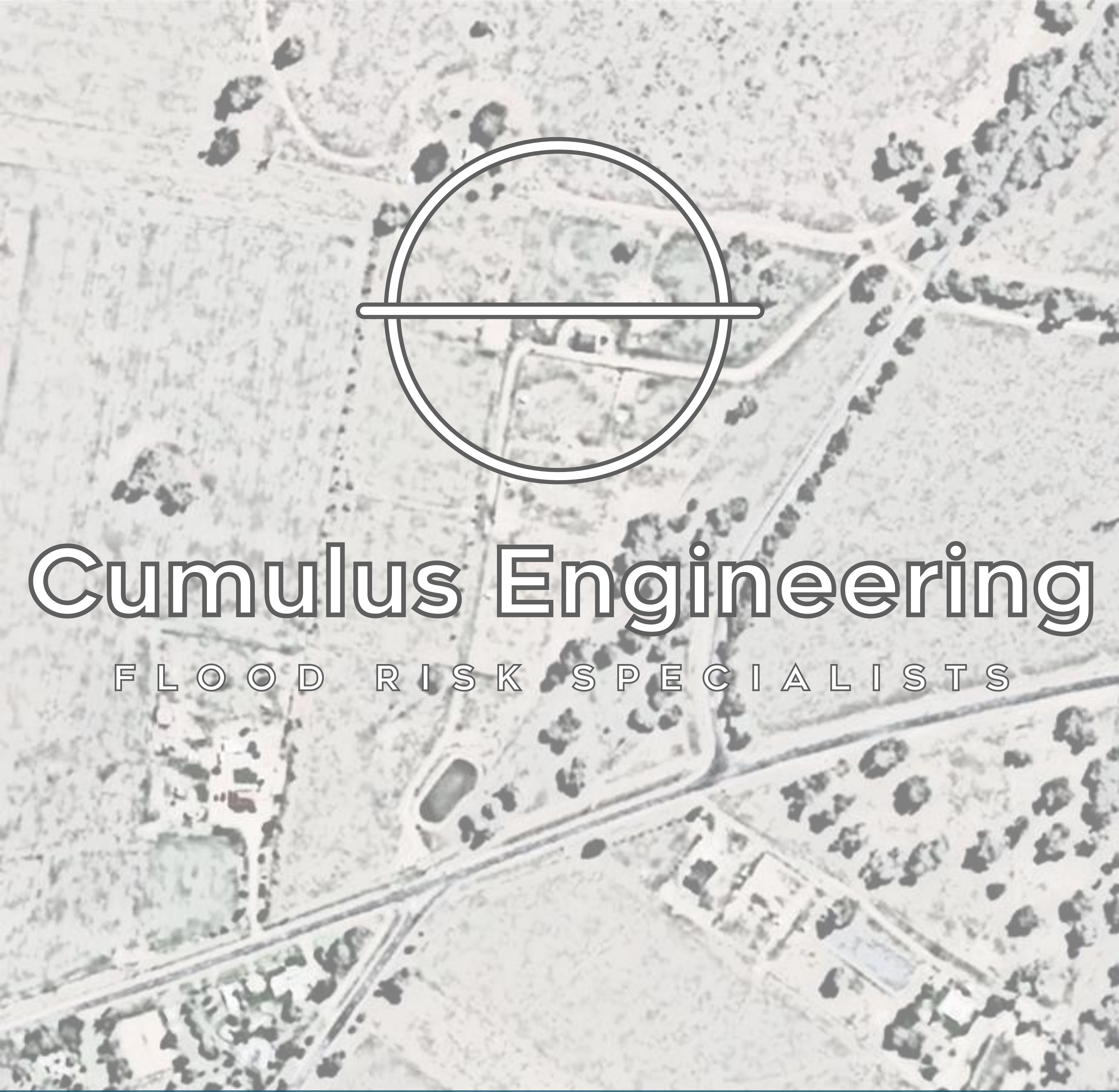

FLOOD IMPACT ASSESSMENT

2028 CULCAIRN-HOLBROOK ROAD, MORVEN

Prepared For Habitat Planning

June 2024

Cumulus Engineering
FLOOD RISK SPECIALISTS

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Cover Image: Subject Site Satellite Image. (2024). Obtained from Nearmap

In the spirit of reconciliation, Cumulus Engineering acknowledges the Traditional Custodians of country throughout Australia and their connections to land, sea, and community. We pay our respect to their Elders past and present and extend that respect to all Aboriginal and Torres Strait Islander peoples today.

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1 Introduction

Cumulus Engineering has undertaken a Flood Impact & Risk Assessment for the proposed development located at 2028 Culcairn-Holbrook Road, Morven (herein referred to as the 'subject site') to determine potential flooding at the site due to the nearby Billabong Creek.

The purpose of this report is to summarise the modelling methodology and present the key findings of the assessment.

1.1 Background

The subject site is located at 2028 Culcairn-Holbrook Road, Morven approximately 50 kilometres northeast of Albury and is currently utilised as a mix of pastured agricultural land and rural residential as illustrated in Figure 1-1.

A Planning Proposal submitted to Greater Hume Council (GHC), seeks to amend the zone and minimum lot size of the Greater Hume Local Environmental Plan (LEP) 2012 to enable development of the land into larger rural residential lots, consistent with the existing fringe of Morven.

In response to the Planning Proposal Scoping Report submitted to GHC, Council have advised that a flood impact and risk assessment is required to determine the potential extent of flooding at the site due to the nearby Billabong Creek and other minor waterways and overland flow paths.

The flood impact assessment is required to demonstrate that the development meets the requirements of the NSW Floodplain Development Manual, to ensure the development is safe for future occupants and has no adverse impacts from a floodplain management perspective.

The primary objectives of this study are:

- To evaluate the flooding characteristics of the site across a range of design events.
- To utilise the modelling outcomes to guide the development design, including minimum floor levels.
- To provide recommendations for flood risk mitigation solutions, if required, to uphold the functionality and safety of infrastructure, prevent negative impacts on neighbouring properties and downstream areas, ensure safe access to and from the site during flood events, and comply with Council requirement.

1.2 Consent Authorities Requirements

As part of the inception stage of the project, Cumulus contacted both GHC as well as the Department of Climate Change, Energy, the Environment and Water (DCCEEW) to give feedback and recommendations based on the proposed scope of works for this flood impact assessment to ensure the final report would fulfil requirements from both Authorities. Based on feedback received the following additional provisions were included:

- Flood Function and Flood hazard category mapping for flood events
- 5% AEP design flood event mapping which is a key consideration as it is an indicator of the extent of the floodways amongst other things
- Flood Planning Area (FPA) mapping across the site based on 1% AEP +0.5m freeboard.
- Consideration of flood studies completed within the region (Culcairn, Henty, Holbrook Flood Studies - Greater Hume Shire Council (2013))
- Inclusion of the 0.5% AEP flood event as part of the modelled events.

1.3 Reference Material

The following reference material has been considered in the preparation of this report:

- Culcairn, Henty, Holbrook Flood Studies - Greater Hume Shire Council (2013)
- Flood Risk Management Manual (2023)
- Development Control Plan – Greater Hume Shire Council (2013)
- Local Environment Plan – Greater Hume Shire Council (2012)
- Australian Rainfall and Runoff (2019)
- Guidelines for Development in Flood Affected Areas (DEECA 2019)

FIGURE 1-1 SUBJECT SITE

2 Hydrology

The RORB hydrological model Version 6.51 (Laurenson, Mein and Nathan, 2010) was used for this study. RORB calculates flood hydrographs from storm rainfall hyetographs and can be used for modelling natural, part urban and fully urban catchments. RORB is an industry standard modelling package that is used widely in hydrological studies in Australia.

To determine appropriate durations and associated peak mean temporal patterns for the 0.5%, 1% and 5% AEP and Probable Maximum Flood (PMF) storm events an ensemble approach was adopted in accordance with ARR2019.

2.1 Catchment Delineation

Delineation of the sites' upstream catchment was determined through automated tools in QGIS using March 2014 LiDAR obtained from the NSW Government Spatial Services. Outputs of the automated process were validated and adjusted visually using topographical data and aerial imagery. The overall delineation for the catchment upstream of the site is illustrated in Figure 2-2. The catchment has been divided into three distinct areas.

- **West Catchment:** This includes the catchment with mainstream flow from 5 km north of the subject site to just west of it, comprising five subareas: Subareas J, H, K, I, and L. (Indicated in pink polygons).
- **Middle Catchment:** This includes the subject site and includes Subareas A, B, C, D, E, F, and G (Indicated in yellow polygons).
- **East Catchment:** This catchment does not have streams or catchments directly flowing over the subject area, however, since its mainstream flows 150 meters south of the site, it is considered to potentially impact the subject site. (Indicated in blue polygons).

2.2 RORB Modelling Parameters

2.2.1 Values of Fraction Imperviousness

Values of fraction imperviousness (FI) were determined through aerial imagery and planning zone codes adopting proposed development plan layouts for the post developed scenario, using standard values which are consistent with ARR2019. Weighted values of FI are outlined in Table 2-1.

TABLE 2-1 FRACTION IMPERVIOUSNESS: WEIGHTED AVERAGE VALUES

Subarea	Area (km^2)	Weighted FI
A	5.66	0.052
B	2.01	0.054
C	2.83	0.046
D	1.63	0.051
E	2.47	0.058
F	1.07	0.100
G	0.39	0.181
H	2.56	0.043
I	1.93	0.045

Subarea	Area (km²)	Weighted FI
J	1.96	0.043
K	1.61	0.047
L	2.05	0.054
M	2.01	0.067
N	0.94	0.066
O	0.70	0.079
P	0.46	0.278

2.2.2 Loss and Routing Parameters

Recommended loss values for the catchment were accessed via online ARR Data Hub (Babister et al 2016). The RORB routing parament k_c was estimated using the recommended equation for catchments east and west of the Great Dividing Range ($k_c = 1.18A^{0.46}$). The typical value for the m value of 0.8 was adopted across the catchment.

To determine losses for NSW catchments, a hierarchy of approaches should be considered, as recommended in ARR2019. Given the catchment is ungauged, adoption of NSW FFA-reconciled losses available through the ARR Data Hub for Jingellic (Station number: 401013) were adopted which is a similar nearby catchment to the site.

Loss and routing parameters adopted for the model are outlined in Table 2-1.

TABLE 2-1 ADOPTED LOSS AND ROUTING PARAMETERS

Input Parameter	Adopted Value
m	0.80
K_c	
Catchment East	2.26
Catchment Middle	4.23
Catchment West	3.42
Initial Loss (IL)	28.8 mm
Continuing Loss (CL)	4.74 mm/h

2.2.3 Pre-burst Rainfall

As the site is in NSW, median pre-burst rainfall is considered the most appropriate for this loss region and was adopted for the purposes of this study.

2.2.4 Event Durations and Temporal Patterns

A range of design storms have been evaluated for durations ranging from 10 minutes to 72 hours for the 5%, 1%, 0.5% AEP events. In line with the procedure outlined in ARR2019 the full range of temporal patterns (TPs) for the region were adopted for the ensemble analysis.

Following the ensemble analysis, multiple simulations were conducted using designed storms with different temporal patterns to evaluate their impacts on peak flows. The maximum of the peak flow medians is adopted. The TPs resulting in a peak flow closest to the median of the ensemble peaks were then selected. Additionally, to assess impacts due to localised rainfall, a shorter duration was selected and representative temporal pattern for a front loaded, mid loaded and rear loaded event included. The adopted durations and associated temporal patterns are detailed in the following section.

2.3 Probable Maximum Flood (PMF)

The PMF hydrology was undertaken utilising the Generalised Short Duration Method (GSDM) as per the ARR 2019 Guidelines. The GSDM is applicable for durations of up to six hours and areas of up to 1000 km^2 (Bureau of Meteorology, 2003). The Generalised Southeast Australia Method (generally adopted for durations greater than 6 hours) was not considered appropriate for the catchment given that the longest critical duration identified for the catchment is the 4.5-hour duration. The zones of application are outlined in Figure 2-1.

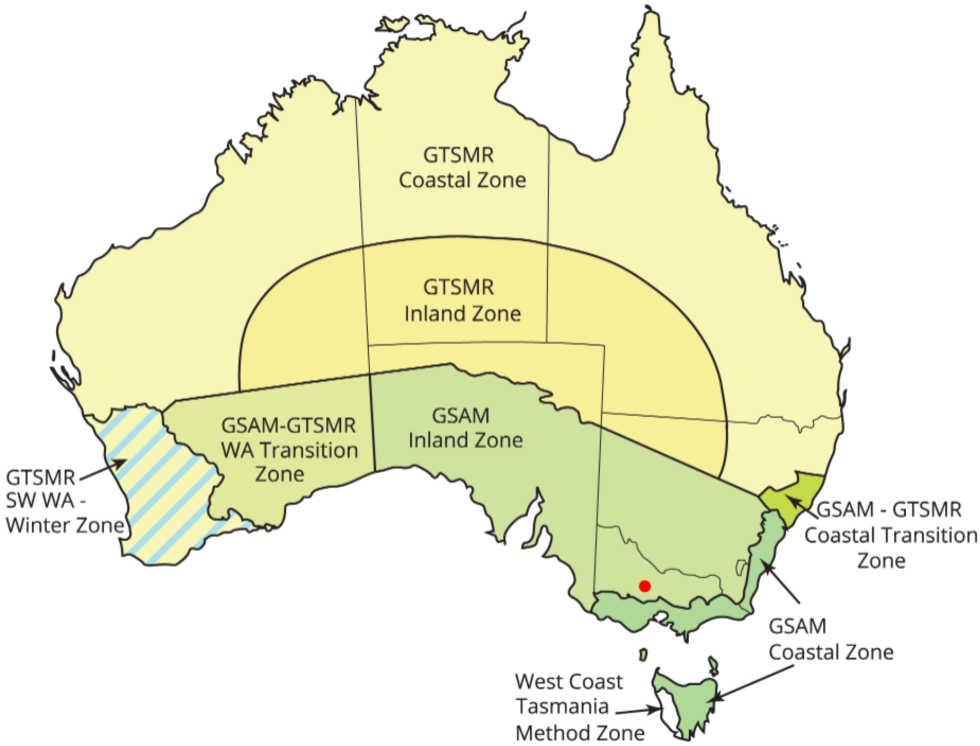


FIGURE 2-1 GENERALISED LONG-DURATION PROBABLE MAXIMUM PRECIPITATION METHOD ZONES (NATHAN, WEINMANN, 2019).

GDSM temporal and spatial patterns were used in line with the ARR 2019 recommendations for short duration events. The durations adopted for PMF calculations were generally the same as those adopted throughout all design events including the 1 hour, 2 hours, 3 hours, 4 hours and 5 hours durations. The same loss model that was adopted for all previous design events was adopted for PMF and the median pre-burst temporal pattern was adopted, as per all previous design events.

2.4 Design Event Hydrologic Modelling

The key results from the hydrological modelling at critical locations within the catchment (as illustrated in Figure 2-2) are summarised in Table 2-2 and shows the adopted critical duration, associated temporal pattern and peak overland flows at each location.

TABLE 2-2 ADOPTED DESIGN EVENTS AND PEAK FLOW

Event	Location	Critical Duration	Adopted Temporal Pattern	Peak Flow (m^3/s)
0.5% AEP	West Catchment	270	6	34.5
	Middle Catchment	270	6	54.8
	East Catchment	120	6	19.7
1% AEP	West Catchment	270	5	31.6
	Middle Catchment	270	6	48.2
	East Catchment	120	7	17.1
5% AEP	West Catchment	180	7	20.2
	Middle Catchment	120	2	34.9
	East Catchment	90	9	13.8

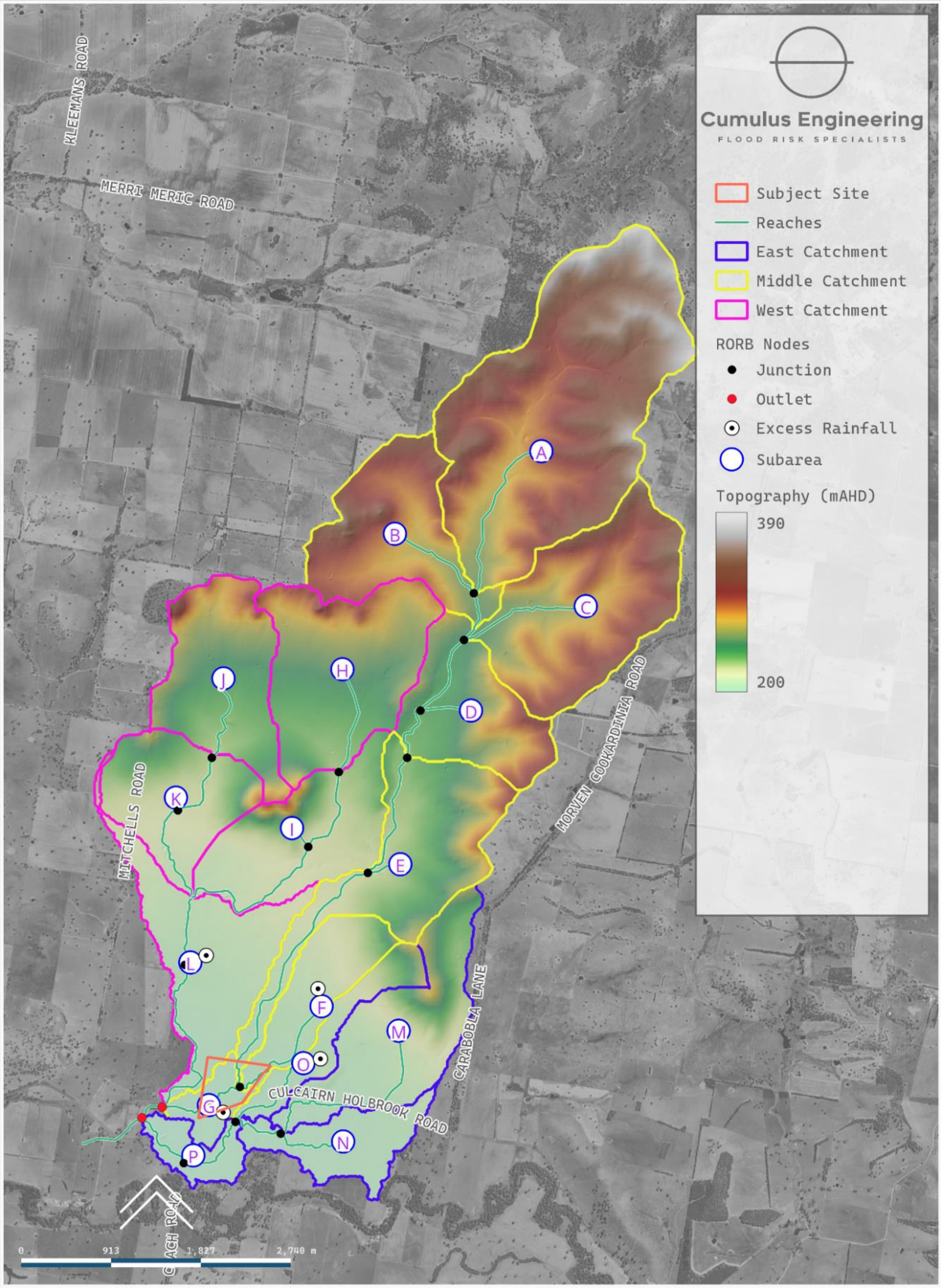
2.5 RORB Model Validation

Several flood studies have been conducted in this region, focusing on the major townships of Henty, Culcairn, and Holbrook. The studies completed to date, however, do not cover the catchment in which the subject site is located and therefore no hydrologic and hydraulic models available for the study area which can be used to validate model results. In the absence of existing models, the Regional Flood Frequency Estimation (RFFE) model was used to validate the RORB design flows. Table 2-3 shows the comparison of the peak flow for the middle catchment (see Figure 2-2) against the RFFE estimate.

This set of comparisons shows a small difference (+1.3 m^3/s in the 1% AEP event), with the flows obtained from the modelled data slightly larger than the RFFE data, but within acceptable limits.

TABLE 2-3 RFFE FLOW RATE VALIDATION FOR MIDDLE CATCHMENT

Event	Location	RFFE Flow Estimate (m^3/s)	RORB Peak Flow (m^3/s)
1% AEP	Middle Catchment	46.9	48.2
5% AEP	Middle Catchment	27.3	34.9



CLIENT: Habitat Planning
PROJECT: Flood Impact & Risk Assessment: 2028 Culcairn-Holbrook Road, Morven

DRAWING NAME: RORB Model Schematisation

Date: 2024-06-06
GDA94 / MGA zone 55

FIGURE 2-2 RORB MODEL SCHEMATISATION

3 Hydraulics

Hydraulic modelling of the existing conditions was undertaken by developing a 2-dimensional model in the industry standard software TUFLOW. TUFLOW is a numerical model widely used to simulate the hydrodynamic behaviour of rivers, floodplains, and urban drainage environments and is considered the industry standard in Australia.

Hyetographs for the 1% AEP with various storm durations and temporal patterns (as outlined in Table 2.2) were derived from RORB and applied to the TUFLOW model as excess rainfall hyetographs for subareas located within the hydraulic model extent.

3.1 Model Setup

The hydraulic model covers the subject site, incorporating sufficient areas upstream and downstream to ensure any impacts of the development on flood behaviour are explored. Model schematics representing existing conditions are displayed in Figure 3-1 and outlined in detail Table 3-1. The model parameters adopted for the hydraulic model are outlined in detail in Appendix A.

TABLE 3-1 HYDRAULIC MODEL PARAMETERS

Modelling Component / Assumptions	Comment
Model Engine	TUFLOW HPC GPU
Model Build	2023-03-AC-iSP-w64
2D Topography	5m LiDAR captured in 2014, owned by the NSW Government. LiDAR is illustrated within Figure 2-2
2D Grid Size	2 metres
Inflow Boundary Conditions	2D Inflow – Local Catchment - Source Area 'direct rainfall' applied as hydrograph representing flows contributing from upstream catchments (see 2D Inflow boundaries illustrated in Figure 3-1) - Applied rainfall excess hyetographs extracted from each of the RORB Subareas to all cells equally (2d_sa_all) for subarea's located wholly within the model extent (see 2d Areal Rainfall Inflow illustrated in Figure 3-1)
Downstream Boundary Condition	HQ (water-discharge boundary) at all other downstream boundaries adopting respective slope upstream of boundary location.
Roughness	Open pervious area (minimal vegetation) Open pervious area (moderate vegetation) Open pervious area (heavy vegetation) Waterway/Channel (Minimal Vegetation) Residential Rural (modelled together) Car Park / Pavement / Driveway / Road
2D Outputs	Water levels, depths, velocity, hazard (ZAEM1)

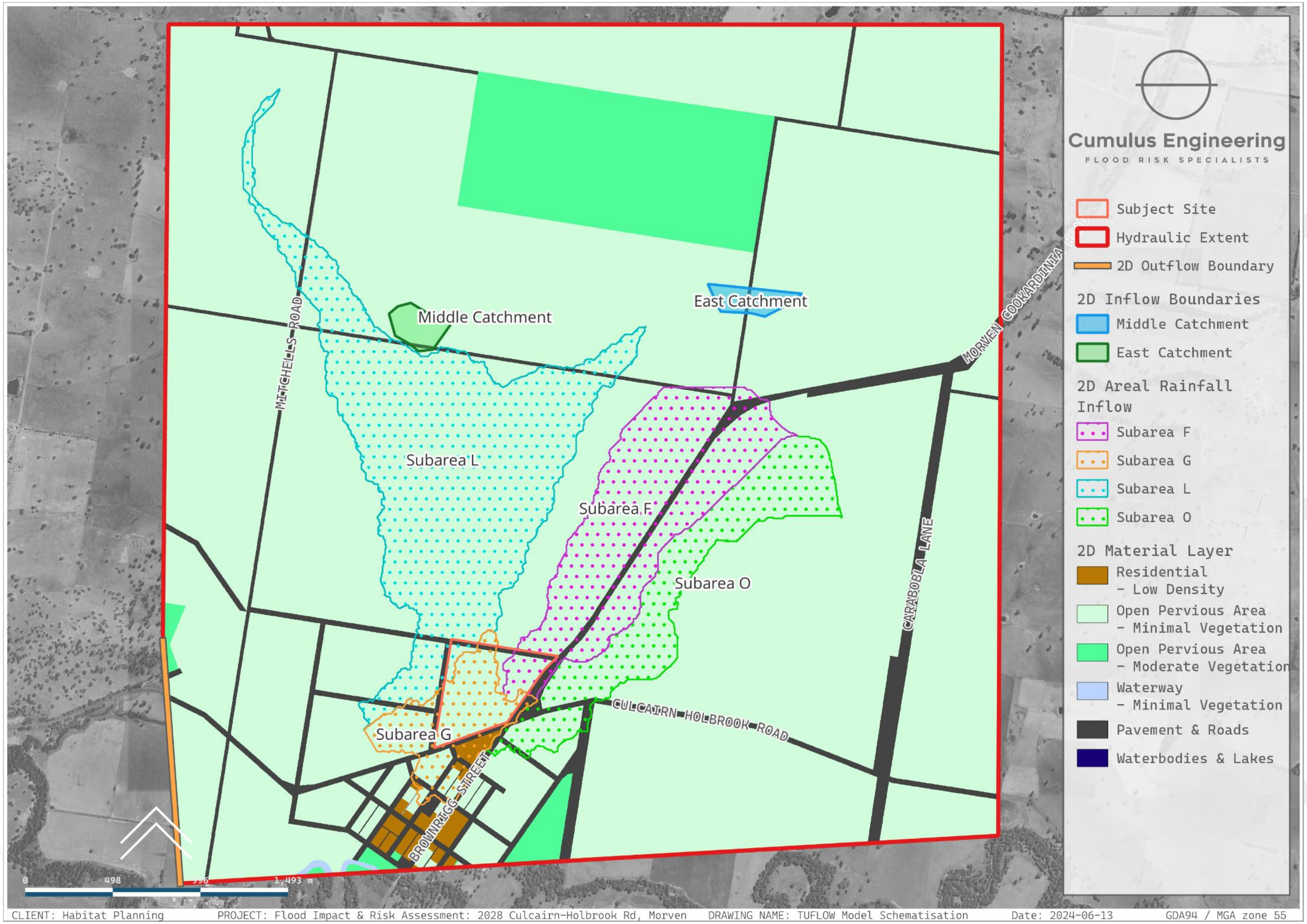


FIGURE 3-1 HYDRAULIC MODEL SETUP – EXISTING CONDITONS

3.2 Model Validation

There is no existing hydraulic model or modelling results at Morven to validate the model to. The modelling was conducted using best practice methods and is considered the best available information to assess flood risk at the site and surrounds.

3.3 Sensitivity Assessment – Billabong Creek

Explicitly representing Billabong Creek, located 600 metres downstream and south of the subject site, was omitted from the model as it was assumed that the Creek would have no impact on the site. To confirm this assumption, a sensitivity assessment of the 1% AEP event in Billabong Creek was conducted to ensure the site is not inundated from breakouts from the Creek.

Inflow data for the assessment was obtained from the previous flood study completed by Greater Hume Shire Council in 2013 (Figure 3-2). The 24-hour storm was found to be critical at Culcairn, which is located approximately 8 kilometres downstream from the site and was therefore adopted as the critical duration for the sensitivity analysis. Selection of the critical duration was further confirmed within the report showing only a small amount of flow attenuation between the stream gauge upstream of the site (410186 B/Bong D/S 10-Mtn Ck) and at Culcairn downstream of the site.

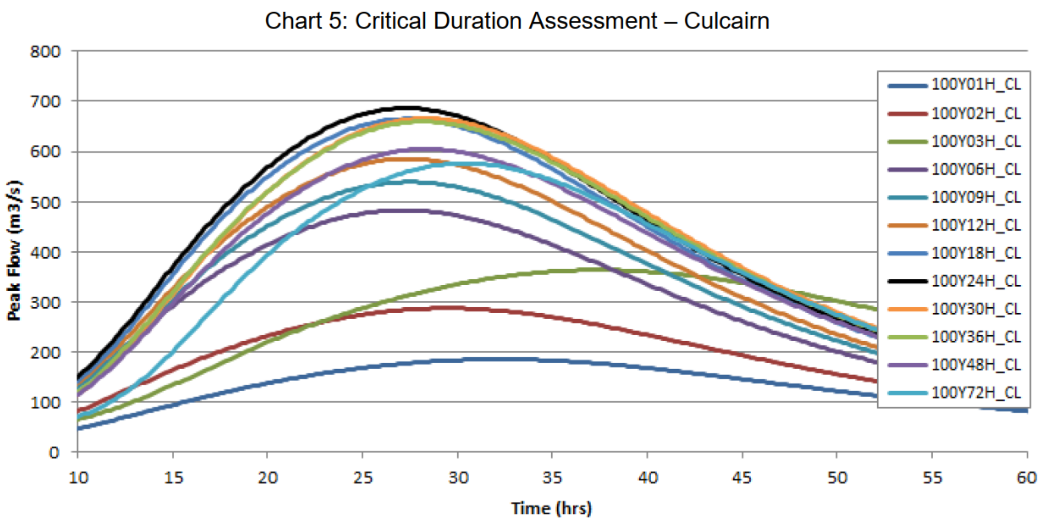


FIGURE 3-2 CRITICAL DURATION ASSESSMENT – CULCARIN (GREATER HUME SHIRE COUNCIL, 2013)

Figure 3-3 shows the TUFLOW model schematization for the sensitivity assessment of Billabong Creek. The Creeks mannings roughness was set to 0.08, representing as a waterway with significant vegetation with the inflow hydrograph for the critical duration applied at the upstream of the model extent.

Figure 3-4 illustrates the creek's flood depth in the 1% AEP event. indicating that during a 1% AEP event, both the subject site and the township are not affected by Billabong Creek in the critical duration. The flow remains primarily within the channel along most of the examined reach, with only minor and shallow out of bank flows occurring south of Billabong Creek near Morven

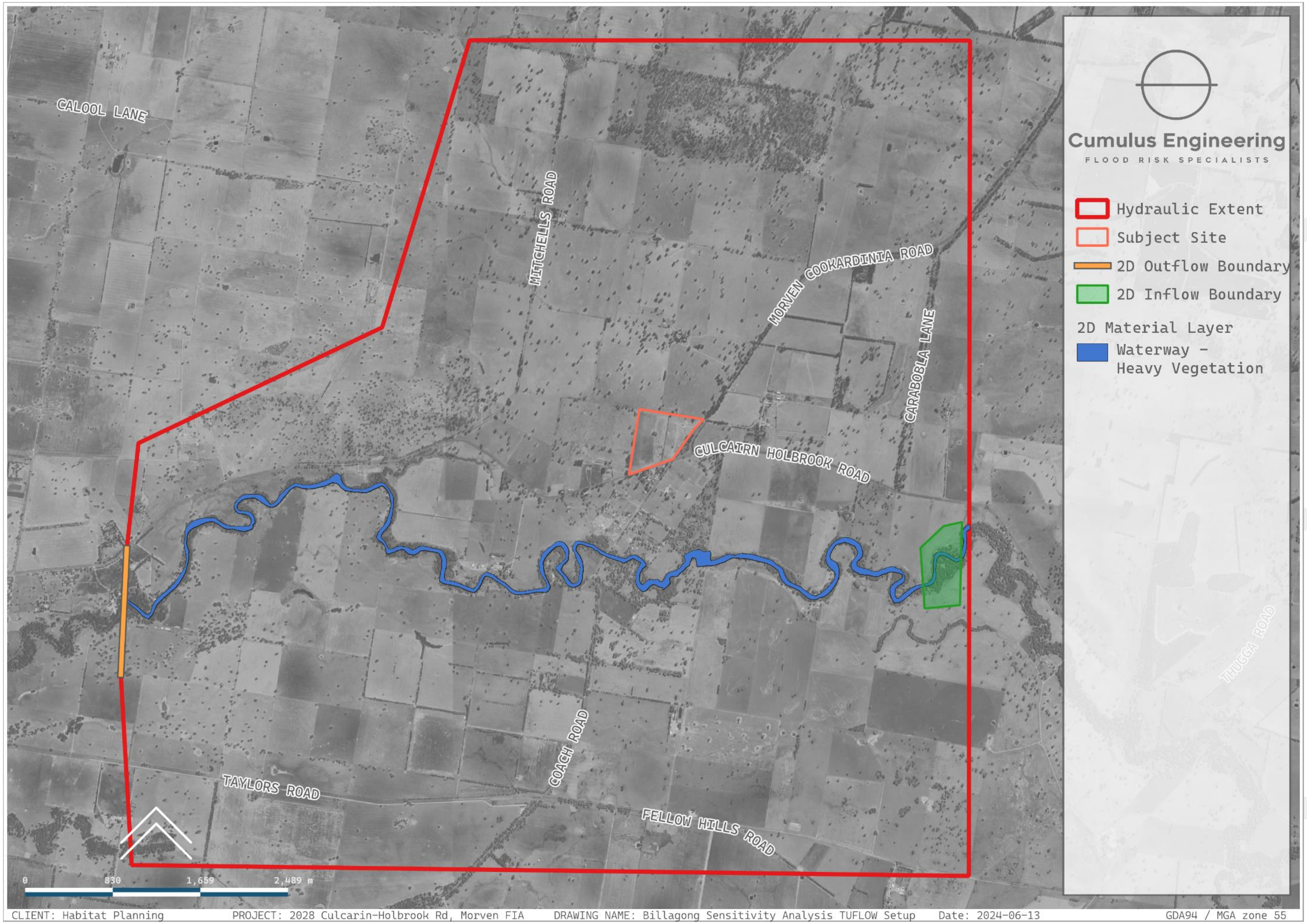


FIGURE 3-3 TUFLOW MODEL SCHEMATISATION FOR SENSITIVITY ASSESSMENT OF BILLAGONG RIVER

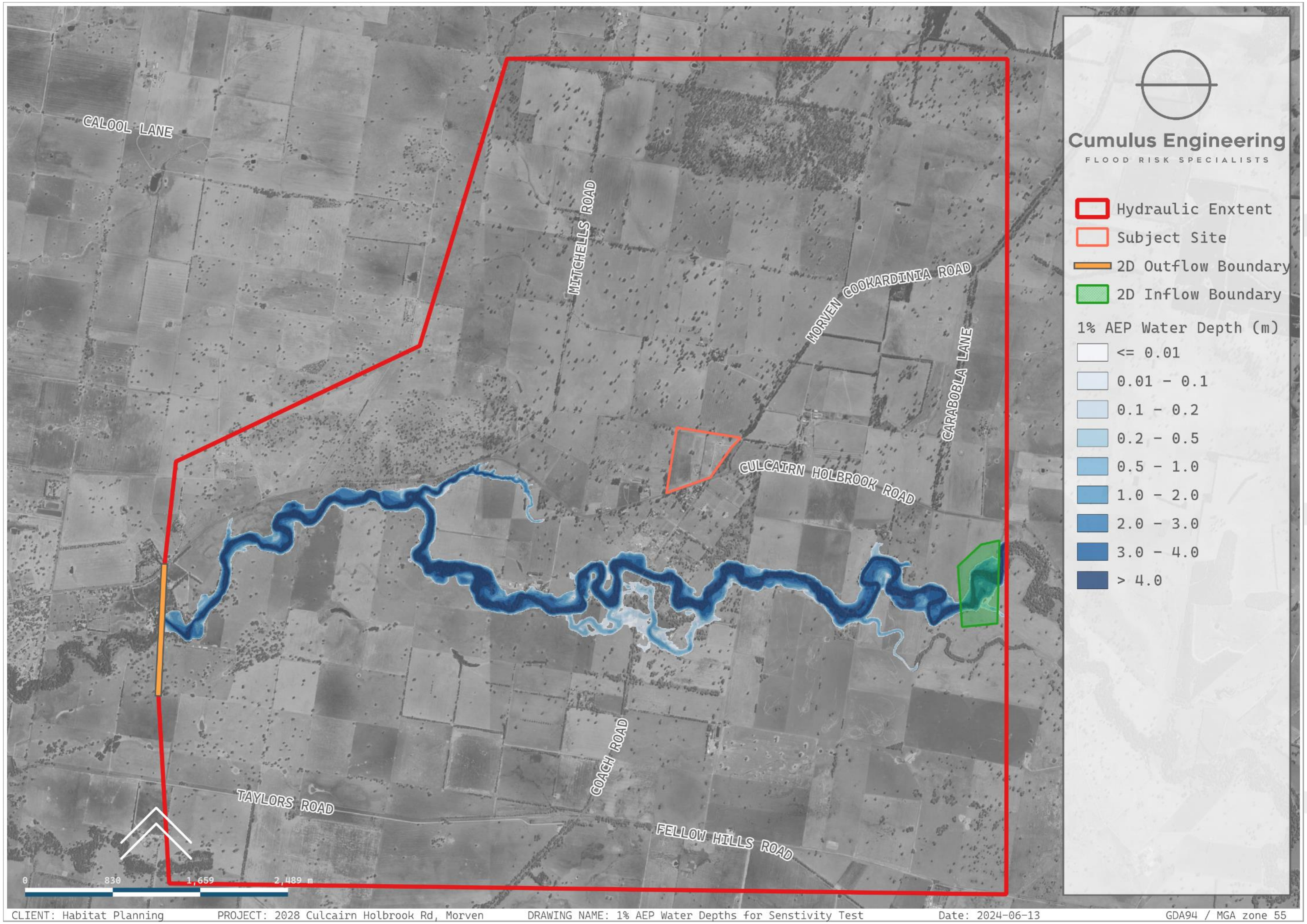


FIGURE 3-4 BILLAGONG CREEK WATER DEPTHS IN 1% AEP EVENT

3.4 Modelling Results

The model was run for existing conditions for the 0.5% AEP, 1% AEP, 5% AEP, and PMF events and associated critical storm durations outlined in Table 2-2. Gridded results of flood depths, water levels, velocities and AEMI Hazards were post-processed and mapped from the TUFLOW raw outputs for all events. The full suite of maps for existing and design scenarios can be found in Appendix B.

3.4.1 Existing Conditions

The results indicate that the site is inundated in the 1% AEP event with widespread sheet flow with flood depths typically remaining below 300mm, as shown in Figure 3-5. Flood depths are noticeably higher at the south-eastern and southwestern corners of the subject site due to the localised topographical low points at these locations. As illustrated in Figure 3-6, flood depths along the proposed key access routes remain below 300 mm. Water surface elevation for the 1% AEP event ranges from 225.07 mAHD in the south-west corner to 226.94 mAHD in the north-east corner, following the rise in topographical elevation.

The hazard classification throughout the area is generally H1, with H2 observed in the middle of the site (see Figure 3-7). The hazard classification along the proposed key access routes is also shown to be H1.

Velocities range between 0.02 m/s and 0.79 m/s, with the highest velocities observed on the north-western boundary of the site.

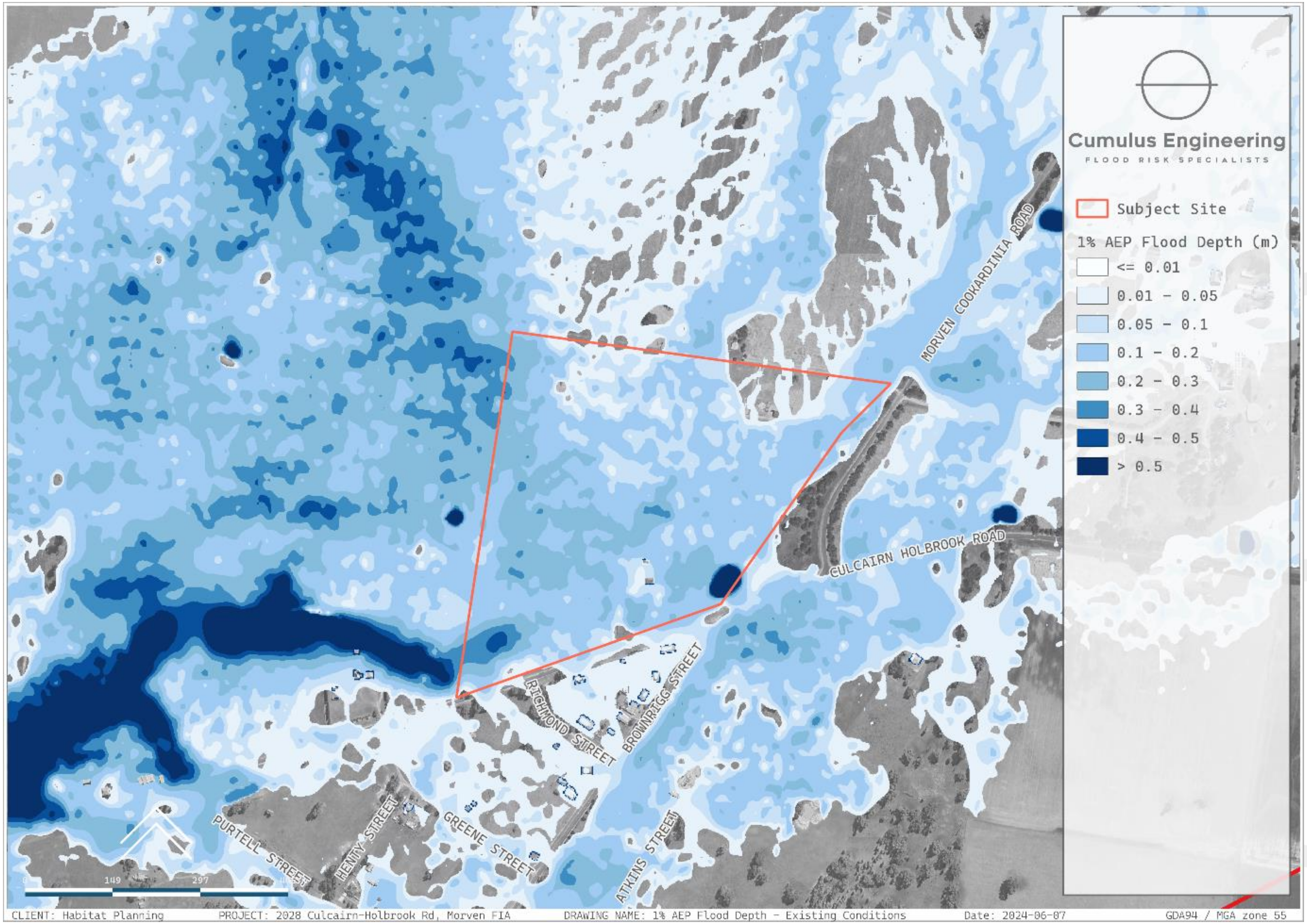


FIGURE 3-5 1% AEP FLOOD DEPTHS - EXISTING CONDITION

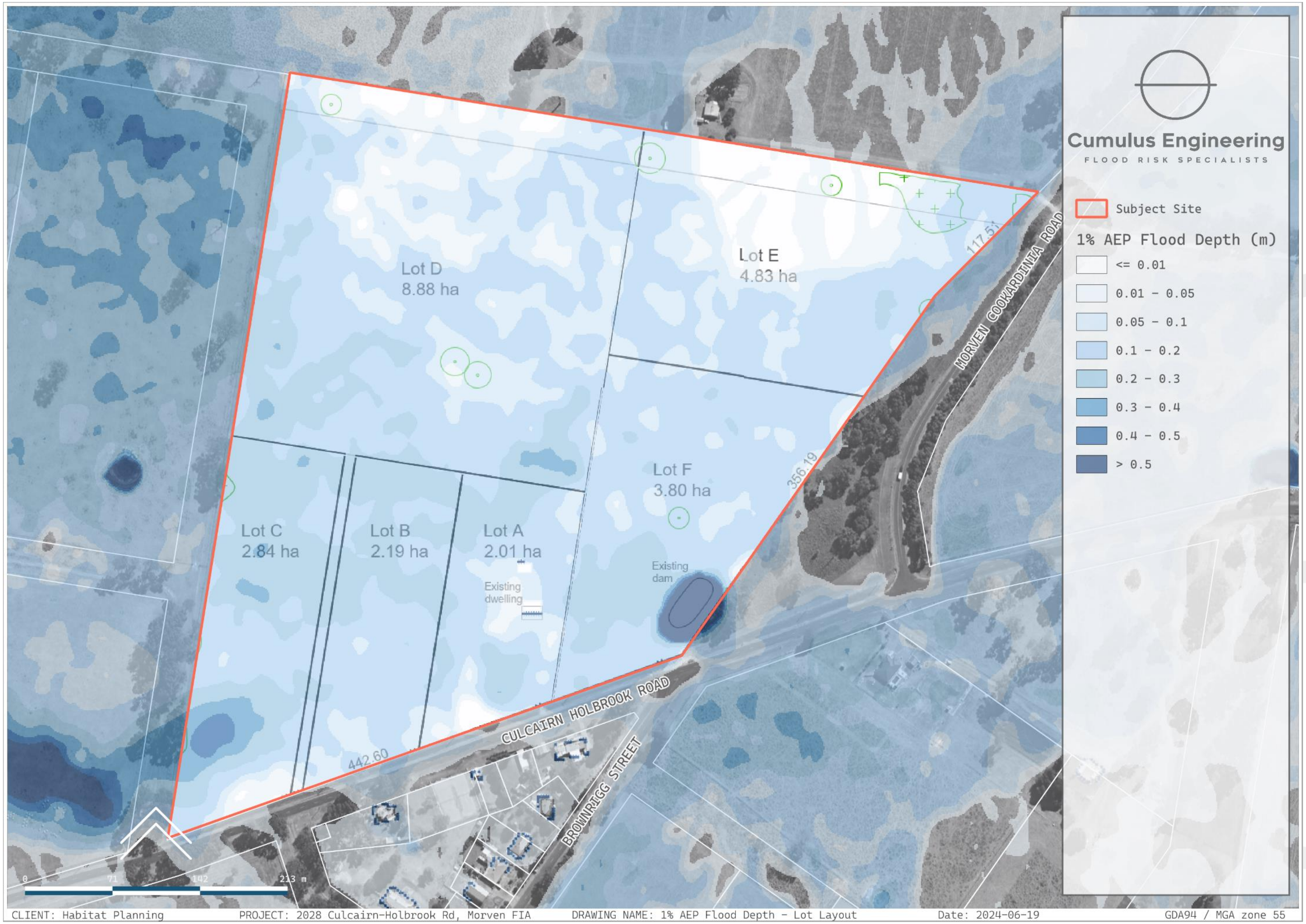


FIGURE 3-6 1% AEP FLOOD DEPTHS - EXISTING CONDITION WITH PROPOSED LOT LAYOUT

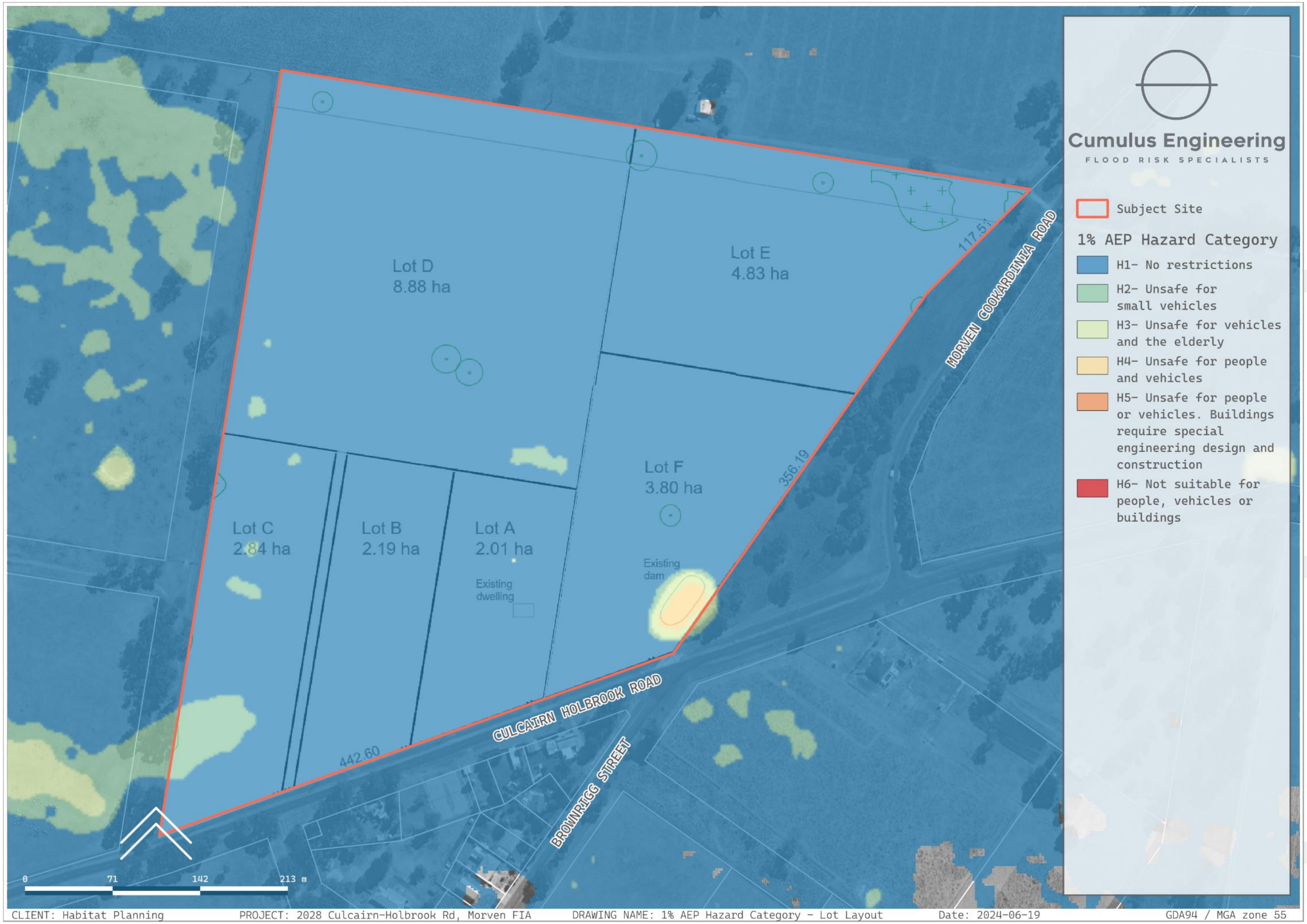


FIGURE 3-7 1% AEP HAZARD - EXISTING CONDITION

4 Authority Requirements

4.1 Flood Planning Area

Typically, the Flood Planning Area (FPA) is developed based on the Flood Planning Level (FPL) for a typical residential development and includes the 1% AEP flood extent plus freeboard of 0.5 metres.

From previous studies completed within the region, adoption of the typical FPA criteria is not considered appropriate for shallow overland flows characterised as sheet flow as adoption of the criteria would result in a significant area which includes areas outside of even the PMF extent which represents land not subject to flood risk in even the most extreme event modelled.

To account for sheet flow in the catchment the following criteria has been considered as appropriate for determination of the FPA which is consistent with the approach adopted within similar catchments:

- 1% AEP flood extent excluding areas with depths of less than 150 mm
- 1% AEP Floodway (including areas with depths less than 150 mm)
- 1% AEP H5 and H6 Hazard Classification (including areas with depths less than 150 mm).

The resulting FPA is illustrated in Figure 4-2. It should be noted that the suggested FPA presented as part of this assessment is considered high level and indicative only. Development of FPA's particularly those that include wide spread sheet flow should be considered as part of a wider flood study.

4.2 Minimum Floor Level

Table 4-1 provides information on applicable flood levels and recommended minimum floor levels for the subject site. According to Greater Hume Council's Development Control Plan (DCP) Section 2.4.1, the recommended minimum floor levels are 600mm above the natural ground level however there are no specific requirements for the exact value of freeboard based on flood levels within the LEP and DCP. Based on available information and previous correspondence with council and DCCEEW, we recommended setting the minimum flood level to 500mm above the 1% AEP flood level, i.e. 500mm freeboard.

TABLE 4-1 MINIMUM FLOOR LEVEL RECOMMENDATIONS

Applicable 1% Flood Level (mAHD)	Recommended Finished Floor Level (mAHD)
To be confirmed once location of building pads known	500mm above applicable flood level

4.3 Flood Function

Based on previous criteria applied to the Culcairn, Henty, Holbrook Flood Studies (GHC, 2013) and given the rural nature of the catchment, the flood function for all events were determined using the following criteria:

- **Floodway:** Hazard (VxD) greater than 0.25 m^2/s and velocity > 0.25 m/s OR Velocity >1m/s
- **Flood storage:** Area outside of the floodway which exceed 0.5 metres in depth.
- **Flood Fringe:** Remainder of the flood extent for depths exceeding 10mm and less than 0.5 metres. Removal of islands and some manual smoothing adopted.

Results of the flood function for the 1% AEP event (as illustrated in Figure 4-1) generally shows that the site is located within the flood fringe with the flood way intersecting the western boundary of the site.

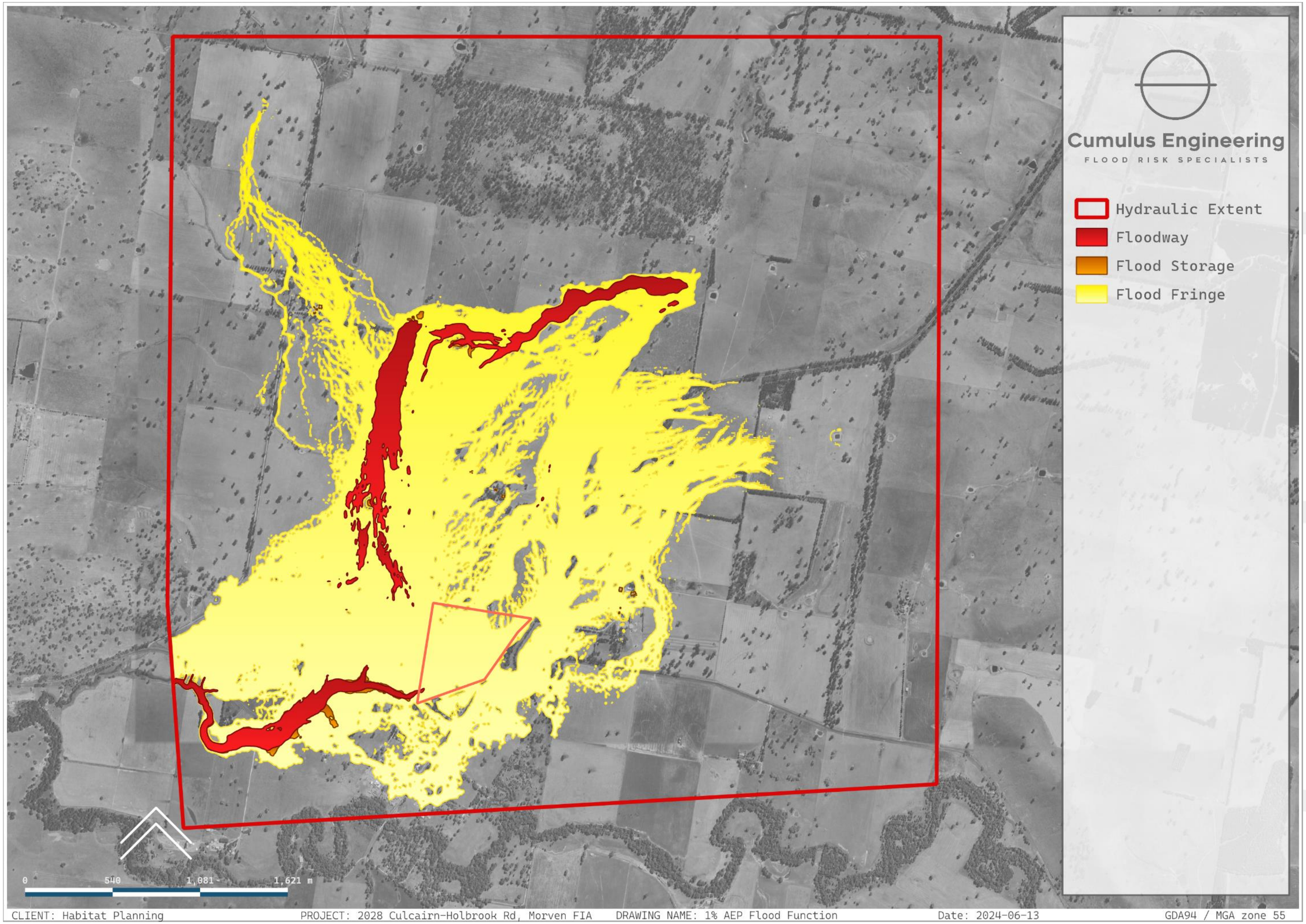


FIGURE 4-1 FLOOD FUNCTION – 1% AEP EVENT

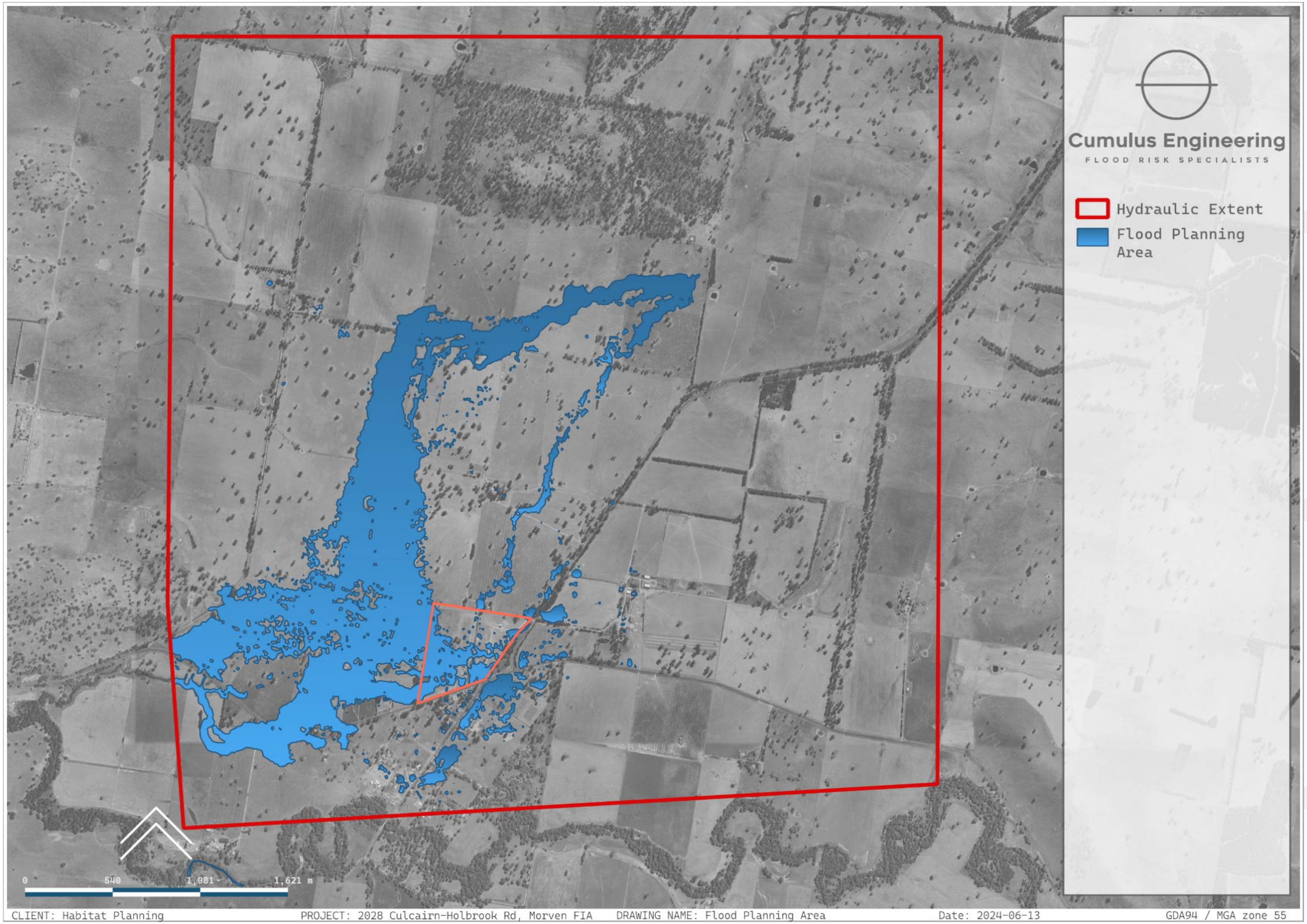


FIGURE 4-2 FLOOD PLANNING AREA (ADOPTING FPA CRITERIA)

5 Conclusions & Recommendations

Cumulus Engineering have undertaken a Flood Impact & Risk Assessment for the site located at 2028 Culcairn-Holbrook Road, Morven to determine potential impacts to overland flows, depths, and residents due to the proposed development.

A newly constructed hydrologic RORB model was used to provide hydrographs for inflows to a newly constructed hydraulic TUFLOW model, which including upstream catchments, that were both utilised to assess the impact of the flood behaviour around and downstream of the subject site.

The investigation has demonstrated that:

- The flood depths and hazards are generally low across the site, and it is concluded that the proposed low-density residential development is appropriate from a floodplain management perspective, provided that the recommended flood mitigation measures, such as minimum floor levels, are implemented.
- A freeboard of 500mm above the applicable 1% AEP flood level is recommended for the proposed dwelling. Specific levels can be provided once building footprint locations are known.
- A sensitivity analysis on Billabong Creek has been conducted and shows that the site is not impacted in the 1% AEP by Billabong Creek.

Please do not hesitate to contact us if you have any questions regarding this report.

Kind regards,

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Appendix A. Hydraulic Model Setup

A1. Model Summary

A summary of the TUFLOW Model is presented in Table A 1.

TABLE A 1 HYDRAULIC MODEL PARAMETERS

Modelling Component / Assumptions	Comment
Model Engine	TUFLOW HPC GPU
Model Build	2023-03-AC-iSP-w64
2D Topography	5m LiDAR captured in 2014, owned by the NSW Government. LiDAR is displayed within Figure A-3.
2D Grid Size	2 metres
Inflow Boundary Conditions	2D Inflow – Local Catchment - Source Area 'direct rainfall' applied as hydrograph representing flows contributing from upstream catchments (see 2D Inflow boundaries illustrated in Figure 3-1) - Applied rainfall excess hyetographs extracted from each of the RORB Subareas to all cells equally (2d_sa_all) for subarea's located wholly within the model extent (see 2d Areal Rainfall Inflow illustrated in Figure 3-1)
Downstream Boundary Condition	HQ (water-discharge boundary) at all other downstream boundaries adopting respective slope upstream of boundary location.
Roughness	Standard ARR2019 values applied, detailed in Table B-2
2D Outputs	Water levels, depths, velocity, hazard (ZAEM1)

A2. Model Extent & Boundary Conditions

The model extent was determined by the catchment delineation completed as part of the hydrologic analysis (as illustrated in Figure 2-2).

Inflows were applied to the model as rainfall excess hyetographs for the respective event (i.e., 5%, 1% and 0.5% AEP and PMF events) which were extracted from each of the RORB subareas completed as part of the hydrologic analysis. The 2D inflow was applied to the model as a Source-Area boundary which evenly distributes the subarea hyetograph to all cells equally (2d_sa_all).

An HQ type boundary condition was implemented at the downstream boundary of the model with a slope of 0.019, derived from the elevation data and distances between points along the downstream boundary with elevation data obtained from LiDAR.

A3. Topography

The Digital Elevation Model (DEM) has been constructed using 5 metre LiDAR which was captured in 2014 by NSW Government – Spatial Services. The 2014 LiDAR is the most recent elevation data that was available. Generally, the LiDAR was considered an appropriate representation of the land surface and no further modifications were made to the surface. Model topography is illustrated in Figure A 3.

A4. Mannings Roughness Values

The area is a mix of large open pervious areas (grasslands and paddocks) and rural low density residential land, divided by two major roads, Culcairn Holbrook Road and Morven-Cookardinia Road

Values of Manning's roughness were adopted as per ARR19 guideline recommendations with values outlined in Table A 2.

TABLE A 2 ADOPTED MANNING'S N ROUGHNESS

Land Use	Adopted Manning's n
Residential: Rural (Lower Density) when buildings footprints and remainder of parcel are modelled together	0.15
Open Pervious Area – Minimal Vegetation	0.04
Open Pervious Area – Moderate Vegetation	0.06
Open Pervious Area – Heavy Vegetation	0.10
Waterway/Channel – Minimal Vegetation	0.03
Driveway / Car Park / Roadway	0.03

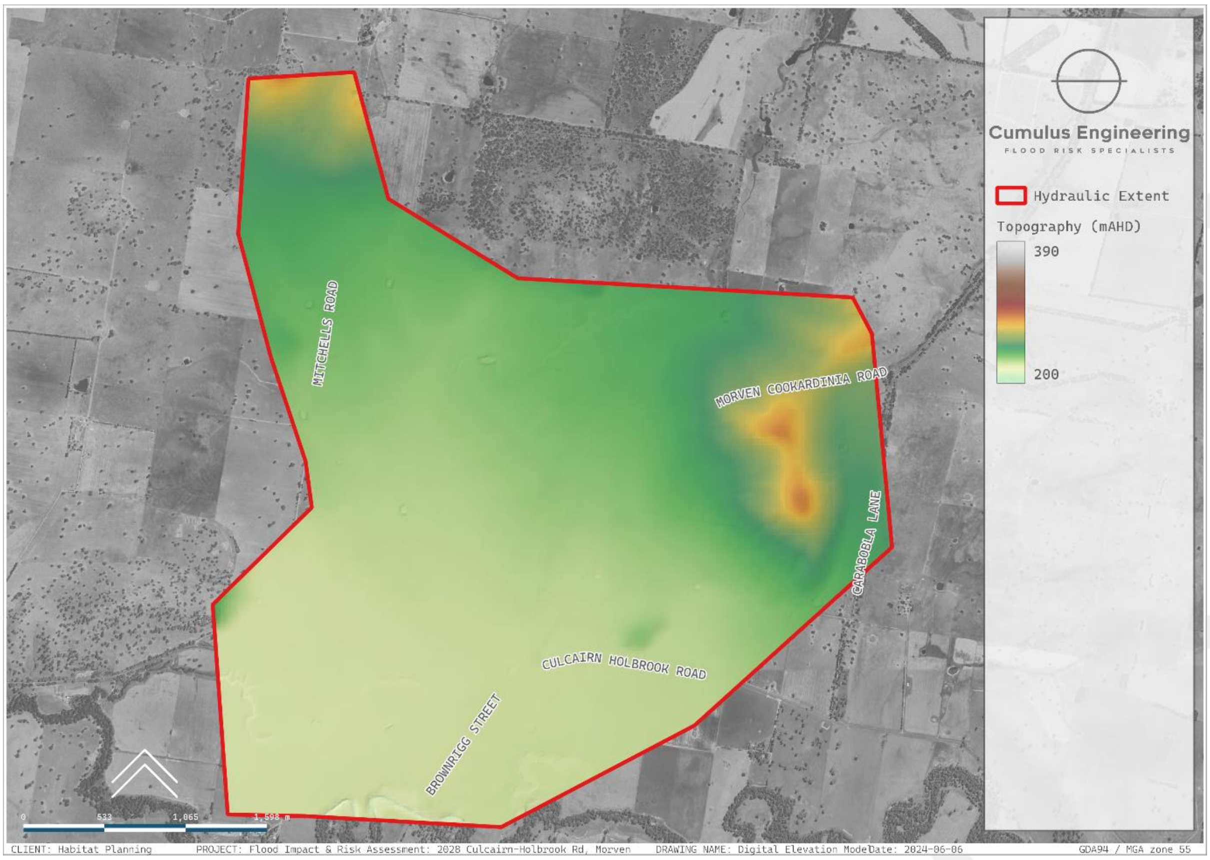
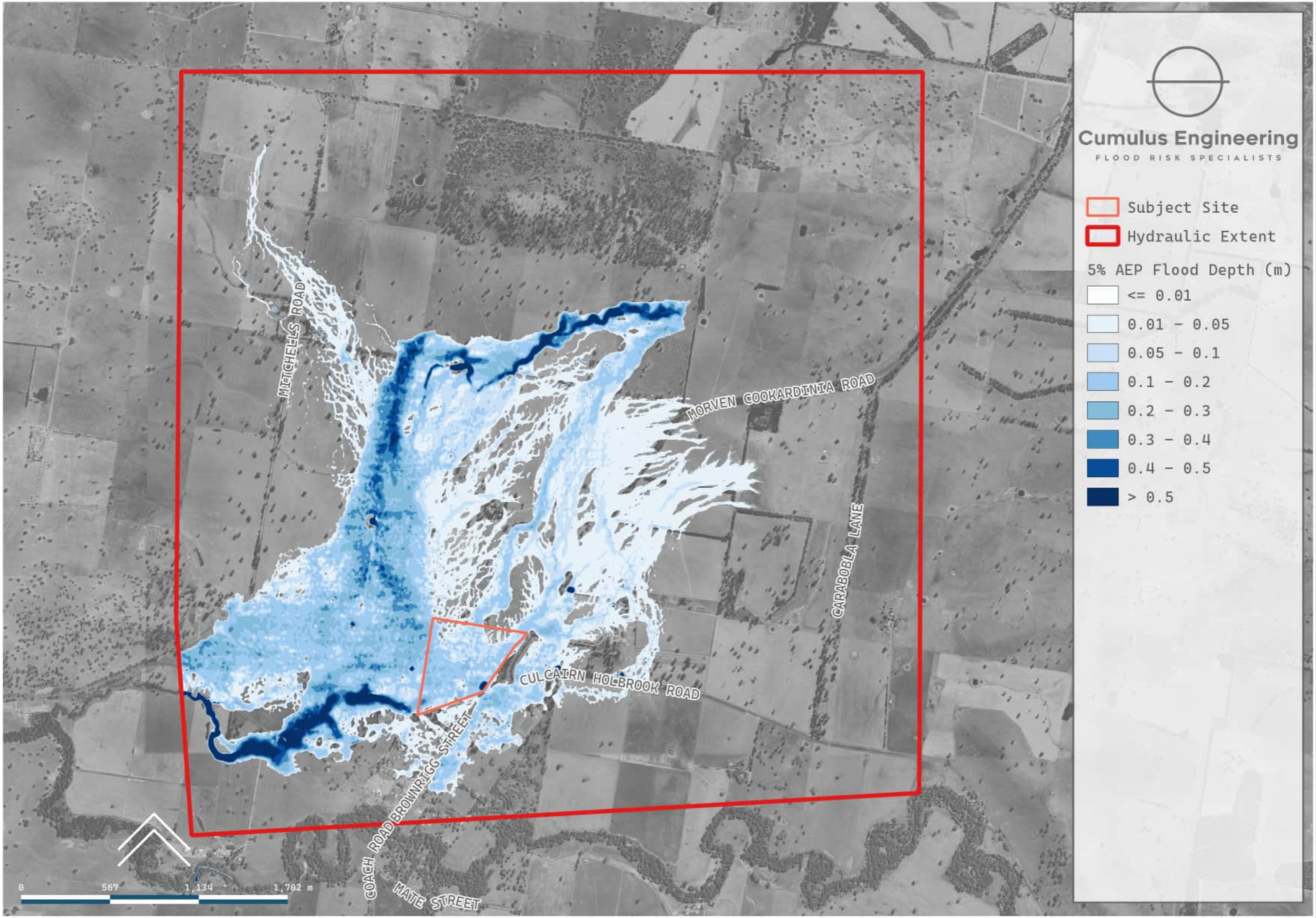
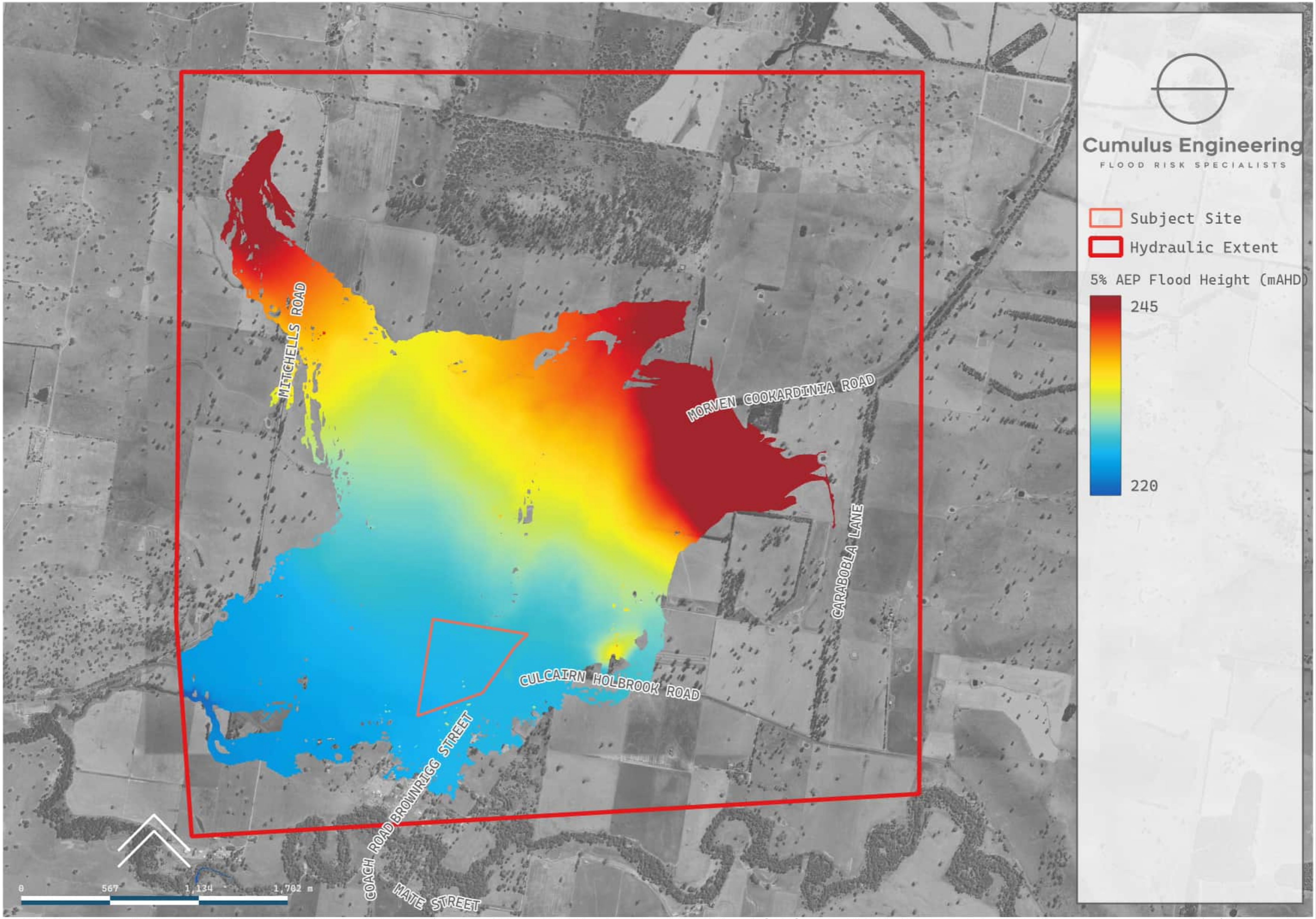


FIGURE A 3 DIGITAL ELEVATION MODEL - EXISTING CONDITION

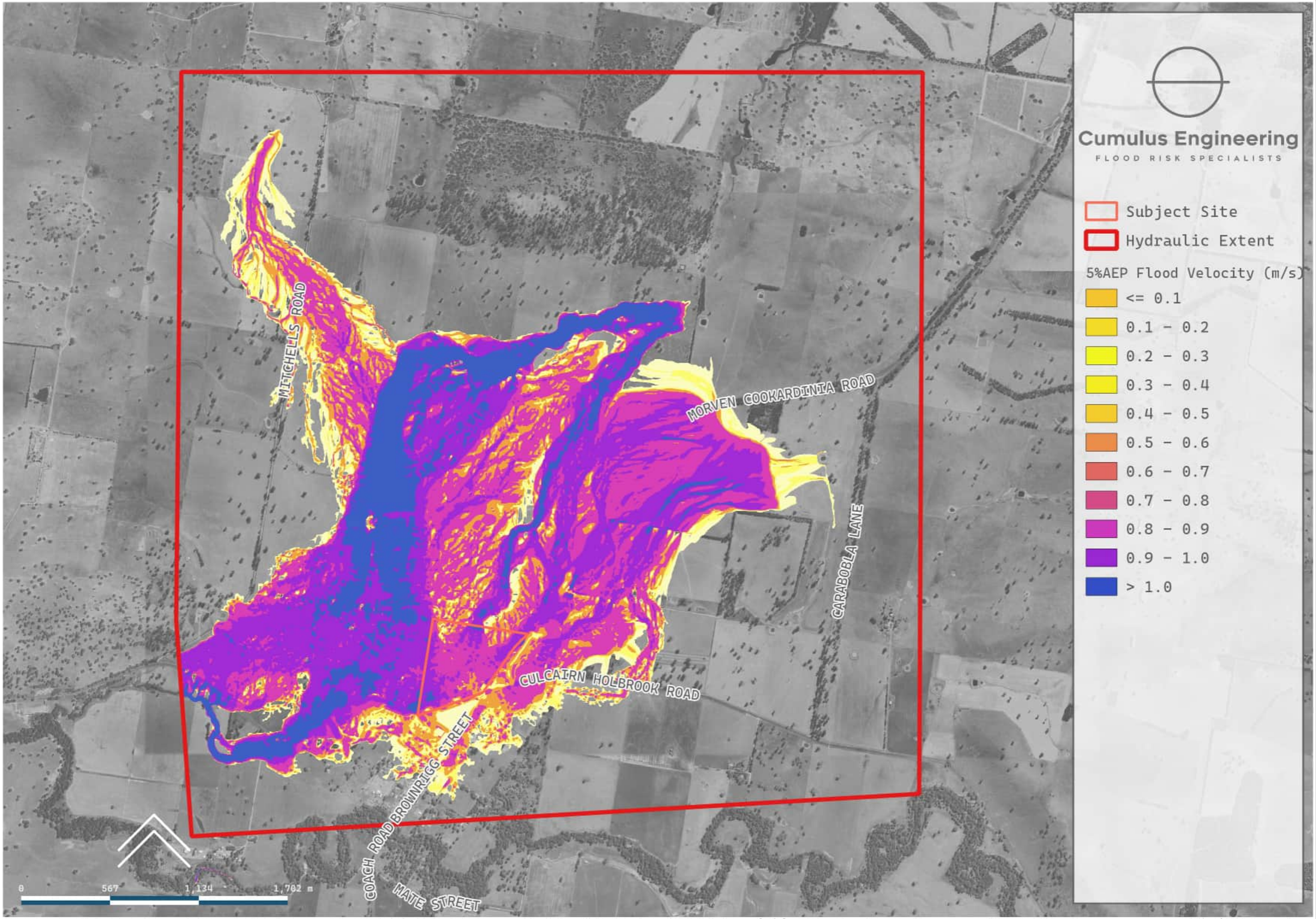
Appendix B. Flood Maps

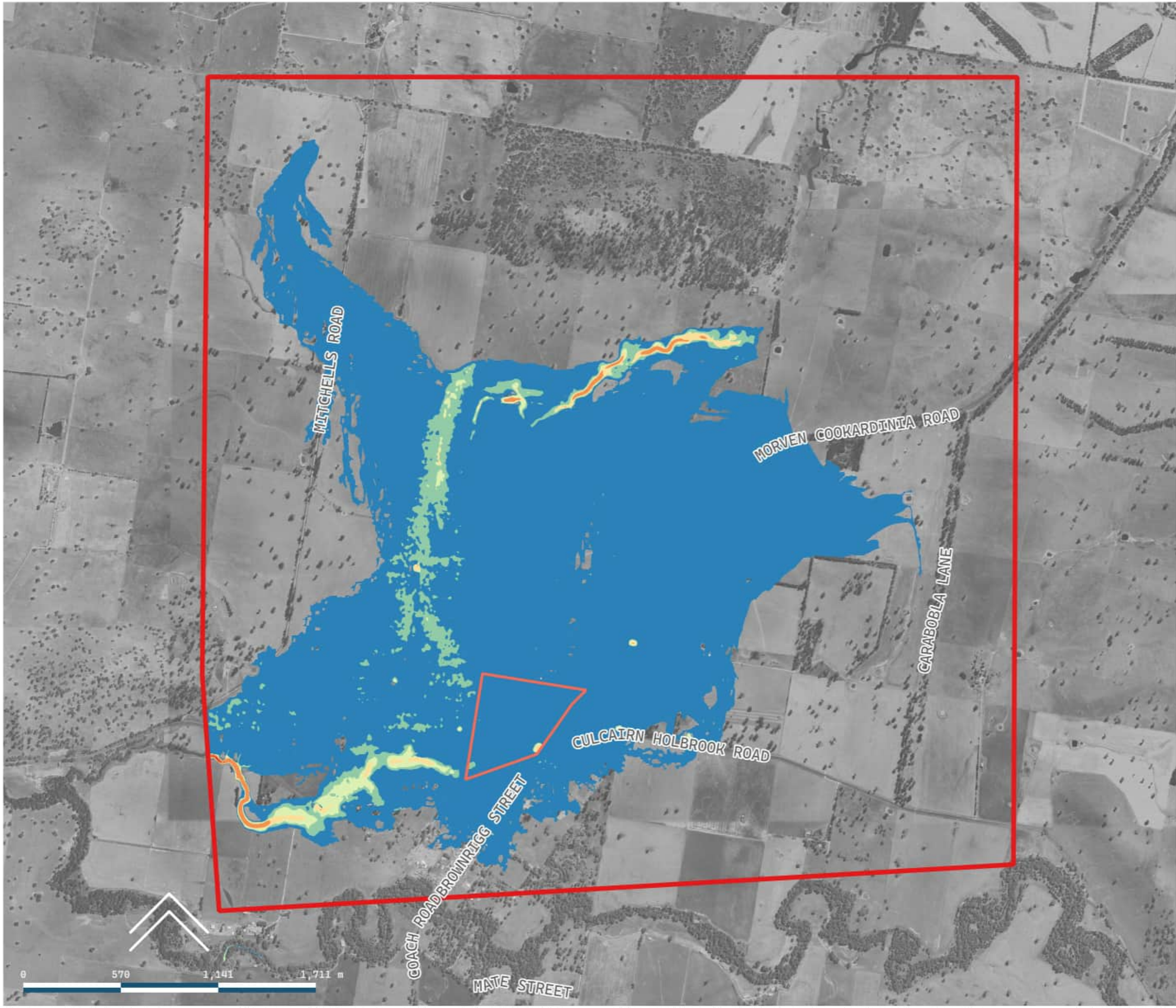


CLIENT: Habitat Planning PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA DRAWING NAME: 5% AEP Flood Depth - Existing Conditions Date: 2024-06-13 GDA94 / MGA zone 55



CLIENT: Habitat Planning PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA DRAWING NAME: 5% AEP Flood Height (mAHD) - Existing Conditions Date: 2024-06-13 GDA94 / MGA zone 55


Cumulus Engineering
FLOOD RISK SPECIALISTS
Subject Site
Hydraulic Extent
5%AEP Flood Velocity (m/s)
<= 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1.0
> 1.0
MITCHELLS ROAD
MORVEN COOKARDINIA ROAD
CARABOBLA LANE
CULCAIRN HOLBROOK ROAD
BROWNRIGG STREET
COACH ROAD
HATE STREET
0
567
1,134
1,702 m



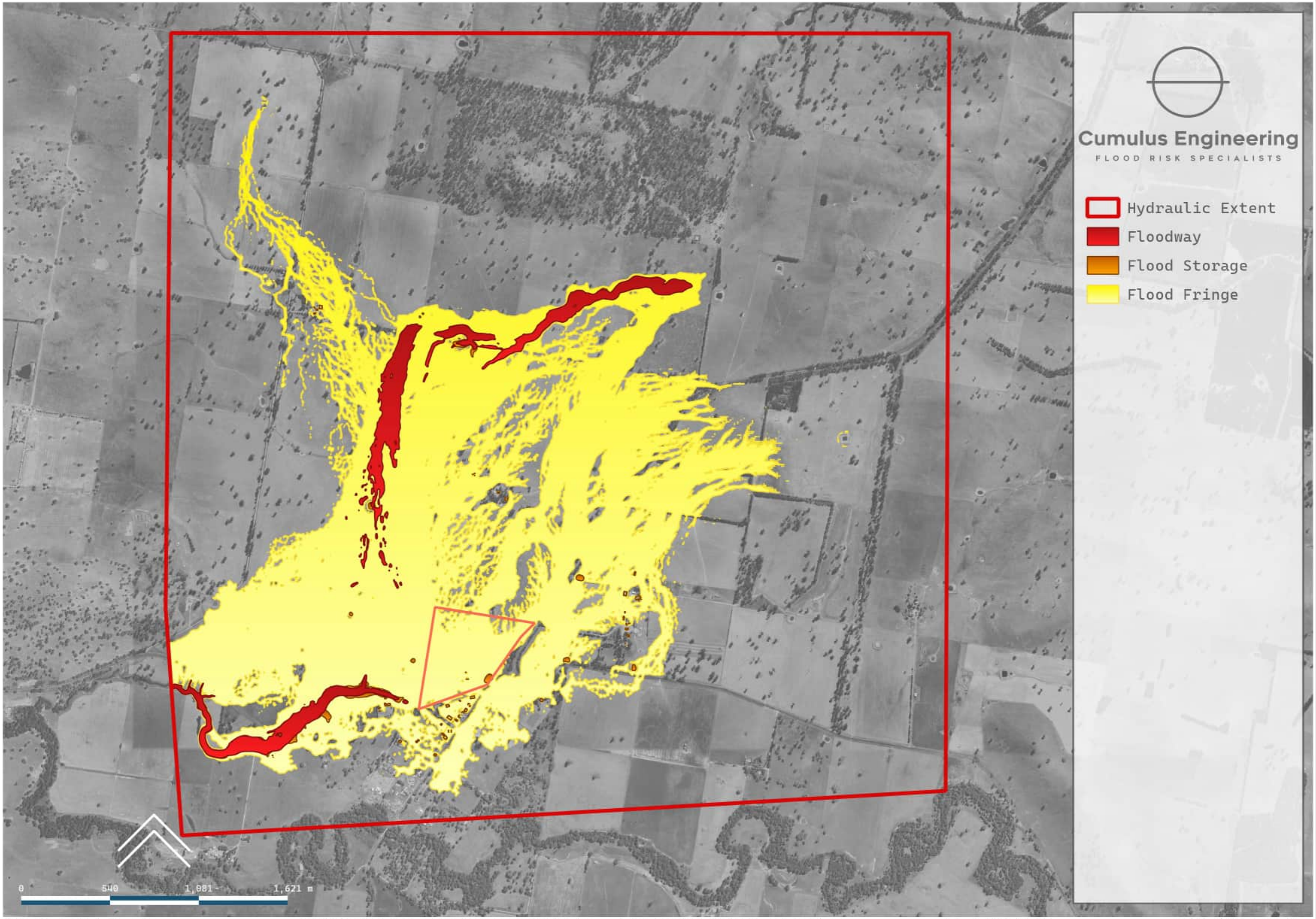
Cumulus Engineering
FLOOD RISK SPECIALISTS

Subject Site
Hydraulic Extent

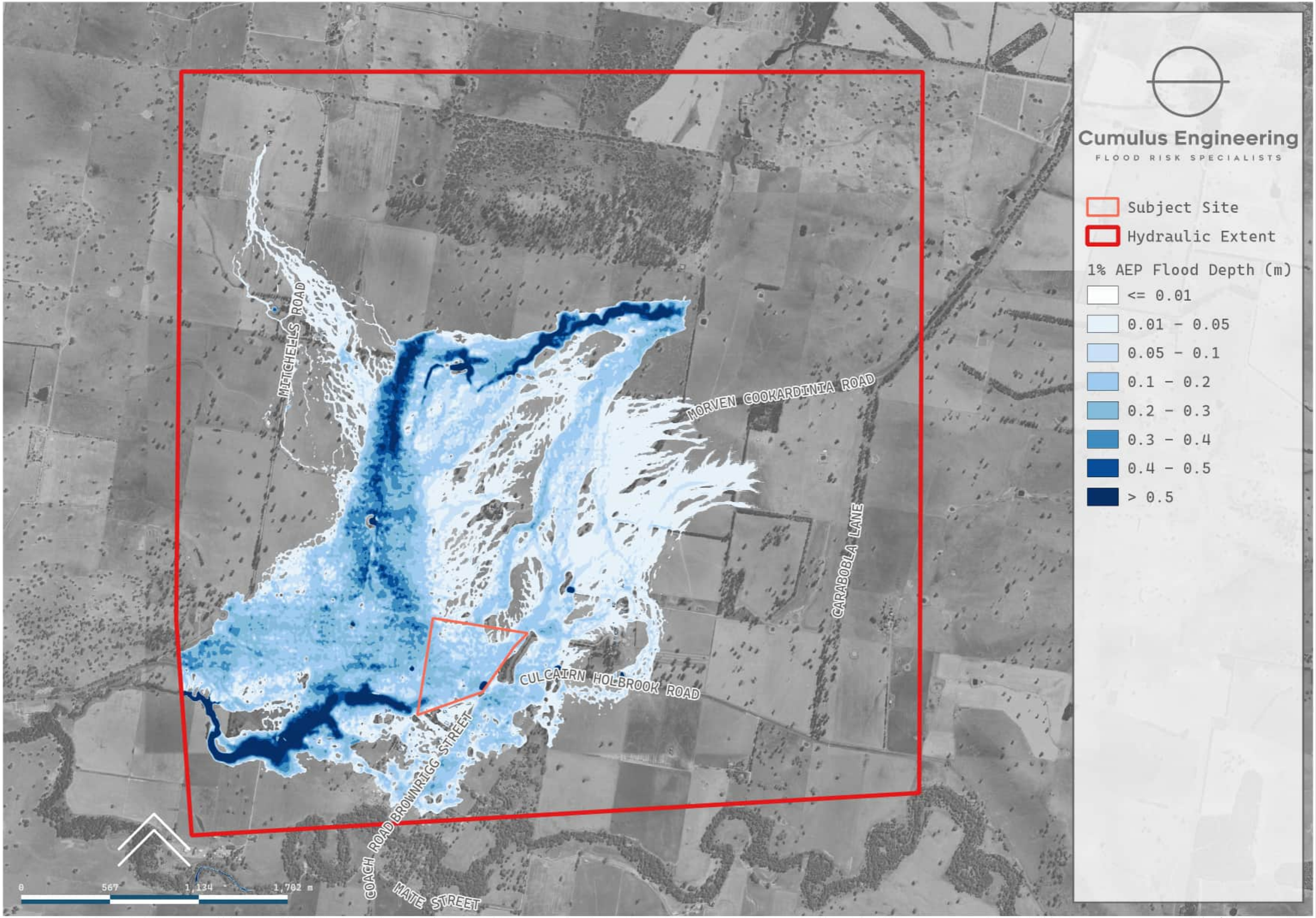
5% AEP Flood Category

H1- No restrictions
H2- Unsafe for small vehicles
H3- Unsafe for vehicles and the elderly
H4- Unsafe for people and vehicles
H5- Unsafe for people or vehicles. Buildings require special engineering design and construction
H6- Not suitable for people, vehicles or buildings

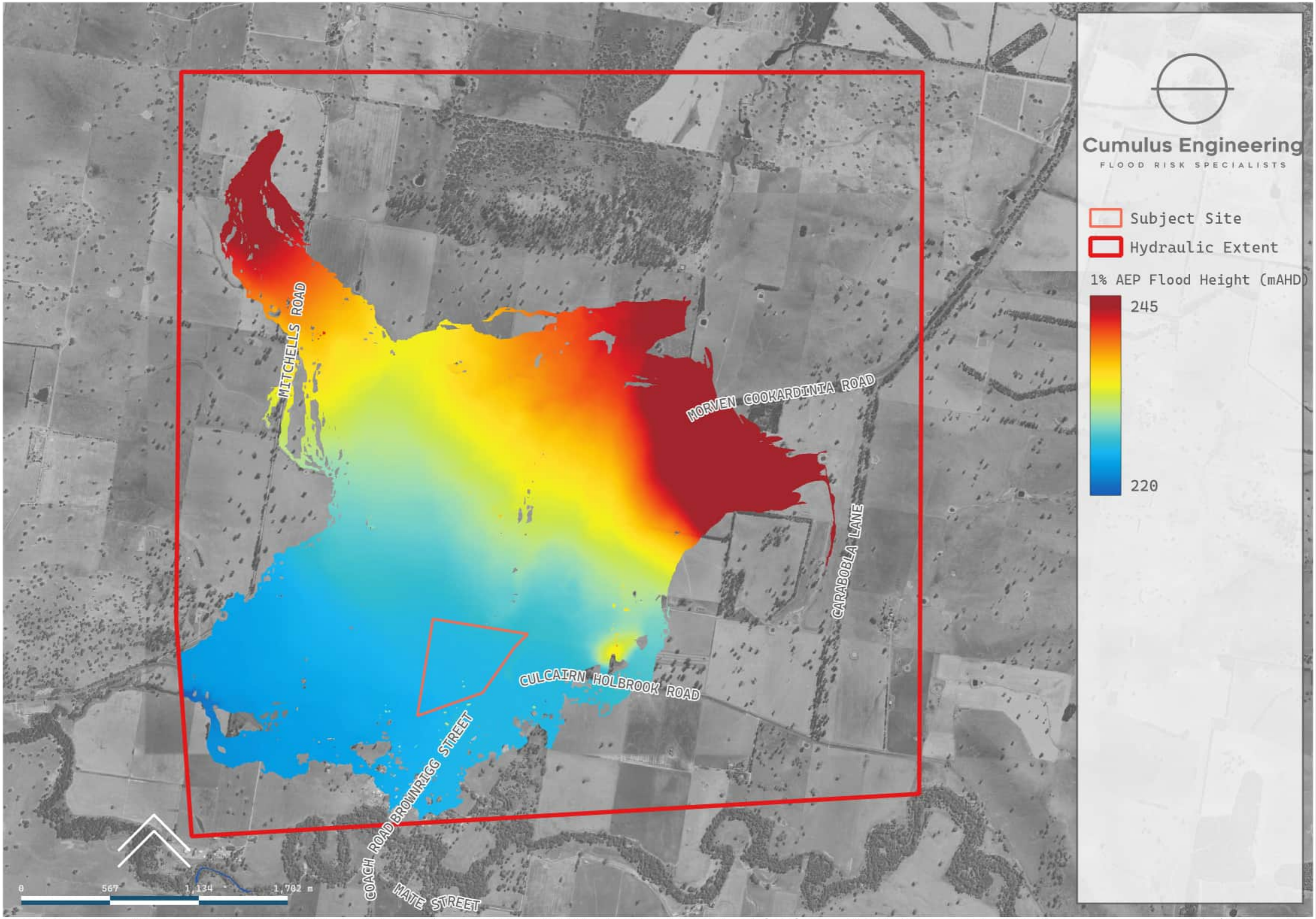
CLIENT: Habitat Planning | PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA | DRAWING NAME: 5% AEP Flood Hazard - Existing Conditions | Date: 2024-06-13 | GDA94 / MGA zone 55



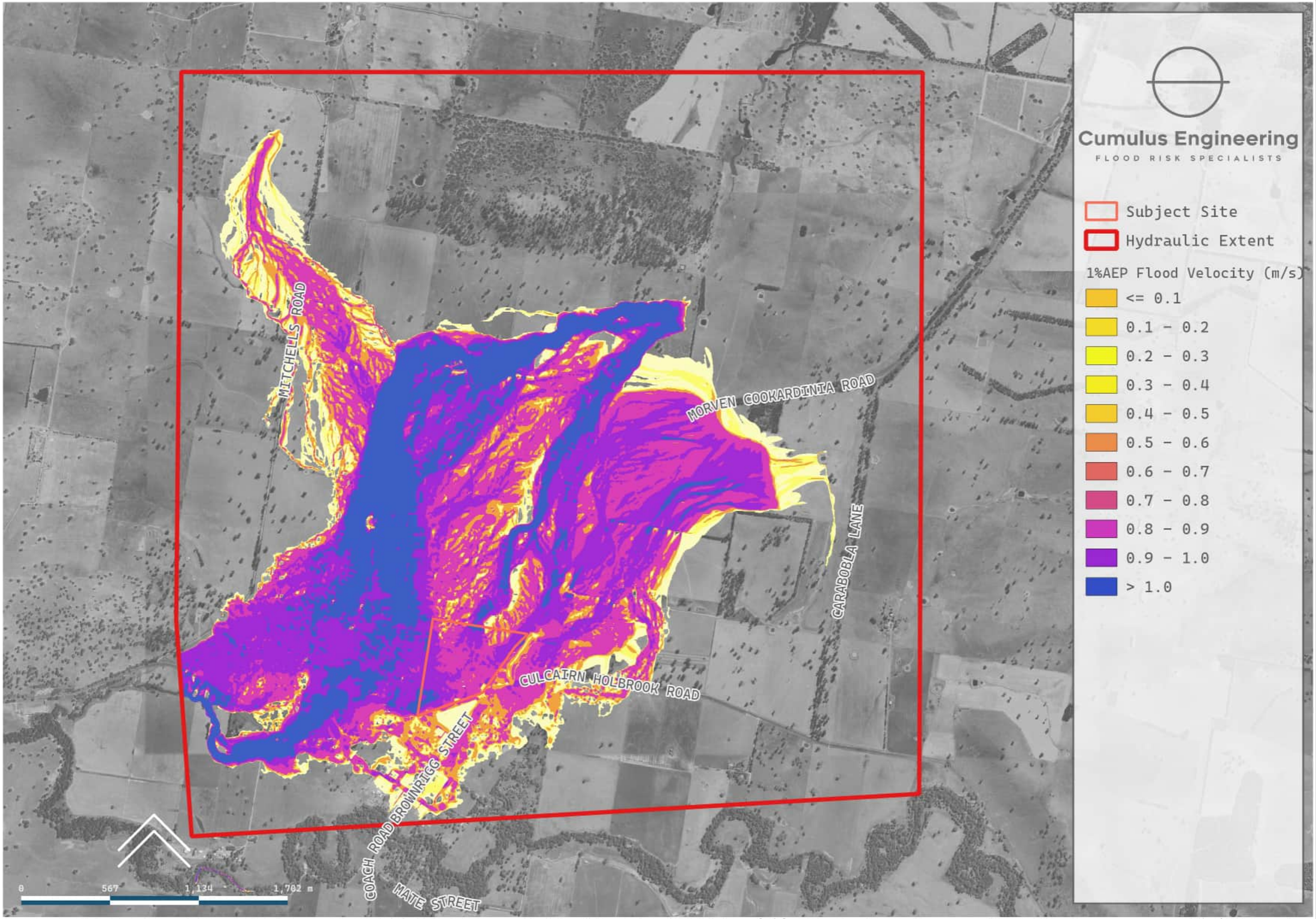
CLIENT: Habitat Planning PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA DRAWING NAME: 5% AEP Flood Function Date: 2024-06-13 GDA94 / MGA zone 55

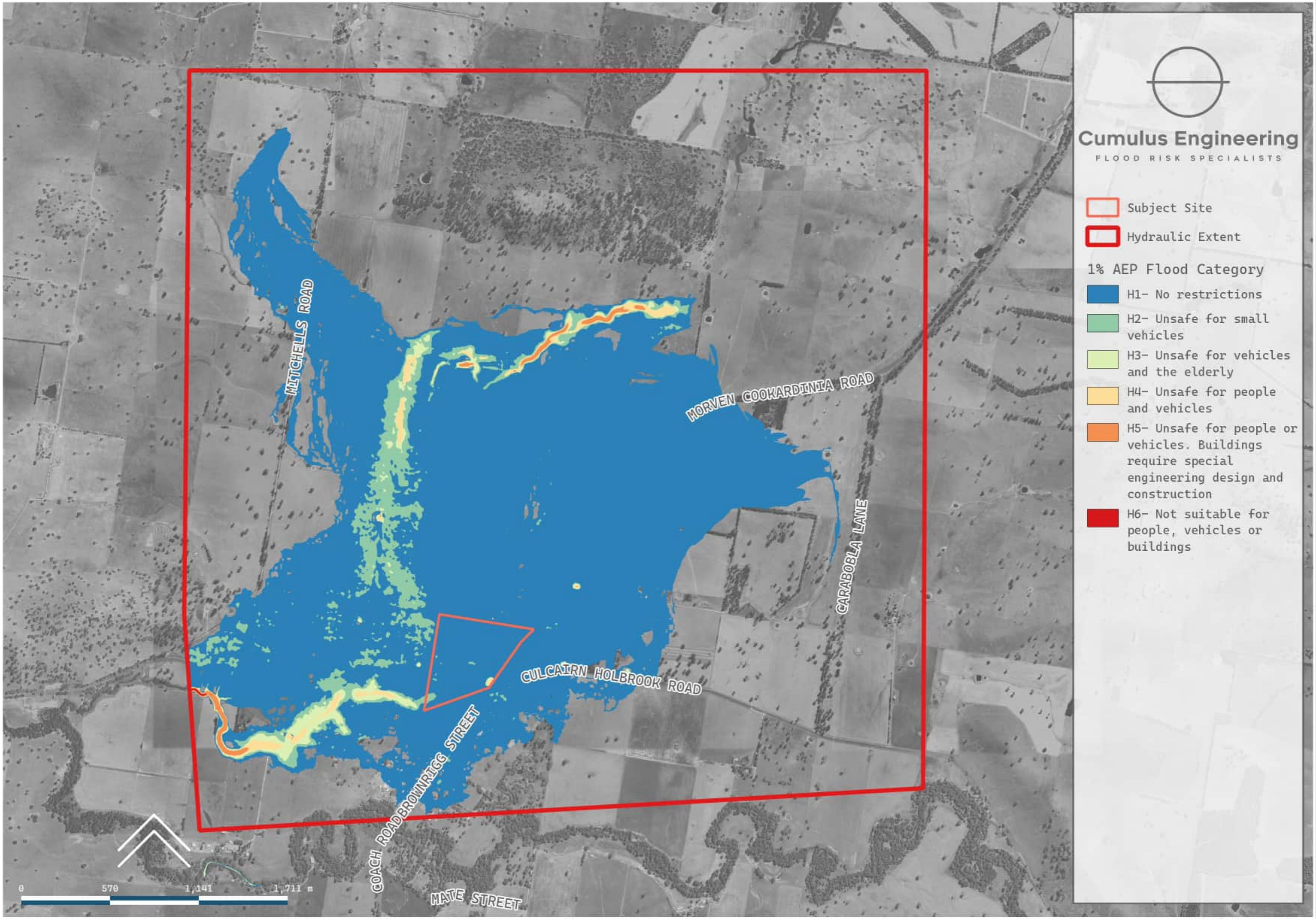


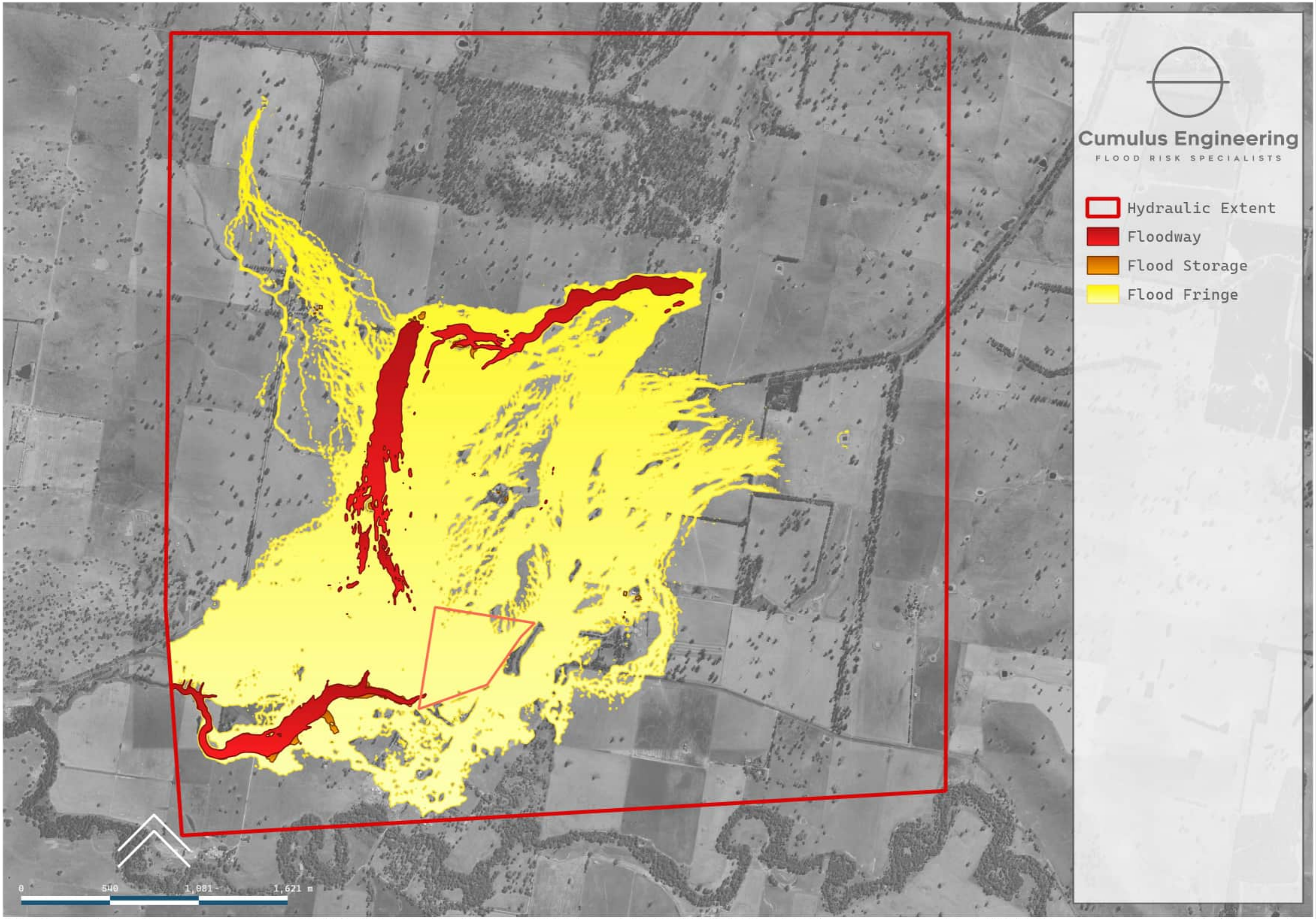
CLIENT: Habitat Planning | PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA | DRAWING NAME: 1% AEP Flood Depth - Existing Conditions | Date: 2024-06-13 | GDA94 / MGA zone 55



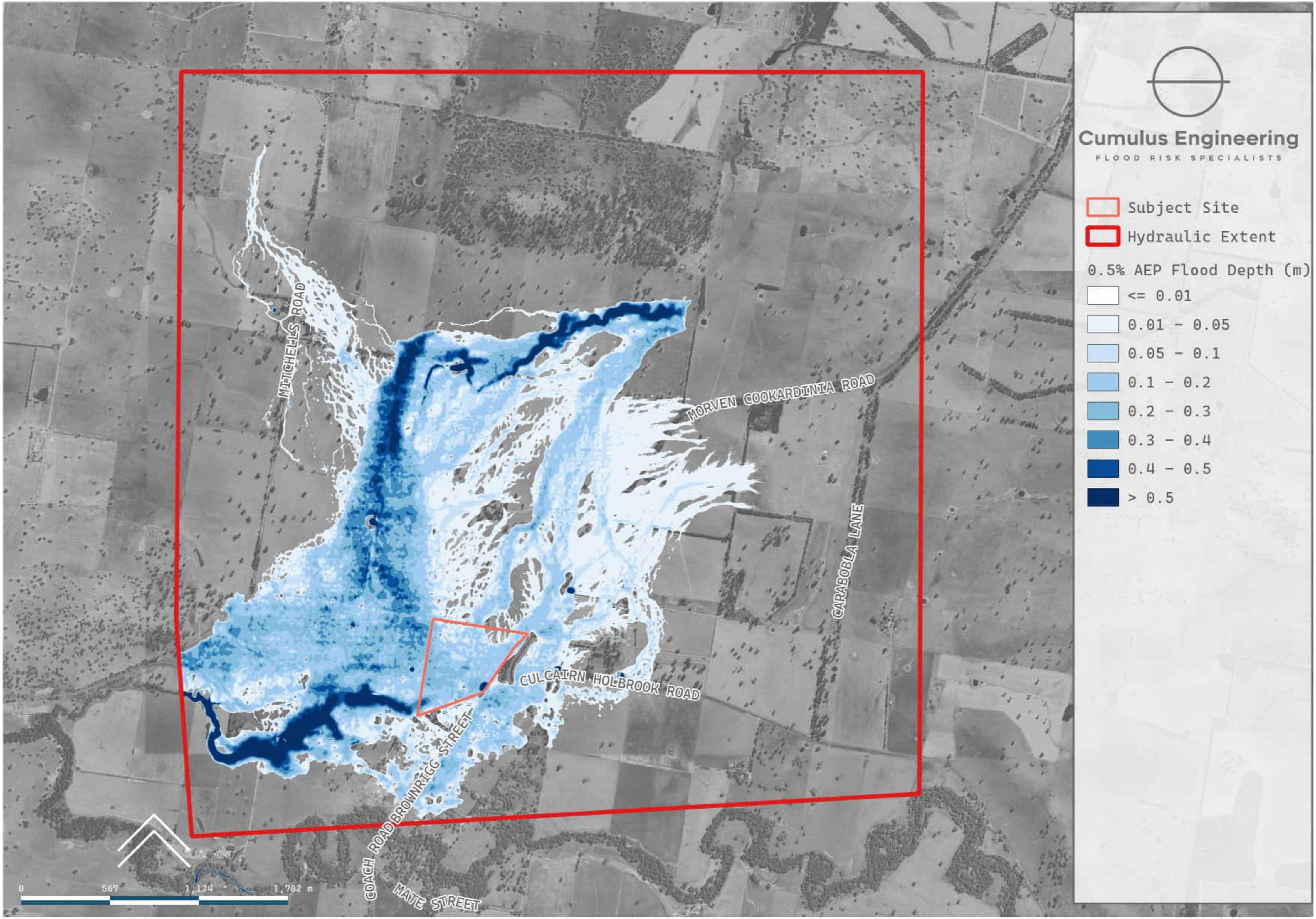
CLIENT: Habitat Planning PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA DRAWING NAME: 1% AEP Flood Height (mAHD) - Existing Conditions Date: 2024-06-13 GDA94 / MGA zone 55

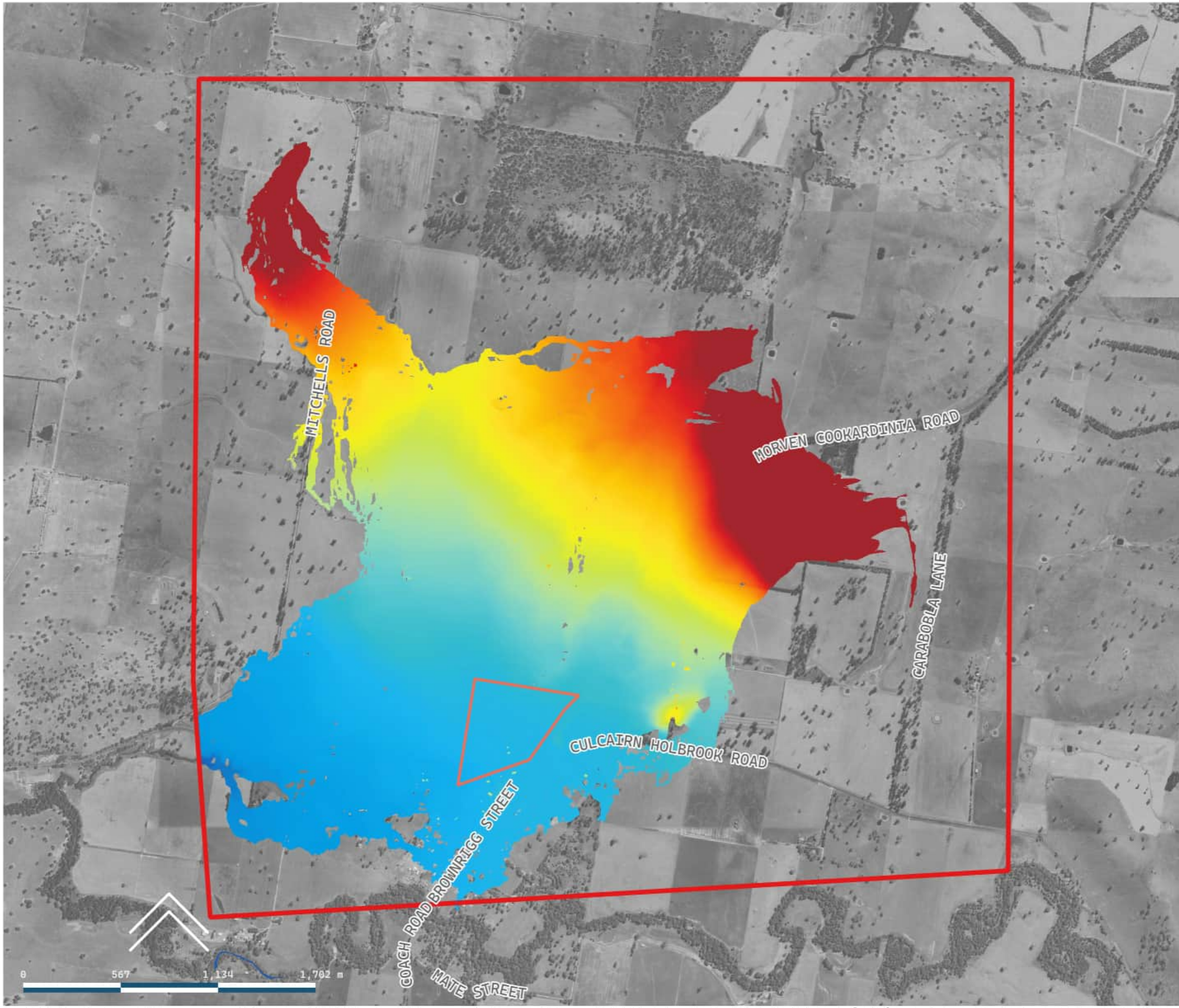

Cumulus Engineering
FLOOD RISK SPECIALISTS
Subject Site
Hydraulic Extent
1%AEP Flood Velocity (m/s)
<= 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1.0
> 1.0
MITCHELLS ROAD
MORVEN COOKARDINIA ROAD
CARABOBLA LANE
CULCAIRN HOLBROOK ROAD
BROWNRIGG STREET
COACH ROAD
MATE STREET
0
567
1,134
1,702 m


MITCHELLS ROAD
MORVEN COOKARDINIA ROAD
CARABOBLA LANE
CULCAIRN HOLBROOK ROAD
BROWNRIGG STREET
COACH ROAD
MATE STREET
0
570
1,141
1,711 m
Cumulus Engineering
FLOOD RISK SPECIALISTS
Subject Site
Hydraulic Extent
1% AEP Flood Category
H1- No restrictions
H2- Unsafe for small vehicles
H3- Unsafe for vehicles and the elderly
H4- Unsafe for people and vehicles
H5- Unsafe for people or vehicles. Buildings require special engineering design and construction
H6- Not suitable for people, vehicles or buildings



CLIENT: Habitat Planning PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA DRAWING NAME: 1% AEP Flood Function Date: 2024-06-13 GDA94 / MGA zone 55


Cumulus Engineering
FLOOD RISK SPECIALISTS
Subject Site
Hydraulic Extent
0.5% AEP Flood Depth (m)
<= 0.01
0.01 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
> 0.5
MITCHELLS ROAD
MORVEN COOKARDINIA ROAD
CARABOBLA LANE
CULCAIRN HOLBROOK ROAD
BROWNRIGG STREET
COACH ROAD
HATE STREET
0
567
1,134
1,702 m



Cumulus Engineering

FLOOD RISK SPECIALISTS

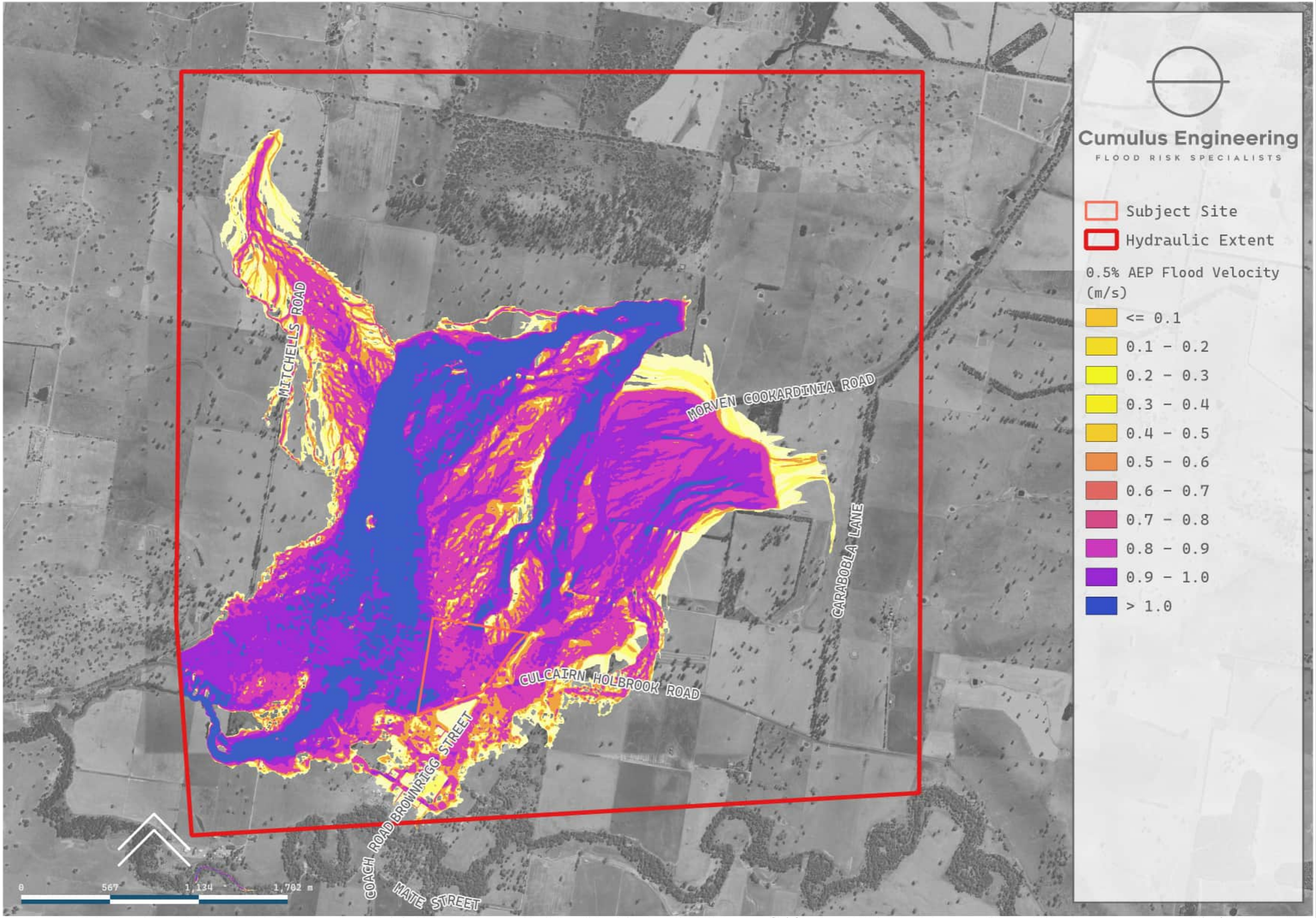
Subject Site

Hydraulic Extent

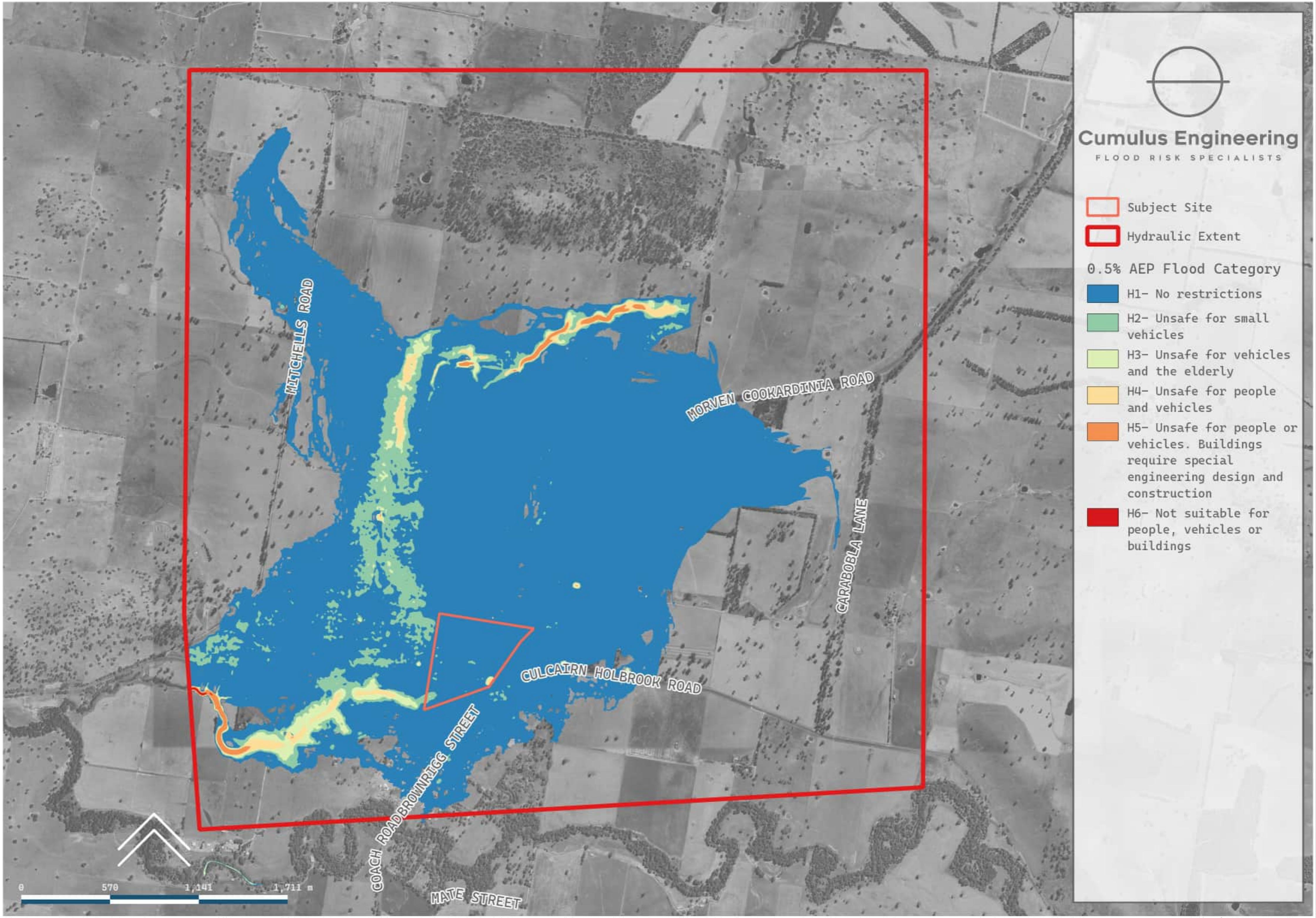
0.5% AEP Flood Height (mAHD)

245

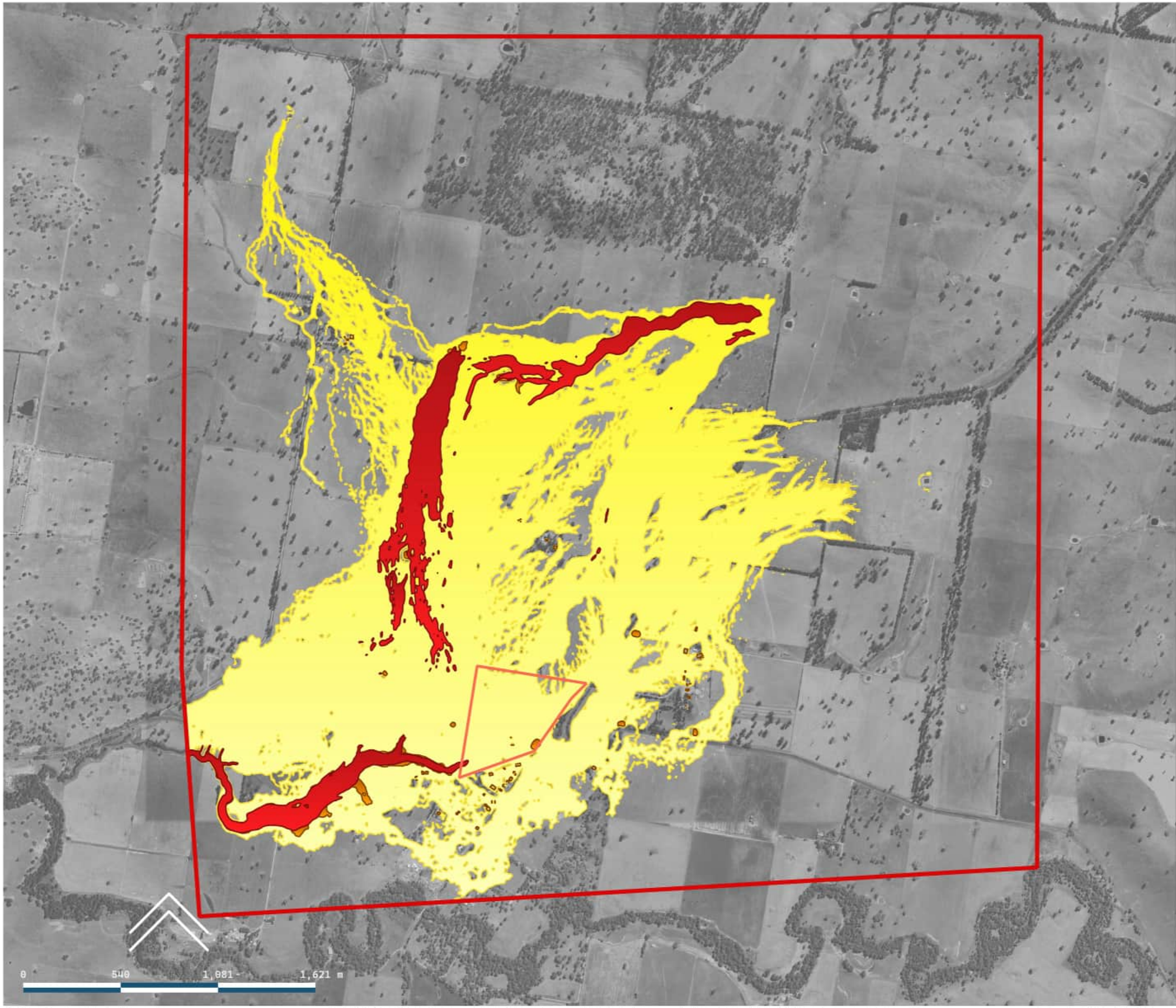
220



CLIENT: Habitat Planning PROJECT: 2028 Culcarin-Holbrook Rd, Morven FIA DRAWING NAME: 0.5% AEP Flood Velocity (m/s) - Existing Conditions Date: 2024-06-13 GDA94 / MGA zone 55

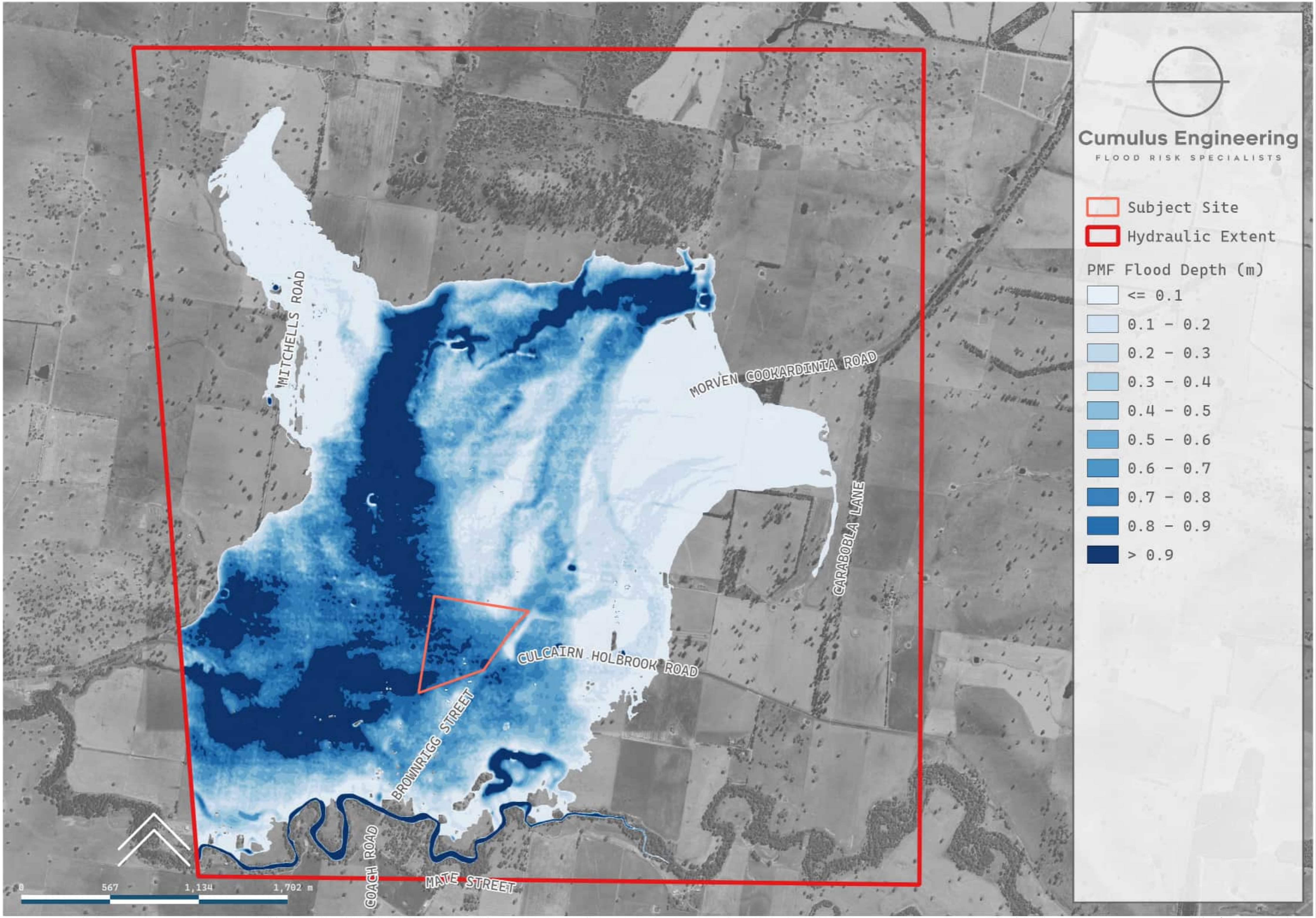


CLIENT: Habitat Planning PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA DRAWING NAME: 0.5% AEP Flood Hazard - Existing Conditions Date: 2024-06-13 GDA94 / MGA zone 55

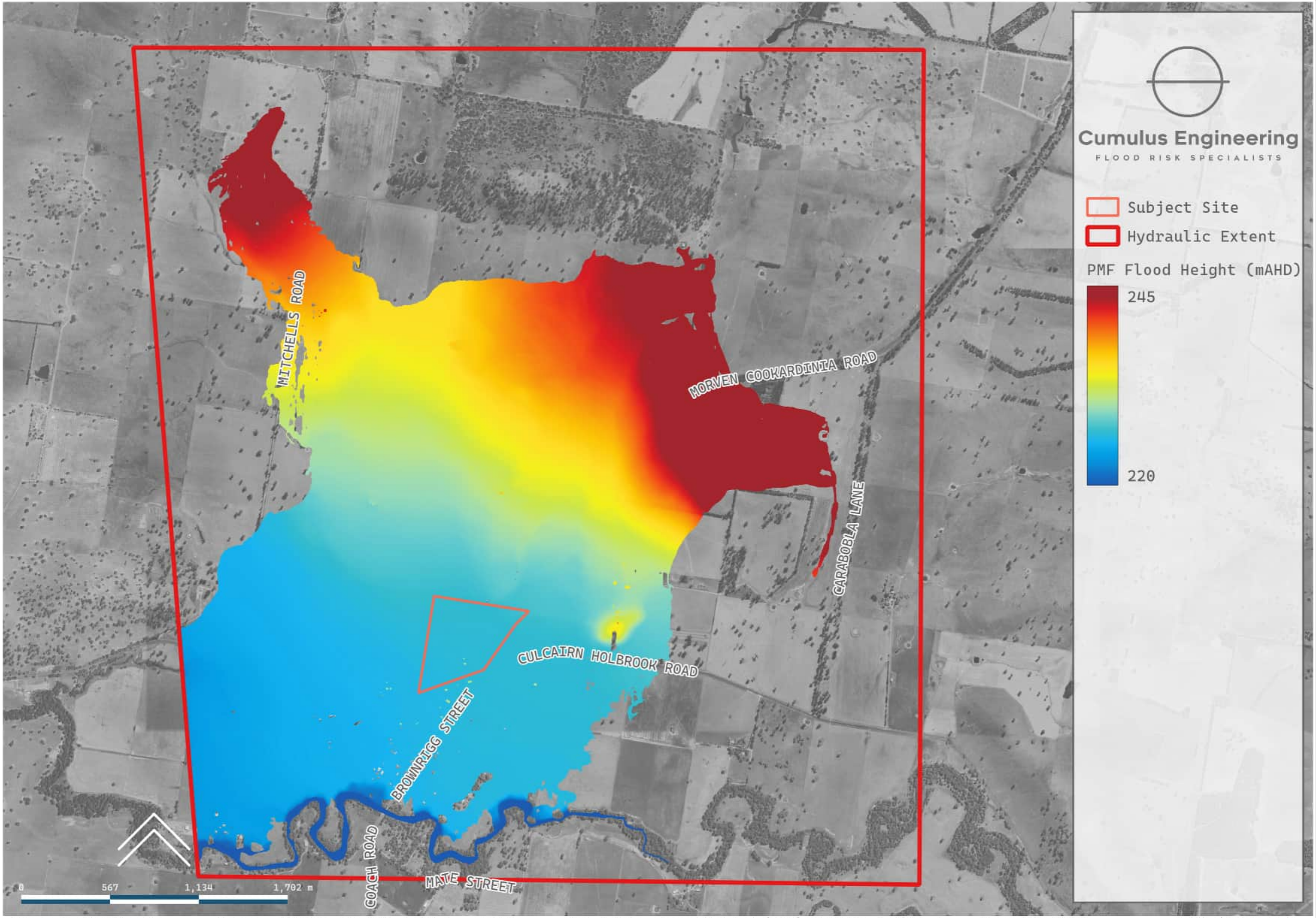


Cumulus Engineering
FLOOD RISK SPECIALISTS

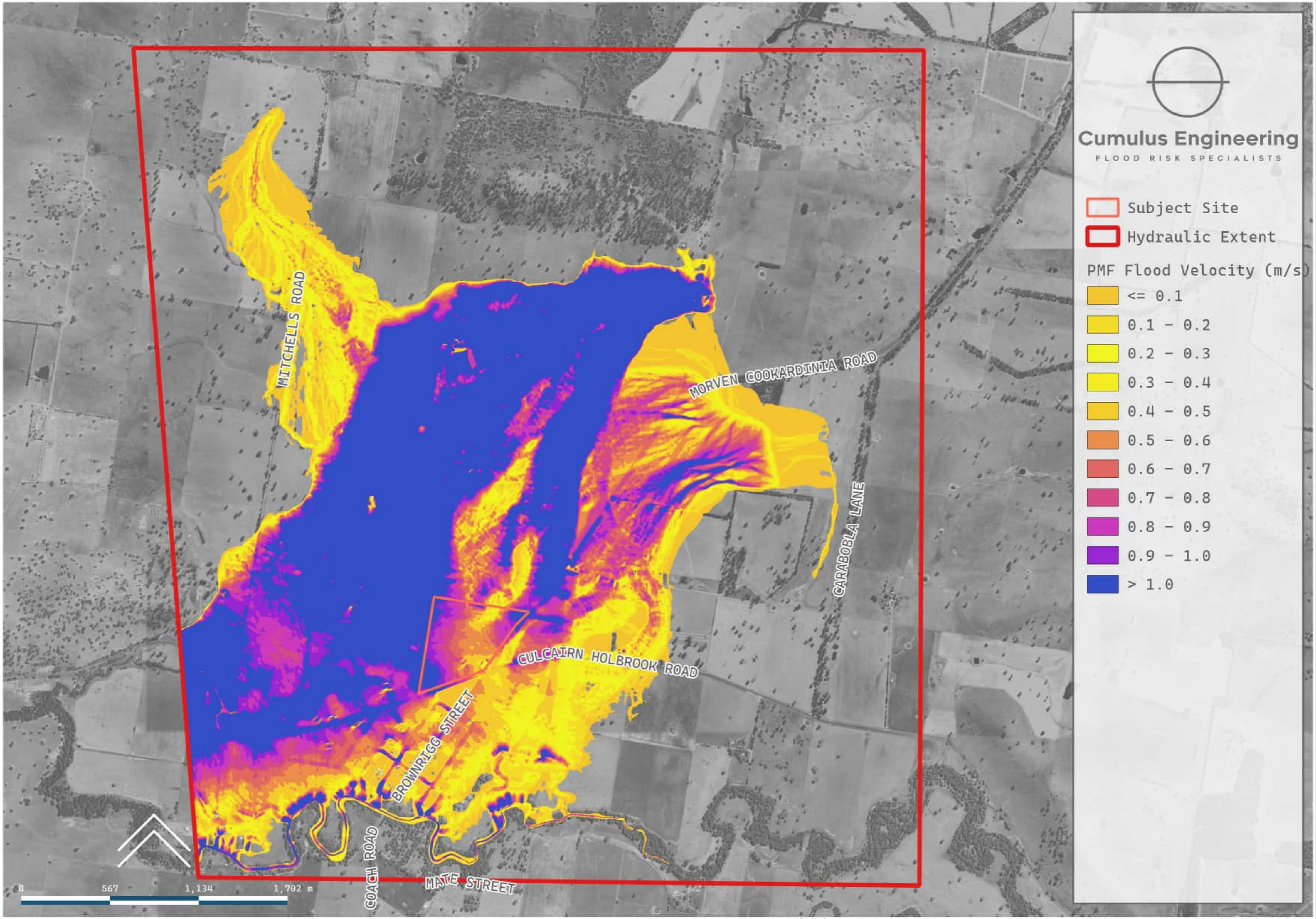
Hydraulic Extent
Floodway
Flood Storage
Flood Fringe



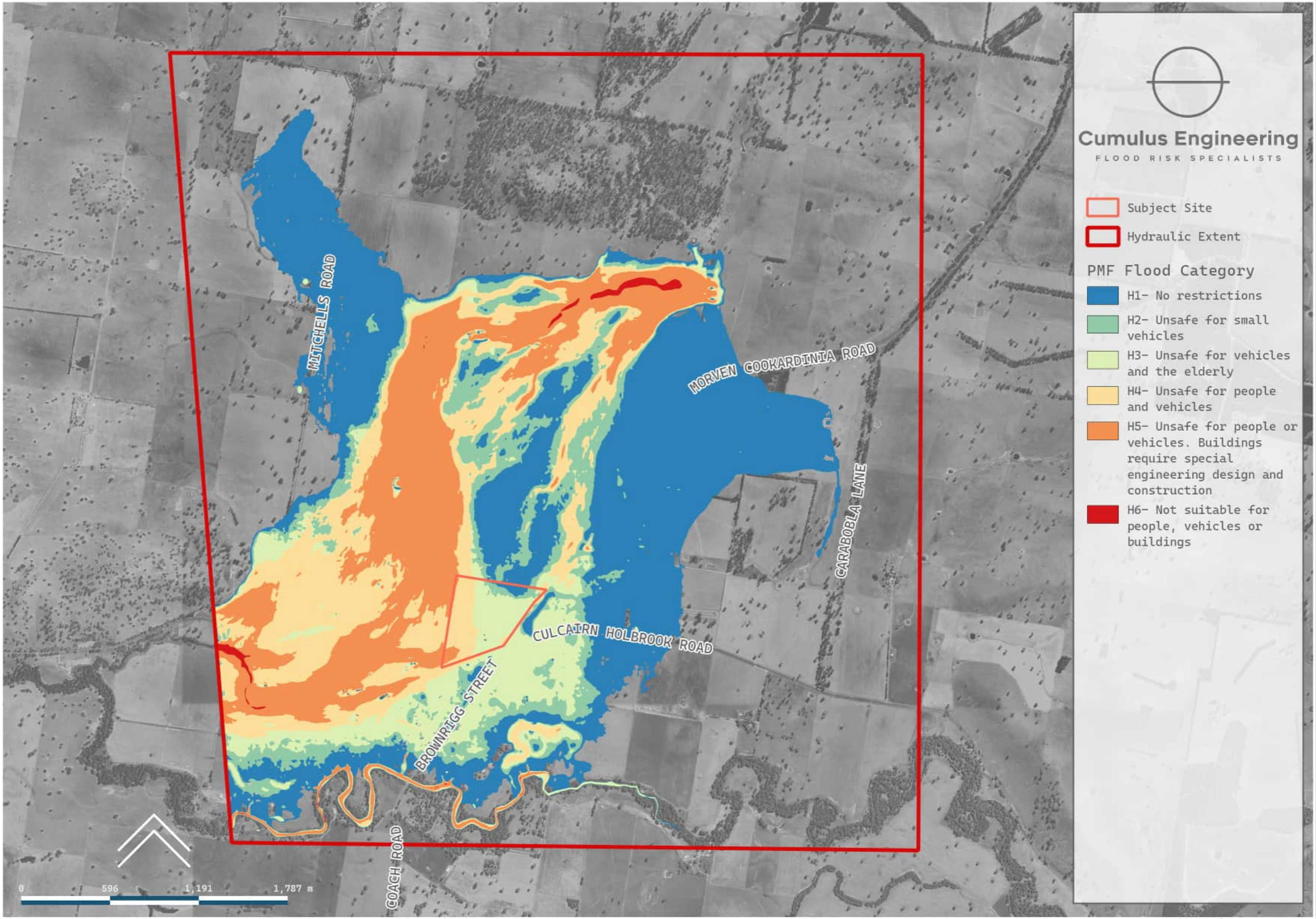
CLIENT: Habitat Planning PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA DRAWING NAME: PMF Flood Depth - Existing Conditions Date: 2024-06-13 GDA94 / MGA zone 55



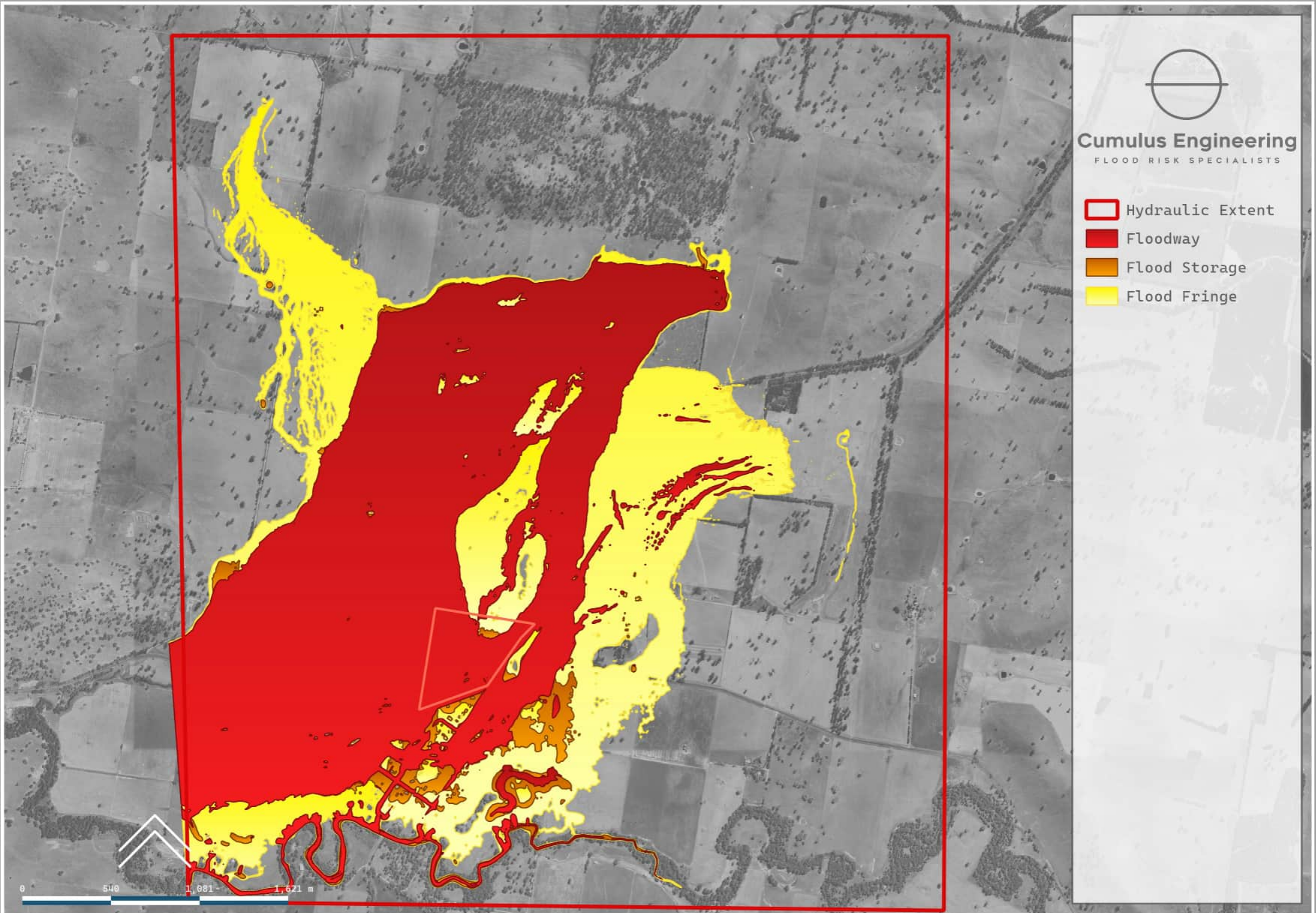
CLIENT: Habitat Planning PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA DRAWING NAME: PMF Flood Height (mAHD) - Existing Conditions Date: 2024-06-13 GDA94 / MGA zone 55



CLIENT: Habitat Planning PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA DRAWING NAME: PMF Flood Velocity (m/s) - Existing Conditions Date: 2024-06-13 GDA94 / MGA zone 55



CLIENT: Habitat Planning | PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA | DRAWING NAME: PMF Flood Hazard - Existing Conditions | Date: 2024-06-13 | GDA94 / MGA zone 55



CLIENT: Habitat Planning PROJECT: 2028 Culcairn-Holbrook Rd, Morven FIA DRAWING NAME: PMF Flood Function Date: 2024-06-13 GDA94 / MGA zone 55