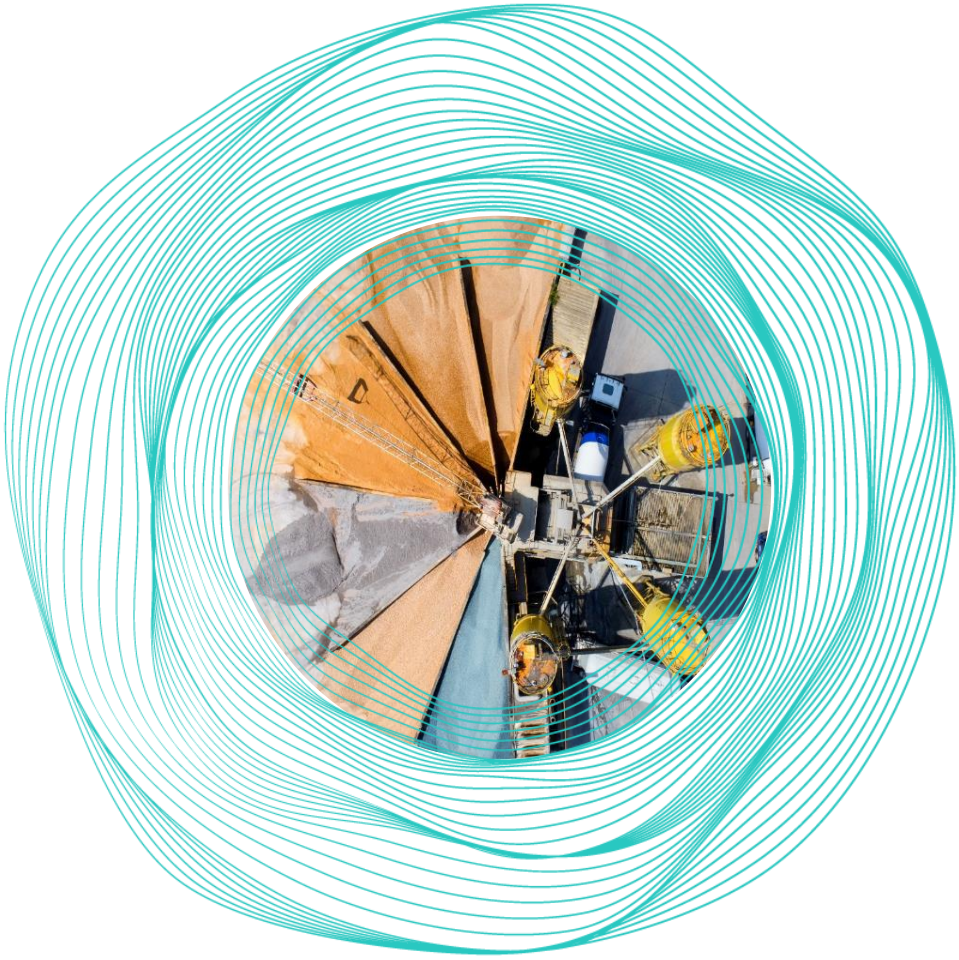
ACCIONA ENERGY AUSTRALIA GLOBAL PTY LTD

Waubra Battery Energy Storage System (BESS)

Hydrological Assessment

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ADVERTISED PLAN

19 Sep 2025

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311001-00505-HY-RPT-001: Waubra Battery Energy Storage System (BESS) - Hydrological Assessment

Rev	Description	Originator	Reviewer	Worley Approver	Revision Date	Customer Approver	Approval Date
Rev 0	IFU	M. Butcher	S. Martinez	M. Butcher	19 September 2025		

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Acronyms and abbreviations

Acronym/abbreviations	Definition
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARR2019	Australian Rainfall and Runoff (2019): A Guide to Flood Estimation
ARR Data Hub	Web based tool that allows for easy access to the design inputs required to undertake flood estimation in Australia
BESS	Battery Energy Storage System
BoM	Bureau of Meteorology
CL	Continuing Loss
DEM	Digital Elevation Model
IFD	Intensity Frequency Duration
IL_s	Storm Initial Loss
FFA	Flood Frequency Analysis
GCS	Grid Cell Size
LiDAR	Light Detection and Ranging
LGA	Local Government Area
MW	Megawatt
RORB	General runoff and streamflow routing program
RFFE	Regional Flood Frequency Estimation Model
SSP	Shared Socioeconomic Pathways

1. Introduction

1.1 Background

Worley was engaged by Biosis Pty Ltd to conduct this hydrology assessments on behalf of Acciona Energy Australia Global Pty Ltd (Acciona Energia).

The Waubra Battery Energy Storage System (BESS) is a proposed energy storage system located near the town of Waubra, approximately 31 km northwest of Ballarat, Victoria. The project area is approximately 60,000m^2, wholly within the Pyrenees Local Government Area (LGA). The project location is shown in Figure 1-1.

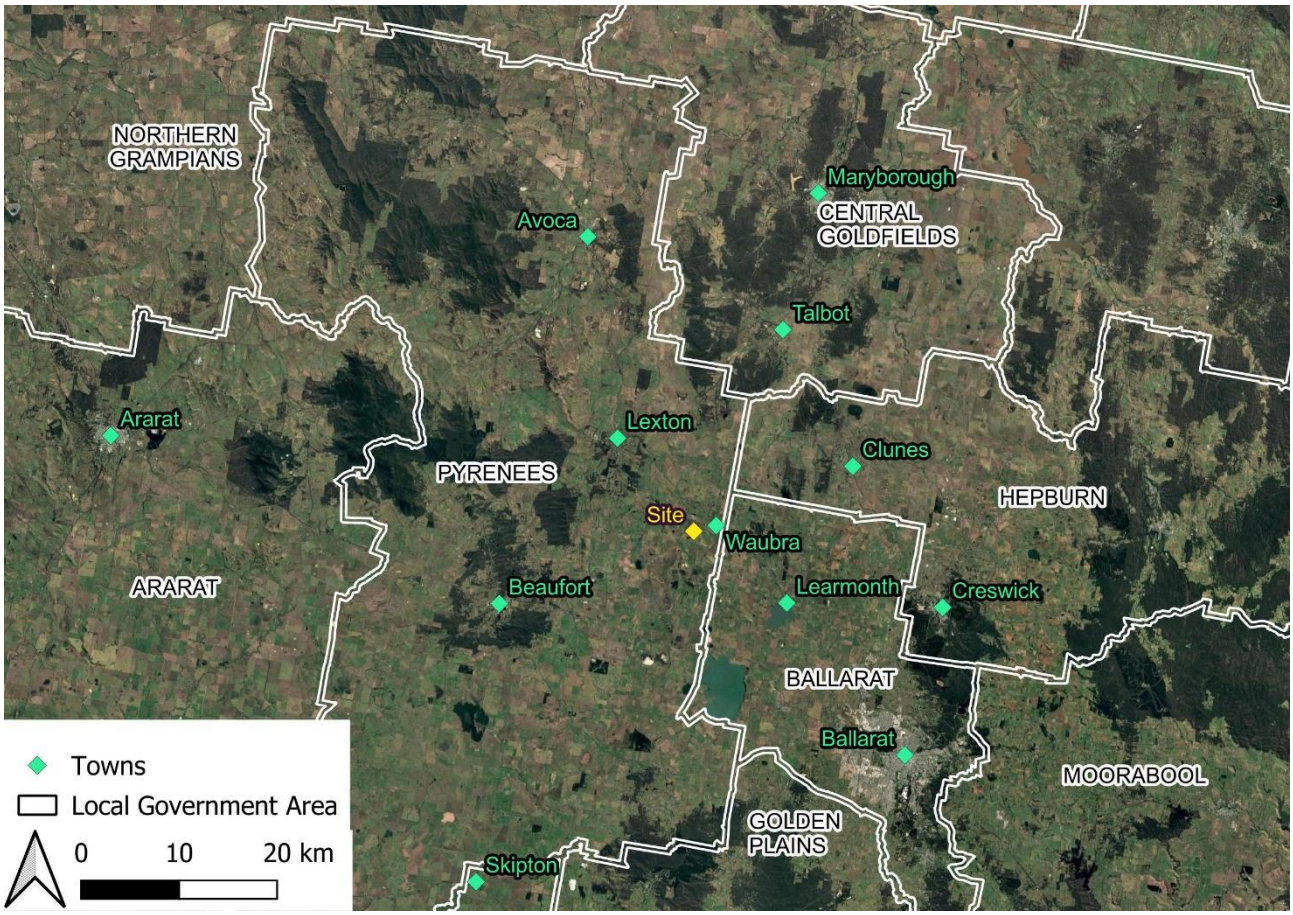


Figure 1-1: Local Government Area Boundaries

The site is located in the Glenelg Hopkins Catchment Management Authority, as shown in Figure 1-2. The layout is shown in Figure 1-3.

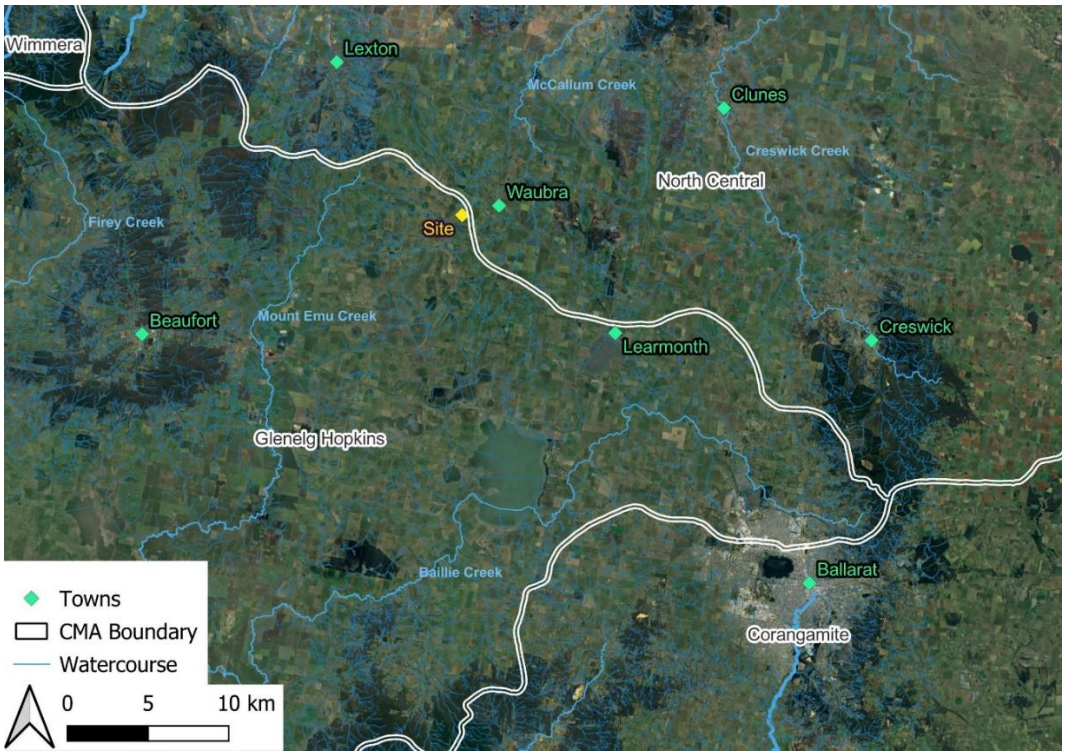


Figure 1-2: Catchment Management Authority Boundaries

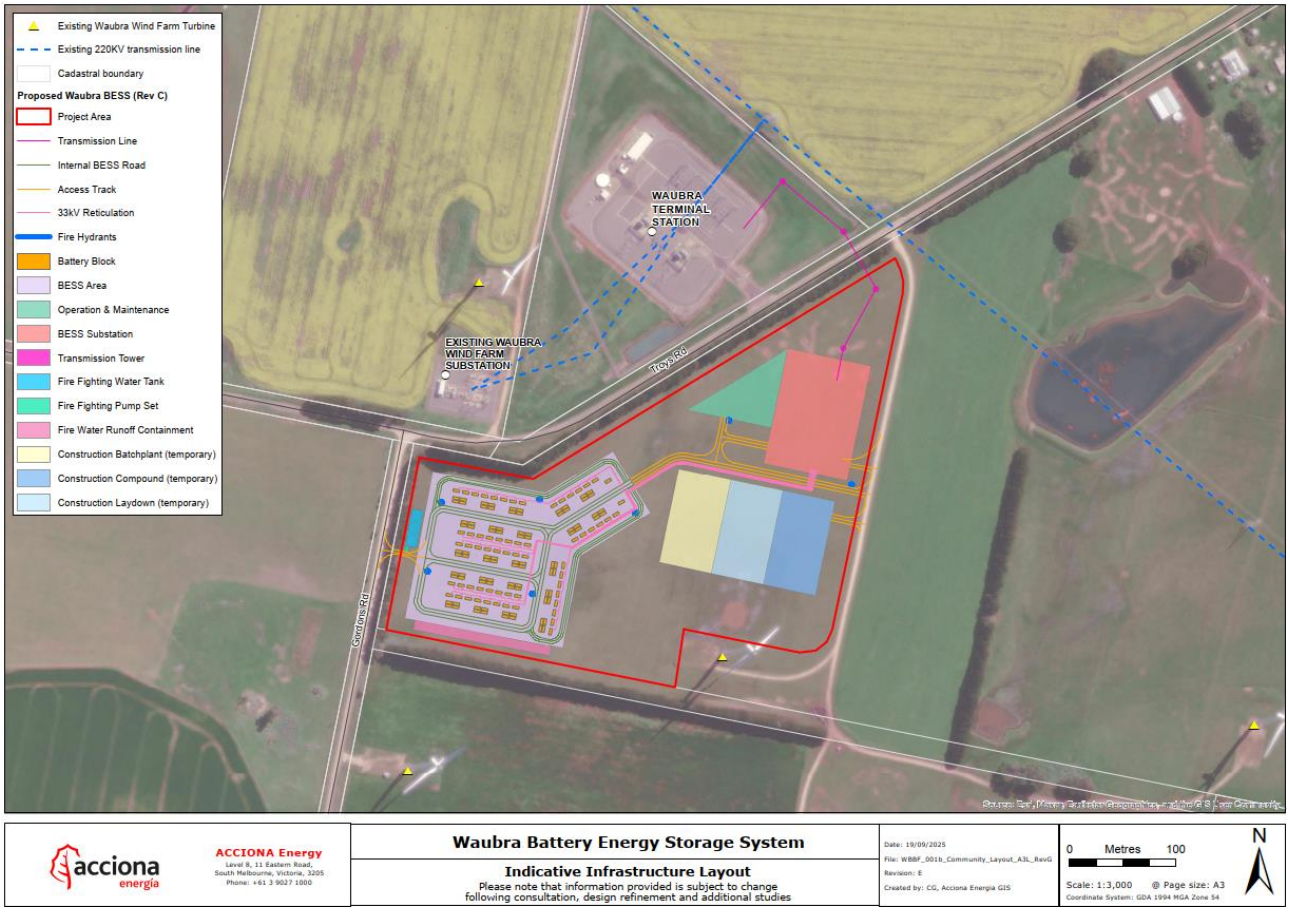


Figure 1-3: Proposed layout

1.2 Scope of works

The following scope of works was undertaken to achieve the Project objectives:

1. Hydrologic assessment and develop hydraulic model:
    - Development of the catchment delineation based on the Digital Elevation Model (DEM), undertaking refinements where required.
    - Description of the catchments in the Project area, giving all the parameters necessary for the undertaking of the hydrological study such as area, length, unevenness, concentration time, etc. Each of the catchments to be considered must be shown in the relevant plan. Where the catchment area exceeds the provided LiDAR information, publicly available LiDAR information to be used to capture all influencing catchment areas.
    - Estimation of percentage of impervious and pervious areas for each sub-area using aerial imagery in conjunction with ARR2019 (Ball, et al. 2019) guidelines. Assumptions and reasoning for estimations must be outlined.
    - Bureau of Meteorology (BoM) Intensity Frequency Duration (IFD) data and the ARR Data Hub must be used to define design rainfall events. Design events to include 2, 5, 10, 20, 25[1], 50, 100 and 200 years return periods.
    - Review of relevant flood studies in the region.
    - Calibration of the hydrological parameters to adjust model response to better match historic record must be performed. If calibration is not possible, industry standards can be used to define model parameters.
    - Generate design flood hydrographs for the storm events, and climate change scenarios (if required), for design events.
    - Use the results of the hydrological model to benchmark with the peak flows calculated using a separate routing method.
2. Flood mapping and assessment:
    - Develop a hydraulic model to determine the flood behaviour of the catchment.
    - Produce flood depths, peak water surface elevations, flow velocities and flow maps (as depth*velocity) for the nominated design rainfall events.
3. Preliminary drainage design:
    - From the hydrologic and hydraulic modelling, calculate flows for the design of the Project's drainage.
4. Reporting:
    - Prepare a brief technical report presenting the approach undertaken and the potential solutions and control commentary for the proposed drainage design.

[1] The 25 year return period was not modelled as it is not a typical rainfall event provided by the BoM.

2. Information and data

2.1 Supplied information

For the purposes of this assessment, Worley Consulting used the datasets described in Table 2-1.

Table 2-1: Dataset

Reference	Description	Application	Source
Waubra North DEM	1m resolution DEM based on a LiDAR survey of the Waubra North Wind Farm/Nyaninyuk Wind Farm	Describing the terrain of the Project Area	Acciona Energia
Golden Plains Area DEM	0.5m resolution DEM based on LiDAR survey. Vertical accuracy +/- 0.1m	Defining the catchment and sub catchments draining to the Project site	Elvis elevation portal https://elevation.fsdf.org.au/
Vicmap Elevation DEM 10m	10m resolution DEM based on a regional LiDAR survey. Vertical accuracy +/- 5m	Defining the catchment and sub catchments draining to the Project site	Elvis elevation portal https://elevation.fsdf.org.au/
Google Tile Map Server (TMS)	Regional satellite imagery	Used in the definition of catchment characteristics such as roughness coefficients, as well as cross checking of terrain and culvert network.	Google
Project layout	Project boundaries and roads layout	Defining the Project boundaries and estimating the flows across the Project roads	Acciona Energia
Vicmap Hydro - Watercourse Line	Vicmap Hydro provides an accurate representation of natural and man-made Hydrographic features across Victoria, at a capture scale of 1:25,000	Identification of watercourse in project vicinity	VICMAP - Department of Environment, Land, Water & Planning
Vicmap Hydro - Water Polygon	This layer is part of Vicmap Hydro and contains polygon features delineating hydrological	Identification of water features in project vicinity	VICMAP - Department of Environment, Land, Water & Planning

Reference	Description	Application	Source
	features.Includes; Lakes, Flats (subject to inundation), Wetlands, Pondages (saltpan & sewrage), Watercourse Areas, Rapids & Waterfalls		
VICMAP - Parcel Footprint Type Table	Part of VMREFTAB, the set of Reference Tables for the VICMAP suite of products	Identification of cadastral boundaries and details	VICMAP - Department of Environment, Land, Water & Planning
Catchment Management Authority Boundaries	This layer represents the Catchment Management Authority (CMA) boundaries (derived from CALP100)	Identification of floodplain management requirements	VICMAP - Department of Environment, Land, Water & Planning Department of Energy, Environment and Climate Action
VICMAP_ADMIN	This dataset series contains polygon features delineating key Victorian administrative boundaries.	Identification of relevant Local Government Area	VICMAP - Department of Environment, Land, Water & Planning
TR_Road	This layer is part of Vicmap Transport and is an extensive digital road network - line features delineating state wide road network.	Identification of relevant roads	VICMAP - Department of Transport and Planning
BOM Design Rainfall Data System	Intensity Frequency Duration (IFD) data for the site	Defining design rainfall depths to estimate design hydrographs	BOM 2016 http://www.bom.gov.au/water/designRainfalls/revised-ifd/
ARR Data Hub	Rainfall Temporal Patterns – Murray Basin Region	Temporal patterns are used to transform rainfall depths into hyetographs	ARR2019 https://data.arr-software.org/
Floodplain roughness	ARR2019 floodplain roughness used for the Project	Provides ARR2019 floodplain roughness (Manning's 'n') values for the catchment	ARR2019

2.2 Regulations and standards

Regulations, standards and guidelines applicable to this study include:

- Australian Rainfall & Runoff (ARR2019): A guide to flood estimation (Ball, et al. 2019)
- ARR2019 Victorian Specification Information (HARC 2020)
- Supplement to Austroads Guide to Road Design. Part 5: Drainage- General and Hydrology Considerations (Austroads 2023)
- Glenelg Hopkins Catchment Management Authority: Flood Modelling - Guidelines and Specifications (Glenelg Hopkins CMA 2024)
- Glenelg Hopkins Catchment Management Authority: Guidelines for Cut and Fill (Glenelg Hopkins CMA 2012)
- Victorian Department of Environment, Land, Water and Planning: Guidelines for Development in Flood Affected Areas (DEWLP 2019)
- Australian Disaster Resilience Guideline 7-3: Flood Hazard. A guide to best practice in flood risk management in Australia (AIDR 2017)

3. Catchment characteristics

3.1 Catchments

A combination of LiDAR data has been used to develop a DEM for the modelled catchment area, with the highest resolution data used in preference to lower resolution. The coverage of the survey data is shown in Figure 3-1.

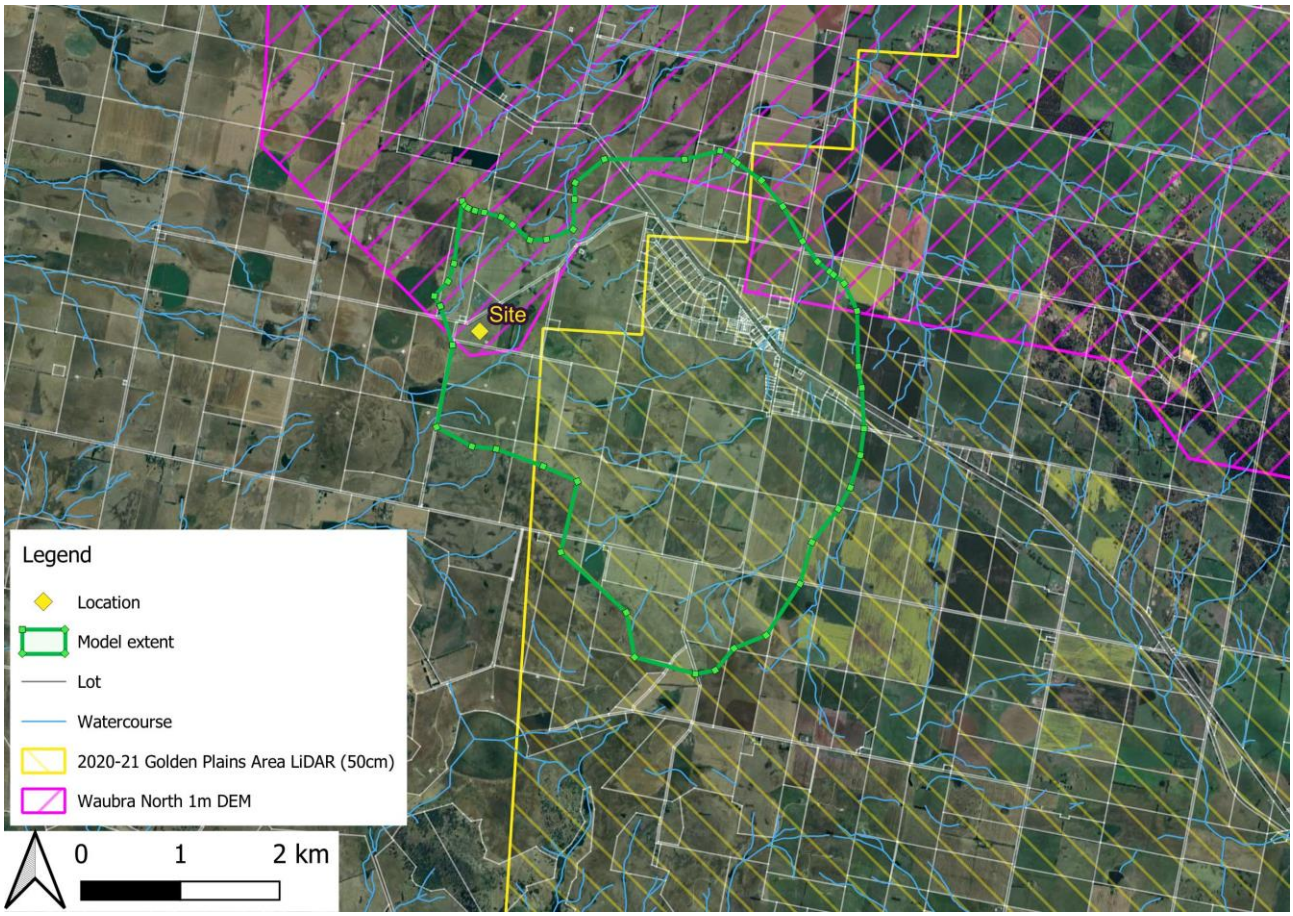


Figure 3-1: Survey coverage

The site is located in the Hopkins River basin, close to the divide to the Loddon River Basin. Catchments 1 and 3 drain to Mt Emu Creek, a tributary of the of the Hopkins River. Catchment 2 (Mt Greencock Creek) and 4 are tributaries on the Loddon River. The catchment delineation is shown in Figure 3-2.

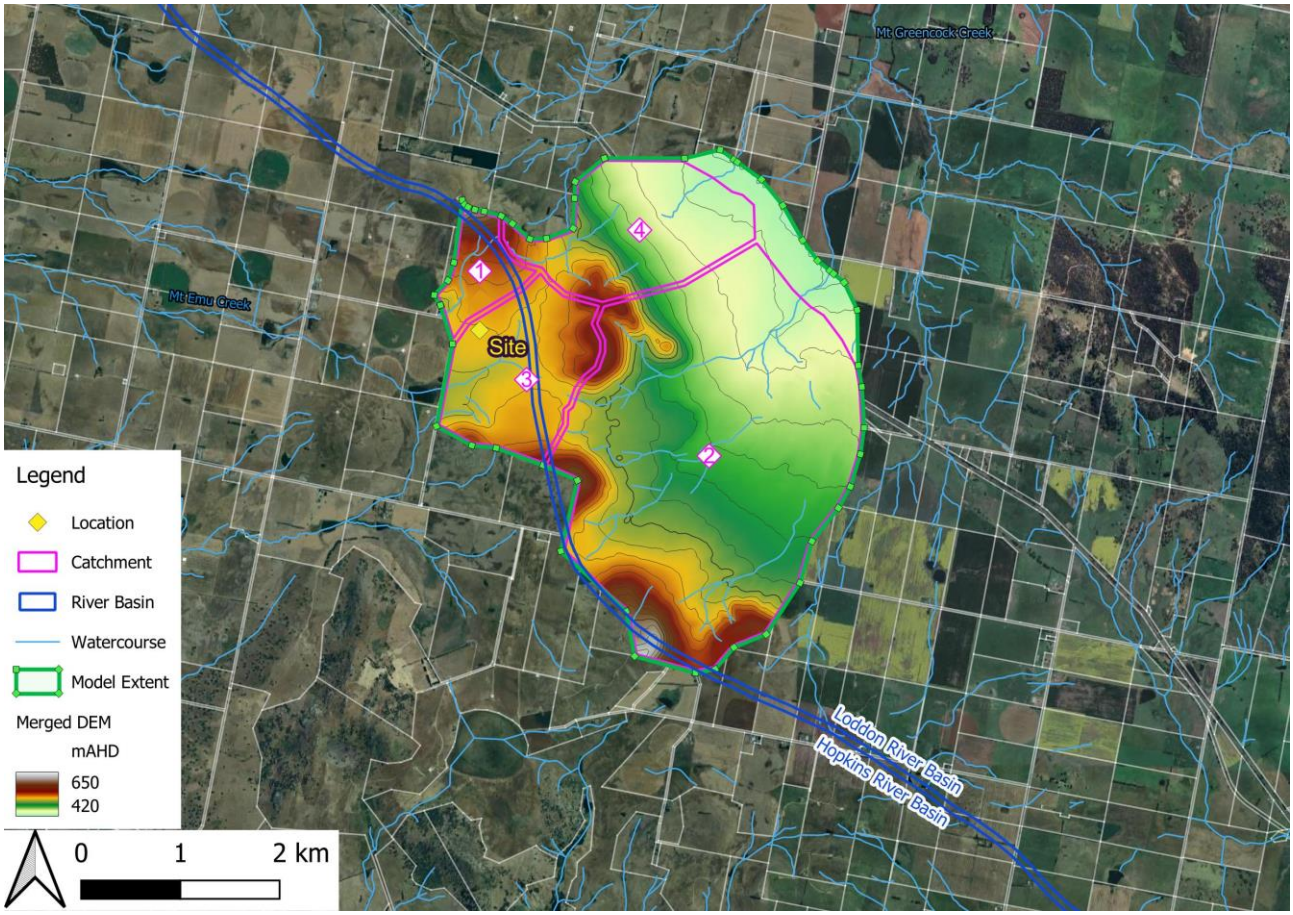


Figure 3-2: Topography and catchments

3.2 Climate

The climate at the site is classified as Temperate, no dry season (warm summer) according to the BoM Köppen climate classification system (Stern, de Hoedt and Ernst 2000). Historic rainfall data available from Addington (BoM 2025) shows an even distribution of rainfall during the year, with mean annual rainfall is approximately 706.2 mm as shown in Figure 3-3.

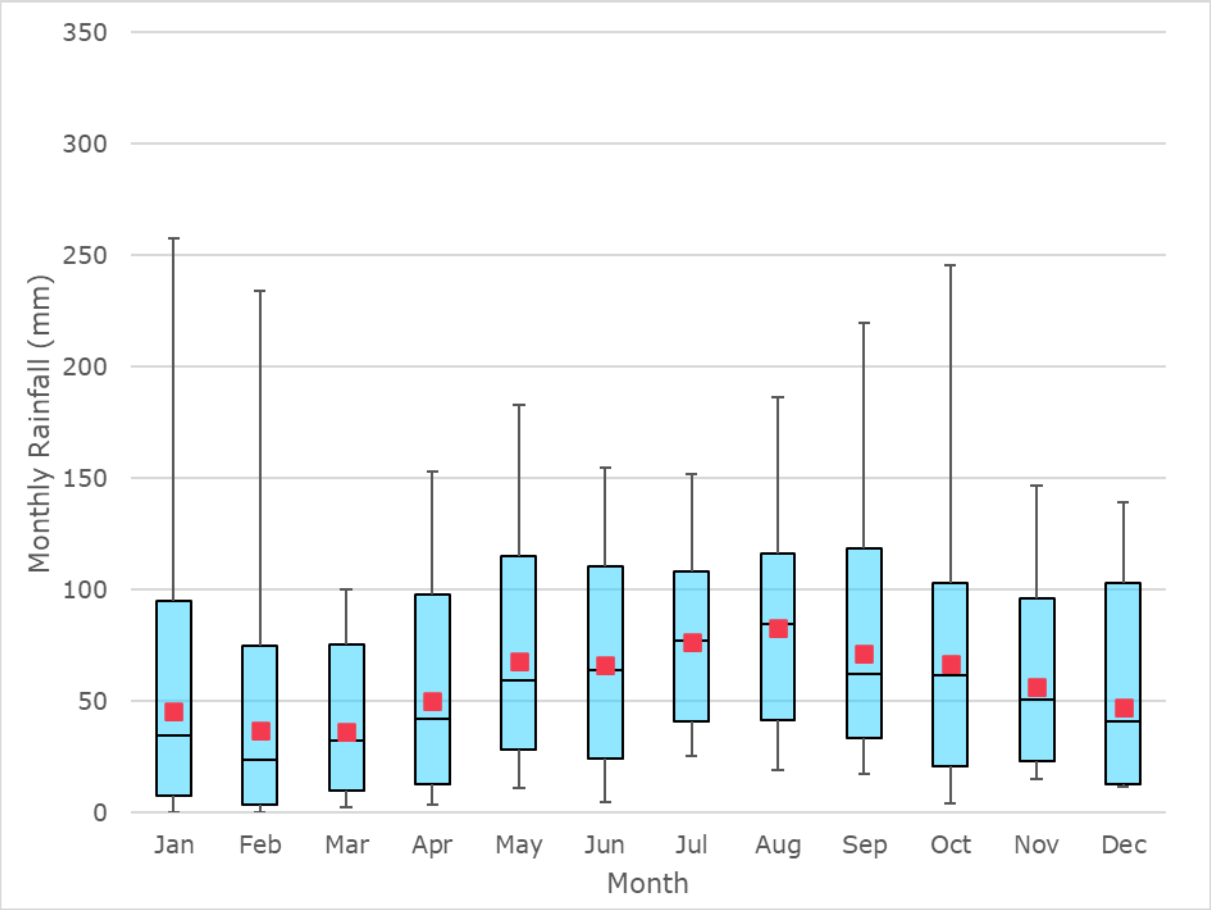


Figure 3-3: Addington monthly rainfall (Source: BoM 2025)

4. Hydrological Investigation

4.1 Waubra Preliminary Flood Study

Pyrenees Shire Council engaged Utilis to undertake a preliminary flood study to determine whether a full flood study is required as well as provide flood risk and flood planning advice for the town (Utilis 2018). The study developed a RORB model for the catchment, adopting the loss parameter from the Beaufort Flood Study (Water Technology 2008).

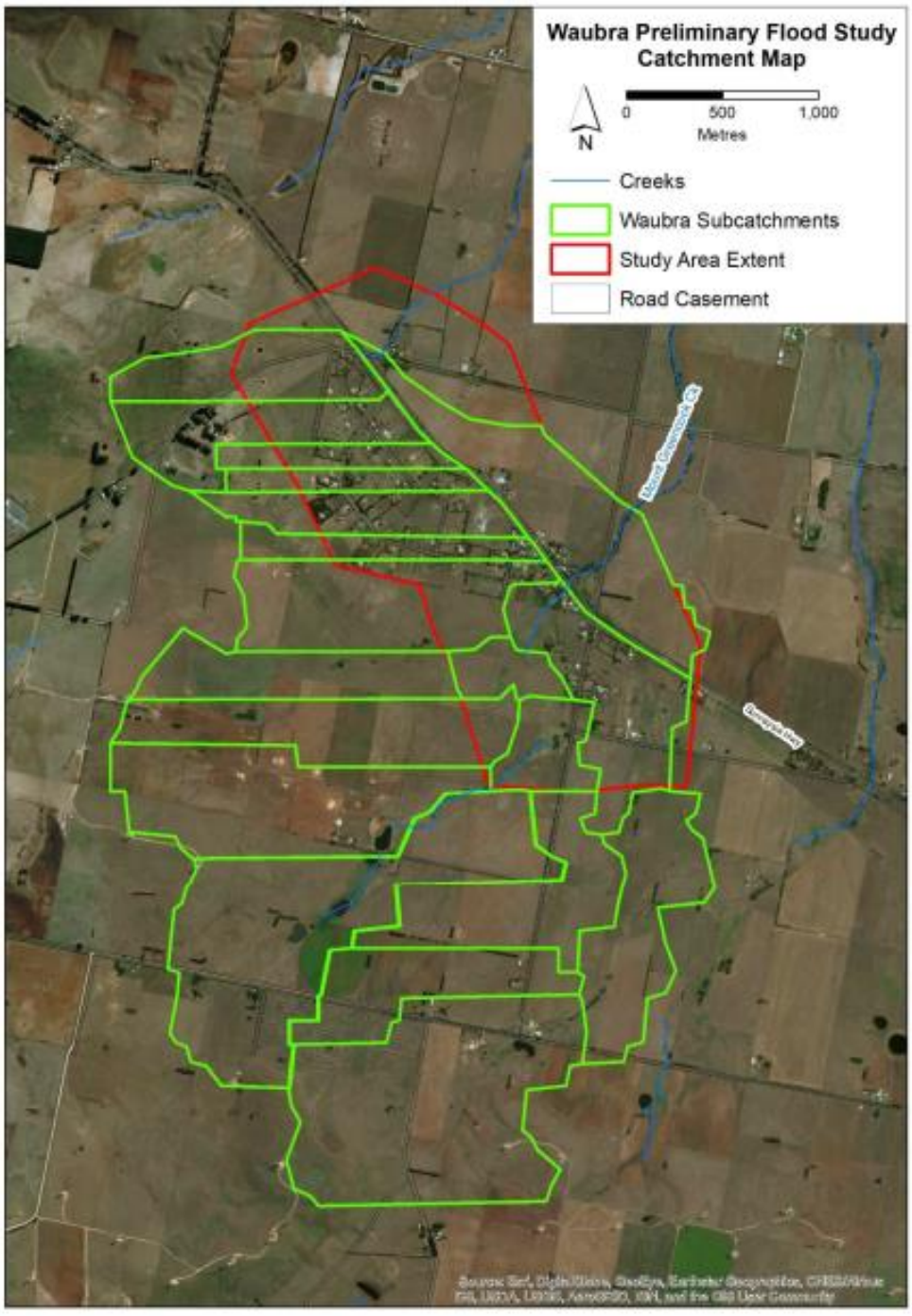


Figure 4-1: Waubra RORB model (Source: (Utilis 2018))

The adopted loss parameters are detailed in Table 4-1.

Table 4-1: Relevant loss parameters and sources

Source	Study	Catchment area (km^2)	Initial Loss (mm)	Continuing loss (mm/hr)	Notes
Utilis 2018	Waubra Preliminary Flood Investigation	10	19.75	1.0	This study adopted loss parameters from the Beaufort Study.
Water Technology 2008	Beaufort Flood Study	49	19.75	1.0	Loss parameters calibrated in study
Water Technology 2020	Upper Mt Emu Creek Flood Investigation	1,250	16	0.5	Loss parameters calibrated in the study. 1%AEP parameters shown
Advisian 2023	Nyaninyuk Wind Farm Hydrologic Study	179.1	10	4.5	Datahub loss parameters adjusted for improve fit with Regional Flood Frequency Estimation (RFFE) estimates. Loss parameters for 10% to 0.5%AEP shown
Babister et al (2016)	ARR Datahub	-	25	4.6	Values obtained for coordinates Longitude 143.6268, Latitude -37.3636

It is noted that Waubra Preliminary Flood Investigation raised concerns regarding the accuracy of RFFE in similar situations. The Waubra and Beaufort Study areas are considered hydrologically similar and have been adopted for this study.

5. Modelling

5.1 General approach

Given the small catchment area contributing to runoff on the site, hydrologic and hydraulic modelling of the local catchments in the development areas was undertaken using TUFLOW (version 2025.0.2). TUFLOW is a linked 1D/2D hydrodynamic computational engine for simulating free-surface long wave propagation processes (tides, floods, tsunamis, dam breaks) by solving the full one and two-dimensional versions of the Navier-Stokes equations incorporating all physical terms including inertia (1D and 2D) and sub-grid turbulence (2D) (BMT 2025).

The model area was extended to include Waubra so that loss parameters could be validated against the Waubra Preliminary Flood Investigation (Utilis 2018). The model utilized variable cell size through the TUFLOW Quadtree function, where the grid mesh varies in cell size, enabling higher resolutions where more refined hydraulic calculations are needed, and lower resolutions where there is little variation in topography.

5.2 Simulation approach

Ensemble analysis using rain-on-grid modelling was used to assess flooding resulting from local catchments. The rain-on-grid refers to simulating rainfall directly on a grid-based model of the earth surface. This is used to evaluate how rainfall distributes across an area, how water flows overland and its eventual impact on drainage systems. Ensemble analysis was adopted as flood magnitudes can be sensitive to temporal patterns and storm duration, thus the ensemble approach provides a straightforward means of avoiding the introduction of bias due to this source of variability (Ball, et al. 2019). A range of design storm durations were simulated to determine the critical storm duration at various locations within the catchment. The approach is conceptualised in Figure 5-1.

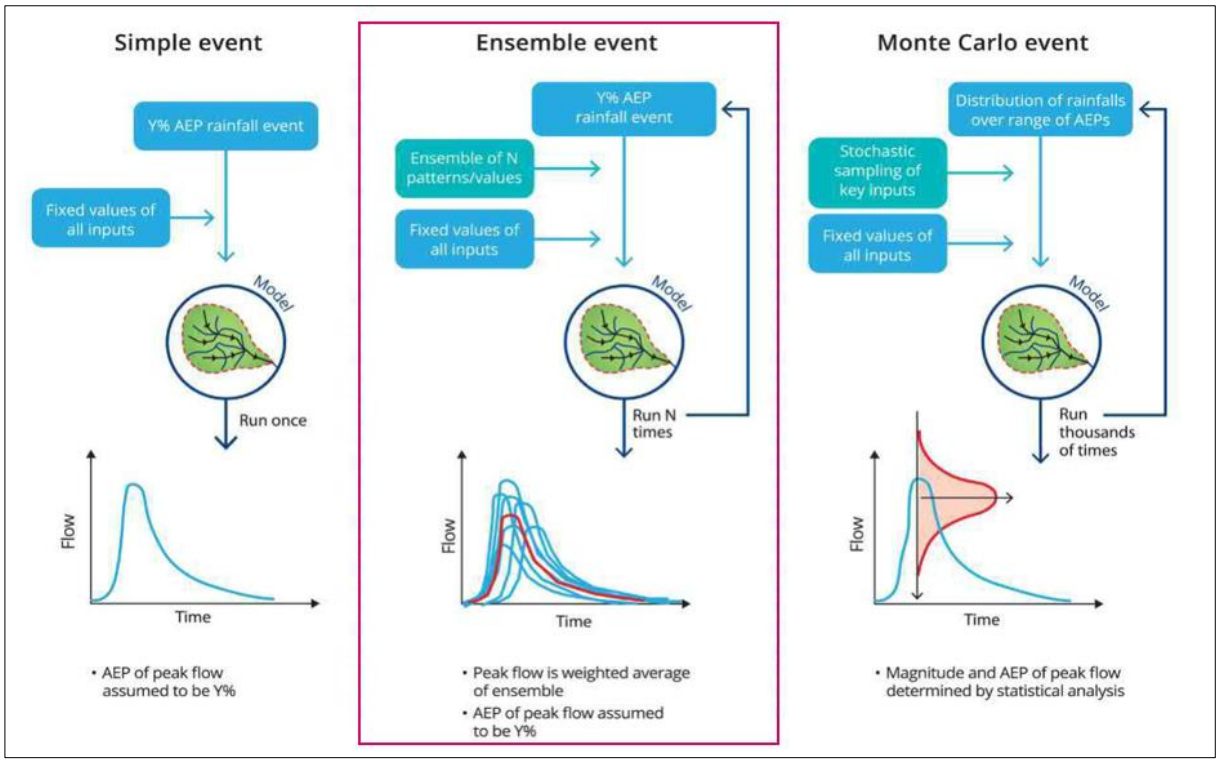


Figure 5-1: Ensemble approach conceptual model (Ball, et al. 2019)

5.3 Design events

Table 5-1 summarises the design storms assessed in the TUFLOW models. The longest storm durations were assessed to ensure that the critical duration was determined in Mt Greencock Creek, as part of loss parameter validation.

Table 5-1: Design storms assessed

Storm detail	Events assessed
Annual Exceedance Probabilities (AEPs)	0.5%, 1%, 2%, 5%, 10%, 20% and 50%
Design Storm Durations (minutes)	15, 30, 60, 120, 270, 360 and 540

5.4 TUFLOW models

5.4.1 Model extent

The model area extended from upstream catchment boundary (Catchment 1 and 2) to the road downstream of the site. The model also extends to the north in the Loddon River catchment to include the area modelled by Utilis for the Waubra Preliminary Flood Study (Utilis 2018).Table 5-2 summarises the catchment details.

Table 5-2: Catchments area

Catchments	Area (km²)	Longest Flowpath (km)	Maximum Elevation (m AHD)	Minimum Elevation (m AHD)	Longest Flowpath Slope (m/m)
Catchment 1	0.677	1230	614	508	0.086
Catchment 2	9.294	4380	546	432	0.026
Catchment 3	2.083	1860	542	506	0.019
Catchment 4	2.395	2820	575	433	0.050

The TUFLOW models are characterised by a number of input parameters which are summarized in Table 5-3. The model domain and setup are shown in Figure 5-2.

Table 5-3: Catchment TUFLOW model parameter summary

Item	Description
Terrain	
Total model area	15.2 km²
Base terrain	Priority layering 1. Golden Plains Area DEM (0.5m) 2. Waubra North DEM (1m) 3. Vicmap Elevation DEM (10m)
Topography reinforcement	Waubra North DEM (1m) • Centerline of Troys Road • Table drains of Troys Road • Perimeter drains of Waubra Terminal Station
Base grid size (SGS sample distance)	16 m (1 m)
Quadtree nesting	Level 1 – 16m Level 2 – 8m Level 3 – 4m Level 4 – 2m
Initial Water Level	Initial water level was applied in the model where required to simulate farm dams being full at the start of the design storm
Manning's 'n' roughness	Refer to Section 5.4.3
Boundary conditions	
Outflow Boundary	Automated stage-discharge curve (HQ) with stream bed slope of 0.01 used as a proxy for water surface slope

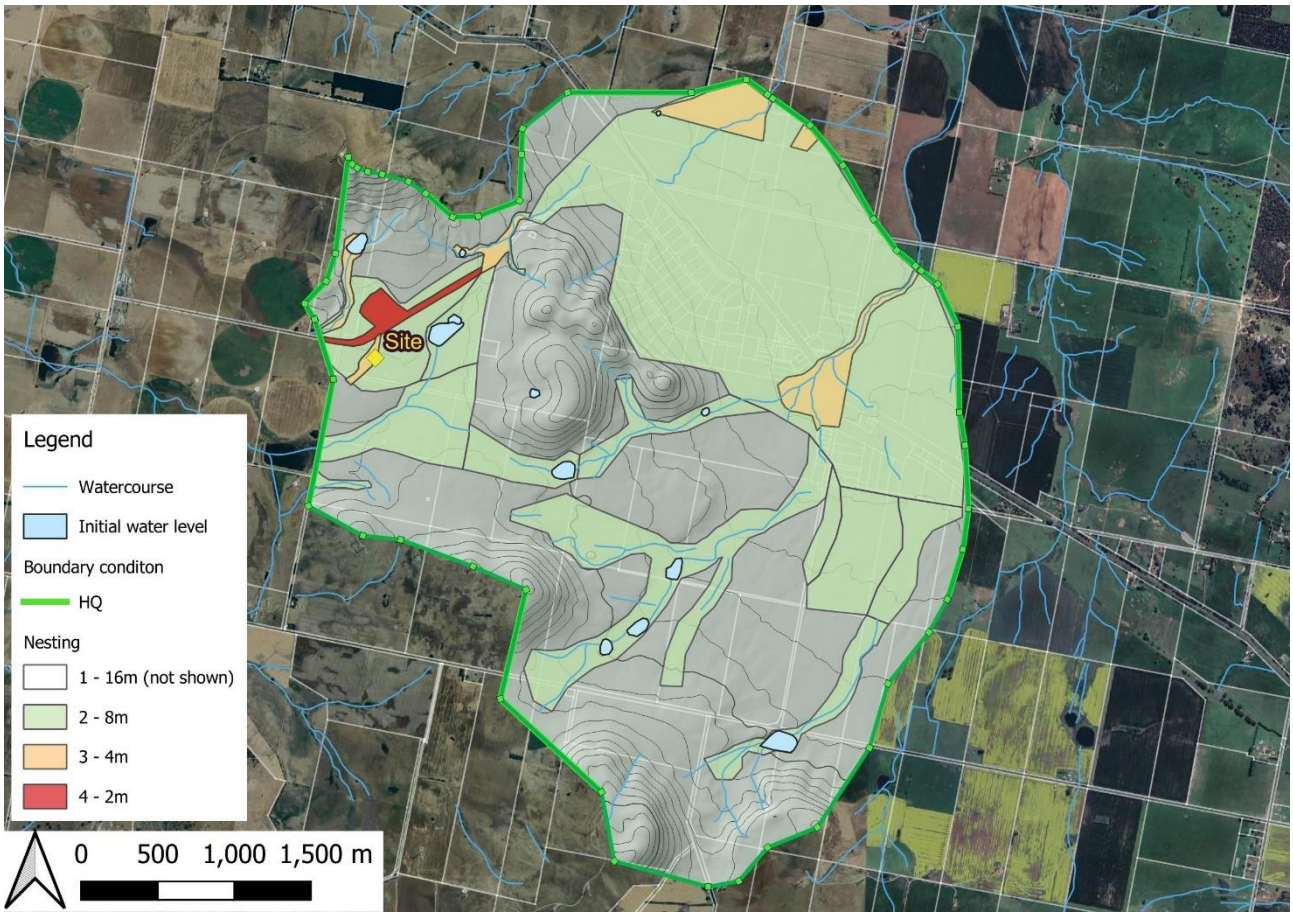


Figure 5-2: TUFLOW model details

A quadtree grid is constructed by dividing a single cell into four cells, with these cells able to be divided into four, and so on, enabling larger cells in areas of uniform terrain (eg. large flat floodplains, parks) and smaller cells where the terrain is variable or along primary flow paths (eg. river channels, roads, open channels) (TUFLOW, 2025). The benefits include:

- Much improved hydraulic computational delineation where most needed, particularly where higher resolution velocity-based calculations and outputs are required.
- Smaller memory footprint on the CPU or GPU as a flexible grid structure is used rather than bounding rectangles, which include a large percentage of inactive cells that consume memory.
- Often a much-reduced total cell count typically leading to faster simulations by a factor of 2 to 5.

An extract of the resultant 2D mesh for the model at the Troys Road entrance is shown in Figure 5-3.

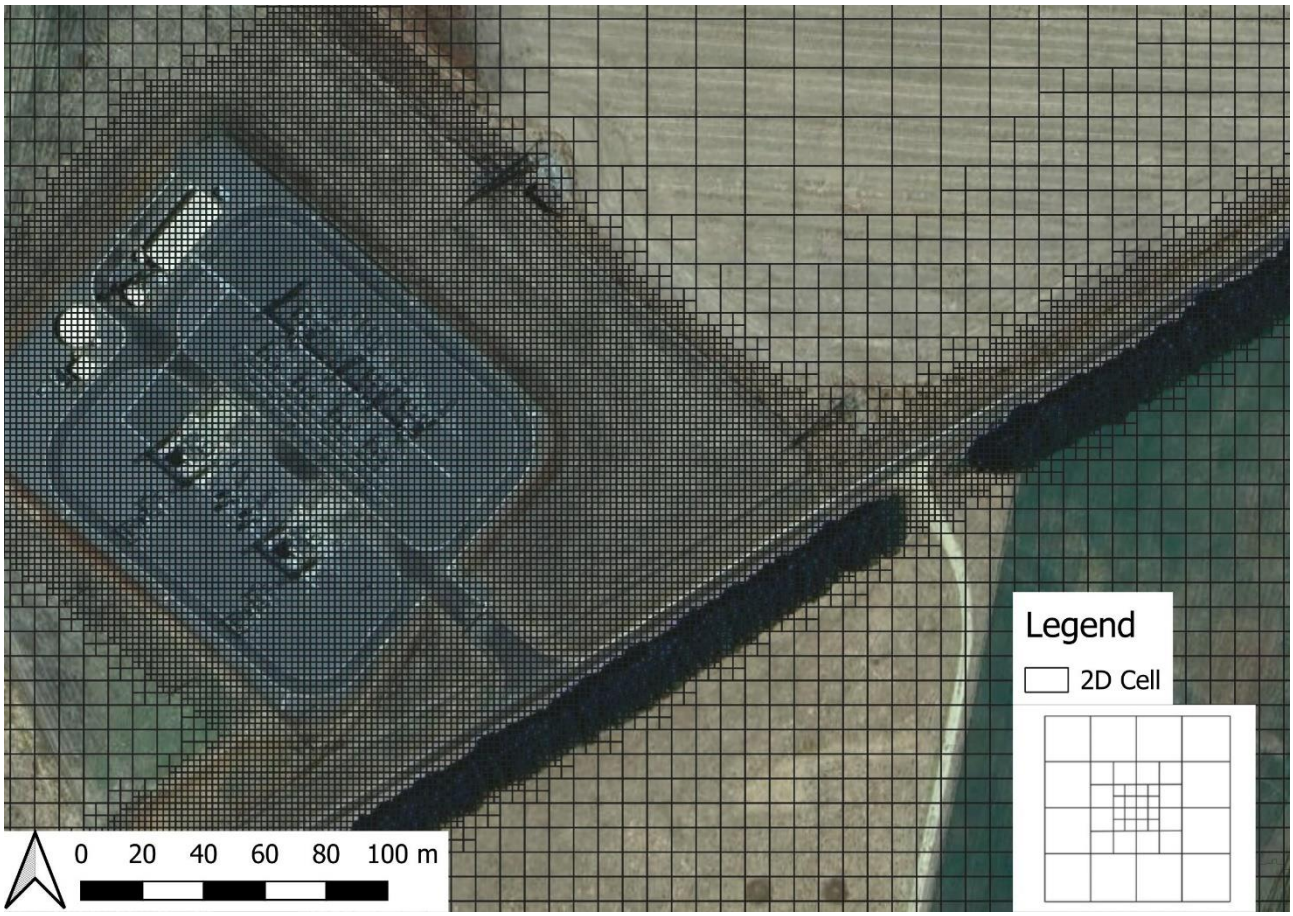


Figure 5-3: Quadtree 2D grid arrangement at Troys Road entrance

5.4.2 Design Rainfall

The latest IFD data for the site (catchment centroid Longitude 143.6268, Latitude -37.3636) was obtained from the BoM Design Rainfall Data System (BoM, 2016). Design rainfall depth for the hydrological assessment are shown in Table 5-4. Median pre-burst rainfall depths were extracted from ARR Datahub (Babister, et al. 2016) presented in Table 5-5. Pre-burst rainfall was removed from the Storm *IL* (IL_S) prior to simulation in the model to represent the Burst *IL* (IL_B).

Table 5-4: Design rainfall depths (mm)

Duration (minutes)	Annual Exceedance Probability (AEP)						
	50%	20%	10%	5%	2%	1%	0.5%
15	9.31	13.6	16.8	20.2	25.1	29.1	33.2
30	12.2	17.8	22	26.4	32.8	38.1	43.3
60	15.5	22.2	27.3	32.7	40.3	46.7	53
120 (2 hr)	19.7	27.7	33.6	39.8	48.7	56	63.5
270 (4.5 hr)	26.7	36.6	43.7	51.1	61.6	70.2	79.9
360 (6 hr)	29.9	40.7	48.4	56.3	67.6	76.8	87.5
540 (9 hr)	35.1	47.4	56.1	65.0	77.6	87.8	100
720 (12 hr)	39.2	52.8	62.4	72.1	86.0	97.1	111

Duration (minutes)	Annual Exceedance Probability (AEP)						
	50%	20%	10%	5%	2%	1%	0.5%
1080 (18 hr)	45.3	61.2	72.3	83.6	99.5	112	128
1440 (1 day)	49.7	67.3	79.9	92.5	110	124	141

Table 5-5: Median pre-burst rainfall depths (mm)

Duration (minutes)	Annual Exceedance Probability (AEP)						
	50%	20%	10%	5%	2%	1%	0.5%
15	20.6	20.6	20.6	20.5	20.4	20.3	-
30	16.2	16.2	16.1	16.1	15.8	15.5	-
60	7.4	7.3	7.2	7.1	6.5	6.0	-
120 (2 hr)	8.6	7.9	7.5	7.1	8.8	10.0	-
270 (4.5 hr)	7.6	7.8	7.95	8.1	10.0	11.35	-
360 (6 hr)	7.0	7.5	7.8	8.1	9.9	11.2	-
540 (9 hr)	6.4	7.1	7.6	8.1	9.8	11.1	-
720 (12 hr)	5.7	6.7	7.4	8.0	9.7	11.0	-
1080 (18 hr)	5.2	5.6	5.9	6.1	7.1	7.9	-
1440 (1 day)	5.2	5.3	5.4	5.5	5.6	5.8	-

5.4.3 Floodplain roughness

Landcover classification was used to assign Manning's *'n'* roughness values for the model extent. Landcover was determined from satellite imagery, as shown in Figure 5-5. The assigned Manning's 'n' was based on the Waubra Preliminary Flood Investigation (Utilis 2018), cross referenced with satellite imagery and guidance from ARR2019 Book 6 Chapter 2. The adopted floodplain roughness is detailed in Figure 5-5. Depth varying Manning's 'n' is applied to the general catchment, with the other classifications adopting constant values, with Figure 5-4 showing the Manning's with depth for this layer.

Table 5-6: Adopted Manning's 'n' values

ID	Description	Manning's n	Notes
1	General catchment	Layer 1 – 0.1 Layer 2 – 0.05	Layer 1 – 0.1 m Layer 2 – 0.2 m
2	Roads and hardstand	0.03	
3	Dense vegetation	0.06	
4	Low density housing	0.04	
5	Water bodies	0.03	

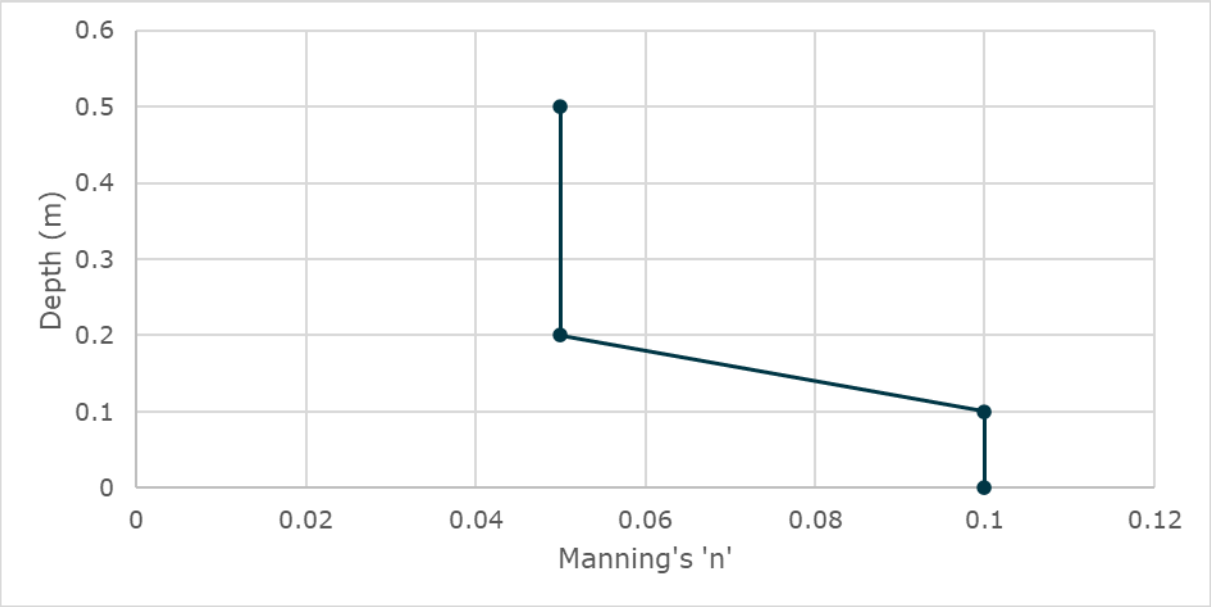


Figure 5-4: General catchment depth-varying Manning's 'n'

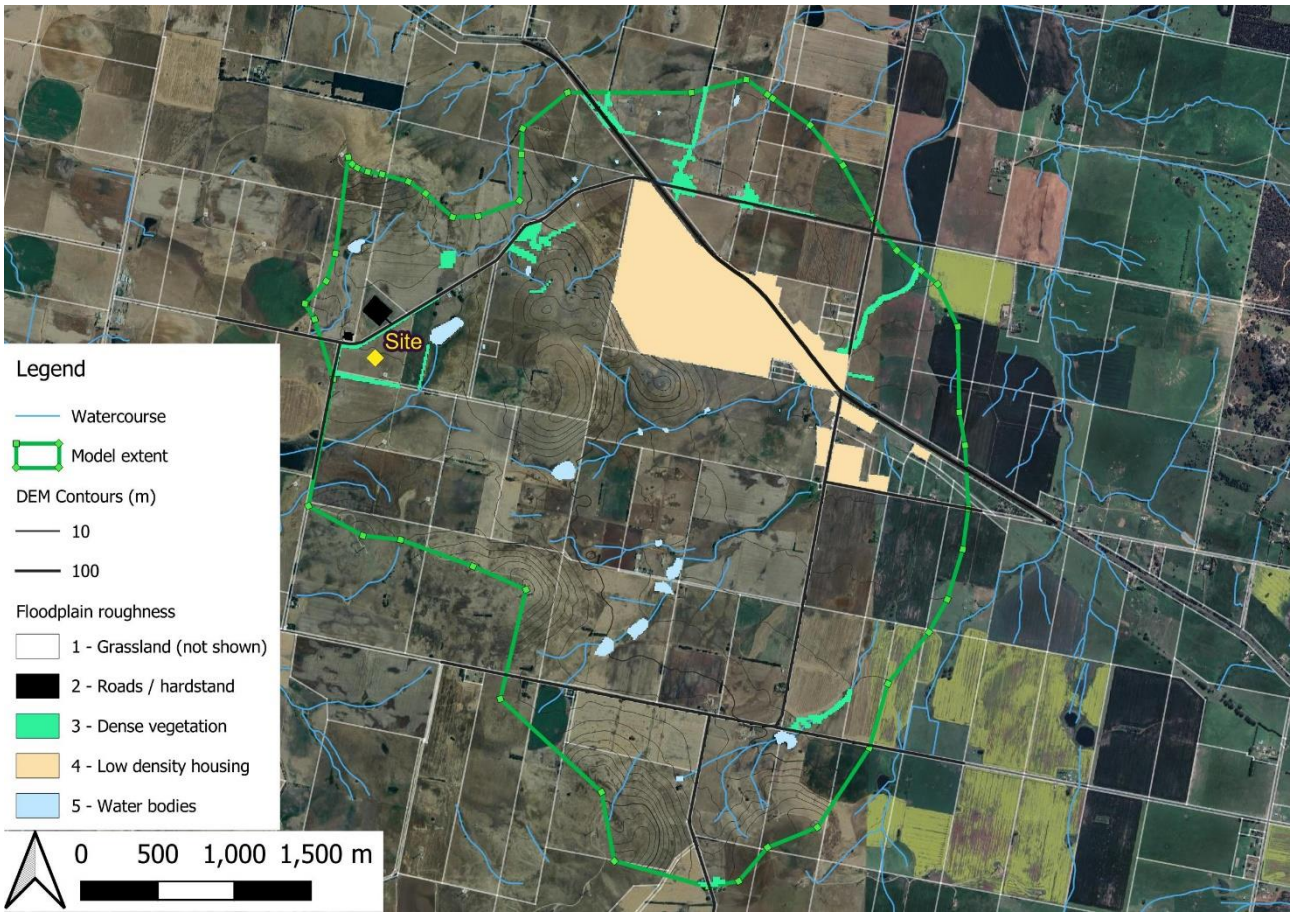


Figure 5-5: Floodplain roughness

5.4.4 Temporal patterns

Given the size of the catchment areas, all events were simulated using the Murray Basin ensemble temporal patterns extracted from the ARR Datahub (Babister, et al. 2016). Adopted hyetographs for different AEP events for this assessment are presented in Figure 5-6.

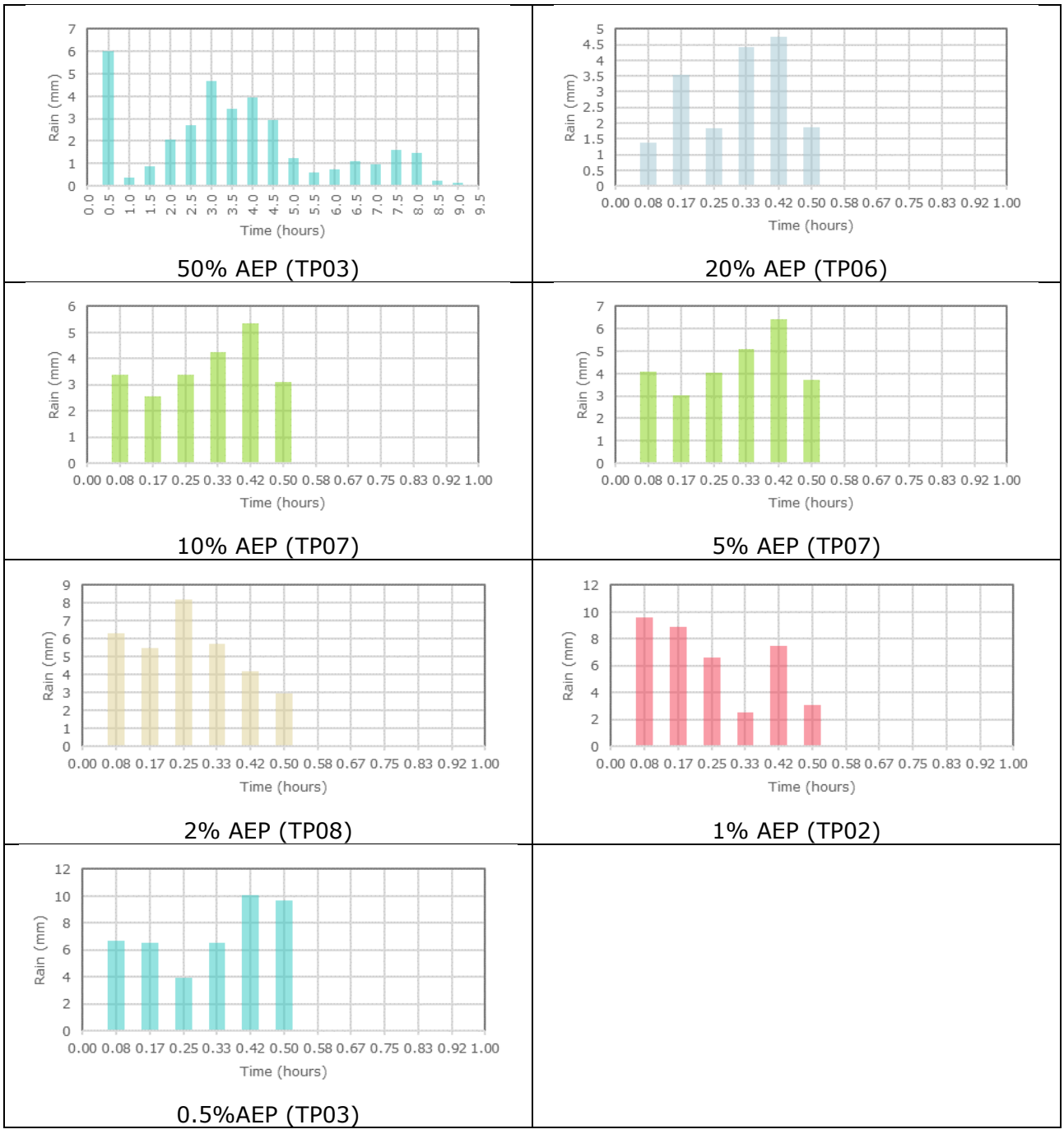


Figure 5-6: Design hyetographs for different AEP events

5.5 Peak flow validation

Peak flow estimates were validated using the following estimation methods.

5.5.1 Comparison to the Waubra Preliminary Flood Investigation

The Waubra Preliminary Flood Investigation (Utilis 2018) determined peak flow for the 1% AEP at the downstream extent of their RORB model. Ensemble analysis of 10 storms with varying temporal patterns was run through the RORB model with varying storm duration (between 15 minutes and 72 hours). The study determined that the 6 hour storm duration provided the critical duration, with the 3 hour storm providing similar peaks. The upper median temporal pattern selected for the design storm was TP07, yielding a peak flow of 45.7m^3/s. The resulting design storm hydrograph is shown in Figure 5-7.

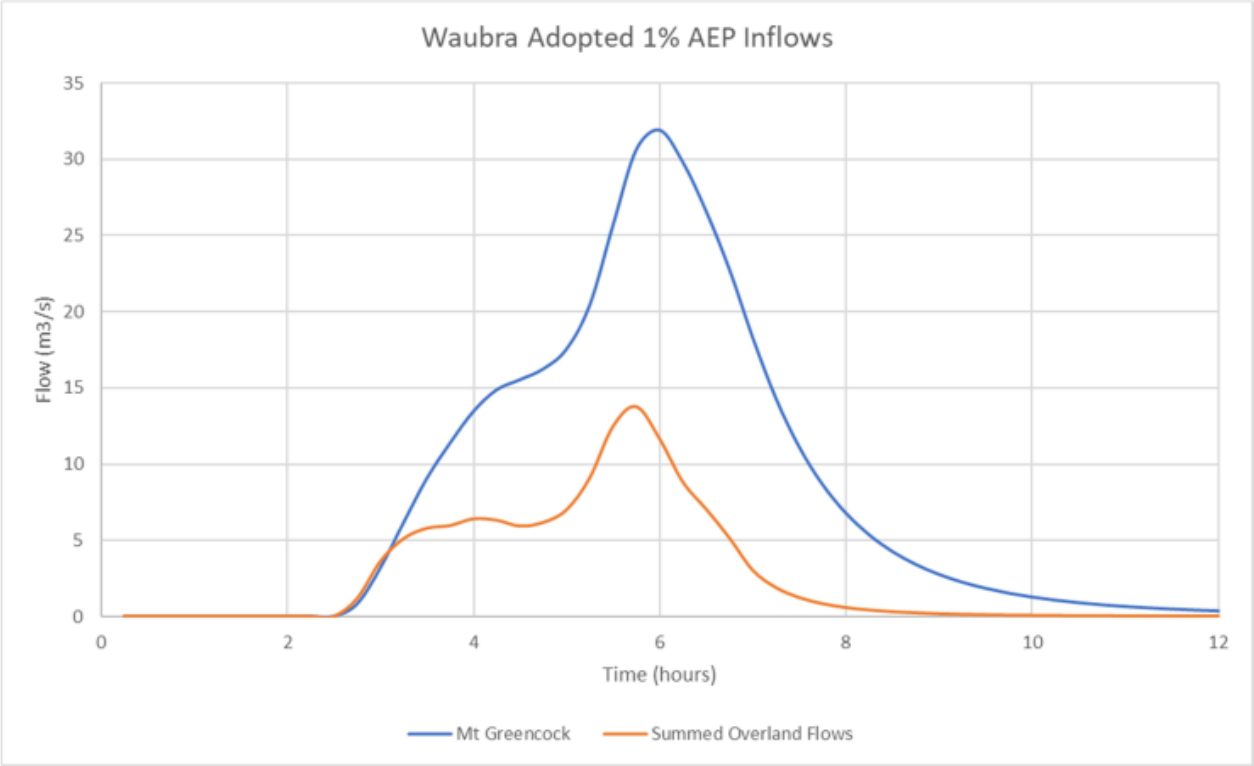


Figure 5-7: Waubra Flood Study design flood hydrograph (source: (Utilis 2018))

5.5.2 Rational method

Rational method calculation as per Austroads Guide to Road Design Part 5: General and Hydrology Considerations (2023) was used to validate the design flows, for catchment 2,3, and 4. While Catchment 1 was included in the model, it doesn't affect runoff to the site, so is not included in the validation. The Rational Method calculates flow according to:

$$Q_x = 0.278 C_x I_{t_{cx}} A$$

Where, Q_x is the design peak runoff rate (m³/s), for an ARI of x years, C_x is the runoff coefficient of an ARI of x years, $I_{t_c}$is the average rainfall (mm/h) for storm duration of t_c hours of the catchment for x years, A is the area of the catchment (ha).

Time of concentration (t_c) is calculated by dividing the channel length by an estimated average velocity of 0.7 m/s, as per Austroads Guidelines (2023).

6. Results

6.1 Peak flow estimation

Peak flow has been calculated at key reporting locations at the BESS site (Table 6-1) and downstream reporting locations (Table 6-2 and Table 6-3), as shown in Figure 6-1. Peak flows represent the maximum of the mean of the temporal patterns for each duration assessed.



Figure 6-1: TUFLOW reporting locations

Table 6-1: BESS tributary (Peak Flow m^3/s)

Reporting Location	Area (ha)	AEP 0.5%	1%	2%	5%	10%	20%	50%
TUFLOW	3	1.5	0.82	0.58	0.32	0.16	0.07	0.02
Rational method			0.35	0.29	0.23	0.18	0.14	0.10

Table 6-2: Catchment 3 Peak Flow (m^3/s)

Reporting Location	Area (ha)	AEP 0.5%	1%	2%	5%	10%	20%	50%
TUFLOW	208	22.4	11.5	9.2	6.4	4.7	3.2	1.5
Rational method			11.3	9.5	7.5	5.8	4.6	3.4

Table 6-3: Catchment 2 combined peak Flow (m^3/s)

Reporting Location	Area (ha)	AEP 0.5%	1%	2%	5%	10%	20%	50%
TUFLOW	929	77.3	43.9	33.9	21.4	17.0	12.5	5.8
Rational method			31.8	26.8	21.3	16.6	13.3	9.8
RORB (Utilis 2018)			32.0					

6.2 Design flow hydrograph

Flow hydrograph at the BESS site for the critical duration and representative temporal pattern is shown in Figure 6-2. Flow hydrograph downstream of the BESS site is shown in Figure 6-3 and Catchment 2 is shown in Figure 6-4.

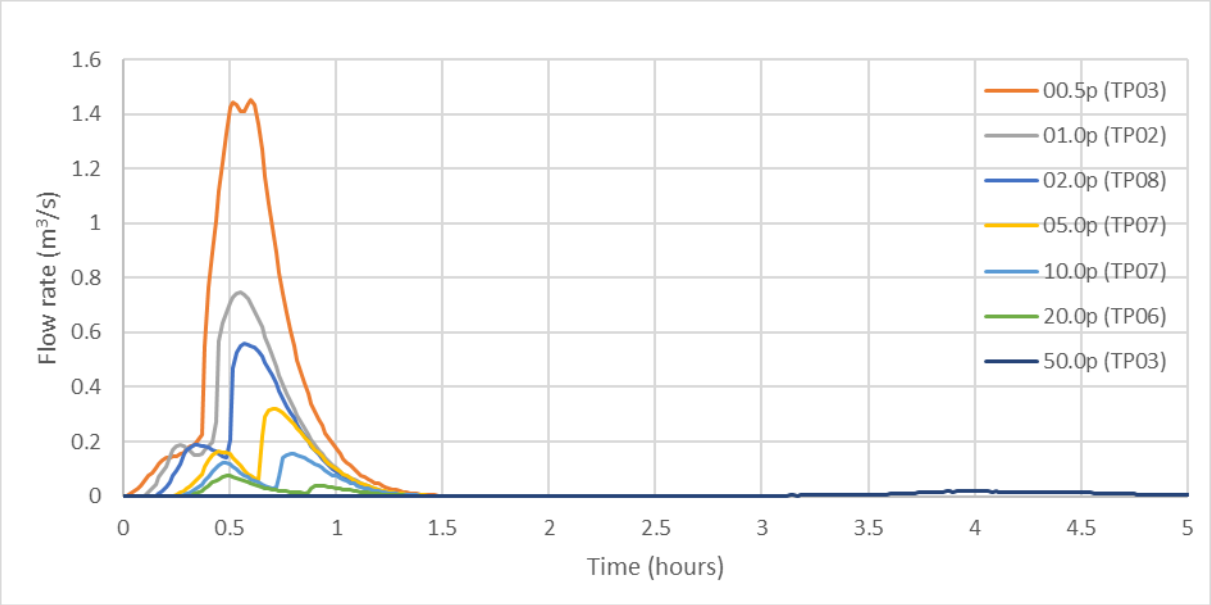


Figure 6-2: Design flow hydrographs at the BESS site

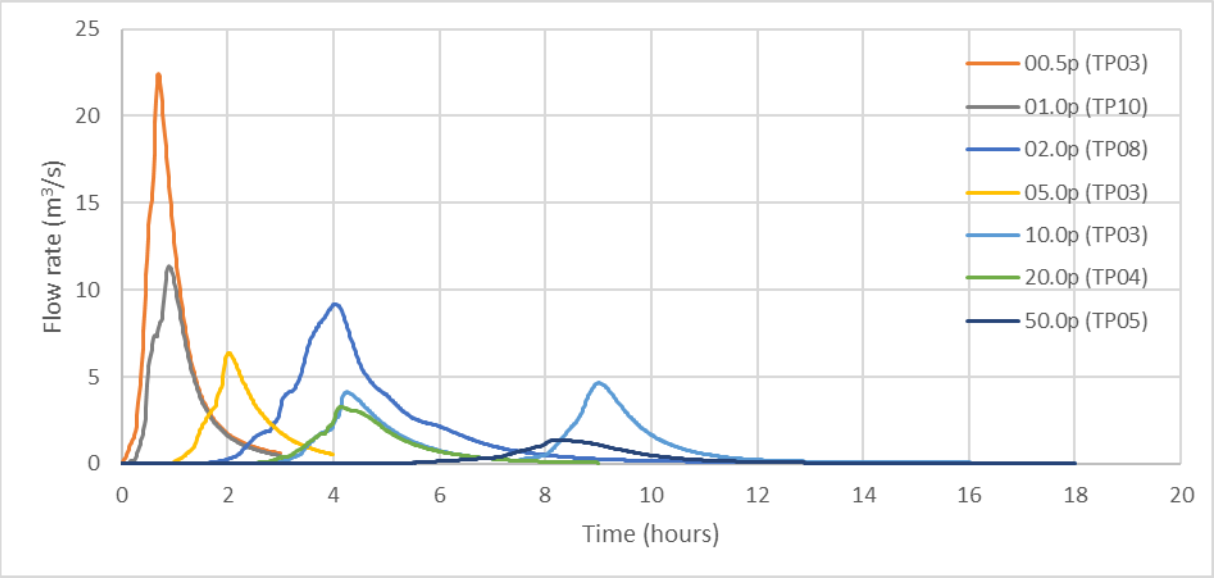


Figure 6-3: Design flow hydrographs downstream of the BESS site

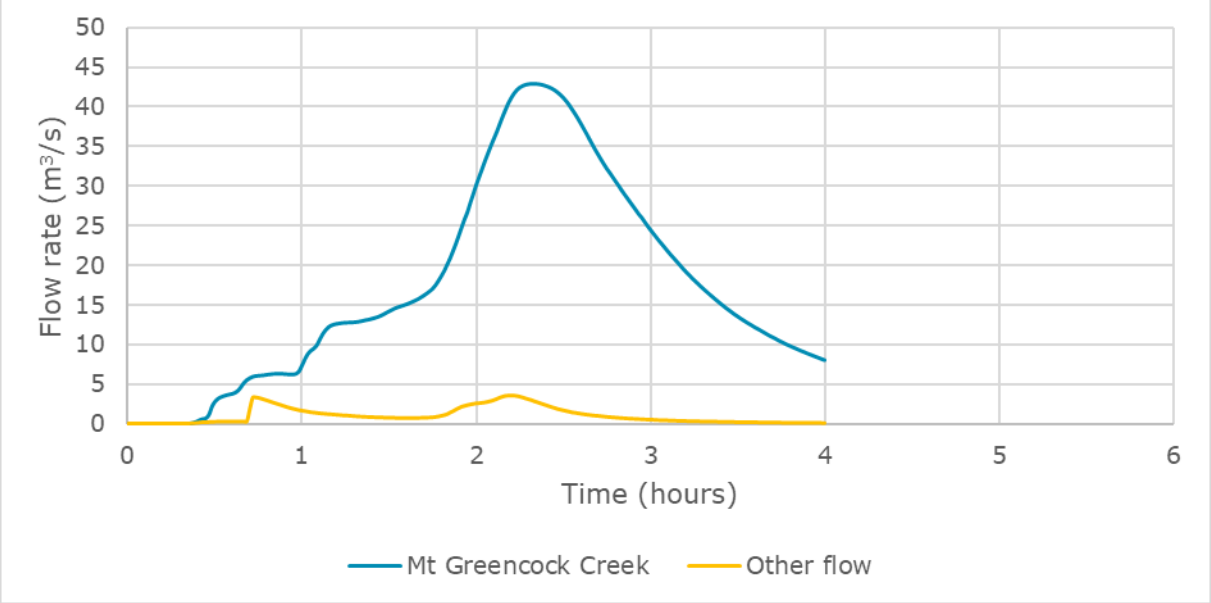


Figure 6-4: Design flow hydrographs for Catchment 2

6.3 Water levels

Consistent with the Guidelines for Development in Flood Affected Areas (DEWLP 2019), a flood is defined as the covering of normally dry land by water. The insurance industry considers flooding to be water that has escaped or been released from the normal confines of:

a) a lake, river, creek or other natural watercourse, whether or not altered or modified; or

b) any reservoir, canal, or dam.

Overland flooding is defined as inundation by local runoff caused by heavier than usual rainfall. Overland flooding and flooding from the mapped watercourses in the vicinity of the site are shown in Figure 6-5.

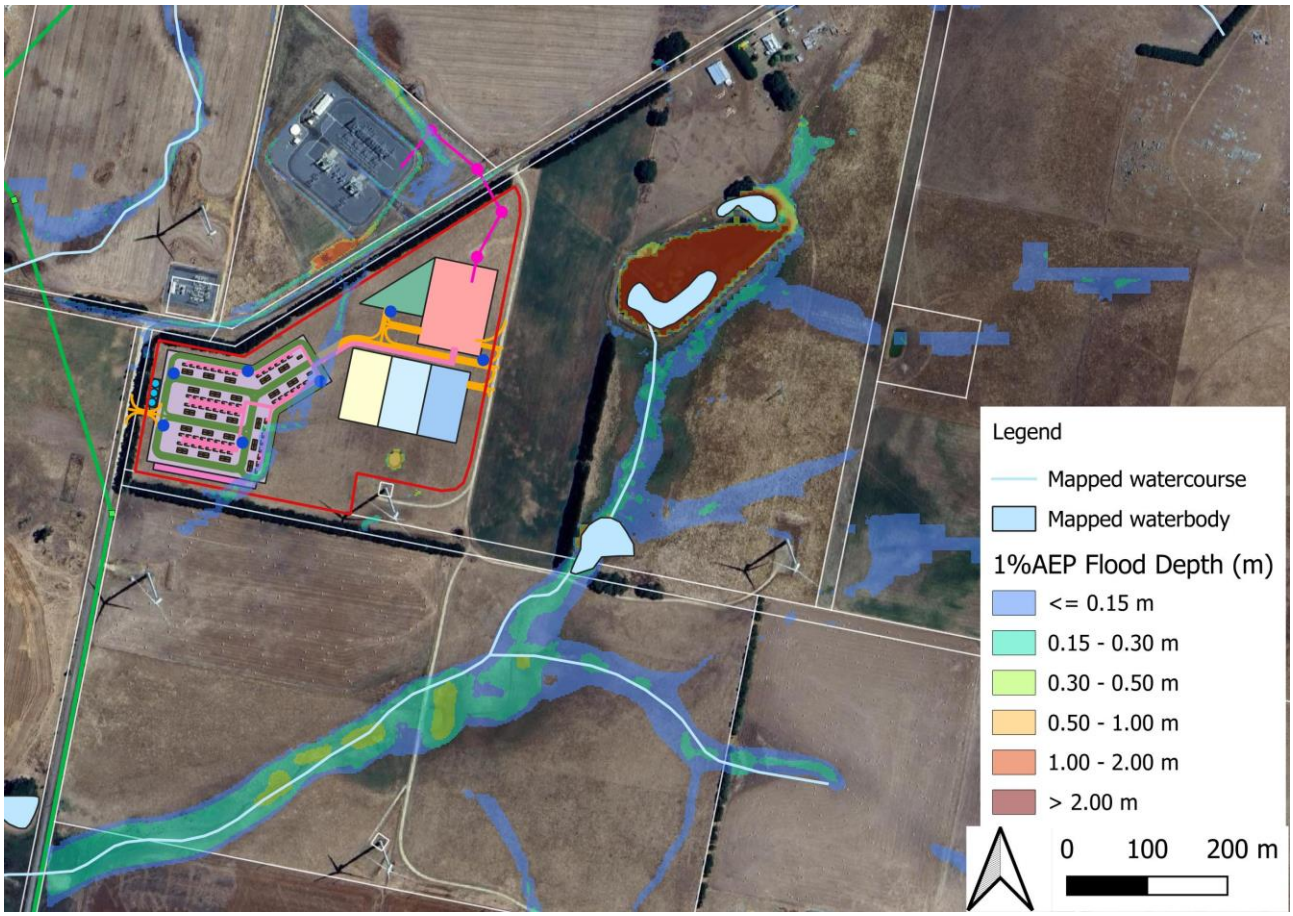


Figure 6-5: 1% AEP Flood Depth and mapped watercourse

Water levels from overland flow in the drainage line through the site were assessed. Peak water levels for the nominated AEP events are presented in Table 6-4, noting that water levels are the maximum recorded water level in the area indicated in the footprint of the layout.

Table 6-4: Maximum surface water elevation BESS plant

Reporting Location	0.5%	1%	2%	5%	10%	20%	50%
Surface water elevation (m AHD)	519.93	519.84	519.83	518.27	517.98	-	-

Depth is greatest along the eastern side of the BESS plant, as shown Figure 6-6 (full details are included in the Appendix). Maximum water levels along the profile are shown in Figure 6-7, with water depth for the 1% AEP and 1% AEP climate change (2100 SSP5-8.5) scenarios 250mm and 350mm, respectively.

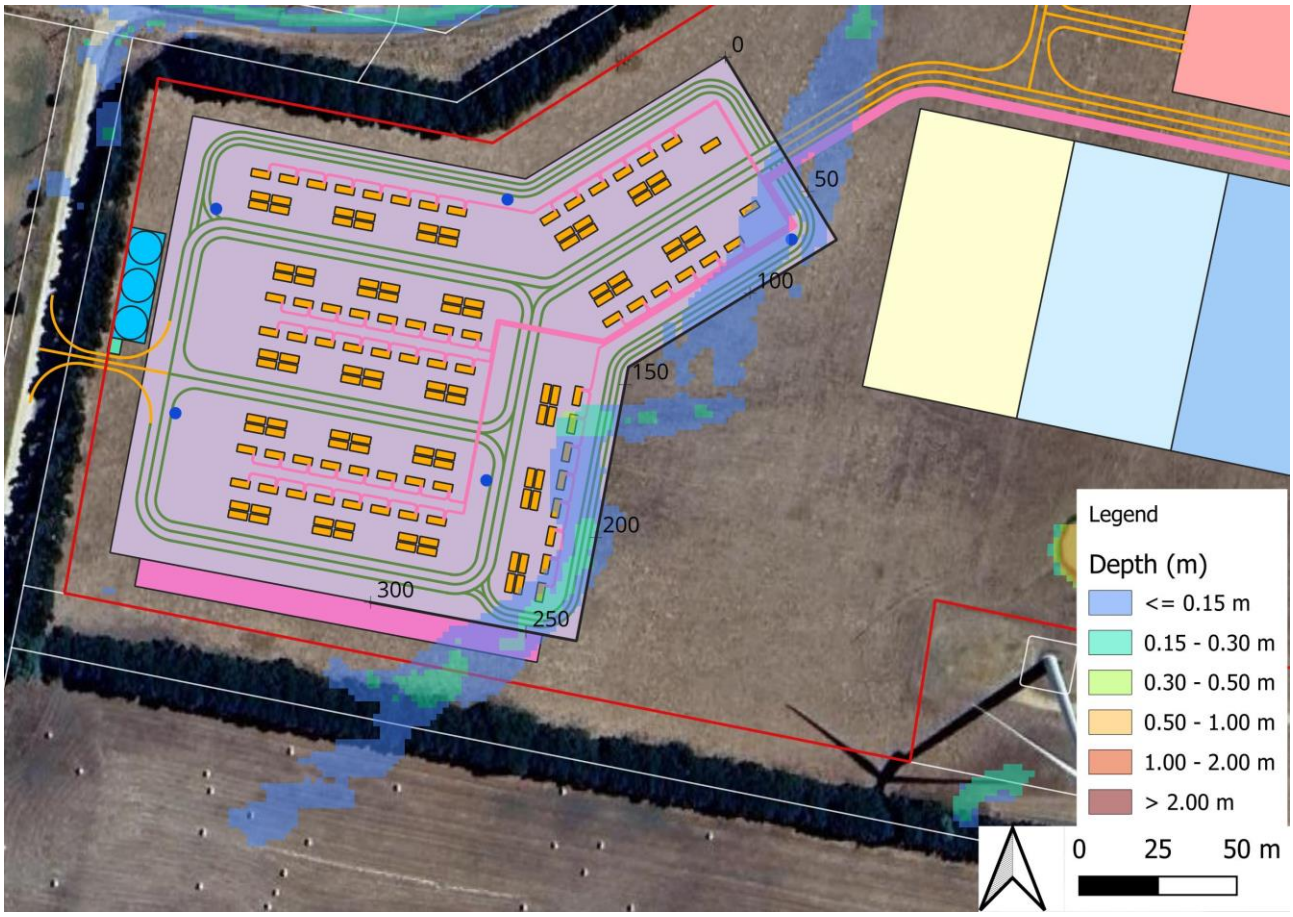


Figure 6-6: BESS plant site profile location

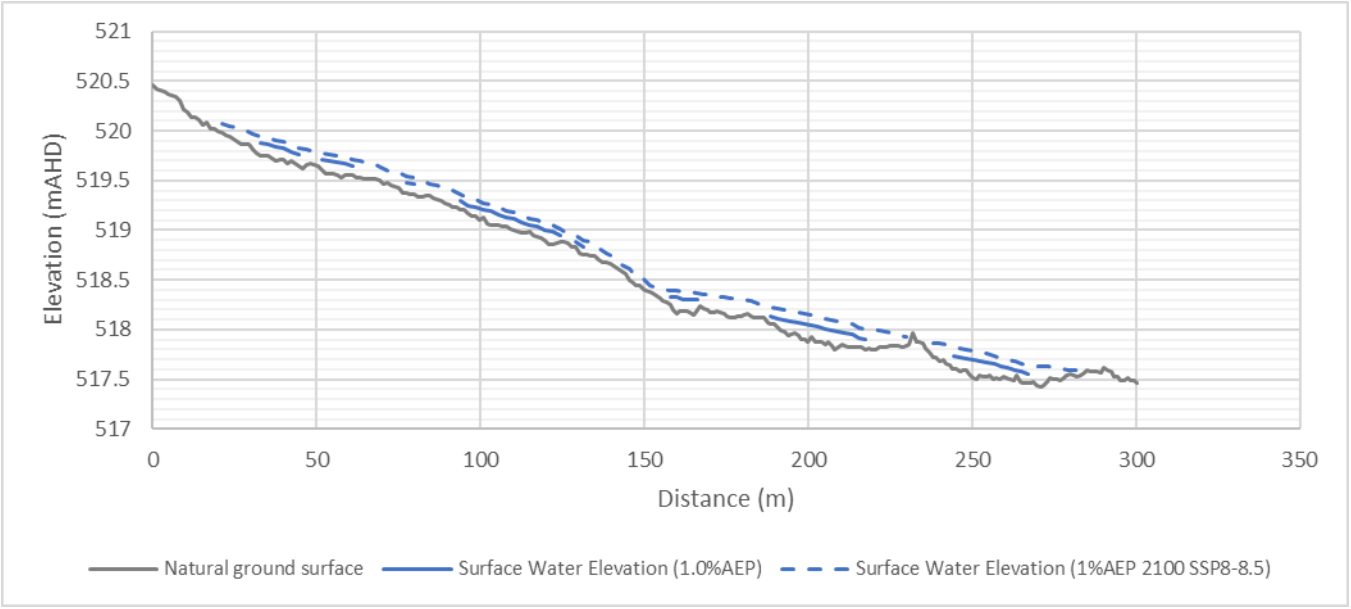


Figure 6-7: BESS plant profile water levels for 1% AEP and 1% AEP 2100 SSP5-8.5

6.4 Mapping

Peak flood depths, peak water surface elevations, flow velocities and depth-velocity product were produced for the project area for the frequent (50% and 20% AEP), infrequent (10% and 5% AEP), and rare (2%, 1% and 0.5% AEP) design rainfall events, and are presented in Appendix B.

As per the local Flood Modelling Guidelines and Specifications (Hopkins Glenelg CMA, 2024) depth-velocity product mapping has been undertaken, using the ranges as specified. The depth-velocity ranges and descriptions from the Guidelines for Development in Flood Affected Areas (DEWLP 2019) are included in Table 6-5, noting that only the relevant development categories are detailed (See Table 2 and 3 of the Guidelines for the full list of situations).

Table 6-5: Depth-velocity product ranges

Depth-velocity product (m^2/s)	Description	Safety Thresholds
< 0.3	Generally safe for vehicles, people and buildings	
< 0.4	Unsafe for small cars	Industrial building, office, place of assembly, retail building, or warehouse Entrance to lots
> 0.4	Unsafe for children	

Due to the nature of the model input, the entire study area can be shown to be inundated, and ponding of isolated pockets can occur. This reduces the practical value of the model output. Filtering is therefore required to make the data more usable. The following procedure was applied, based on Sunshine Coast Council Rainfall on Grid Output Filtering (Sunshine Coast Council 2018):

1. Remove areas where the depth is less than 0.01m AND the depth-velocity product is less than 0.125 m^2/s.
2. Remove areas where the depth-velocity product is less than 0.02 m^2/s.
3. Retain areas where depth is greater than 0.3 m, even if the depth-velocity product is low.

The direct rainfall on the project area which produce overland flows towards south-west direction through the infrastructure area. Some infrastructure areas experience shallow overland flooding up to 0.3m, with low flood severity (depth-velocity is less than $0.3m^2/s$). The access road connecting the BESS to the substation also experiences shallow flooding with low flood severity. No overland flooding is indicated in the design event for the access to the site from Troys Road. Flooding from the mapped watercourse to the east and south is not expected to impact the site.

6.5 Validation

TUFLOW results were validated against the Waubra Preliminary Flood Study (Utilis, 2018) for the 1%AEP at the downstream boundary to the north (Catchment 2 and 4 combined), supplemented with rational method calculations (Table 6-2 and Table 6-3). Peak flow at the

key reporting location on Mt Greencock Creek is detailed in Table 6-6. While there is some difference in the 1%AEP flow, there is reasonable alignment is the reported flows between the different methods and with the Waubra Flood Study (Utilis 2018). For the purposes of is study, the results are considered appropriate.

Table 6-6: Peak flow validation (m^3/s)

AEP (%)	TUFLOW	Rational Method	Waubra Flood Study (Utilis 2018)
50	7.25	13.5	
20	16.0	18.3	
10	21.8	22.8	
5	28.3	29.3	
2	42.3	36.9	
1	54.8	43.6	45.7

6.6 Sensitivity analysis

6.6.1 Climate change

Increased flow associated with the 2050 SSP2-4.5 and 2100 SSP5-8.5 design horizon were assessed for the 1% AEP in accordance with the Hopkins Glenelg CMA Flood Modelling Guidance (Glenelg Hopkins CMA 2024), with mapping included in Appendix B. The analysis shows that water levels are expected to increase by up 50 mm under the 2050 SSP2-4.5 and up to 150 mm under the 2100 SSP5-8.5 scenarios in the project area. Greater increases are noted further downstream in the modelled area.

Peak depth-velocity product for the 2100 SSP5-8.5 is included in Appendix A (A23). Mapping shows that the while the extent of flooding increases, the site remains low flood severity, with dv < 0.3 m^2/s. Depth-velocity product of less than 0.3 m^2/s indicates minimal risk to people, vehicles and buildings.

6.6.2 Floodplain roughness

The adoption of a 20% increase in floodplain roughness across the model areas has resulted in increased flood levels in the main creek systems, as is to be expected. Analysis shows that water levels could be up to 20 mm higher within the project area, although greater increases are noted further downstream.

Based on the results of the assessment, it is expected that uncertainty and risk associated with the difference between the adopted and actual floodplain roughness values across the Study Area could typically be mitigated by adoption of a standard design freeboard of 300 mm, consistent with Victorian Guidelines for Development in Flood Affected Areas (DEWLP 2019).

7. Conclusions

Worley Consulting has undertaken a hydrological study of the Waubra BESS using the latest industry assessment methods and data.

A direct rain on grid approach was applied in this study with loss parameters applied from the Waubra Preliminary Flood Investigation (2018). The events analysed included 50%, 20%, 10%, 5%, 2%, 1% and 0.5% (1 in 200) AEP with durations ranging from 15 minutes to 9 hours. An ensemble approach, as recommended by ARR2019 (i.e. 10 temporal patterns for each duration) was undertaken.

It can be concluded from the analysis that:

- The Waubra Preliminary Flood Study (Utilis 2018) provides local loss parameters and flow estimates in the adjacent catchment, in close proximity to the site. Loss parameters from this report are adopted for the study, with initial loss (IL_s) 19.8 mm and continuing loss (CL) of 1.0 mm/hr.
- A 1% AEP event has been adopted as the design event for this study, with the 2100 design horizon under the SSP5-8.5 climate change scenario used here to notionally represent a plausible upper bound on the projected climate impacts.
- The proposed BESS infrastructure is not affected by flooding from any mapped watercourse. The site does experience shallow overland flow in the design flood event, as do associated laydown areas.
- Site access may be affected by shallow overland flow, however flood severity is expected to be low.
- Sensitivity assessment of the future climate scenario as well as increased floodplain roughness typically showed peak flood level increases of up to approximately 250 mm. Uncertainties and associated risks relating to both the exact floodplain roughness across the Study Area and future climate could be mitigated by adoption of a standard design freeboard of 300 mm.

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Appendix A. Flood Mapping

730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
- Transmission Line
- Internal BESS Road
- Access Track
- 33kV Reticulation
- Fire Hydrants
- Battery Block
- BESS Area
- Operation & Maintenance
- BESS Substation
- Transmission Tower
- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A1: Peak Flood Depth 0.5% AEP

Legend

Depth (m)
- <= 0.15 m
- 0.15 - 0.30 m
- 0.30 - 0.50 m
- 0.50 - 1.00 m
- 1.00 - 2.00 m
- > 2.00 m

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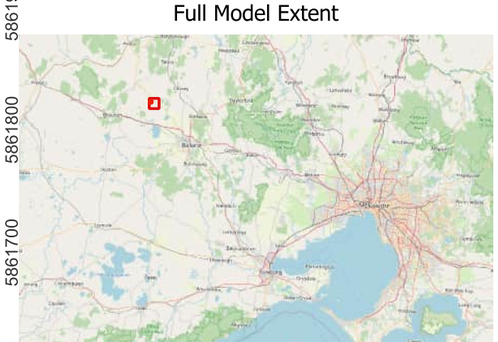
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
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- BESS Substation
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- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

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Waubra BESS

Figure A2: Peak Flood Velocity 0.5% AEP

Legend

Velocity (m/s)
- <= 0.5 m/s
- 0.5 - 1.0 m/s
- 1.0 - 1.5 m/s
- 1.5 - 2.0 m/s
- > 2.0 m/s

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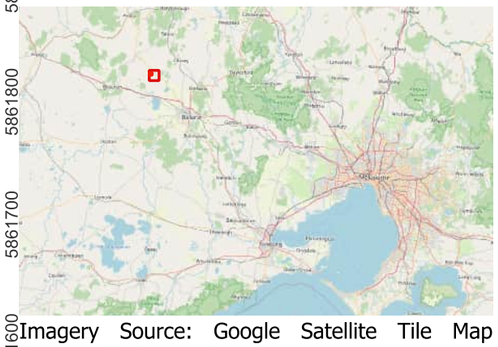
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Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

worley consulting

730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
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- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A3: Depth Velocity Product 0.5% AEP

Legend

Depth-Velocity Product (m2/s)
- <= 0.3
- 0.3 - 0.4
- > 0.4

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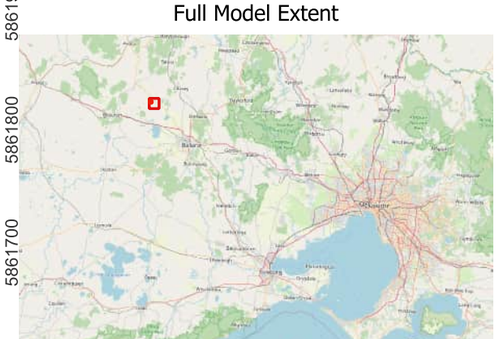
Coordinate System: GDA2020 / MGA Zone 54

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Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
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- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A4: Peak Flood Depth 1% AEP

Legend

Depth (m)
- <= 0.15 m
- 0.15 - 0.30 m
- 0.30 - 0.50 m
- 0.50 - 1.00 m
- 1.00 - 2.00 m
- > 2.00 m

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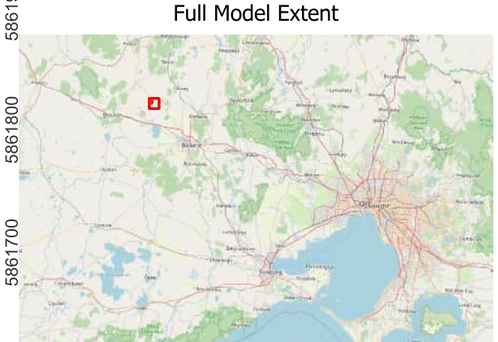
Coordinate System: GDA2020 / MGA Zone 54

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0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
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- Transmission Tower
- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A5: Peak Flood Velocity 1% AEP

Legend

Velocity (m/s)
- <= 0.5 m/s
- 0.5 - 1.0 m/s
- 1.0 - 1.5 m/s
- 1.5 - 2.0 m/s
- > 2.0 m/s

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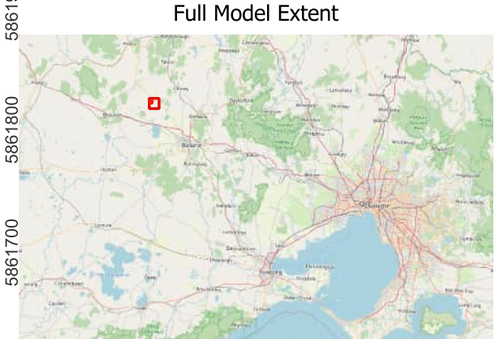
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
- Transmission Line
- Internal BESS Road
- Access Track
- 33kV Reticulation
- Fire Hydrants
- Battery Block
- BESS Area
- Operation & Maintenance
- BESS Substation
- Transmission Tower
- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A6: Depth Velocity Product 1% AEP

Legend

Depth-Velocity Product (m2/s)
- <= 0.3
- 0.3 - 0.4
- > 0.4

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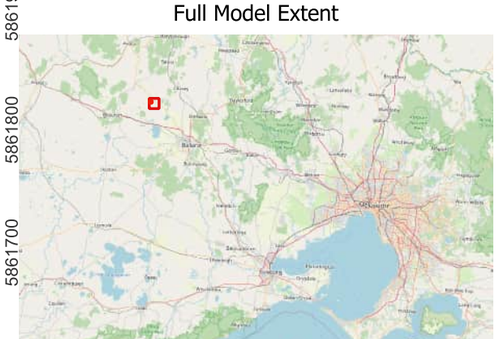
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
- Transmission Line
- Internal BESS Road
- Access Track
- 33kV Reticulation
- Fire Hydrants
- Battery Block
- BESS Area
- Operation & Maintenance
- BESS Substation
- Transmission Tower
- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A7: Peak Flood Depth 2% AEP

Legend

Depth (m)
- <= 0.15 m
- 0.15 - 0.30 m
- 0.30 - 0.50 m
- 0.50 - 1.00 m
- 1.00 - 2.00 m
- > 2.00 m

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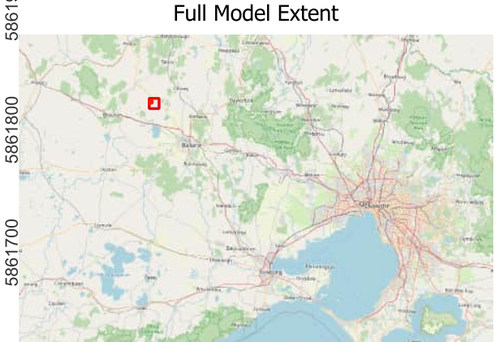
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
- Transmission Line
- Internal BESS Road
- Access Track
- 33kV Reticulation
- Fire Hydrants
- Battery Block
- BESS Area
- Operation & Maintenance
- BESS Substation
- Transmission Tower
- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A8: Peak Flood Velocity 2% AEP

Legend

Velocity (m/s)
- <= 0.5 m/s
- 0.5 - 1.0 m/s
- 1.0 - 1.5 m/s
- 1.5 - 2.0 m/s
- > 2.0 m/s

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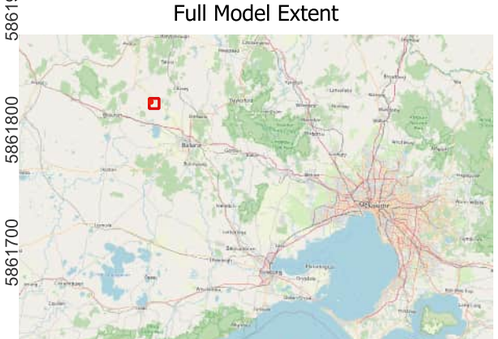
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



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5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
- Transmission Line
- Internal BESS Road
- Access Track
- 33kV Reticulation
- Fire Hydrants
- Battery Block
- BESS Area
- Operation & Maintenance
- BESS Substation
- Transmission Tower
- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

0 50 100 200 300
0 50 100 250

Waubra BESS

Figure A9: Depth Velocity Product 2% AEP

Legend

Depth (m)
- <= 0.15 m
- 0.15 - 0.30 m
- 0.30 - 0.50 m
- 0.50 - 1.00 m
- 1.00 - 2.00 m
- > 2.00 m

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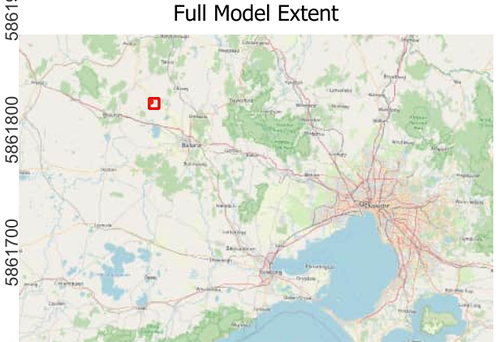
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
- Transmission Line
- Internal BESS Road
- Access Track
- 33kV Reticulation
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- Battery Block
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- Operation & Maintenance
- BESS Substation
- Transmission Tower
- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A10: Peak Flood Depth 5% AEP

Legend

Depth (m)
- <= 0.15 m
- 0.15 - 0.30 m
- 0.30 - 0.50 m
- 0.50 - 1.00 m
- 1.00 - 2.00 m
- > 2.00 m

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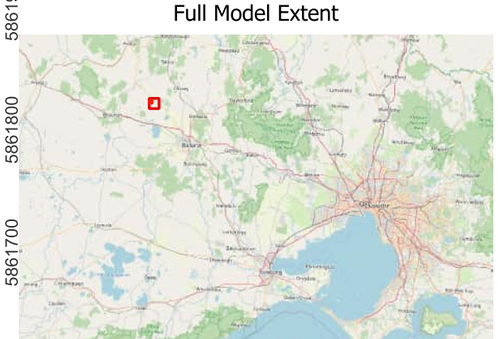
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



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Layout
- Project Area
- Transmission Line
- Internal BESS Road
- Access Track
- 33kV Reticulation
- Fire Hydrants
- Battery Block
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- Operation & Maintenance
- BESS Substation
- Transmission Tower
- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A11: Peak Flood Velocity 5% AEP

Legend

Velocity (m/s)
- <= 0.5 m/s
- 0.5 - 1.0 m/s
- 1.0 - 1.5 m/s
- 1.5 - 2.0 m/s
- > 2.0 m/s

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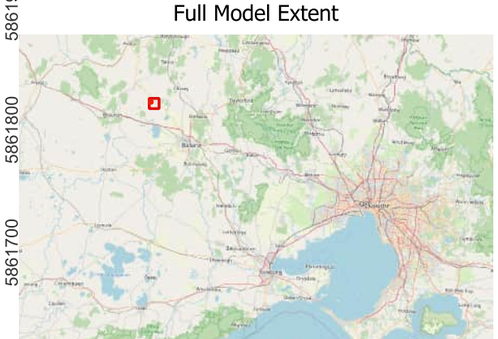
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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Layout
- Project Area
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- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A12: Depth Velocity Product 5% AEP

Legend

Depth-Velocity Product (m2/s)
- <= 0.3
- 0.3 - 0.4
- > 0.4

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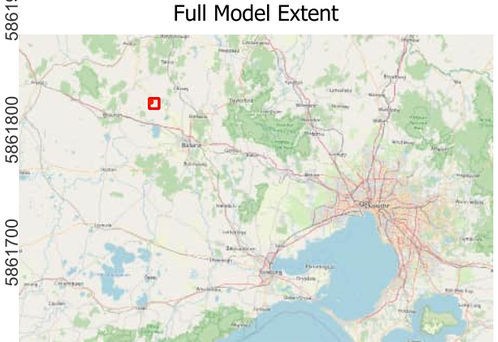
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



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5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
- Transmission Line
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- BESS Substation
- Transmission Tower
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- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A13: Peak Flood Depth 10% AEP

Legend

Depth (m)
- <= 0.15 m
- 0.15 - 0.30 m
- 0.30 - 0.50 m
- 0.50 - 1.00 m
- 1.00 - 2.00 m
- > 2.00 m

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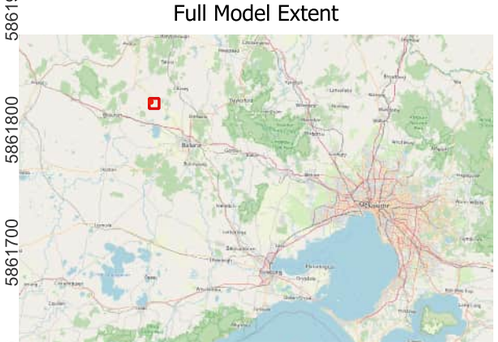
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



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Layout
- Project Area
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- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A14: Peak Flood Velocity 10% AEP

Legend

Velocity (m/s)
- <= 0.5 m/s
- 0.5 - 1.0 m/s
- 1.0 - 1.5 m/s
- 1.5 - 2.0 m/s
- > 2.0 m/s

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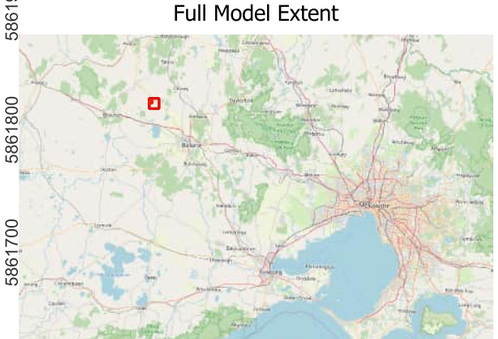
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



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Layout
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- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

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Waubra BESS

Figure A15: Depth Velocity Product
10% AEP

Legend

Depth-Velocity Product (m2/s)
- <= 0.3
- 0.3 - 0.4
- > 0.4

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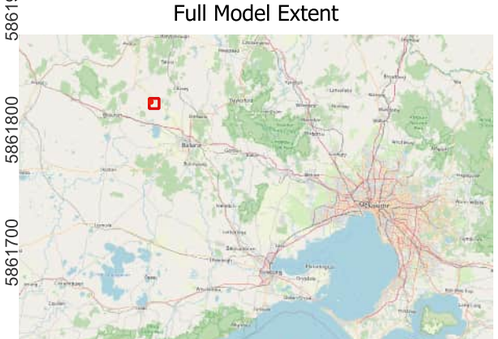
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



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5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
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- Fire Fighting Pump Set
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- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A16: Peak Flood Depth 20% AEP

Legend

Depth (m)
- <= 0.15 m
- 0.15 - 0.30 m
- 0.30 - 0.50 m
- 0.50 - 1.00 m
- 1.00 - 2.00 m
- > 2.00 m

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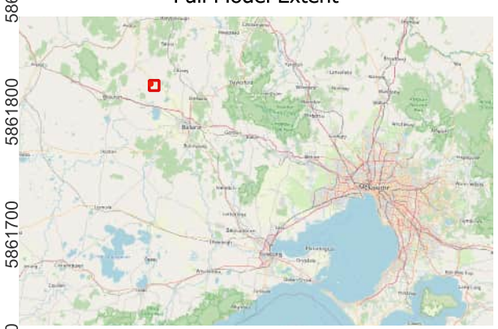
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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Layout
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- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A17: Peak Flood Velocity 20% AEP

Legend

Velocity (m/s)
- <= 0.5 m/s
- 0.5 - 1.0 m/s
- 1.0 - 1.5 m/s
- 1.5 - 2.0 m/s
- > 2.0 m/s

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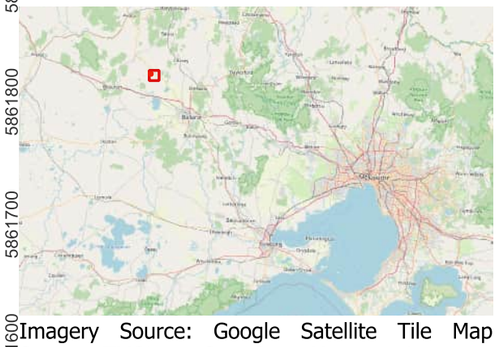
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



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Layout
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- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

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Waubra BESS

Figure A18: Depth Velocity Product
20% AEP

Legend

Depth-Velocity Product (m2/s)
- <= 0.3
- 0.3 - 0.4
- > 0.4

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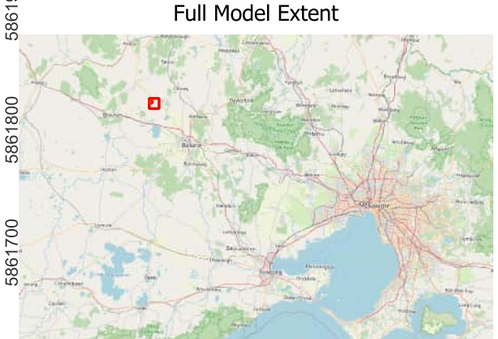
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
- Transmission Line
- Internal BESS Road
- Access Track
- 33kV Reticulation
- Fire Hydrants
- Battery Block
- BESS Area
- Operation & Maintenance
- BESS Substation
- Transmission Tower
- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

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Waubra BESS

Figure A19: Peak Flood Depth 50% AEP

Legend

Depth (m)
- <= 0.15 m
- 0.15 - 0.30 m
- 0.30 - 0.50 m
- 0.50 - 1.00 m
- 1.00 - 2.00 m
- > 2.00 m

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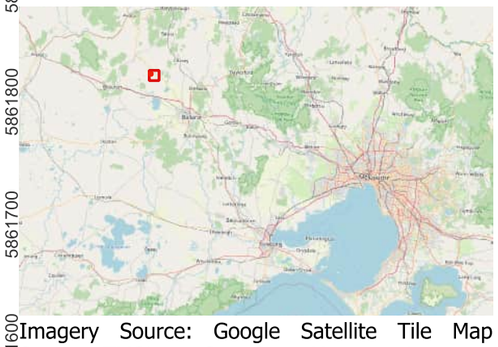
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
- Transmission Line
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- BESS Area
- Operation & Maintenance
- BESS Substation
- Transmission Tower
- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A20: Peak Flood Velocity 50% AEP

Legend

Velocity (m/s)
- <= 0.5 m/s
- 0.5 - 1.0 m/s
- 1.0 - 1.5 m/s
- 1.5 - 2.0 m/s
- > 2.0 m/s

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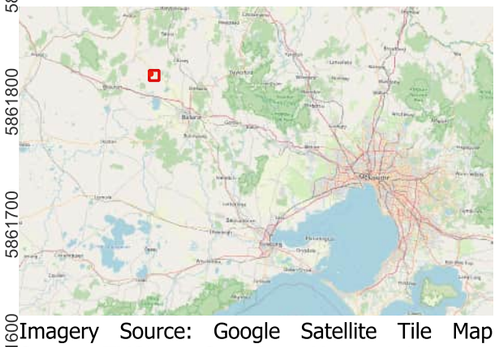
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
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TUFLOW
- Model Extent

Troys Road

Gordons Road

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Waubra BESS

Figure A21: Depth Velocity Product
50% AEP

Legend

Depth-Velocity Product (m2/s)
- <= 0.3
- 0.3 - 0.4
- > 0.4

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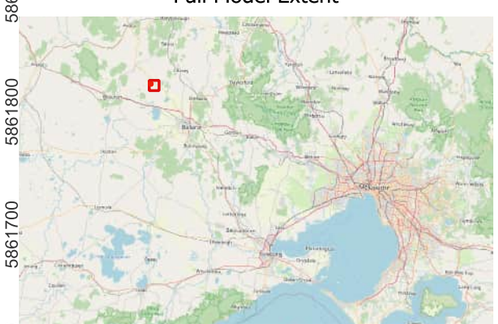
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
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- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Waubra BESS

Figure A22: Depth Velocity Product 1% AEP CC 2100

Legend

Depth (m)
- <= 0.15 m
- 0.15 - 0.30 m
- 0.30 - 0.50 m
- 0.50 - 1.00 m
- 1.00 - 2.00 m
- > 2.00 m

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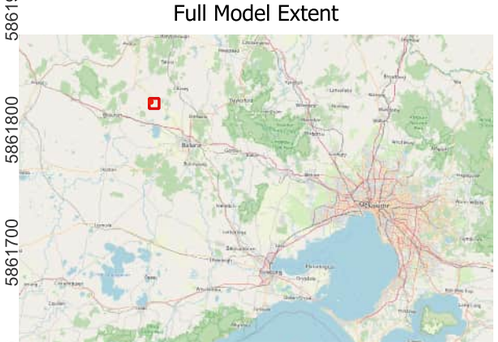
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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Appendix B. Sensitivity Maps

730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
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- Fire Fighting Pump Set
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- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Legend

Afflux	Afflux (m)
Was wet, now dry	<= -2.00
Was dry, now wet	-2.00 - -1.00
	-1.00 - -0.50
	-0.50 - -0.30
	-0.30 - -0.20
	-0.20 - -0.10
	-0.10 - -0.05
	-0.05 - -0.02
	-0.02 - 0.02
	0.02 - 0.05
	0.05 - 0.10
	0.10 - 0.20
	0.20 - 0.30
	0.30 - 0.50
	0.50 - 1.00
	1.00 - 2.00
	> 2.00

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Waubra BESS

Figure B1: Climate change afflux
1% AEP
SSP2-4.5 2050

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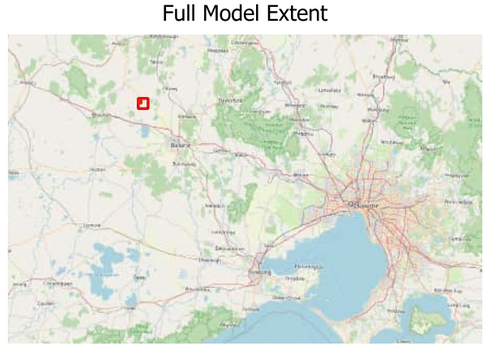
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

Layout
- Project Area
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- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Troys Road

Gordons Road

Legend

Afflux	Afflux (m)
Was wet, now dry	<= -2.00
Was dry, now wet	-2.00 - -1.00
	-1.00 - -0.50
	-0.50 - -0.30
	-0.30 - -0.20
	-0.20 - -0.10
	-0.10 - -0.05
	-0.05 - -0.02
	-0.02 - 0.02
	0.02 - 0.05
	0.05 - 0.10
	0.10 - 0.20
	0.20 - 0.30
	0.30 - 0.50
	0.50 - 1.00
	1.00 - 2.00
	> 2.00

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Waubra BESS

Figure B2: Climate change afflux
1% AEP
SSP5-8.5 2100

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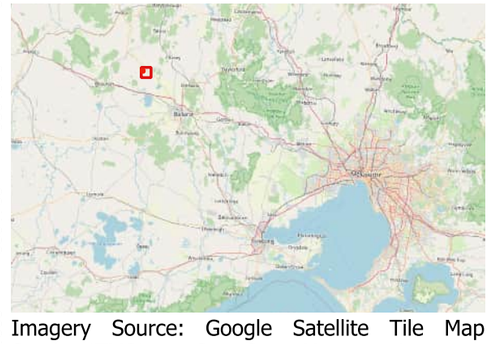
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent

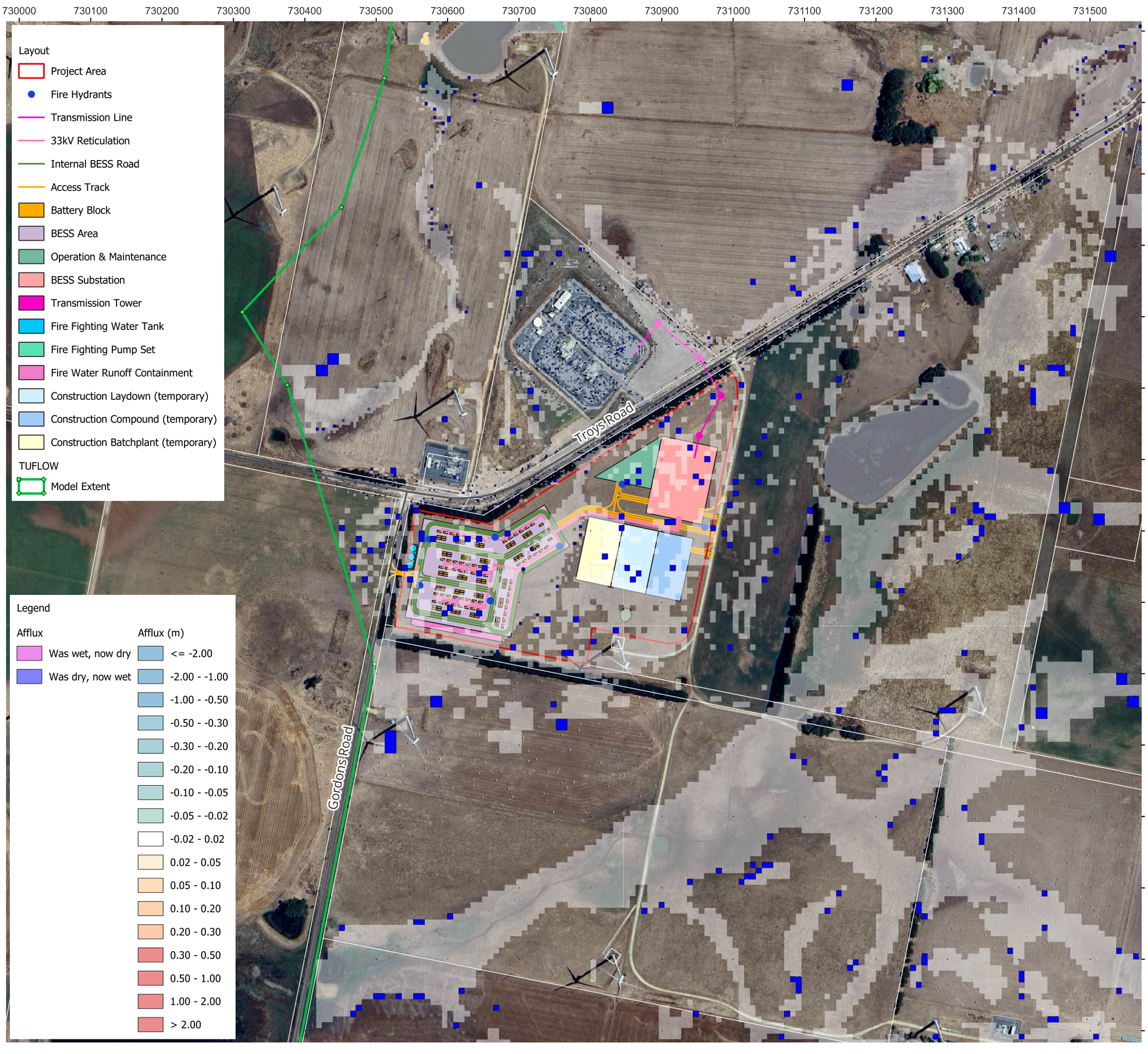


Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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Waubra BESS

Figure B3: Higher Manning's 'n' afflux
1% AEP
1%AEP +20%



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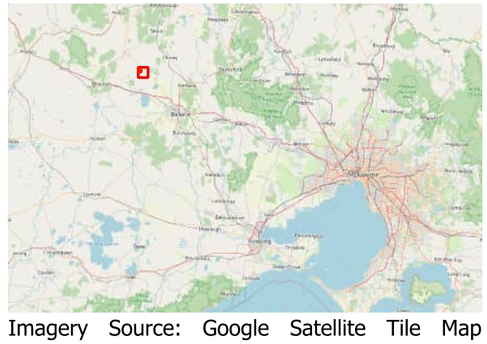
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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Waubra BESS

Figure B4: Lower Manning's 'n' afflux
1% AEP
-20%

Layout
- Project Area
- Fire Hydrants
- Transmission Line
- 33kV Reticulation
- Internal BESS Road
- Access Track
- Battery Block
- BESS Area
- Operation & Maintenance
- BESS Substation
- Transmission Tower
- Fire Fighting Water Tank
- Fire Fighting Pump Set
- Fire Water Runoff Containment
- Construction Laydown (temporary)
- Construction Compound (temporary)
- Construction Batchplant (temporary)

TUFLOW
- Model Extent

Legend

Afflux	Afflux (m)
Was wet, now dry	<= -2.00
Was dry, now wet	-2.00 - -1.00
	-1.00 - -0.50
	-0.50 - -0.30
	-0.30 - -0.20
	-0.20 - -0.10
	-0.10 - -0.05
	-0.05 - -0.02
	-0.02 - 0.02
	0.02 - 0.05
	0.05 - 0.10
	0.10 - 0.20
	0.20 - 0.30
	0.30 - 0.50
	0.50 - 1.00
	1.00 - 2.00
	> 2.00

Troys Road

Gordons Road

730000 730100 730200 730300 730400 730500 730600 730700 730800 730900 731000 731100 731200 731300 731400 731500

5862900 5862800 5862700 5862600 5862500 5862400 5862300 5862200 5862100 5862000 5861900 5861800 5861700 5861600 5861500

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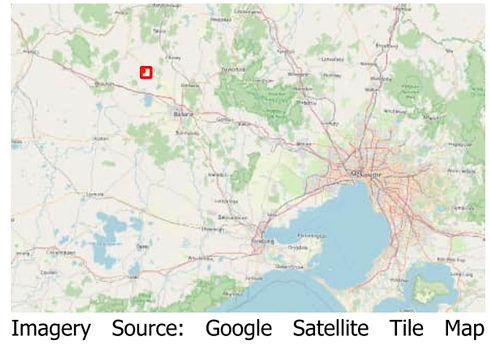
Coordinate System: GDA2020 / MGA Zone 54

N

0 100 200 300 m

Scale at A3 - 1:5,000

Full Model Extent



Imagery Source: Google Satellite Tile Map Service (TMS) and OpenStreetMap contributors.

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