale Defended by revetment Geotechnical and Geophysical Survey - Tetra Tech
Thirroul2	6	206	7	251	10	460			-1	298	Quarternary Map - Shale Geotechnical and Geophysical Survey - Tetra Tech

Beach Unit	Unit Type	Av Shoreline Change (m/yr)	St.Dev. Shoreline Change	100-yr Hs (m)	Wave Exposure Factor	Headland Protection	Headland Protection Factor	% Reef Cover	Nearshore Protection Factor	Combined Exposure Factor	Design Storm Volume	Crest Height (m)	DoC 2025 (mAHD)	DoC 2025 width (m)
Thirroul3	Beach	-0.3	0.2	3.90	0.886	Open	1.0	0.1	1.0	0.842	211	4	5	132
Thirroul4	Headland	n/a	n/a	3.90	0.886	Open	1.0	0.4	0.7	0.620	n/a	n/a	5	152
Austinmer1	Beach	0.2	0.1	3.89	0.884	Open	1.0	0.2	0.9	0.796	199	2.7	5	131
Austinmer2	Headland	n/a	n/a	3.89	0.884	Open	1.0	0.3	0.8	0.707	n/a	n/a	5	192
Austinmer3	Beach	-0.2	0.1	3.91	0.888	Partially Protected	0.9	0.0	1.0	0.775	194	4	5	89
Austinmer4	Headland	n/a	n/a	3.91	0.888	Open	1.0	0.2	0.8	0.711	n/a	n/a	5	220
Austinmer5	Beach	0.0	0.0	3.91	0.888	Partially Protected	0.9	0.0	1.0	0.799	200	4	5	116
Austinmer6	Headland	n/a	n/a	3.91	0.888	Open	1.0	0.0	1.0	0.888	n/a	n/a	5	166
Sharky1	Beach	0.0	0.0	3.87	0.879	Partially Protected	0.9	0.0	1.0	0.791	198	4.7	5	147
Sharky2	Beach	0.2	0.2	3.87	0.879	Partially Protected	0.9	0.1	0.9	0.712	178	3	5	250

Beach Unit	DoC 2045 (mAHD)	DoC 2045 width (m)	DoC 2075 (mAHD)	DoC 2075 width (m)	DoC 2125 (mAHD)	DoC 2125 width (m)	Sand Limited?	Length to Escarpment (m)	Scour Level (m)	Erodable Volume abv 0 mAHD	Notes
Thirroul3	6	165	7	198	10	257			-1	272	Cliff top from Tetra Tech Quarternary Map - Shale Rock platform visible Landforms dataset suggests benthic protection Geotechnical and Geophysical Survey - Tetra Tech
Thirroul4	6	167	7	181	10	281			-1		Headland
Austinmer1	5	131	5	131	5	131			-1	44	Cliff top from Tetra Tech Quarternary Map - Shale Rock platform visible Landforms dataset suggests benthic protection
Austinmer2	6	250	6	250	6	250			-1		Headland
Austinmer3	6	175	7	260	7	260			-1	153	Boreholes - Assumed rock Cliff top from Tetra Tech Quarternary Map - Shale Rock platform visible Landforms dataset suggests benthic protection Defended by revetment
Austinmer4	5	220	5	220	5	220			-1		Headland
Austinmer5	6	158	7	201	10	402	Yes	92	0	150	Quarternary Map - Shale Cliff top from Tetra Tech Rock platform visible Landforms dataset suggests benthic protection Geotechnical and Geophysical Survey - Tetra Tech
Austinmer6	5	166	5	166	5	166			-1		Headland
Sharky1	6	211	7	275	8	339	Yes	96	-1	150	Cliff top from Tetra Tech Quarternary Map - Shale Rock platform visible Landforms dataset suggests benthic protection
Sharky2	6	308	7	367	8	425	Yes	102	-1	100	Cliff top from Tetra Tech Quarternary Map - Shale Rock platform visible Landforms dataset suggests benthic protection

Beach Unit	Unit Type	Av Shoreline Change (m/yr)	St.Dev. Shoreline Change	100-yr Hs (m)	Wave Exposure Factor	Headland Protection	Headland Protection Factor	% Reef Cover	Nearshore Protection Factor	Combined Exposure Factor	Design Storm Volume	Crest Height (m)	DoC 2025 (mAHD)	DoC 2025 width (m)
Sharky3	Beach	0.2	0.1	3.87	0.879	Open	1.0	0.1	0.9	0.791	198	4.6	5	189
Coledale1	Headland	n/a	n/a	3.89	0.885	Partially Protected	0.9	0.0	1.0	0.797	n/a	n/a	5	334
Coledale2	Beach	0.0	0.0	3.89	0.885	Partially Protected	0.8	0.0	1.0	0.708	177	5	5	107
Coledale3	Headland	n/a	n/a	3.89	0.885	Partially Protected	0.8	0.0	1.0	0.708	n/a	n/a	5	152
Coledale4	Beach	0.0	0.0	3.89	0.885	Partially Protected	0.8	0.0	1.0	0.708	177	4	5	187
Coledale5	Headland	-0.1	0.1	3.89	0.885	Partially Protected	0.8	0.1	0.9	0.651	n/a	n/a	5	142
Coledale6	Beach	0.0	0.0	3.89	0.885	Partially Protected	0.8	0.1	0.9	0.637	159	5	5	77
Coledale7	Headland	n/a	n/a	3.88	0.882	Open	1.0	0.1	0.9	0.829	n/a	n/a	5	155
Wombarra1	Beach	-0.2	0.1	3.88	0.882	Open	0.9	0.5	0.6	0.476	119	2.3	5	140
Scarborough1	Estuary	0.0	0.0	3.92	0.891	Open	1.0	0.0	1.0	0.891	223	3.5	10	288

Beach Unit	DoC 2045 (mAHD)	DoC 2045 width (m)	DoC 2075 (mAHD)	DoC 2075 width (m)	DoC 2125 (mAHD)	DoC 2125 width (m)	Sand Limited?	Length to Escarpment (m)	Scour Level (m)	Erodable Volume abv 0 mAHD	Notes
Sharky3	6	227	7	264	8	302	Yes	83	-1	180	Cliff top from Tetra Tech Quarternary Map - Shale Rock platform visible Landforms dataset suggests benthic protection
Coledale1	6	365	6	365	6	365			-1		Headland
Coledale2	6	176	6	176	6	176	Yes	null	0	10	Based on vegetation line 2010-2024 Cliff retreat averaged as there is no 'beach' but erosion is still occuring Cliff top from Tetra Tech Quarternary Map - Shale Rock platform visible Landforms dataset suggests benthic protection
Coledale3	6	201	7	251	8	300			-1		Headland
Coledale4	6	223	7	258	8	294			0	29	Quarternary Map - Shale Rock platform visible Landforms dataset suggests benthic protection
Coledale5	6	227	7	312	8	397			-1		Headland
Coledale6	6	121.6667	7	166.3333	8	211			-1	104	Borehole - Suggests rock Cliff top from Tetra Tech Quarternary Map - Shale Rock platform visible Landforms dataset suggests benthic protection Defended by revetment
Coledale7	6	261	7	367	8	473			-1		Headland
Wombarra1	6	167.3333	7	194.6667	8	222			0	84	Cliff top from Tetra Tech Quarternary Map - Shale Rock platform visible Landforms dataset suggests benthic protection
Scarborough1	10	288	10	288	10	288			-1	140	Borehole - Suggests rock Cliff top from Tetra Tech Quarternary Map - Shale

Beach Unit	Unit Type	Av Shoreline Change (m/yr)	St.Dev. Shoreline Change	100-yr Hs (m)	Wave Exposure Factor	Headland Protection	Headland Protection Factor	% Reef Cover	Nearshore Protection Factor	Combined Exposure Factor	Design Storm Volume	Crest Height (m)	DoC 2025 (mAHD)	DoC 2025 width (m)
Scarborough2	Beach	0.0	0.0	3.92	0.891	Open	1.0	0.1	0.9	0.829	207	3.5	10	301
Scarborough3	Headland	n/a	n/a	3.92	0.891	Open	0.9	0.1	0.9	0.722	n/a	n/a	5	224
Sammy1	Beach	0.0	0.0	3.93	0.894	Partially Protected	0.8	0.1	0.9	0.651	163	3.6	5	90
Sammy2	Headland	n/a	n/a	3.93	0.894	Open	1.0	0.2	0.8	0.715	n/a	n/a	5	178
Clifton1	Beach	0.0	0.0	3.90	0.887	Partially Protected	0.8	0.3	0.8	0.567	142	1.9	5	178
Clifton2	Headland	n/a	n/a	4.01	0.911	Open	1.0	0.0	1.0	0.875	n/a	n/a	5	147
Coalcliff1	Beach	-0.4	0.1	4.01	0.911	Partially Protected	0.8	0.0	1.0	0.700	175	4	10	467
Coalcliff2	Headland	n/a	n/a	4.01	0.911	Partially Protected	0.8	0.0	1.0	0.700	n/a	4	10	467
Coalcliff3	Headland	n/a	n/a	4.01	0.911	Open	1.0	0.0	1.0	0.911	n/a	n/a	8	217
Stanwell1	Estuary	0.0	0.0	4.09	0.928	Open	1.0	0.0	1.0	0.928	232	6	10	358
Bulgo1	Rocky Beach	0.0	0.0	4.00	0.909	Open	1.0	0.0	0.7	0.636	159	3.8	5	117

Beach Unit	DoC 2045 (mAHD)	DoC 2045 width (m)	DoC 2075 (mAHD)	DoC 2075 width (m)	DoC 2125 (mAHD)	DoC 2125 width (m)	Sand Limited?	Length to Escarpment (m)	Scour Level (m)	Erodable Volume abv 0 mAHD	Notes
Scarborough2	10	301	10	301	10	301			-1	153	Cliff top from Tetra Tech Quarternary Map - Shale and Sandstone Rock platform visible Landforms dataset suggests benthic protection
Scarborough3	6	267	7	310	10	396			-1		Headland
Sammy1	6	116.6667	7	143.3333	10	297	Yes	62	-1	78	Cliff top from Tetra Tech Quarternary Map - Shale and Sandstone Rock platform visible Landforms dataset suggests benthic protection
Sammy2	6	260.6667	7	343.3333	10	517			-1		Headland
Clifton1	6	167	6	167	6	167	Yes	50	-1	23	No points in this unit Cliff top from Tetra Tech Quarternary Map - Shale and Sandstone Rock platform visible Landforms dataset suggests benthic protection
Clifton2	6	264	7	315	10	467			-1		Headland
Coalcliff1	12	531	14	626	19	950	Yes	59	-1	100	Boreholes- Sandstone Cliff top from Tetra Tech Quarternary Map - Sandstone Rock platform visible Protected by seawall Geotechnical and Geophysical Survey - Tetra Tech
Coalcliff2	12	531	14	626	19	950	Yes	35	-1		Rocky, limited sand visbale from aerial imagery. Headland?
Coalcliff3	10	280	12	351	14	446			-1		Headland
Stanwell1	12	432	14	511	19	758			-1	190	Boreholes- Claystone Cliff top from Tetra Tech Quarternary Map - Sandstone Geotechnical and Geophysical Survey - Tetra Tech
Bulgo1	6	141.3333	7	165.6667	10	238	Yes	40	0	40	Boreholes- Claystone Cliff top from Tetra Tech Quarternary Map - Sandstone Rock platform visible

Beach Unit	Unit Type	Av Shoreline Change (m/yr)	St.Dev. Shoreline Change	100-yr Hs (m)	Wave Exposure Factor	Headland Protection	Headland Protection Factor	% Reef Cover	Nearshore Protection Factor	Combined Exposure Factor	Design Storm Volume	Crest Height (m)	DoC 2025 (mAHD)	DoC 2025 width (m)
Bulgo2	Beach	0.0	0.0	4.00	0.909	Open	1.0	0.0	1.0	0.909	227	3.8	5	134
Bulgo3	Beach	0.0	0.0	4.00	0.909	Open	1.0	0.0	1.0	0.909	227	3.5	5	248
Werrong1	Headland	n/a	n/a	4.20	0.955	Open	1.0	0.0	1.0	0.955	n/a	n/a	5	83
Werrong2	Beach	-0.4	0.1	4.20	0.955	Partially Protected	0.9	0.0	1.0	0.859	215	2.8	8	302
BurningPalms1	Headland	n/a	n/a	4.20	0.955	Open	1.0	0.0	1.0	0.955	n/a	n/a	10	281
BurningPalms2	Beach	0.0	0.0	4.20	0.955	Partially Protected	0.8	0.0	1.0	0.764	191	3.1	10	380
Era1	Headland	n/a	n/a	4.20	0.955	Partially Protected	0.9	0.0	1.0	0.859	n/a	n/a	10	214
Era2	Beach	0.0	0.0	4.20	0.955	Partially Protected	0.8	0.0	1.0	0.764	191	5.4	10	592
Era4	Headland	n/a	n/a	4.40	1.000	Partially Protected	0.8	0.0	1.0	0.800	n/a	n/a	10	305
Era5	Beach	-0.4	0.2	4.40	1.000	Partially Protected	0.8	0.0	1.0	0.800	200	4	10	459
LittleGarie1	Headland	n/a	n/a	4.40	1.000	Open	1.0	0.0	1.0	1.000	n/a	n/a	8	202
LittleGarie2	Bay	n/a	n/a	4.40	1.000	Partially Protected	0.9	0.0	1.0	0.900	n/a	4	8	300
LittleGarie3	Bay	0.0	0.0	4.40	1.000	Partially Protected	0.9	0.0	1.0	0.900	225	4.7	10	368
LittleGarie4	Headland	n/a	n/a	4.30	0.977	Partially Protected	0.9	0.0	1.0	0.880	n/a	n/a	10	328

Beach Unit	DoC 2045 (mAHD)	DoC 2045 width (m)	DoC 2075 (mAHD)	DoC 2075 width (m)	DoC 2125 (mAHD)	DoC 2125 width (m)	Sand Limited?	Length to Escarpment (m)	Scour Level (m)	Erodable Volume abv 0 mAHD	Notes
Bulgo2	6	174	7	214	10	335	Yes	132	0	128	Quarternary Map - Sandstone Rock platform visible Landforms dataset suggests benthic protection
Bulgo3	6	287	7	326	10	427	Yes	135	-1	63	Quarternary Map - Sandstone Rock platform visible Landforms dataset suggests benthic protection
Werrong1	6	112	7	141	10	224			-1		Headland
Werrong2	10	357	12	424	14	487	Yes	147	-1	69	Quarternary Map - Sandstone Rock platform visible
BurningPalms1	12	340	14	406	19	619			-1		Headland
BurningPalms2	12	459	14	521	19	765	Yes	null	-1	93	Quarternary Map - Sandstone
Era1	12	276	14	339	19	542			-1		Headland
Era2	12	713	14	828	19	1084	Yes	null	-1	542	Quarternary Map - Sandstone Rock platform visible
Era4	12	379	14	469	19	777			-1		Headland
Era5	12	554	14	638	19	937	Yes	null	-1	868	Quarternary Map - Sandstone Rock platform visible
LittleGarie1	10	228	12	279	14	350			1		Headland
LittleGarie2	10	371	12	466	14	634			1		Quarternary Map - Sandstone Rock platform visible Landforms dataset suggests benthic protection
LittleGarie3	12	460	14	619	19	948	Yes	90	1	167	Quarternary Map - Sandstone Rock platform visible Landforms dataset suggests benthic protection
LittleGarie4	12	412	14	501	19	771			1		Headland

C.1.3 Table of statistical model outputs – beach unit summary

Beach Unit	Profiles	Epoch	Design Storm Vol (m3/m)	Limited Sand	Est. Minimum Sand Available (m3/m)	Storm Vol 63% (m3/m)	Storm Vol 5% (m3/m)	Storm Vol 1% (m3/m)	Long-term Erosion Vol 63% (m3/m)	Long-term Erosion Vol 5% (m3/m)	Long-term Erosion Vol 1% (m3/m)	SLR Erosion Vol 63% (m3/m)	SLR Erosion Vol 5% (m3/m)	SLR Erosion Vol 1% (m3/m)
Windang1	15	2025	223	No	380	56.4	167.5	223.3	0	0	0	0	0	0
Windang1	15	2045	223	No	380	56.4	167.5	223.3	-17	1.3	7.4	10.8	14	14.7
Windang1	15	2075	223	No	380	56.4	167.5	223.3	-17	1.3	7.4	44.7	63.2	67.1
Windang1	15	2125	223	No	380	56.4	167.5	223.3	-17	1.3	7.4	131.5	201.1	215.9
Windang2	26	2025	223	No	688	56.4	167.5	223.3	0	0	0	0	0	0
Windang2	26	2045	223	No	688	56.4	167.5	223.3	0	0	0	8.6	11.1	11.7
Windang2	26	2075	223	No	688	56.4	167.5	223.3	0	0	0	30.8	43.6	46.3
Windang2	26	2125	223	No	688	56.4	167.5	223.3	0	0	0	109.7	167.8	180.1
Windang3	19	2025	223	No	547	56.4	167.5	223.3	0	0	0	0	0	0
Windang3	19	2045	223	No	547	56.4	167.5	223.3	16.2	36.5	43.3	7.8	10.2	10.7
Windang3	19	2075	223	No	547	56.4	167.5	223.3	40.4	91.1	108.2	28.1	39.7	42.1
Windang3	19	2125	223	No	547	56.4	167.5	223.3	80.7	182.3	216.3	96.2	147.1	157.9
Windang4	2	2025	201	No	488	50.8	150.8	201	0	0	0	0	0	0
Windang4	2	2045	201	No	488	50.8	150.8	201	0	0	0	9.8	12.7	13.3
Windang4	2	2075	201	No	488	50.8	150.8	201	0	0	0	35.4	50.1	53.2
Windang4	2	2125	201	No	488	50.8	150.8	201	0	0	0	108.9	166.6	178.8
Fishermans1	9	2025	155	Yes	45	39.2	45	45	0	0	0	0	0	0
Fishermans1	9	2045	155	Yes	45	39.2	45	45	0	0	0	5.9	7.7	8.1
Fishermans1	9	2075	155	Yes	45	39.2	45	45	0	0	0	19.6	27.8	29.5
Fishermans1	9	2125	155	Yes	45	39.2	45	45	0	0	0	50	76.4	82
MMBeach1	10	2025	179	No	185	45.1	134	178.7	0	0	0	0	0	0
MMBeach1	10	2045	179	No	185	45.1	134	178.7	1.6	3.7	4.3	7.5	9.7	10.2
MMBeach1	10	2075	179	No	185	45.1	134	178.7	4	9.1	10.8	23	32.5	34.5
MMBeach1	10	2125	179	No	185	45.1	134	178.7	8.1	18.2	21.6	55.4	84.8	91
MMBeach2	16	2025	201	No	226	50.8	150.8	201	0	0	0	0	0	0
MMBeach2	16	2045	201	No	226	50.8	150.8	201	0	0	0	13	16.9	17.7
MMBeach2	16	2075	201	No	226	50.8	150.8	201	0	0	0	40.8	57.6	61.2

Beach Unit	Profiles	Epoch	Combined Erosion Vol 63% (m3/m)	Combined Erosion Vol 5% (m3/m)	Combined Erosion Vol 1% (m3/m)	L_ZWI 63% (m)	L_ZWI 5% (m)	L_ZWI 1% (m)	L_ZSA 63% (m)	L_ZSA 5% (m)	L_ZSA 1% (m)	L_ZRFC 63% (m)	L_ZRFC 5% (m)	L_ZRFC 1% (m)
Windang1	15	2025	56.4	167.5	223.3	49.6	78.7	90	0.9	2.2	1.5	8.9	9.2	13.3
Windang1	15	2045	54.2	166.8	223.7	48.9	78.6	90.1	0.9	2.2	1.5	8.9	9.2	13.4
Windang1	15	2075	91.7	205.2	262.9	60.2	86	99.3	1.1	1.8	2.8	10.3	10.8	21
Windang1	15	2125	186.9	314.5	373.7	82.3	108.4	115.9	2.5	6.8	6.2	9.1	18.5	19.4
Windang2	26	2025	56.4	167.5	223.3	46.2	67.8	76.1	1	3.2	2.4	17.4	10.8	9.8
Windang2	26	2045	65.6	176.7	233.1	49	69.2	77.7	1.2	3.5	2.4	17.3	10.2	9.5
Windang2	26	2075	90.1	201.6	259.6	55.3	72.8	82.5	2.5	2.9	2	14.8	9.8	12.1
Windang2	26	2125	177.1	298.5	357.4	69.2	90.9	102.4	3.5	1.9	2.9	10.2	13.1	8.3
Windang3	19	2025	56.4	167.5	223.3	46.2	73.9	83.7	0.4	2.4	3.1	8	12.6	9.4
Windang3	19	2045	84.4	197.5	253.7	56.7	79.3	88.6	0.8	3.3	2	15.2	10.2	11
Windang3	19	2075	136.2	256.9	313.6	68.9	89.1	100.6	3.2	2	2.1	13	11	10.8
Windang3	19	2125	257.6	411.1	473.6	89.2	120.8	134.4	2	1.9	3.6	11	11.8	14
Windang4	2	2025	50.8	150.8	201	59.3	96.6	110.1	0.2	1.2	1.4	7	9.2	9.6
Windang4	2	2045	61.2	161.2	211.8	64.1	99.5	112.9	0.2	1.6	1.4	7	9	9.7
Windang4	2	2075	89.4	190	241	76.8	107.1	120.4	0.3	1.3	1.5	9.3	9.6	9.9
Windang4	2	2125	170.2	281.1	334.9	101.8	130.5	143.1	1.4	1.6	1.9	9.2	10.8	21
Fishermans1	9	2025	39.2	45	45	28.6	29.2	29.2	12.2	15.3	15.3	29	25.7	25.7
Fishermans1	9	2045	45	45	45	29.2	29.2	29.2	15.3	15.3	15.3	25.7	25.7	25.7
Fishermans1	9	2075	45	45	45	29.2	29.2	29.2	15.3	15.3	15.3	25.7	25.7	25.7
Fishermans1	9	2125	45	45	45	29.2	29.2	29.2	15.3	15.3	15.3	25.7	25.7	25.7
MMBeach1	10	2025	45.1	134	178.7	38.2	50	54.6	5.5	6.8	5.8	19.2	17.9	19.1
MMBeach1	10	2045	55.1	143.9	189.5	39.8	51.1	55.7	5.7	6.2	5.9	19	18.5	18.9
MMBeach1	10	2075	75.2	164.8	210.6	42.8	53.2	57.8	5.8	5.8	6.1	18.7	19	18.8
MMBeach1	10	2125	116.6	208.9	256.9	48	57.6	62.5	7.2	6.1	5.8	17.7	18.8	19
MMBeach2	16	2025	50.8	150.8	201	71.4	88.5	94.4	0.2	5	5	21	16.2	18.3
MMBeach2	16	2045	64.7	164.5	215	76.2	90.1	96	7	5	5	14.5	16.1	18.5
MMBeach2	16	2075	95.2	195.9	247.1	81.5	93.8	99.7	5.4	5.1	4.8	16.1	18.2	18.8

Beach Unit	Profiles	Epoch	Design Storm Vol (m3/m)	Limited Sand	Est. Minimum Sand Available (m3/m)	Storm Vol 63% (m3/m)	Storm Vol 5% (m3/m)	Storm Vol 1% (m3/m)	Long-term Erosion Vol 63% (m3/m)	Long-term Erosion Vol 5% (m3/m)	Long-term Erosion Vol 1% (m3/m)	SLR Erosion Vol 63% (m3/m)	SLR Erosion Vol 5% (m3/m)	SLR Erosion Vol 1% (m3/m)
MMBeach2	16	2125	201	No	226	50.8	150.8	201	0	0	0	107.8	164.9	177
WollongongCity1	12	2025	224	No	490	56.6	168.1	224.1	0	0	0	0	0	0
WollongongCity1	12	2045	224	No	490	56.6	168.1	224.1	0	0	0	7.3	9.4	9.9
WollongongCity1	12	2075	224	No	490	56.6	168.1	224.1	0	0	0	26.2	37	39.3
WollongongCity1	12	2125	224	No	490	56.6	168.1	224.1	0	0	0	102.2	156.4	167.8
WollongongCity2	39	2025	223	No	653	56.3	167.2	222.9	0	0	0	0	0	0
WollongongCity2	39	2045	223	No	653	56.3	167.2	222.9	0	0	0	6.8	8.8	9.2
WollongongCity2	39	2075	223	No	653	56.3	167.2	222.9	0	0	0	47.9	67.7	71.9
WollongongCity2	39	2125	223	No	653	56.3	167.2	222.9	0	0	0	136.2	208.3	223.6
WollongongCity3	51	2025	222	No	819	56	166.2	221.6	0	0	0	0	0	0
WollongongCity3	51	2045	222	No	819	56	166.2	221.6	0	0	0	6.2	8.1	8.5
WollongongCity3	51	2075	222	No	819	56	166.2	221.6	0	0	0	21.5	30.4	32.3
WollongongCity3	51	2125	222	No	819	56	166.2	221.6	0	0	0	67.5	103.2	110.8
Brighton1	15	2025	71	No	56	18	53.4	71.2	0	0	0	0	0	0
Brighton1	15	2045	71	No	56	18	53.4	71.2	2	8.5	10.7	3	3.9	4.1
Brighton1	15	2075	71	No	56	18	53.4	71.2	4.9	21.2	26.6	9.8	13.9	14.7
Brighton1	15	2125	71	No	56	18	53.4	71.2	9.8	42.3	53.2	24.9	38.1	40.9
North1	0	2025	183	Yes	60	46.4	60	60	0	0	0	0	0	0
North1	0	2045	183	Yes	60	46.4	60	60	0	0	0	8.2	10.6	11.1
North1	0	2075	183	Yes	60	46.4	60	60	0	0	0	24.4	34.5	36.7
North1	0	2125	183	Yes	60	46.4	60	60	0	0	0	56	85.7	91.9
North2	4	2025	204	No	500	51.5	152.9	203.9	0	0	0	0	0	0
North2	4	2045	204	No	500	51.5	152.9	203.9	0	0	0	4.3	5.5	5.8
North2	4	2075	204	No	500	51.5	152.9	203.9	0	0	0	14	19.8	21
North2	4	2125	204	No	500	51.5	152.9	203.9	0	0	0	35.6	54.5	58.5
FairyMeadow2	35	2025	222	No	423	56.1	166.5	222	0	0	0	0	0	0
FairyMeadow2	35	2045	222	No	423	56.1	166.5	222	0	0	0	5.8	7.5	7.9

Beach Unit	Profiles	Epoch	Combined Erosion Vol 63% (m3/m)	Combined Erosion Vol 5% (m3/m)	Combined Erosion Vol 1% (m3/m)	L_ZWI 63% (m)	L_ZWI 5% (m)	L_ZWI 1% (m)	L_ZSA 63% (m)	L_ZSA 5% (m)	L_ZSA 1% (m)	L_ZRFC 63% (m)	L_ZRFC 5% (m)	L_ZRFC 1% (m)
MMBeach2	16	2125	169	279.8	333.2	90.6	103.5	109.7	5	4.8	6	16.2	17.6	15.4
WollongongCity1	12	2025	56.6	168.1	224.1	42.7	74.5	85.4	0.7	1.9	3.2	8.3	15.3	14.5
WollongongCity1	12	2045	64.4	176	232.4	45.3	76.1	86.8	0.7	2.4	4.5	8.2	14.7	13
WollongongCity1	12	2075	85.1	197	255.2	52.2	80.4	90.5	0.8	2.6	3.4	9	15.1	13.6
WollongongCity1	12	2125	169	289.1	349.7	74.7	95.5	104.3	1.9	3.8	3.3	15.3	12.6	10.9
WollongongCity2	39	2025	56.3	167.2	222.9	47.3	83.1	93.4	0.3	2.3	3.4	7.5	14.3	14.4
WollongongCity2	39	2045	63.6	174.5	230.6	50.3	84.7	94.6	0.3	2.8	3.2	7.7	14.4	14.6
WollongongCity2	39	2075	108.4	220.2	277.9	67.2	92.9	101.9	0.9	3.4	3.9	10	14.4	13.9
WollongongCity2	39	2125	205.1	331.6	391.5	90.5	109.6	118.2	3.5	3.8	3.9	14.3	13.3	12.8
WollongongCity3	51	2025	56	166.2	221.6	49.9	73.7	79.1	0.1	8.9	7.7	7.5	20.1	21.2
WollongongCity3	51	2045	62.7	173	228.8	53	74.4	79.7	0.1	8.9	7.5	9.6	20.1	21.4
WollongongCity3	51	2075	79.4	189.8	246.9	59.9	76.1	81.3	1.2	8.6	7.3	27.4	20.3	21.5
WollongongCity3	51	2125	130.6	244.3	305	69.8	81	86.2	7.4	7.3	7.6	21.8	21.6	21.3
Brighton1	15	2025	18	53.4	71.2	40	53.2	57.1	0	2.2	2.2	7.5	11.2	11.3
Brighton1	15	2045	24.3	60.3	78.2	43	54.8	58.5	0.1	2.3	2.2	12.6	11.2	11.4
Brighton1	15	2075	36.5	74.8	92.9	48.4	57.8	61.5	0.6	2.2	2.2	12.4	11.3	33.2
Brighton1	15	2125	59.8	108.3	128.2	54.7	64.7	68.7	2.3	2.3	2.3	11.1	33.4	33.8
North1	0	2025	46.4	60	60	27.9	30.2	30.2	16.8	17.2	17.2	23.6	24.2	24.2
North1	0	2045	55.1	60	60	29.4	30.2	30.2	17.5	17.2	17.2	23.7	24.2	24.2
North1	0	2075	60	60	60	30.2	30.2	30.2	17.2	17.2	17.2	24.2	24.2	24.2
North1	0	2125	60	60	60	30.2	30.2	30.2	17.2	17.2	17.2	24.2	24.2	24.2
North2	4	2025	51.5	152.9	203.9	50.6	86	96	0.1	2.2	2.9	6.8	12.9	10.9
North2	4	2045	56.1	157.5	208.6	52.7	87	96.8	0.1	2.2	2.8	6.8	12.8	10.9
North2	4	2075	66.8	168	219.9	57.8	89.1	98.7	0.1	2.3	2.8	6.9	12.7	10.8
North2	4	2125	91	193.4	246.1	69.1	94.1	103.3	0.2	3.2	2.5	11.9	11	10.6
FairyMeadow2	35	2025	56.1	166.5	222	46.3	73.4	84.8	0.8	2.3	1.6	9.2	9.4	9.7
FairyMeadow2	35	2045	62.3	172.8	228.6	48.3	74.6	86.4	0.9	2.1	1.5	9.2	9.4	10

Beach Unit	Profiles	Epoch	Design Storm Vol (m3/m)	Limited Sand	Est. Minimum Sand Available (m3/m)	Storm Vol 63% (m3/m)	Storm Vol 5% (m3/m)	Storm Vol 1% (m3/m)	Long-term Erosion Vol 63% (m3/m)	Long-term Erosion Vol 5% (m3/m)	Long-term Erosion Vol 1% (m3/m)	SLR Erosion Vol 63% (m3/m)	SLR Erosion Vol 5% (m3/m)	SLR Erosion Vol 1% (m3/m)
FairyMeadow2	35	2075	222	No	423	56.1	166.5	222	0	0	0	21	29.7	31.5
FairyMeadow2	35	2125	222	No	423	56.1	166.5	222	0	0	0	65.6	100.3	107.6
Towradgi1	11	2025	226	No	603	57	169.2	225.6	0	0	0	0	0	0
Towradgi1	11	2045	226	No	603	57	169.2	225.6	0	0	0	8.8	11.5	12
Towradgi1	11	2075	226	No	603	57	169.2	225.6	0	0	0	28	39.6	42
Towradgi1	11	2125	226	No	603	57	169.2	225.6	0	0	0	125.7	192.3	206.5
Towradgi3	4	2025	180	No	623	45.6	135.4	180.5	0	0	0	0	0	0
Towradgi3	4	2045	180	No	623	45.6	135.4	180.5	0	0	0	15.4	20	20.9
Towradgi3	4	2075	180	No	623	45.6	135.4	180.5	0	0	0	51.5	72.8	77.4
Towradgi3	4	2125	180	No	623	45.6	135.4	180.5	0	0	0	124.3	190.1	204.1
Corrimal1	9	2025	224	No	889	56.5	167.8	223.7	0	0	0	0	0	0
Corrimal1	9	2045	224	No	889	56.5	167.8	223.7	0	0	0	15	19.4	20.4
Corrimal1	9	2075	224	No	889	56.5	167.8	223.7	0	0	0	55	77.8	82.6
Corrimal1	9	2125	224	No	889	56.5	167.8	223.7	0	0	0	149.9	229.3	246.1
Corrimal2	24	2025	224	No	292	56.5	167.8	223.7	0	0	0	0	0	0
Corrimal2	24	2045	224	No	292	56.5	167.8	223.7	-11.9	-1.8	1.6	8.4	10.9	11.4
Corrimal2	24	2075	224	No	292	56.5	167.8	223.7	-11.9	-1.8	1.6	24.6	34.8	37
Corrimal2	24	2125	224	No	292	56.5	167.8	223.7	-11.9	-1.8	1.6	57.9	88.5	95
Corrimal3	16	2025	224	No	779	56.5	167.8	223.7	0	0	0	0	0	0
Corrimal3	16	2045	224	No	779	56.5	167.8	223.7	0	0	0	14.7	19.1	20.1
Corrimal3	16	2075	224	No	779	56.5	167.8	223.7	0	0	0	48.8	69	73.3
Corrimal3	16	2125	224	No	779	56.5	167.8	223.7	0	0	0	133.8	204.6	219.7
Bellambi1	17	2025	179	No	900	45.2	134.3	179	0	0	0	0	0	0
Bellambi1	17	2045	179	No	900	45.2	134.3	179	-26.4	2	11.6	7.7	10.1	10.5
Bellambi1	17	2075	179	No	900	45.2	134.3	179	-26.4	2	11.6	25.4	35.9	38.1
Bellambi1	17	2125	179	No	900	45.2	134.3	179	-26.4	2	11.6	64.6	98.7	106
Bellambi3	25	2025	123	Yes	80	31.1	80	80	0	0	0	0	0	0

Beach Unit	Profiles	Epoch	Combined Erosion Vol 63% (m3/m)	Combined Erosion Vol 5% (m3/m)	Combined Erosion Vol 1% (m3/m)	L_ZWI 63% (m)	L_ZWI 5% (m)	L_ZWI 1% (m)	L_ZSA 63% (m)	L_ZSA 5% (m)	L_ZSA 1% (m)	L_ZRFC 63% (m)	L_ZRFC 5% (m)	L_ZRFC 1% (m)
FairyMeadow2	35	2075	79	189.5	246.7	53.5	77.9	90.7	1.1	2.1	1.5	11.9	9.3	10.8
FairyMeadow2	35	2125	128.6	242.2	303.4	66	89.6	104.1	2.3	1.6	2	10.9	10.6	10.8
Towradgi1	11	2025	57	169.2	225.6	51.9	74.6	81.8	0.5	4.3	3.9	15.2	14.1	13.5
Towradgi1	11	2045	66.5	178.7	235.7	55.3	75.8	83.1	0.6	4.3	3.8	18.9	13.9	13.6
Towradgi1	11	2075	87.5	200	258.5	61.9	78.5	86.1	3.4	4.3	3.9	16.3	13.5	13.5
Towradgi1	11	2125	194.8	320.1	380.3	77.9	94.5	103.2	4.4	3.4	3.5	13.6	22.9	16.7
Towradgi3	4	2025	45.6	135.4	180.5	62.5	88.7	104.5	1.2	0.7	1.6	8.4	7.3	12.3
Towradgi3	4	2045	62.1	151.6	197.5	67	94.2	108.8	1.7	0.7	2.1	8.3	8.8	11.5
Towradgi3	4	2075	101.6	193	241.2	78	107.8	117.9	1.1	2.4	2.2	7.7	11.3	11
Towradgi3	4	2125	180.9	287.9	336.8	104.6	127	136.9	1.7	2.2	2.1	12.2	10.7	10.7
Corrimal1	9	2025	56.5	167.8	223.7	59.4	104.4	113.9	0	3.4	2.3	6.7	11.5	14.1
Corrimal1	9	2045	72.6	183.6	239.9	67.4	107.3	116.4	0	2.9	2.7	6.7	11.9	13.6
Corrimal1	9	2075	116.3	229.4	287	87.6	114.7	124.7	0.4	2	3.5	8	14.9	9.6
Corrimal1	9	2125	219.9	351	411.7	113.3	135	148.2	2.5	1.9	1.2	13.8	9.4	7.9
Corrimal2	24	2025	56.5	167.8	223.7	58.3	101.2	116.8	0.3	0.8	3.1	7.2	10.3	13.1
Corrimal2	24	2045	55.3	167.1	223.5	57.8	101	116.7	0.3	0.8	3	7.2	10.4	13.2
Corrimal2	24	2075	73.4	185.3	242.6	65.4	106.7	120.8	0.3	1.2	4.5	7.2	15.6	10.9
Corrimal2	24	2125	110.7	225.1	284.8	80.7	117.1	127.3	0.6	3.2	3.2	7.9	12.8	11.5
Corrimal3	16	2025	56.5	167.8	223.7	64.4	82.5	89	3.3	5.5	5	18.5	18.5	19.3
Corrimal3	16	2045	72.3	183.4	239.6	67.6	84.4	90.7	3.5	6.4	4.5	20	17.7	19.9
Corrimal3	16	2075	109.6	221.8	279.9	73.8	88.8	95.1	2.9	5.1	5.6	18.9	19.2	18.3
Corrimal3	16	2125	202.8	329	389.3	86.6	100.6	106.9	5.8	6.2	6	18.3	16.3	15
Bellambi1	17	2025	45.2	134.3	179	67.7	88.3	96.7	1.3	2.6	1.8	11.7	9.6	9.4
Bellambi1	17	2045	32.1	124.7	171.1	63.1	86.5	95.2	0.4	2.5	1.9	10.5	10.1	9.4
Bellambi1	17	2075	51.6	144.3	189.7	69.6	90.2	98.9	1.3	2.5	1.7	11.7	9.8	9.4
Bellambi1	17	2125	95.4	191.5	238.5	80.5	99.3	110.3	2.1	1.8	1.4	11.9	9.3	10.5
Bellambi3	25	2025	31.1	80	80	51	63.6	63.6	0.9	1.7	1.7	7.4	7.1	7.1

Beach Unit	Profiles	Epoch	Design Storm Vol (m3/m)	Limited Sand	Est. Minimum Sand Available (m3/m)	Storm Vol 63% (m3/m)	Storm Vol 5% (m3/m)	Storm Vol 1% (m3/m)	Long-term Erosion Vol 63% (m3/m)	Long-term Erosion Vol 5% (m3/m)	Long-term Erosion Vol 1% (m3/m)	SLR Erosion Vol 63% (m3/m)	SLR Erosion Vol 5% (m3/m)	SLR Erosion Vol 1% (m3/m)
Bellambi3	25	2045	123	Yes	80	31.1	80	80	7.3	16.4	19.5	10.2	13.3	13.9
Bellambi3	25	2075	123	Yes	80	31.1	80	80	18.2	41	48.7	34.7	49	52.1
Bellambi3	25	2125	123	Yes	80	31.1	80	80	36.3	82	97.4	92.1	140.9	151.3
Bellambi4	2	2025	178	No	101	45	133.7	178.3	0	0	0	0	0	0
Bellambi4	2	2045	178	No	101	45	133.7	178.3	0	0	0	8.5	11.1	11.6
Bellambi4	2	2075	178	No	101	45	133.7	178.3	0	0	0	29.8	42.1	44.7
Bellambi4	2	2125	178	No	101	45	133.7	178.3	0	0	0	79.8	122	131
Bellambi5	6	2025	210	No	206	53.1	157.6	210.1	0	0	0	0	0	0
Bellambi5	6	2045	210	No	206	53.1	157.6	210.1	0	0	0	5	6.5	6.8
Bellambi5	6	2075	210	No	206	53.1	157.6	210.1	0	0	0	19.4	27.5	29.2
Bellambi5	6	2125	210	No	206	53.1	157.6	210.1	0	0	0	56	85.7	92
Bellambi6	15	2025	220	No	677	55.6	165.1	220.1	0	0	0	0	0	0
Bellambi6	15	2045	220	No	677	55.6	165.1	220.1	-6	-0.9	0.8	6.4	8.3	8.7
Bellambi6	15	2075	220	No	677	55.6	165.1	220.1	-6	-0.9	0.8	29.6	41.9	44.5
Bellambi6	15	2125	220	No	677	55.6	165.1	220.1	-6	-0.9	0.8	89.9	137.5	147.6
Woonona1	6	2025	224	No	158	56.7	168.4	224.5	0	0	0	0	0	0
Woonona1	6	2045	224	No	158	56.7	168.4	224.5	0	0	0	7.9	10.2	10.7
Woonona1	6	2075	224	No	158	56.7	168.4	224.5	0	0	0	34.2	48.4	51.4
Woonona1	6	2125	224	No	158	56.7	168.4	224.5	0	0	0	95.9	146.7	157.5
Woonona2	15	2025	224	No	376	56.7	168.4	224.5	0	0	0	0	0	0
Woonona2	15	2045	224	No	376	56.7	168.4	224.5	0	0	0	5.9	7.6	8
Woonona2	15	2075	224	No	376	56.7	168.4	224.5	0	0	0	33.1	46.9	49.8
Woonona2	15	2125	224	No	376	56.7	168.4	224.5	0	0	0	86.4	132.1	141.8
Bulli1	3	2025	203	No	304	51.3	152.3	203	0	0	0	0	0	0
Bulli1	3	2045	203	No	304	51.3	152.3	203	0	0	0	8.2	10.6	11.2
Bulli1	3	2075	203	No	304	51.3	152.3	203	0	0	0	28.8	40.7	43.2
Bulli1	3	2125	203	No	304	51.3	152.3	203	0	0	0	85.1	130.2	139.8

Beach Unit	Profiles	Epoch	Combined Erosion Vol 63% (m3/m)	Combined Erosion Vol 5% (m3/m)	Combined Erosion Vol 1% (m3/m)	L_ZWI 63% (m)	L_ZWI 5% (m)	L_ZWI 1% (m)	L_ZSA 63% (m)	L_ZSA 5% (m)	L_ZSA 1% (m)	L_ZRFC 63% (m)	L_ZRFC 5% (m)	L_ZRFC 1% (m)
Bellambi3	25	2045	51	80	80	56.6	63.6	63.6	1.4	1.7	1.7	7.4	7.1	7.1
Bellambi3	25	2075	80	80	80	63.6	63.6	63.6	1.7	1.7	1.7	7.1	7.1	7.1
Bellambi3	25	2125	80	80	80	63.6	63.6	63.6	1.7	1.7	1.7	7.1	7.1	7.1
Bellambi4	2	2025	45	133.7	178.3	47.8	84.8	103.4	0.2	0.2	2.1	7	6.4	22.5
Bellambi4	2	2045	54.2	142.8	187.7	51.8	89	105.6	0.2	0.1	2.1	6.9	7.4	21.9
Bellambi4	2	2075	77.5	166.8	212.2	62.4	99.8	110.8	0.1	0.7	6.4	8.2	24.2	17.9
Bellambi4	2	2125	132.9	228.1	276.3	84.4	113.6	119.9	0.2	7.2	7.1	6.4	17.6	17.8
Bellambi5	6	2025	53.1	157.6	210.1	64.3	131.4	141.4	0	2.3	3.3	6.6	20.8	13.6
Bellambi5	6	2045	58.4	163	215.7	67.2	132.5	142.3	0	2.4	3.1	7.4	20.2	14.3
Bellambi5	6	2075	74.3	178.8	232.9	75	135.8	145.1	1.4	3.2	8.3	6.1	17.7	9.7
Bellambi5	6	2125	115.1	221.9	279.6	92.2	143.3	150.6	0	8.7	4.6	2.5	9.2	13.3
Bellambi6	15	2025	55.6	165.1	220.1	48.1	78.8	90.5	0.4	2.5	2.1	9.7	11.6	13.3
Bellambi6	15	2045	57.3	166.7	222.4	48.8	79.1	90.9	0.4	2.5	2.4	9.8	11.8	13
Bellambi6	15	2075	82.9	193.1	249.8	57.8	84.8	95.9	1.3	2	3	9.8	13.1	13
Bellambi6	15	2125	149.5	265.6	325	74.9	98.7	108.8	1.3	2.8	3.2	11.2	12.6	11
Woonona1	6	2025	56.7	168.4	224.5	51.9	86.9	102	0.3	1.1	1.3	7.9	9.4	9.8
Woonona1	6	2045	65.2	176.9	233.4	55.3	89.4	104.3	0.4	1.6	1.4	8.1	8.9	9.7
Woonona1	6	2075	94	206.3	264	65.9	97.1	112.2	0.7	1.2	1.5	10.3	9.8	9.4
Woonona1	6	2125	162.3	281.1	342.5	85.1	116.4	132	1	1.5	1.6	9.8	9.4	11.1
Woonona2	15	2025	56.7	168.4	224.5	82	119	126.8	0.2	5.8	4.3	7.1	13.9	15.4
Woonona2	15	2045	63	174.8	231.2	84.7	120.1	127.7	0.2	5.8	4.4	7.1	13.9	15.3
Woonona2	15	2075	92.9	205.1	263	97.8	124.4	131.7	0.2	4.5	4.4	7.7	15.5	15.1
Woonona2	15	2125	151.9	269.8	329.2	116.1	132.5	140	3.6	4.4	4.6	16.3	15.2	14.9
Bulli1	3	2025	51.3	152.3	203	46.3	87.3	98.7	0.2	1.8	2.1	7	11	11.5
Bulli1	3	2045	60.1	161	212.4	50.3	89.5	100.7	0.2	1.9	2.1	7.1	10.9	11.6
Bulli1	3	2075	82.7	184.1	236.6	60.4	94.6	105.7	0.2	2.1	2.2	7.1	11.1	11.6
Bulli1	3	2125	145	252.1	307.4	85.4	108.9	119.7	1.5	2.3	2.4	11.3	11.5	11.1

Beach Unit	Profiles	Epoch	Design Storm Vol (m3/m)	Limited Sand	Est. Minimum Sand Available (m3/m)	Storm Vol 63% (m3/m)	Storm Vol 5% (m3/m)	Storm Vol 1% (m3/m)	Long-term Erosion Vol 63% (m3/m)	Long-term Erosion Vol 5% (m3/m)	Long-term Erosion Vol 1% (m3/m)	SLR Erosion Vol 63% (m3/m)	SLR Erosion Vol 5% (m3/m)	SLR Erosion Vol 1% (m3/m)
Bulli2	11	2025	225	No	238	57	169.2	225.5	0	0	0	0	0	0
Bulli2	11	2045	225	No	238	57	169.2	225.5	0	0	0	7.7	9.9	10.4
Bulli2	11	2075	225	No	238	57	169.2	225.5	0	0	0	26.8	37.9	40.2
Bulli2	11	2125	225	No	238	57	169.2	225.5	0	0	0	77.4	118.3	127
Bulli3	16	2025	225	No	107	57	169.2	225.5	0	0	0	0	0	0
Bulli3	16	2045	225	No	107	57	169.2	225.5	0	0	0	12.6	16.4	17.2
Bulli3	16	2075	225	No	107	57	169.2	225.5	0	0	0	44.1	62.3	66.2
Bulli3	16	2125	225	No	107	57	169.2	225.5	0	0	0	105.3	161	172.9
Bulli4	4	2025	158	No	120	39.9	118.4	157.9	0	0	0	0	0	0
Bulli4	4	2045	158	No	120	39.9	118.4	157.9	0	0	0	6.7	8.7	9.2
Bulli4	4	2075	158	No	120	39.9	118.4	157.9	0	0	0	29.2	41.3	43.9
Bulli4	4	2125	158	No	120	39.9	118.4	157.9	0	0	0	88.1	134.8	144.7
Sandon1	7	2025	182	No	122	46.1	136.7	182.3	0	0	0	0	0	0
Sandon1	7	2045	182	No	122	46.1	136.7	182.3	0	0	0	10.3	13.4	14
Sandon1	7	2075	182	No	122	46.1	136.7	182.3	0	0	0	33.7	47.7	50.7
Sandon1	7	2125	182	No	122	46.1	136.7	182.3	0	0	0	85.9	131.3	141
Sandon2	10	2025	182	No	216	46.1	136.7	182.3	0	0	0	0	0	0
Sandon2	10	2045	182	No	216	46.1	136.7	182.3	9	14.1	15.8	10.5	13.7	14.3
Sandon2	10	2075	182	No	216	46.1	136.7	182.3	22.6	35.3	39.5	34.5	48.8	51.8
Sandon2	10	2125	182	No	216	46.1	136.7	182.3	45.2	70.6	79.1	87.8	134.3	144.2
Sandon3	7	2025	182	No	216	46.1	136.7	182.3	0	0	0	0	0	0
Sandon3	7	2045	182	No	216	46.1	136.7	182.3	-2.3	9.9	14	6.4	8.3	8.7
Sandon3	7	2075	182	No	216	46.1	136.7	182.3	-5.8	24.7	34.9	20.9	29.5	31.3
Sandon3	7	2125	182	No	216	46.1	136.7	182.3	-11.6	49.4	69.8	53.1	81.2	87.2
McCauleys1	5	2025	180	Yes	15	15	15	15	0	0	0	0	0	0
McCauleys1	5	2045	180	Yes	15	15	15	15	6.5	11.6	13.3	3.4	4.3	4.6
McCauleys1	5	2075	180	Yes	15	15	15	15	16.3	29	33.3	12.3	17.3	18.4

Beach Unit	Profiles	Epoch	Combined Erosion Vol 63% (m3/m)	Combined Erosion Vol 5% (m3/m)	Combined Erosion Vol 1% (m3/m)	L_ZWI 63% (m)	L_ZWI 5% (m)	L_ZWI 1% (m)	L_ZSA 63% (m)	L_ZSA 5% (m)	L_ZSA 1% (m)	L_ZRFC 63% (m)	L_ZRFC 5% (m)	L_ZRFC 1% (m)
Bulli2	11	2025	57	169.2	225.5	52.1	86.6	95.1	0.4	3.8	3.4	5.1	11.4	11
Bulli2	11	2045	65.2	177.5	234.2	55.4	87.8	96.4	0.4	3.1	3.5	5	12	10.7
Bulli2	11	2075	86.1	198.8	257.2	64	91	99.7	0.3	4	3.5	6.3	10.8	10.5
Bulli2	11	2125	142.5	259.3	320.2	81.4	100	109.1	3.2	3.5	3.1	12.1	10.5	10.1
Bulli3	16	2025	57	169.2	225.5	59.6	90.8	103.1	0.3	2	1.9	7.6	10.3	26.6
Bulli3	16	2045	70.5	182.5	239.3	65.1	93.6	106.1	0.4	1.7	2	8.8	10.9	26.9
Bulli3	16	2075	105.1	218	275.1	77.2	101.4	112.5	1.3	1.9	6.6	11.8	23.2	19.2
Bulli3	16	2125	172.7	294.2	354.5	91.6	114.5	120.7	2.2	5.9	8.6	10.2	18.7	11.9
Bulli4	4	2025	39.9	118.4	157.9	44.9	56.1	61.5	5.2	4	4	11.3	12.6	12.6
Bulli4	4	2045	47.1	125.6	165.6	46.2	57.1	62.5	4.6	4	4	11.9	12.6	12.6
Bulli4	4	2075	71.8	150.9	190.9	49.7	60.5	65.9	4.1	4	4.1	12.4	12.6	12.6
Bulli4	4	2125	136.5	224.2	266.4	58.6	70.4	76.1	4	4.1	4.1	12.6	12.7	12.7
Sandon1	7	2025	46.1	136.7	182.3	50.8	92.6	107.6	0.2	0.8	1.1	7.1	8	10.8
Sandon1	7	2045	57.1	147.6	193.5	55.5	96.3	110.8	0.3	0.7	1.3	6.9	8.6	11.5
Sandon1	7	2075	82.9	174.2	220.4	67	105.1	117.8	0	0.9	1.9	6.6	10.3	11.7
Sandon1	7	2125	140.5	238.6	287.4	93.8	121.9	131.7	0.6	2.3	2.3	8.5	10.9	11.7
Sandon2	10	2025	46.1	136.7	182.3	46.3	78.4	88.7	0	1.7	1.8	6.8	10.6	10.1
Sandon2	10	2045	67.2	158	203.8	56.6	83.3	93.4	0.2	2.1	1.8	8.1	10	10
Sandon2	10	2075	108.7	200.8	247.6	71.4	92.7	103.4	1.4	1.8	1.7	10.6	10	9.7
Sandon2	10	2125	192.6	293.7	340.7	90.9	114.3	126	1.8	1.5	1.5	10	9.7	9.3
Sandon3	7	2025	46.1	136.7	182.3	55.9	75	81.2	0.6	5.1	7.9	14.5	22.4	19.5
Sandon3	7	2045	52.6	144	190.2	58.3	76.1	82.2	1.9	5.3	8.4	16.1	22.2	18.9
Sandon3	7	2075	68.5	163.2	210.3	62.5	78.8	84.6	2.2	5.8	8.8	18.1	21.6	18.4
Sandon3	7	2125	102.8	212.8	260.9	69.5	84.9	90	4.1	8.8	7.4	23.5	18.4	19.9
McCauleys1	5	2025	15	15	15	36.1	36.1	36.1	0.8	0.8	0.8	8	8	8
McCauleys1	5	2045	15	15	15	36.1	36.1	36.1	0.8	0.8	0.8	8	8	8
McCauleys1	5	2075	15	15	15	36.1	36.1	36.1	0.8	0.8	0.8	8	8	8

Beach Unit	Profiles	Epoch	Design Storm Vol (m3/m)	Limited Sand	Est. Minimum Sand Available (m3/m)	Storm Vol 63% (m3/m)	Storm Vol 5% (m3/m)	Storm Vol 1% (m3/m)	Long-term Erosion Vol 63% (m3/m)	Long-term Erosion Vol 5% (m3/m)	Long-term Erosion Vol 1% (m3/m)	SLR Erosion Vol 63% (m3/m)	SLR Erosion Vol 5% (m3/m)	SLR Erosion Vol 1% (m3/m)
McCauleys1	5	2125	180	Yes	15	15	15	15	32.7	58.1	66.6	42.9	65.6	70.4
McCauleys2	1	2025	212	No	246	53.5	158.8	211.7	0	0	0	0	0	0
McCauleys2	1	2045	212	No	246	53.5	158.8	211.7	5.4	15.1	18.4	6.2	8.1	8.5
McCauleys2	1	2075	212	No	246	53.5	158.8	211.7	13.4	37.8	45.9	27.4	38.7	41.1
McCauleys2	1	2125	212	No	246	53.5	158.8	211.7	26.8	75.5	91.8	83.4	127.5	136.9
McCauleys3	10	2025	223	Yes	52	52	52	52	0	0	0	0	0	0
McCauleys3	10	2045	223	Yes	52	52	52	52	4.4	9.8	11.7	3.6	4.6	4.9
McCauleys3	10	2075	223	Yes	52	52	52	52	10.9	24.6	29.2	11.8	16.8	17.8
McCauleys3	10	2125	223	Yes	52	52	52	52	21.8	49.2	58.4	35.3	54	58
Thirroul1	18	2025	222	No	343	56	166.3	221.7	0	0	0	0	0	0
Thirroul1	18	2045	222	No	343	56	166.3	221.7	8.9	25.2	30.6	6.7	8.7	9.2
Thirroul1	18	2075	222	No	343	56	166.3	221.7	22.3	62.9	76.5	22.4	31.6	33.6
Thirroul1	18	2125	222	No	343	56	166.3	221.7	44.6	125.8	153.1	56.9	87	93.4
Thirroul2	24	2025	215	No	298	54.3	161.3	215	0	0	0	0	0	0
Thirroul2	24	2045	215	No	298	54.3	161.3	215	11	24.8	29.4	4.4	5.7	6
Thirroul2	24	2075	215	No	298	54.3	161.3	215	27.5	62	73.6	15.9	22.4	23.8
Thirroul2	24	2125	215	No	298	54.3	161.3	215	54.9	124	147.1	57.4	87.7	94.2
Thirroul3	31	2025	211	No	272	53.2	158	210.6	0	0	0	0	0	0
Thirroul3	31	2045	211	No	272	53.2	158	210.6	8.9	25.2	30.6	3.9	5.1	5.3
Thirroul3	31	2075	211	No	272	53.2	158	210.6	22.3	62.9	76.5	13.9	19.7	20.9
Thirroul3	31	2125	211	No	272	53.2	158	210.6	44.6	125.8	153.1	36.1	55.2	59.3
Austinmer3	7	2025	194	No	153	49	145.5	193.9	0	0	0	0	0	0
Austinmer3	7	2045	194	No	153	49	145.5	193.9	5.2	9.3	10.7	4.1	5.4	5.6
Austinmer3	7	2075	194	No	153	49	145.5	193.9	13.1	23.2	26.6	18.3	25.9	27.5
Austinmer3	7	2125	194	No	153	49	145.5	193.9	26.2	46.5	53.3	46.5	71.2	76.4
Austinmer5	19	2025	200	Yes	150	50.5	150	150	0	0	0	0	0	0
Austinmer5	19	2045	200	Yes	150	50.5	150	150	0	0	0	3.7	4.9	5.1

Beach Unit	Profiles	Epoch	Combined Erosion Vol 63% (m3/m)	Combined Erosion Vol 5% (m3/m)	Combined Erosion Vol 1% (m3/m)	L_ZWI 63% (m)	L_ZWI 5% (m)	L_ZWI 1% (m)	L_ZSA 63% (m)	L_ZSA 5% (m)	L_ZSA 1% (m)	L_ZRFC 63% (m)	L_ZRFC 5% (m)	L_ZRFC 1% (m)
McCauleys1	5	2125	15	15	15	36.1	36.1	36.1	0.8	0.8	0.8	8	8	8
McCauleys2	1	2025	53.5	158.8	211.7	52.6	84	98.1	0.4	1.1	3.1	7.9	9.8	9.3
McCauleys2	1	2045	67.2	173.1	226.3	57.8	88	101.2	0.6	1.3	2.1	11	12.3	9.9
McCauleys2	1	2075	101.1	209.8	263.2	68.9	97.6	108.7	1.5	3.2	1.8	8.9	9.3	9.2
McCauleys2	1	2125	180.3	301.2	355.8	89.9	117.3	130.7	1.4	1.5	1.5	12	9.7	11.2
McCauleys3	10	2025	52	52	52	35	35	35	8.1	8.1	8.1	17.2	17.2	17.2
McCauleys3	10	2045	52	52	52	35	35	35	8.1	8.1	8.1	17.2	17.2	17.2
McCauleys3	10	2075	52	52	52	35	35	35	8.1	8.1	8.1	17.2	17.2	17.2
McCauleys3	10	2125	52	52	52	35	35	35	8.1	8.1	8.1	17.2	17.2	17.2
Thirroul1	18	2025	56	166.3	221.7	48	84	94.9	0.3	2.6	1.7	6.9	10.2	8.9
Thirroul1	18	2045	74.9	186.1	242.6	56.1	88	99.3	0.2	2.4	1.6	7.1	9.4	8.6
Thirroul1	18	2075	109.9	226.5	281.9	71.1	95.8	109.3	2.7	1.5	1.1	10	9	8
Thirroul1	18	2125	176.1	312.1	371.7	86.1	118.3	137.3	2.8	0.8	0.9	9.4	8.4	8.5
Thirroul2	24	2025	54.3	161.3	215	52	91.8	104.8	0.4	1.3	1.4	7.3	10.8	11
Thirroul2	24	2045	72.3	180.1	234.5	59.1	96.9	109.6	0.4	1.8	1.6	7.1	9.6	12
Thirroul2	24	2075	105.2	216.4	272	72.8	105.1	118.3	0.5	1.3	2.4	8.2	11.2	11.6
Thirroul2	24	2125	183.7	311.9	368.2	97.7	126.2	136.9	1.7	2.5	2.5	9.9	11.4	10.9
Thirroul3	31	2025	53.2	158	210.6	55.6	70.7	74.4	0.1	11.5	10.3	36.6	26.2	27.4
Thirroul3	31	2045	69.1	175	228.9	61.2	71.9	75.7	16.7	10.4	10.2	20.9	27.2	27.5
Thirroul3	31	2075	98	208.9	261.3	65.2	74.3	77.9	14.4	10.3	10.3	22.9	27.4	27.6
Thirroul3	31	2125	149.8	280.2	335.2	70	79.1	82.8	11.9	10.3	10.4	25.7	27.4	27.4
Austinmer3	7	2025	49	145.5	193.9	57.8	86.2	97.2	0.1	1.4	6.5	7.7	17.6	15.9
Austinmer3	7	2045	59.3	155.8	204.8	62.4	88.7	99.2	0.3	1.2	4.9	8.5	16.8	18.9
Austinmer3	7	2075	84	180.7	230.6	71.8	94.5	102.5	0.9	2.3	3.6	11.6	13.4	19.7
Austinmer3	7	2125	130.7	231.1	281.5	83	102.5	109.5	1.6	3.6	5.4	11.7	19.7	17.5
Austinmer5	19	2025	50.5	150	150	21.5	27.8	27.8	15	12.9	12.9	21.6	23.5	23.5
Austinmer5	19	2045	54.5	150	150	21.8	27.8	27.8	14.8	12.9	12.9	21.8	23.5	23.5

Beach Unit	Profiles	Epoch	Design Storm Vol (m3/m)	Limited Sand	Est. Minimum Sand Available (m3/m)	Storm Vol 63% (m3/m)	Storm Vol 5% (m3/m)	Storm Vol 1% (m3/m)	Long-term Erosion Vol 63% (m3/m)	Long-term Erosion Vol 5% (m3/m)	Long-term Erosion Vol 1% (m3/m)	SLR Erosion Vol 63% (m3/m)	SLR Erosion Vol 5% (m3/m)	SLR Erosion Vol 1% (m3/m)
Austinmer5	19	2075	200	Yes	150	50.5	150	150	0	0	0	14.1	19.9	21.2
Austinmer5	19	2125	200	Yes	150	50.5	150	150	0	0	0	56.5	86.3	92.7
Sharky1	12	2025	198	Yes	150	50	148.4	150	0	0	0	0	0	0
Sharky1	12	2045	198	Yes	150	50	148.4	150	0	0	0	5.5	7.1	7.4
Sharky1	12	2075	198	Yes	150	50	148.4	150	0	0	0	21.3	30.2	32
Sharky1	12	2125	198	Yes	150	50	148.4	150	0	0	0	61.7	94.3	101.2
Sharky2	15	2025	178	Yes	100	45	100	100	0	0	0	0	0	0
Sharky2	15	2045	178	Yes	100	45	100	100	-8.3	3.9	8	6.1	7.9	8.3
Sharky2	15	2075	178	Yes	100	45	100	100	-8.3	3.9	8	21.2	30	31.9
Sharky2	15	2125	178	Yes	100	45	100	100	-8.3	3.9	8	57	87.1	93.5
Sharky3	12	2025	198	Yes	180	50	148.4	180	0	0	0	0	0	0
Sharky3	12	2045	198	Yes	180	50	148.4	180	-11	-1.6	1.5	5.8	7.5	7.9
Sharky3	12	2075	198	Yes	180	50	148.4	180	-11	-1.6	1.5	20.2	28.6	30.4
Sharky3	12	2125	198	Yes	180	50	148.4	180	-11	-1.6	1.5	54.2	82.9	89
Coledale2	9	2025	177	Yes	10	10	10	10	0	0	0	0	0	0
Coledale2	9	2045	177	Yes	10	10	10	10	1.6	3.7	4.3	1.2	1.5	1.6
Coledale2	9	2075	177	Yes	10	10	10	10	4	9.1	10.8	3.9	5.5	5.8
Coledale2	9	2125	177	Yes	10	10	10	10	8.1	18.2	21.6	9.8	15	16.1
Coledale4	7	2025	177	No	29	44.7	132.8	177.1	0	0	0	0	0	0
Coledale4	7	2045	177	No	29	44.7	132.8	177.1	0	0	0	5.3	6.8	7.2
Coledale4	7	2075	177	No	29	44.7	132.8	177.1	0	0	0	18.1	25.7	27.3
Coledale4	7	2125	177	No	29	44.7	132.8	177.1	0	0	0	48.2	73.7	79.1
Coledale6	9	2025	159	No	104	40.3	119.5	159.4	0	0	0	0	0	0
Coledale6	9	2045	159	No	104	40.3	119.5	159.4	0	0	0	3.3	4.2	4.4
Coledale6	9	2075	159	No	104	40.3	119.5	159.4	0	0	0	13.4	18.9	20.1
Coledale6	9	2125	159	No	104	40.3	119.5	159.4	0	0	0	39.9	61	65.5
Wombarra1	10	2025	119	No	84	30.1	89.4	119.1	0	0	0	0	0	0

Beach Unit	Profiles	Epoch	Combined Erosion Vol 63% (m3/m)	Combined Erosion Vol 5% (m3/m)	Combined Erosion Vol 1% (m3/m)	L_ZWI 63% (m)	L_ZWI 5% (m)	L_ZWI 1% (m)	L_ZSA 63% (m)	L_ZSA 5% (m)	L_ZSA 1% (m)	L_ZRFC 63% (m)	L_ZRFC 5% (m)	L_ZRFC 1% (m)
Austinmer5	19	2075	65.9	150	150	22.6	27.8	27.8	14.3	12.9	12.9	22.2	23.5	23.5
Austinmer5	19	2125	112.9	150	150	25.5	27.8	27.8	13	12.9	12.9	23.3	23.5	23.5
Sharky1	12	2025	50	148.4	150	47.8	59.9	60	8.6	8.2	8.3	41	41.7	41.6
Sharky1	12	2045	55.9	150	150	49	60	60	8.7	8.3	8.3	41	41.6	41.6
Sharky1	12	2075	73.3	150	150	51.8	60	60	8.3	8.3	8.3	41.7	41.6	41.6
Sharky1	12	2125	118.2	150	150	56.9	60	60	7.4	8.3	8.3	42.3	41.6	41.6
Sharky2	15	2025	45	100	100	42.3	53.4	53.4	1.1	12.1	12.1	31.8	31	31
Sharky2	15	2045	45.3	100	100	42.4	53.4	53.4	1.1	12.1	12.1	31.8	31	31
Sharky2	15	2075	62.3	100	100	47	53.4	53.4	1.7	12.1	12.1	36.4	31	31
Sharky2	15	2125	100	100	100	53.4	53.4	53.4	12.1	12.1	12.1	31	31	31
Sharky3	12	2025	50	148.4	180	32.7	41.8	44.1	12.5	9.4	8.7	19	23.1	23.3
Sharky3	12	2045	46.8	145.8	177.2	32.3	41.6	43.9	12.4	9.4	8.8	19	23.1	23.3
Sharky3	12	2075	62.9	161.7	180	34.4	42.7	44.1	12	9.1	8.7	19.6	23.1	23.3
Sharky3	12	2125	100.9	180	180	38	44.1	44.1	10	8.7	8.7	21.7	23.3	23.3
Coledale2	9	2025	10	10	10	6.4	6.4	6.4	0	0	0	7.7	7.7	7.7
Coledale2	9	2045	12.9	14.9	15.6	7	7.4	7.5	0	0	0	7.9	8	8.1
Coledale2	9	2075	18.2	23.5	25.2	8	9	9.4	0	0	0	8.1	8.8	14.5
Coledale2	9	2125	28.8	40	43.9	10	12	12.6	0	0	0	14.3	14.9	15.7
Coledale4	7	2025	44.7	132.8	177.1	29.8	37.9	41.1	14.7	12.8	12	24.6	27	28.1
Coledale4	7	2045	50.4	138.5	183.1	30.5	38.3	41.5	14	12.5	11.9	25.3	27.3	28.3
Coledale4	7	2075	64.5	152.8	198.5	31.9	39.4	42.6	12.9	11.9	12	26.4	28	28.4
Coledale4	7	2125	98.1	188.2	237.2	35	41.9	45.2	12.9	11.9	11.8	26.7	28.4	28.7
Coledale6	9	2025	40.3	119.5	159.4	54.6	85.4	92.3	0	3.4	3.2	5.7	13.2	13.4
Coledale6	9	2045	43.7	123.1	162.9	57.1	86.1	92.9	0	3.5	3	6.1	12.9	13.3
Coledale6	9	2075	54.9	134.1	175	64.2	88.2	94.7	0	4.1	3.2	7.8	14	13.7
Coledale6	9	2125	84.5	165.6	208.8	76.5	93.3	100	1.3	3	3	15.4	13.3	20
Wombarra1	10	2025	30.1	89.4	119.1	23.8	30	32.6	10.5	9.4	9	32.7	37.1	37.5

Beach Unit	Profiles	Epoch	Design Storm Vol (m3/m)	Limited Sand	Est. Minimum Sand Available (m3/m)	Storm Vol 63% (m3/m)	Storm Vol 5% (m3/m)	Storm Vol 1% (m3/m)	Long-term Erosion Vol 63% (m3/m)	Long-term Erosion Vol 5% (m3/m)	Long-term Erosion Vol 1% (m3/m)	SLR Erosion Vol 63% (m3/m)	SLR Erosion Vol 5% (m3/m)	SLR Erosion Vol 1% (m3/m)
Wombarra1	10	2045	119	No	84	30.1	89.4	119.1	3.7	8.4	10	2.7	3.6	3.7
Wombarra1	10	2075	119	No	84	30.1	89.4	119.1	9.3	21	24.9	9.3	13.2	14
Wombarra1	10	2125	119	No	84	30.1	89.4	119.1	18.6	41.9	49.8	24.4	37.3	40
Scarborough1	6	2025	223	No	140	56.3	167.1	222.8	0	0	0	0	0	0
Scarborough1	6	2045	223	No	140	56.3	167.1	222.8	0	0	0	4.4	5.7	6
Scarborough1	6	2075	223	No	140	56.3	167.1	222.8	0	0	0	14.4	20.4	21.7
Scarborough1	6	2125	223	No	140	56.3	167.1	222.8	0	0	0	36.7	56.1	60.3
Scarborough2	11	2025	207	No	153	52.4	155.4	207.2	0	0	0	0	0	0
Scarborough2	11	2045	207	No	153	52.4	155.4	207.2	0	0	0	4.6	6	6.3
Scarborough2	11	2075	207	No	153	52.4	155.4	207.2	0	0	0	15.1	21.3	22.6
Scarborough2	11	2125	207	No	153	52.4	155.4	207.2	0	0	0	38.4	58.7	63
Coalcliff1	10	2025	175	Yes	100	44.2	100	100	0	0	0	0	0	0
Coalcliff1	10	2045	175	Yes	100	44.2	100	100	14.5	22.6	25.3	7.8	10.2	10.7
Coalcliff1	10	2075	175	Yes	100	44.2	100	100	36.2	56.5	63.3	26.9	38	40.4
Coalcliff1	10	2125	175	Yes	100	44.2	100	100	72.3	112.9	126.5	81.2	124.2	133.3
Stanwell1	4	2025	232	No	190	58.7	174.2	232.2	0	0	0	0	0	0
Stanwell1	4	2045	232	No	190	58.7	174.2	232.2	0	0	0	8.5	11	11.6
Stanwell1	4	2075	232	No	190	58.7	174.2	232.2	0	0	0	29.6	41.9	44.5
Stanwell1	4	2125	232	No	190	58.7	174.2	232.2	0	0	0	89.4	136.8	146.8
Bulgo1	5	2025	159	Yes	40	40	40	40	0	0	0	0	0	0
Bulgo1	5	2045	159	Yes	40	40	40	40	0	0	0	3.2	4.2	4.4
Bulgo1	5	2075	159	Yes	40	40	40	40	0	0	0	11.3	15.9	16.9
Bulgo1	5	2125	159	Yes	40	40	40	40	0	0	0	32.2	49.3	52.9
Bulgo2	9	2025	227	Yes	128	57.5	128	128	0	0	0	0	0	0
Bulgo2	9	2045	227	Yes	128	57.5	128	128	0	0	0	4	5.2	5.4
Bulgo2	9	2075	227	Yes	128	57.5	128	128	0	0	0	14.5	20.6	21.8
Bulgo2	9	2125	227	Yes	128	57.5	128	128	0	0	0	45.3	69.3	74.4

Beach Unit	Profiles	Epoch	Combined Erosion Vol 63% (m3/m)	Combined Erosion Vol 5% (m3/m)	Combined Erosion Vol 1% (m3/m)	L_ZWI 63% (m)	L_ZWI 5% (m)	L_ZWI 1% (m)	L_ZSA 63% (m)	L_ZSA 5% (m)	L_ZSA 1% (m)	L_ZRFC 63% (m)	L_ZRFC 5% (m)	L_ZRFC 1% (m)
Wombarra1	10	2045	37.5	97	127	24.6	30.7	33.3	10.2	9.3	9.3	33.4	37.1	37.2
Wombarra1	10	2075	51.6	112	141.6	26.2	32	34.5	10.2	9	9.6	34.1	37.5	36.9
Wombarra1	10	2125	79.9	143.5	173.5	29.1	34.6	37	9.4	9.7	14.4	37	36.8	31.9
Scarborough1	6	2025	56.3	167.1	222.8	58.7	81.1	86.2	1.4	8.1	7.9	9.8	32.6	40.3
Scarborough1	6	2045	61	171.9	227.6	60.1	81.6	86.6	1.2	7.6	8	10.6	33.4	40.4
Scarborough1	6	2075	72.1	182.7	239.2	63.1	82.6	87.6	1.3	7.1	9.3	25.8	40.9	39.2
Scarborough1	6	2125	97	208.8	266.2	69.6	85	90	1.9	7.3	10.1	31.4	41	38.2
Scarborough2	11	2025	52.4	155.4	207.2	45	54.5	57.9	76.4	72	78.5	85.6	90.1	83.7
Scarborough2	11	2045	57.3	160.4	212.4	45.6	54.8	58.2	76.4	72	78.3	85.6	90.2	83.9
Scarborough2	11	2075	68.8	171.7	224.5	47	55.6	58.9	75.7	72	77.7	86.4	90.2	84.5
Scarborough2	11	2125	94.8	199.6	252.8	49.7	57.4	60.4	74.9	73	66.7	87.3	89.2	95.5
Coalcliff1	10	2025	44.2	100	100	37.1	44.6	44.6	14.3	63.6	63.6	118.2	70.8	70.8
Coalcliff1	10	2045	68.5	100	100	41.1	44.6	44.6	65	63.6	63.6	67.7	70.8	70.8
Coalcliff1	10	2075	100	100	100	44.6	44.6	44.6	63.6	63.6	63.6	70.8	70.8	70.8
Coalcliff1	10	2125	100	100	100	44.6	44.6	44.6	63.6	63.6	63.6	70.8	70.8	70.8
Stanwell1	4	2025	58.7	174.2	232.2	45.4	64.6	67.7	0.7	20.6	19.9	8.2	56.6	57.4
Stanwell1	4	2045	67.8	183.3	241.9	48.5	65.1	68.2	0.7	20.3	19.9	8.5	56.9	57.4
Stanwell1	4	2075	91	206.9	267.2	56.3	66.4	69.4	0.8	20.3	20	76.3	57	57.3
Stanwell1	4	2125	157.2	279.2	340.6	63.7	70	73	20.8	20.2	21.7	56.4	57.1	55.6
Bulgo1	5	2025	40	40	40	67.1	67.1	67.1	0.2	0.2	0.2	7.8	7.8	7.8
Bulgo1	5	2045	40	40	40	67.1	67.1	67.1	0.2	0.2	0.2	7.8	7.8	7.8
Bulgo1	5	2075	40	40	40	67.1	67.1	67.1	0.2	0.2	0.2	7.8	7.8	7.8
Bulgo1	5	2125	40	40	40	67.1	67.1	67.1	0.2	0.2	0.2	7.8	7.8	7.8
Bulgo2	9	2025	57.5	128	128	42.4	56.9	56.9	1.6	5.5	5.5	8.8	80.8	80.8
Bulgo2	9	2045	61.7	128	128	43.4	56.9	56.9	1.6	5.5	5.5	8.9	80.8	80.8
Bulgo2	9	2075	73.4	128	128	46.1	56.9	56.9	1.9	5.5	5.5	14.3	80.8	80.8
Bulgo2	9	2125	107.7	128	128	53.1	56.9	56.9	2.4	5.5	5.5	75.1	80.8	80.8

Beach Unit	Profiles	Epoch	Design Storm Vol (m3/m)	Limited Sand	Est. Minimum Sand Available (m3/m)	Storm Vol 63% (m3/m)	Storm Vol 5% (m3/m)	Storm Vol 1% (m3/m)	Long-term Erosion Vol 63% (m3/m)	Long-term Erosion Vol 5% (m3/m)	Long-term Erosion Vol 1% (m3/m)	SLR Erosion Vol 63% (m3/m)	SLR Erosion Vol 5% (m3/m)	SLR Erosion Vol 1% (m3/m)
Bulgo3	6	2025	227	Yes	63	57.5	63.3	63.3	0	0	0	0	0	0
Bulgo3	6	2045	227	Yes	63	57.5	63.3	63.3	0	0	0	6.2	8.1	8.5
Bulgo3	6	2075	227	Yes	63	57.5	63.3	63.3	0	0	0	21	29.7	31.5
Bulgo3	6	2125	227	Yes	63	57.5	63.3	63.3	0	0	0	54.4	83.2	89.3
Werrong2	7	2025	215	Yes	69	54.3	69.1	69.1	0	0	0	0	0	0
Werrong2	7	2045	215	Yes	69	54.3	69.1	69.1	10.1	15.8	17.7	4.6	6	6.3
Werrong2	7	2075	215	Yes	69	54.3	69.1	69.1	25.3	39.5	44.3	15.5	21.9	23.3
Werrong2	7	2125	215	Yes	69	54.3	69.1	69.1	50.6	79	88.6	39.9	61	65.5
BurningPalms2	15	2025	191	Yes	93	48.3	93.3	93.3	0	0	0	0	0	0
BurningPalms2	15	2045	191	Yes	93	48.3	93.3	93.3	0	0	0	5.6	7.2	7.6
BurningPalms2	15	2075	191	Yes	93	48.3	93.3	93.3	0	0	0	18.2	25.8	27.4
BurningPalms2	15	2125	191	Yes	93	48.3	93.3	93.3	0	0	0	52.7	80.7	86.6
Era2	20	2025	191	Yes	542	48.3	143.3	191	0	0	0	0	0	0
Era2	20	2045	191	Yes	542	48.3	143.3	191	0	0	0	13	16.9	17.8
Era2	20	2075	191	Yes	542	48.3	143.3	191	0	0	0	44.5	62.9	66.9
Era2	20	2125	191	Yes	542	48.3	143.3	191	0	0	0	117.9	180.3	193.6
Era5	20	2025	200	Yes	868	50.6	150.1	200.1	0	0	0	0	0	0
Era5	20	2045	200	Yes	868	50.6	150.1	200.1	12.9	29.2	34.6	8.2	10.6	11.1
Era5	20	2075	200	Yes	868	50.6	150.1	200.1	32.3	72.9	86.5	27.4	38.7	41.1
Era5	20	2125	200	Yes	868	50.6	150.1	200.1	64.6	145.8	173.1	80.1	122.5	131.5
LittleGarie3	17	2025	225	Yes	167	56.9	167.3	167.3	0	0	0	0	0	0
LittleGarie3	17	2045	225	Yes	167	56.9	167.3	167.3	0	0	0	7.6	9.9	10.4
LittleGarie3	17	2075	225	Yes	167	56.9	167.3	167.3	0	0	0	30.1	42.5	45.1
LittleGarie3	17	2125	225	Yes	167	56.9	167.3	167.3	0	0	0	92.4	141.3	151.7

Beach Unit	Profiles	Epoch	Combined Erosion Vol 63% (m3/m)	Combined Erosion Vol 5% (m3/m)	Combined Erosion Vol 1% (m3/m)	L_ZWI 63% (m)	L_ZWI 5% (m)	L_ZWI 1% (m)	L_ZSA 63% (m)	L_ZSA 5% (m)	L_ZSA 1% (m)	L_ZRFC 63% (m)	L_ZRFC 5% (m)	L_ZRFC 1% (m)
Bulgo3	6	2025	57.5	63.3	63.3	39	40.5	40.5	2.5	2.6	2.6	14.9	24.9	24.9
Bulgo3	6	2045	63.3	63.3	63.3	40.5	40.5	40.5	2.6	2.6	2.6	24.9	24.9	24.9
Bulgo3	6	2075	63.3	63.3	63.3	40.5	40.5	40.5	2.6	2.6	2.6	24.9	24.9	24.9
Bulgo3	6	2125	63.3	63.3	63.3	40.5	40.5	40.5	2.6	2.6	2.6	24.9	24.9	24.9
Werrong2	7	2025	54.3	69.1	69.1	20.5	21.9	21.9	118.5	117.9	117.9	97.2	96.6	96.6
Werrong2	7	2045	69.1	69.1	69.1	21.9	21.9	21.9	117.9	117.9	117.9	96.6	96.6	96.6
Werrong2	7	2075	69.1	69.1	69.1	21.9	21.9	21.9	117.9	117.9	117.9	96.6	96.6	96.6
Werrong2	7	2125	69.1	69.1	69.1	21.9	21.9	21.9	117.9	117.9	117.9	96.6	96.6	96.6
BurningPalms2	15	2025	48.3	93.3	93.3	47.9	60.6	60.6	0.7	2.2	2.2	8.9	16.8	16.8
BurningPalms2	15	2045	54.3	93.3	93.3	49.8	60.6	60.6	0.8	2.2	2.2	11.2	16.8	16.8
BurningPalms2	15	2075	68.2	93.3	93.3	54.1	60.6	60.6	1.1	2.2	2.2	11.1	16.8	16.8
BurningPalms2	15	2125	93.3	93.3	93.3	60.6	60.6	60.6	2.2	2.2	2.2	16.8	16.8	16.8
Era2	20	2025	48.3	143.3	191	26.3	33.2	36.2	14	11	9.4	22.2	25.1	26.4
Era2	20	2045	62.2	157.1	205	27.4	34.1	37	13.3	10.6	8.8	22.3	25.2	26.7
Era2	20	2075	96.6	193	242.1	30.1	36.3	39.1	12.1	9.3	8.3	24.2	26.4	27.2
Era2	20	2125	177.1	285.8	337.5	35.3	41.6	44.6	9.8	8.8	9.2	26.2	27	25.5
Era5	20	2025	50.6	150.1	200.1	43.2	51.8	55.1	16.2	14.3	14.1	29.5	33.4	33.8
Era5	20	2045	75	175.9	226.9	45.9	53.5	56.7	15.3	14.4	13.8	31	33.4	35.3
Era5	20	2075	119.9	226.4	276.6	49.6	56.7	59.6	14.4	13.9	14.2	32.9	35.3	35.1
Era5	20	2125	215.7	346.7	400.6	56	63.6	66.5	14.1	13.8	13.7	34.5	36.9	36.5
LittleGarie3	17	2025	56.9	167.3	167.3	27.2	38.3	38.3	28.1	27.1	27.1	35.1	44.7	44.7
LittleGarie3	17	2045	65.1	167.3	167.3	28.4	38.3	38.3	28.2	27.1	27.1	40.4	44.7	44.7
LittleGarie3	17	2075	89.6	167.3	167.3	31.4	38.3	38.3	26.8	27.1	27.1	41.1	44.7	44.7
LittleGarie3	17	2125	158.5	167.3	167.3	37.7	38.3	38.3	27.7	27.1	27.1	44.1	44.7	44.7

C.2 One-page Beach Unit Summaries

A **one-page summary** is provided for each beach unit where mapping has been undertaken.

Each summary includes the following key components:

- **Illustrative cross-section figure**: A representative beach profile with key features highlighted. This is provided for illustrative purposes only.
- **Transect location and Historical shoreline change map**: A map showing the locations of transects used as the basis for developing the coastal erosion zones and long-term historical shoreline retreat rates.
- **Extreme wave height plot**: A distribution plot of extreme wave heights offshore of the beach, as modelled at a depth of around 10 m.
- **Storm erosion demand distribution**: A plot showing the distribution of storm erosion demand. Accompanying text provides the **1% probability storm demand volume** (also referred to as the design storm volume) and the **estimated available sand volume** on the beach.

Note: The available sand volume is derived from the representative beach profile. In some cases, the geological composition at the back of the beach for that profile is uncertain. Although there is no bedrock constraining further retreat in these areas, the composition of the scarp at the back of the beach is expected to be more resistant to erosion. Regardless, a conservative assumption is applied, and the model is not considered sand-limited. These locations are marked with an asterisk (*) in the one-pagers. In this instance, the actual storm demand may exceed the estimated sand volume, due to the uncertainty at the back of the beach. This is relatively common along the Wollongong Coast, due to the prevalence of receded barriers, where the scarp at the back of the beach may well comprise silty or clayey soils. In the absence of a detailed geotechnical assessment, it is difficult to be certain how these soils may affect erosion during storms and is considered reasonably conservative to adopt erosion similar to that which would occur if a sandy dune was present behind the beach.

- **Probabilistic model outputs for 2125**: Plots showing the projected erosion volumes from the statistical model for the year 2125. Bedrock limitations are shown where relevant, but it must be realised that bedrock limitations at representative profile are likely not representative of the entire beach.
- **Hazard zones due to slumping and instability:** This figure illustrates the final transect of each beach unit, highlighting the spatial extent of calculated hazard zones due to dune instability. The hazard zones are based on the model of dune slumping and instability proposed by Nielsen et al. (1992). Three key zones are identified: the Zone of Wave Impact (ZWI), representing the combine erosion volume from the statistical model; the Zone of Slope Adjustment (ZSA), which encompasses the immediate area affected by dune face collapse and slumping after the storm erosion has occurred; and the Zone of Reduced Foundation Capacity (ZRFC),

extending landward of the ZSA to account for ground instability and the potential reduction in load-bearing capacity. Note: when converting these distances into mapped extents, the results may be constrained by known bedrock.

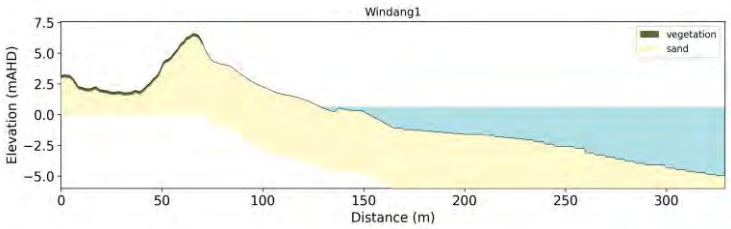
Beach: Windang Beach

Beach unit: Windang1

Description

Bording the Lake Illawarra training wall. Open coast, sandy beach, backed by a vegetated sand dune, Windang SLSC and Windang Beach Tourist Park.

Representative Cross Section (2021 LiDAR)

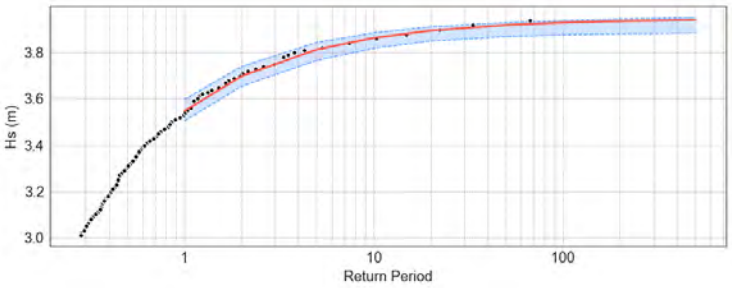


Historic Shoreline Change

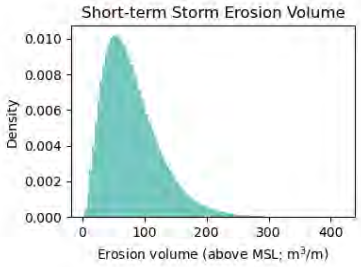
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



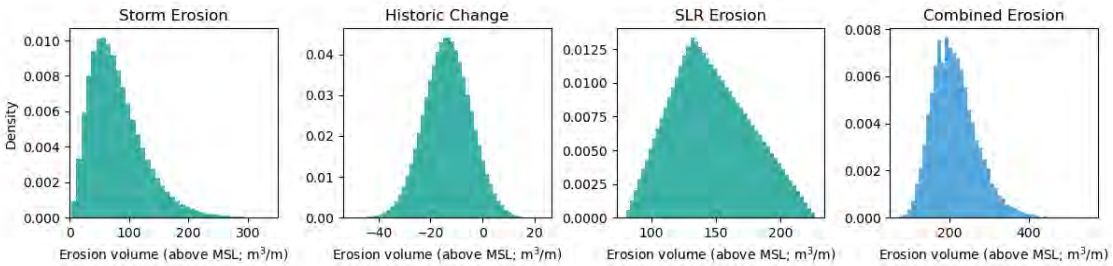
Storm Erosion Demand



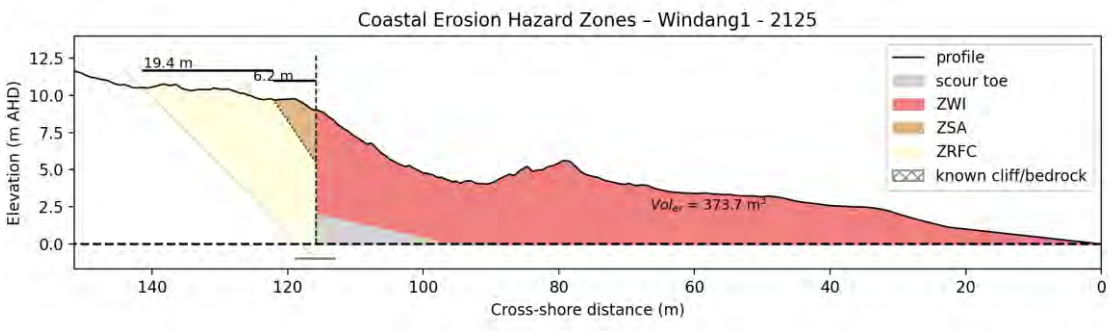
1% design volume: 223 m3/m

Available: 380 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



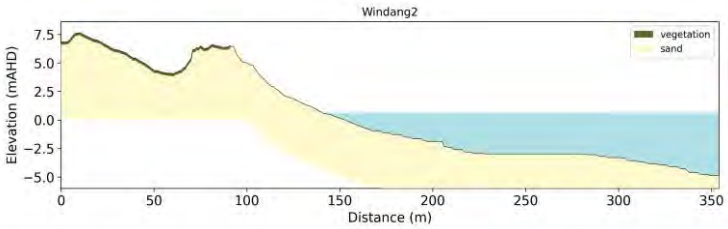
Beach: Windang Beach

Beach unit: Windang2

Description

Open coast, sandy beach, backed by vegetated sand dune.

Representative Cross Section (2021 LiDAR)

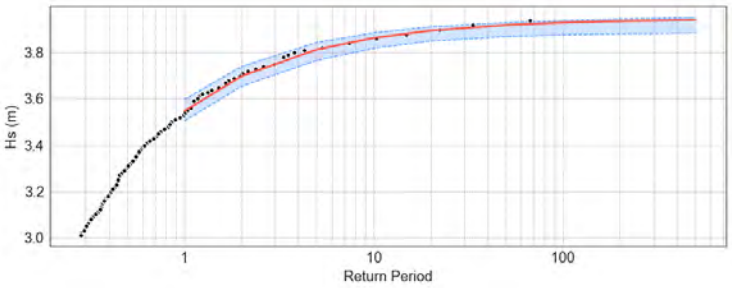


Historic Shoreline Change

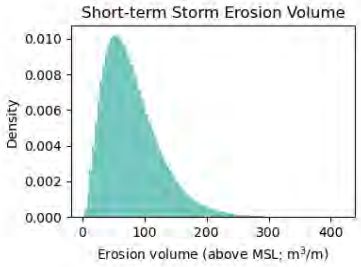
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



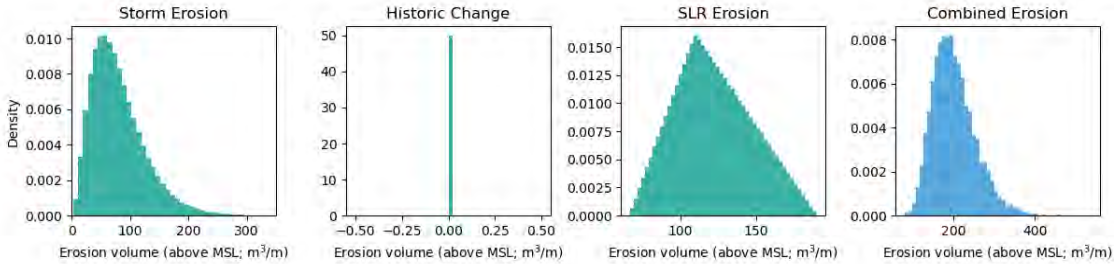
Storm Erosion Demand



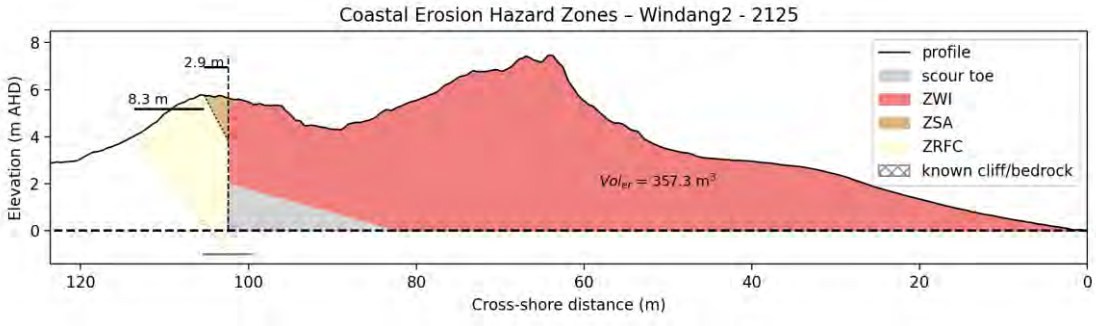
1% design volume: 223 m3/m

Available: 688 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



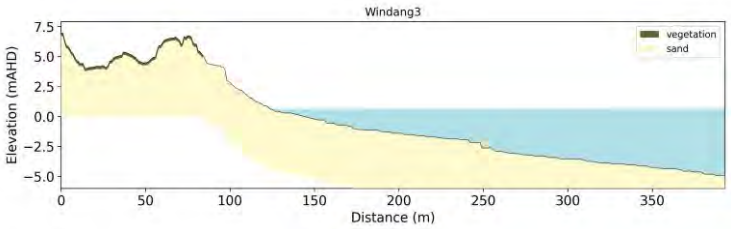
Beach: Windang Beach

Beach unit: Windang3

Description

Open coast, sandy beach, backed by vegetated sand dune.

Representative Cross Section (2021 LiDAR)

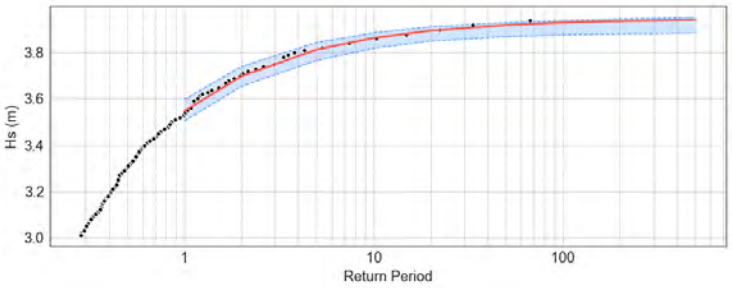


Historic Shoreline Change

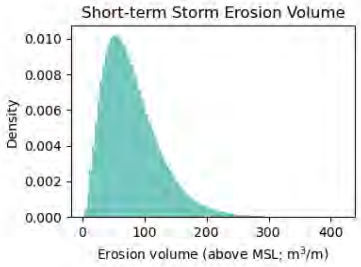
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



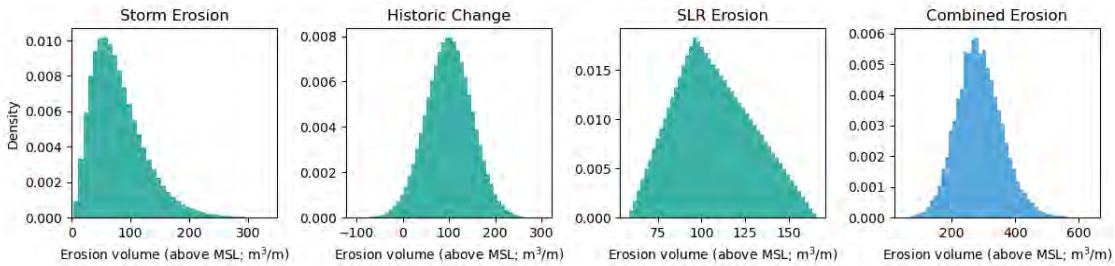
Storm Erosion Demand



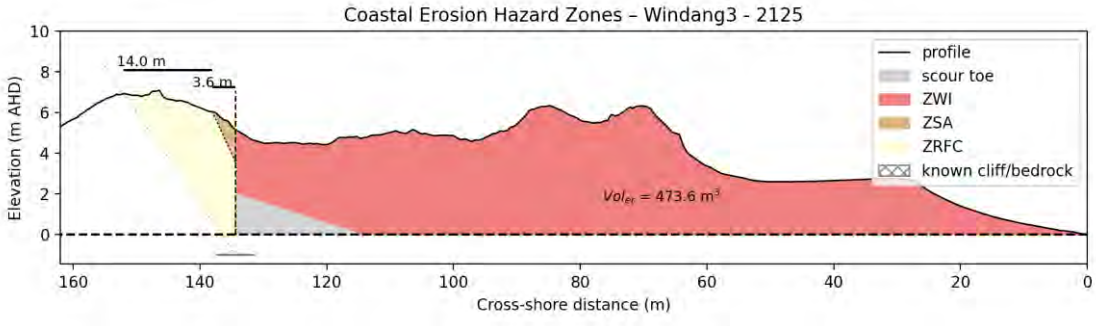
1% design volume: 223 m3/m

Available: 547 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



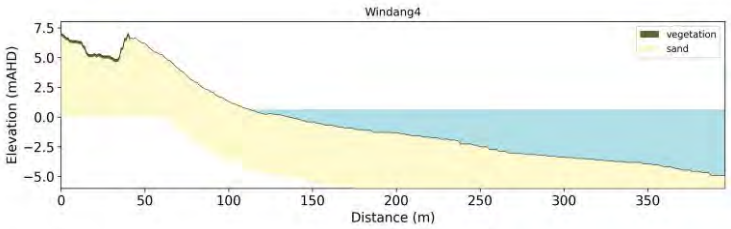
Beach: Windang Beach

Beach unit: Windang4

Description

Open coast, sandy beach, backed by vegetated sand dune.

Representative Cross Section (2021 LiDAR)

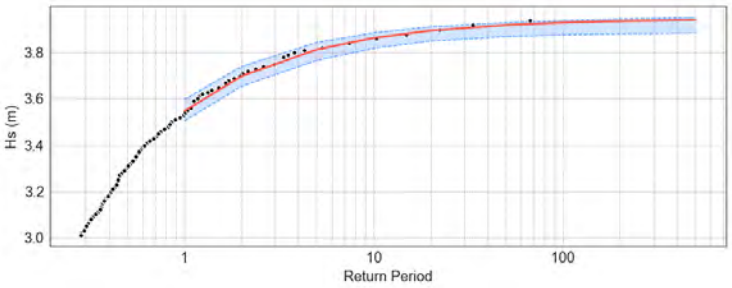


Historic Shoreline Change

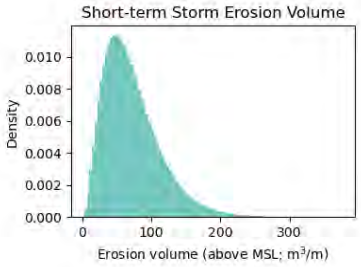
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



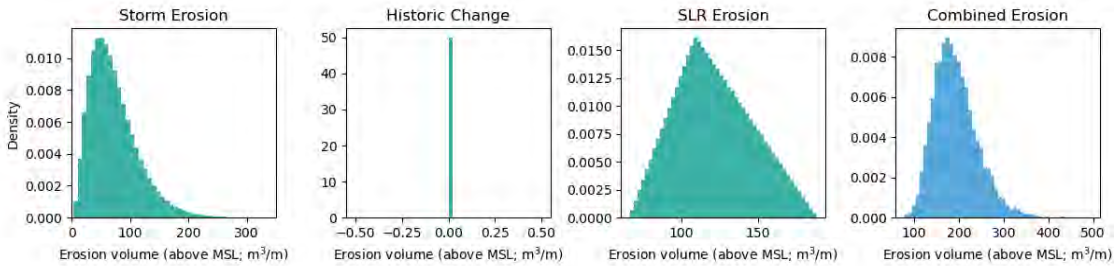
Storm Erosion Demand



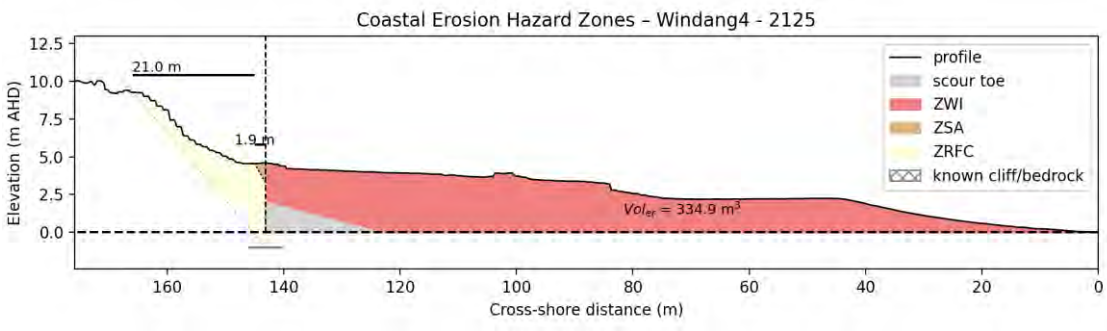
1% design volume: 201 m3/m

Available: 488 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



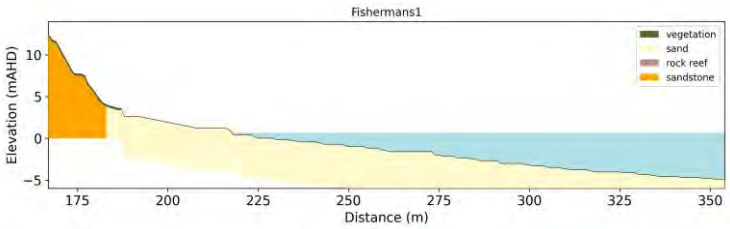
Beach: Fishermans Beach

Beach unit: Fishermans1

Description

Open coast, sandy beach, backed by vegetated sand dune and a predominantly sandstone rock formation. Protection by Red Point, Five Islands and Rocky Island.

Representative Cross Section (2021 LiDAR)

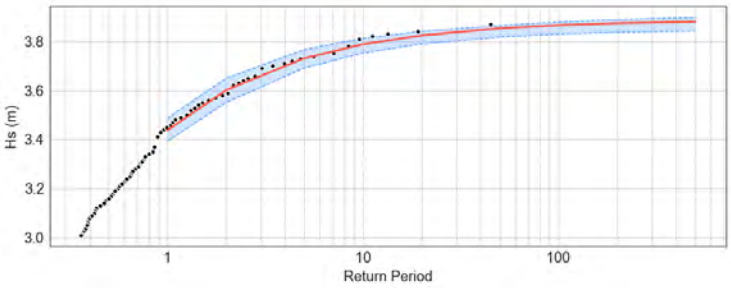


Historic Shoreline Change

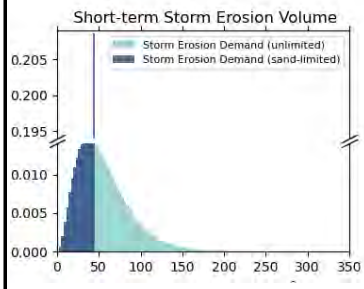
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



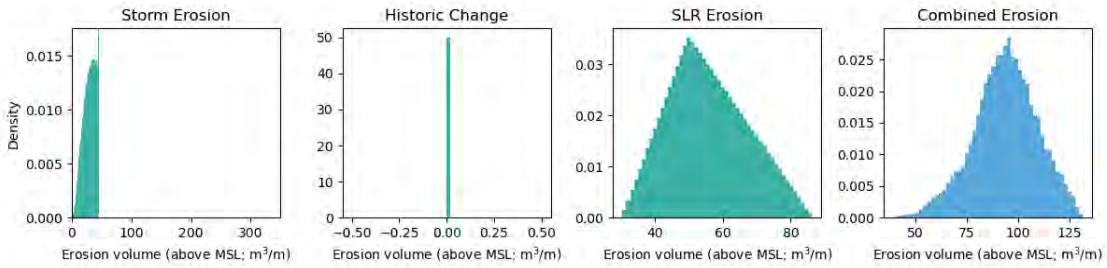
Storm Erosion Demand



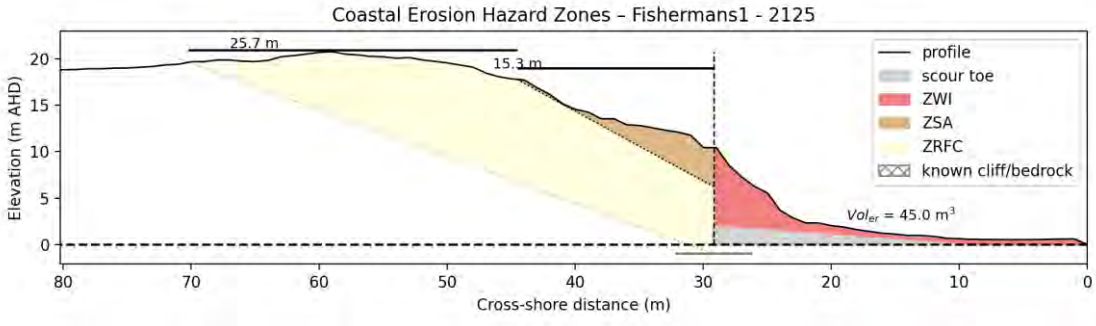
1% design volume: 155 m3/m

Available: 45 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



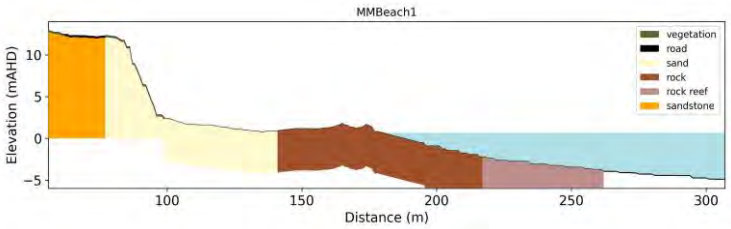
Beach: MM Beach

Beach unit: MMBeach1

Description

Perched sandy beach with rock platform at its toe. Backed by vegetated dunes, Gloucester Boulevard and a predominantly sandstone rock formation.

Representative Cross Section (2021 LiDAR)

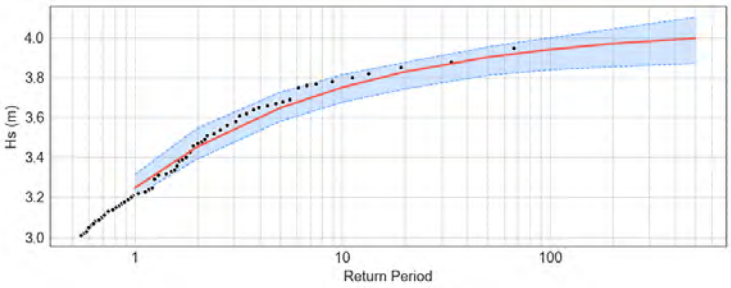


Historic Shoreline Change

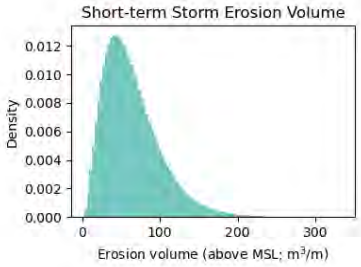
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



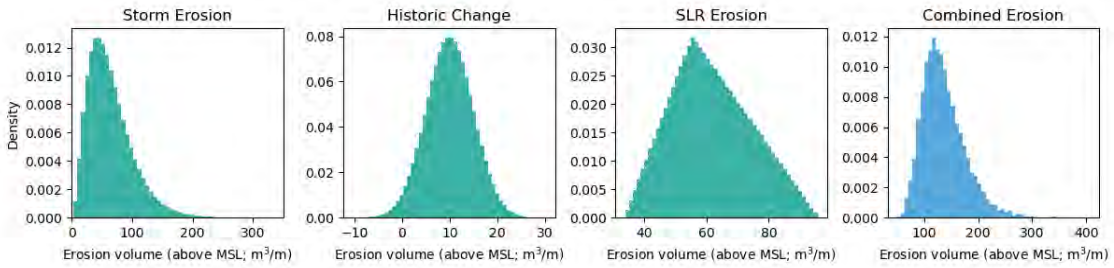
Storm Erosion Demand



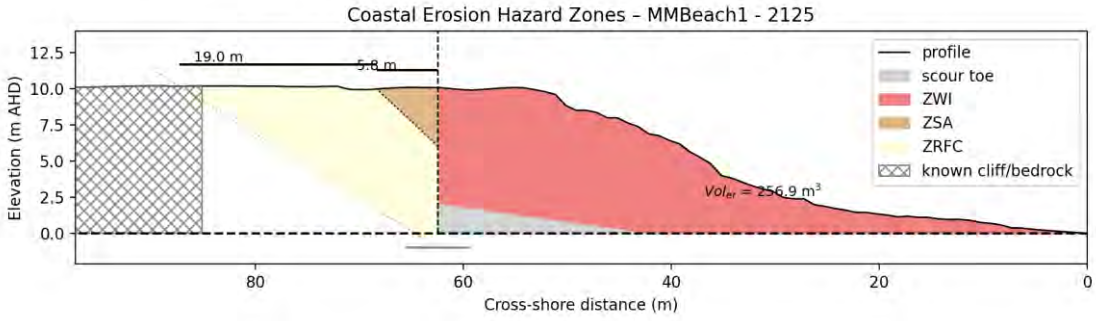
1% design volume: 179 m3/m

Available: 185 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



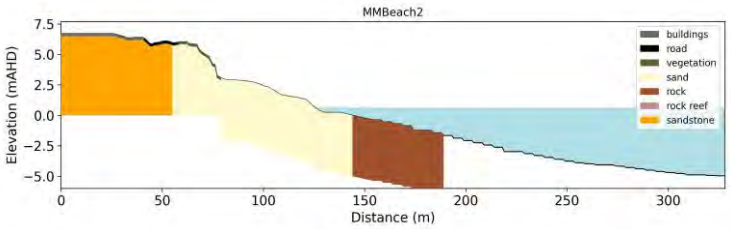
Beach: MM Beach

Beach unit: MMBeach2

Description

Perched sandy beach with rock platform at its toe. Backed by vegetated dunes, Gloucester Boulevard and a predominantly sandstone rock formation.

Representative Cross Section (2021 LiDAR)

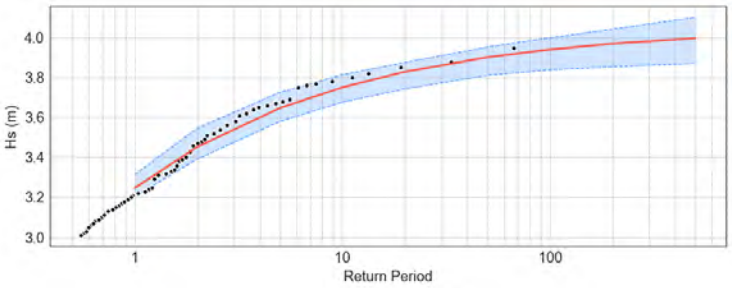


Historic Shoreline Change

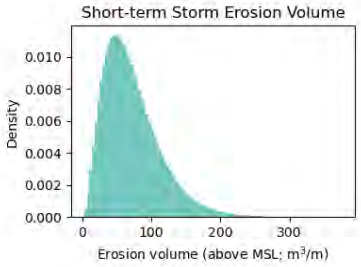
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



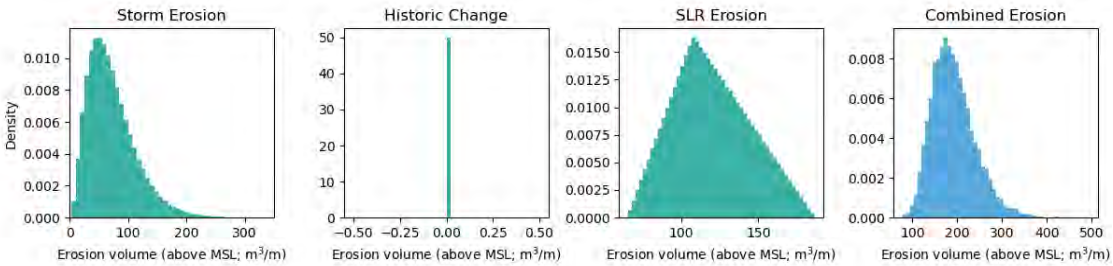
Storm Erosion Demand



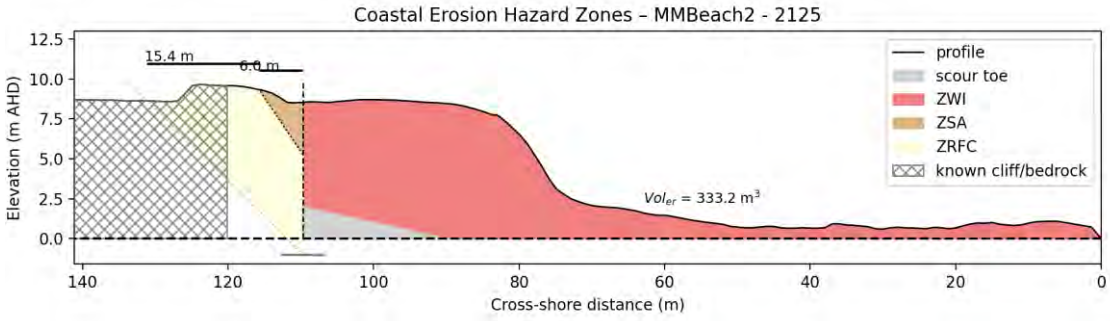
1% design volume: 201 m3/m

Available: 226 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



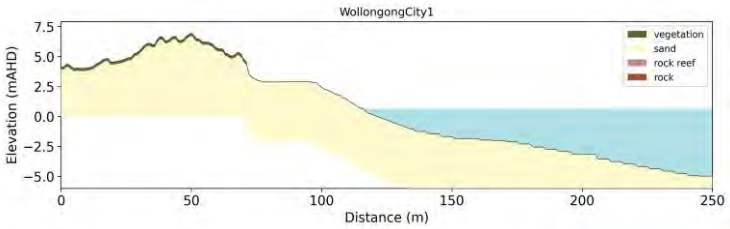
Beach: Wollongong City Beach

Beach unit: WollongongCity1

Description

Open coast, sandy beach, backed by vegetated sand dune.

Representative Cross Section (2021 LiDAR)

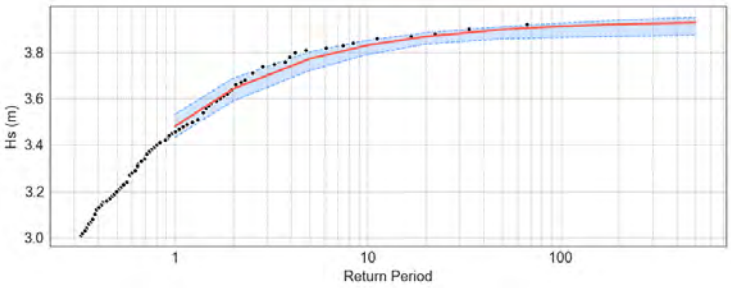


Historic Shoreline Change

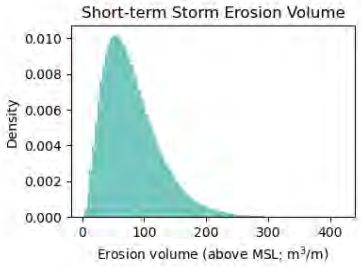
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



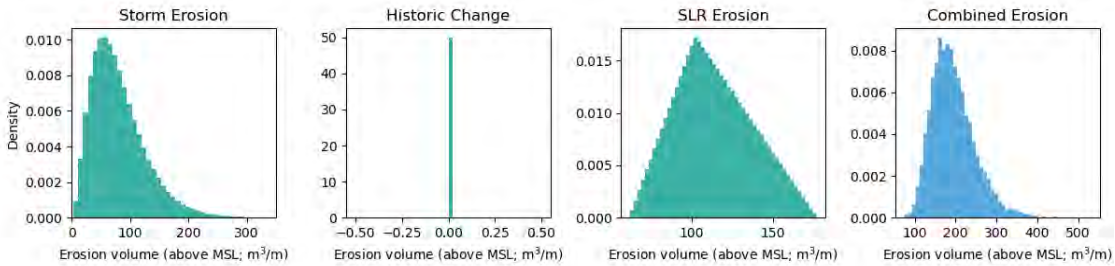
Storm Erosion Demand



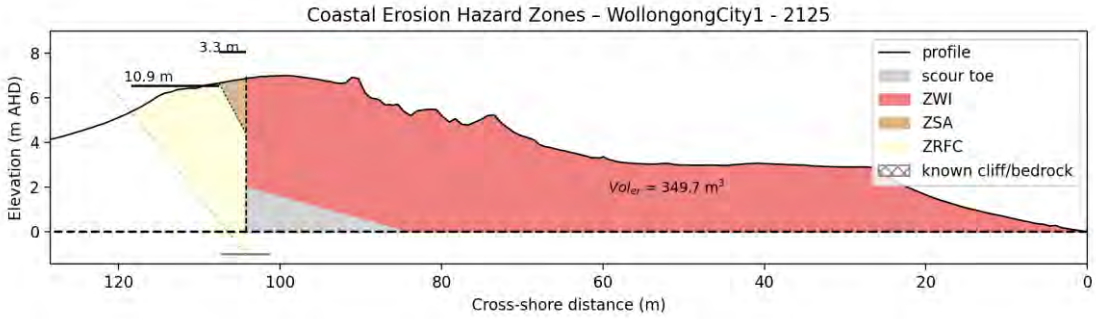
1% design volume: 224 m3/m

Available: 490 m3/m

2125 Statistical Model



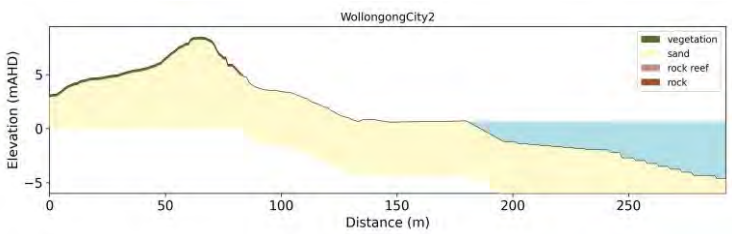
Zone of Reduced Foundation Capacity (1% probability of occurrence)



Description

Open coast, sandy beach, backed by vegetated sand dune.

Representative Cross Section (2021 LiDAR)

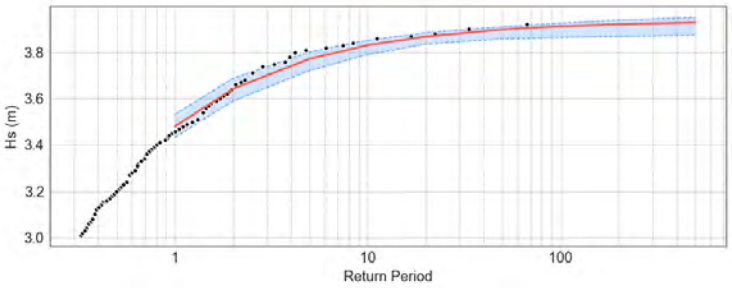


Historic Shoreline Change

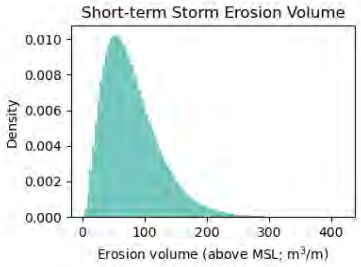
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



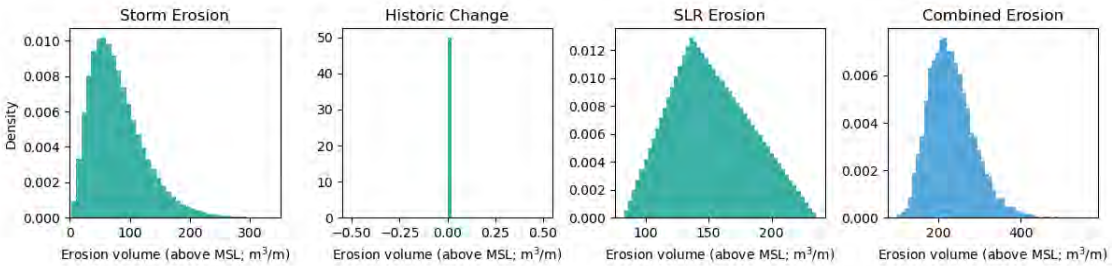
Storm Erosion Demand



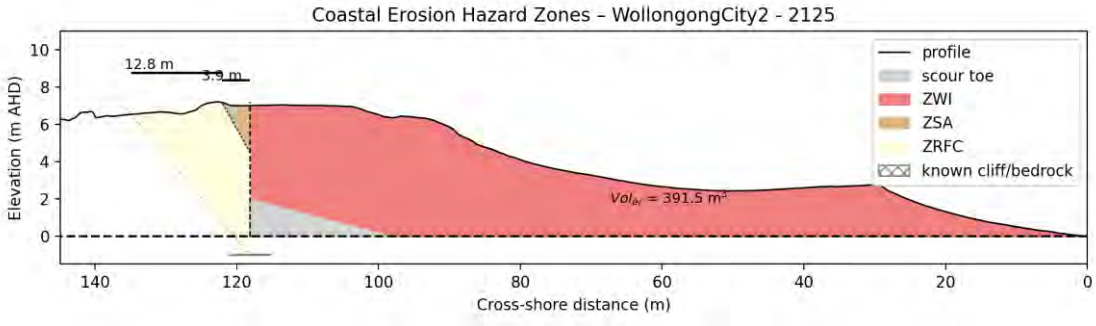
1% design volume: 223 m3/m

Available: 653 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



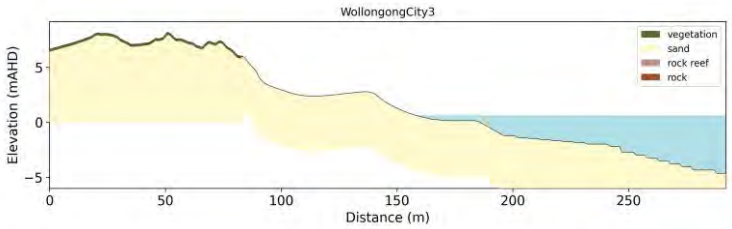
Beach: Wollongong City Beach

Beach unit: WollongongCity3

Description

Open coast, sandy beach, backed by vegetated sand dune and WIN Stadium.

Representative Cross Section (2021 LiDAR)

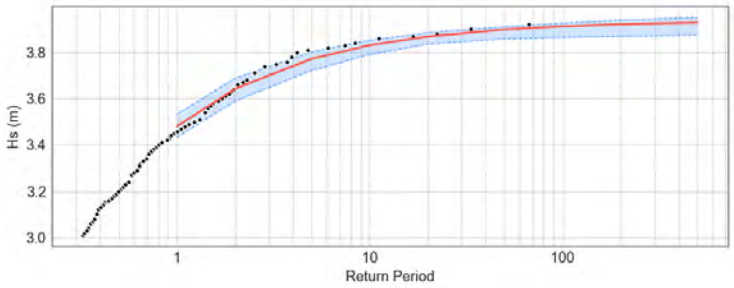


Historic Shoreline Change

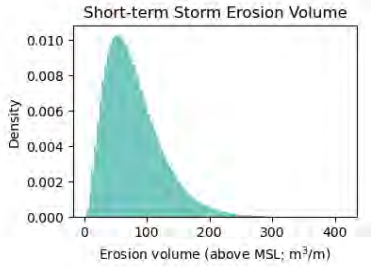
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



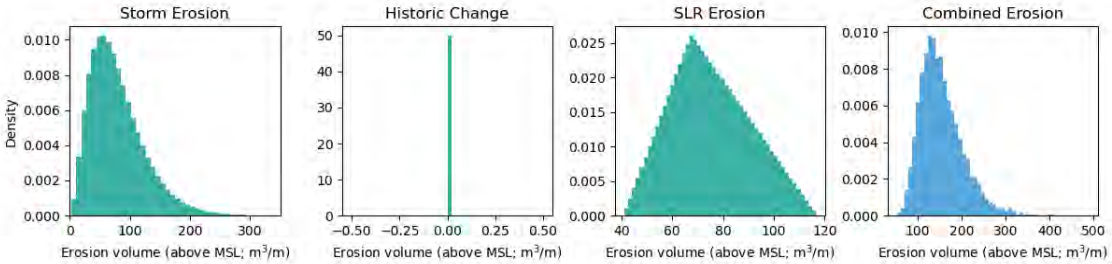
Storm Erosion Demand



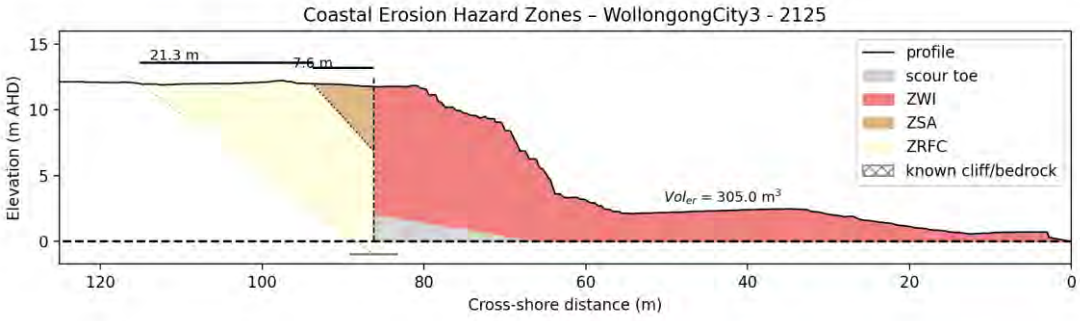
1% design volume: 222 m3/m

Available: 819 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



Beach: Brighton Beach

Beach unit: Brighton1

Description

Sheltered beach inside a harbour. Backed by sandstone topped with footpaths, a seawall and Cliff Road.

Representative Cross Section (2021 LiDAR)

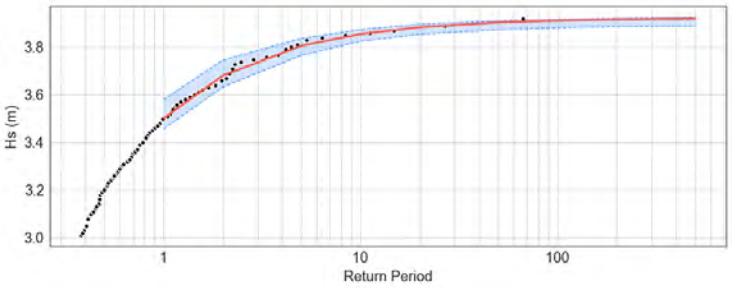


Historic Shoreline Change

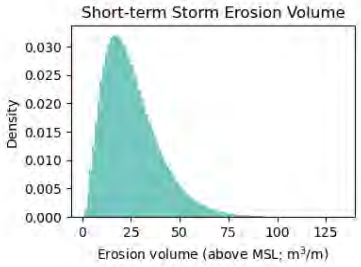
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

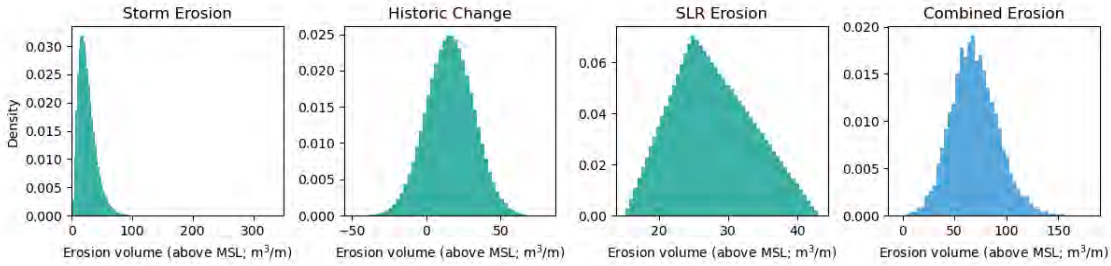


1% design volume: 71 m3/m

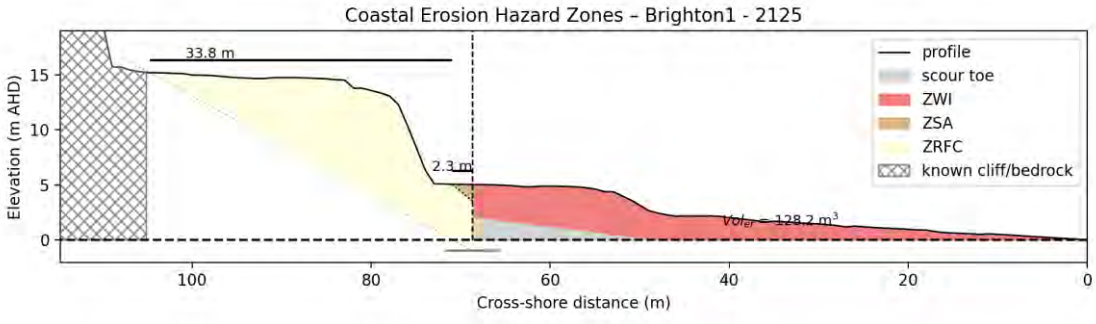
Available: >56 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



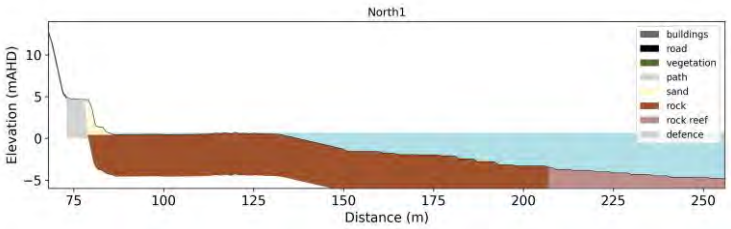
Beach: North Beach

Beach unit: North1

Description

Perched sandy beach with sandstone rock platform at its toe as well as the Continental Pool. Backed by a vertical seawall protecting Cliff Road.

Representative Cross Section (2021 LiDAR)

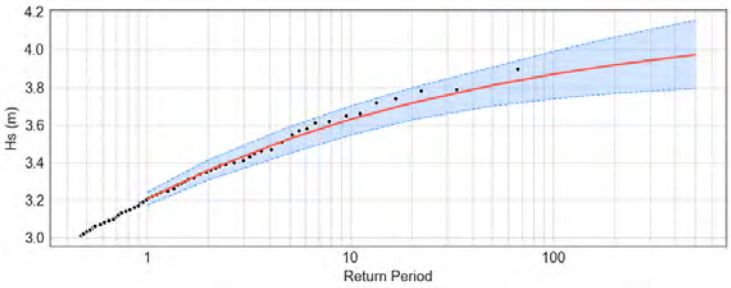


Historic Shoreline Change

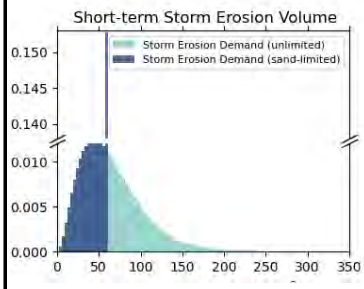
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



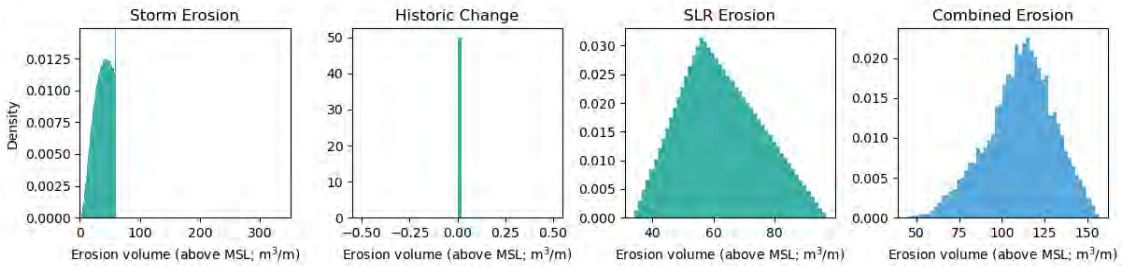
Storm Erosion Demand



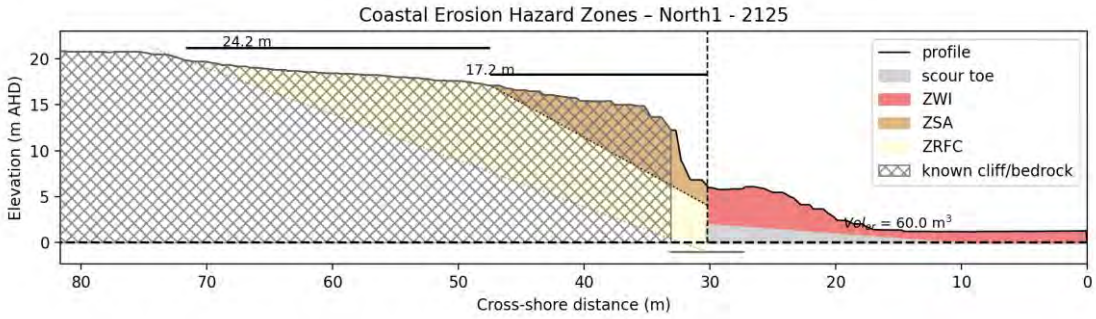
1% design volume: 183 m3/m

Available: 60 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



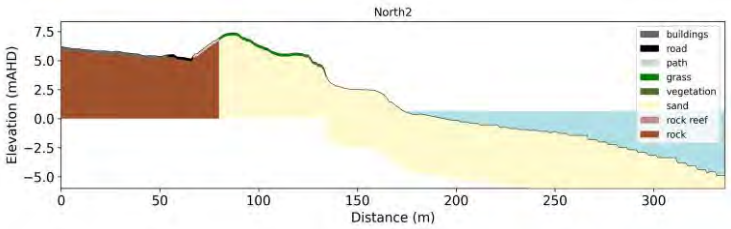
Beach: North Beach

Beach unit: North2

Description

Open coast, sandy beach, backed by a seawall and foreshore area (JP Galvin Park).

Representative Cross Section (2021 LiDAR)

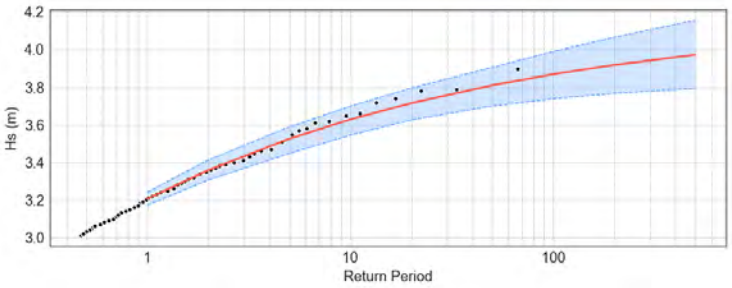


Historic Shoreline Change

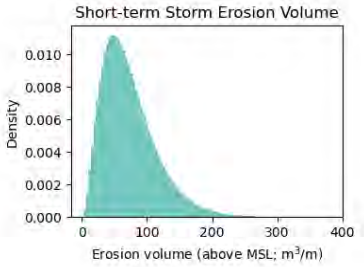
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



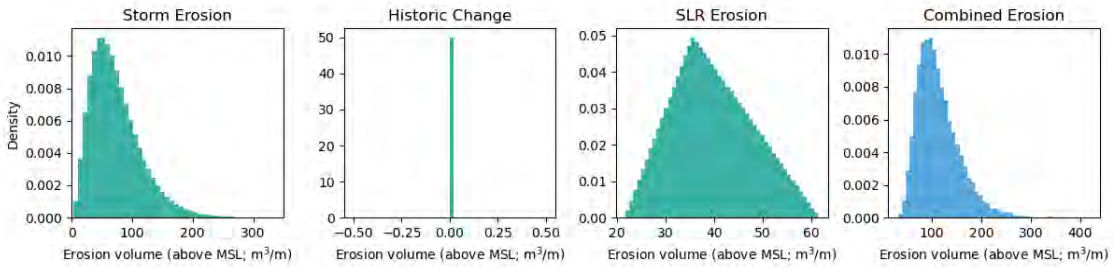
Storm Erosion Demand



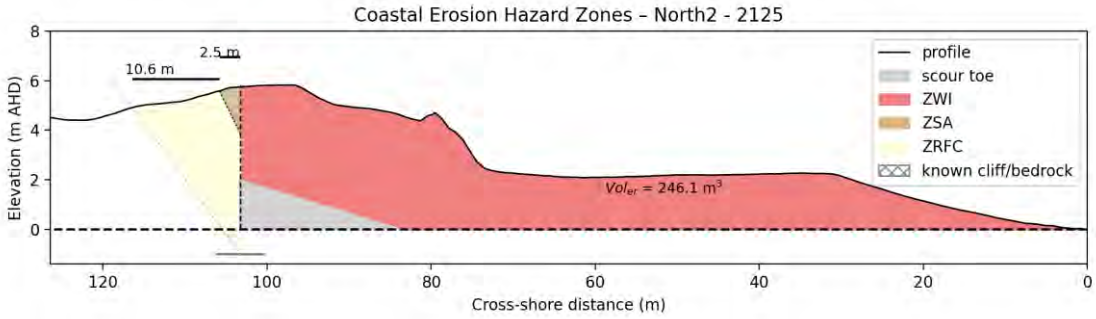
1% design volume: 204 m3/m

Available: 500 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



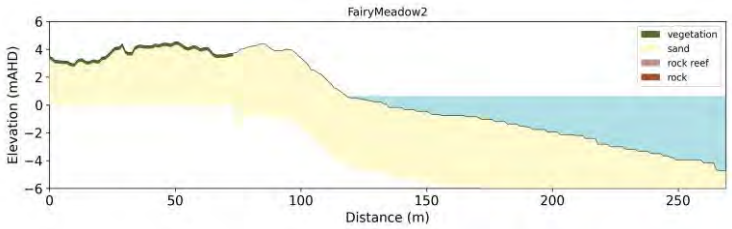
Beach: Fairy Meadow Beach

Beach unit: FairyMeadow2

Description

Open coast, sandy beach, backed by vegetated sand dune, Towradgi Arm and Fairy Meadow SLSC.

Representative Cross Section (2021 LiDAR)

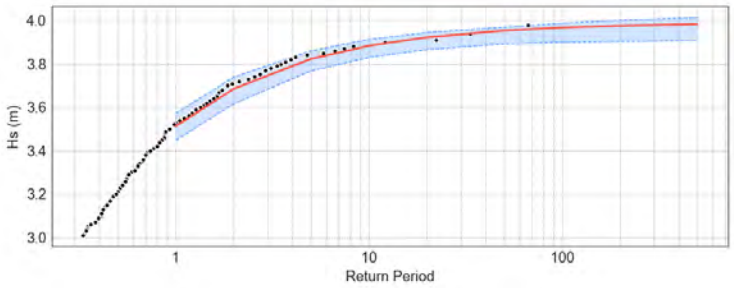


Historic Shoreline Change

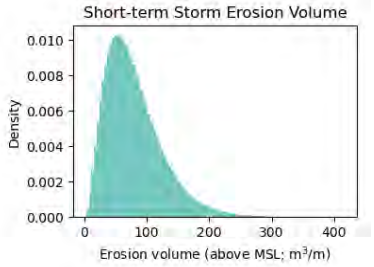
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



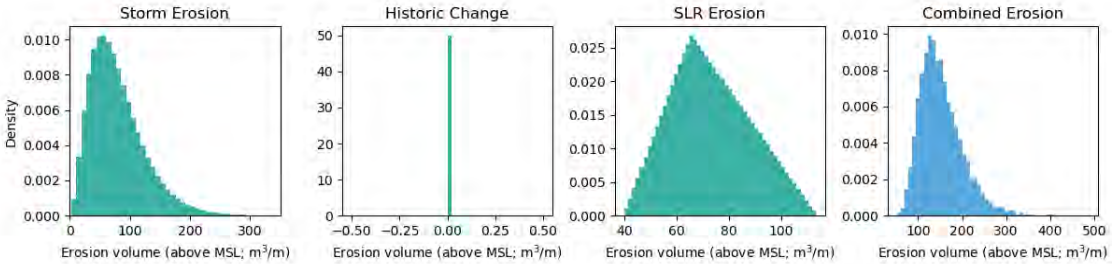
Storm Erosion Demand



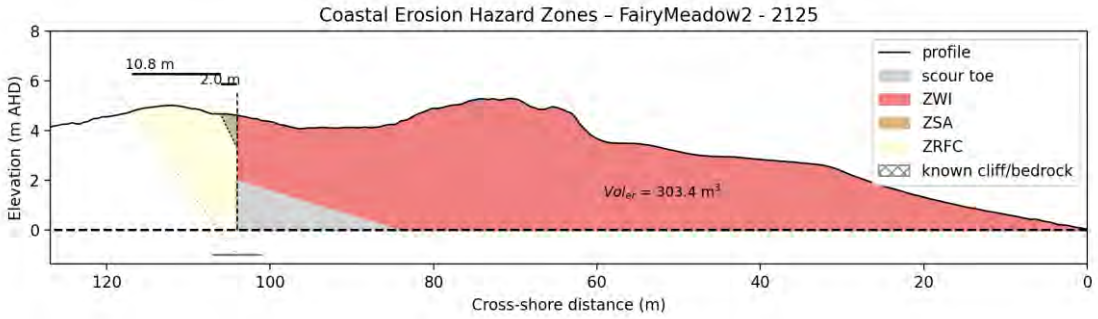
1% design volume: 222 m3/m

Available: 423 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



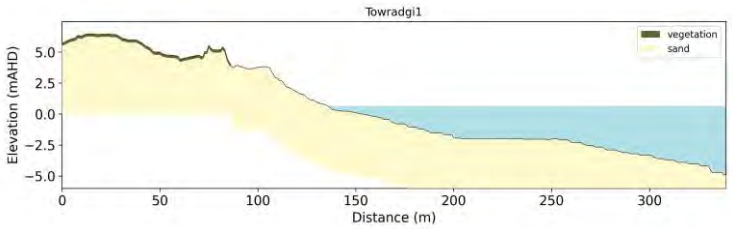
Beach: Towradgi Beach

Beach unit: Towradgi1

Description

Open coast, sandy beach, backed by vegetated sand dune.

Representative Cross Section (2021 LiDAR)

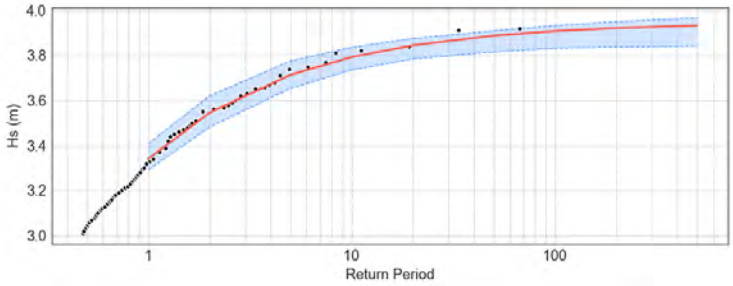


Historic Shoreline Change

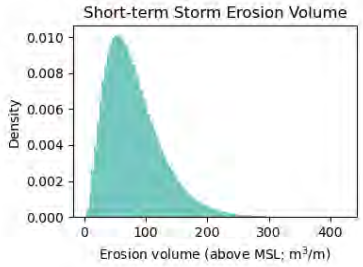
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



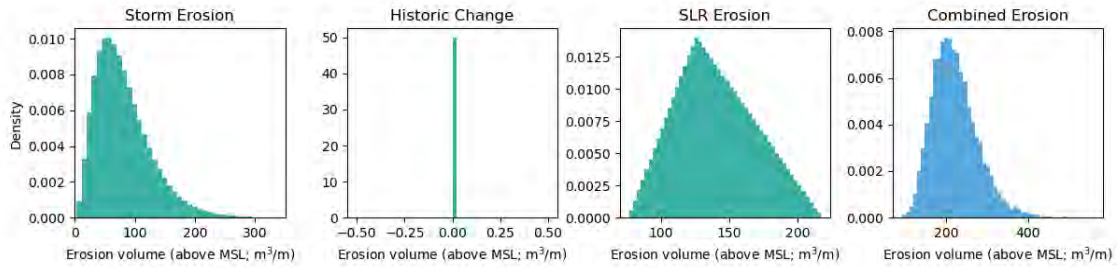
Storm Erosion Demand



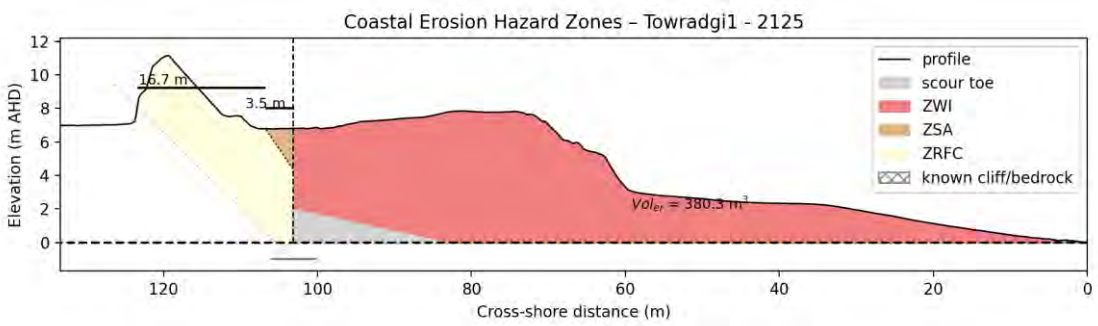
1% design volume: 226 m3/m

Available: 603 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



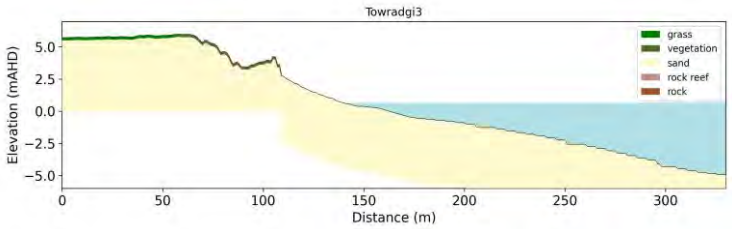
Beach: Towradgi Beach

Beach unit: Towradgi3

Description

Open coast, sandy beach, backed by vegetated sand dune and Towradgi Sports Park.

Representative Cross Section (2021 LiDAR)

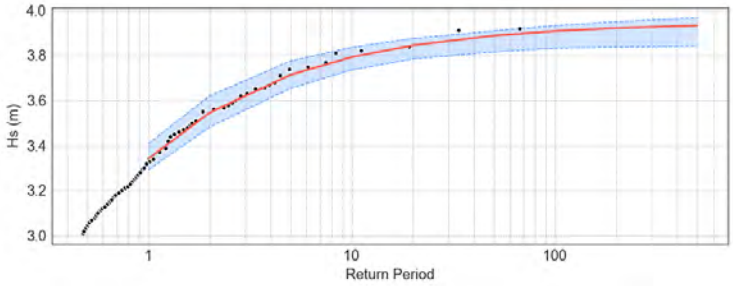


Historic Shoreline Change

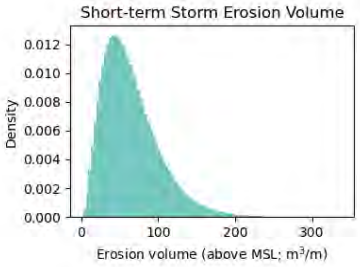
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



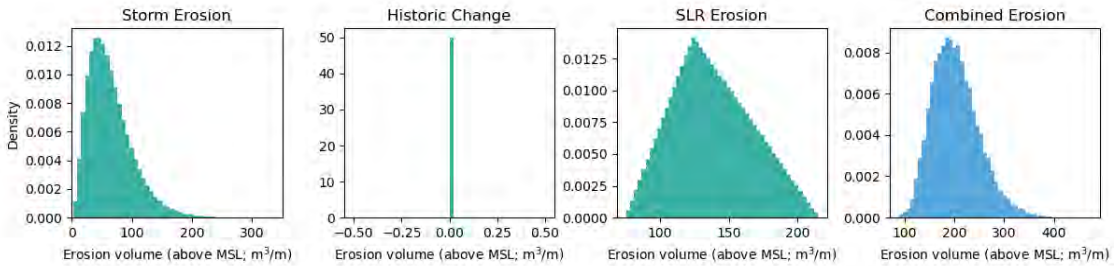
Storm Erosion Demand



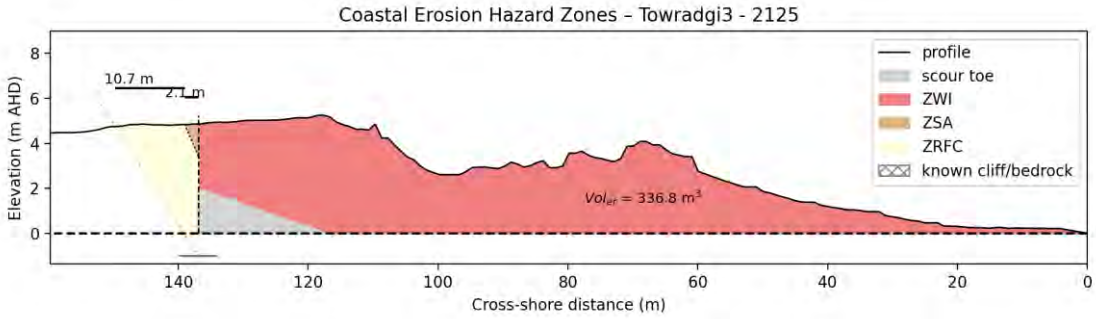
1% design volume: 180 m3/m

Available: 623 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



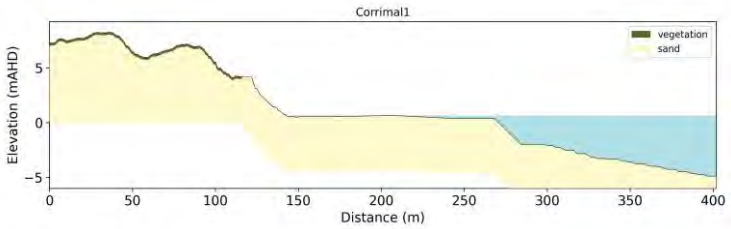
Beach: Corrimal Beach

Beach unit: Corrimal1

Description

Open coast, sandy beach, backed by vegetated sand dune.

Representative Cross Section (2021 LiDAR)

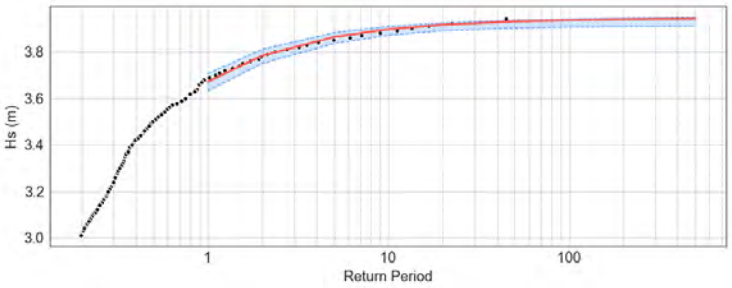


Historic Shoreline Change

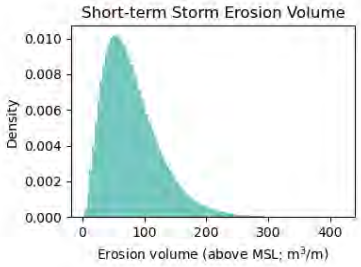
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



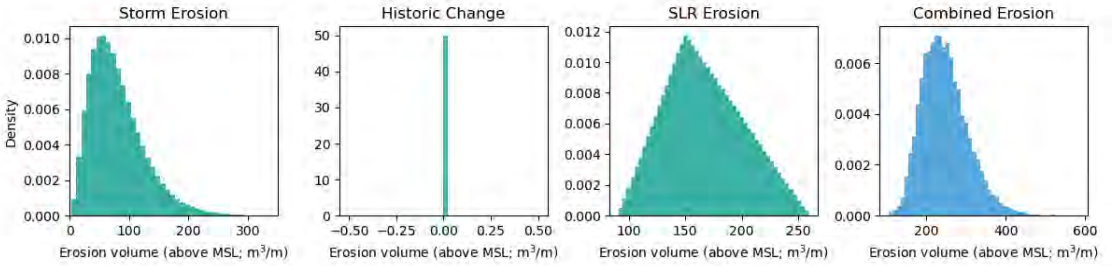
Storm Erosion Demand



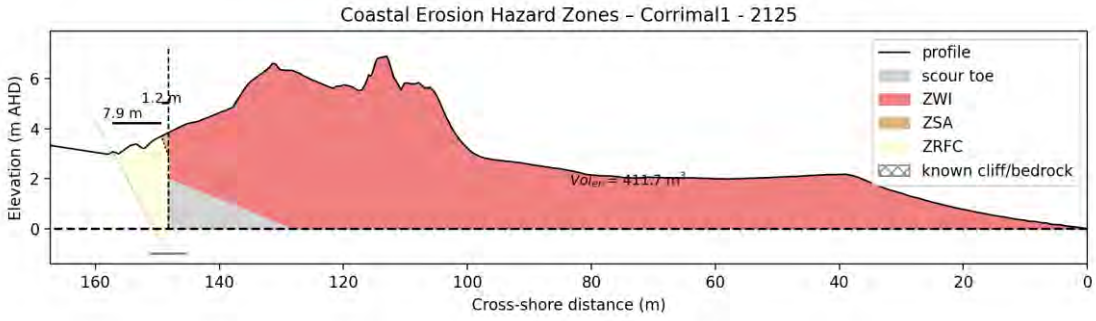
1% design volume: 224 m3/m

Available: 889 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



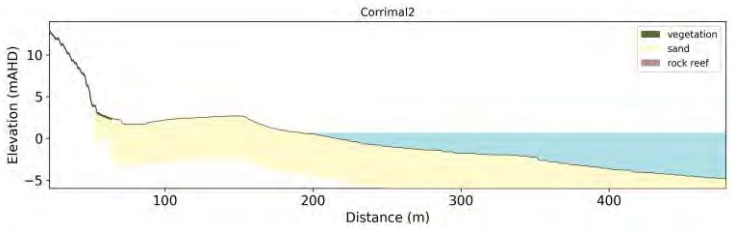
Beach: Corrimal Beach

Beach unit: Corrimal2

Description

Open coast, sandy beach, backed by vegetated sand dune. Near the ICOLL entrance/flow path of Bellambi Lake.

Representative Cross Section (2021 LiDAR)

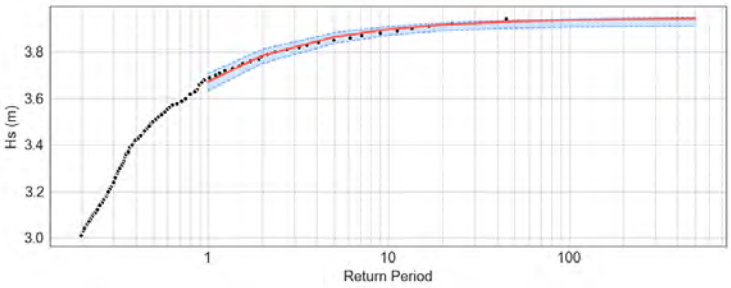


Historic Shoreline Change

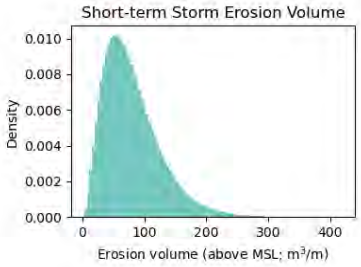
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



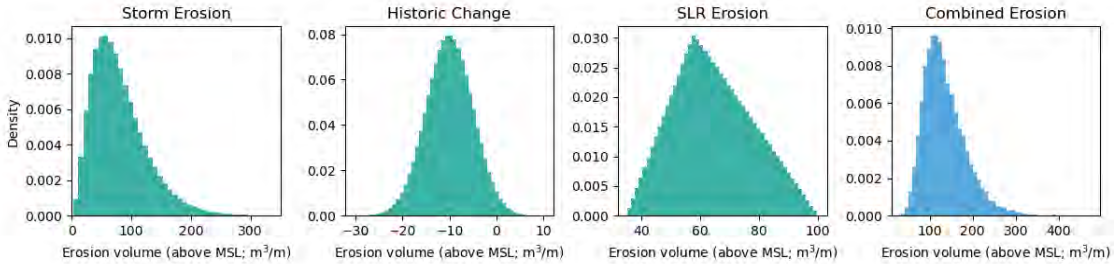
Storm Erosion Demand



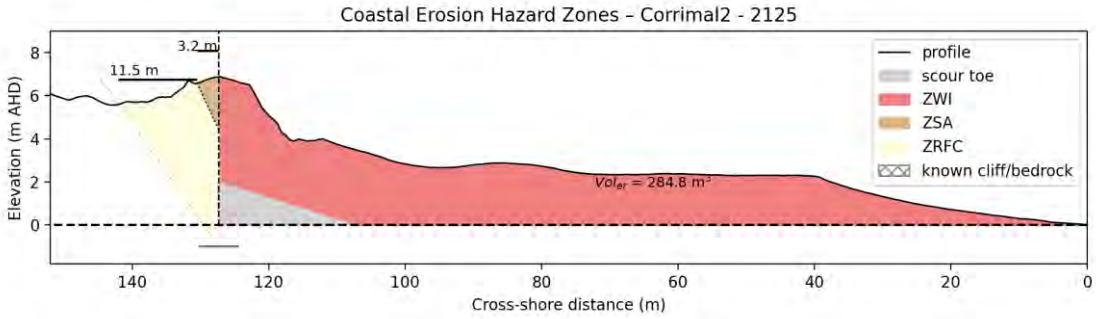
1% design volume: 224 m3/m

Available: 292 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



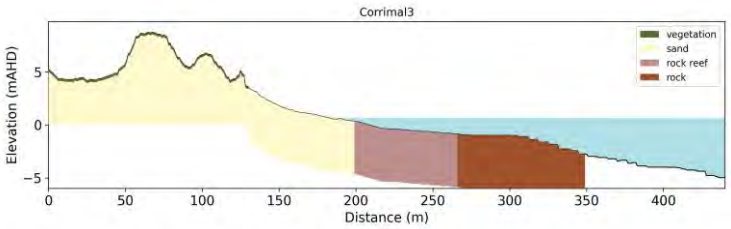
Beach: Corrimal Beach

Beach unit: Corrimal3

Description

Open coast sandy beach with partial exposure of rock platform at toe. Backed by vegetated dunes.

Representative Cross Section (2021 LiDAR)

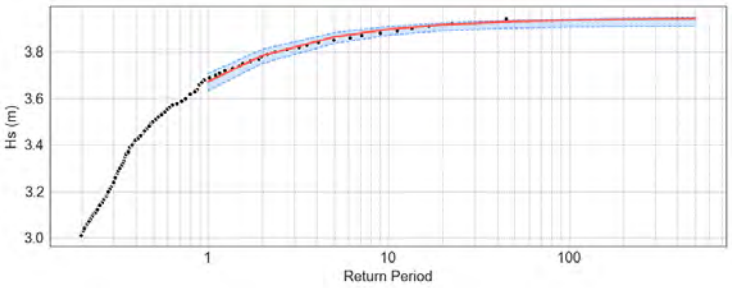


Historic Shoreline Change

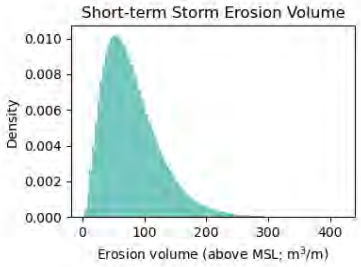
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



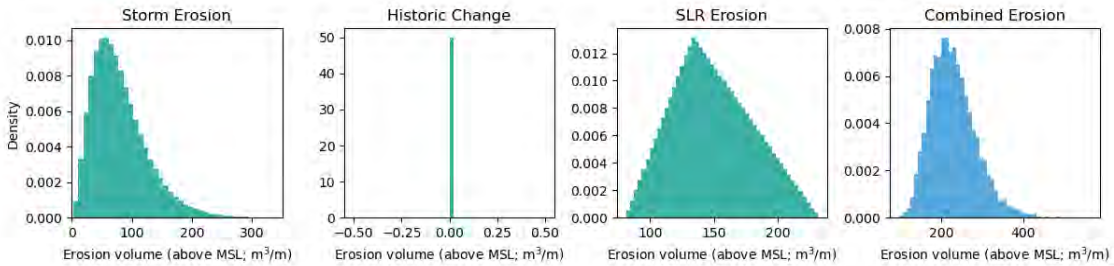
Storm Erosion Demand



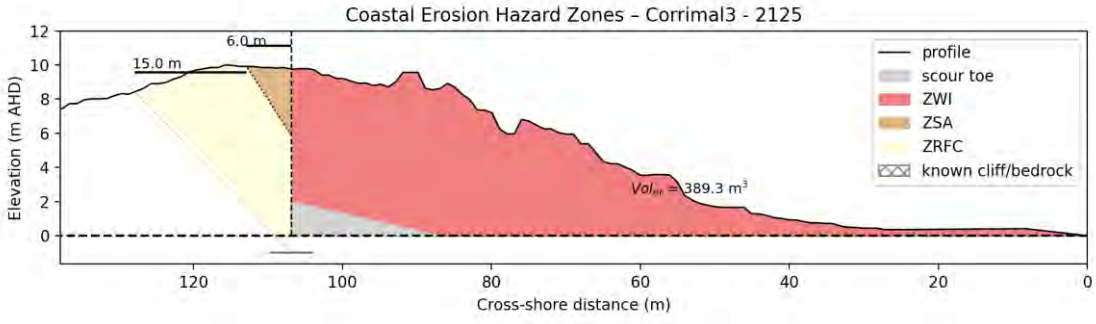
1% design volume: 224 m3/m

Available: 779 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



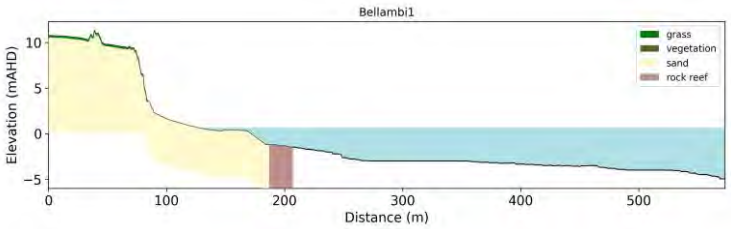
Beach: Bellambi Beach

Beach unit: Bellambi1

Description

Open coast sandy beach with partial exposure of rock platform at toe. Backed by vegetated dunes.

Representative Cross Section (2021 LiDAR)

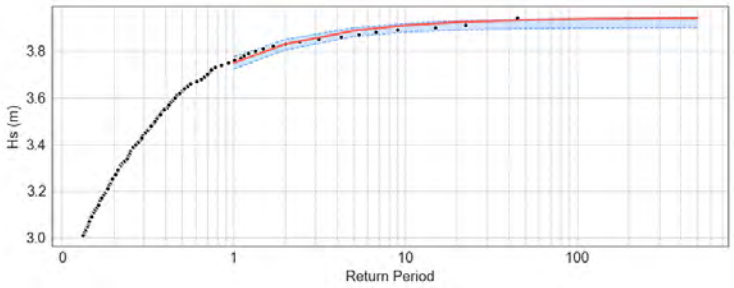


Historic Shoreline Change

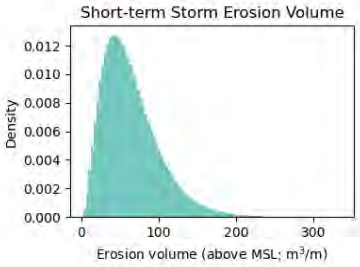
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



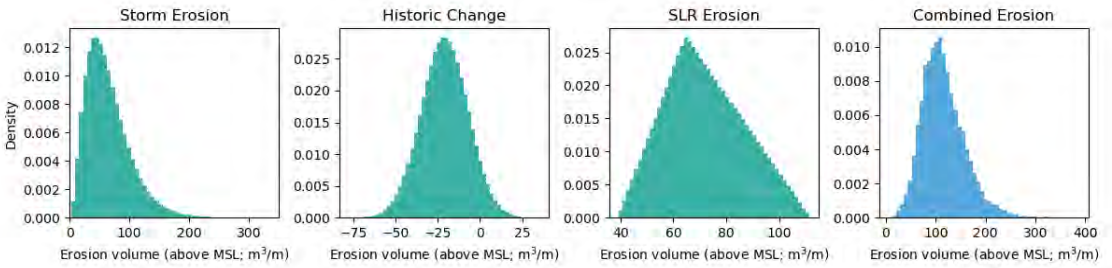
Storm Erosion Demand



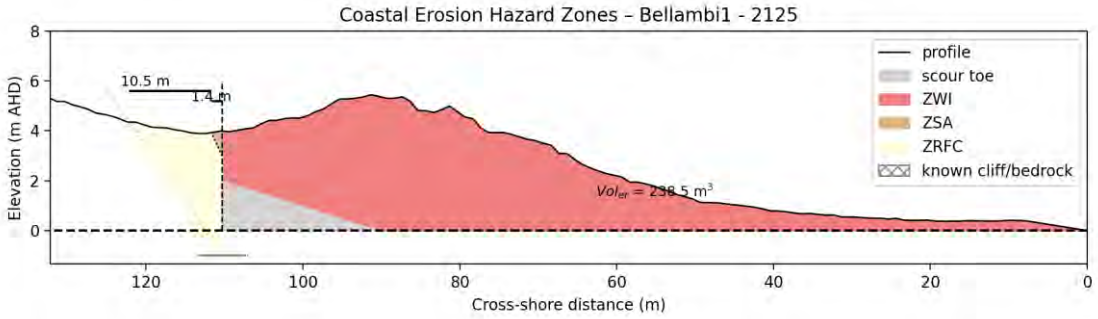
1% design volume: 179 m3/m

Available: 900 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



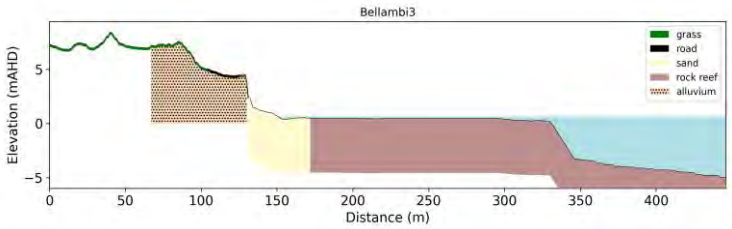
Beach: Bellambi Beach

Beach unit: Bellambi3

Description

Perched sandy beach with rock platform at its toe. Backed by an area of dune and alluvium under Robert Cram Drive.

Representative Cross Section (2021 LiDAR)

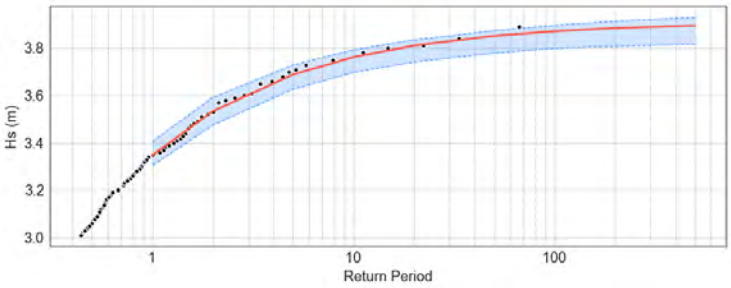


Historic Shoreline Change

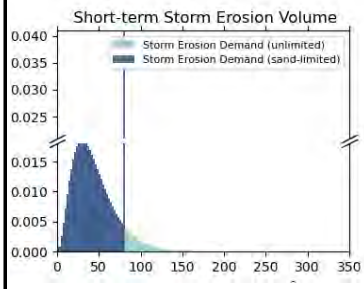
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



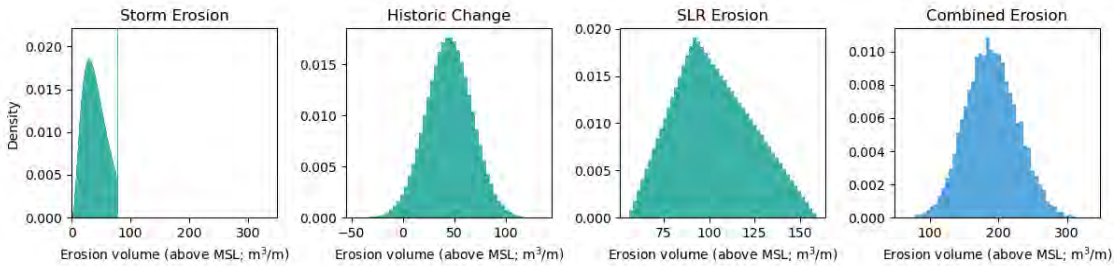
Storm Erosion Demand



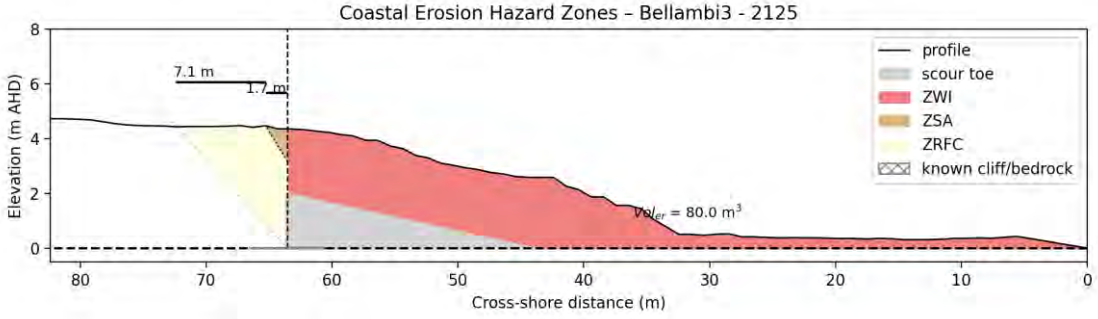
1% design volume: 123 m3/m

Available: 80 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



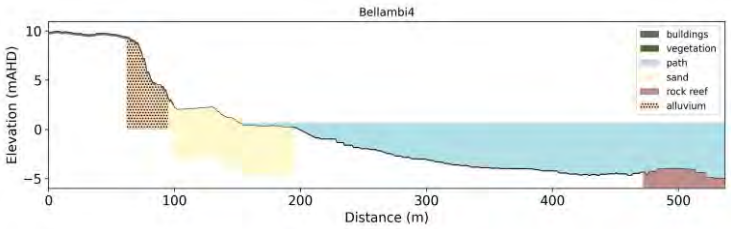
Beach: Bellambi Beach

Beach unit: Bellambi4

Description

Open coast, sandy beach, backed by alluvium.

Representative Cross Section (2021 LiDAR)

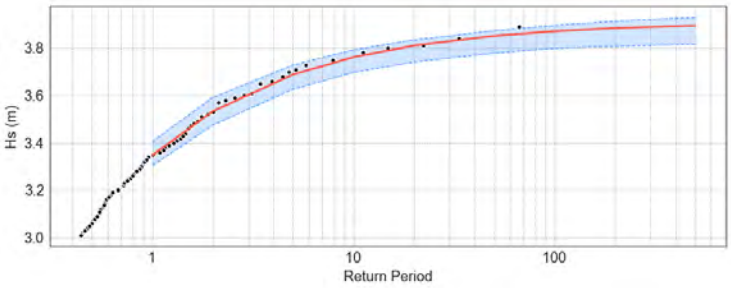


Historic Shoreline Change

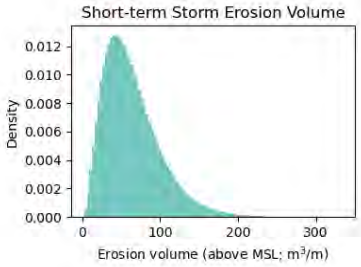
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

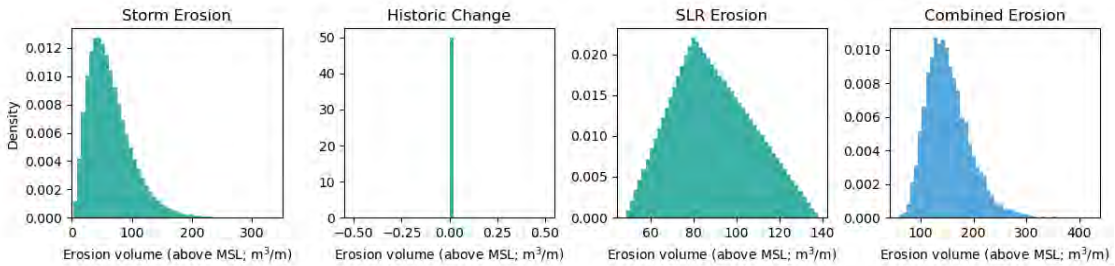


1% design volume: 178 m3/m

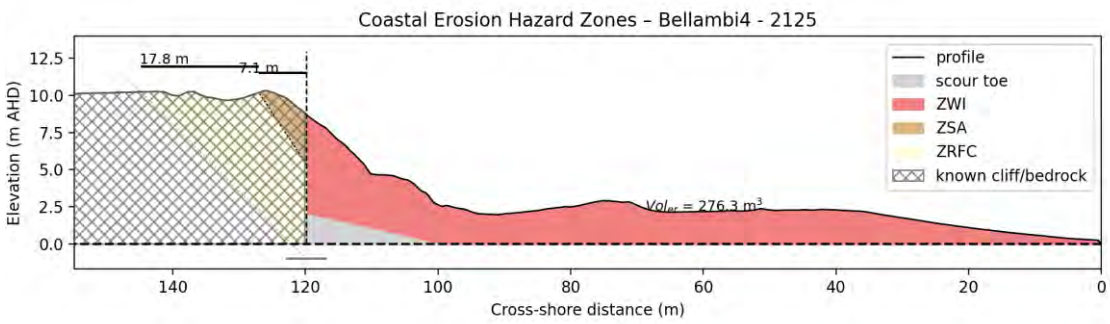
Available: >101 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



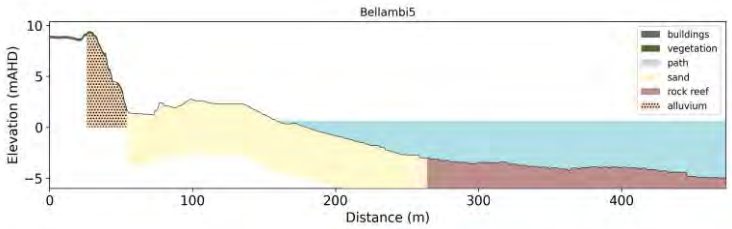
Beach: Bellambi Beach

Beach unit: Bellambi5

Description

Open coast, sandy beach, backed by alluvium.

Representative Cross Section (2021 LiDAR)

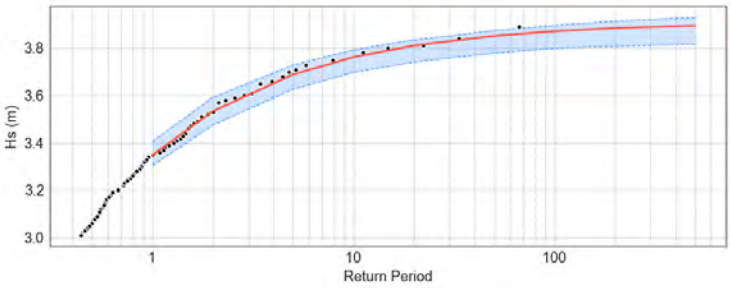


Historic Shoreline Change

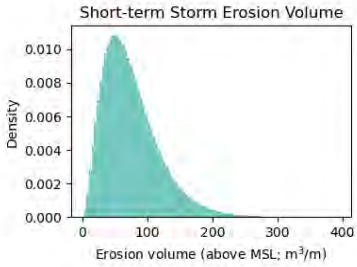
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

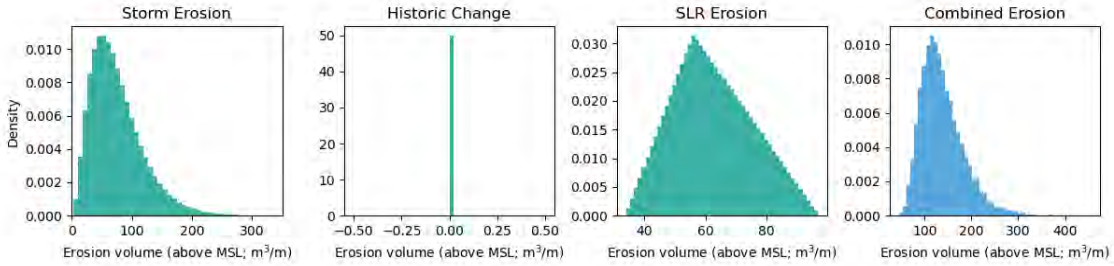


1% design volume: 210 m3/m

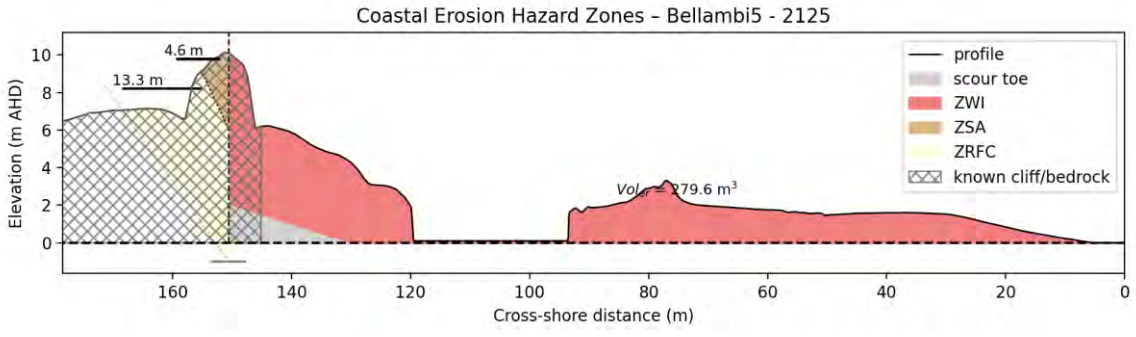
Available: >206 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



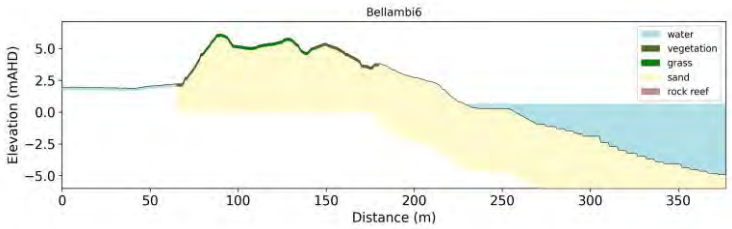
Beach: Bellambi Beach

Beach unit: Bellambi6

Description

Open coast, sandy beach, backed by vegetated sand dune and Blue Lagoon.

Representative Cross Section (2021 LiDAR)

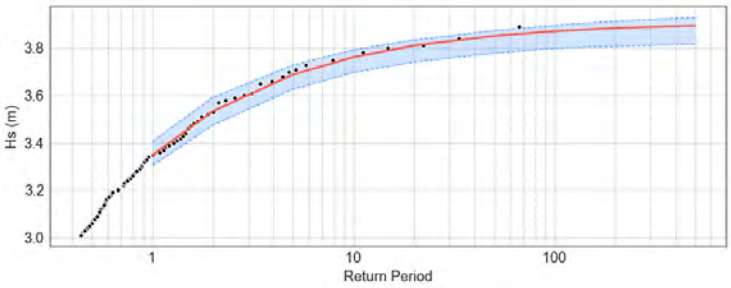


Historic Shoreline Change

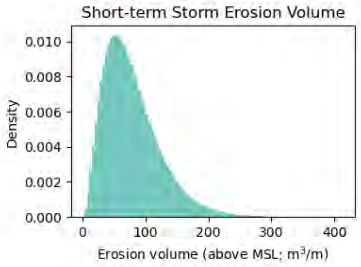
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



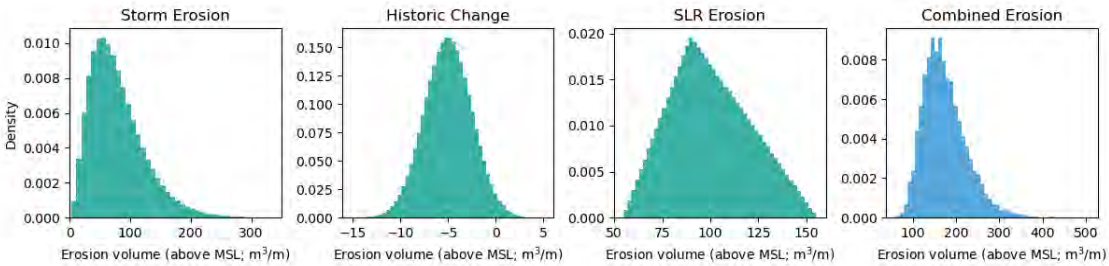
Storm Erosion Demand



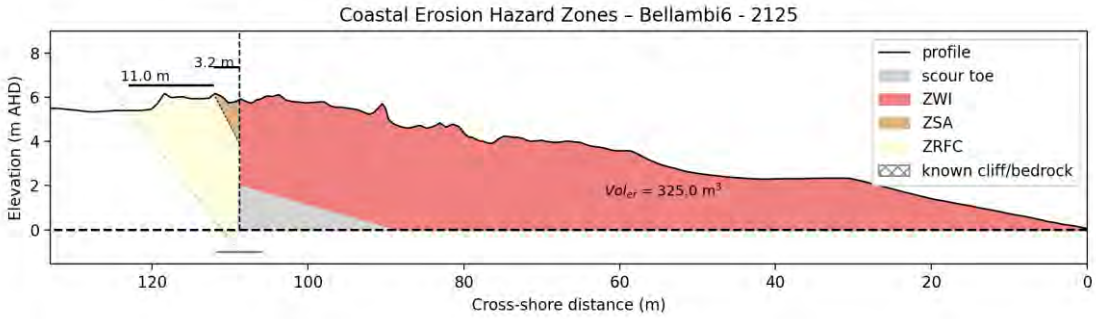
1% design volume: 220 m3/m

Available: 677 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



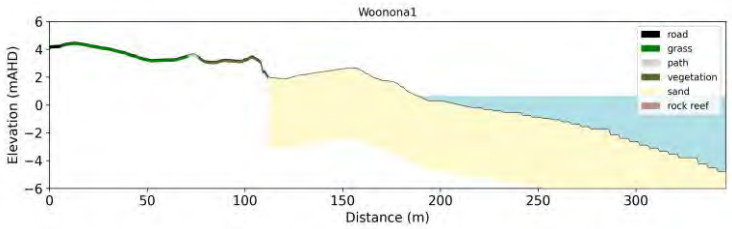
Beach: Woonona Beach

Beach unit: Woonona1

Description

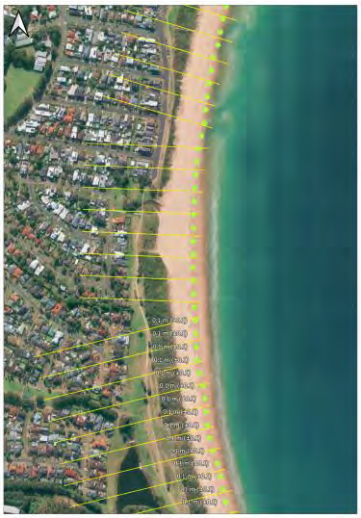
Open coast, sandy beach, backed by vegetated sand dune.

Representative Cross Section (2021 LiDAR)

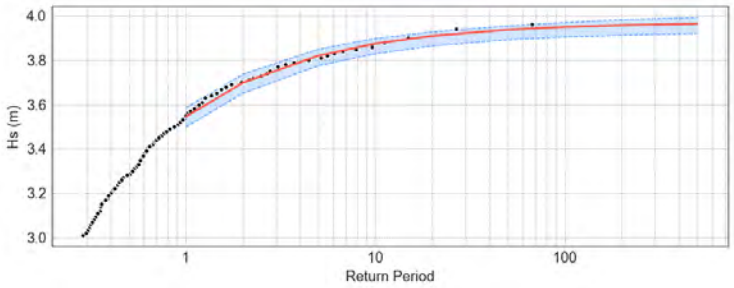


Historic Shoreline Change

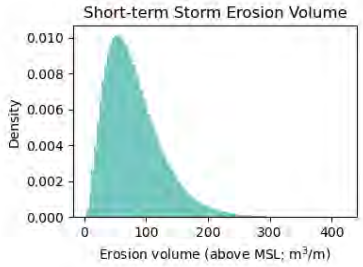
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

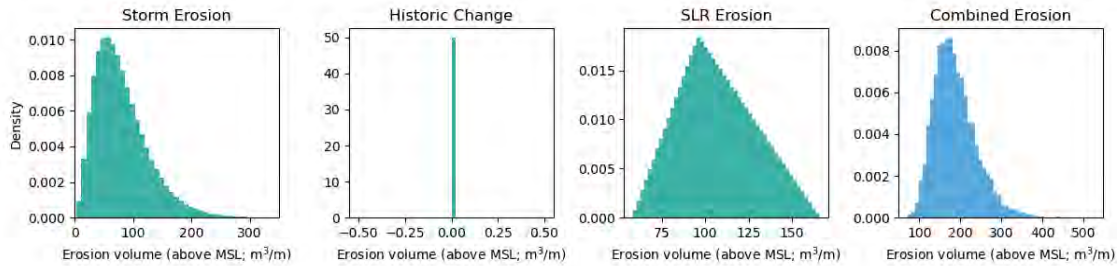


1% design volume: 224 m3/m

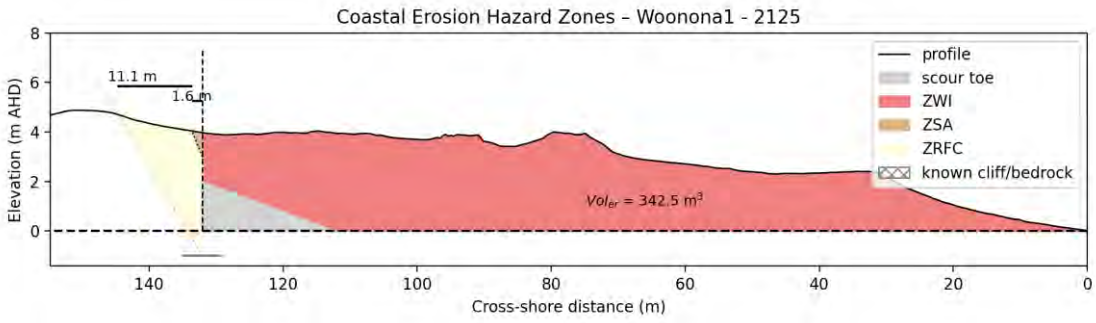
Available: >158 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



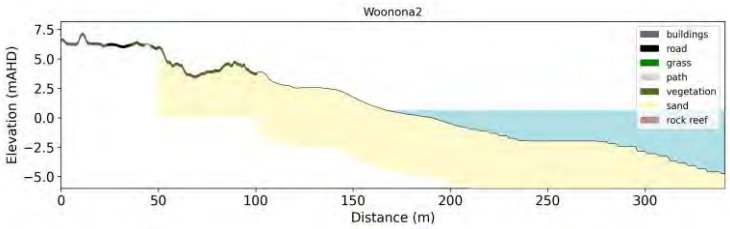
Beach: Woonona Beach

Beach unit: Woonona2

Description

Open coast, sandy beach, backed by vegetated sand dune and Beach Drive.

Representative Cross Section (2021 LiDAR)

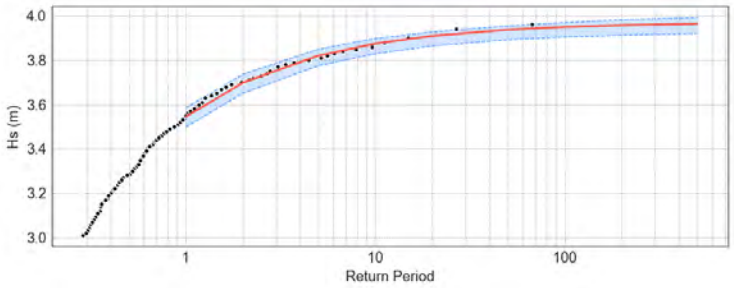


Historic Shoreline Change

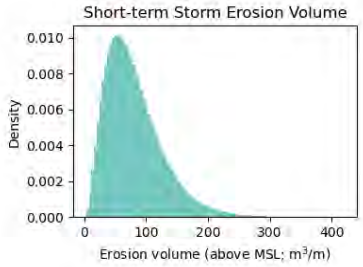
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



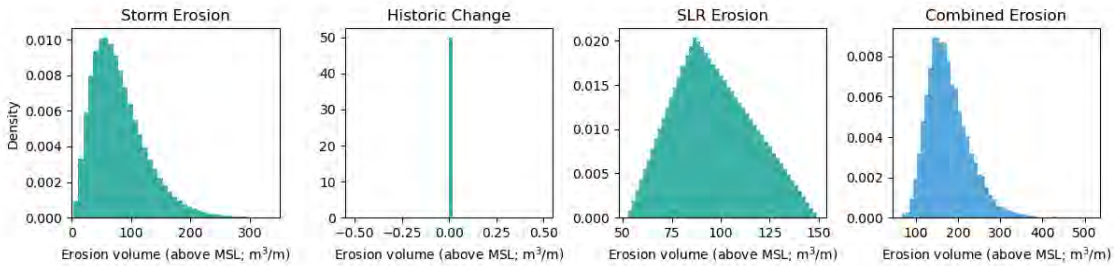
Storm Erosion Demand



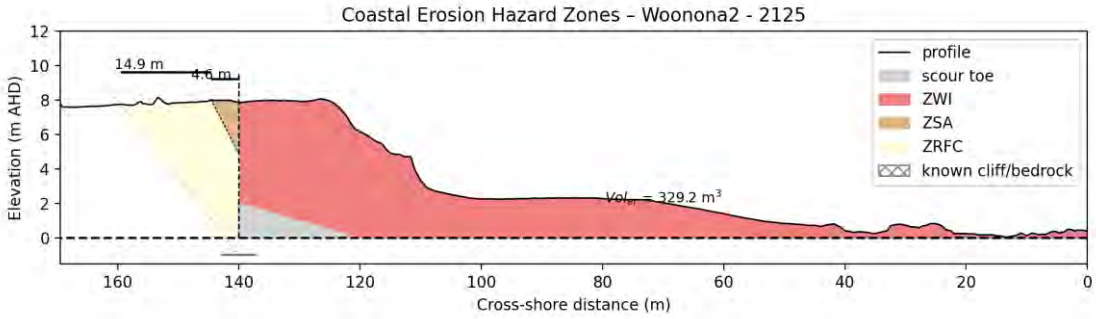
1% design volume: 224 m3/m

Available: 376 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



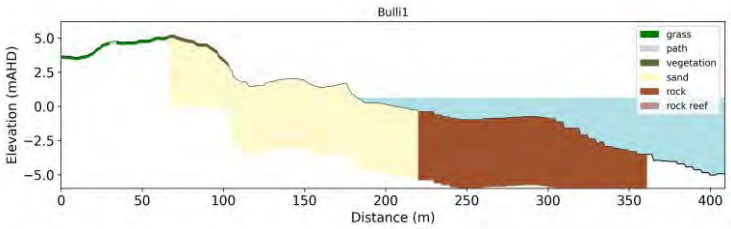
Beach: Bulli Beach

Beach unit: Bulli1

Description

Open coast sandy beach with partial exposure of rock platform at toe. Backed by vegetated dunes. Near the ICOLL entrance/flow path of Collins Creek.

Representative Cross Section (2021 LiDAR)

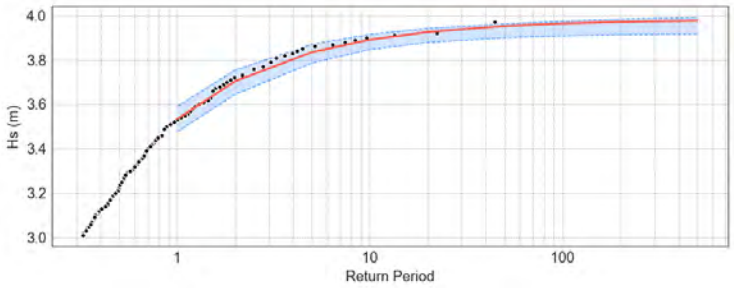


Historic Shoreline Change

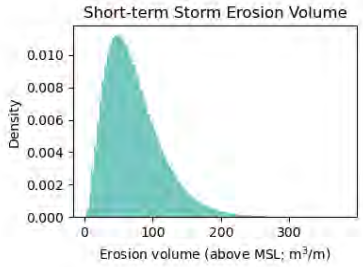
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



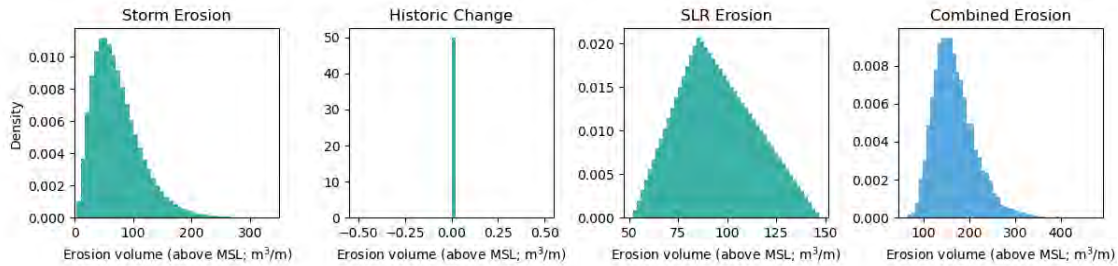
Storm Erosion Demand



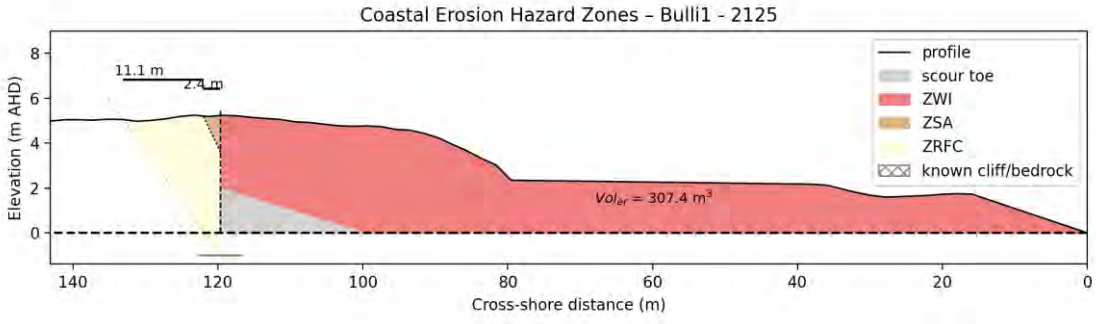
1% design volume: 203 m3/m

Available: 304 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



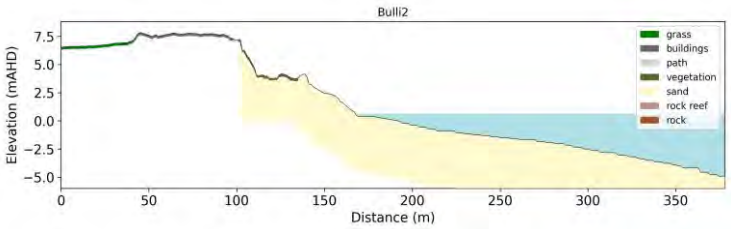
Beach: Bulli Beach

Beach unit: Bulli2

Description

Open coast, sandy beach, backed by vegetated sand dune.

Representative Cross Section (2021 LiDAR)

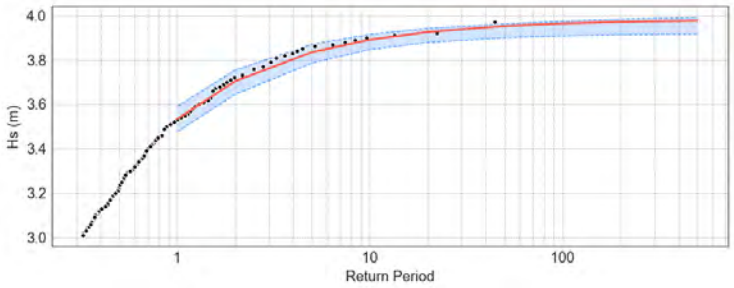


Historic Shoreline Change

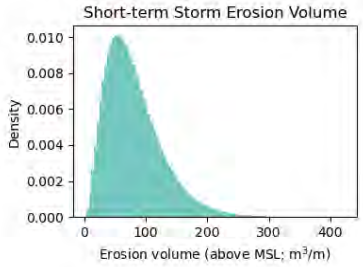
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



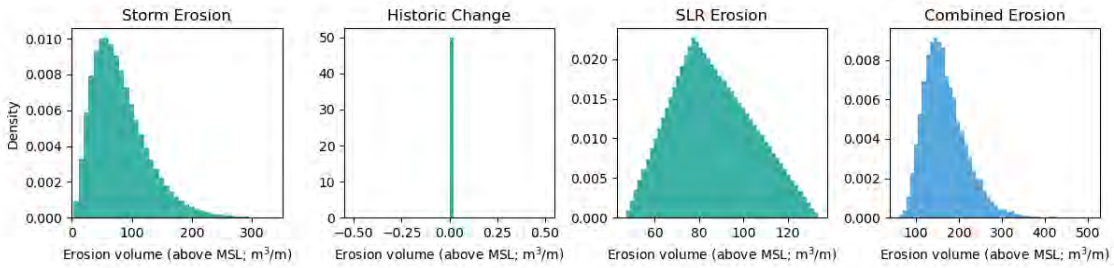
Storm Erosion Demand



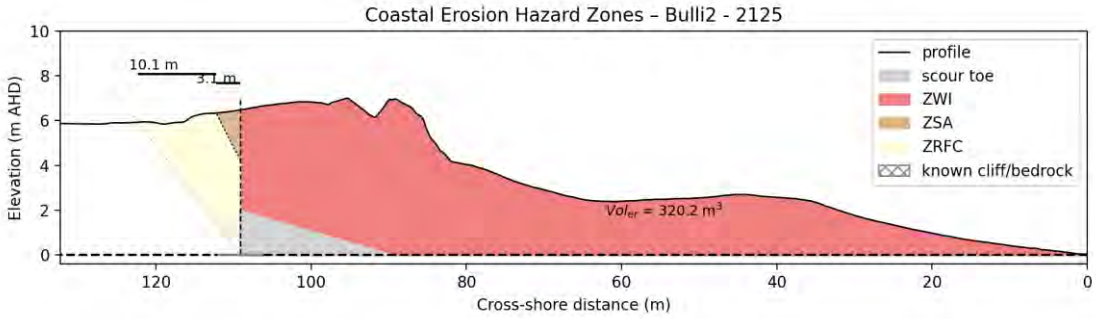
1% design volume: 225 m3/m

Available: 238 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



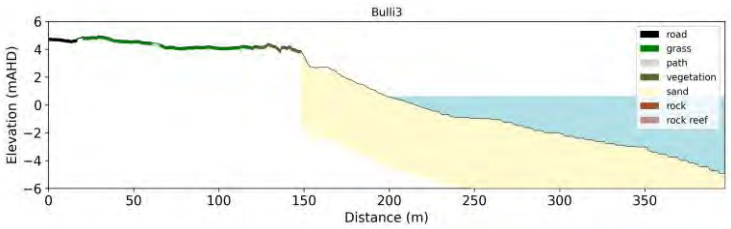
Beach: Bulli Beach

Beach unit: Bulli3

Description

Open coast, sandy beach, backed by vegetated sand dune. Near the ICOLL entrance/flow path of Whartons Creek.

Representative Cross Section (2021 LiDAR)

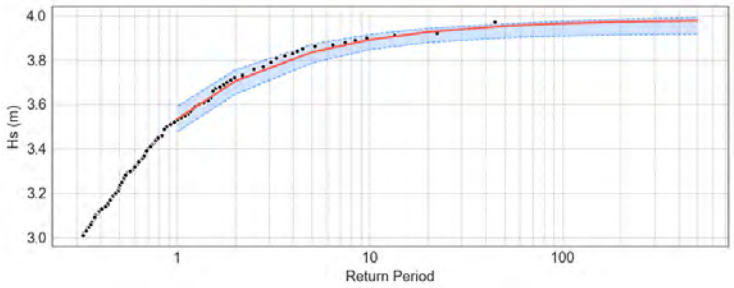


Historic Shoreline Change

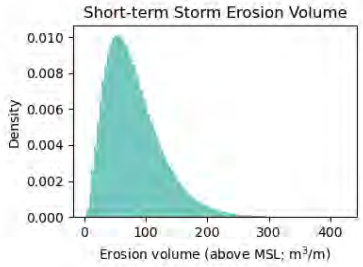
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



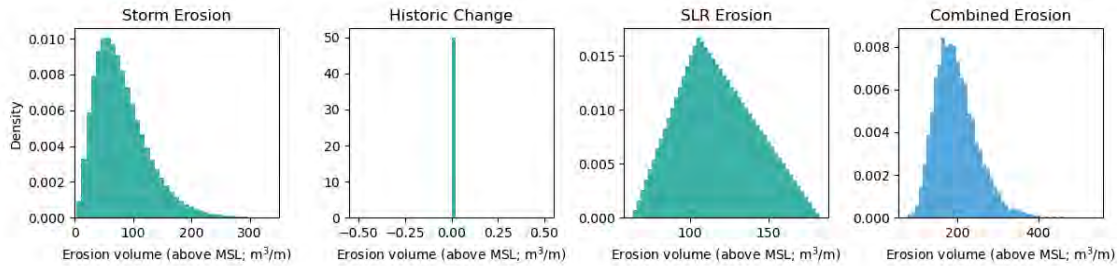
Storm Erosion Demand



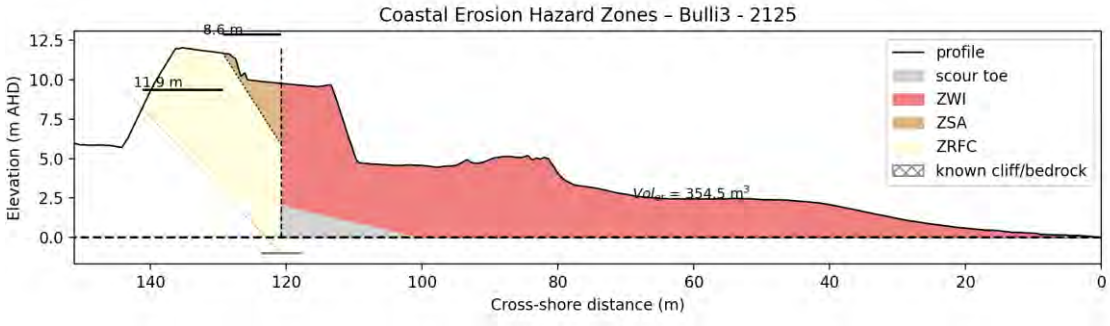
1% design volume: 225 m3/m
Available: >107 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



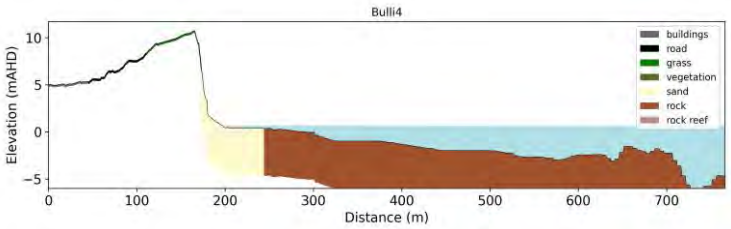
Beach: Bulli Beach

Beach unit: Bulli4

Description

Perched sandy beach with rock platform at its toe. Backed by vegetated sand dune and Bulli Beach Tourist Park.

Representative Cross Section (2021 LiDAR)

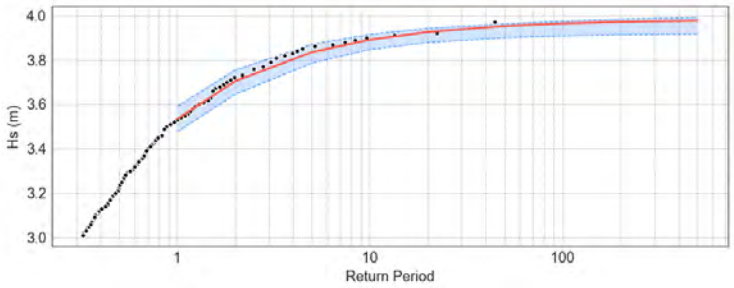


Historic Shoreline Change

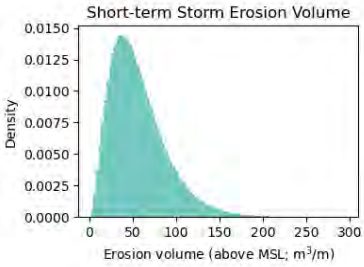
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

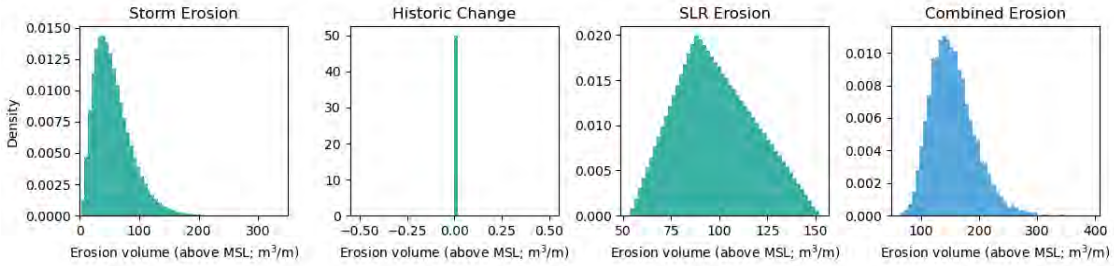


1% design volume: 158 m3/m

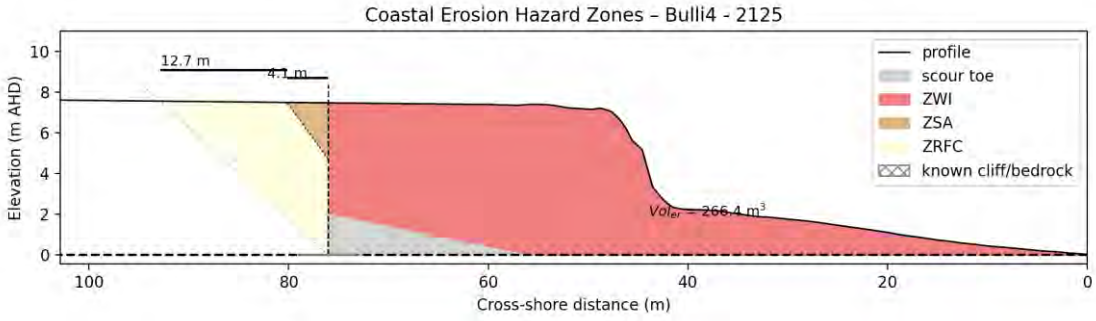
Available: >120 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



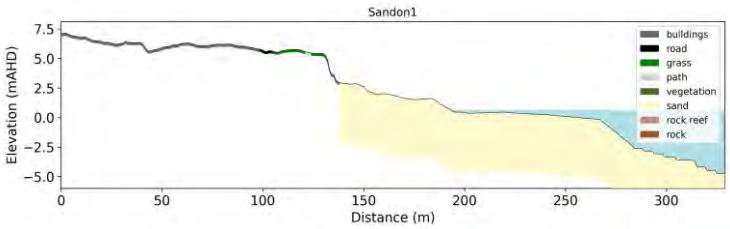
Beach: Sandon Point Beach

Beach unit: Sandon1

Description

Open coast, sandy beach, backed by vegetated sand dune.

Representative Cross Section (2021 LiDAR)

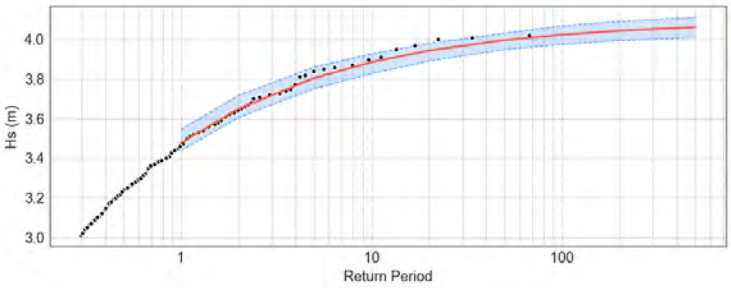


Historic Shoreline Change

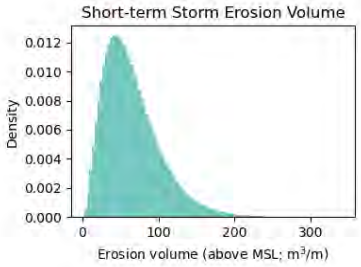
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

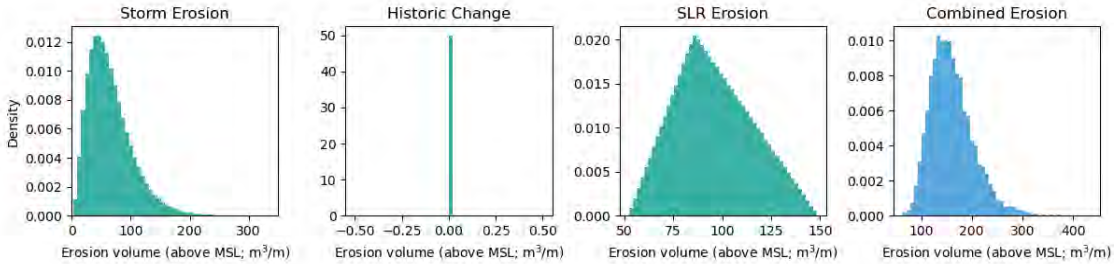


1% design volume: 182 m3/m

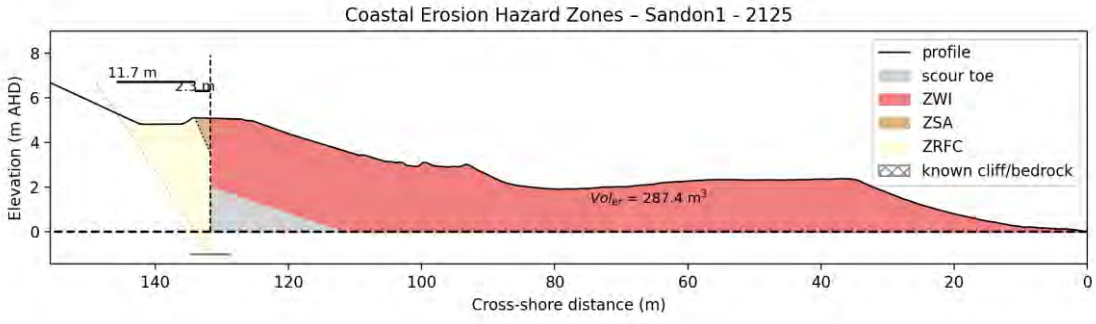
Available: >122 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



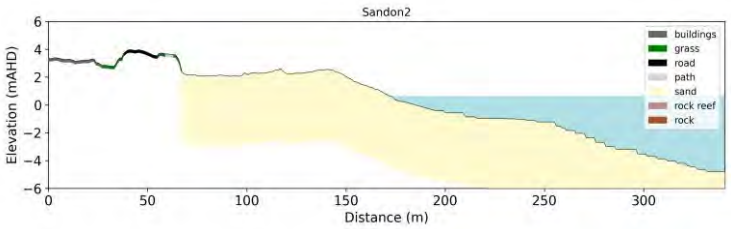
Beach: Sandon Point Beach

Beach unit: Sandon2

Description

Open coast, sandy beach, backed by vegetated sand dune. Near the ICOLL entrance/flow path of Slacky Creek.

Representative Cross Section (2021 LiDAR)

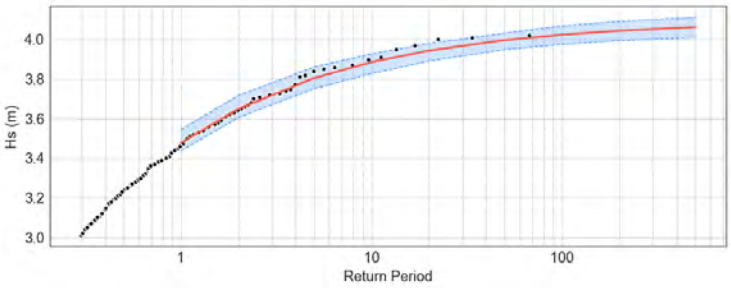


Historic Shoreline Change

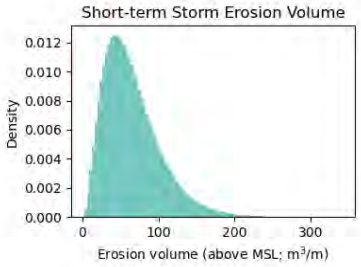
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



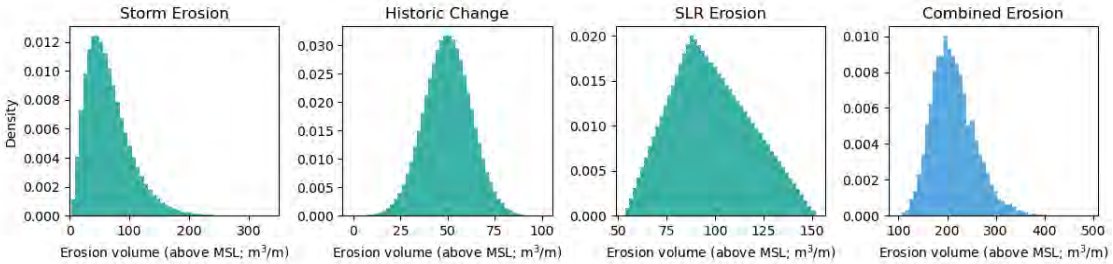
Storm Erosion Demand



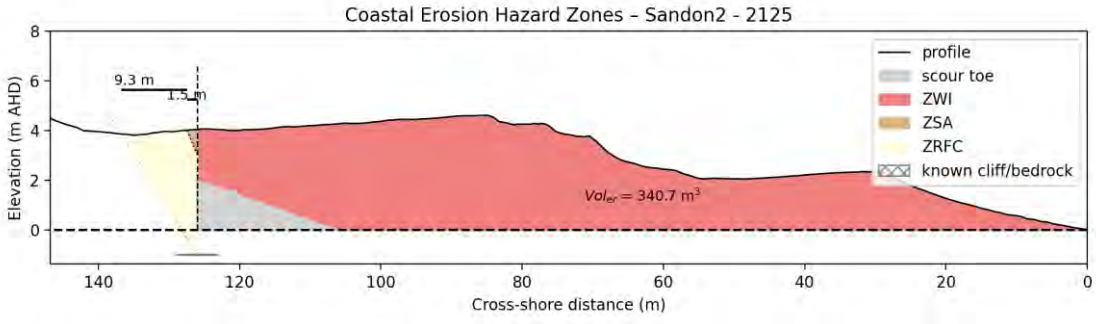
1% design volume: 182 m3/m

Available: 216 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



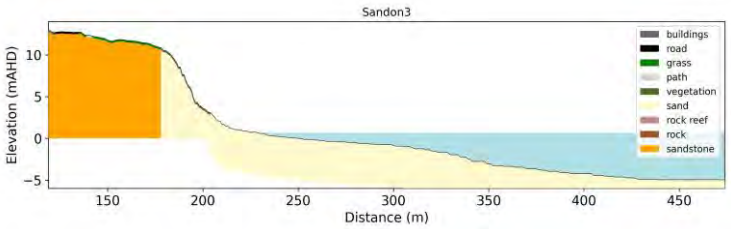
Beach: Sandon Point Beach

Beach unit: Sandon3

Description

Open coast, sandy beach, backed by vegetated sand dune and sandstone cliff.

Representative Cross Section (2021 LiDAR)

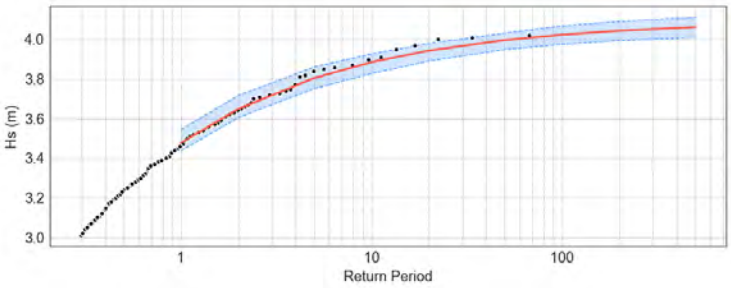


Historic Shoreline Change

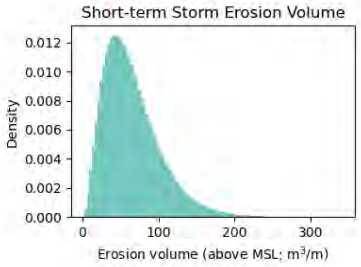
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



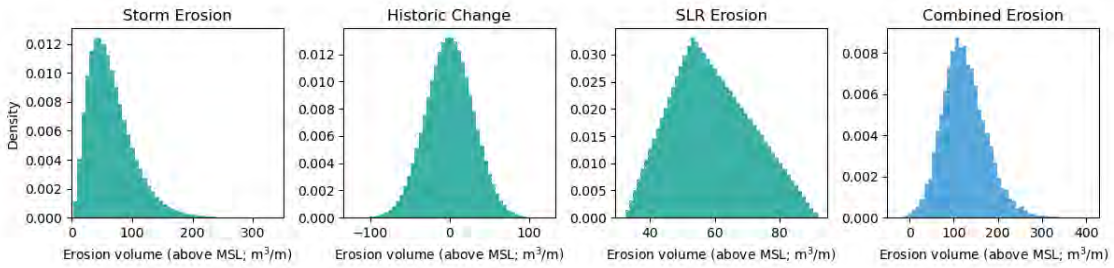
Storm Erosion Demand



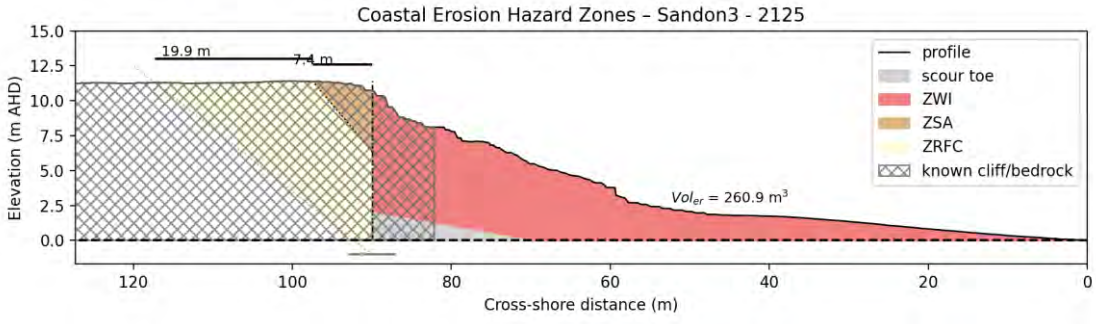
1% design volume: 182 m3/m

Available: 216 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



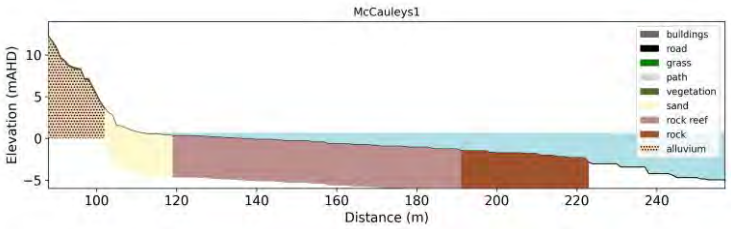
Beach: McCauleys Beach

Beach unit: McCauleys1

Description

Perched sandy beach with rock platform at its toe. Backed by an alluvium cliff.

Representative Cross Section (2021 LiDAR)

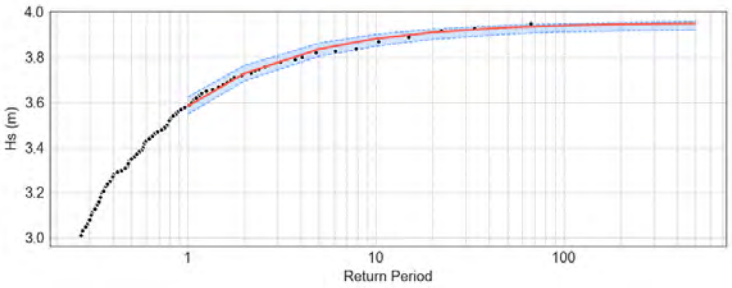


Historic Shoreline Change

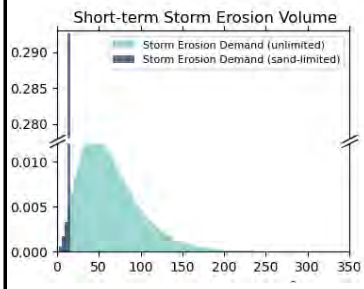
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



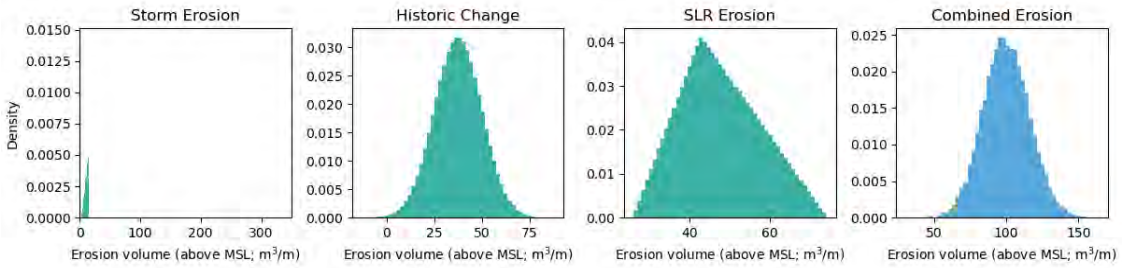
Storm Erosion Demand



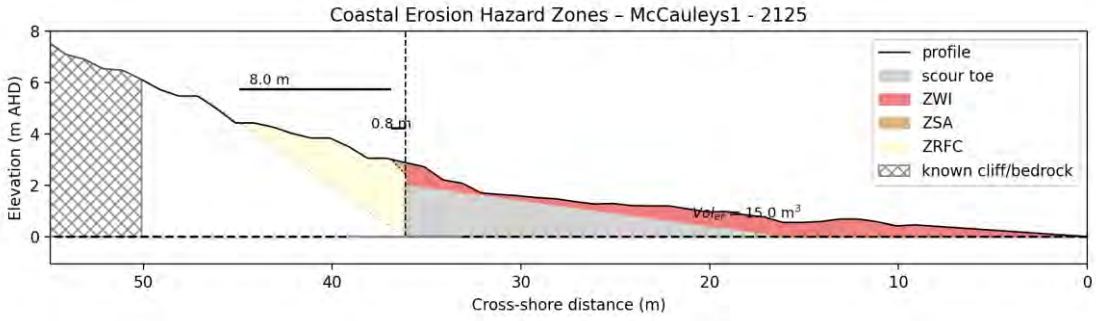
1% design volume: 180 m3/m

Available: 15 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



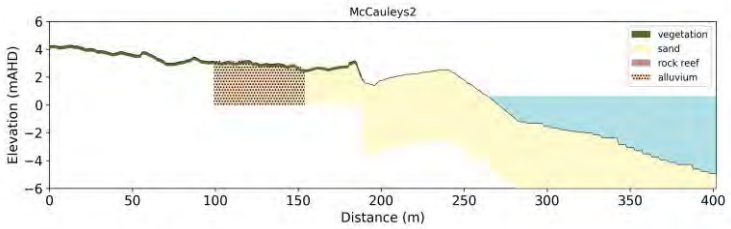
Beach: McCauleys Beach

Beach unit: McCauleys2

Description

Open coast, sandy beach, backed by low-lying vegetated sand dune and alluvium. Near the ICOLL entrance/flow path of Hewitts and Tramway/Woodlands Creek.

Representative Cross Section (2021 LiDAR)

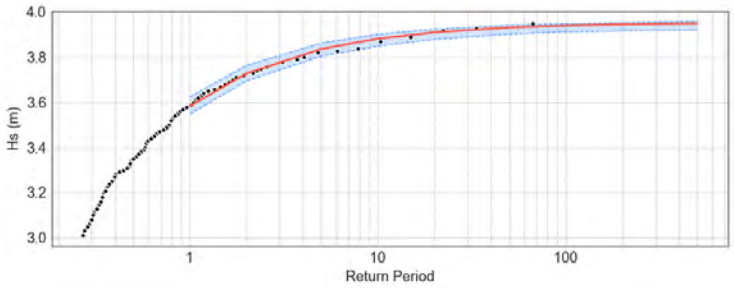


Historic Shoreline Change

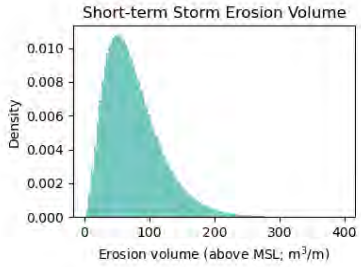
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



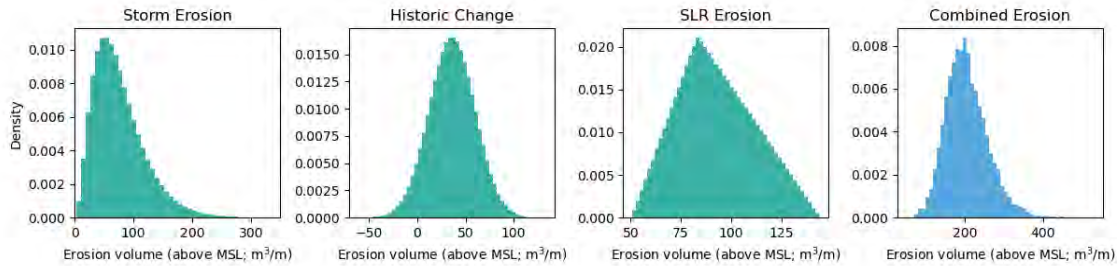
Storm Erosion Demand



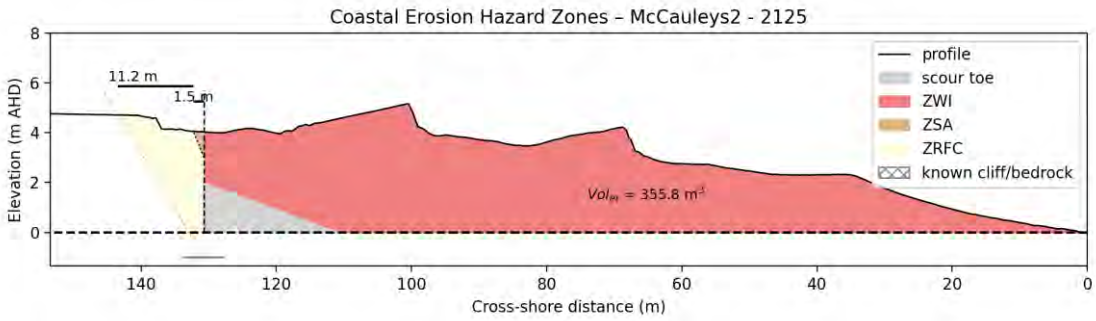
1% design volume: 212 m3/m

Available: 246 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



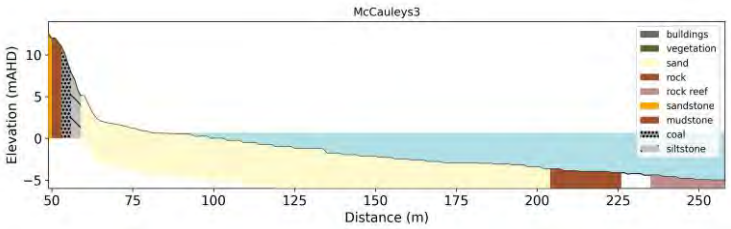
Beach: McCauleys Beach

Beach unit: McCauleys3

Description

Perched sandy beach with rock platform at its toe. Backed by a cliff made of sandstone, siltstone laminations, coal and mudstone.

Representative Cross Section (2021 LiDAR)

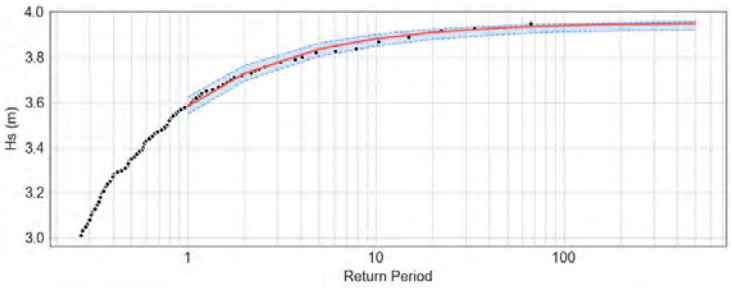


Historic Shoreline Change

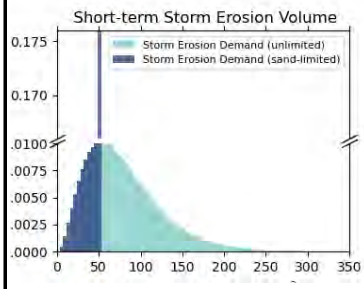
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



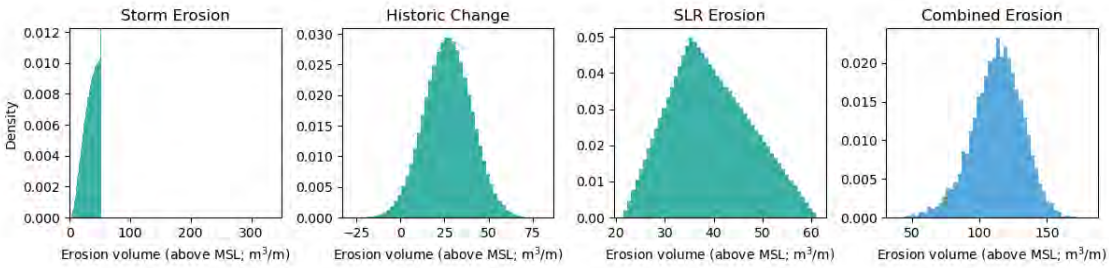
Storm Erosion Demand



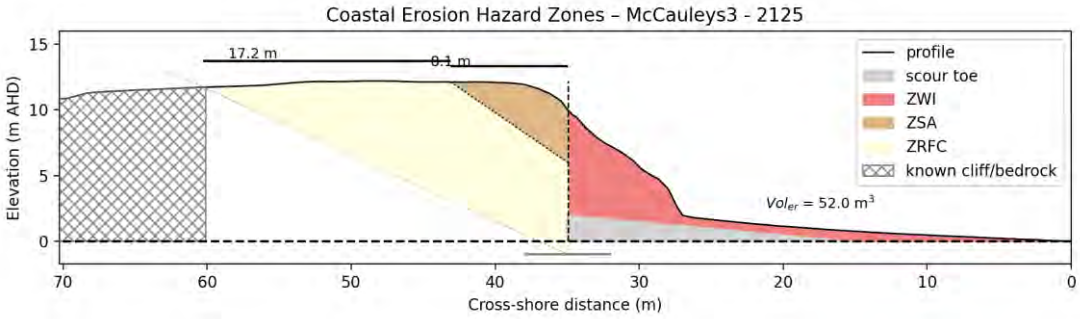
1% design volume: 223 m3/m

Available: 52 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



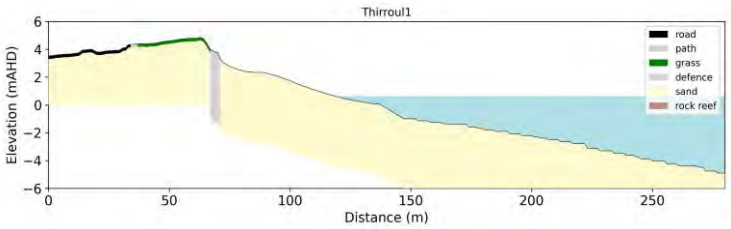
Beach: Thirroul Beach

Beach unit: Thirroul1

Description

Open coast, sandy beach, backed by a vertical seawall, foreshore area and Thirroul SLSC.

Representative Cross Section (2021 LiDAR)

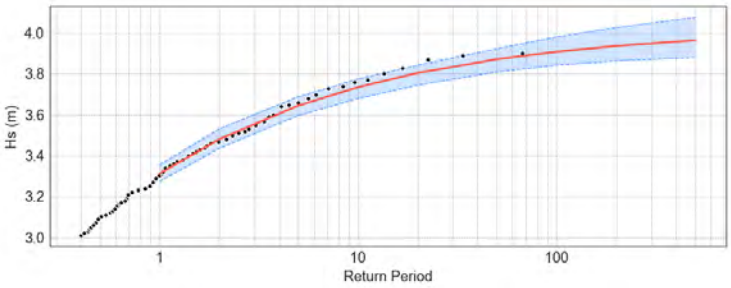


Historic Shoreline Change

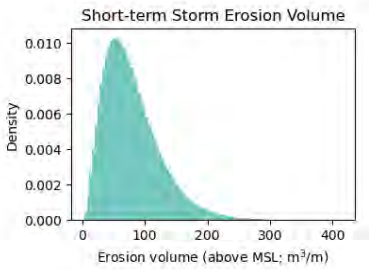
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



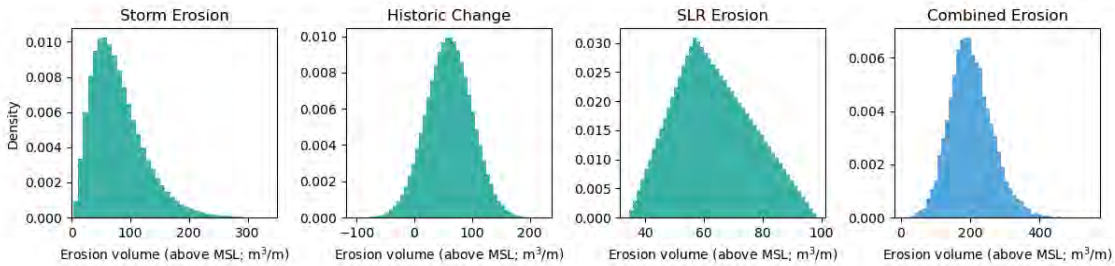
Storm Erosion Demand



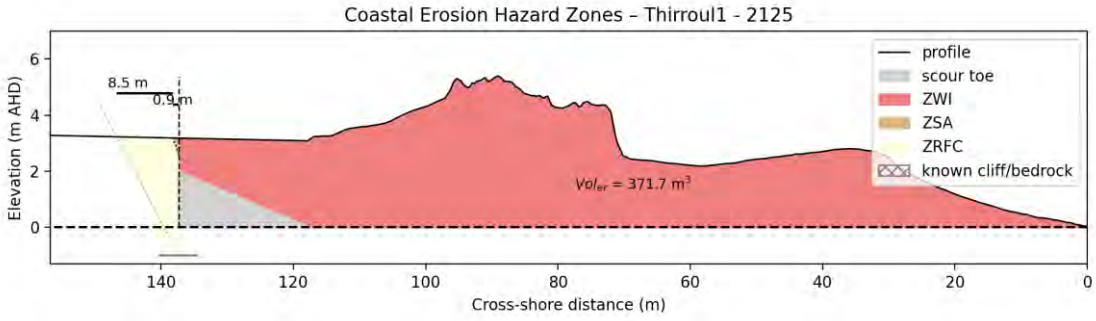
1% design volume: 222 m3/m

Available: 343 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



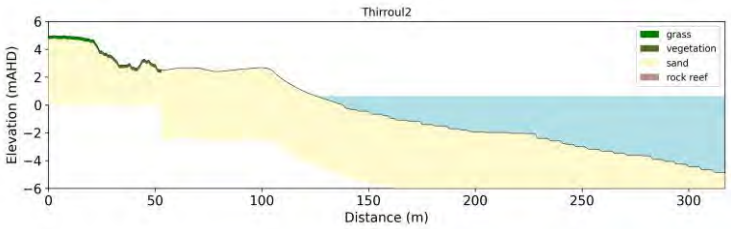
Beach: Thirroul Beach

Beach unit: Thirroul2

Description

Open coast, sandy beach, backed by vegetated sand dune. Near the ICOLL entrance/flow path of Flanagans Creek.

Representative Cross Section (2021 LiDAR)

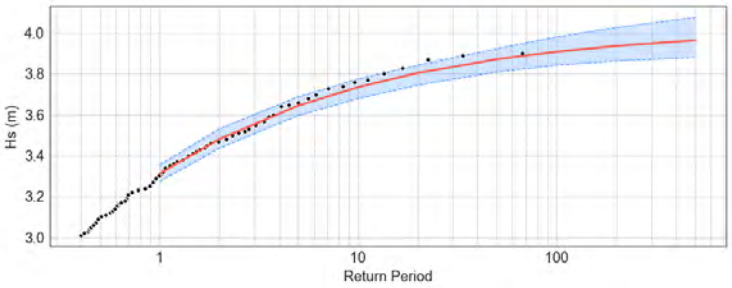


Historic Shoreline Change

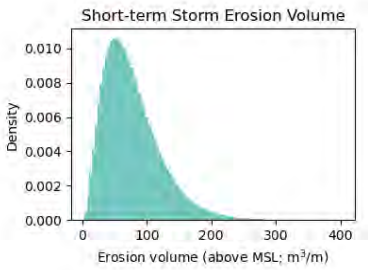
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



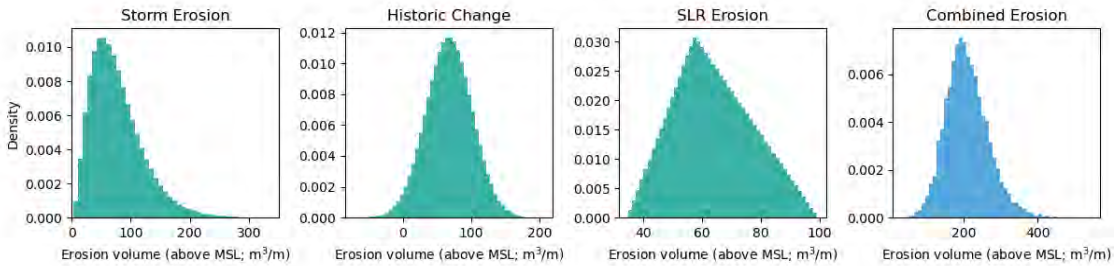
Storm Erosion Demand



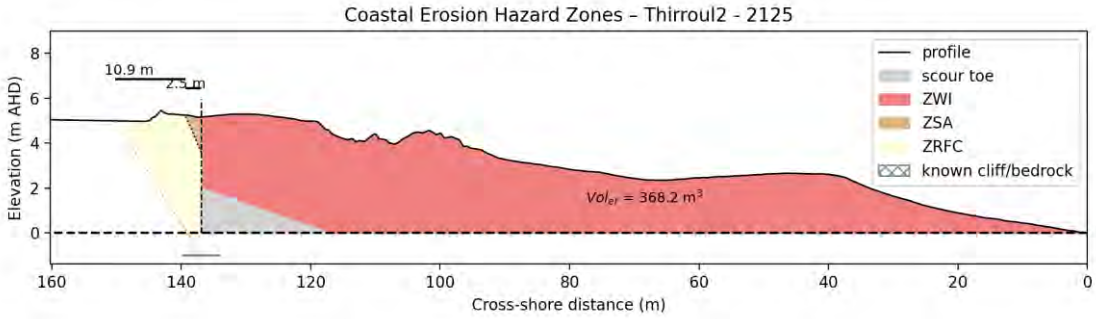
1% design volume: 215 m3/m

Available: 298 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



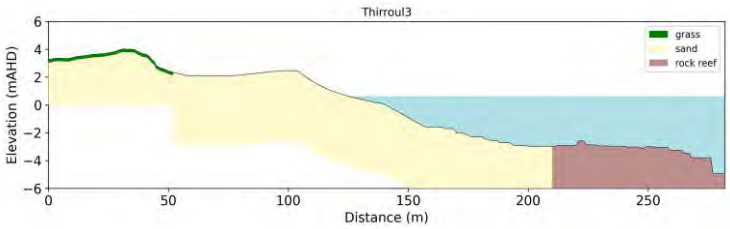
Beach: Thirroul Beach

Beach unit: Thirroul3

Description

Open coast, sandy beach, backed by vegetated sand dune. In the northern section, there is rocky reef at the toe, backed by a cliff.

Representative Cross Section (2021 LiDAR)

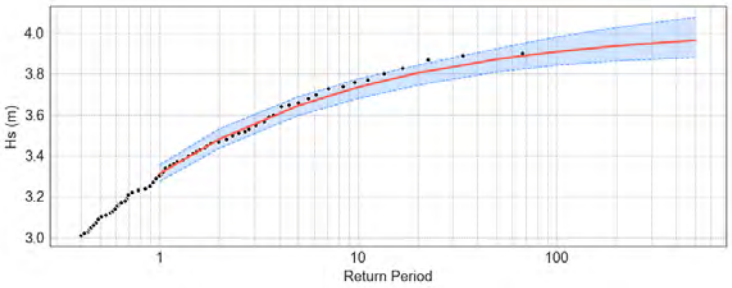


Historic Shoreline Change

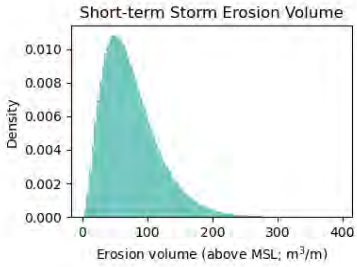
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



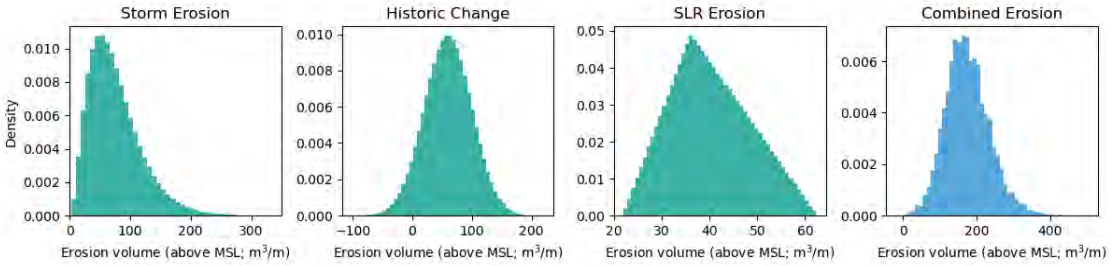
Storm Erosion Demand



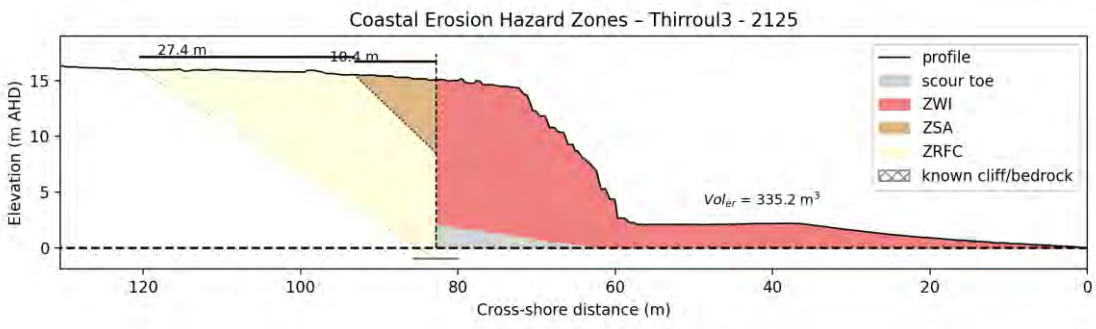
1% design volume: 211 m3/m

Available: 272 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



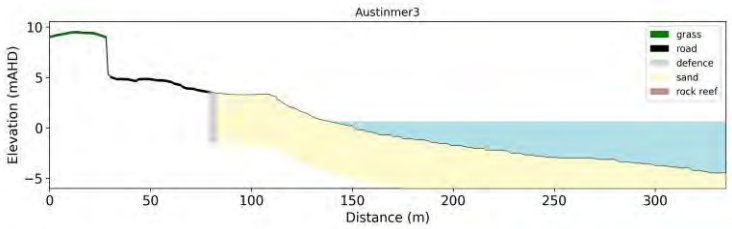
Beach: Austinmer Beach

Beach unit: Austinmer3

Description

Open coast sandy beach. Backed by a seawall, foreshore area and Lawrence Hargrave Drive.

Representative Cross Section (2021 LiDAR)

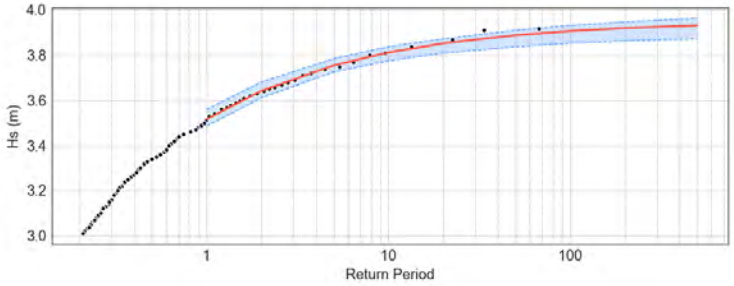


Historic Shoreline Change

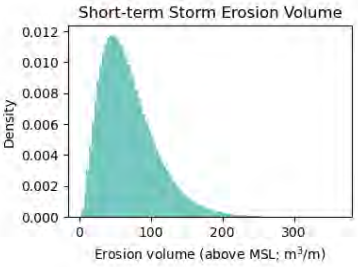
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

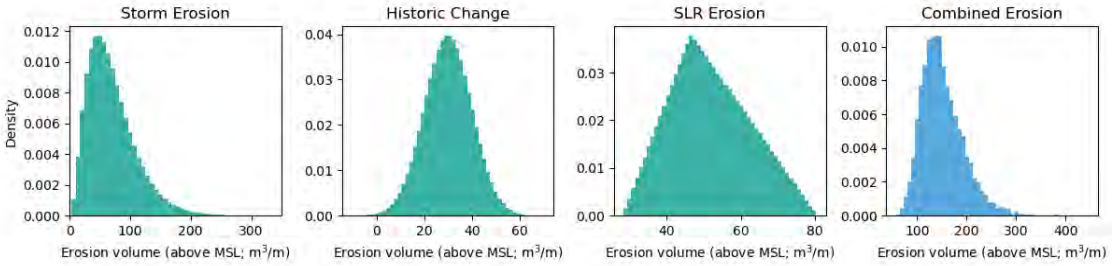


1% design volume: 194 m3/m

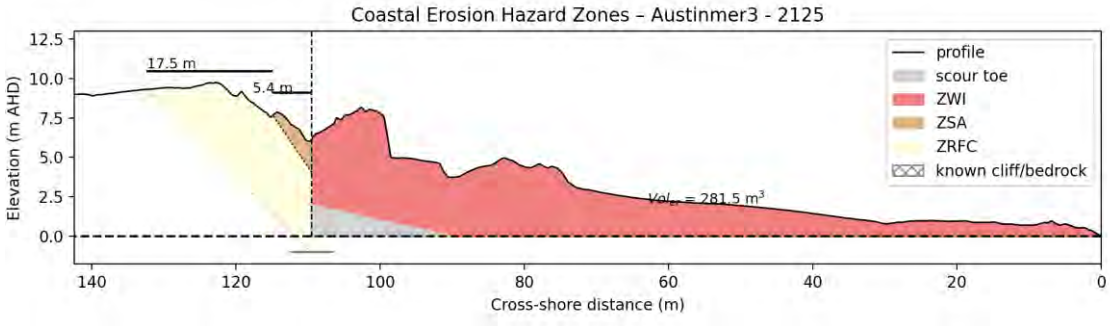
Available: >153 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



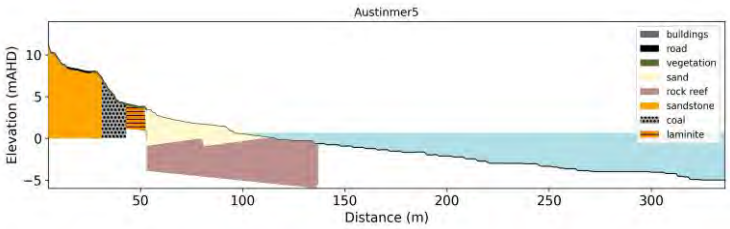
Beach: Austinmer Beach

Beach unit: Austinmer5

Description

Perched sandy beach with rock platform at its toe. Backed by laminite, coal and sandstone.

Representative Cross Section (2021 LiDAR)

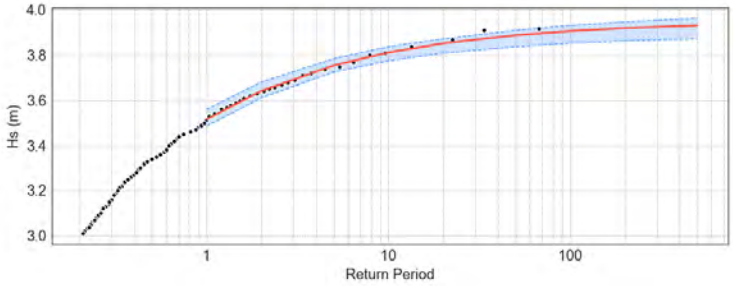


Historic Shoreline Change

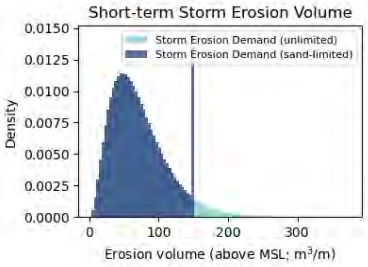
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



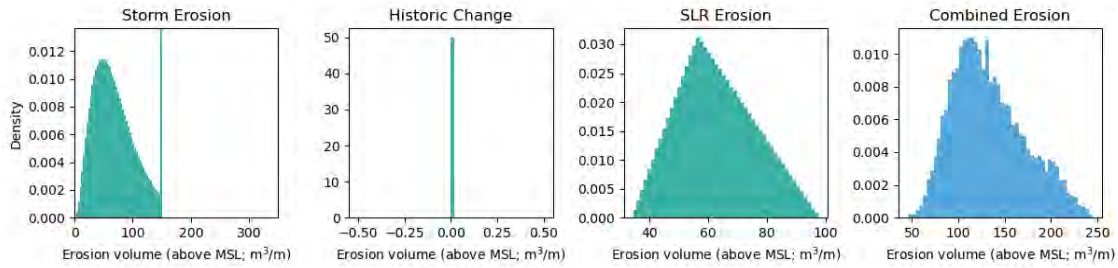
Storm Erosion Demand



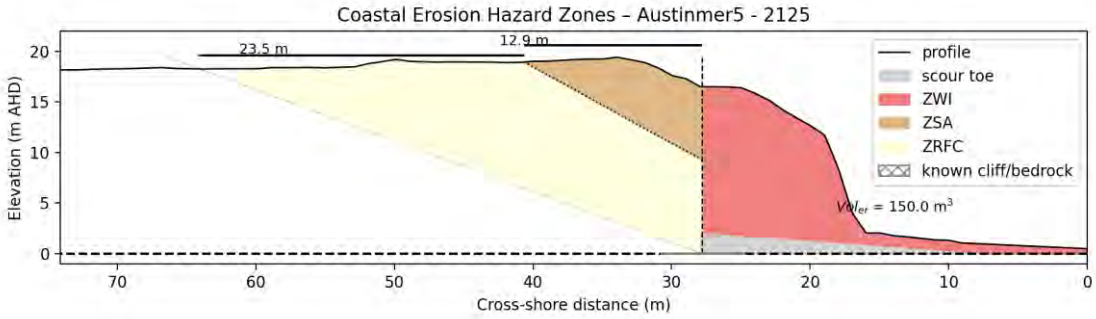
1% design volume: 200 m3/m

Available: 150 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



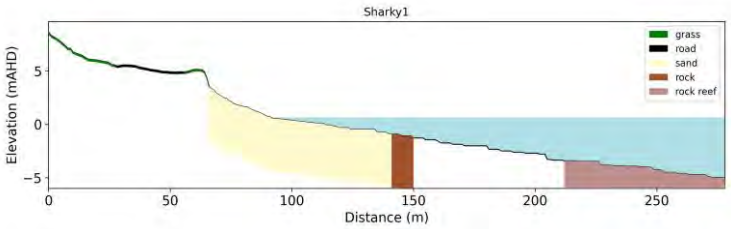
Beach: Sharky Beach

Beach unit: Sharky1

Description

Perched sandy beach with rock platform at its toe. Backed by Headlands Beach carpark.

Representative Cross Section (2021 LiDAR)

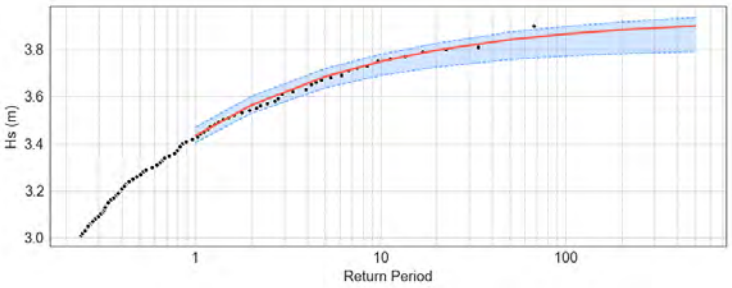


Historic Shoreline Change

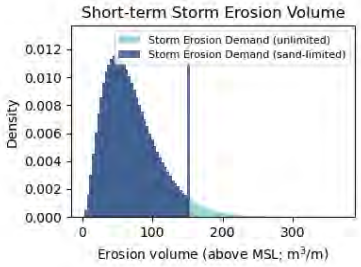
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



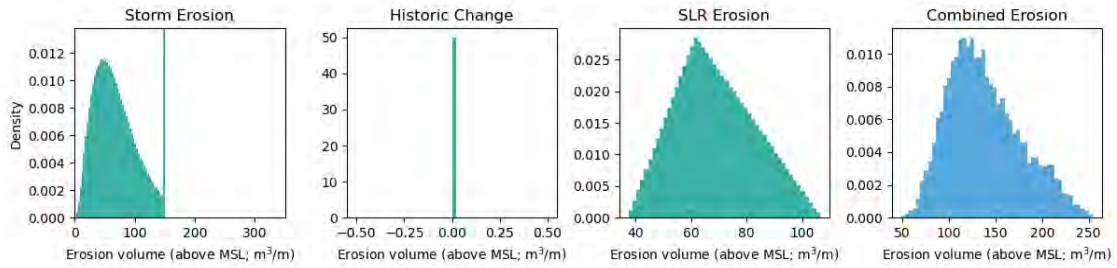
Storm Erosion Demand



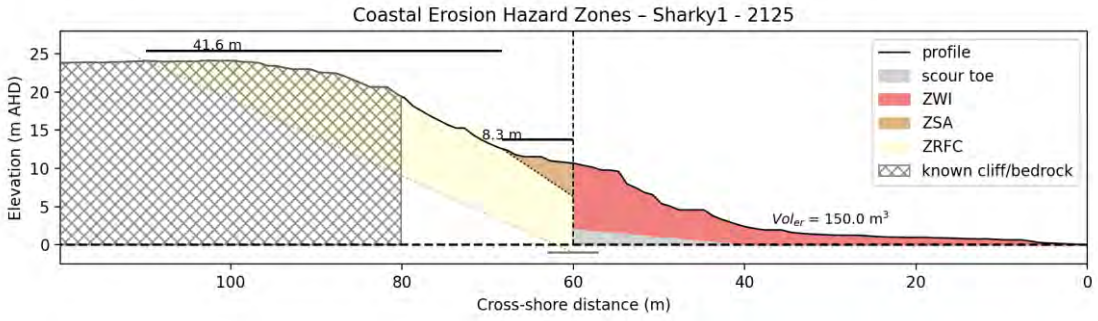
1% design volume: 198 m3/m

Available: 150 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



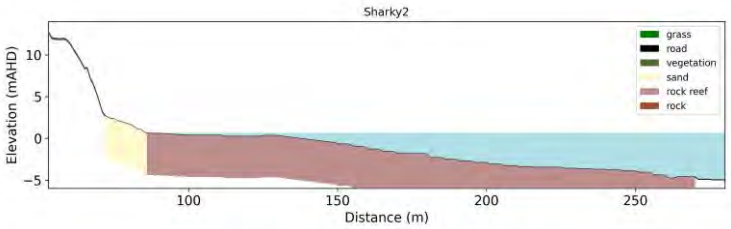
Beach: Sharky Beach

Beach unit: Sharky2

Description

Perched sandy beach with rock platform at its toe. Backed by a cliff.

Representative Cross Section (2021 LiDAR)

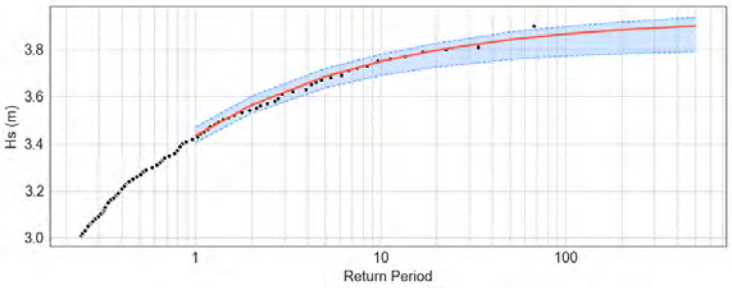


Historic Shoreline Change

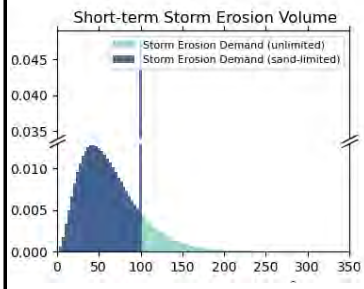
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



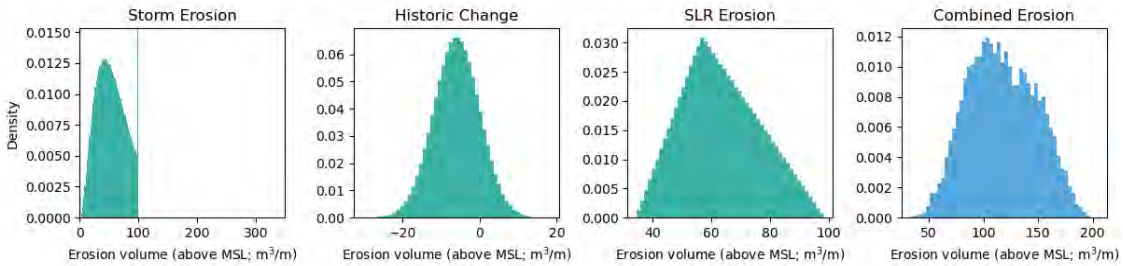
Storm Erosion Demand



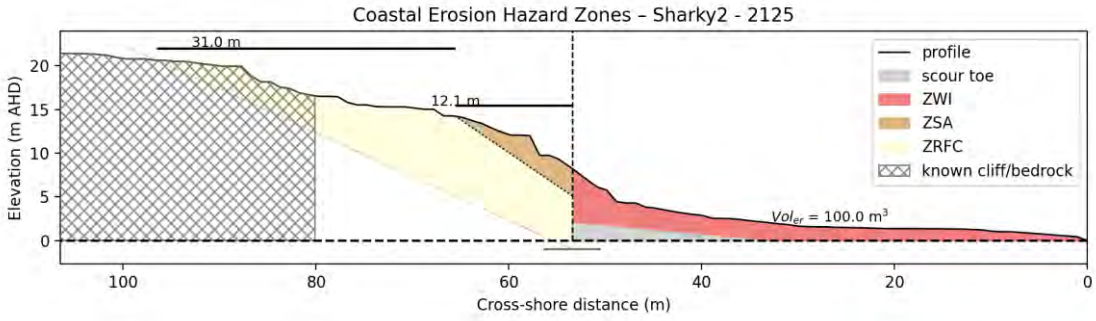
1% design volume: 178 m3/m

Available: 100 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



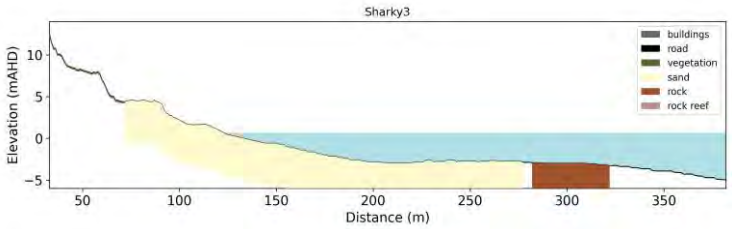
Beach: Sharky Beach

Beach unit: Sharky3

Description

Open coast sandy beach with partial exposure of rock platform at toe. Backed by a cliff.

Representative Cross Section (2021 LiDAR)

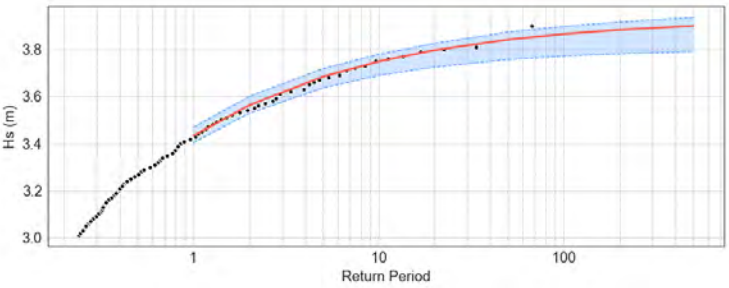


Historic Shoreline Change

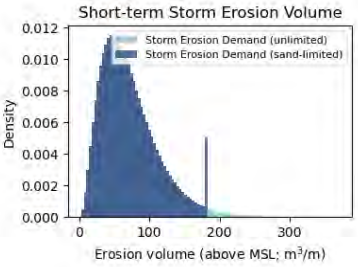
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



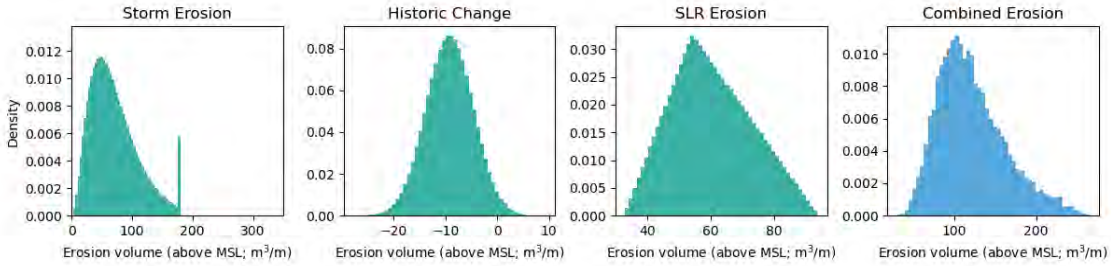
Storm Erosion Demand



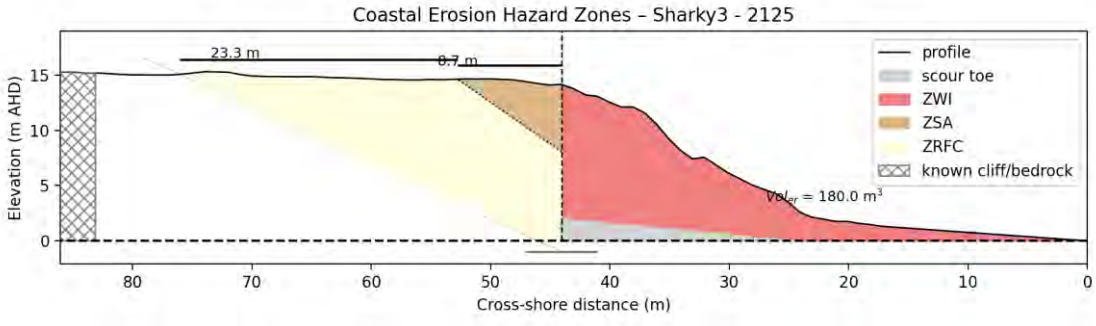
1% design volume: 198 m3/m

Available: 180 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



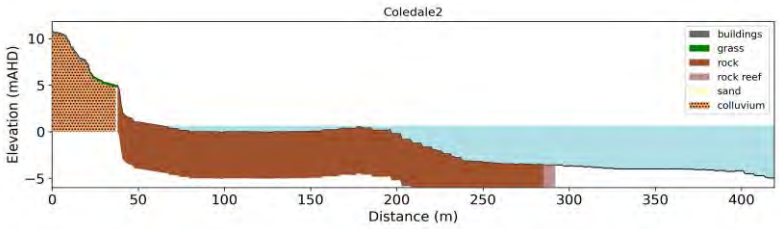
Beach: Coledale Beach

Beach unit: Coledale2

Description

Rock platform with a fine covering of sand. Backed by a colluvium cliff.

Representative Cross Section (2021 LiDAR)

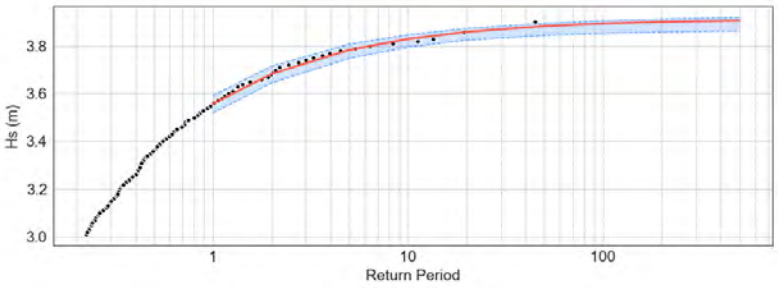


Historic Shoreline Change

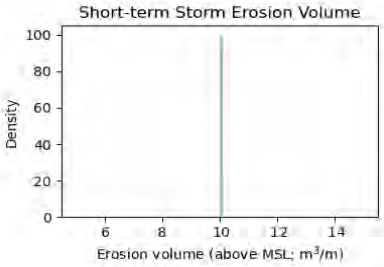
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



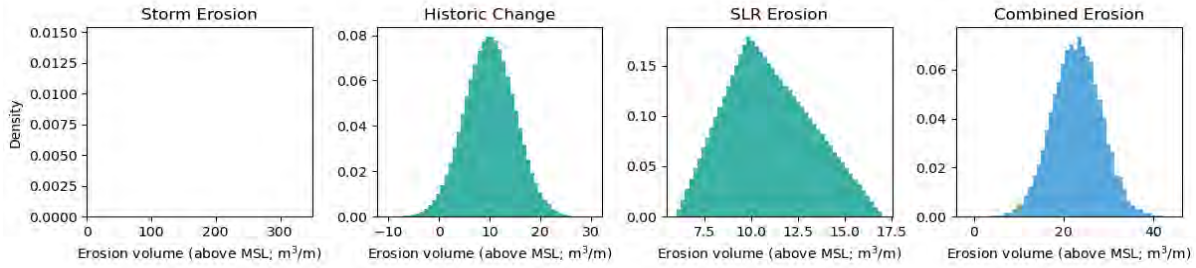
Storm Erosion Demand



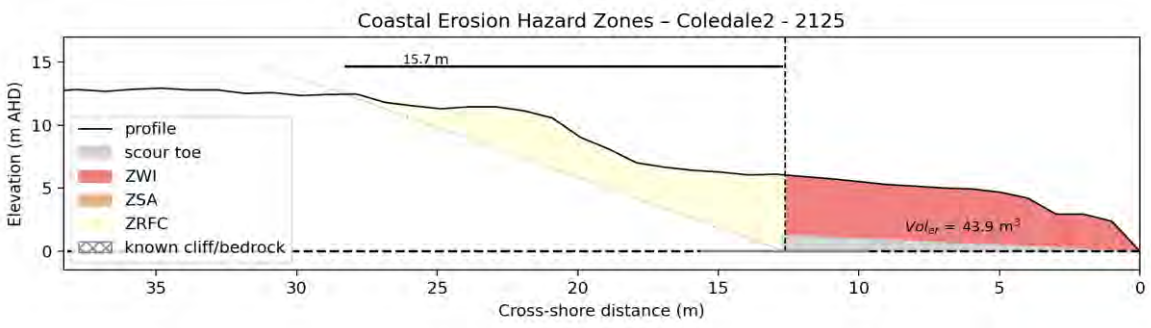
1% design volume: 177 m3/m

Available: 10 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



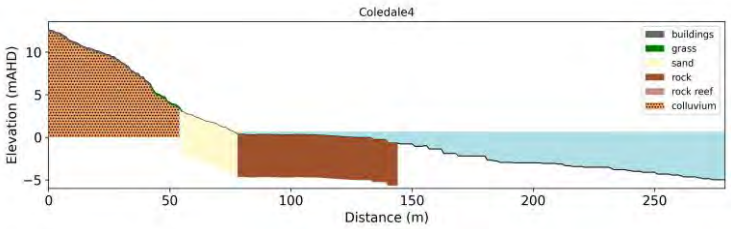
Beach: Coledale Beach

Beach unit: Coledale4

Description

Rock platform with a fine covering of sand. Backed by a colluvium cliff.

Representative Cross Section (2021 LiDAR)

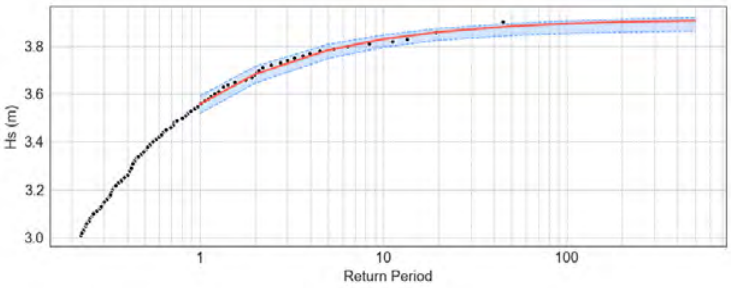


Historic Shoreline Change

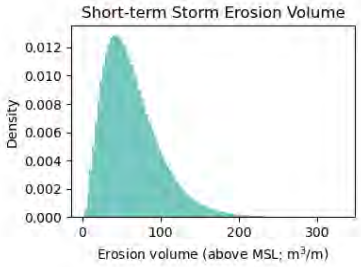
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

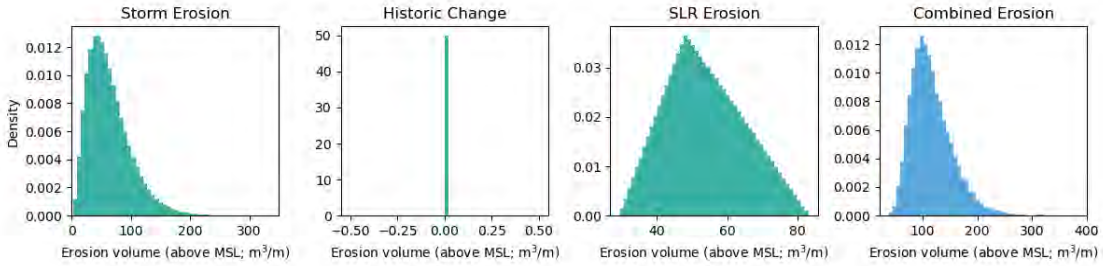


1% design volume: 177 m3/m

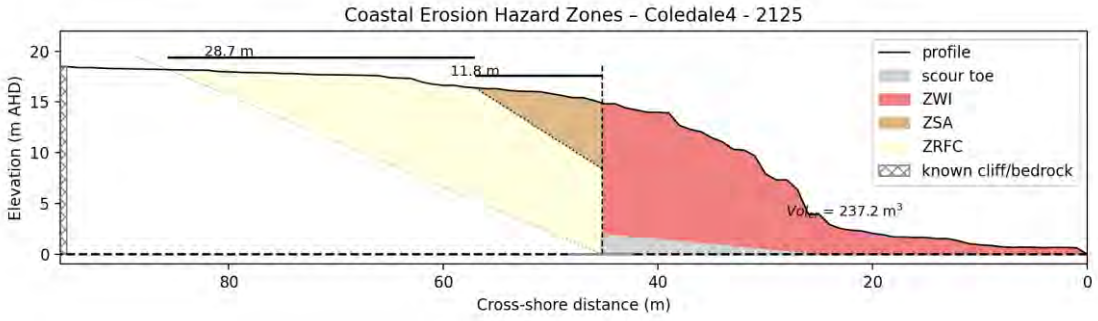
Available: >29 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



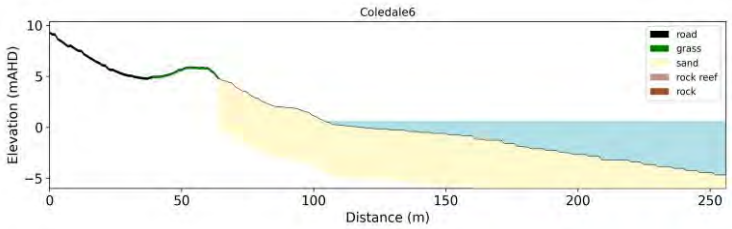
Beach: Coledale Beach

Beach unit: Coledale6

Description

Open coast, sandy beach, backed by vegetated dune, foreshore and Coledale SLSC.

Representative Cross Section (2021 LiDAR)

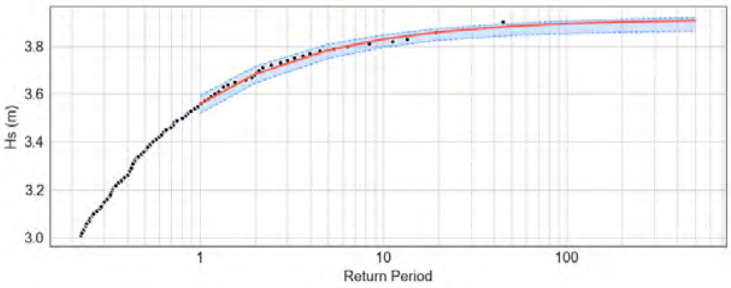


Historic Shoreline Change

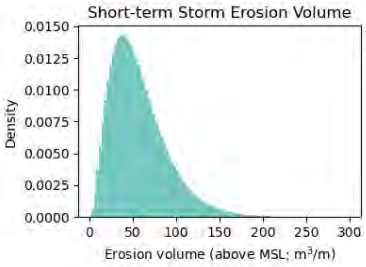
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



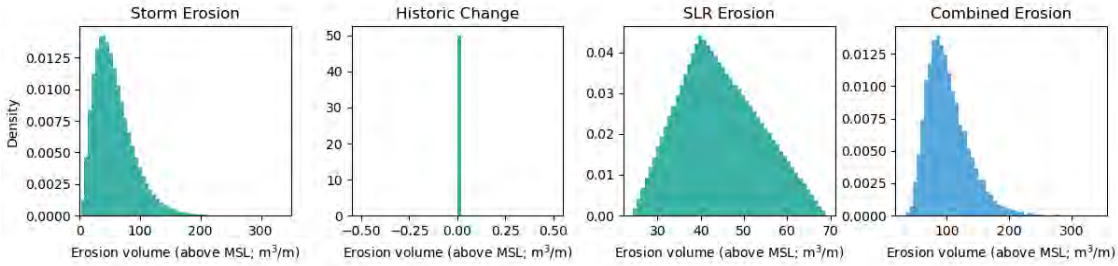
Storm Erosion Demand



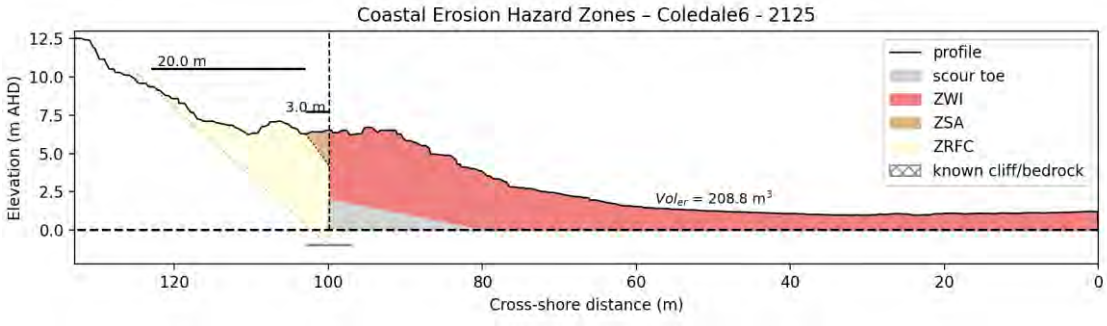
1% design volume: 159 m3/m
Available: >104 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



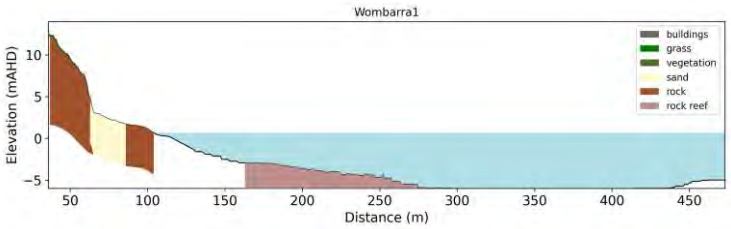
Beach: Wombarra Beach

Beach unit: Wombarra1

Description

Perched sandy beach with rock platform at its toe. Backed by a cliff.

Representative Cross Section (2021 LiDAR)

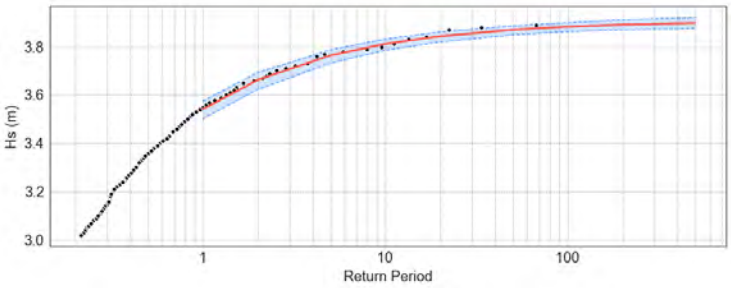


Historic Shoreline Change

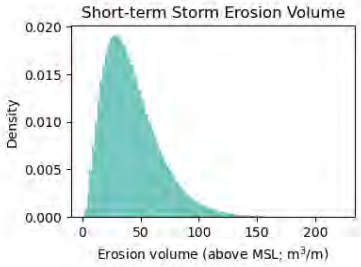
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

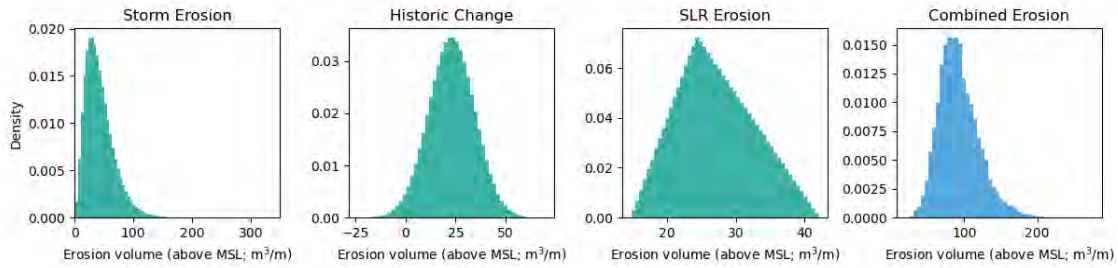


1% design volume: 119 m3/m

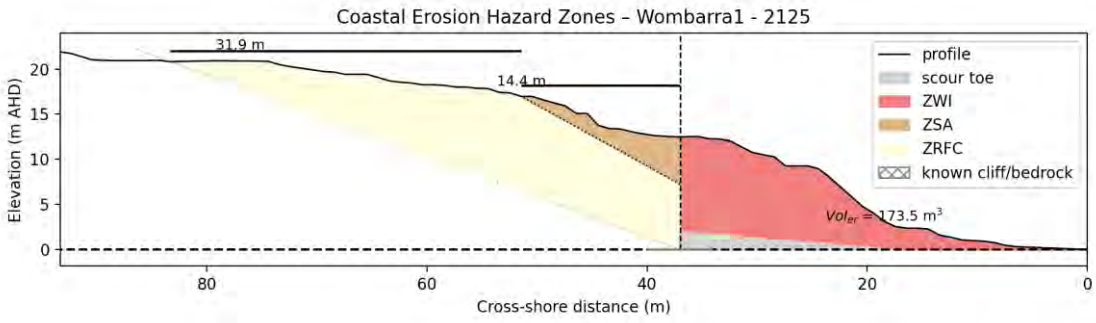
Available: >84 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



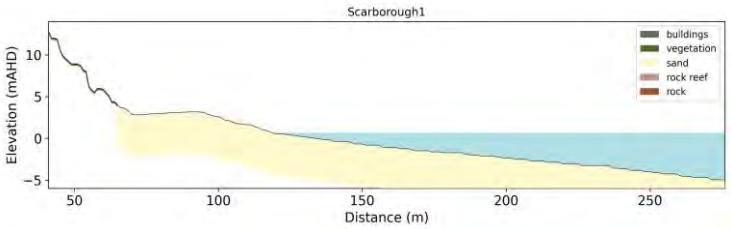
Beach: Scarborough Beach

Beach unit: Scarborough1

Description

Open coast, sandy beach, backed by vegetated sand dune and Scarborough SLSC. Near the ICOLL entrance/flow path of Horse Creek.

Representative Cross Section (2021 LiDAR)

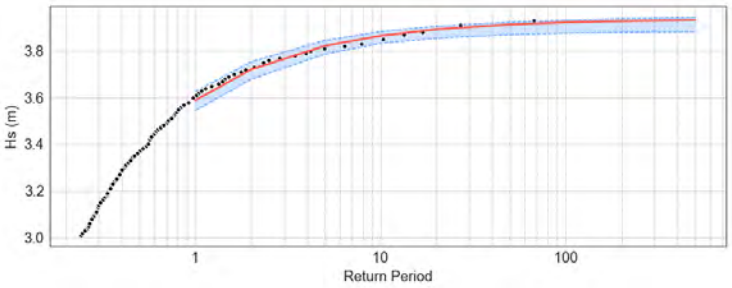


Historic Shoreline Change

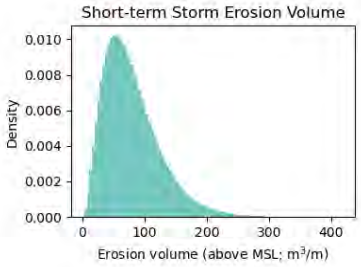
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

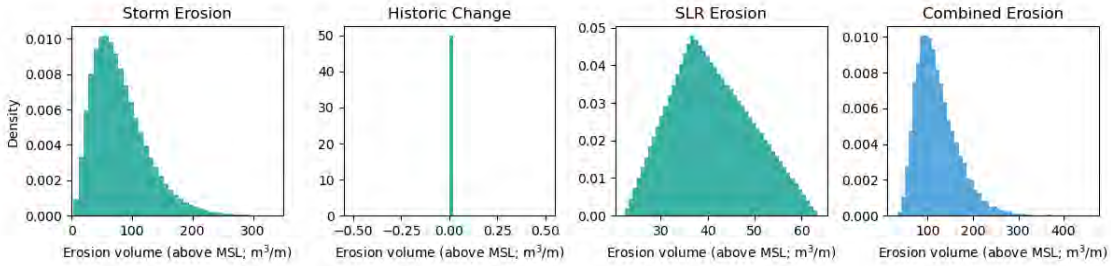


1% design volume: 223 m3/m

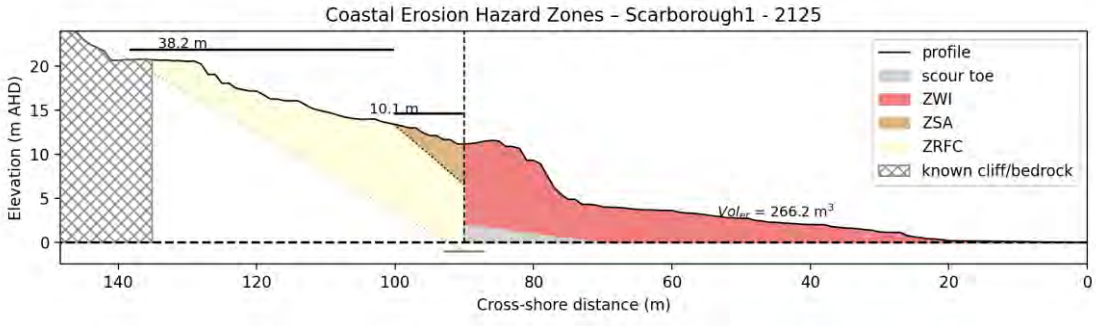
Available: >140 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



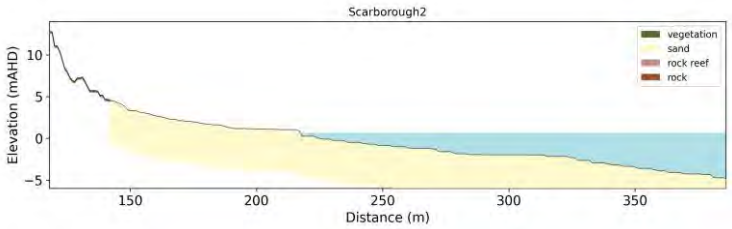
Beach: Scarborough Beach

Beach unit: Scarborough2

Description

Open coast, sandy beach, backed by vegetated sand dune and cliff.

Representative Cross Section (2021 LiDAR)

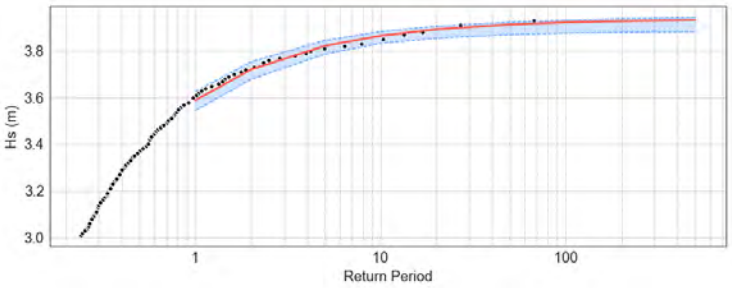


Historic Shoreline Change

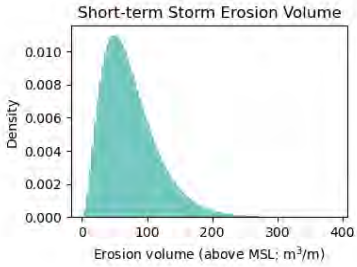
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

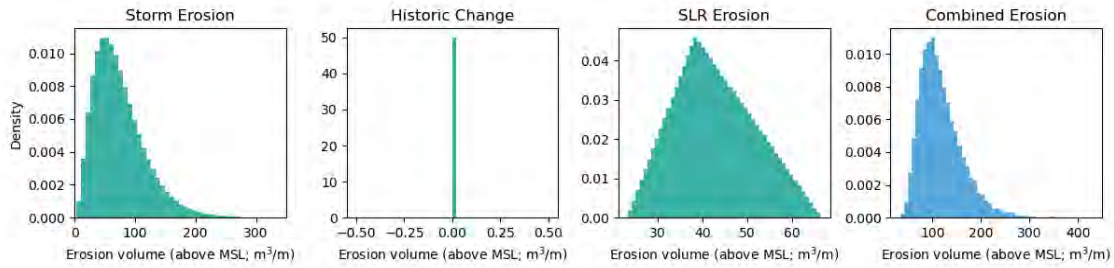


1% design volume: 207 m3/m

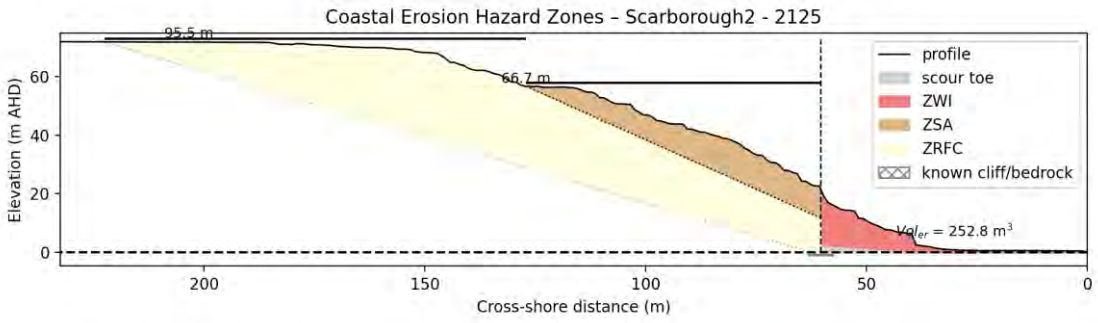
Available: >153 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



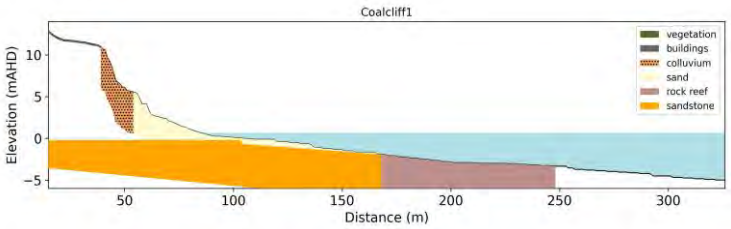
Beach: Coalcliff Beach

Beach unit: Coalcliff1

Description

Perched sandy beach with rock platform at toe. Backed by colluvium and sandstone.

Representative Cross Section (2021 LiDAR)

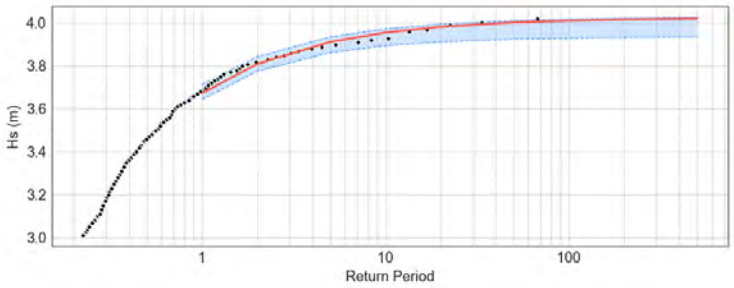


Historic Shoreline Change

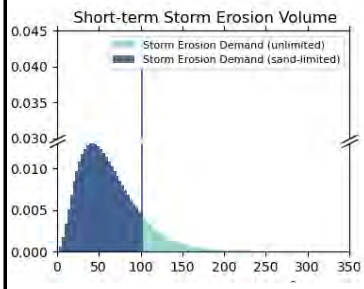
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



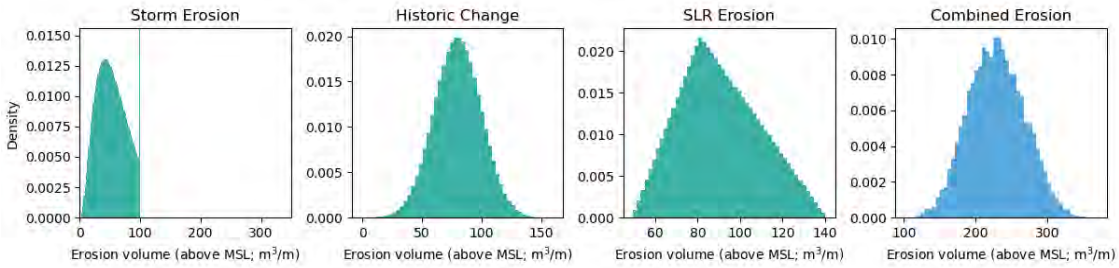
Storm Erosion Demand



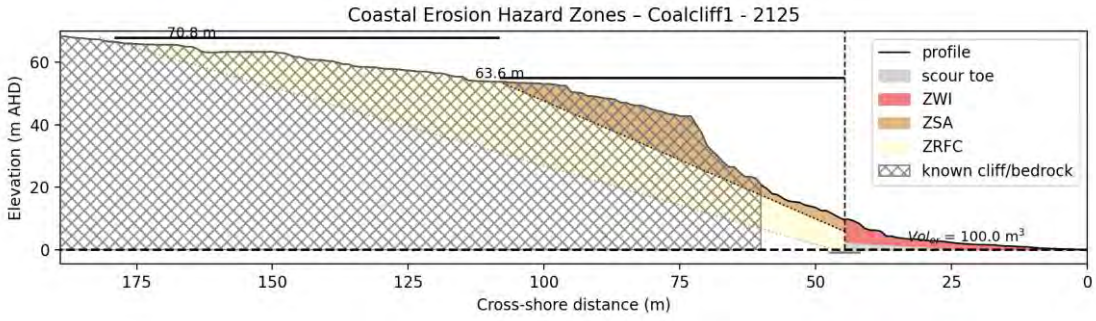
1% design volume: 175 m3/m

Available: 100 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



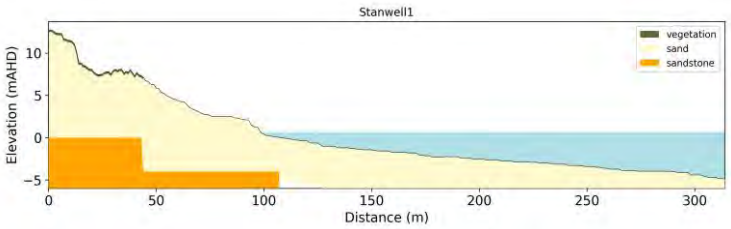
Beach: Stanwell Park Beach

Beach unit: Stanwell1

Description

Open coast, sandy beach, backed by vegetated sand dune, sandstone and a cliff at the SLSC. Near the ICOLL entrance/flow path of Stanwell and Hargraves Creek.

Representative Cross Section (2021 LiDAR)

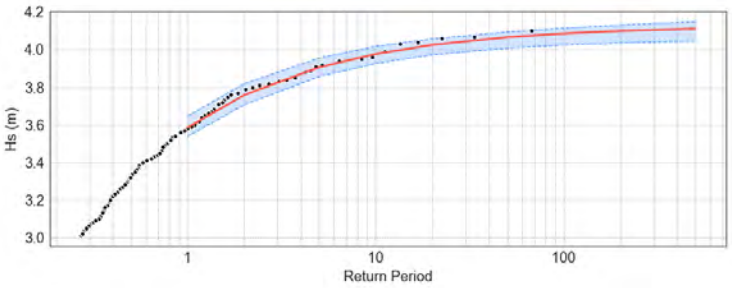


Historic Shoreline Change

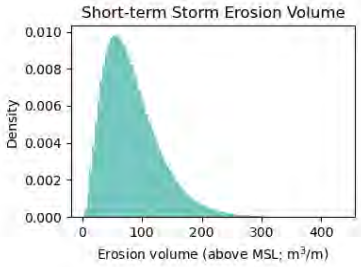
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



Storm Erosion Demand

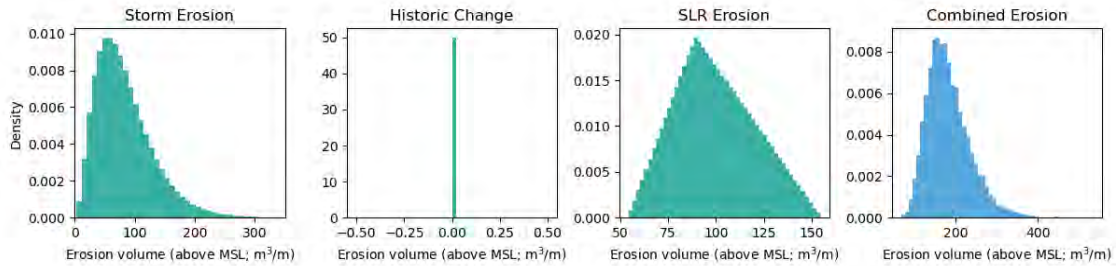


1% design volume: 232 m3/m

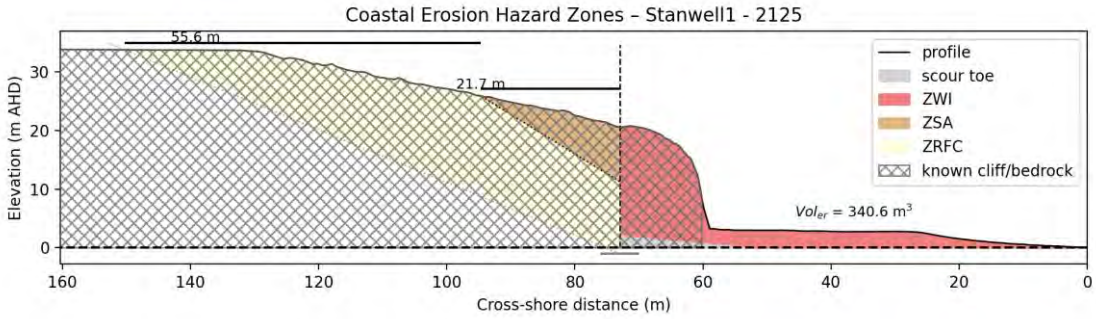
Available: >190 m3/m*

*Landward sand extent unverified, sand has not been limited in the model

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



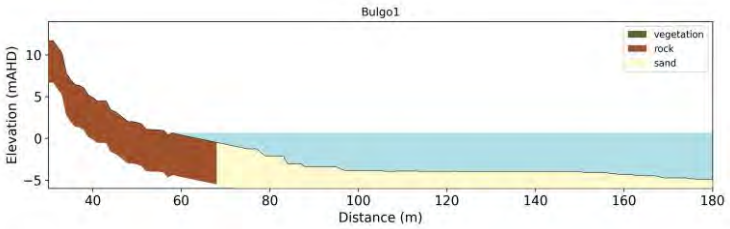
Beach: Bulgo Beach

Beach unit: Bulgo1

Description

Perched rocky beach with rock platform at its toe. Backed by a cliff.

Representative Cross Section (2021 LiDAR)

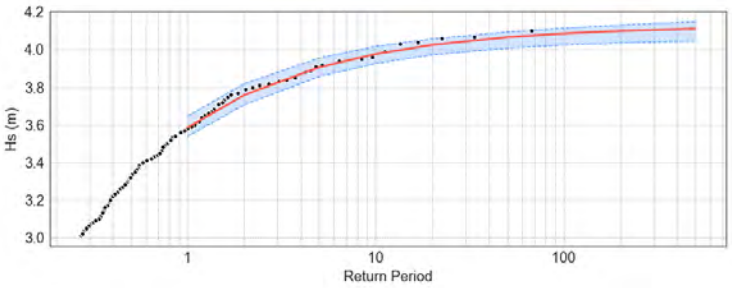


Historic Shoreline Change

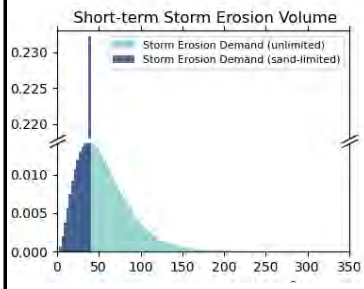
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



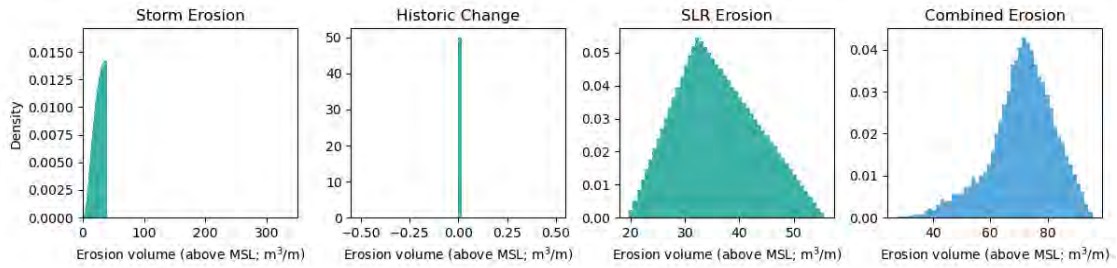
Storm Erosion Demand



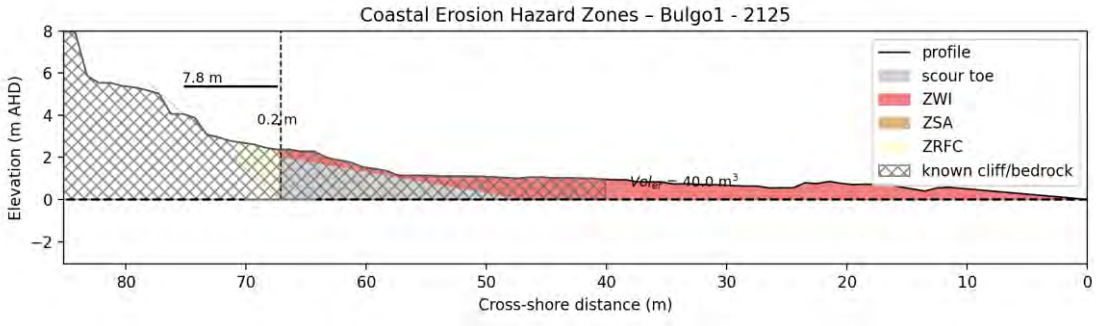
1% design volume: 159 m3/m

Available: 40 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



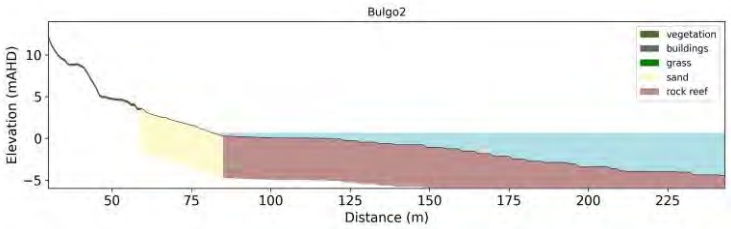
Beach: Bulgo Beach

Beach unit: Bulgo2

Description

Perched sandy beach with rock platform at its toe. Backed by a cliff.

Representative Cross Section (2021 LiDAR)

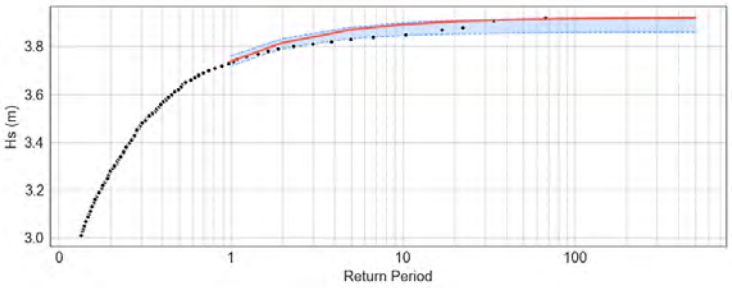


Historic Shoreline Change

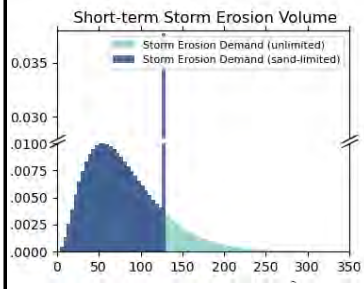
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



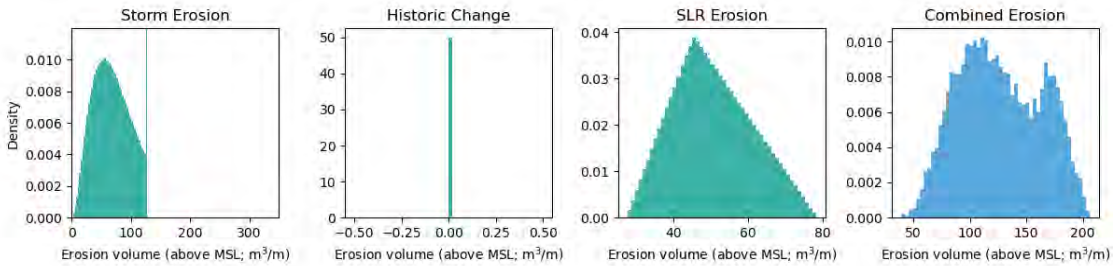
Storm Erosion Demand



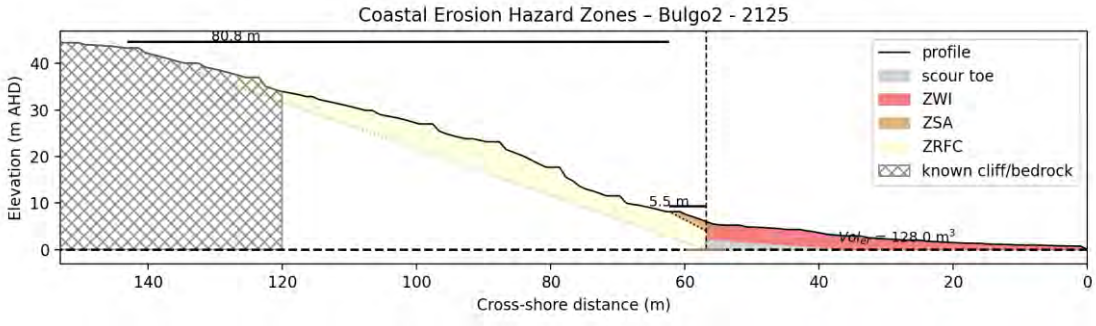
1% design volume: 227 m3/m

Available: 128 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



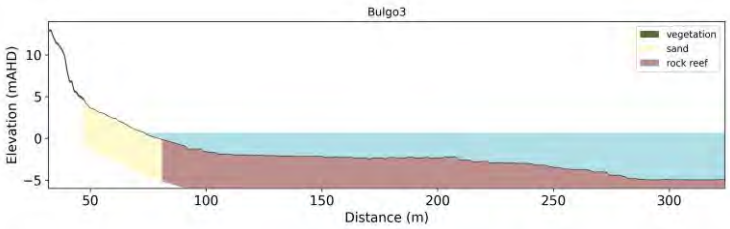
Beach: Bulgo Beach

Beach unit: Bulgo3

Description

Perched sandy beach with rock platform at its toe. Backed by a cliff.

Representative Cross Section (2021 LiDAR)

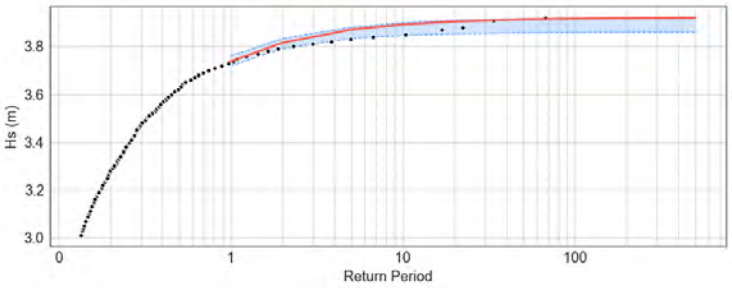


Historic Shoreline Change

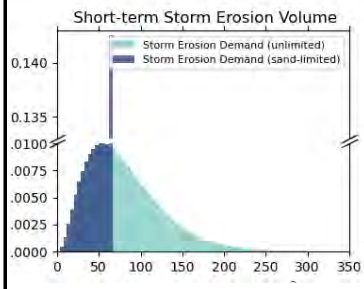
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



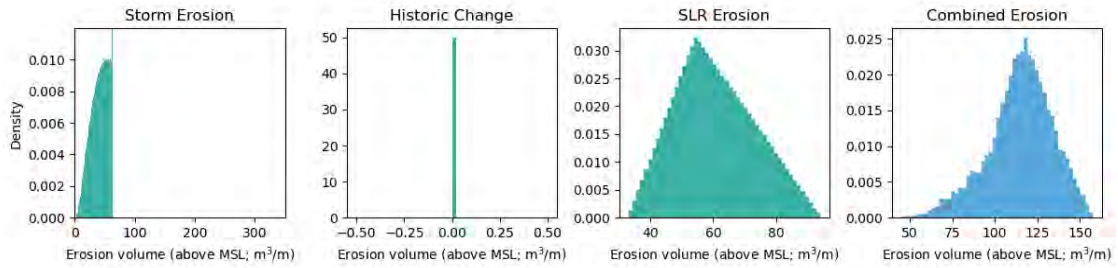
Storm Erosion Demand



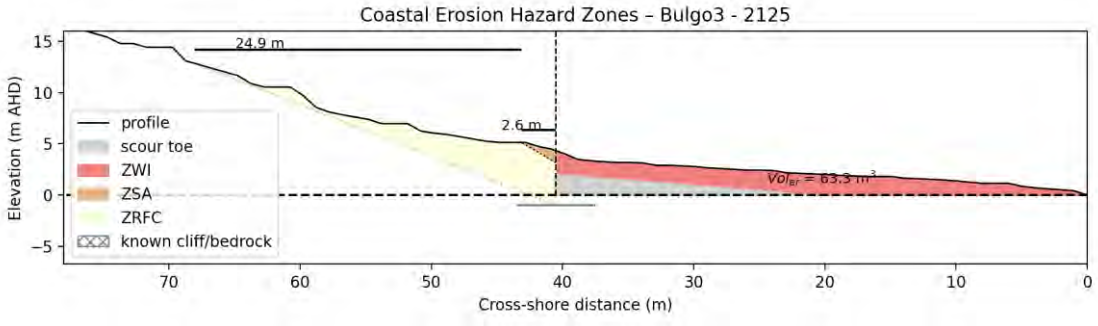
1% design volume: 227 m3/m

Available: 63 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



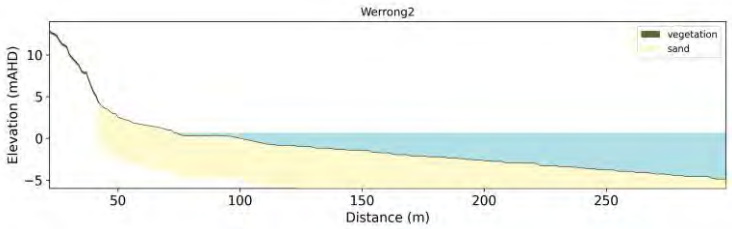
Beach: Werrong Beach

Beach unit: Werrong2

Description

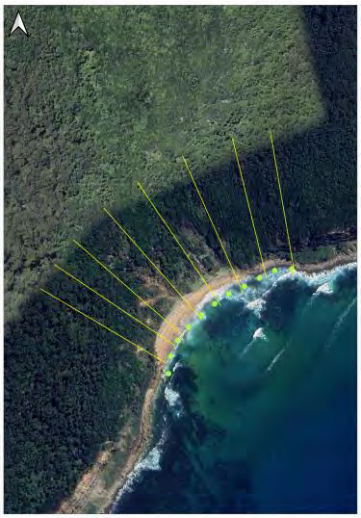
Open coast, sandy beach, backed by a cliff.

Representative Cross Section (2021 LiDAR)

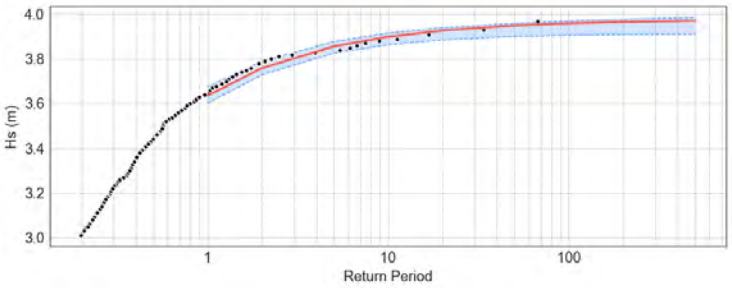


Historic Shoreline Change

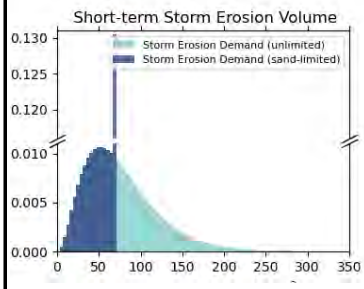
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



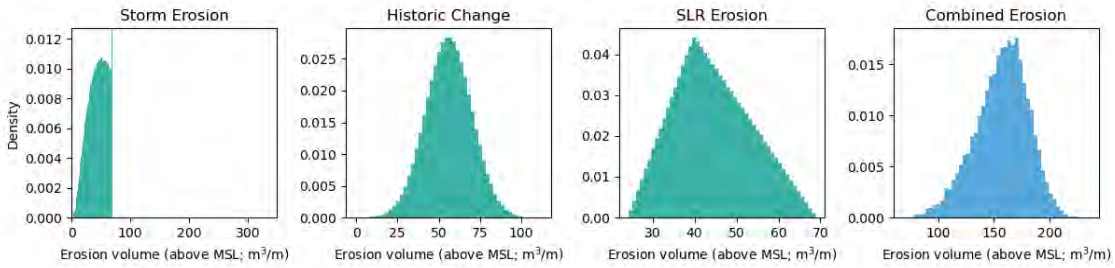
Storm Erosion Demand



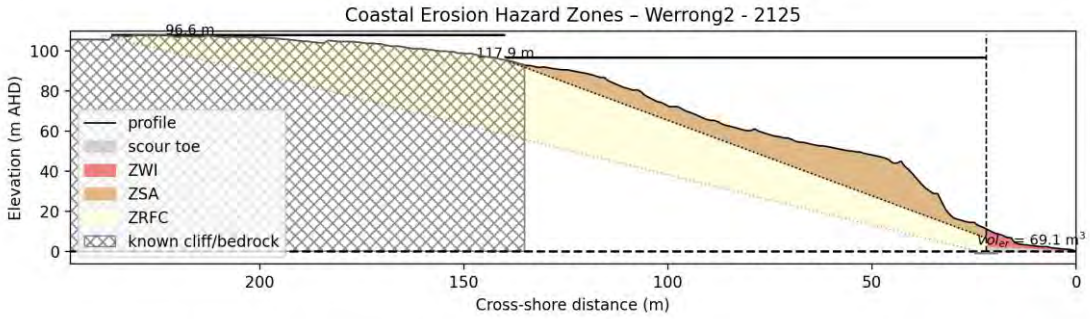
1% design volume: 215 m3/m

Available: 69 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



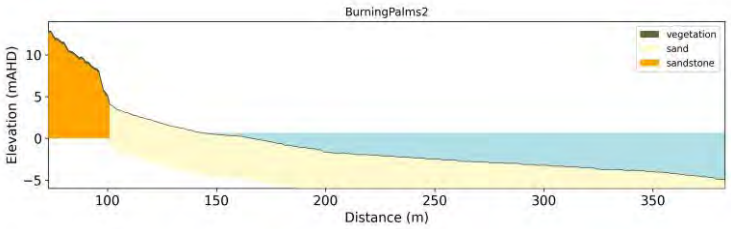
Beach: Burning Palms Beach

Beach unit: BurningPalms2

Description

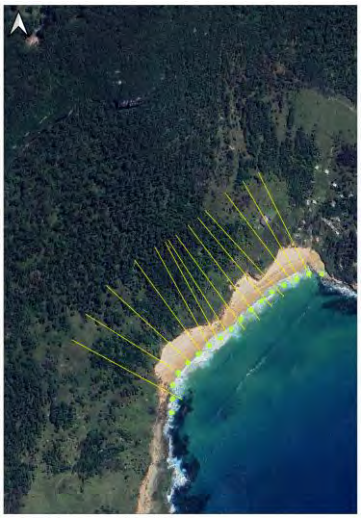
Open coast, sandy beach, backed by a sandstone cliff.

Representative Cross Section (2021 LiDAR)

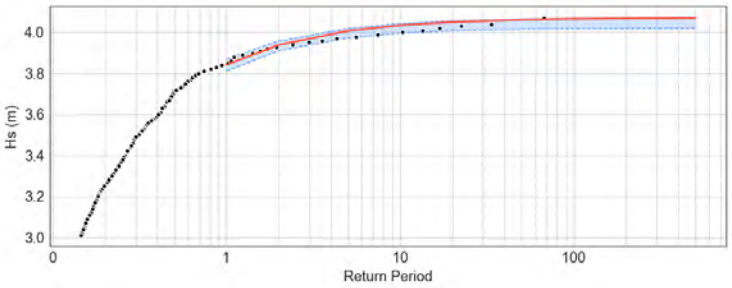


Historic Shoreline Change

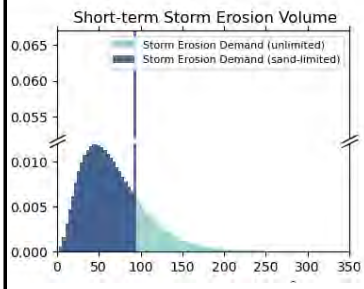
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



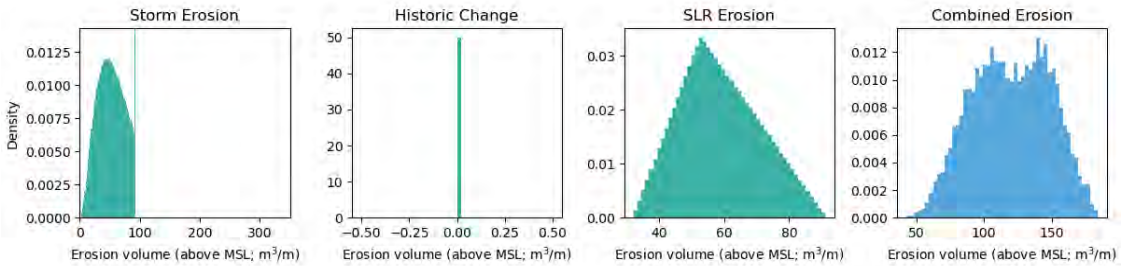
Storm Erosion Demand



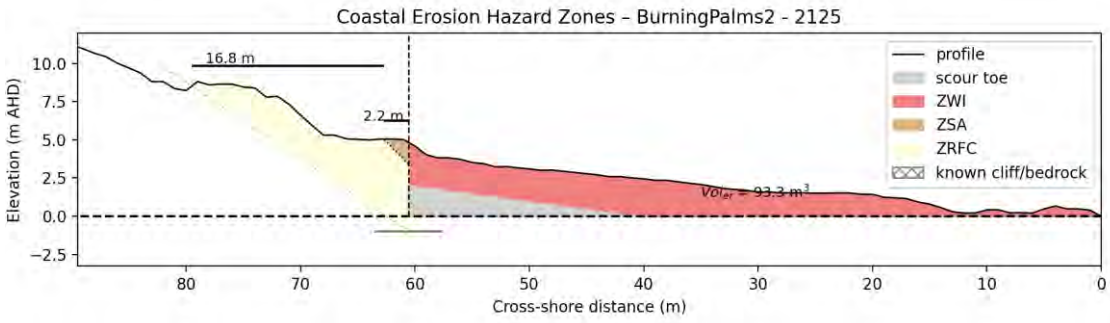
1% design volume: 191 m3/m

Available: 93 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



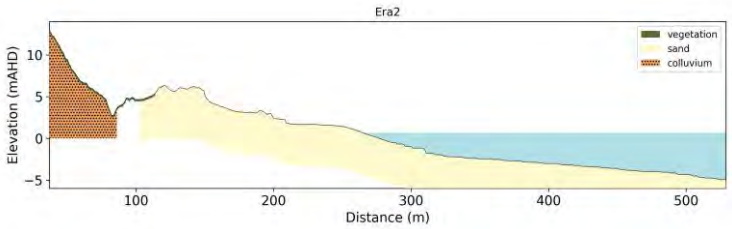
Beach: Era Beach

Beach unit: Era2

Description

Open coast, sandy beach, backed by a colluvium cliff.

Representative Cross Section (2021 LiDAR)

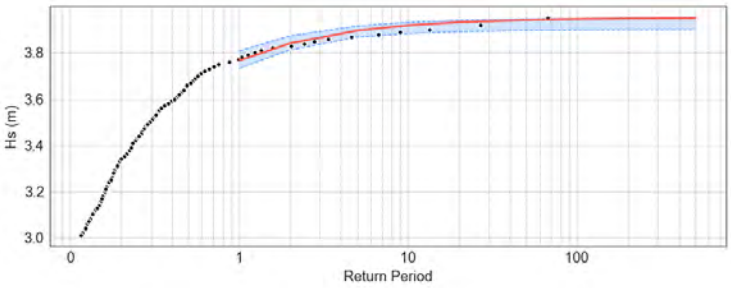


Historic Shoreline Change

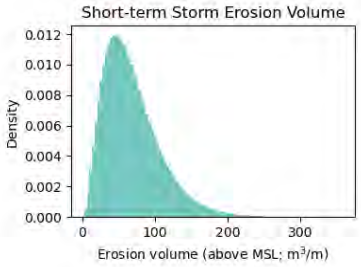
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



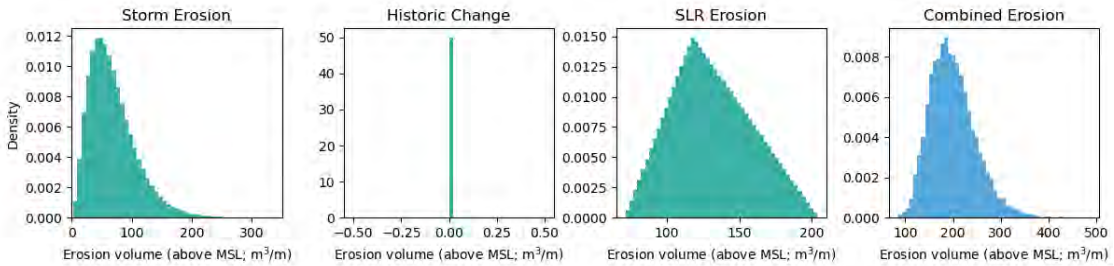
Storm Erosion Demand



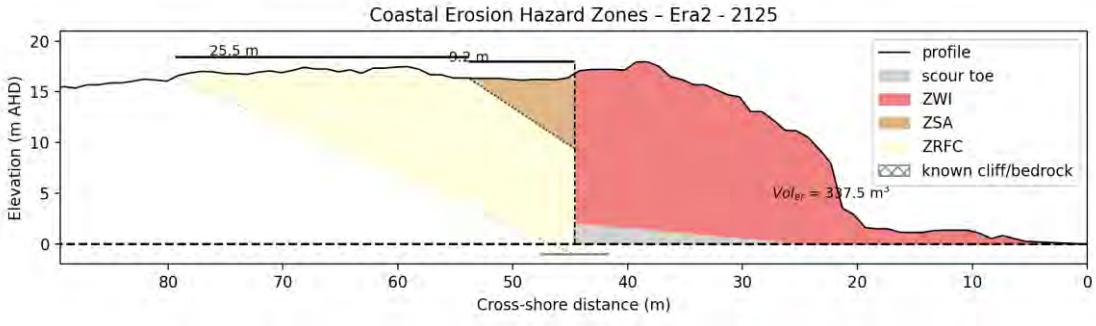
1% design volume: 191 m3/m

Available: 542 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



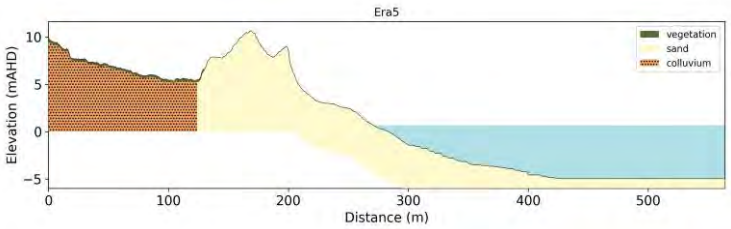
Beach: Era Beach

Beach unit: Era5

Description

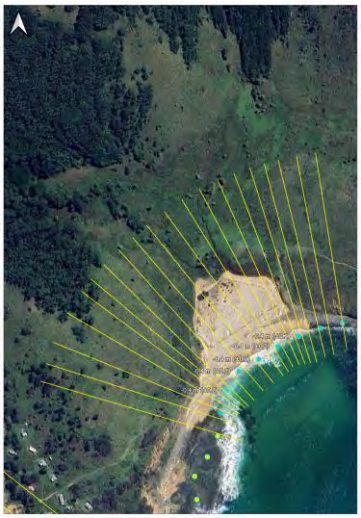
Open coast, sandy beach, backed by colluvium.

Representative Cross Section (2021 LiDAR)

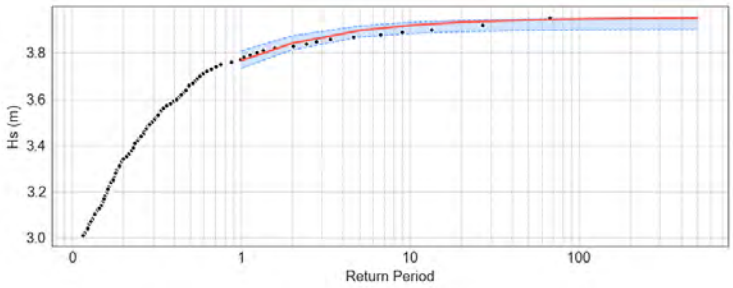


Historic Shoreline Change

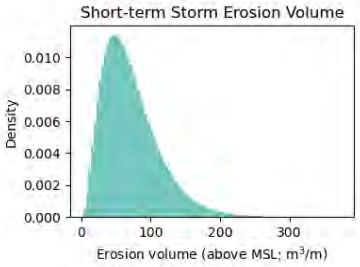
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



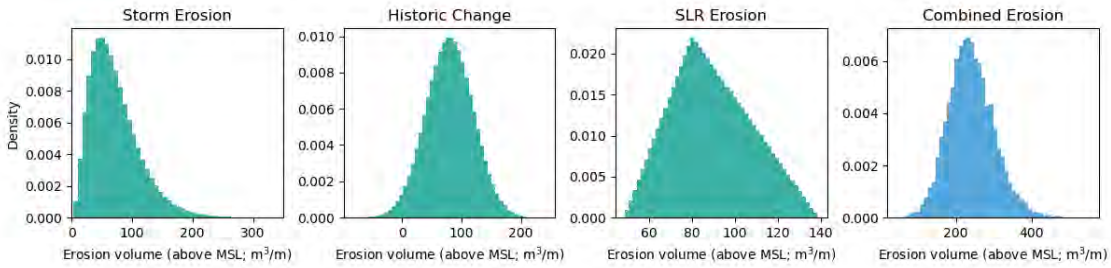
Storm Erosion Demand



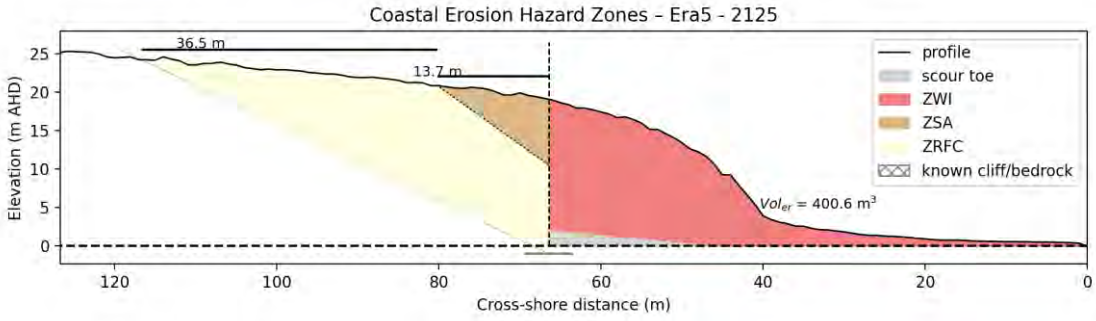
1% design volume: 200 m3/m

Available: 868 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



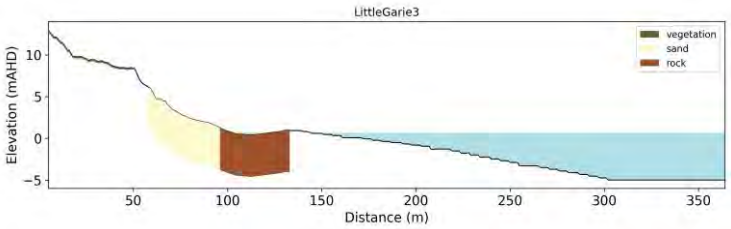
Beach: Little Garie Beach

Beach unit: LittleGarie3

Description

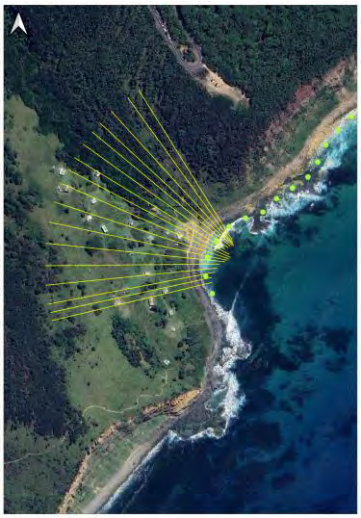
Perched sandy beach with rock platform at its toe. Backed by a cliff.

Representative Cross Section (2021 LiDAR)

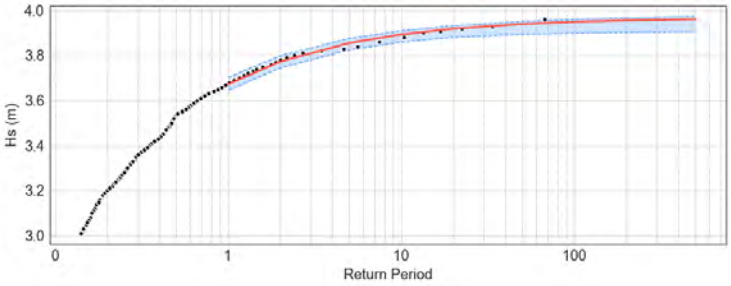


Historic Shoreline Change

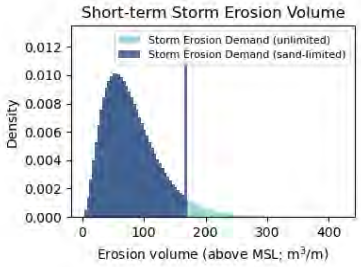
- Erosion
- No/Minimal Change
- Accretion
- Cross Section



Extreme Wave Height



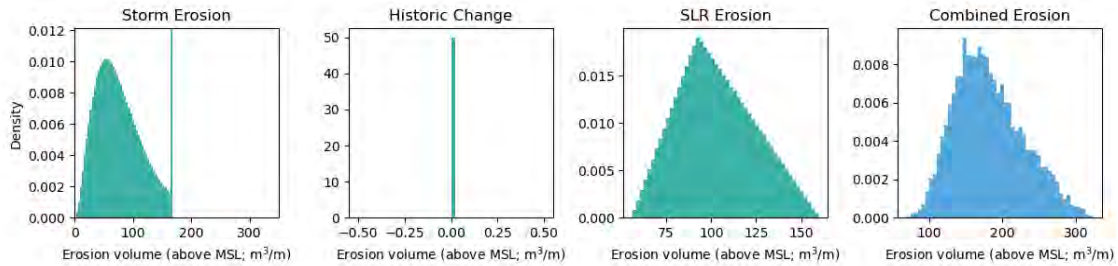
Storm Erosion Demand



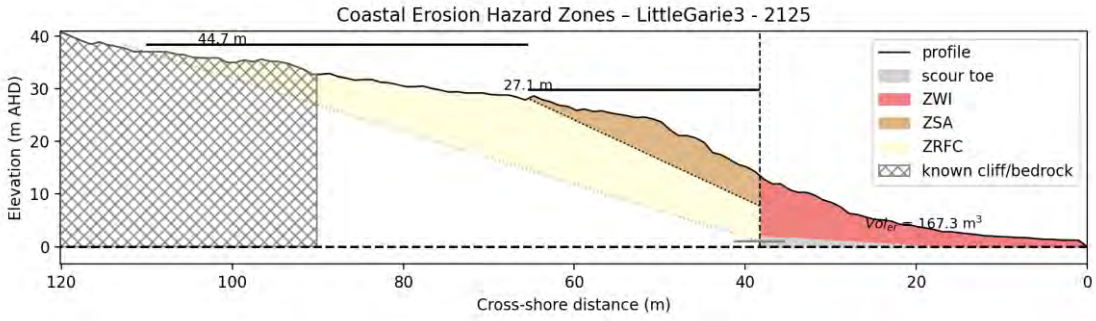
1% design volume: 225 m3/m

Available: 167 m3/m

2125 Statistical Model



Zone of Reduced Foundation Capacity (1% probability of occurrence)



D Appendix D – Coastal and Recession Hazard Zones

This appendix item has been supplied as a separate item alongside this report. The appendix comprises a pdf file displaying of a single map per beach unit. Each map contains erosion lines for the following:

- 2025 1% erosion extent with ZSA,
- 2025 1% erosion extent with ZSA and ZRFC,
- 2125 1% erosion extent with ZSA,
- 2125 1% erosion extent with ZSA and ZRFC.

Each erosion calculation has been taken from the 0m AHD contour of the accreted beach profile.



0 100 200 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

Map ID: 1

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0 150 300 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

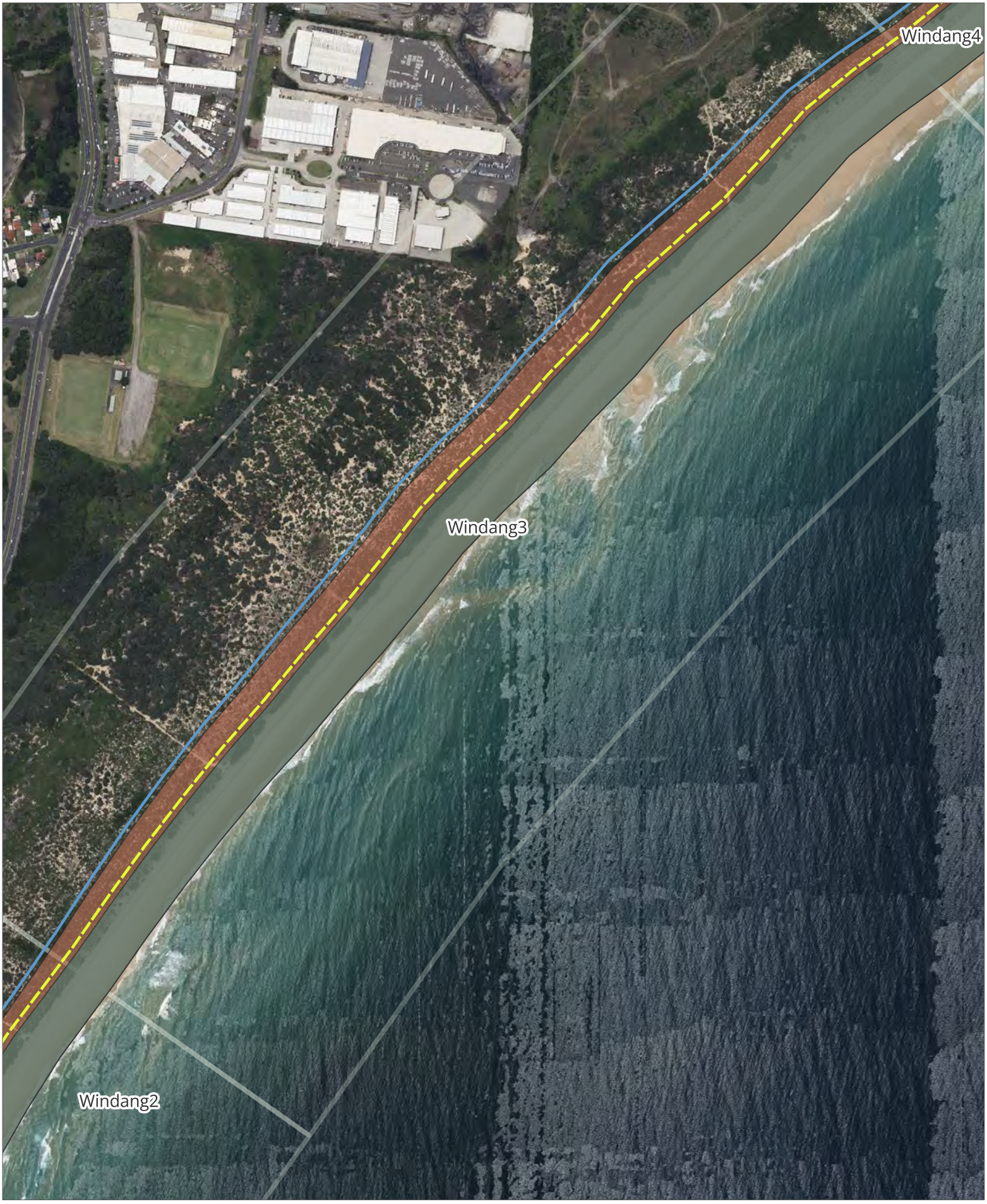
Map ID: 2

Date: 14/10/2025
Version: 2
Page Size: A4
EPSG: 7856
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0 100 200 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

Map ID: 3

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0 50 100 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 50 100 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

Map ID: 5

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0 25 50 m

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

Map ID: 6

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0 50 100 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 100 200 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 50 100 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

Map ID: 11

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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 100 200 m

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

Map ID: 14

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0 50 100 m

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 50 100 m

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 20 40 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 50 100 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 50 100 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

Map ID: 29

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0 25 50 m

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

Map ID: 30

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0 25 50 m

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Date: 14/10/2025
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0 20 40 m

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Credit(s): Microsoft Bing (2023)

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Date: 14/10/2025
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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

Map ID: 35

Date: 14/10/2025
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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

Map ID: 36

Date: 14/10/2025
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0 25 50 m

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

Map ID: 37

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0 25 50 m

Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

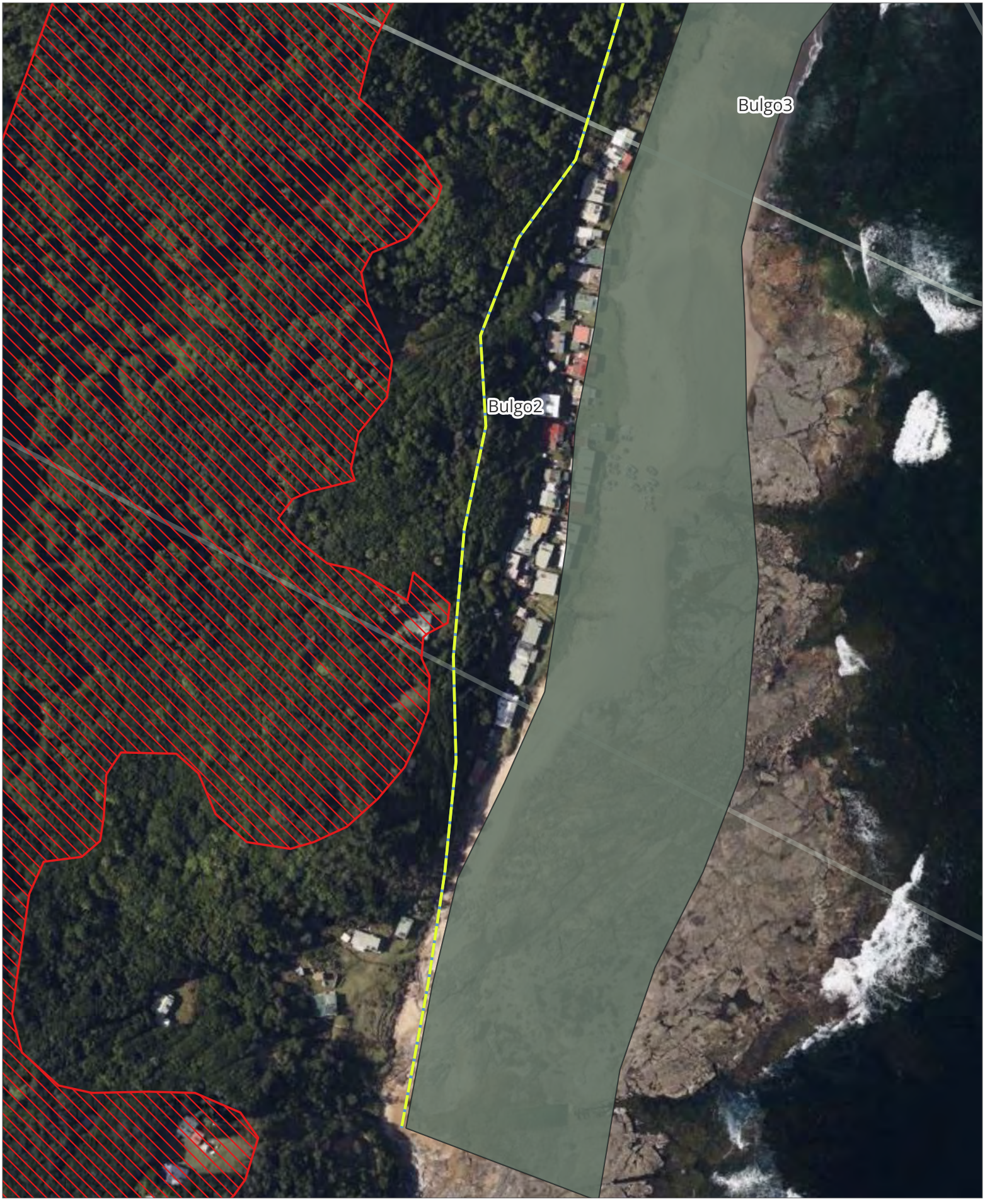
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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

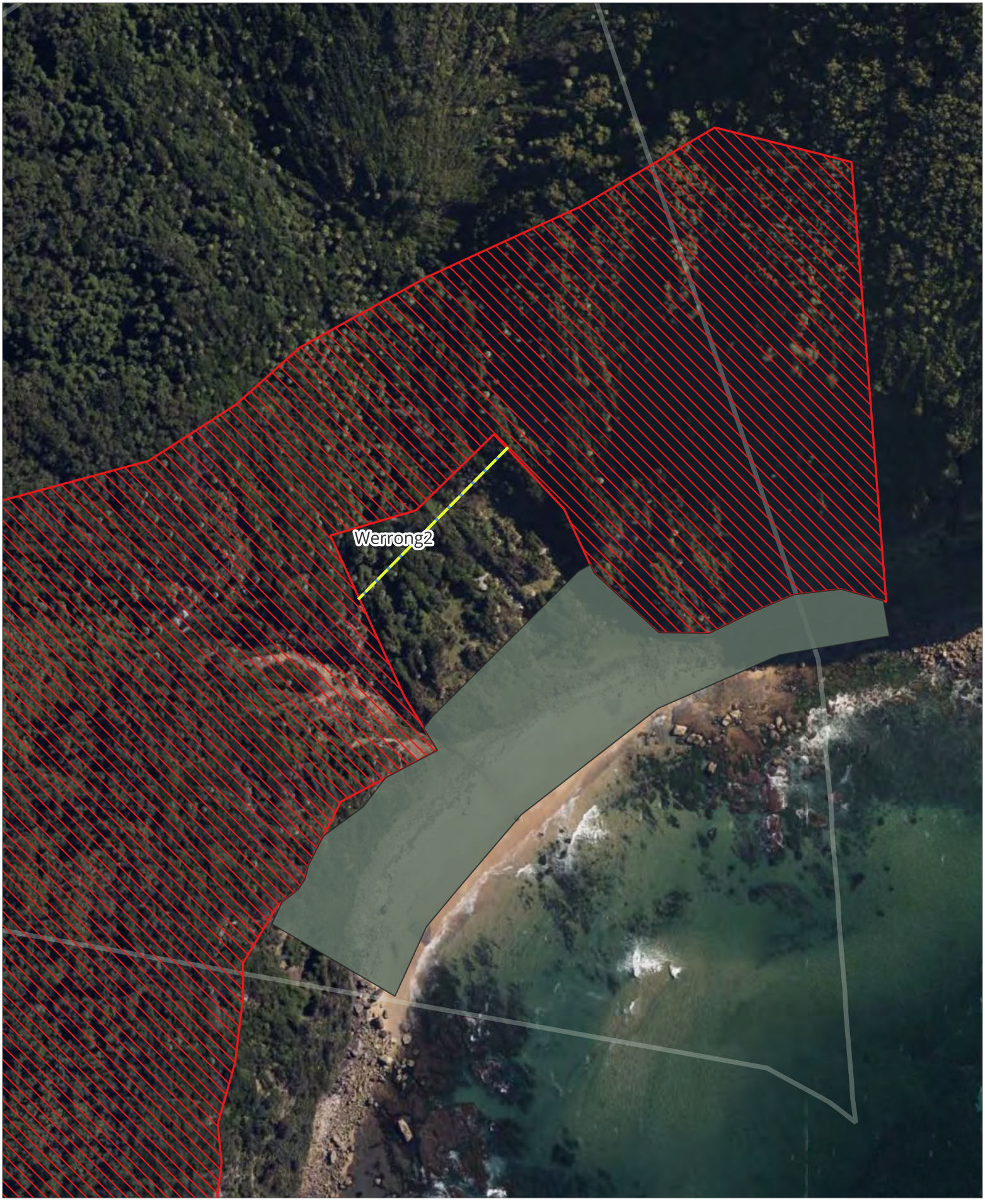
- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

- Non-Erodible Area
- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

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- 2025 1% Exceedence Probability with ZSA
- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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Erosion and Recession Hazard Zones - No Protection

Legend

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- 2125 1% Exceedence Probability with ZSA
- 2025 1% Exceedence Probability with ZSA and ZRFC
- 2125 1% Exceedence Probability with ZSA and ZRFC

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