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Mortlake Energy Hub Hydrology Assessment

Urbis

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Template 2.8.1

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Abbreviations

Abbreviation	Description
2D	Two dimensional
AEP	Annual Exceedance Probability
ARR	Australian Rainfall and Runoff
BESS	Battery Energy Storage System
BOM	Bureau of Meteorology
CL	Continuing loss
DEM	Digital Elevation Model
ELA	Eco Logical Australia Pty Ltd.
HEC-RAS	Hydrologic Engineering Centre River Analysis System
IFD	Intensity-Frequency-Duration
IL	Initial loss
RFFE	Regional Flood Frequency Estimation

Executive Summary

Eco Logical Australia Pty Ltd (ELA) were engaged by Urbis to assess potential flood impacts at the Mortlake Energy Hub (MEH) Project Site associated with existing hydrologic conditions under the 10%, 2%, 1%, 0.5%, 0.2% and 0.1% Annual Exceedance Probability (AEP) flood events.

Hydrologic and hydraulic modelling of existing conditions at the Project Site were undertaken using the RORB and HEC-RAS software packages to determine flood extents, flood levels and flow velocities associated with each target AEP rainfall design scenario. The modelling methods were calibrated using best initial loss estimates based on previous similar modelling and RFFE analysis for the region.

The existing conditions' flood depths showed that, in general, the flows are concentrated to the waterways and defined overland flow paths in the region with sufficient terrain relief to limit the amount (depth and velocity) of sheet flow. The primary flood features relevant to the MEH comprise Salt Creek to the north, Blind Creek to the southeast and an unnamed tributary to Salt Creek in the southwest. The model predicts that flow in these features stay largely confined to their banks and their defined flood plains and their most significant impact may be to affect access tracks at the site.

Maximum modelled depths outside these channels across the MEH proposed solar array area were generally shallow (<0.4 m) under each AEP scenario and stormwater should pass under the proposed arrays. Shallow inundation (<0.25 m) is predicted in the southwest corner of the battery energy storage system (BESS) area under each modelled scenario and should drain quickly to the west with minimal impact to the BESS area or natural overland flow patterns. Although the proposed BESS layout includes impervious surfaces, the total area was such a small proportion (<0.1%) of the overall catchment that it is not considered to affect the outcomes of hydraulic modelling nor impact existing condition overland flow regimes.

The proposed gravel emergency access track and the underground transmission cable line will intersect an unnamed drainage line located between the MEH BESS/ substation and solar array area boundaries. The proposed emergency access track will not be raised and will therefore not impact natural flow regimes. Although maximum modelled depths within the proposed track alignment may reach between 1 and 5m under flood conditions, modelled velocities indicate erosion is unlikely to occur (<0.4 m/s under 0.1% AEP). The underground transmission line is similarly very unlikely to present impacts to surface water flows as the proposed depth to cabling will be 0.6 m below ground level. This assumes the existing surface is reinstated following completion of underground cable installation earthworks.

Although some access points and tracks within the Project Site boundary intersect the inundation area, the modelled flood extent and maximum depths indicate that these will generally remain passible under flooded conditions (typically <0.25 m).

The modelled velocities show that, in general, velocities across the MEH Project Site (excluding Salt Creek) tend to be low (< 1 m/s) and below the threshold (< 2 m/s) where rock armouring to protect waterways and features is required.

Based on results of hydrologic and hydraulic modelling, the proposed layout (as provided by Urbis on 15th April 2024) is considered suitable from a flood risk perspective. Further minor changes to the site

layout should not impact the site from a surface water impact perspective but should be reviewed in the context of flood modelling results to confirm suitability of the updated design. It is recommended to include general stormwater management and erosion control measures during construction and operational activities at the Project Site.

1. Introduction

Eco Logical Australia Pty Ltd (ELA) has been engaged by Urbis to assess hydrological conditions associated with the 10%, 2%, 1%, 0.5%, 0.2% and 0.1% Annual Exceedance Probability (AEP) flood events at the proposed Mortlake Energy Hub (MEH), located approximately 200 km west of Melbourne, Victoria (Figure 1-1), 6 km north-east of the confluence of the Hopkins River Catchment (the 'Project Site').

The objective of the flood impact assessment was to provide:

1. Estimated peak flow rates for the specified AEP storm events (see Section 5.1).
2. Estimated peak flood depths and velocities for the specified AEP storm events (see Section 5.2).

This report details the modelling approach and modelling results that underpin the flood impact assessment.

1.1. Scope of work

The scope of work included:

- Review and collation of data sourced and applied as part of the assessment (Section 2).
- Hydrologic modelling to determine flow rates and verify the hydraulic modelling (Section 3).
- Hydraulic modelling to determine water levels and velocities (Section 4).
- Presentation and review of hydrologic and hydraulic modelling results (Section 5).
- Assessment of flood impact results in the context of the Project Site (Section 6).

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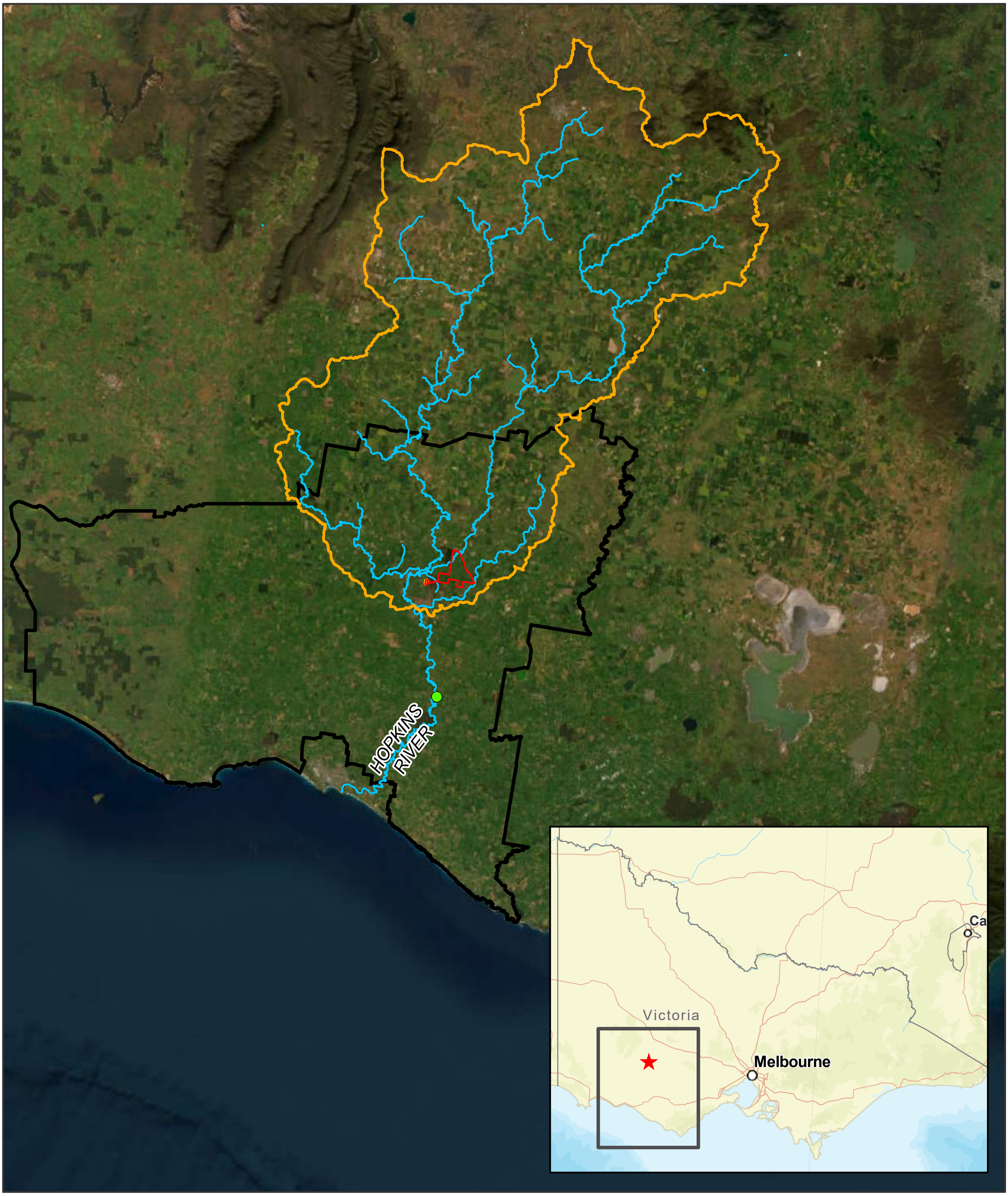

Figure 1-1 Site locality

- MEH development boundary
- Proposed BESS and substation boundary
- Catchment boundary
- Watercourse
- BoM Gauge 236210
- Moyne LGA boundary

0 5 10 20
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD5272-ED Date: 4/18/2024

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2. Data requirements

The following datasets were sourced for use in this assessment:

- Digital Elevation Model (DEM) to represent the watershed (catchment) that drains the site and any adjacent waterways.
- Site survey within the Project Site boundary, as provided by Urbis.
- Development footprint for the Project Site, as provided by Urbis.
- Gauged rainfall data representing the rainfall falling on the catchment at a sub-daily time step for use in calibration.
- Gauged flow data representing flows in the catchment for calibration of flow rates.
- Bureau of Meteorology (BoM) Intensity Frequency Duration (IFD) data representing the rainfall intensities for design rainfall events for the specified catchment.
- Australian Rainfall and Runoff (AR&R) information for rainfall patterns and loss information for use in the flow rate modelling.
- Regional Flood Frequency Estimation (RFFE) modelling to validate the flow rate model results for design storm events.

2.1. Digital Elevation Model (DEM)

A regional DEM was sourced to determine runoff catchments for waterways that drain to or through the Project Site. Regional elevation information was sourced from the Australian Government's Intergovernmental Committee on Surveying and Mapping (ICSM) Elevation and Depth – Foundation Spatial Data (ELVIS) website. The most detailed DEM available that covered the regional catchment area relevant to the Project Site was at a resolution of 10 metres (m) by 10 m.

The regional DEM was supplemented by the Project Site topographical survey data as provided by Urbis.

The resulting surface elevation used for hydrologic modelling is illustrated in Figure 2-1.

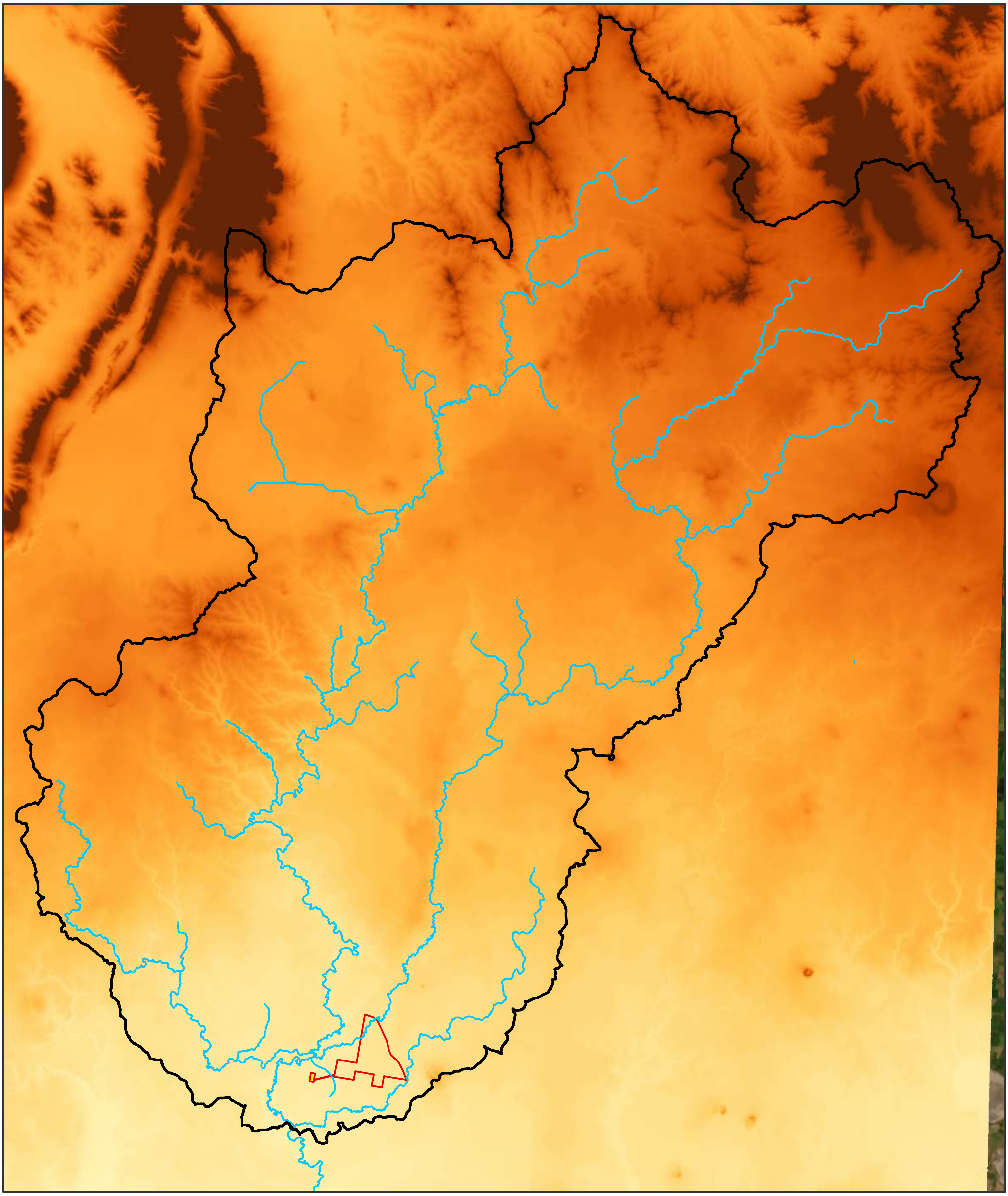

Figure 2-1 Catchment features

2.2. Observed streamflow

Observed streamflow information was available at the Hopkins River gauge at Framlingham (gauge number 236210), located within the same regional catchment as the Project Site but approximately 27 km south (down-stream) (-38.2438˚ S, 142.703˚ E) as shown in Figure 1-1. Data was sourced from the Bureau of Meteorology (BoM) from 15 July 1974 to 17 September 2023 as shown in Figure 2-2.

Although useful in providing context for expected peak flows at the Project Site, the Hopkins River sub-catchments relevant to the Project Site covers less area than the catchment as measured at the Framlingham gauge and the available observed discharge records (<300 m^3/s) do not capture a flood event more intense than the 10% AEP. Therefore, the total observed flows at the nearest available gauge station were not considered suitable for calibration of the RORB model, and the relevant Regional Flood Frequency Estimation (RFFE; AR&R, 2019) was utilised instead (see Section 3.2.3).

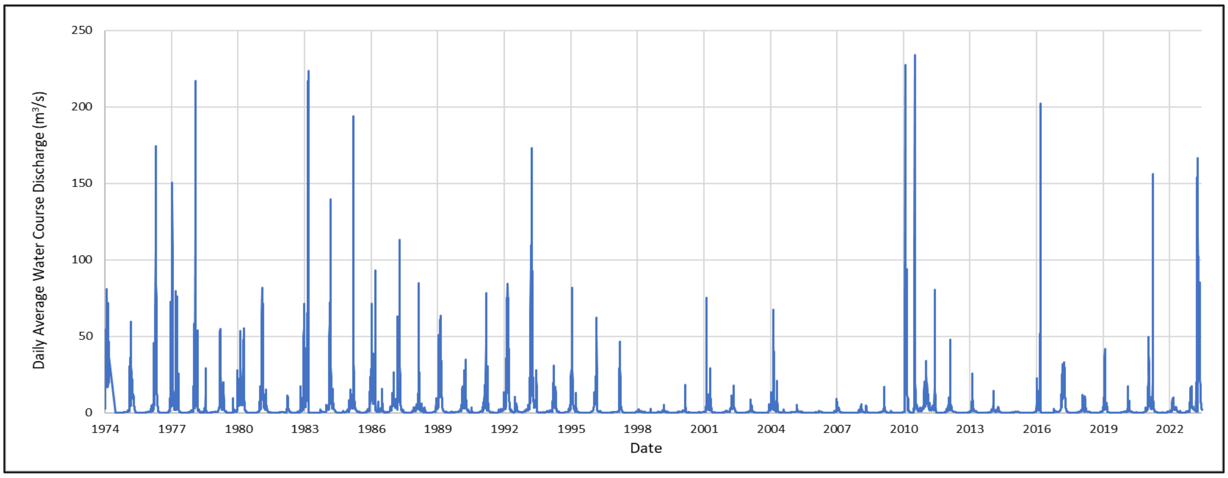

Figure 2-2 Observed streamflow at the Hopkins River gauge at Framlingham (236210)

2.3. Observed rainfall

Observed rainfall information was available at the Mortlake Racecourse weather station (gauge 90176). Data was sourced from the BoM from 01 January 1994 to 26 September 2023 as shown in Figure 2-3.

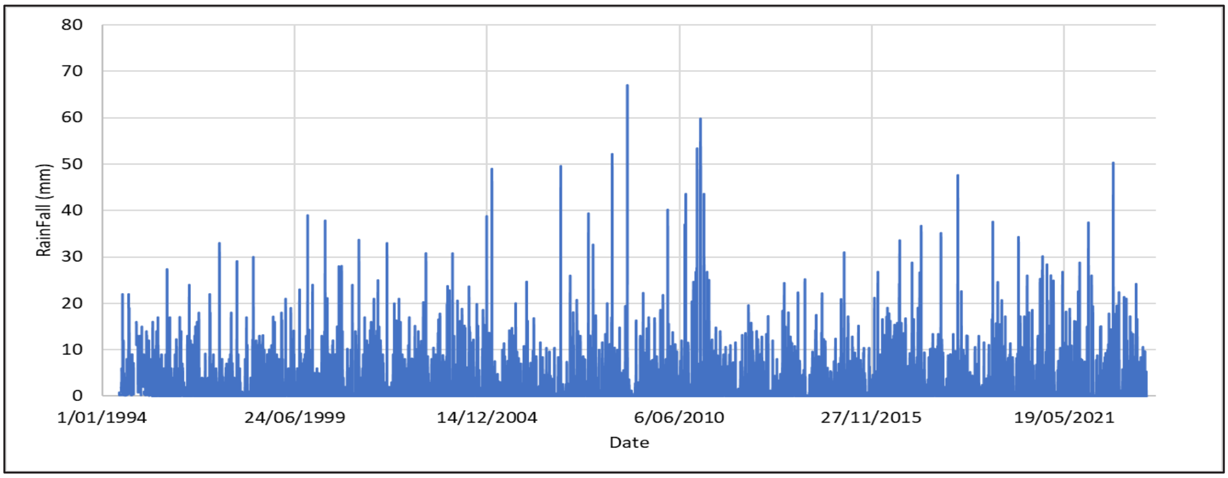

Figure 2-3 Observed daily rainfall at the Mortlake Racecourse station (90176)

2.4. Intensity-Frequency-Duration (IFD) information

The IFD information was sourced from the BoM IFD curves (retrieved 29 September 2023) using the centroid coordinates for the relevant contributing catchment (-37.6446° S, 142.8394° E) (Figure 2-1). IFD information is required to produce design (e.g. 1% AEP) flow and flood events from the modelling suite. The IFD data is presented in Appendix A1.

2.5. Australian Rainfall and Runoff (AR&R) data hub information

Information required for parameterising the models was sourced from the AR&R data hub[1] (retrieved 29 September 2023) at the catchment centroid coordinate location specified in Section 2.4. Relevant parameters were sourced from the South-East Coast (Victoria) Division, Barwon River-Lake Corangamite sub-region . Retrieved parameters included:

- Initial loss of 22.0 mm and continuing loss of 4.8 mm/hr.
- Point and areal temporal patterns. Available durations of the point and areal temporal patterns, compared with the IFD durations, are shown in Appendix A2.
- Areal reduction factor (ARF) parameters from the South-East Coast (Victoria) Division:
    - a = 0.158
    - b = 0.276
    - c = 0.372
    - d = 0.315
    - e = 0.000141
    - f = 0.41
    - g = 0.15
    - h = 0.01
    - i = -0.0027.

AR&R data hub information imported into the flow modelling software is provided in Appendix A3.

2.6. Regional Flood Frequency Estimation (RFFE) Modelling

The RFFE model[2] was run on 3 October 2023 and used to provide design flow comparison for the RORB model (Section 3.2.3) for the full catchment domain (Figure 2-1). This model uses information from nearby similar catchments to provide an estimation of the peak flow rates. The details required for this are:

- Catchment outlet: 142.6572° (E) and -38.0991° (S)
- Catchment centroid: 142.8394° (E) and -37.6446° (S)
- Catchment area: 4691 km^2

[1] http://data.arr-software.org

[2] http://rffe.arr-software.org

The expected RFFE peak flows and upper and lower confidence limits are presented in Figure 2-4. RFFE analysis is provided in Appendix A4.

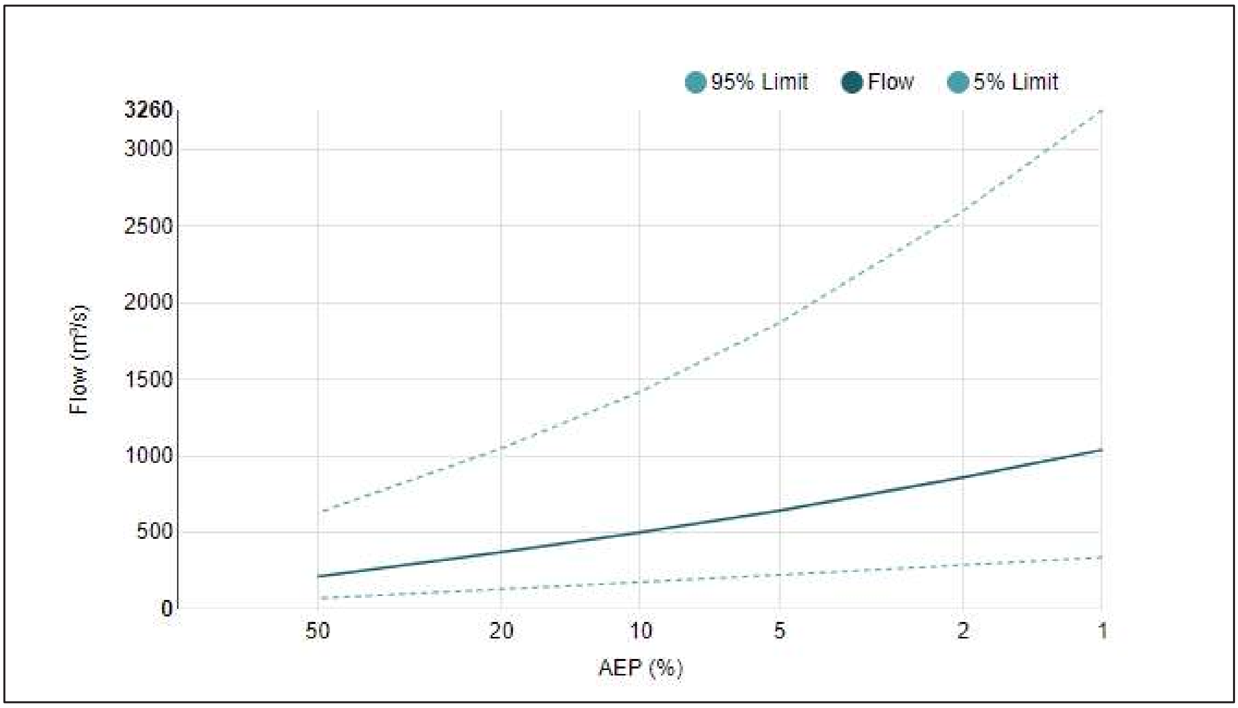

Figure 2-4 RFFE flow estimates including 5% and 95% confidence intervals

3. Hydrologic modelling

This section outlines the hydrologic model approach for determining rainfall-runoff relationships at the Project Site. The flow rate modelling was undertaken using the RORB (version 6.49) software package[3] to determine sub-catchment flows for the relevant regional catchment shown in Figure 2-1.

The RORB runoff and routing modelling software package simulates rainfall-runoff processes using the unit hydrograph method to predict the temporal distribution of runoff and associated hydrological response of a catchment resulting from a given rainfall event.

The in-built routing equations allow for adjustment of the following parameters to calibrate the hydrologic model to observed streamflow or RFFE in accordance with AR&R guidelines:

- Rainfall-runoff transformation (m) – the response time between rainfall input and resulting runoff within the specified catchment area. A higher ‘m’ value indicates a relatively faster response and shorter duration, while a lower ‘m’ value results in a broader peaked unit hydrograph with a more prolonged runoff response.
- Channel routing coefficient (kc) – the rate at which runoff travels through the defined catchment channels or reaches. A higher ‘kc’ value indicates faster routing through the channel network, while a lower 'kc' value represents slower routing.
- Initial loss (IL) – the amount of rainfall that is removed from the input hydrograph, due to immediate infiltration, transpiration and/or evaporation of water which does not contribute to surface runoff within the specified catchment area.
- Continuing loss (CL) – the amount of rainfall that is lost during a storm event after runoff has started due to infiltration, storage and/or evaporation.

The resulting peak flows were used as inputs to the subsequent hydraulic (water level and velocity) modelling for each design AEP scenario (10%, 2%, 1%, 0.5%, 0.2% and 0.1%). The RORB runoff routing software was used to calculate flood hydrographs from rainfall for input to the HEC-RAS hydraulic modelling package (see Section 3.2.3).

3.1. Catchment and drainage

The DEM presented in Figure 2-1 was used as input to create the overall catchment boundary, sub-catchment boundaries and drainages for use in the RORB modelling process. The ArcHydro add-in to ArcGIS was applied to generate the catchment, sub-catchments and drainage line features.

[3] Monash University and Hydrology and Risk Consulting https://www.harc.com.au/software/rorb/, version 6.49

3.2. Runoff model setup

3.2.1. Catchment input file

The RORB model requires a catchment file to specify how rainfall is applied to the area of interest and how water is routed through the catchment to the outlet. An add-in to ArcGIS, ArcRORB[4], was used to develop shapefiles (Figure 3-1) that were converted into the catchment input file for RORB (Figure 3-2).

The modelled catchment relevant to the Project Site is assumed to be in a natural condition (i.e. no artificially formed waterways/channels/drains) and all reach types within the catchment file were set to 'Natural'. The 'fraction impervious' for the model domain was set to zero. The fraction impervious in this context refers to impervious areas directly connected to waterways. Any impervious regions of the model (e.g. roads) were considered unlikely to be directly connected to the streamlines and any areas that are connected would be such a small proportion (<0.1%) of the overall catchment that they would not affect the modelled outcome.

Reach and sub-catchment details along with the catchment file layout are outlined in Appendix B.

[4] https://www.harc.com.au/software/arcrorb/

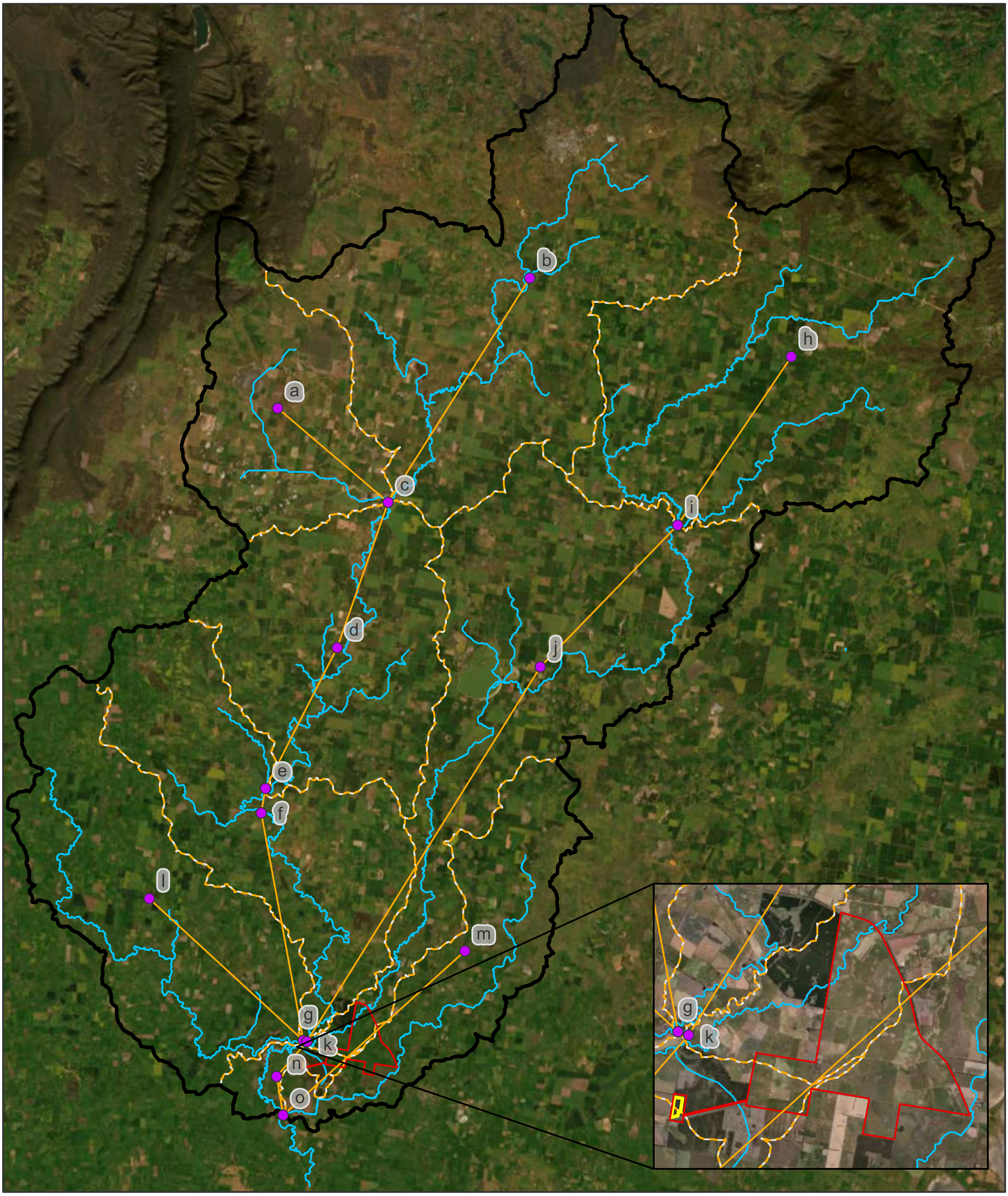

Figure 3-1 ArcRORB model layout

- MEH development boundary
- Proposed BESS and substation boundary
- Drainage lines
- Catchment boundary
- Sub-catchment boundary
- Sub-catchment nodes
- Reaches

0 5 10 20
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD5272-ED Date: 4/18/2024

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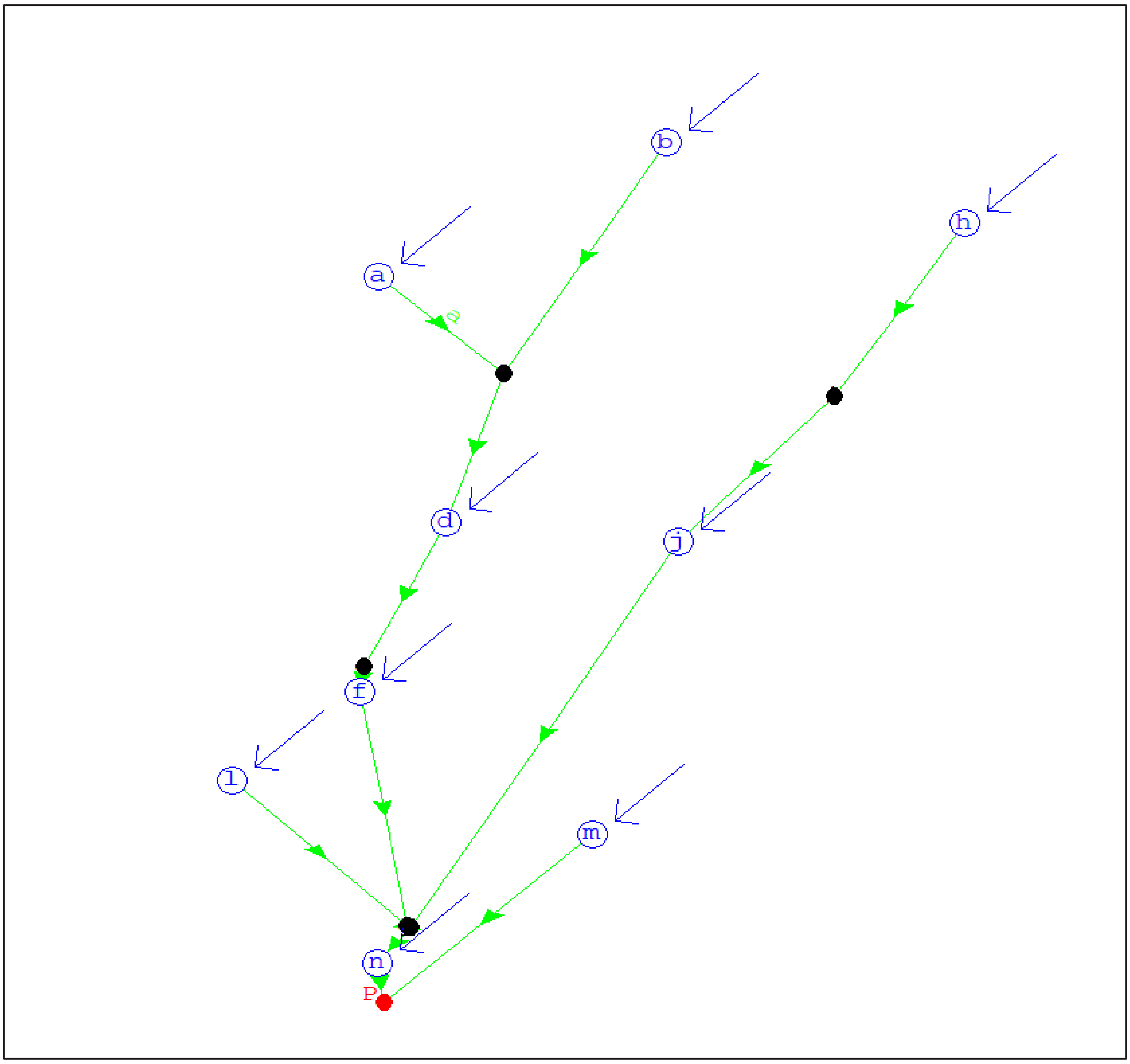

Figure 3-2 RORB catchment file structure

3.2.2. Design storm parameter file

Parameter files were created for the RORB model for design storm simulations. The following setup parameterisation was used:

- Separate catchment and generated design storm
- RORB catchment file (Figure 3-2)
- Storm file corresponding to the event being modelled
- Single set of routing parameters
- Initial loss / continuing loss model
- DESIGN run
- Parameters of m, kc, IL and CL calibrated to RFFE (Section 3.2.3):
    - m = 0.8
    - kc = 150.68
    - IL = 10 mm

  - CL = 1 mm/hr

- Print at nodes K (approximately 500 m hydraulically downgradient of the Project Site to the south-west) and Outlet (approximately 10 km hydraulically downgradient of the Project Site to the south-west).

The setup for the design storm simulations run in RORB is shown in

Table 3-1. The Monte Carlo framework was used to examine the impact of different temporal patterns upon the design flow rate results.

Table 3-1 RORB parameter file specification for design storms

Parameter file section	Detail
Data Hub Files	• Data hub file as discussed in Section 2.5. • Temporal patterns as discussed in Section 2.5. • Use regional losses is unchecked. • Use ARFs from file is checked.
Design Rainfall Specification	• A user defined IFD as discussed in Section 2.4. • Monte Carlo simulation from 10 minute to 168-hour durations. • Default time increments of 200. • Uniform areal pattern. • No pre burst. • Constant losses.
Parameter Specification	• Adjusted k_c of 150.68. • Adjusted m of 0.7. • Adjusted IL of 10 mm. • Adjusted CL of 1 mm/hr.
Monte Carlo Specification	• Number of rainfall divisions: 50 (default). • Number of samples per division: 20 (default). • Temporal patterns as described above. • Monte-Carlo sample initial loss.

3.2.3. Calibration

Although observed flows relevant to the Hopkins River catchment downgradient of the Project Site were available for contextual review of peak flow results within the model boundaries, the hydrologic model was calibrated to the RFFE analysis to fit the expected peak flow curve within the confidence limits specified.

The resulting calibration parameters shown in Table 3-2 with routing parameter and loss sensitivity analysis presented in Figure 3-3. Comparing the IL and CL values with those from AR&R (22 mm and 4.8 mm/hr, respectively) showed that a reduced IL and CL were required to calibrate the model to expected RFFE results for the catchment.

Table 3-2 Resulting RORB parameters calibrated to RFFE

Event	m	k_c	IL (mm)	CL (mm)
Adopted for design events	0.7	150.68	10	1

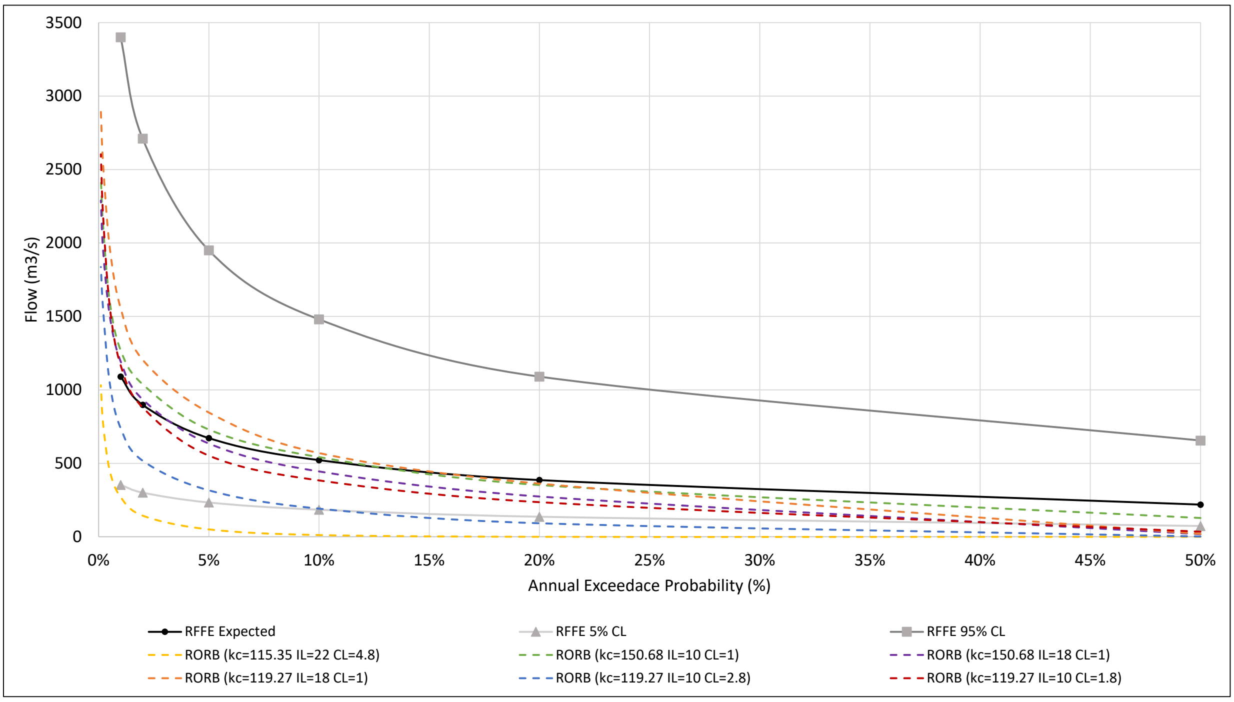

Figure 3-3 RORB routing parameter and loss sensitivity analysis

Figure 3-4 shows the RORB model results calculated relative to the specified catchment size (4,934 km^2) compared to weighted design event results for nearby gauged catchments. The results show that the RORB model fits within the mid-range of the nearby gauged catchment results. The storm design events are therefore considered applicable for use in providing target peak flow rates for the hydraulic modelling results in Section 5.2.

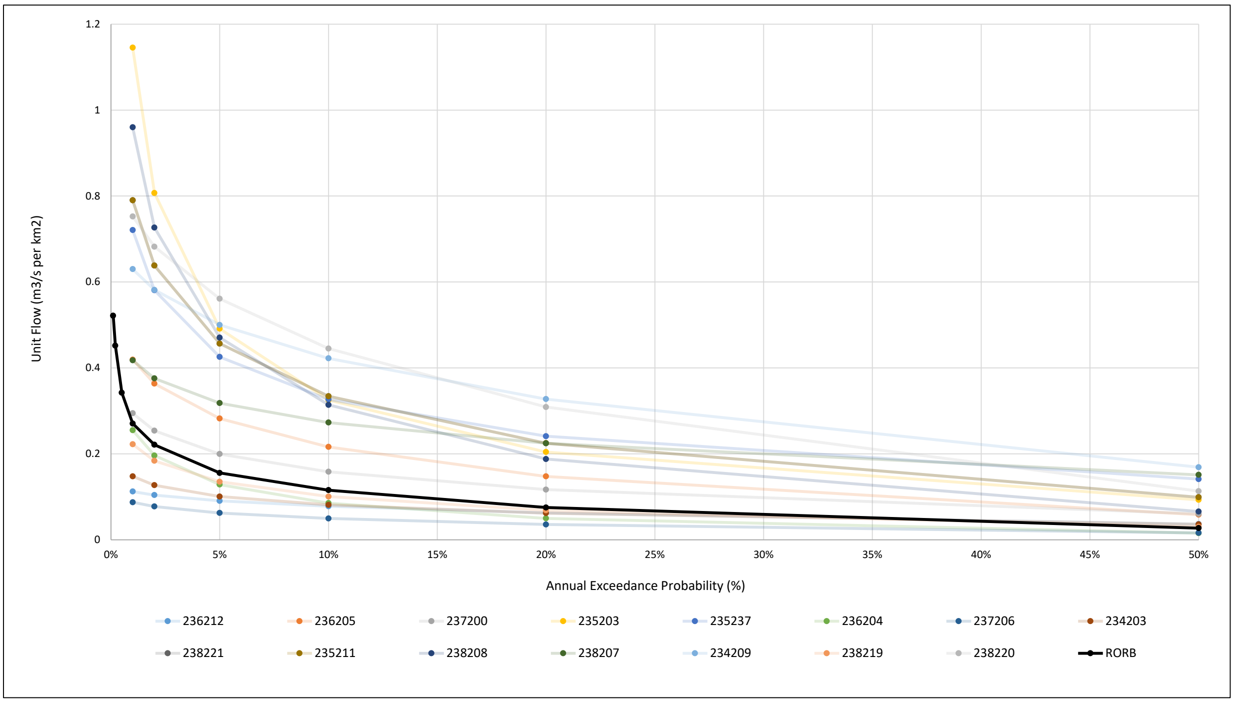

Figure 3-4 RFFE area weighted nearby catchments comparison

4. Hydraulic modelling

This section outlines the hydraulic modelling approach for determining flow characterisation across the MEH Project Site. Hydraulic modelling was conducted using the U.S. Army Corps of Engineers' HEC-RAS[5] (version 6.5) software package. HEC-RAS models were developed using a two-dimensional (2D) rain-on-grid analysis for the target AEP scenarios (10%, 2%, 1%, 0.5%, 0.2% and 0.1%). The sections below outline the process undertaken to set up the HEC-RAS model.

4.1. Model setup

4.1.1. Precipitation

No inflow hydrographs were required as inputs to this model as the entire catchment is within the model domain and there are no water transfers into the catchment.

The precipitation inputs were derived from the IFD tables sourced from the Bureau of Meteorology (BOM, 2016) on the 10 October 2023.

To define the critical rainfall duration, i.e. the duration which yields the highest flow and depth, the time of concentration for the catchment was calculated using two different methods. The first method used the Friend's formula (Australian Rainfall & Runoff, 2014), which considers the land cover, the length of the main drainage path and the average slope in determining the time of concentration:

$$Time\ of\ Concentration = 107\ \times \frac{n\ \times L^{0.333}}{S^{0.2}}$$

Equation 1: Friend's time of concentration formula

Where *n* is the Horton's roughness value for the surface, *L* is the flow path length in metres, *S* is the slope of the surface in percentage, and *Time of Concentration* is in minutes.

The second method used the following formula from Pilgrim (1989), which returns the time of concentration in hours and uses only the drainage area in square kilometres as input:

$$Time\ of\ Concentration = 0.76\ \times A^{0.38}$$

Equation 2: Pilgrim & McDermott's time of concentration formula

The Pilgrim and McDermott method usually results in smaller values than those produced by the Friend method. Therefore, the Friend method was used as a reference for the smallest duration tested whilst the Pilgrim and McDermott was used as a reference for the longest duration, in order to find the critical rainfall duration for the catchment. However, durations higher and lower than the values determined by the Pilgrim and McDermott, and Friends methods, respectively, were also tested to extend confidence in the interpretation of results.

The model results for the rainfall durations (using a 1% AEP) were compared to evaluate which duration would yield the highest flows and depths. For this assessment, the rainfall was distributed across the

[5] U.S. Army Corps of Engineers' HEC-RAS Version 6.5 (USACE 2023)

temporal patterns downloaded from the AR&R Data Hub and the time series produced were used as an unsteady flow boundary condition for the model.

When the critical duration was found for each target AEP for the catchment, the ten temporal patterns for that duration were compared to choose the pattern that yielded the next highest peak flow from the median for each AEP event. This pattern was then applied to represent the rainfall pattern for the design event/s modelled (10% AEP, 2%, 1% AEP, 0.5% AEP, 0.2% AEP and 0.1% AEP.

The patterns applied are shown in Figure 4-1 and a summary of the Temporal patterns and AEP events can be found in Table 4-1. Note 10% AEP, 2% AEP, 0.5% AEP, 0.2% AEP and 0.1% AEP events are 24 hours in duration, and the 1% AEP event is 36 hours in duration, as determined from the RORB results. As the temporal patterns were selected based on each AEP event they vary in their form.

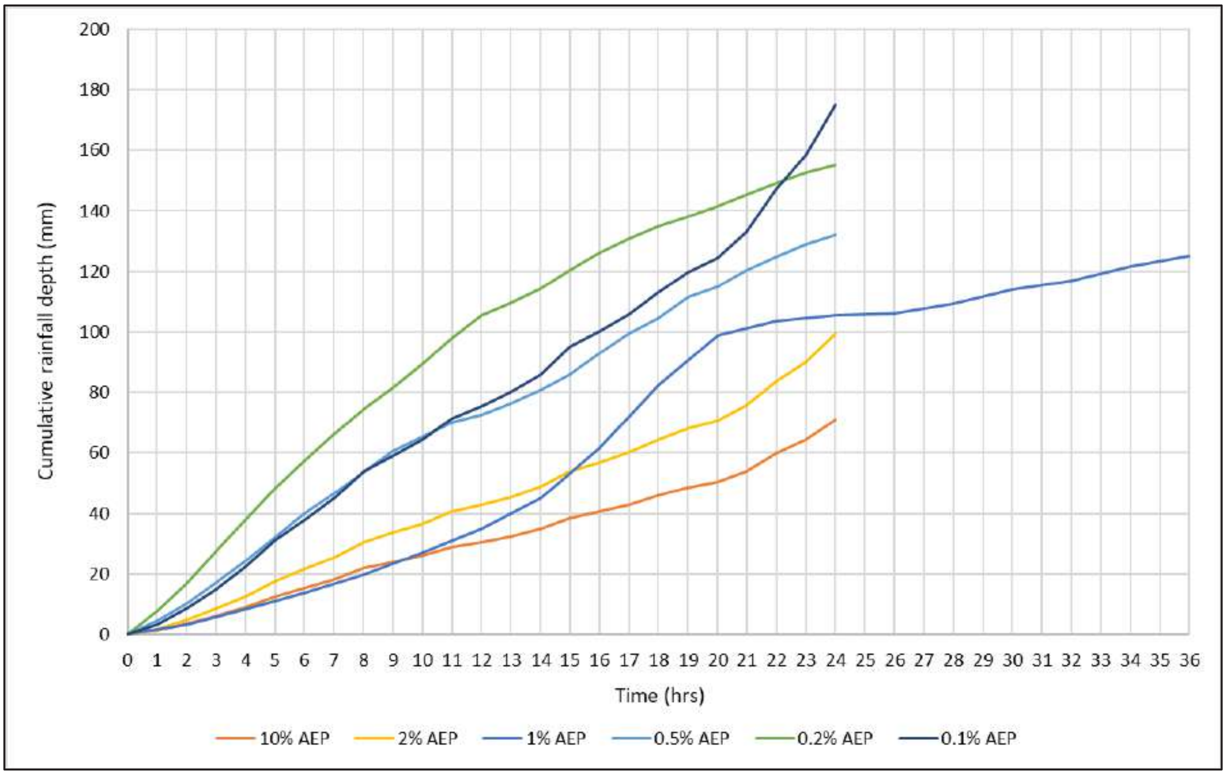

Figure 4-1 Rainfall depths applied to 2D flow area for the 10%, 2%, 1%, 0.5%, 0.2% and 0.1% AEP design events

Table 4-1: Event and temporal pattern summary

AEP (%)	Rain depth (mm)	Temporal pattern (event ID)	Critical duration (h)
10	71	6469	24
2	99.4	6469	24
1	125	6565	36
0.5	132	6471	24
0.2	155	6473	24
0.1	175	6469	24

4.1.2. Losses

A rainfall excess time series (the amount of rain that runs off after the losses) was directly applied to the model through manual removal of initial and continuing losses. An example of this is outlined in Figure 4-2 for the 1% AEP event using the adjusted initial and continuing losses (10 mm and 1 mm, respectively) determined through calibration of the RORB model to RFFE expected peak and nearby observed flows.

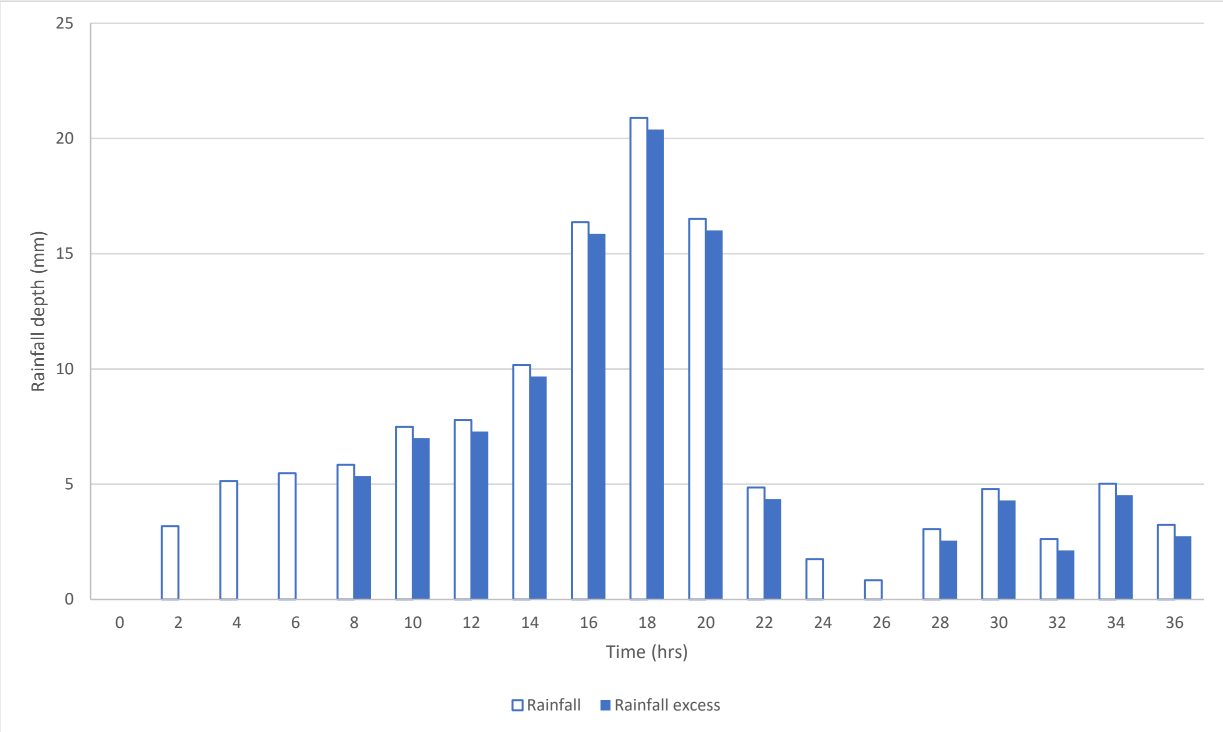

Figure 4-2 1% AEP design event rainfall pattern applied to HEC-RAS after losses are removed

4.1.3. Outflow

Locations where water exits the model domain (outflows) require boundary conditions to be specified. The concentrated flow path that exits the model domain was set to a normal depth boundary condition, using the uniform bed slope of that flow path as the estimated energy slope, as measured from the available terrain data. The normal depth boundary condition applied to the outlet was 0.0005.

4.1.4. Computational mesh

A 2D flow area was delineated in HEC-RAS to coincide with the catchment boundary. A computational mesh spacing of 500 m by 500 m was applied across the regional catchment, as shown in Figure 4-3. HEC-RAS recognises the sub-grid terrain resolution within individual computational cells and the flow transfer calculations between individual grid cells account for the geometry of the underlying surface at the terrain resolution. This computational mesh was applied except as noted surrounding breaklines and the refinement regions.

Breaklines were used to alter the direction of grid cells to align with features within the catchment. Breaklines were implemented in the model for drainage lines as per Figure 2-1.

Refinement regions were used to denote areas where the computation mesh resolution required a finer scale than the overall mesh. The following refinement regions were specified:

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- drainage line breaklines with a computational mesh of 100 m by 100 m
- approximately 150 m beyond the extent of the Project Site and immediately adjacent waterways with a computational mesh spacing of 50 m by 50 m.

Figure 4-3 outlines an example region of the computation mesh applied to the existing terrain, showing the mesh spacing, break lines and refinement regions applied.

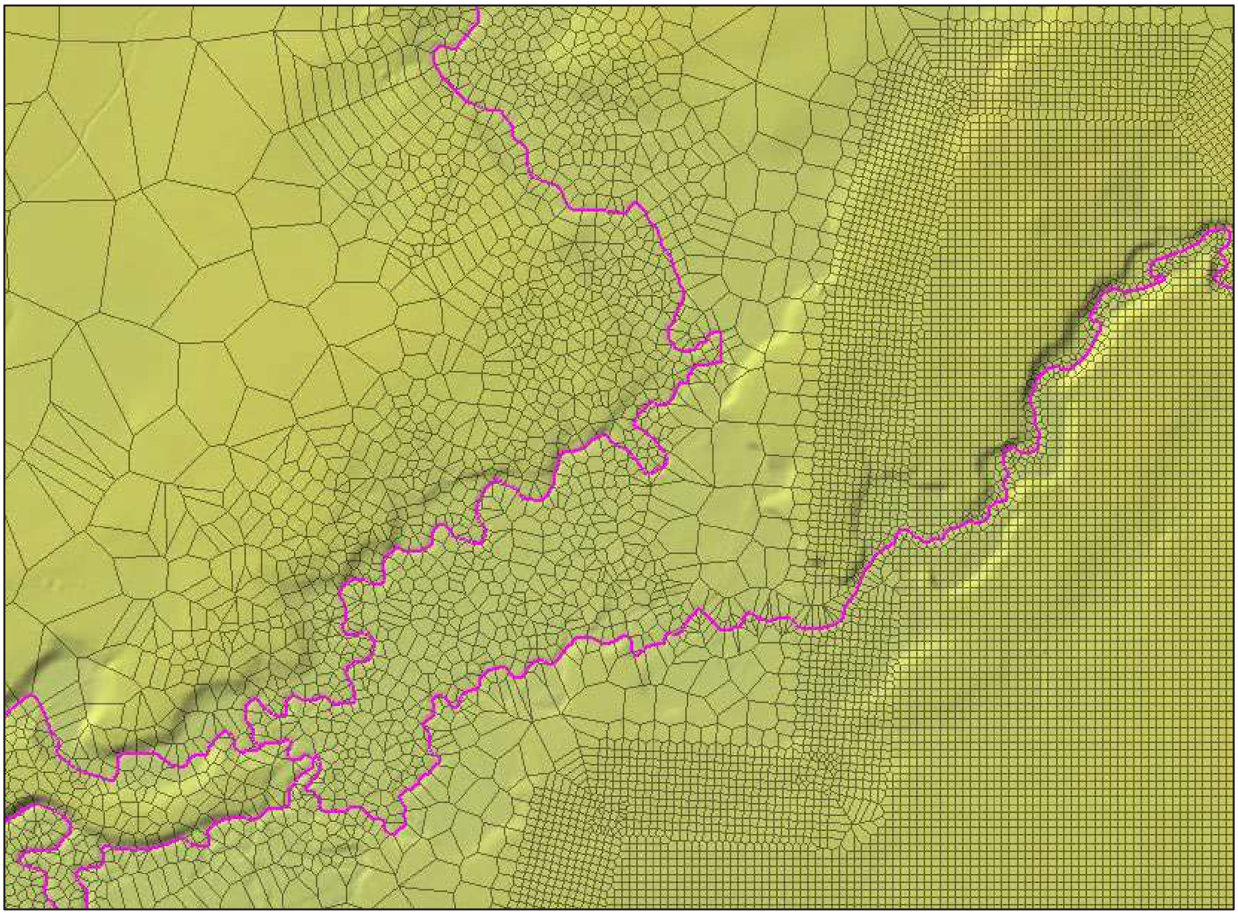

Figure 4-3 Example configuration of HEC-RAS computational mesh (black lines) and breaklines (pink lines)

4.1.5. Roughness

Roughness coefficients are used to define how quickly water moves across the terrain and controls the shape of flow hydrographs resulting from the rainfall and upstream flow. Typical roughness values are defined for the range of flow path extents, i.e. from concrete channels to floodplains. Modelling the full 2D catchment area which extends outside of normal channels and their corresponding slopes requires much larger roughness values than are typically applied to models that just model stream flow.

An initial roughness coefficient of 0.08, representing a natural channel condition, was applied to the whole model. This roughness was used in combination with a 10% AEP rainfall event to define waterway channel extents.

HEC-RAS has the ability to apply different roughness coefficients spatially across the model domain. This is achieved through applying a shapefile of “land cover” regions to the model and assigning a roughness coefficient to those regions independently. To improve accuracy of the hydraulics assessment, a roughness of 0.06 was applied to the land cover representing the channels adjacent to the Project Site, these regions are shown in Figure 4-4.

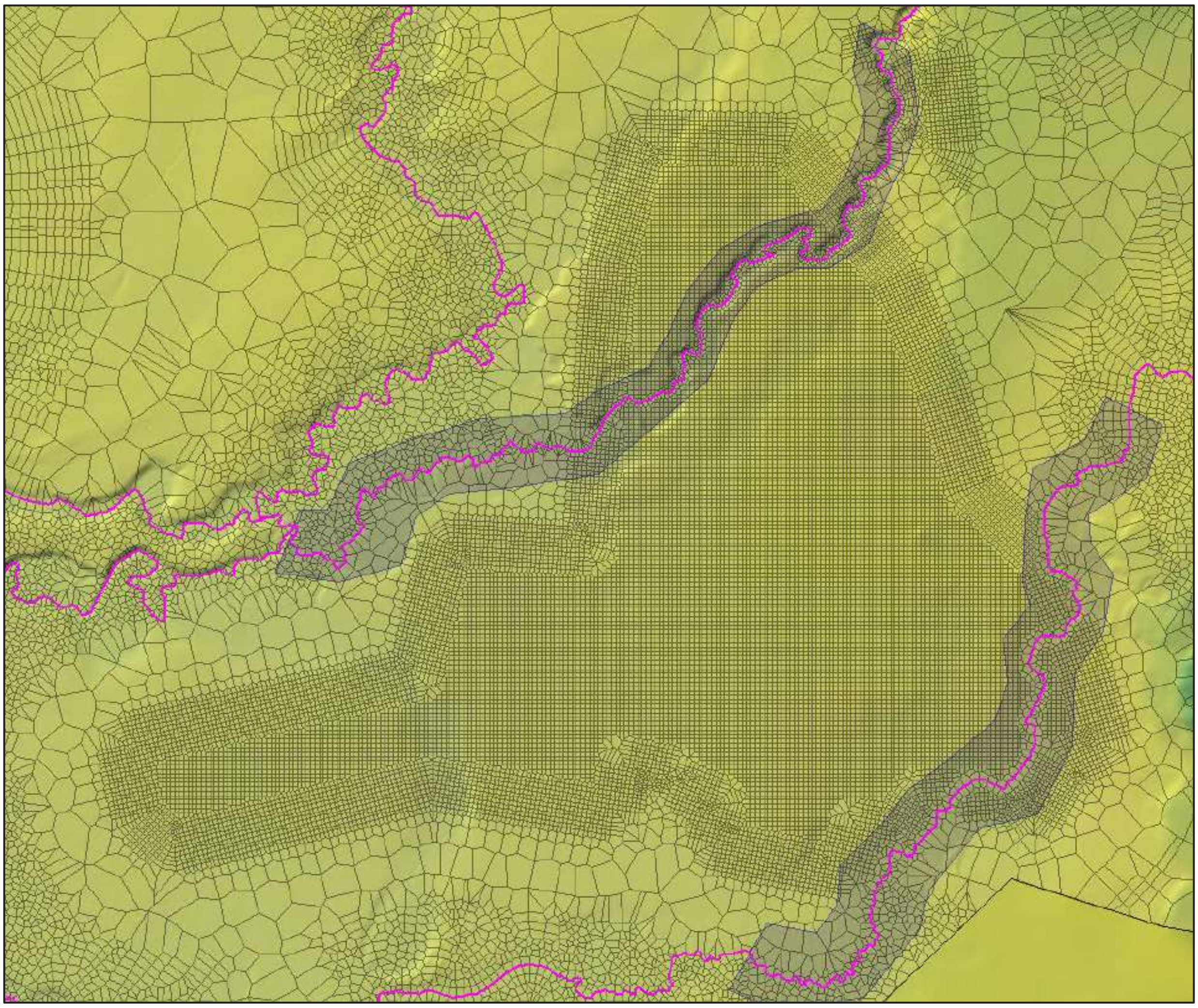

Figure 4-4 Manning's n roughness coefficient specification (green is 0.08, blue is 0.06)

4.1.6. Computational setting

An adaptive computational time-step was applied based on a maximum Courant Number of 2.0. This results in a minimum adopted time-step of approximately 2 seconds. The Full Momentum equation set was adopted in the model to account for the varying flow directions. Mass balance errors and water surface elevation convergence errors were checked for model stability and to confirm that imbalances remained below reasonable thresholds for model stability. A 168-hour simulation window was applied to capture critical-duration peak discharges and allow the flood peaks to propagate through the model.

Default threshold depths were decreased by one order of magnitude to capture the flow transfer effects of direct precipitation sheet flow across the catchment. Except where otherwise noted, other program defaults have been applied to all remaining coefficients, options, tolerances and model settings.

4.1.7. Model set-up summary

Table 4-2 below summarises the model parameters used for the catchment in this project.

Table 4-2: HEC-RAS parameters

Model Parameter	Value
Inflow	10%, 5%, 1%, 0.5%, 0.2% and 0.1% AEP frequency storm excess precipitation hyetographs
Losses	IL = 10 mm CL = 1 mm
Outflow	Normal depth slope of 0.05%
Simulation window	168 hours
Computational time step	Controlled by Courant number
Computational mesh grid	500 m by 500 m to 50 m by 50 m
Roughness	0.06 for channels adjacent to Project Site, 0.08 for remaining catchment area including land cover and overland flow
Equation Set	Full Momentum
DEM grid resolution	10 m by 10 m

5. Results and discussion

5.1. Hydrology results

5.1.1. Peak flows

The RORB model was run to provide verification flows for the water level modelling. The HEC-RAS model was subsequently calibrated to the RORB results. A summary of the peak flows for each exceedance probability at the catchment outlet from the two modelling methods is provided in Table 5-1 and presented in Figure 5-1.

Table 5-1 Summary of design event peak flow rates at specified Hopkins River catchment outlet

AEP (%)	RORB peak flow (m^3/s)	HEC-RAS peak flow (m^3/s)
10%	542	426
2%	1037	799
1%	1269	1126
0.5%	1605	1296
0.2%	2119	1700
0.1%	2446	2057

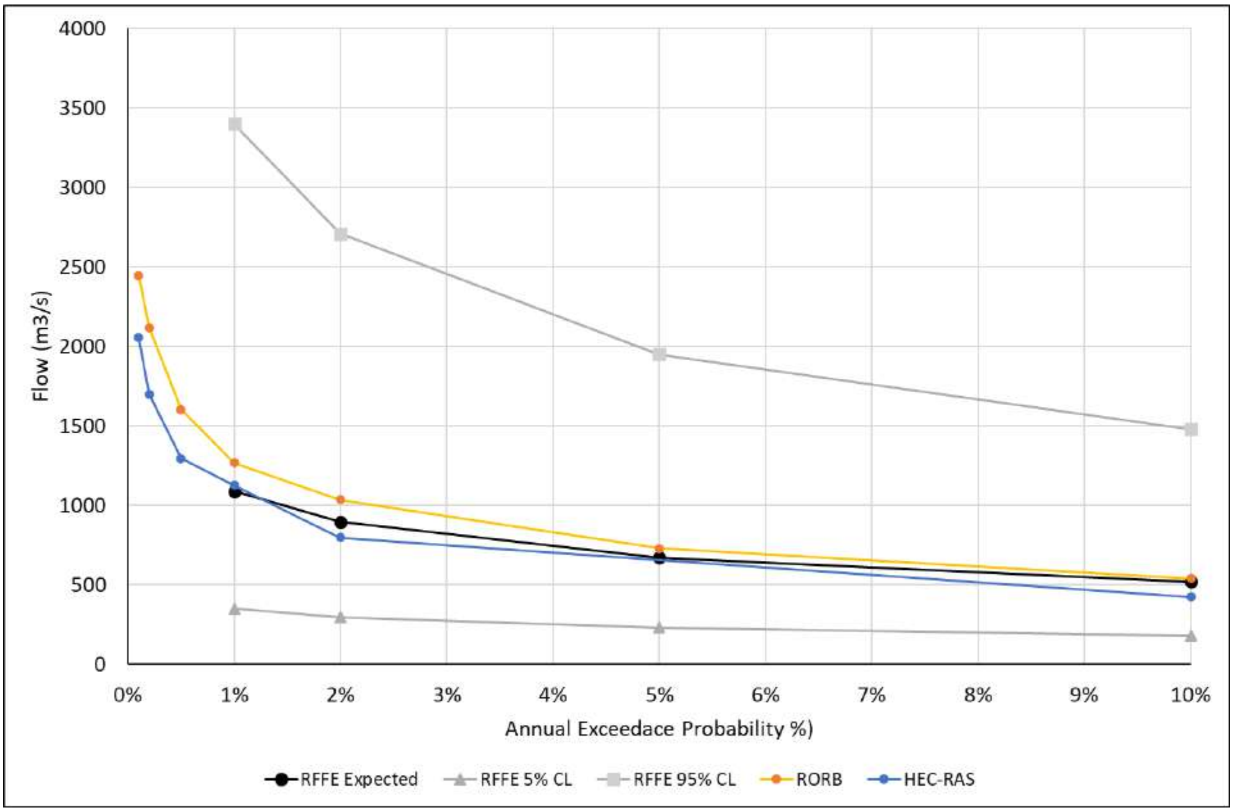

Figure 5-1 RORB and HEC-RAS peak discharge results at Hopkins River catchment outlet (approximately 10 km downgradient of Project Site to the south-west)

5.2. Hydraulic results

For each AEP event, site and regional depth and velocity were extracted across the model domain and are discussed below. Maximum flood depths and maximum flood velocities are presented in Appendix C1 and Appendix C2, respectively.

5.2.1. Depth and inundation extent

The flood depths for existing conditions at the Project Site (Appendix C1) show that, in general, the flows are concentrated to the waterways and defined overland flow paths in the region with sufficient terrain relief to limit the amount of sheet flow.

One significant drainage line, Salt Creek, crosses the project site in the northern corner of the MEH solar array area and will need to be considered in planning infrastructure locations. During all flood events modelled, the flow remained constrained to the channel and well-defined floodplain approximately 100-150m wide (see Appendix C1). Table 5-2 shows the max depth and flow velocity for the Project Site and the Project Site, excluding salt Creek. The maximum depth and velocity for the Project Site in each scenario is within Salt Creek.

Secondary flood features comprise Blind Creek and an unnamed drainage line, located in the southeast and southwest corners of the Project Site, respectively. Modelling indicates Blind Creek only impacts the Project Site during a flood event greater than the 10% AEP scenario.

Shallow inundation (<0.25 m) is predicted in the southwest corner of the BESS area under each modelled scenario, and this should drain quickly to the west following cessation of a storm event, with minimal impact to the BESS area or existing condition overland flow patterns. Although the proposed BESS layout includes impervious surfaces, the total area was such a small proportion (<0.1%) of the overall catchment that it is not considered to affect the outcomes of hydraulic modelling nor impact existing condition overland flow regimes.

The proposed gravel emergency access track and the underground transmission cable will intersect the unnamed drainage line located between the MEH BESS/ substation and solar array area boundaries. The proposed emergency access track will not be raised and will therefore not impact natural flow regimes. Although maximum modelled depths within the proposed track alignment may reach between 1 and 5m under flood conditions, modelled velocities indicate erosion is unlikely to occur (<0.4 m/s under 0.1% AEP). The underground transmission line is similarly very unlikely to present impacts to surface water flows as the proposed depth to cabling will be 0.6 m below ground level. This assumes the existing surface is reinstated following completion of underground cable installation earthworks.

Although minor potential impacts were identified, the flood model is considered a conservative assessment of potential impacts and major inundation is considered unlikely. Nevertheless, access tracks traversing Blind Creek may require installation of a floodway or raised surface with box culvert of sufficient capacity to convey flows down gradient. The unnamed draining line has only a marginal impact on the Project Site but should be considered when finalising design for the access tracks between the Mortlake power station and the MEH solar array area, as maximum flood depths may be above 2 m under 0.1% AEP conditions.

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The remaining inundation across the Project Site are generally shallow (<0.4 m), with small isolated pockets of deeper water. Maximum depths for each modelled design storm AEP scenario are presented in Table 5-2 and shown in Appendix C1.

Table 5-2: Maximum modelled depths and flow velocities for each AEP event

	Project Site*		Project Site excl. Salt Creek	
AEP	Depth (m)	Velocity (m/s)	Depth (m)	Velocity (m/s)
10%	2.23	1.23	0.78	0.45
2%	2.55	1.41	1.12	0.52
1%	2.90	1.64	1.54	0.66
0.5%	3.13	1.78	1.74	0.72
0.2%	3.84	2.21	2.19	0.80
0.1%	4.37	2.41	2.57	0.86

*Note: The Project Site includes Salt Creek; therefore, the maximum flows and velocities can be attributed to the creek.

*Note: Within the proposed BESS and substation boundary, the maximum depth and velocity under each modelled scenario was <0.25 m and <0.25 m/s, respectively.

5.2.2. Peak velocities

Outside the channels discussed above, modelled velocities across the Project Site, including the BESS area, as shown in Appendix C2, remain relatively low (generally <0.25 m/s) and below the threshold (< 2 m/s) where rock armouring to protect waterways and features is required. Some isolated higher velocities (> 0.75 m/s) occur along an overland flow path / waterway through the mid-north of the site (south of Salt creek) and at other isolated locations under current conditions. Should erosion form at these locations then mitigation strategies should be implemented. It is noted that existing tracks within the Project Site (inferred by publicly available satellite images) are likely to be passable under these conditions.

5.2.3. Flood mapping

The maximum flood depths and velocities relevant to the Project Site under modelled 1% AEP scenario are presented in Figure 5-2 and Figure 5-3, respectively.

A comparison of inundation extent and depth under each modelled AEP scenario (10%, 2%, 1%, 0.5%, 0.2% and 0.1%) is shown in Figure 5-4, with a comparison specifically for the BESS area results presented in Figure 5-5.

Depth and velocity mapping for each modelled AEP scenario are presented in Appendix C1 and Appendix C2, respectively.

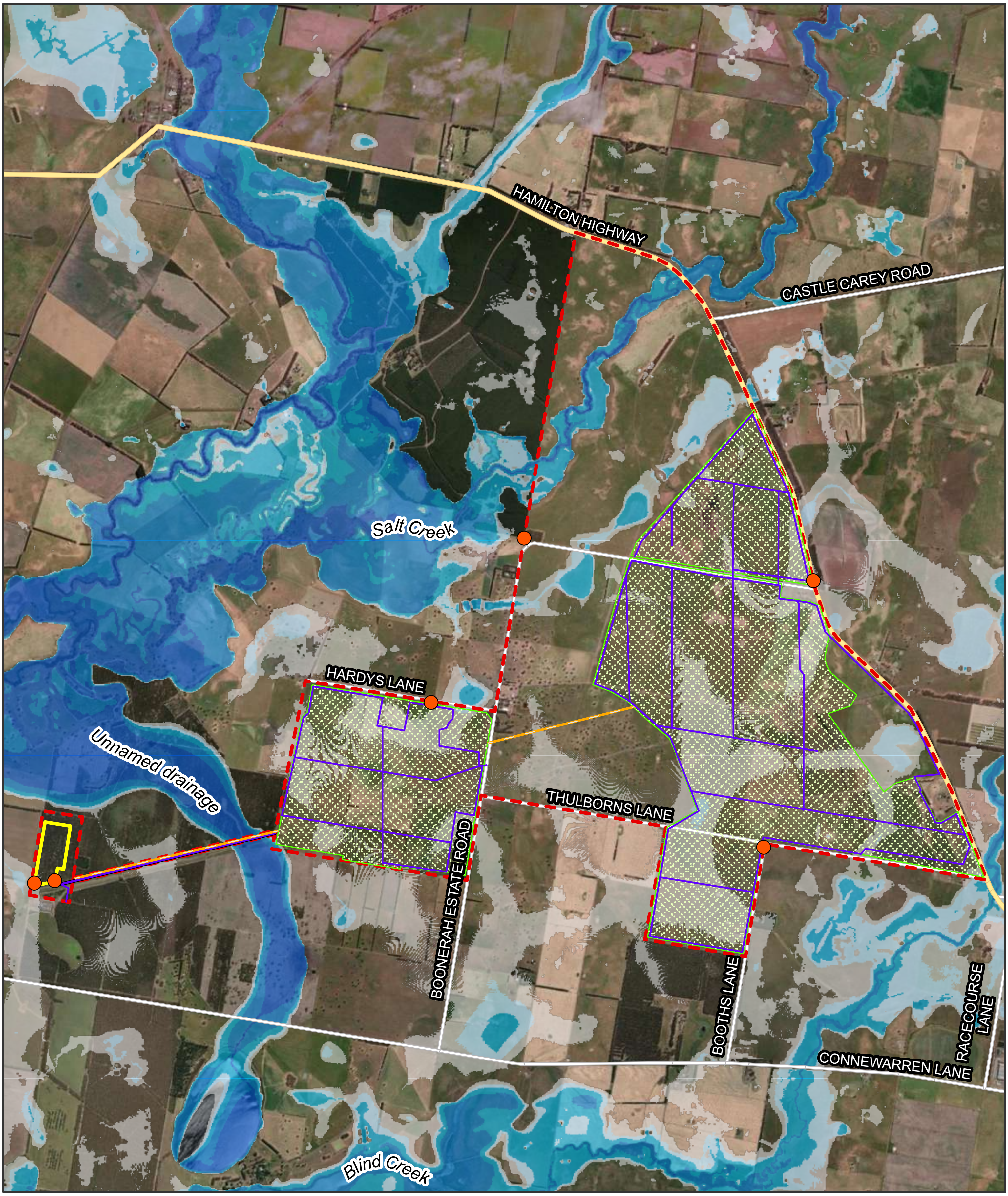

Figure 5-2 1% AEP maximum flood depth

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD5272-ED Date: 4/18/2024

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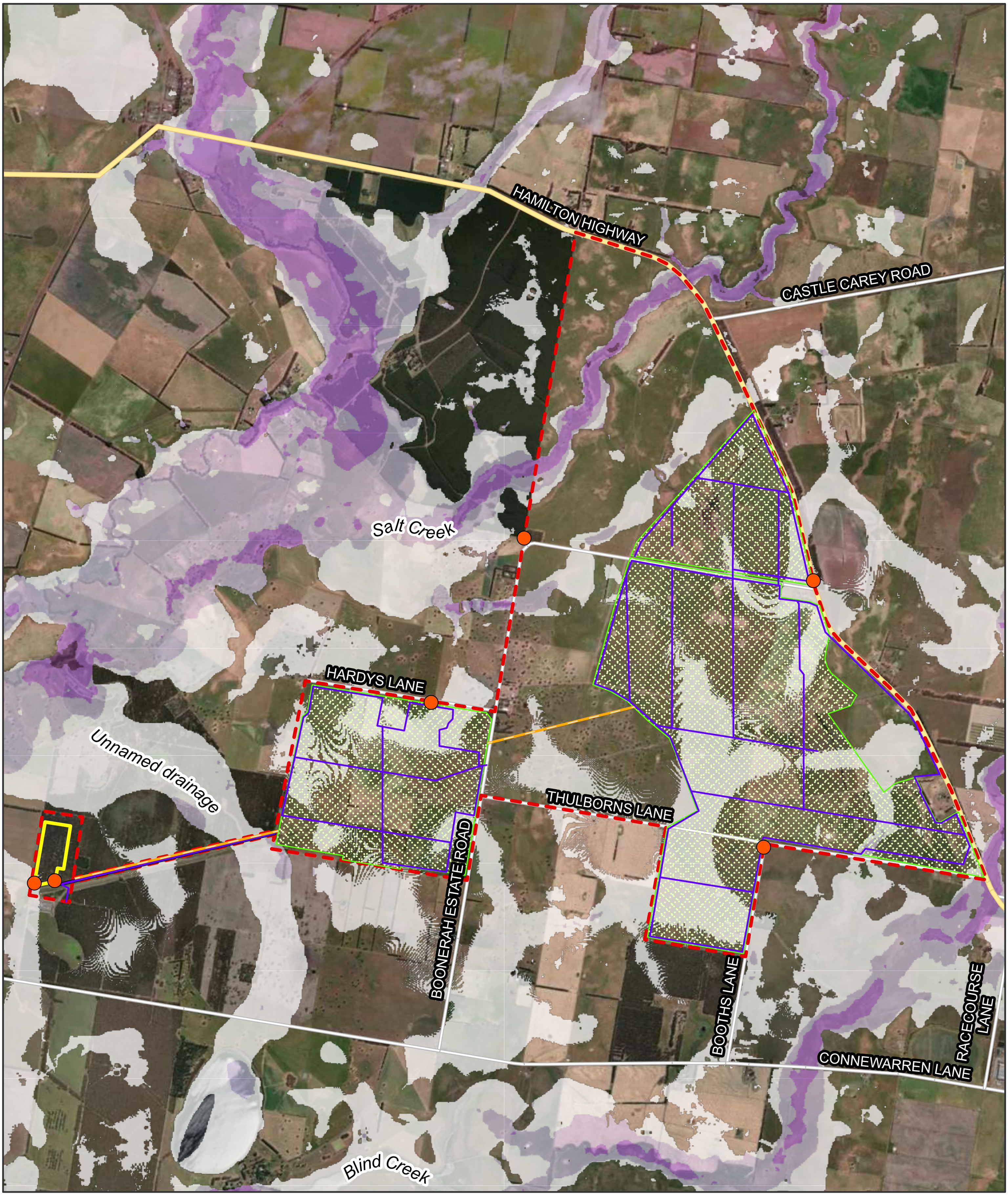

Figure 5-3 1% AEP maximum flood velocity

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood velocity (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD5272-ED Date: 4/18/2024

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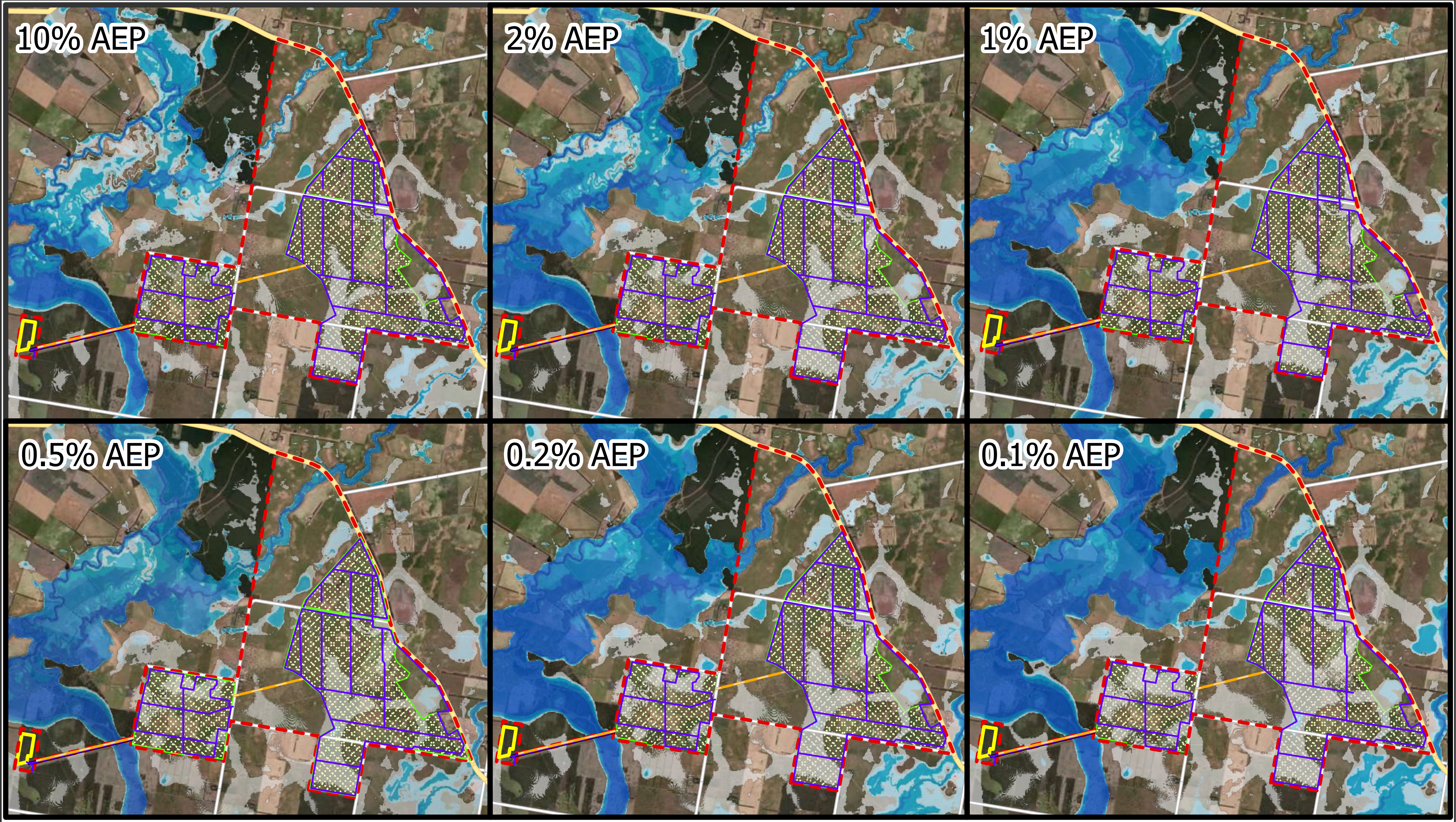

Figure 5-4 MEH maximum flood depth comparison

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed internal road
- Highway
- Road

Maximum flood depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 500 1,000 2,000
Metres

Datum/Projection:
GDA2020 MGA Zone 54
Project: 23SYD5272-ED Date: 4/19/2024

N

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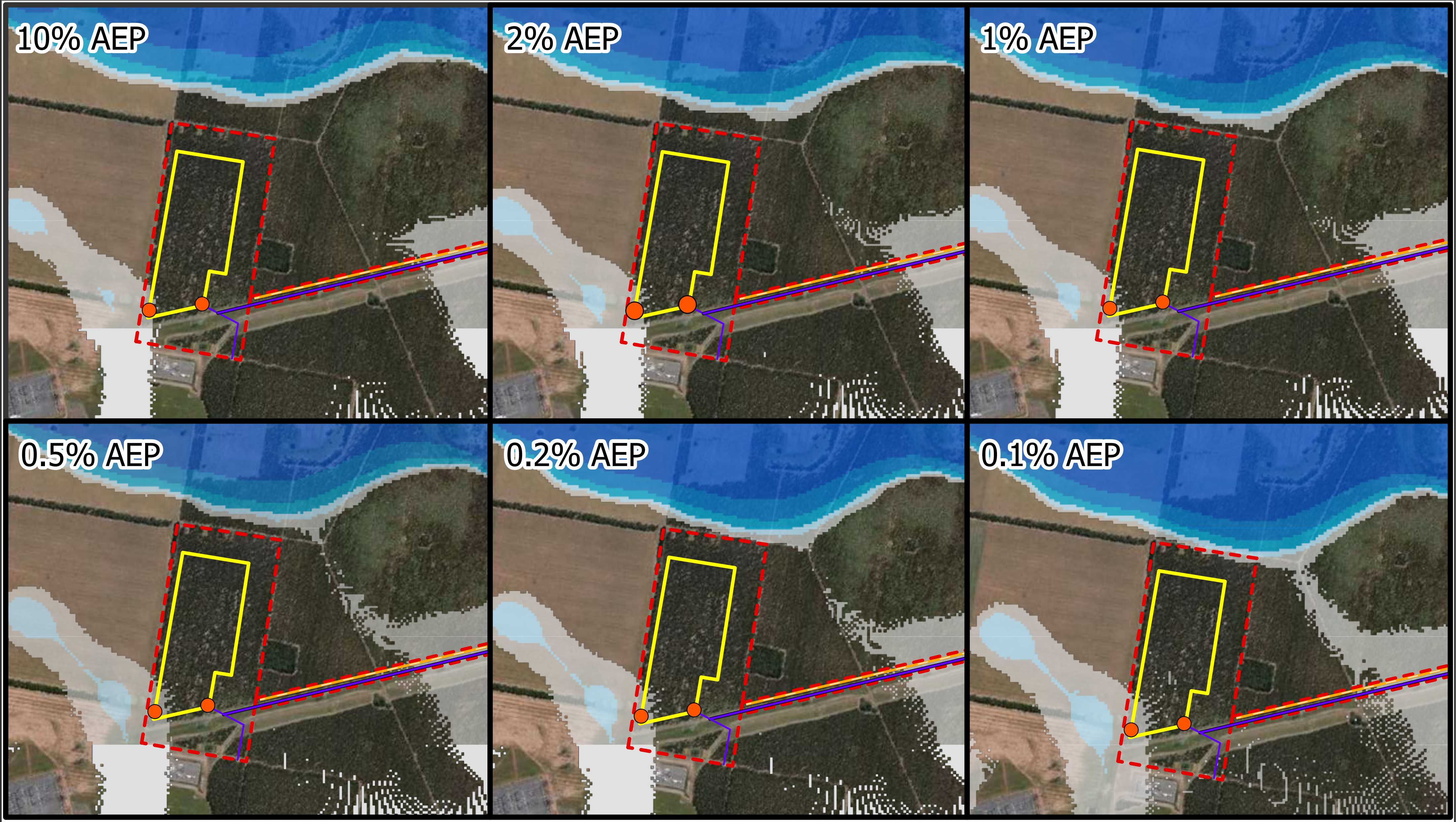

Figure 5-5 MEH BESS maximum flood depth comparison

6. Conclusion and recommendations

ELA was engaged by Urbis to assess potential flood impacts at the MEH Project Site associated with hydrologic and hydraulic conditions under the 10%, 5%, 1%, 0.5%, 0.2% and 0.1% AEP flood events to support regulatory approvals for the proposed Project development.

Flow rate modelling was undertaken using the RORB software package to determine sub-catchment flows and verify the flow rates from subsequent water level modelling. Hydraulic modelling was conducted representing existing conditions using the HEC-RAS software package. HEC-RAS models were developed using a 2D rain-on-grid analysis to determine inundation extent, flood depth levels and flow velocities. The modelling methods were calibrated using best initial loss estimates based on previous similar modelling and RFFE analysis for the region.

The flood depths showed that, in general, the flows are concentrated to the waterways and defined overland flow paths in the region, with sufficient terrain relief to limit the amount of sheet flow. The primary flood features relevant to the MEH Project Site comprise: Salt Creek to the north; Blind Creek to the southeast and an unnamed tributary to Salt Creek in the southwest. The model predicts that these features stay largely confined to their banks and their defined flood plains and their most significant impact may be to affect access tracks at the site.

Maximum modelled depths outside these channels across the MEH solar array area were generally shallow (<0.4 m) under each AEP scenario and stormwater should pass under the proposed arrays. Shallow inundation (<0.25 m) is predicted in the southwest corner of the BESS area under each modelled scenario and should drain quickly to the west following cessation of a storm event, with minimal impact to the BESS area or existing condition overland flow patterns.

The proposed underground transmission cable will run beneath the unnamed drainage line located between the MEH BESS/ substation and solar array area boundaries and is unlikely to present impacts to surface water flows as the proposed depth to cabling will be 0.6 m below ground level. This assumes the existing surface is reinstated following completion of underground cable installation earthworks.

Although some access points and tracks within the Project Site boundary intersect the inundation area, the modelled flood extent and maximum depths indicate that these will generally remain passible under flooded conditions (i.e. <0.25 m).

The modelled velocities show that, in general, velocities across the MEH Project Site (excluding Salt Creek) tend to be low (< 1 m/s) and below the threshold (< 2 m/s) where rock armouring to protect waterways and features is required.

Based on results of hydrologic and hydraulic modelling, the proposed layout (provided by Urbis on 15th April 2024) is considered suitable from a flood risk perspective. Further minor changes to the site layout should not impact the site from a surface water impact perspective. but should be reviewed in the context of flood modelling results to confirm suitability of the updated design. It is recommended to include general stormwater management and erosion control measures during construction and operational activities at the Project Site.

7. References

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Appendix A AR&R inputs

A1 IFD table

Table 7-1 Rainfall depths for 50% to 0.1% design rainfall events

Duration	50%	20%	10%	5%	2%	1%	0.50%	0.20%	0.10%
1 min	1.58	2.33	2.89	3.48	4.32	5.01	5.86	6.9	7.76
2 min	2.7	3.93	4.83	5.75	6.99	8.01	9.14	10.6	11.8
3 min	3.62	5.28	6.49	7.74	9.45	10.9	12.5	14.6	16.3
4 min	4.39	6.43	7.92	9.47	11.6	13.4	15.5	18.2	20.3
5 min	5.05	7.42	9.17	11	13.5	15.6	18.2	21.4	24
10 min	7.4	11	13.6	16.4	20.5	23.8	27.9	33	37.1
15 min	8.94	13.3	16.6	20	24.9	29	34.1	40.2	45.3
20 min	10.1	15	18.7	22.6	28.2	32.8	38.4	45.3	51
25 min	11.1	16.4	20.4	24.6	30.7	35.7	41.8	49.2	55.3
30 min	11.9	17.6	21.8	26.3	32.7	38.1	44.4	52.3	58.8
45 min	13.8	20.2	25	30.1	37.3	43.3	50.3	59.1	66.4
1 hour	15.2	22.2	27.4	32.9	40.6	47	54.6	64	71.9
1.5 hour	17.5	25.3	31	37	45.4	52.4	60.9	71.4	80.2
2 hour	19.3	27.6	33.7	40.1	49.1	56.5	65.7	77.2	86.8
3 hour	22.2	31.3	38	45	54.8	62.8	73.5	86.6	97.4
4.5 hour	25.5	35.5	42.9	50.5	61.3	70.1	82.6	97.5	110
6 hour	28.1	38.9	46.8	54.9	66.6	76	89.9	106	120
9 hour	32.1	44.3	53	62	75	85.5	101	120	136
12 hour	35.2	48.4	57.9	67.6	81.6	93	110	131	148
18 hour	39.8	54.8	65.4	76.1	91.8	104	123	146	164
24 hour	43.1	59.5	71	82.5	99.4	113	132	155	175
30 hour	45.7	63.2	75.4	87.5	105	119	136	158	175
36 hour	47.7	66.1	78.9	91.6	110	125	140	161	178
48 hour	50.8	70.6	84.2	97.7	117	132	147	167	184
72 hour	54.7	76.1	90.7	105	125	141	156	178	195
96 hour	57.2	79.1	94.1	109	129	145	161	185	203
120 hour	59	80.8	95.8	111	131	147	165	189	208
144 hour	60.5	81.8	96.6	112	132	148	167	191	210
168 hour	61.9	82.3	96.8	112	132	148	167	192	211

A2 Available temporal patterns

Available durations of point and areal temporal patterns are shown in Table 7-2 and Table 7-3, respectively, compared to available IFD information. The shaded boxes are those where IFD information is available, but for which no temporal pattern durations are available. Areal temporal patterns are typically used for catchments greater than 75 km² in size. Using the point temporal patterns over the areal patterns generally produces a more conservative (higher) estimation of the peak flows within the catchment.

Table 7-2 Available point temporal pattern durations from AR&R

Durations				
1 minute	15 minutes	1.5 hours	12 hours	72 hours
2 minutes	20 minutes	2 hours	18 hours	96 hours
3 minutes	25 minutes	3 hours	24 hours	120 hours
4 minutes	30 minutes	4.5 hours	30 hours	144 hours
5 minutes	45 minutes	6 hours	36 hours	168 hours
10 minutes	1 hour	9 hours	48 hours	

Table 7-3 Available areal temporal pattern durations from AR&R

Durations				
1 minute	15 minutes	1.5 hours	12 hours	72 hours
2 minutes	20 minutes	2 hours	18 hours	96 hours
3 minutes	25 minutes	3 hours	24 hours	120 hours
4 minutes	30 minutes	4.5 hours	30 hours	144 hours
5 minutes	45 minutes	6 hours	36 hours	168 hours
10 minutes	1 hour	9 hours	48 hours	

A3 Data hub results

Data

River Region

Division	South East Coast (Victoria)
River Number	11
River Name	Hopkins River

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2016_v1

ARF Parameters

$$ARF = Min\left\{1, \left[1 - a\left(Area^{b} - c\log_{10}Duration\right)Duration^{-d} + eArea^{f}Duration^{g}\left(0.3 + \log_{10}AEP\right) + h10^{iArea\frac{Duration}{1440}}\left(0.3 + \log_{10}AEP\right)\right]\right\}$$

Zone	a	b	c	d	e	f	g	h	i
Southern Temperate	0.158	0.276	0.372	0.315	0.000141	0.41	0.15	0.01	-0.0027

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2016_v1

Short Duration ARF

$$ARF = Min\left[1, 1 - 0.287\left(Area^{0.265} - 0.439\log_{10}(Duration)\right).Duration^{-0.36} + 2.26 \times 10^{-3} \times Area^{0.226}.Duration^{0.125}\left(0.3 + \log_{10}(AEP)\right) + 0.0141 \times Area^{0.213} \times 10^{-0.021\frac{(Duration-180)^2}{1440}}\left(0.3 + \log_{10}(AEP)\right)\right]$$

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are **NOT FOR DIRECT USE** in urban areas

Note: As this point is in Victoria the advice provided on losses and pre-burst in the VIC specific tab of the ARR Data Hub should be considered.

ID	18771.0
Storm Initial Losses (mm)	23.0
Storm Continuing Losses (mm/h)	4.6

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2016_v1

Temporal Patterns | Download (.zip)

code	SSmainland
Label	Southern Slopes (Vic/NSW)

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2016_v2

Areal Temporal Patterns | Download (.zip)

code	SSmainland
arealabel	Southern Slopes (Vic/NSW)

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2016_v2

BOM IFDs

Click here to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	03 October 2023 02:05PM

Median Preburst Depths and Ratios

Note: As this point is in Victoria the advice provided on losses and pre-burst in the VIC specific tab of the ARR Data Hub should be considered.

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	1.9 (0.133)	3.0 (0.148)	3.7 (0.150)	4.4 (0.149)	2.5 (0.071)	1.2 (0.028)
90 (1.5)	1.2 (0.078)	1.7 (0.074)	2.0 (0.071)	2.3 (0.068)	2.0 (0.049)	1.8 (0.038)
120 (2.0)	1.8 (0.099)	2.0 (0.080)	2.2 (0.071)	2.3 (0.064)	2.0 (0.046)	1.8 (0.036)
180 (3.0)	1.4 (0.067)	1.7 (0.059)	1.9 (0.054)	2.1 (0.051)	2.5 (0.049)	2.8 (0.048)
360 (6.0)	0.2 (0.009)	1.4 (0.038)	2.1 (0.048)	2.9 (0.055)	3.2 (0.050)	3.5 (0.047)
720 (12.0)	0.0 (0.000)	0.7 (0.016)	1.2 (0.022)	1.7 (0.026)	3.8 (0.046)	5.4 (0.057)
1080 (18.0)	0.0 (0.000)	0.0 (0.001)	0.1 (0.001)	0.1 (0.001)	1.0 (0.010)	1.6 (0.015)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

10% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

25% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.001)	0.1 (0.002)
90 (1.5)	0.1 (0.008)	0.1 (0.003)	0.0 (0.001)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

75% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	8.9 (0.635)	11.6 (0.581)	13.4 (0.549)	15.2 (0.520)	13.6 (0.378)	12.4 (0.299)
90 (1.5)	8.8 (0.551)	10.1 (0.439)	10.9 (0.389)	11.6 (0.350)	12.7 (0.313)	13.5 (0.290)
120 (2.0)	8.9 (0.501)	9.8 (0.390)	10.4 (0.340)	11.0 (0.303)	13.2 (0.299)	14.9 (0.294)
180 (3.0)	7.8 (0.384)	9.6 (0.332)	10.7 (0.306)	11.9 (0.286)	13.1 (0.260)	14.0 (0.244)
360 (6.0)	4.2 (0.160)	9.8 (0.265)	13.5 (0.302)	17.0 (0.324)	20.5 (0.320)	23.2 (0.315)
720 (12.0)	2.5 (0.074)	7.5 (0.160)	10.9 (0.191)	14.1 (0.209)	19.0 (0.230)	22.7 (0.237)
1080 (18.0)	0.2 (0.006)	4.2 (0.078)	6.8 (0.105)	9.3 (0.121)	12.4 (0.130)	14.8 (0.133)
1440 (24.0)	0.0 (0.000)	3.2 (0.054)	5.2 (0.074)	7.2 (0.086)	8.9 (0.085)	10.2 (0.084)
2160 (36.0)	0.0 (0.000)	1.0 (0.015)	1.6 (0.020)	2.2 (0.023)	3.5 (0.030)	4.5 (0.033)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.1 (0.001)	0.1 (0.001)	0.8 (0.007)	1.4 (0.010)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

90% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	22.8 (1.636)	27.0 (1.352)	29.8 (1.217)	32.5 (1.112)	28.3 (0.789)	25.2 (0.609)
90 (1.5)	17.8 (1.109)	23.4 (1.021)	27.1 (0.969)	30.6 (0.922)	32.8 (0.809)	34.4 (0.741)
120 (2.0)	17.5 (0.985)	18.6 (0.739)	19.4 (0.632)	20.1 (0.554)	31.2 (0.706)	39.5 (0.781)
180 (3.0)	19.5 (0.954)	21.3 (0.735)	22.4 (0.638)	23.5 (0.567)	30.8 (0.611)	36.3 (0.629)
360 (6.0)	15.8 (0.604)	22.5 (0.610)	26.9 (0.603)	31.1 (0.593)	38.1 (0.594)	43.3 (0.587)
720 (12.0)	18.0 (0.540)	23.0 (0.491)	26.3 (0.463)	29.5 (0.439)	35.2 (0.426)	39.5 (0.412)
1080 (18.0)	8.3 (0.218)	13.6 (0.254)	17.1 (0.263)	20.4 (0.265)	26.7 (0.279)	31.3 (0.282)
1440 (24.0)	5.9 (0.141)	11.8 (0.203)	15.8 (0.222)	19.6 (0.232)	21.2 (0.202)	22.4 (0.183)
2160 (36.0)	8.8 (0.186)	10.4 (0.158)	11.4 (0.144)	12.5 (0.131)	23.2 (0.198)	31.3 (0.229)
2880 (48.0)	4.7 (0.092)	5.6 (0.079)	6.1 (0.072)	6.7 (0.065)	11.6 (0.093)	15.4 (0.105)
4320 (72.0)	0.4 (0.007)	5.6 (0.073)	9.1 (0.098)	12.4 (0.112)	19.8 (0.147)	25.3 (0.164)

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Interim Climate Change Factors

	RCP 4.5	RCP6	RCP 8.5
2030	**0.648 (3.2%)**	0.687 (3.4%)	**0.811 (4.0%)**
2040	**0.878 (4.4%)**	0.827 (4.1%)	**1.084 (5.4%)**
2050	**1.081 (5.4%)**	1.013 (5.1%)	**1.446 (7.3%)**
2060	**1.251 (6.3%)**	1.229 (6.2%)	**1.862 (9.5%)**
2070	**1.381 (7.0%)**	1.460 (7.4%)	**2.298 (11.9%)**
2080	**1.465 (7.4%)**	1.691 (8.6%)	**2.719 (14.2%)**
2090	**1.496 (7.6%)**	1.906 (9.7%)	**3.090 (16.3%)**

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2019_v1
Note	ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.

Baseflow Factors

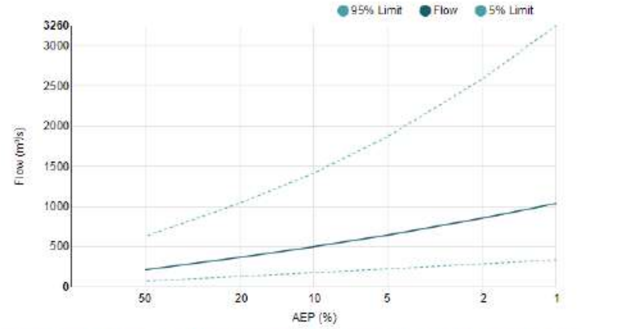
Downstream	11256
Area (km2)	5404.76339187
Catchment Number	11201
Volume Factor	0.395019
Peak Factor	0.066622

Layer Info

Time Accessed	03 October 2023 02:05PM
Version	2016_v1

A4 RFFE Results

Results | Regional Flood Frequency Estimation Model



*The catchment is outside the recommended catchment size of 0.5 to 1,000 km². Results have lower accuracy and may not be directly applicable in practice.

AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	210	69.7	628
20	370	130	1050
10	500	176	1420
5	644	223	1870
2	860	288	2600
1	1040	338	3260

Input Data	
Date/Time	2023-10-03 16:32
Catchment Name	Mortlake
Latitude (Outlet)	-38.09912794
Longitude (Outlet)	142.6571968
Latitude (Centroid)	-37.64461353
Longitude (Centroid)	142.83936756
Catchment Area (km^2)	4691.056994*
Distance to Nearest Gauged Catchment (km)	27.9
50% AEP 6 Hour Rainfall Intensity (mm/h)	4.677673
2% AEP 6 Hour Rainfall Intensity (mm/h)	11.060698
Rainfall Intensity Source (User/Auto)	Auto
Region	East Coast
Region Version	RFFE Model 2016 v1
Region Source (User/Auto)	Auto
Shape Factor	0.77
Interpolation Method	Natural Neighbour
Bias Correction Value	-0.66

Statistics

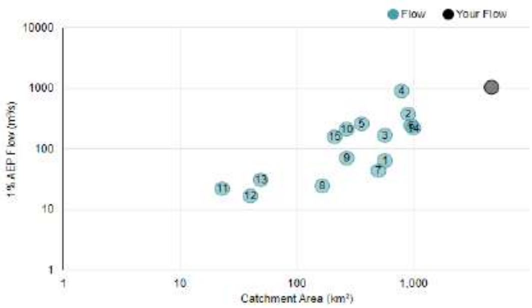
Variable	Value	Standard Dev
Mean	5.308	0.659
Standard Dev	0.668	0.205
Skew	0.097	0.031

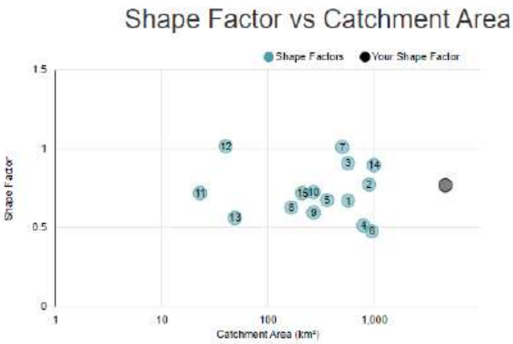
Note: These statistics come from the nearest gauged catchment. Details

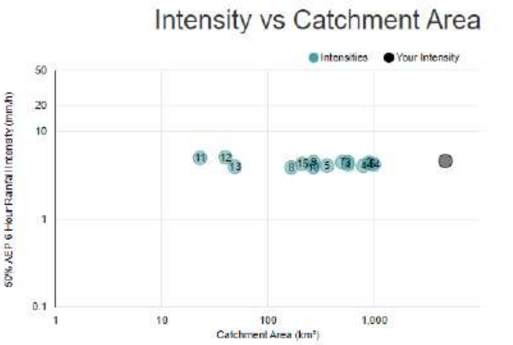
Correlation		
1.000		
-0.330	1.000	
0.170	-0.280	1.000

Note: These statistics are common to each region. Details

1% AEP Flow vs Catchment Area




Shape Factor vs Catchment Area
Shape Factors
Your Shape Factor
Shape Factor
1.5
1
0.5
0
1
10
100
1,000
Catchment Area (km²)
12
7
3
14
2
11
15
10
5
1
8
9
13
4
6


Intensity vs Catchment Area
Intensities
Your Intensity
50% AEP 6 Hour Rainfall Intensity (mm/h)
50
20
10
1
0.1
1
10
100
1,000
Catchment Area (km²)
11
12
13
8
15
5

Appendix B RORB details

Table 7-4 RORB reach details

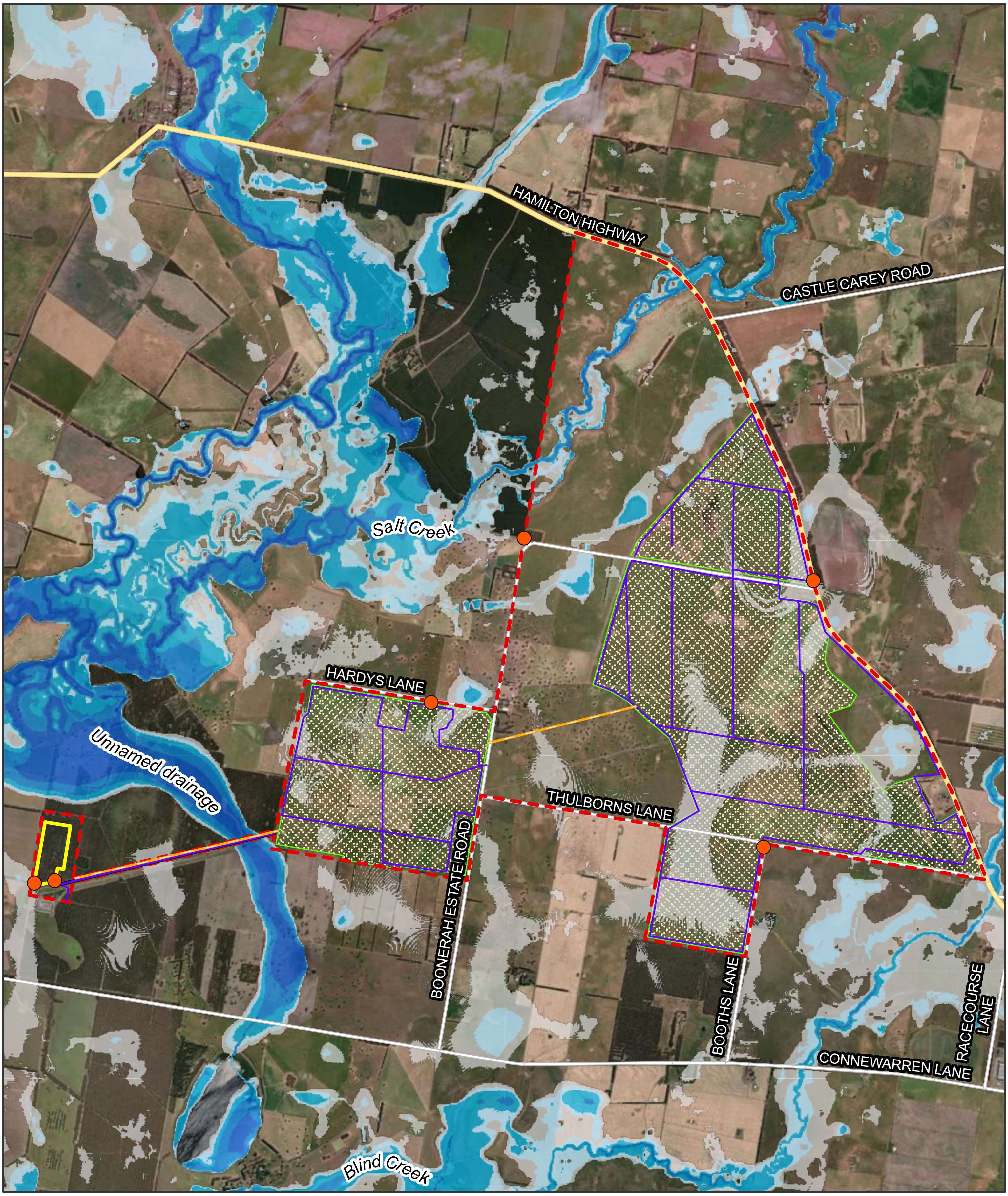
No.	Reach Name	Reach Type	Reach Length (km)
1	DS A	1. Natural	13.45
2	DS B	1. Natural	24.59
3	DS C	1. Natural	14.28
4	DS D	1. Natural	14.65
5	DS E	1. Natural	2.309
6	DS F	1. Natural	21.46
7	DS H	1. Natural	18.84
8	DS I	1. Natural	18.30
9	DS J	1. Natural	40.93
10	DS L	1. Natural	19.42
11	DS G	1. Natural	0.335
12	DS K	1. Natural	4.288
13	DS N	1. Natural	3.635
14	DS M	1. Natural	22.72

Table 7-5 RORB sub-catchment area details

No.	Node Name	Node Area (km^2)
1	SA AC	338.57
2	SA BC	939.94
3	SA CDE	471.71
4	SA EFG	479.80
5	SA HI	870.84
6	SA IJK	717.25
7	SA LG	518.39
8	SA KNO	43.313
9	SA MO	311.90

Appendix C HEC-RAS results

C1 Flood depth



10% AEP maximum flood depth

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

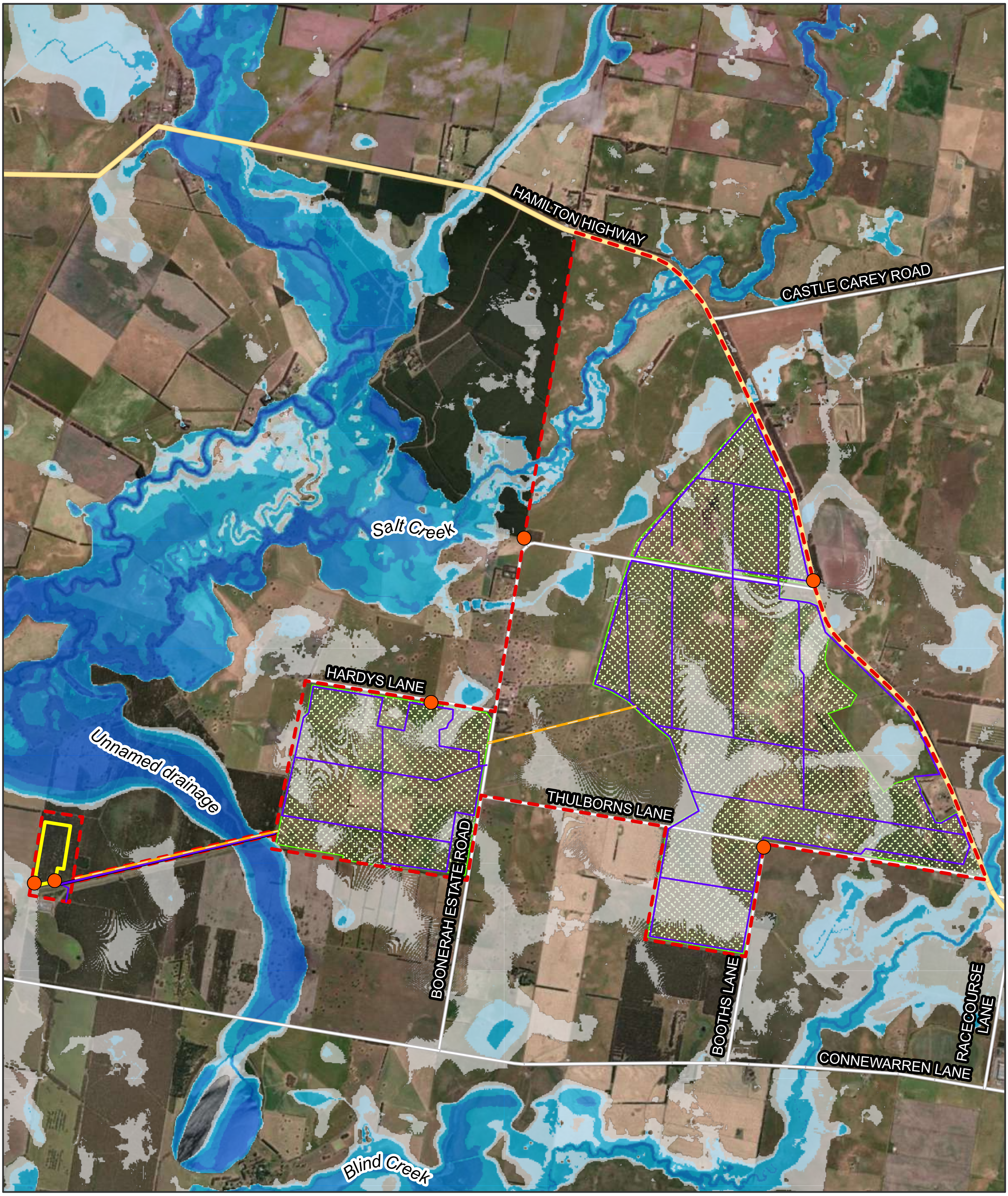
0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD527-ED Date: 4/18/2024

N

eco logical AUSTRALIA
A TETRA TECH COMPANY



2% AEP maximum flood depth

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD527-ED Date: 4/18/2024

N

eco logical AUSTRALIA
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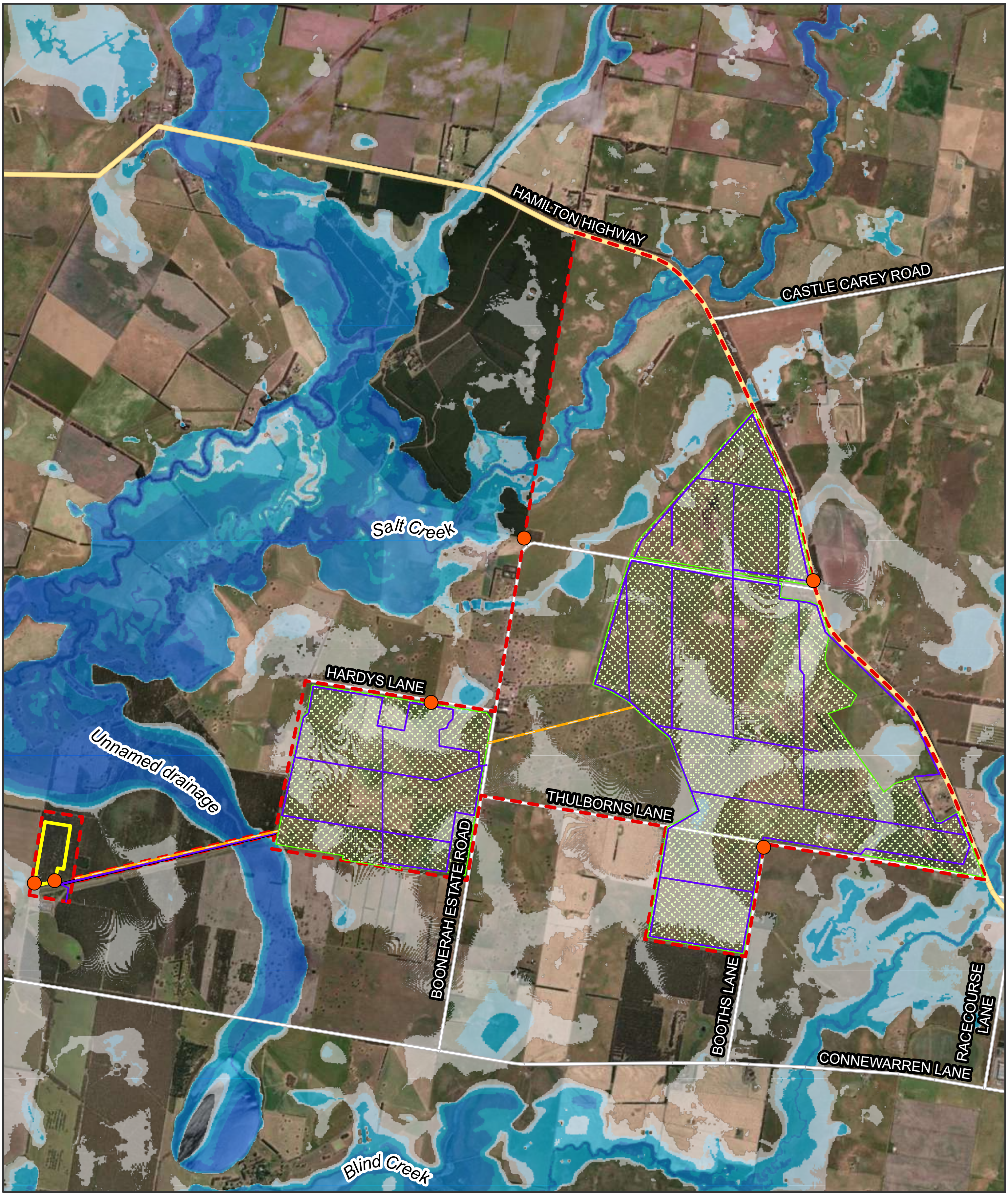

1% AEP maximum flood depth

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD5272-ED Date: 4/18/2024

N

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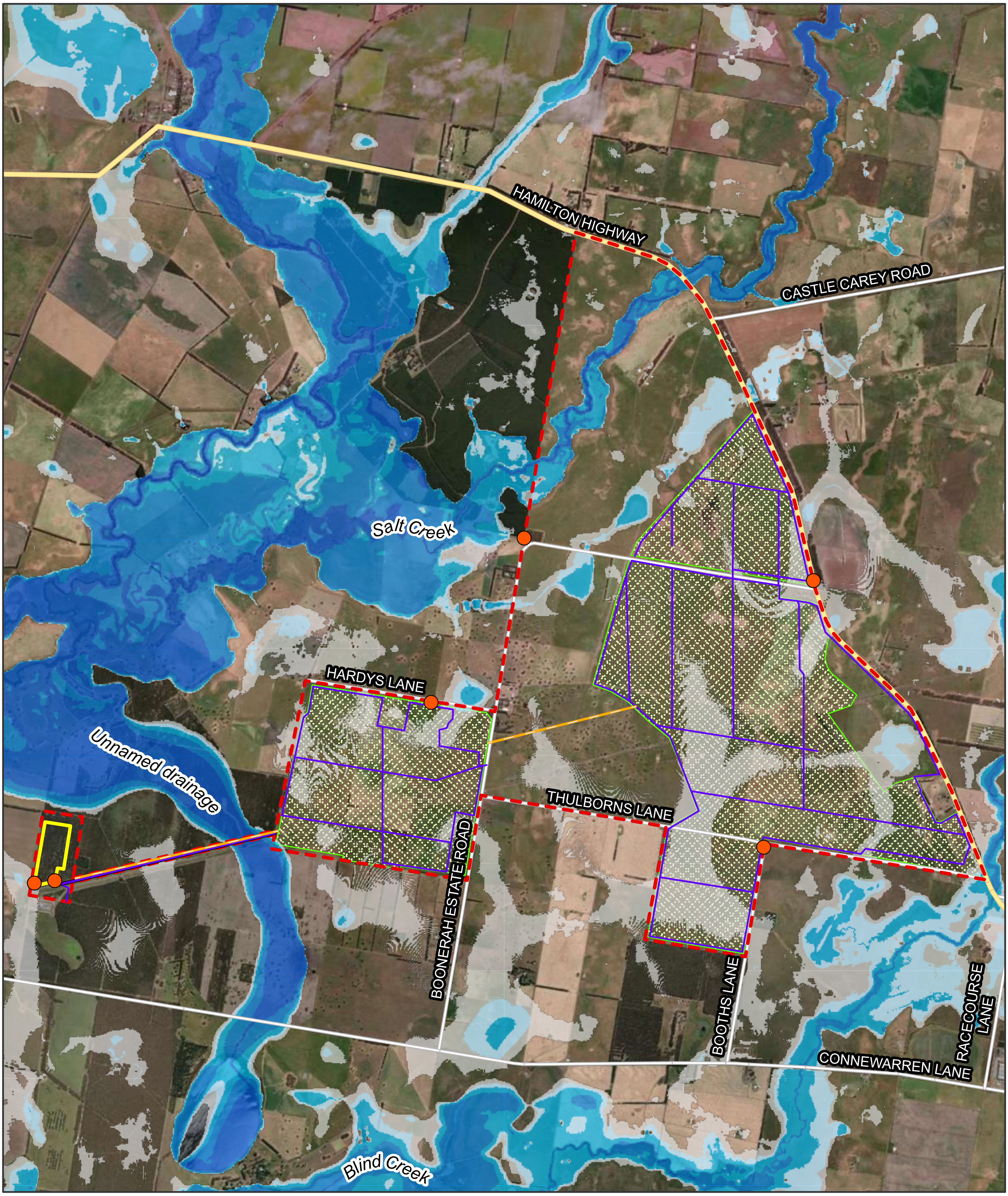

0.5% AEP maximum flood depth

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD527-ED Date: 4/18/2024

N

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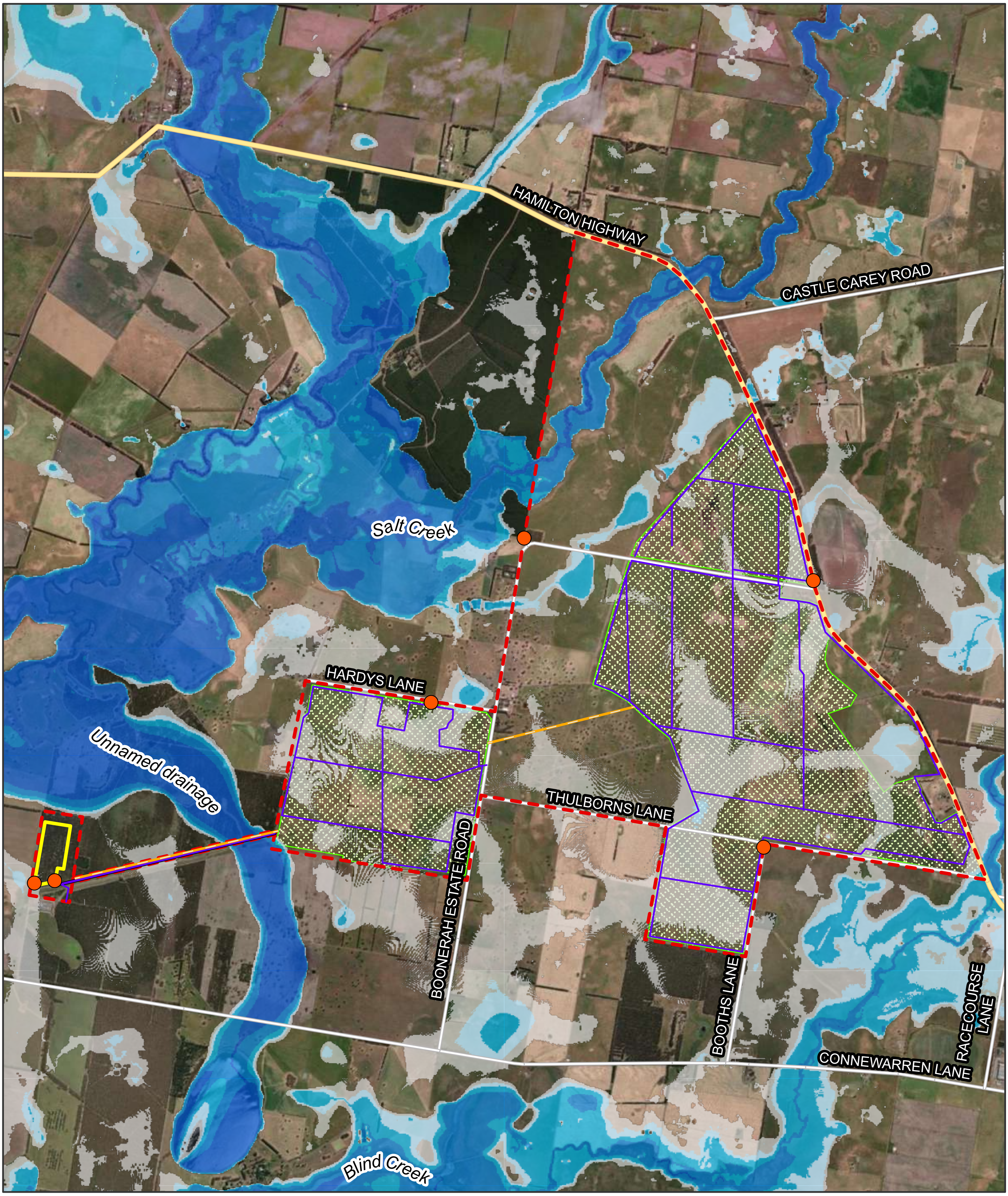

0.2% AEP maximum flood depth

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD527-ED Date: 4/18/2024

N

eco logical AUSTRALIA
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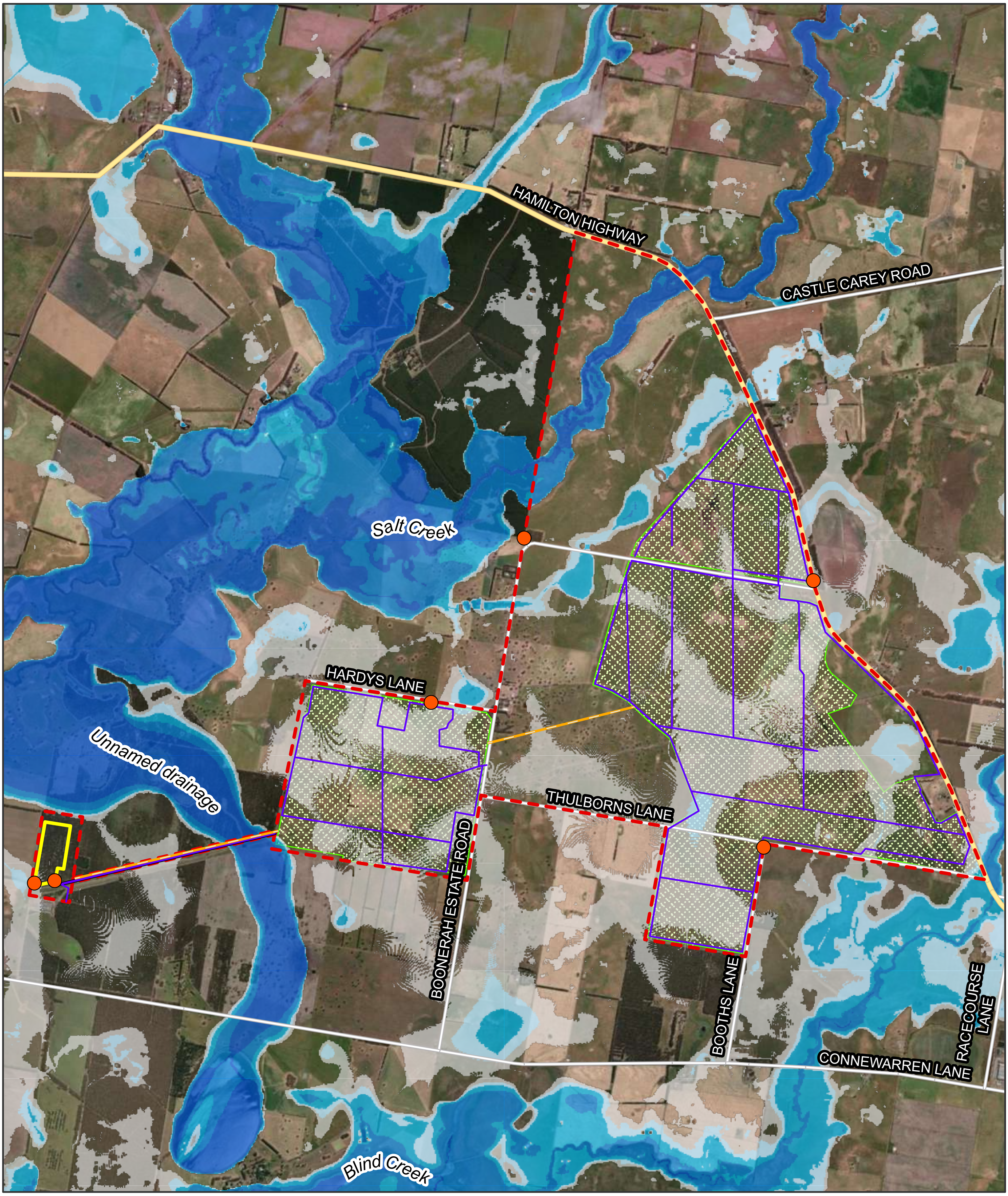

0.1% AEP maximum flood depth

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD527-ED Date: 4/18/2024

N

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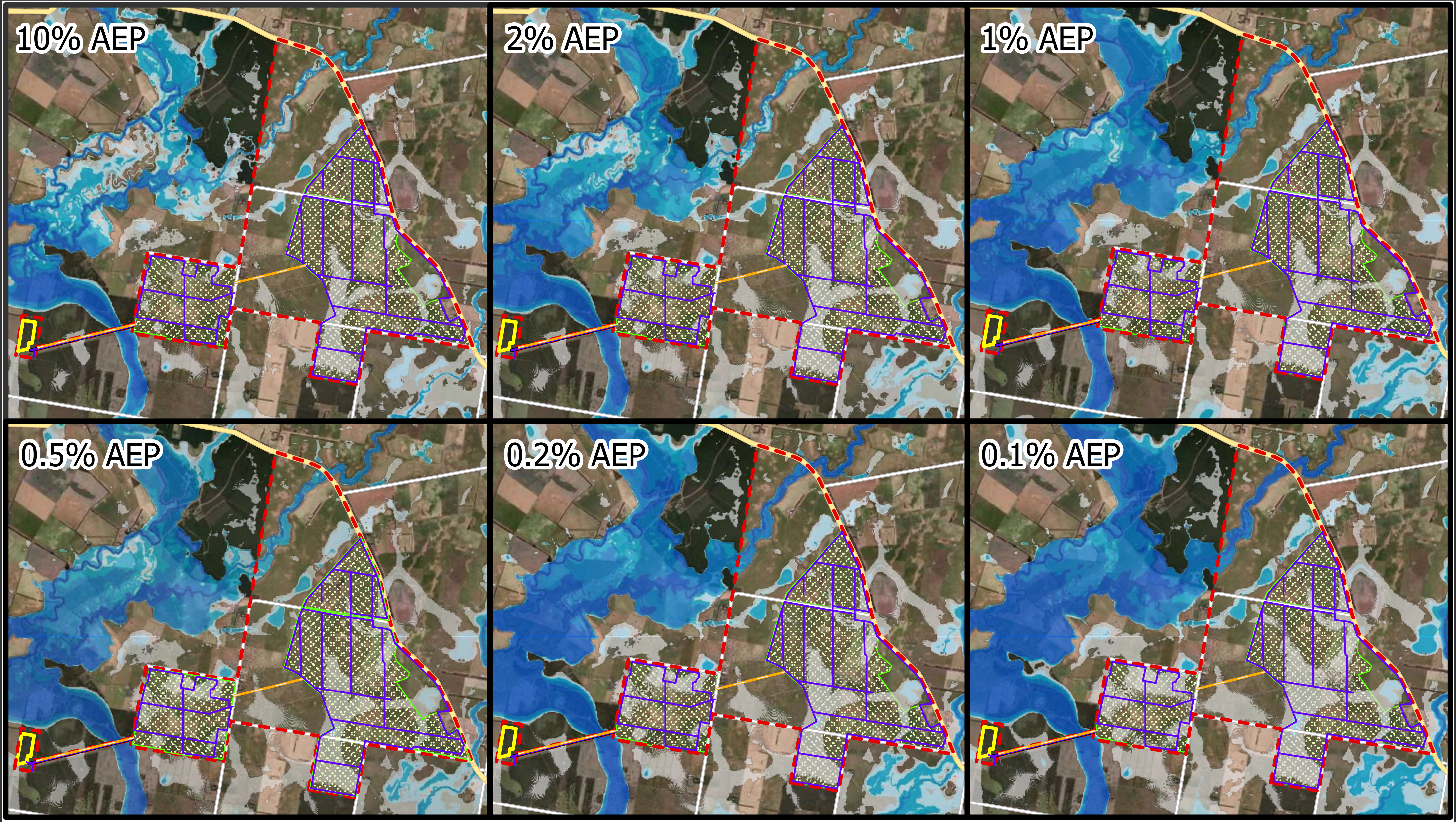

MEH maximum flood depth comparison

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed internal road
- Highway
- Road

Maximum flood depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 500 1,000 2,000
Metres

Datum/Projection:
GDA2020 MGA Zone 54
Project: 23SYD5272-ED Date: 4/19/2024

N

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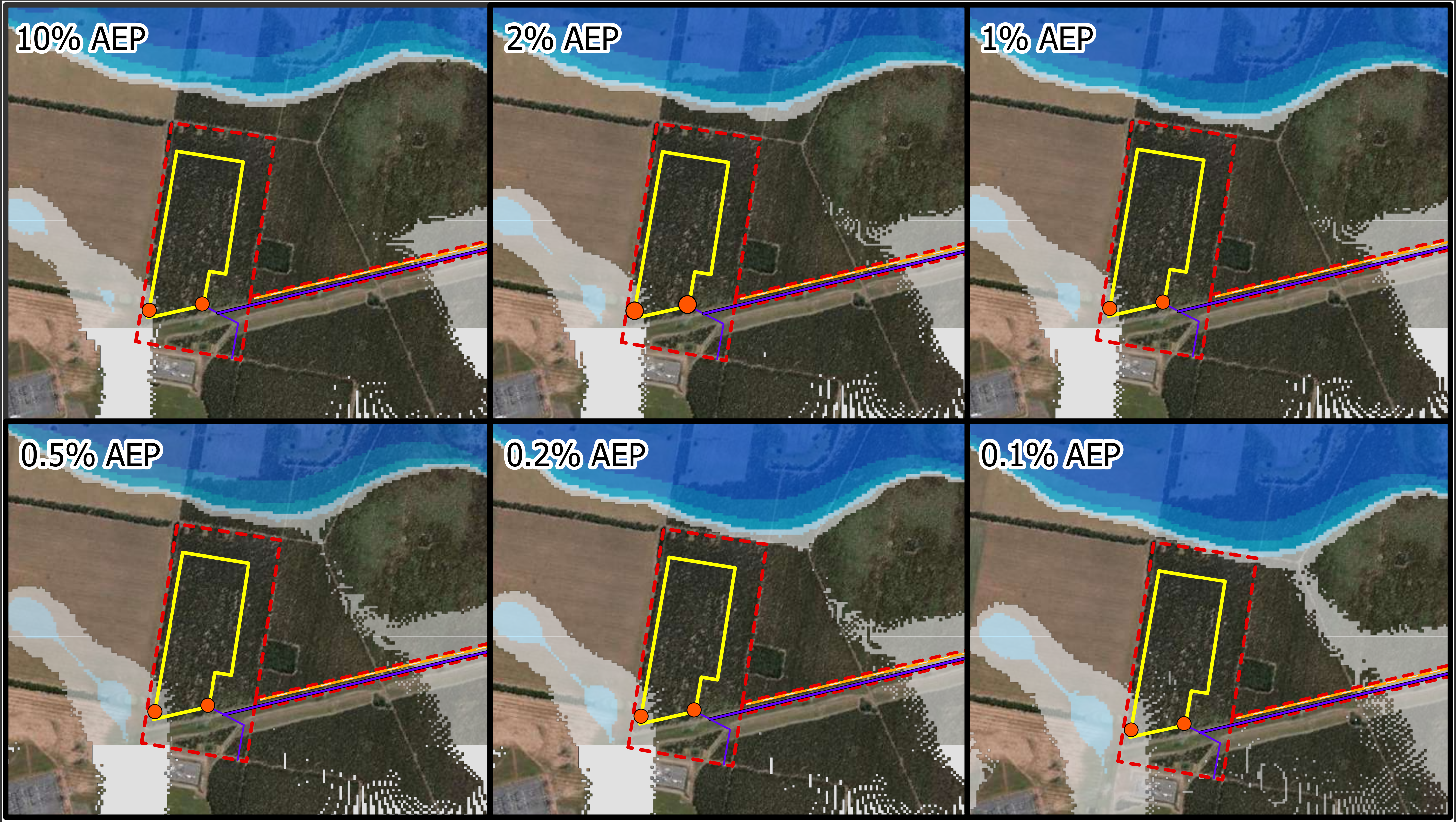

MEH BESS maximum flood depth comparison

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed access point

Maximum flood depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 165 330 660
Metres

Datum/Projection:
GDA2020 MGA Zone 54
Project: 23SYD5272-ED Date: 4/19/2024

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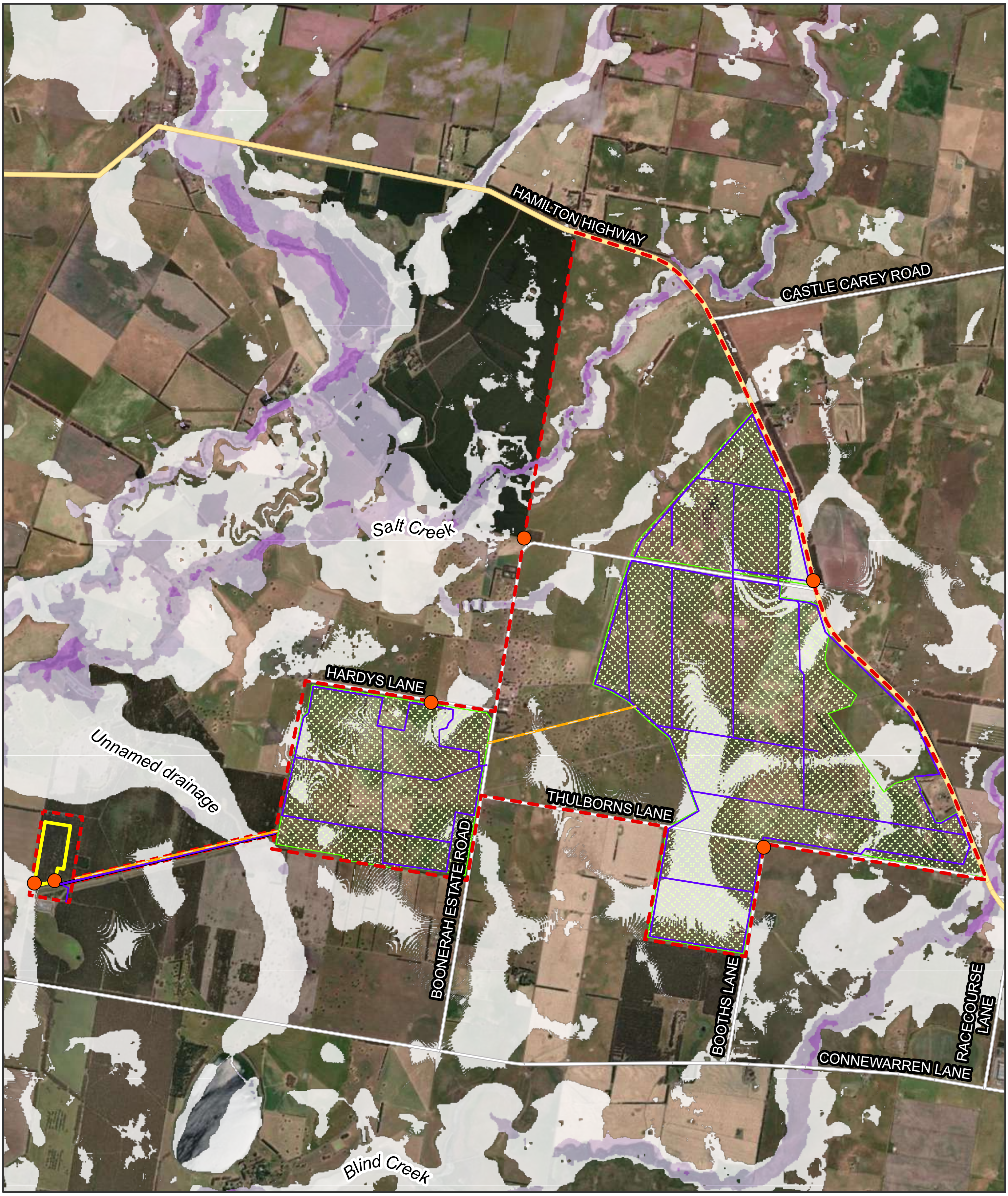
C2 Velocities



10% AEP maximum flood velocity

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood velocity (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD5272-ED Date: 4/18/2024

N

eco logical AUSTRALIA
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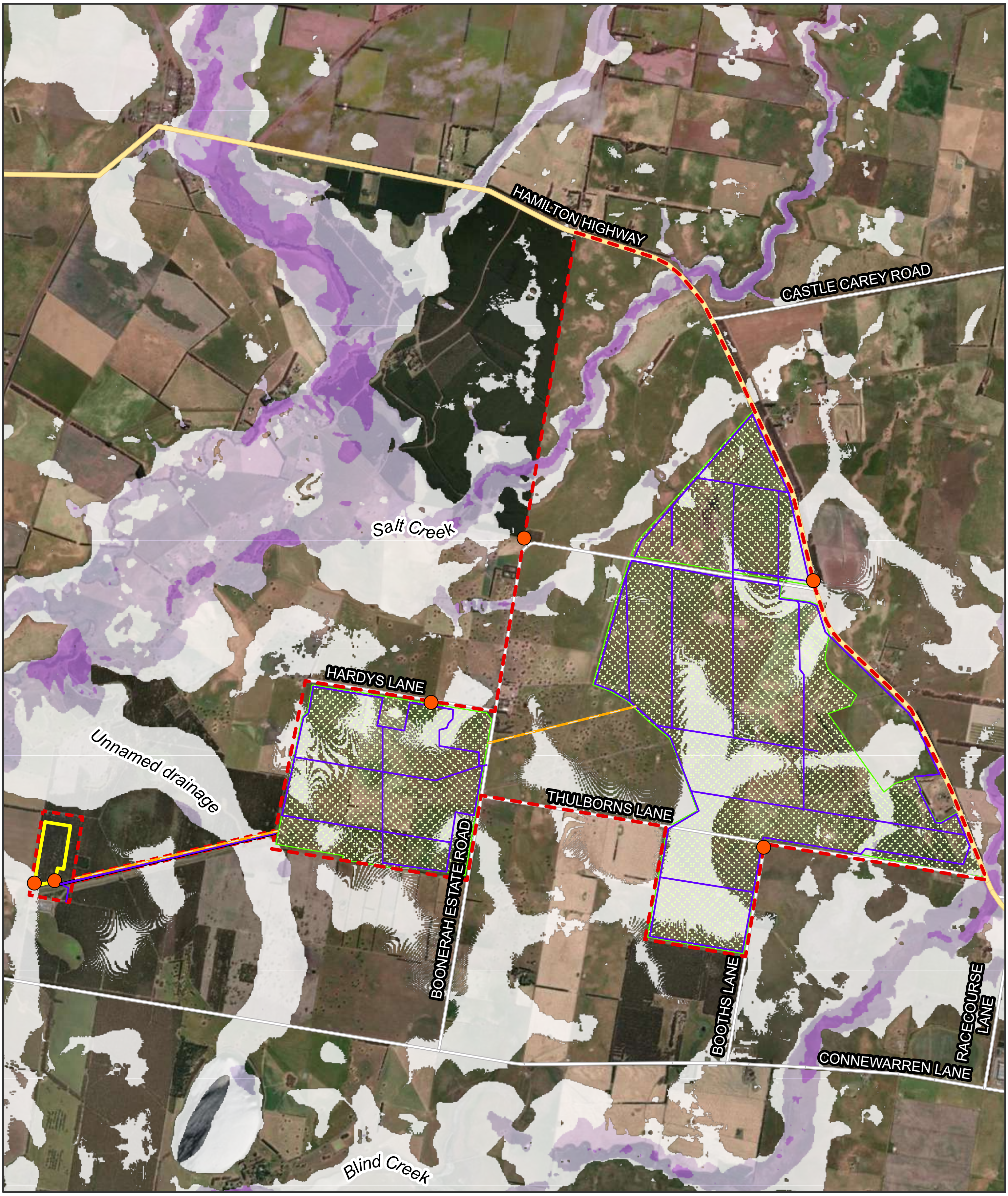


2% AEP maximum flood velocity

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood velocity (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

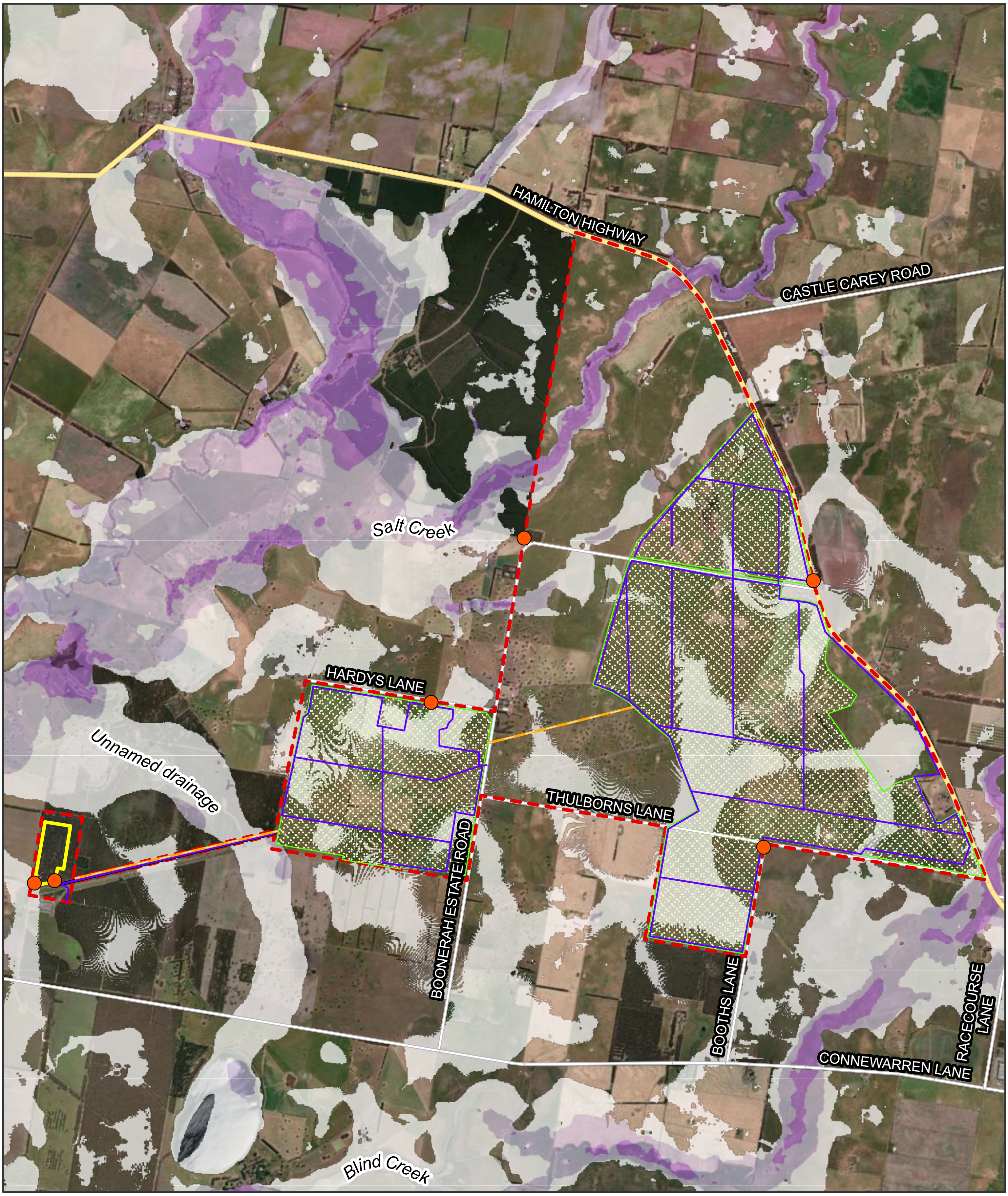
0 0.5 1 2

Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD5272-ED Date: 4/18/2024

N



1% AEP maximum flood velocity

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood velocity (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD5272-ED Date: 4/18/2024

N

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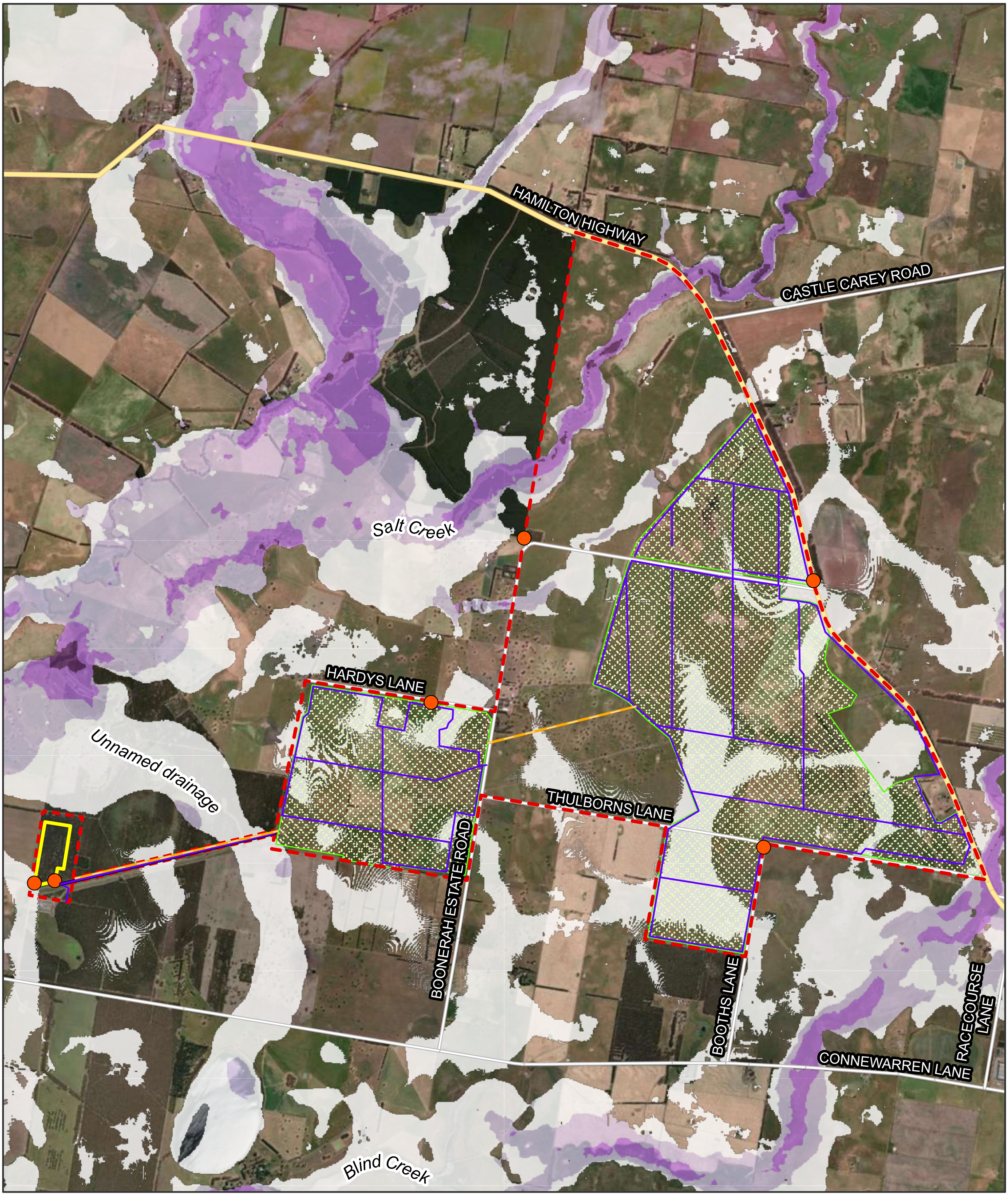

0.5% AEP maximum flood velocity

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood velocity (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD5272-ED Date: 4/18/2024

N

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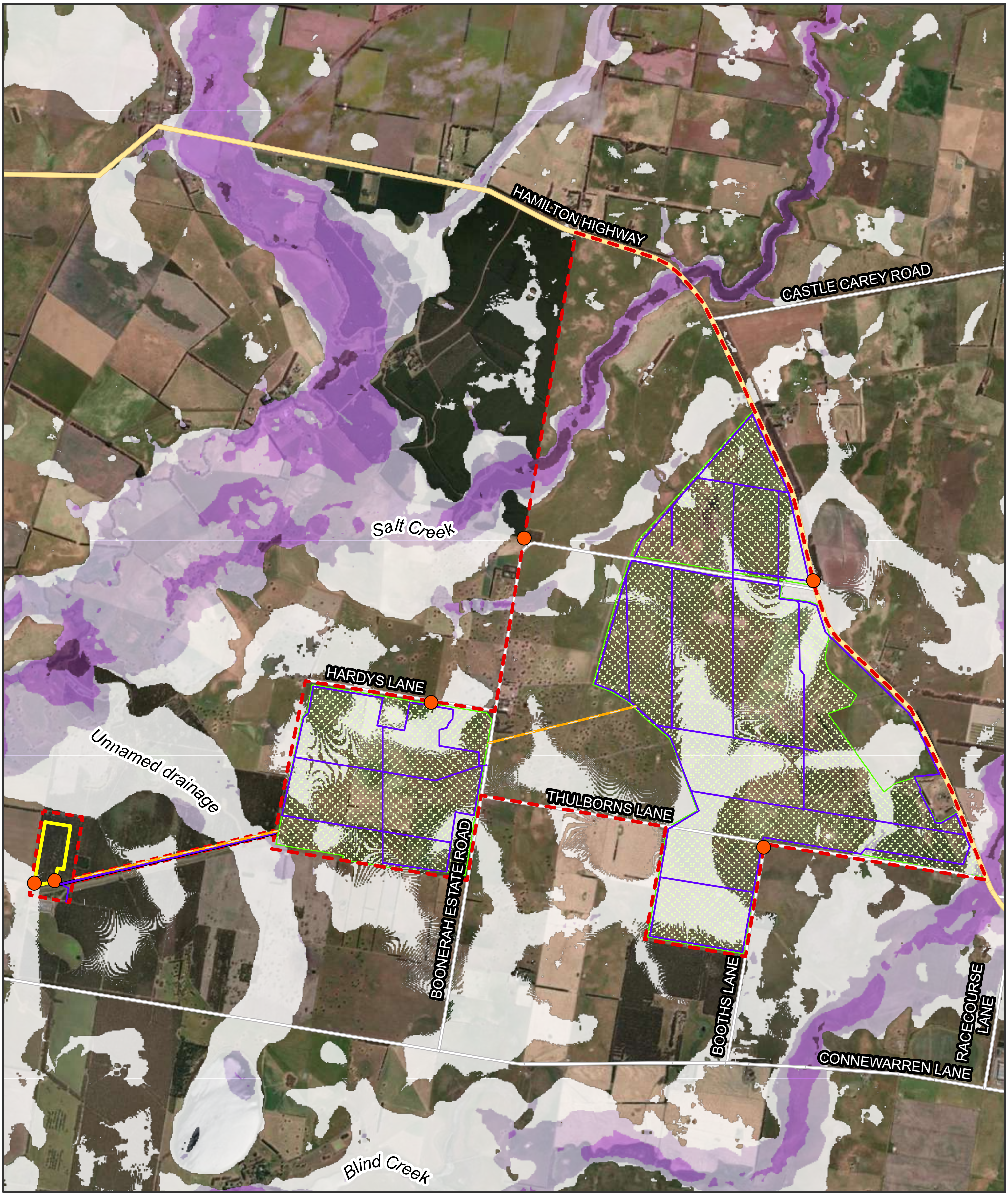

0.2% AEP maximum flood velocity

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood velocity (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD5272-ED Date: 4/18/2024

N

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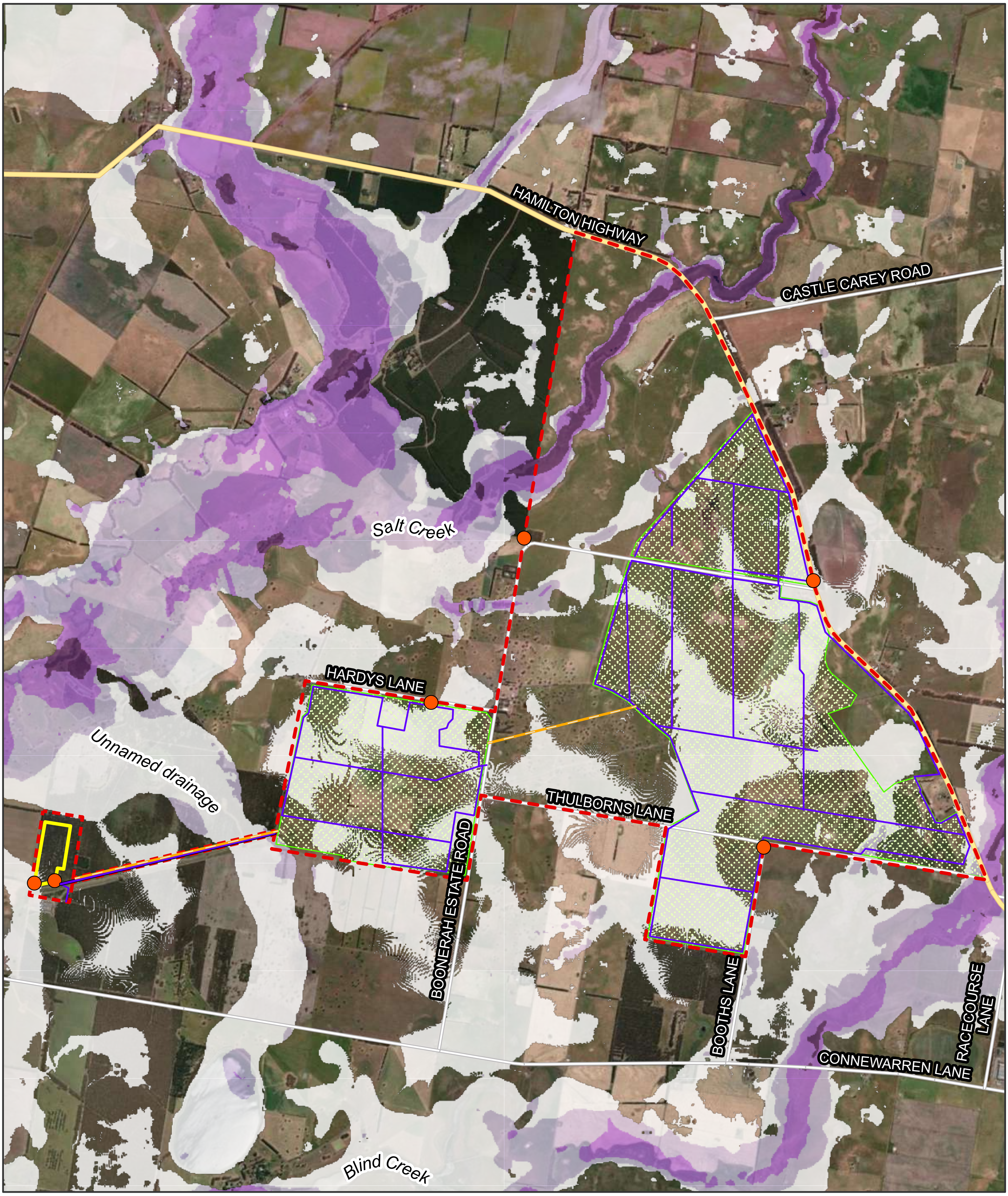

0.1% AEP maximum flood velocity

- MEH development boundary
- Proposed BESS and substation boundary
- Proposed emergency access track
- Proposed underground transmission cable
- Proposed array area
- Proposed access point
- Proposed internal road
- Highway
- Road

Maximum flood velocity (m/s)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- >2

0 0.5 1 2
Kilometres

Datum/Projection:
GDA2020 MGA Zone 54

Project: 23SYD5272-ED Date: 4/18/2024

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