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Latrobe Valley Battery Energy Storage System (BESS)

Tilt Renewables

Desktop Hydrology and Flood Risk Assessment – Phase 2

Document control record

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Acronym / Term	Definition
BESS	Battery Energy Storage System
MWTS	Morwell Terminal Station
IN1Z	Industrial 1 Zone
AEP	Annual Exceedance Probability
ARI	Annual Recurrence Interval
DEM	Digital Elevation Model
SRTM	Shuttle Radar Topography Mission
AHD	Australian Height Datum
LiDAR	Light Detection and Ranging
ELVIS	Elevation Information System
LSIO	Land Subject to Inundation Overlay
FO	Floodway Overlay
CMA	Catchment Management Authority
WGCMA	West Gippsland Catchment Management Authority
NFPL	Nominal Flood Protection Level

1 Introduction

Aurecon Australasia Pty Ltd (Aurecon) has been engaged by Tilt Renewables (the Proponent) to prepare a hydrology and flood risk assessment for the proposed Latrobe Valley Battery Energy Storage System (BESS) to support a Planning Permit application to the Minister for Planning.

The hydrology and flood assessment have been completed and were reported in summary in the *Latrobe Valley Battery Energy Storage System (BESS); Desktop Hydrology and Flood Risk Assessment* (July, 2020) to inform the Phase 1 component of this study. Phase 1 was undertaken to provide a detailed assessment of the hydrology and flooding behaviour at the project site, including a constraints and risk assessment of any potential impacts that many influence design.

The outcome of Phase 1 was used to inform the current site layout and design. Subsequently, the impact of the Project on flooding behaviour has been ascertained by undertaking further modelling which incorporated the proposed development conditions.

This report provides more technical detail on the data collection, methodology, and modelling outcomes of the assessment for submission with the Planning Permit application.

2 Location

The Project is located in Morwell, approximately 149 kilometres east of Melbourne in the Latrobe Valley area of Gippsland. The Project area is situated at 240 Monash Way, Morwell, adjacent to the existing Morwell Terminal Station (MWTS). The study area is comprised of one private landholding as well as the MWTS which is owned and operated by AusNet. The location of the Project area is presented in Figure 2-1.

The total Project area comprises approximately 25.5 hectares with the final disturbance area for the BESS anticipated to be approximately 4.4 hectares of land.

It is bounded by the Morwell Power Station to the west, Monash Way to the east and adjoining Industrial zoned land holdings to the north and south. The Project area also runs adjacent to a waterway (Bennetts Creek) on its western border.

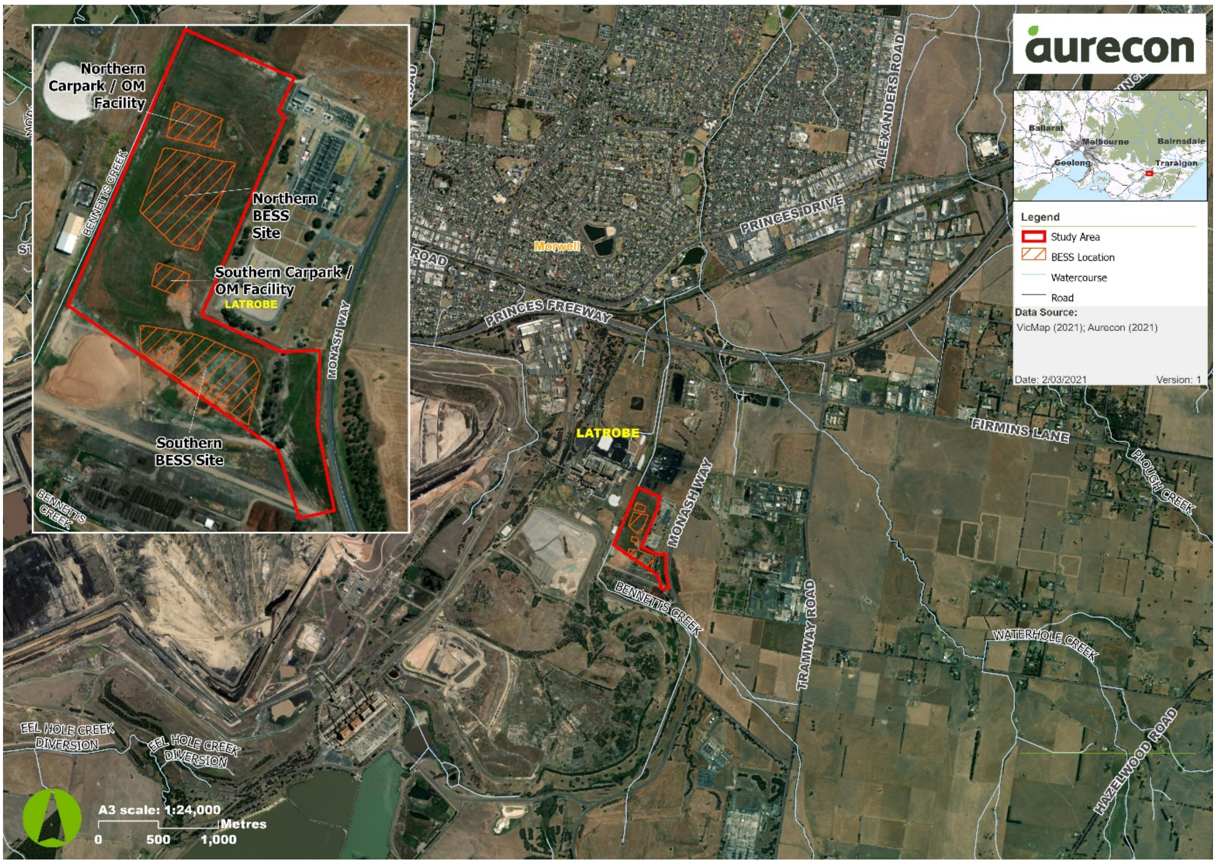


Figure 2-1: Proposed site location

3 Available Data

Several sources of flood related information were reviewed to support the hydrology and hydraulic modelling assessment. This information was reviewed to identify flood risks at the regional and local scale. Correspondence with West Gippsland Catchment Management Authority (WGCMA) was made in July 2020 to identify whether there are any existing flood studies covering the project area. Table 3-1 documents the data available from previous studies and relevant authorities for this assessment.

WGCMA advised that the latest available flood study is the Waterhole Creek Flood Study (2007). They further noted that the study was deemed unreliable due to extensive settlement of the land as a consequence of dewatering of the aquifer by mining activities. WGCMA also advised they no longer had possession of the Waterhole Creek Flood Study model. As a result, a detailed hydrological and hydraulic assessment was undertaken to better understand the flood behaviour and risk on the site and provide definitive outcomes to assist in site layout and design.

Table 3-1: Available Data

Data	Description	Source	Date received
SRTM data	Digital Elevation Model (DEM) information used to identify the upstream catchment	ELVIS (https://elevation.fsdf.org.au/)	23rd Jul 2020
1m LiDAR data	Digital Elevation Model (DEM) information used for hydraulic model set up and simulation	Spatial Vision (https://spatialvision.com.au/)	10th Sep 2020
LSIO and FO	Land Subject to Inundation Overlay* and Floodway Overlay**	VicPlan (https://mapshare.vic.gov.au/vicplan/)	22nd Jul 2020
Waterhole Creek Flood Study (2007)	NA	West Gippsland Catchment Management Authority (WGCMA)	22nd Jul 2020
West Gippsland Floodplain Management Strategy 2018 - 2027	The Strategy: - Identifies those parts of the region with significant flood risk - Identifies possible actions to mitigate those risks - Establishes a list of priority actions to be implemented over the ten-year duration of the Strategy	West Gippsland Catchment Management Authority (WGCMA)	27th Jul 2020
Flood Guidelines (2020)	Guidelines for development in flood prone areas	West Gippsland Catchment Management Authority (WGCMA)	27th Jul 2020
12D earthworks and drainage design data	Proposed site layout, earthworks and drainage design	Aurecon	2nd Feb 2021

* These are planning scheme controls that apply to land affected by flooding associated with waterways and open drainage systems. Such areas are commonly known as floodplains. These overlays require a planning permit for buildings and works.

** These apply to land that's identified as carrying active flood flows associated with waterways and open drainage systems. This overlay is categorised by depths in excess of one metre.

4 Flooding Mechanisms

The Land Subject to Inundation Overlay (LSIO) and the Floodway Overlay (FO) relevant to the site have been extracted from the Vicplan database. The LSIO identifies land in a flood storage or flood fringe area affected by the 1% AEP (100-year ARI) regional flood event or any other area determined by the floodplain management authority. The FO applies to land that's subject to active flood flows associated with waterways and open drainage systems with depths higher than one metre.

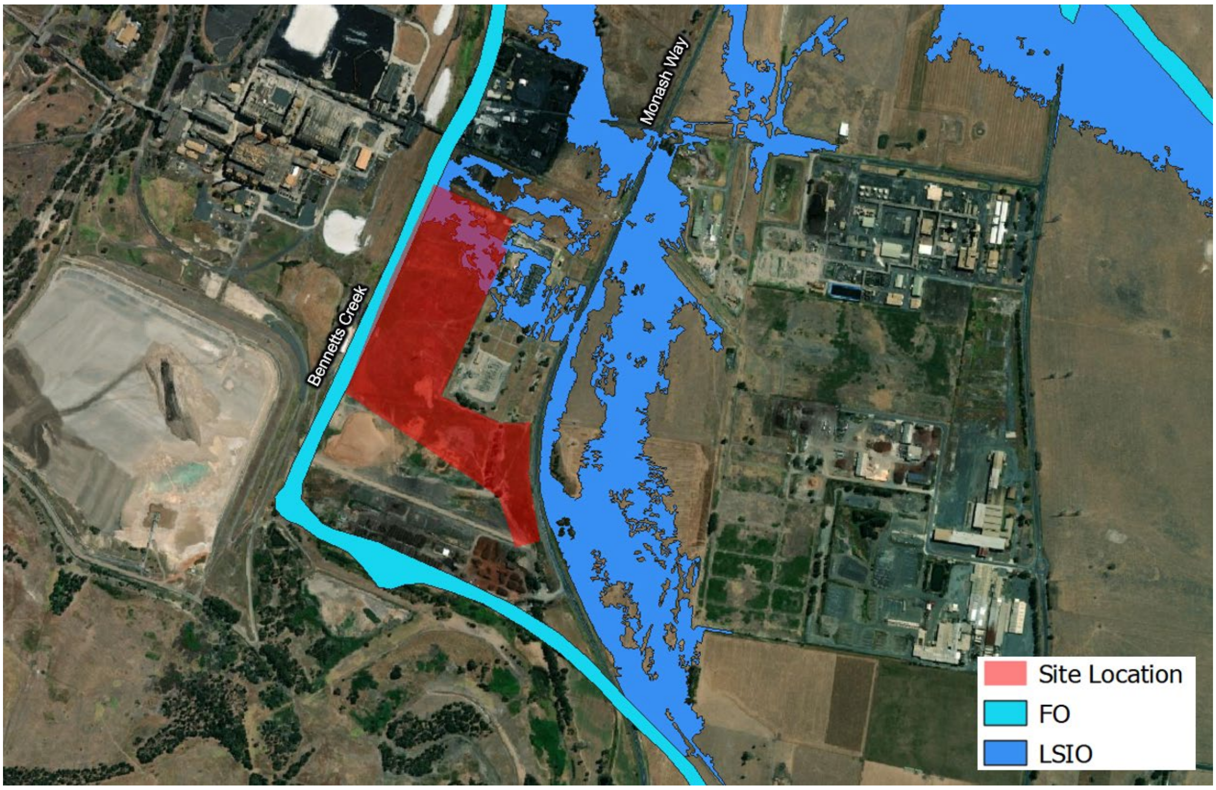


Figure 4-1: VicPlan – LSIO: Land Subject to Inundation Overlay and FO: Floodway Overlay

Based on the available LSIO and FO information (Figure 4-1) and general topography of the area, it appears that inundation in the vicinity of the site is the result of local catchment flooding (accumulation of overland flow) rather than regional flooding (flooding from a river system – in this case Latrobe River).

WGCMA have noted that the LSIO shown in Figure 4-1 was derived from a previous investigation, the Waterhole Creek Flood Study (2007). A review of the results from this investigation found that the 1% AEP (100-year ARI) flood depth is predicted to remain below 250 mm across the northern portion of the site. However, WGCMA confirmed that the Waterhole Creek Flood Study (2007) is no longer reliable. As a result, a more detailed flood study with current ground levels has been undertaken as part of this scope to confirm the flood behaviour across this area to provide advice on the magnitude and flood risk expected at the site. This detailed flood study builds on the initial flood modelling that was undertaken to inform the site layout and design. Subsequently, the impact of the Project on flooding behaviour has been ascertained by undertaking further modelling simulation which incorporated the proposed development conditions.

5 Hydrologic and Hydraulic Modelling

5.1 Catchment Description

The proposed site is located within the lower portion of the Bennetts Creek Catchment. The main creek channel drains north adjacent to the site on the western side, joining Waterhole Creek approximately 2km north of the site between Princes Freeway and Princes Drive, before ultimately discharging to the Latrobe River. Given the proximity of the site to the confluence of the two creeks, cross-catchment flood behaviour at Princes Freeway has been considered in this assessment.

The local catchments for Bennetts Creek and Waterhole Creek, Figure 5-1, were delineated in CatchmentSim using 1 second SRTM data**.** Based on the ground levels across the area, the catchments are relatively steep, extending into the Gippsland hill country south of Churchill. Both catchments are dominated by pastural land before becoming forested in the hill country. Drainage through the catchments is via open drains with interspersed road crossings. The areas of Bennetts Creek and Waterhole Creek catchments are approximately 35.32 km^2 and 38.16 km^2 respectively.

5.2 Hydrological Model

Hydrologic modelling of the Bennetts Creek and Waterhole Creek catchments was undertaken using the runoff routing model RORB. A RORB model representing both catchments to their confluence was developed for extracting hydrographs to be used as boundary conditions within a TUFLOW hydraulic model.

The following reach types were used in the RORB model setup to represent catchment routing:

Reach Type 1 – for natural reaches through rural areas;

Reach Type 2 - for flow in excavated but unlined channels; and

Reach Type 3 - for flow in lined channels, roads and pipes.

The total combined catchments are represented in the hydrologic model using 36 sub-areas. The schematisation of the model is provided in Appendix B. For areas with overland flow across rural areas and farmland where there were no defined channels or drainage Reach Type 1 has been used. Where the flow was found to be in an excavated unlined channel Reach Type 2 has been used (only one reach has been designated as Type 2). Where flow would be largely contained within piped assets or within the road reserve, then Reach Type 3 was used (only one reach has been designated as Type 1).

Figure 5-1: Approximate Catchment delineation and ground contour levels – SRTM data (m AHD)

5.2.1 Design Rainfall, Temporal Patterns, and Loss Model

The design rainfall and temporal patterns adopted for the modelling were extracted from Australian Rainfall and Runoff (ARR, 2016) using the ARR Data Hub. The ARR Data Hub is a tool that allows for easy access to the design inputs required to undertake flood estimation.

The location for which this data was extracted is shown in Table 5-1. The ARR Data Hub also links to the Bureau of Meteorology 2016 Rainfall IFD data system which provides the design rainfall depths for different storm probabilities and durations. The adopted design rainfall depths are shown in Appendix B.

All the collected data is then combined to define the design rainfall and pattern to apply to the study area. The adopted rainfall parameters are shown in Table 5-1.

An initial loss and continuing loss model was adopted for the hydrologic modelling. ARR 2019 provides guidance on losses for a rural catchment in this region and were applied in initial modelling, however, the final losses, shown in Table 5-1, were adopted following a model refinement process (Section 5.2.3).

Table 5-1: Adopted hydrological parameters

Parameter	Value
Location	Longitude: 146.4266, Latitude: -38.2396
River Region	Mitchell-Thomson Rivers
Temporal Patterns	SSmainland
Initial Loss	20.0 mm
Continuing Loss	1.0 mm/hr
Kc (RORB routing parameter)	13

ARR 2019 provides recommendations for preburst rainfalls to simulate catchment conditions prior to the start of a storm event. Preburst rainfall depths reported in the ARR Data Hub were less than 1mm for the 1% AEP short duration storms and 5.4mm for the 6 hour storm duration. As a conservative approach, the small magnitude of the preburst depths were not subtracted from the adopted storm initial losses outlined in Table 5-1.

5.2.2 Fraction Impervious

The fraction impervious across the catchments was assessed for representation in the hydrological model. This was done using aerial imagery and available land zoning information downloaded from Spatial Datamart Victoria. The majority of the RORB model subcatchments (sub-areas) were medium to lightly vegetated areas where a fraction impervious value 0.05 has been applied. Toward the downstream extent of each catchment the land becomes more developed (nearing Morwell) and the fraction pervious was varied from 0.135 to 0.544 across relevant subcatchments.

5.2.3 Model Calibration

No stream flow or rainfall gauge data was available for use at the time of this investigation. In the absence of this, the Regional Flood Frequency Estimation (RFFE) tool (ARR 2019) and a previous Water Technology Pty Ltd (WaterTech) investigation was used to validate the RORB model results.

The RFFE tool is a statistical tool that estimates a peak flow for the identified catchment. This is calculated using flood data from nearby gauged catchments combined with user defined catchment characteristics. Details of the RFFE analysis are provide in Appendix B.

A flood study of Waterhole Creek was completed in 2007 by WaterTech. The investigation included a calibration phase using data available at the time to refine the applied parameters of the RORB model for the Waterhole Creek catchment. The study also highlighted a diversion or spill of a portion of flow in Waterhole Creek into the adjacent Plough Creek catchment.

The results from the RFFE calculations and the WaterTech study are shown in Appendix B, along the with final results from the current RORB model. Final RORB parameters adopted following this phase of work are provided above in Table 5-1. The initial and continuing losses values were adopted directly from the WaterTech model as they were found to be suitable, while the final kc value (13) was finalised following an iterative refinement process.

5.2.4 ARR 2019 Critical Storm Duration

The 1% AEP design storm events were assessed for the ensemble of storm durations and temporal patterns. ARR 2019 provides 10 recommended temporal patters per storm duration. A series of design storm events were adopted based on the durations and patterns that generated the maximum flood height across the subject property. Table 5-2 provides a list of the events simulated to generate a composite maximum flood height at the BESS site.

Table 5-2: Adopted design storm durations and temporal patterns

AEP	Duration (hrs)	ARR Temporal Pattern
1%	0.5	2
1%	1.0	2
1%	1.0	3
1%	1.0	6
1%	1.0	8
1%	4.5	2
1%	9.0	1
1%	12.0	6

5.2.5 Results

Using the above parameter values, the peak flow at three locations in the model were extracted from RORB and compared to the WaterTech and RFFE results. The current model results match the WaterTech flows better as the RFFE results do not account for any flow lost via the diversion to the Plough Ck catchment. No further calibration of the RORB model was undertaken.

Table 5-3: RORB median 1% AEP peak flow results compared to RFFE results

Location	RORB (1% AEP peak flow)	WaterTech (1% AEP flow)	RFFE (1% AEP flow)
Water Hole Ck #1 (East)	58.6 m^3/s	58	65 m^3/s
Water Hole Ck #2 (West)	7.4 m^3/s	13	17 m^3/s
Bennetts Ck (West)	35.45 m^3/s	21	63 m^3/s

5.3 Hydraulic Modelling – Existing Condition

A hydraulic model representing the study area was built using the dynamically linked 1D/2D hydraulic modelling software, TUFLOW. Through the simulation of flood behaviour, flow direction, flood depths, velocities and hazard are able to be determined within the limitations and accuracy of the model and can be used to inform flood risk within the study area.

The TUFLOW model developed for this assessment represents the following elements:

- Overland flow conveyance in two-dimensional (2D) space, characterised by topography and hydraulic roughness.

- Drainage culverts represented as one-dimensional (1D) elements to convey channel flows beneath roads and other embankments, accounting for the dynamic interaction between culvert flows and overland flows.

Key aspects of the model development are described further in the following sections.

5.3.1 Model Extent

The final adopted model extent is shown in Figure 5-2. The model extent has been set to ensure that flooding at the site is not influenced by any potential boundary condition effects, and that the model focuses on channel flooding adjacent to the site and overland flow through the site.

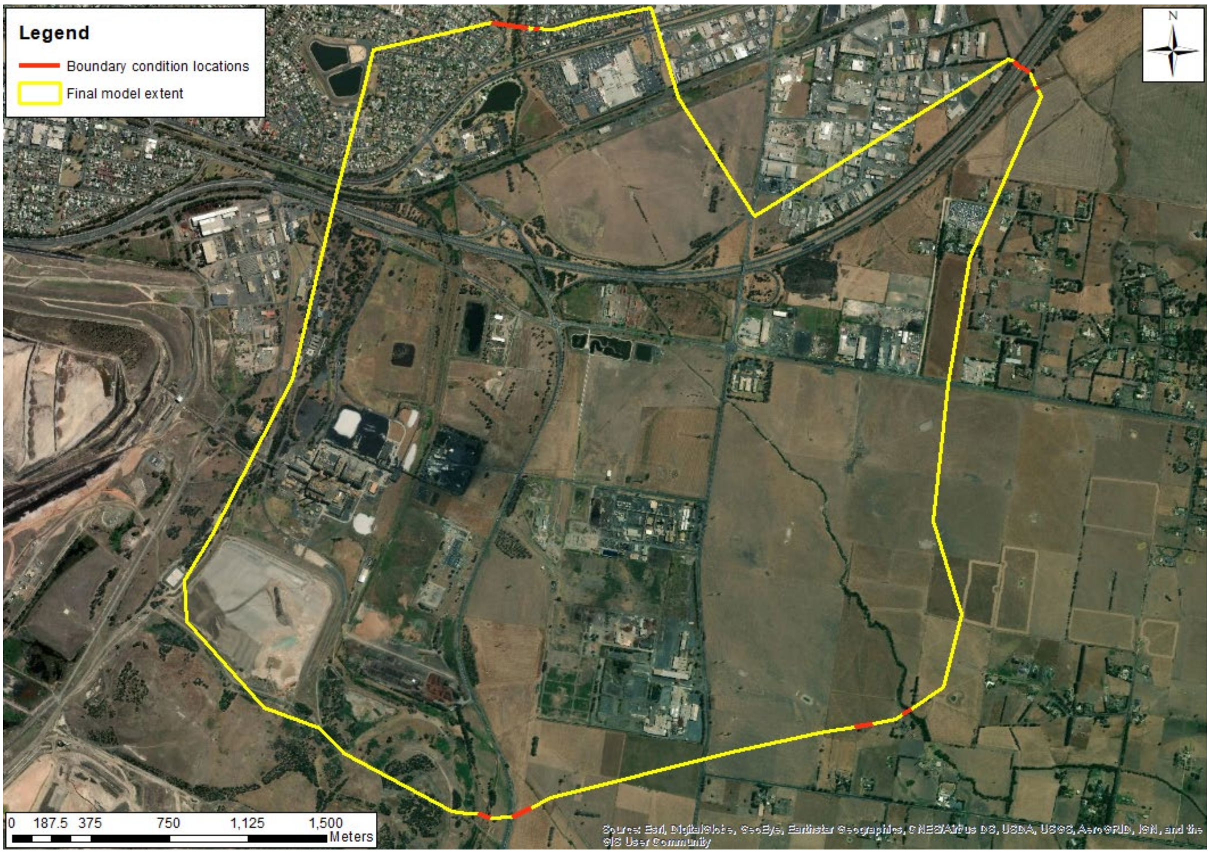


Figure 5-2: Model extent and boundary condition locations

5.3.2 Surface Roughness

Surface roughness coefficients were determined based on documented values (ARR Project 15), aerial imagery, and features noted in Google's Street View software package. Although a large portion of the area is zoned as industrial and has the potential to be developed, there is uncertainty on how development would influence flood behaviour and whether flood management measures would be implemented at a regional scale. In the absence of this information, the current catchment development condition has been adopted.

The adopted roughness values for each material type are summarised in Table 5-4. A spatial representation of the hydraulic roughness is shown in Figure 5-3.

Table 5-4: Adopted Surface Roughness Values (Manning's n)

Model Code	Material Type	Manning's n Coefficient
1	Road/Pavement	0.018
2	Urban Residential & Commercial	0.040

3	Light Vegetation	0.050
4	Weedy, winding floodway	0.100
5	Industrial	0.025
6	Light Industrial	0.030

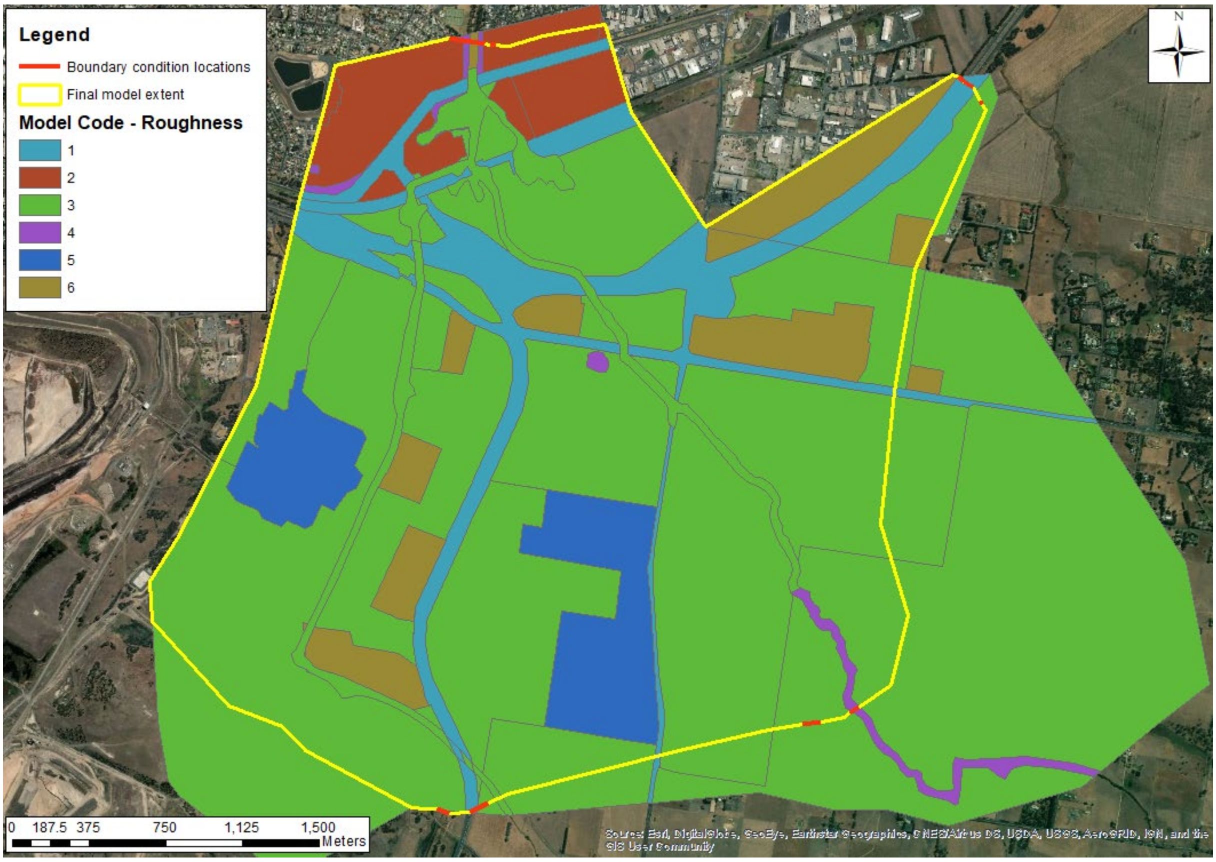


Figure 5-3: Adopted surface roughness extents

5.3.3 Grid Size and Timestep

The TUFLOW model adopted a grid resolution of 2m. This grid size was chosen to maintain a fair degree of accuracy while maintaining acceptable run times for the project. The TUFLOW GPU module was adopted for this assessment. TUFLOW GPU uses adaptive time stepping with the ability to revert to previous calculations should a numerical inconsistency occur, thereby providing numerical stability.

5.3.4 Boundary Conditions

5.3.4.1 Inflow Boundary Conditions

Inflow boundaries were applied at the main drainage lines in the Bennetts Creek and Waterhole Creek catchments to represent flows from these creeks into the model extent. Hydrographs extracted from the hydrological model are applied to these boundaries. These hydrographs conservatively assume all upstream flow arrives at the boundary location, that is, there is no upstream flooding in the catchments that would potentially attenuate peak flow in the creeks (except for the Plough Creek diversion).

The inflow boundary locations are shown in Figure 5-2 along the southern extent of the model and were located sufficiently far enough away from the BESS site to not influence flood behaviour.

5.3.4.2 Outflow Boundary Conditions

A series of level versus flow boundaries has been applied as downstream (outflow) boundary conditions to the model. The location of these boundaries are shown in Figure 5-2 along the northern extent of the model and were located sufficiently far enough away from the BESS site to not influence flood behaviour. The level versus flow relationships have been set to be defined by TUFLOW using the topography and roughness data available in the model.

5.3.5 Hydraulic Controls

5.3.5.1 Culverts

Key culvert crossings were represented in the model, including conveyance structures beneath Princes Freeway and Firmins Lane. The VicRoads online database provided data for hydraulic structures for major roads downstream of the project. Where information was available, the dimensions of the structures were adopted although, the alignment, length, upstream and downstream inverts were assumed by reviewing the LiDAR data.

In areas beyond VicRoads asset information, no drainage structures data were available. The locations of the cross-drainage structures were determined based on drainage flowpath and the 1m LiDAR data. The dimensions of the structures were determined based on the width of the open channel upstream and downstream of the structure. Based on engineering judgment, an approximate structure width was determined at a height of 1/3 of the channel depth. Secondly, LiDAR data was utilised to ascertain the likely upstream and downstream inverts. Thirdly, the long profile of the structures' alignment were reviewed compared to the road surface level to confirm that the structure achieved approximate 600 mm cover.

5.3.5.2 Channels

Key channels throughout the study area were represented in 2D with the channel inverts reinforced in the model to represent the channel depth using the LiDAR data information. No survey information of the channels were available at the time of the assessment.

5.3.5.3 Road embankments

The crest of the main road carriageways within the model extent were also reinforced. This was based on elevations from the LiDAR data and allowed for the representation of barriers to flow.

5.4 Hydraulic Modelling - Proposed Condition

The baseline model described in Section 5.3 was updated to incorporate the proposed earthworks and drainage design within the BESS development site. The location of the proposed northern BESS infrastructure overlays an existing stormwater drain; however, this will be managed by an upstream diversion of the flow path around the BESS site through a new roadside drain and a cross drainage culvert. The proposed civil works design is shown in Figure 5-4.

The transformer locations within the MWTS were not shown in the model. It is recommended that if it is determined that the transformers are to be located on a flood prone area or over an overland flow path within MWTS, further assessment is required as to the preferred location.

5.4.1 Topography

Proposed modifications to the ground surface were represented in the model to account for changes in the overland flow paths and flood behaviour. These include the proposed earthwork fill on the Northern BESS and Southern BESS sites, access track embankment, and roadside drains which were all represented in 2D.

The MWTS northern transformer should be located to avoid impacts on the existing swale within the MWTS, or flow diversions should be provided to mitigate runoff impacts.

5.4.2 Cross Drainage Culvert

The diverted flows around the BESS site is intended to be discharged into the existing pond adjacent to Bennetts Creek on the western side of the BESS infrastructures. This will be achieved by introducing a twin 450mm diameter cross culvert under the access track as show in Figure 5-4. This was modelled as a circular pipe with manning's roughness n = 0.013.

Figure 5-4: Proposed drainage design

6 Results

6.1 Existing Condition

The existing flood behaviour (depths and flow direction) around the BESS site for the 1% AEP design flood event is shown in Figure 6-1. The figure shows how flow from Bennetts Creek splits into two flowpaths east and west of Monash Way, with the majority travelling north on the eastern side of the road embankment. The culvert under Monash Way conveys a minor proportion of approaching flows from towards the west and around the site via the Bennetts Creek constructed open channel. It should be noted that currently, no further information regarding any other culverts under Monash Way is known.

Runoff on the eastern side of Monash Way overtop the embankment and flowing across the MWTS and the northern end of the proposed BESS site with average depths of about 300 mm. This flood behaviour is somewhat consistent with the Waterhole Creek Flood Study (2007) and LSIO.

Flooding of the south western corner of the proposed BESS site is also predicted in the 1% AEP event. However, the flooding in this section is predicted to be predominantly shallow with average depths of 200 mm and velocities of 0.2 m/s.

Velocities throughout the site vary from 0.3 m/sec on the south-west of the site to a maximum of 1.2 m/s in the northern end. Along the western side, a similar maximum velocity of 1.2 m/s is predicted in Bennetts Creek flowing north-east. Peak velocities of this magnitude are not considered a concern in general, however they should be reviewed as part of the site civil design, particularly for unsealed or areas of un-grassed, bare earth.

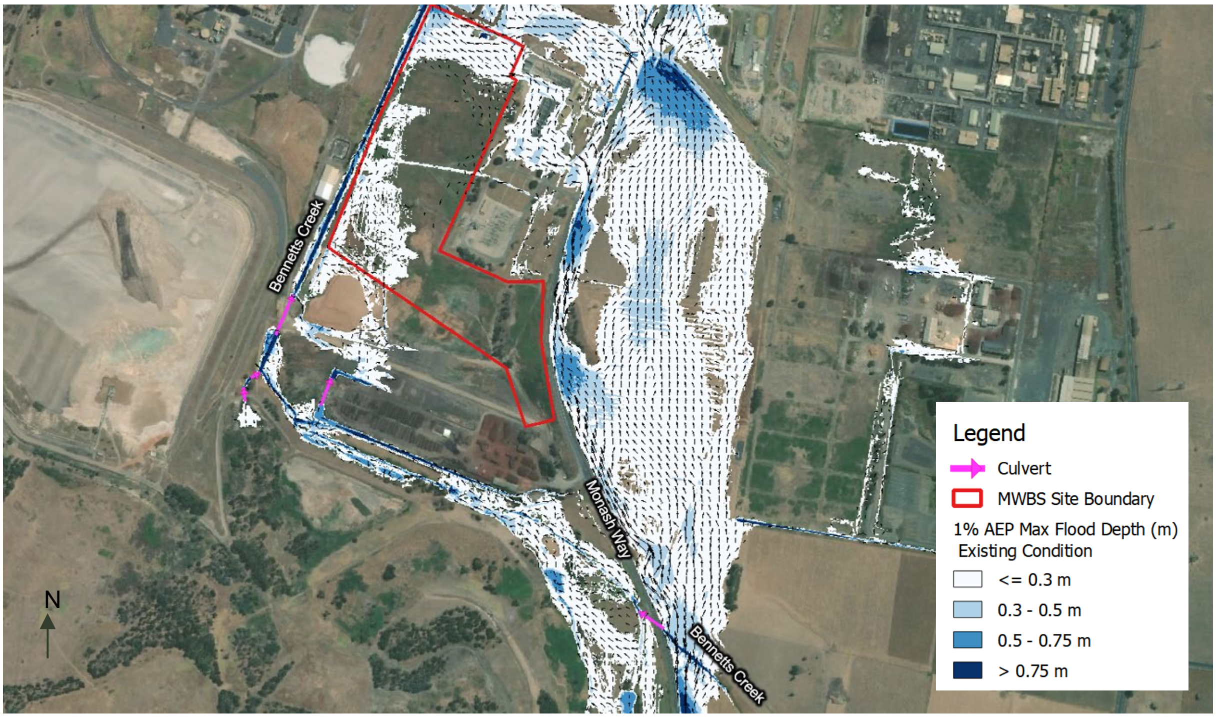


Figure 6-1: Existing condition 1% AEP - maximum flood depths (m) and flow direction

Figure 6-2 shows the flood prone and flood free areas throughout the site prepared to inform the optimal site layout. This site area includes the MWTS as the Phase 1 assessment looked at flooding across the wider project area. Based on this, the proposed BESS has been situated dominantly outside of the flood prone area as shown in Figure 6-3, with only very minor encroachment on the 1% AEP flood extent. However, most of the flood prone area is experiencing flood depths of less than 300 mm depth, therefore, in accordance with the Flood Guidelines (2020) is deemed developable, subject to the finished floor levels and impacts on adjacent properties.

Figure 6-2: Flood prone areas throughout the site

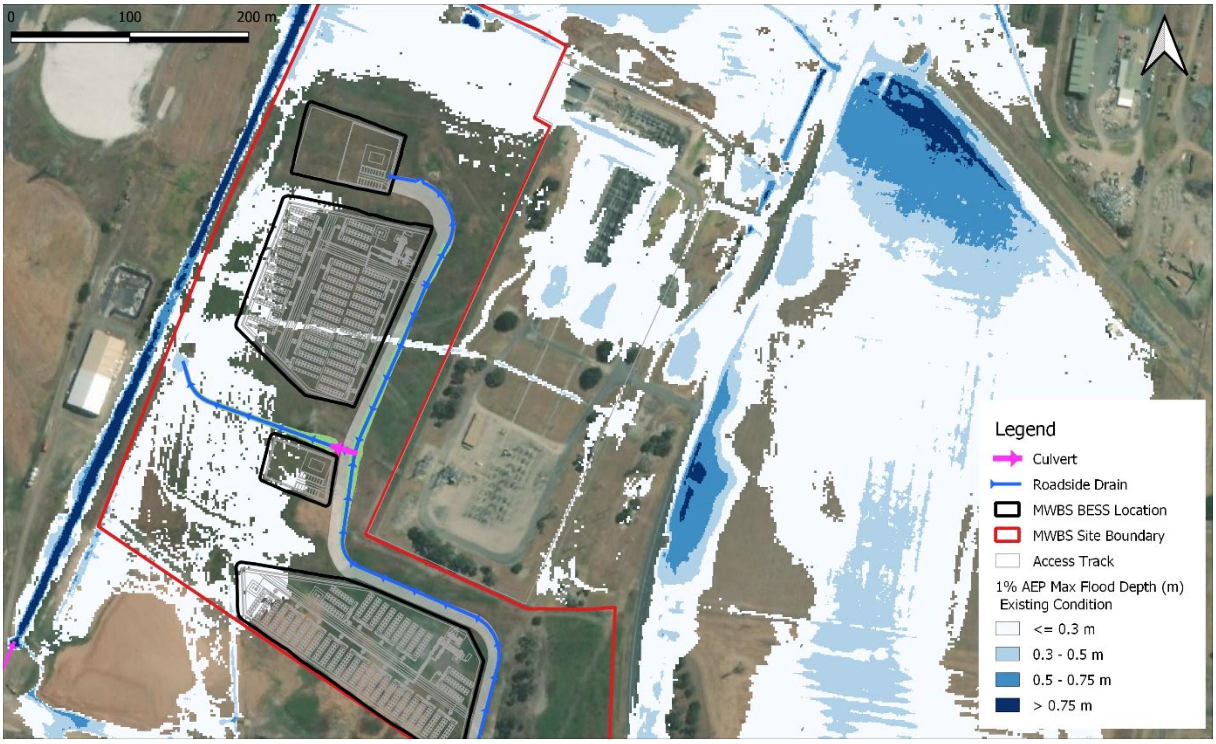


Figure 6-3: Proposed civil works site layout and areas with below and above 300 mm flood depths

6.2 Proposed Condition

The post-development flood behaviour (depths and flow direction) around the BESS site for the 1% AEP design flood event is presented in Figure 6-4.

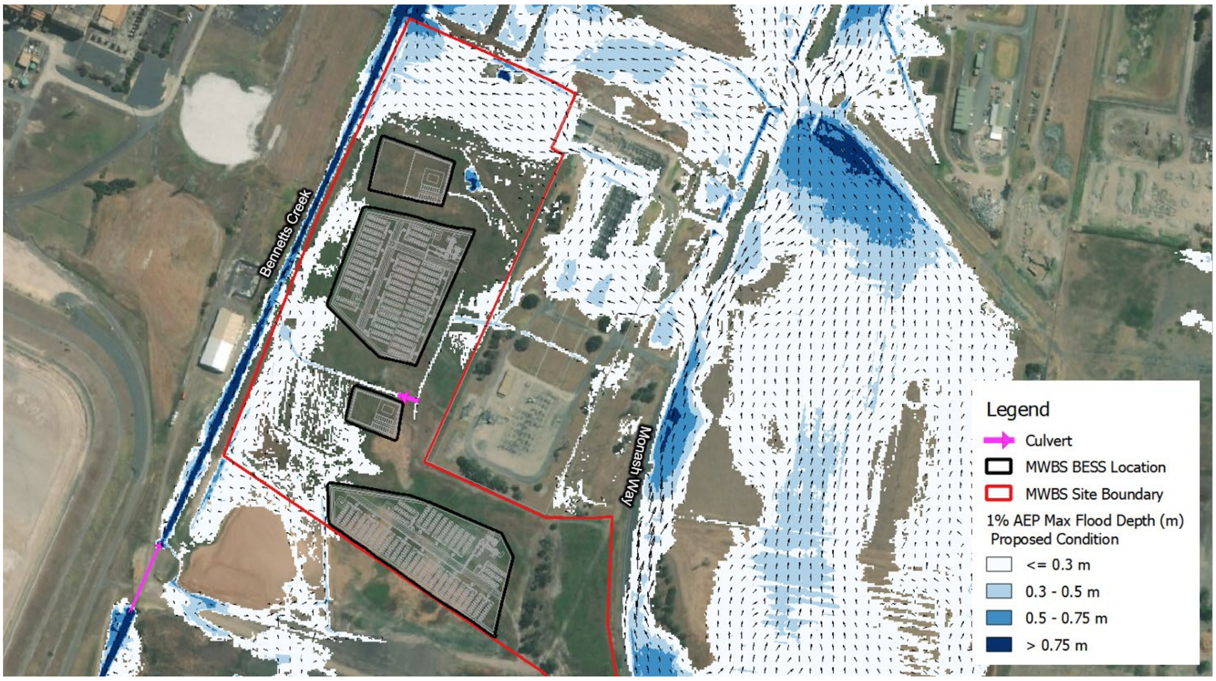


Figure 6-4: Proposed condition 1% AEP - maximum flood depths (m) and flow direction

The proposed Northern BESS location intersects an existing overland flow path that traverses across the site from east to west. Since this infrastructure is likely to form an obstruction to the existing flow path, the proposed development has introduced a roadside drain and a twin 450mm diameter culvert to redirect the flow around the Northern BESS site. The design aims to protect the assets from inundation whilst maintaining the upstream and downstream volume and velocity of flow.

6.3 Flooding Impact

The change in flood levels (afflux) for the 1% AEP event as a result of the proposed development is shown in Figure 6-5. Newly dry areas (black colour) are observed within the BESS infrastructure area due to earthwork fill pads. This however displaced some runoff which results in positive afflux on the adjacent areas. This is particularly true on the west corner of the Southern BESS site where flood depths in the existing condition range up to 250mm.

On the west side of the Northern BESS site, a reduction in flood levels has been observed due to redirection of the overland flow path. This diverted flow has resulted in additional discharge at the downstream end of the proposed open drain. This in turn leads to increased flood levels in that area by up to 55mm as indicated by the yellow and orange colours.

Newly wet areas have also been observed immediately upstream at a point where the existing storm drain intersects with the proposed roadside drain. This is in conjunction with the increased flood depths in the swale within the MWTS site. Nonetheless, it should be noted that these newly wet areas are predominantly within the Latrobe Valley BESS site.

Further discussion of the impacts and recommendations on potential mitigation measures are presented in Section 7.

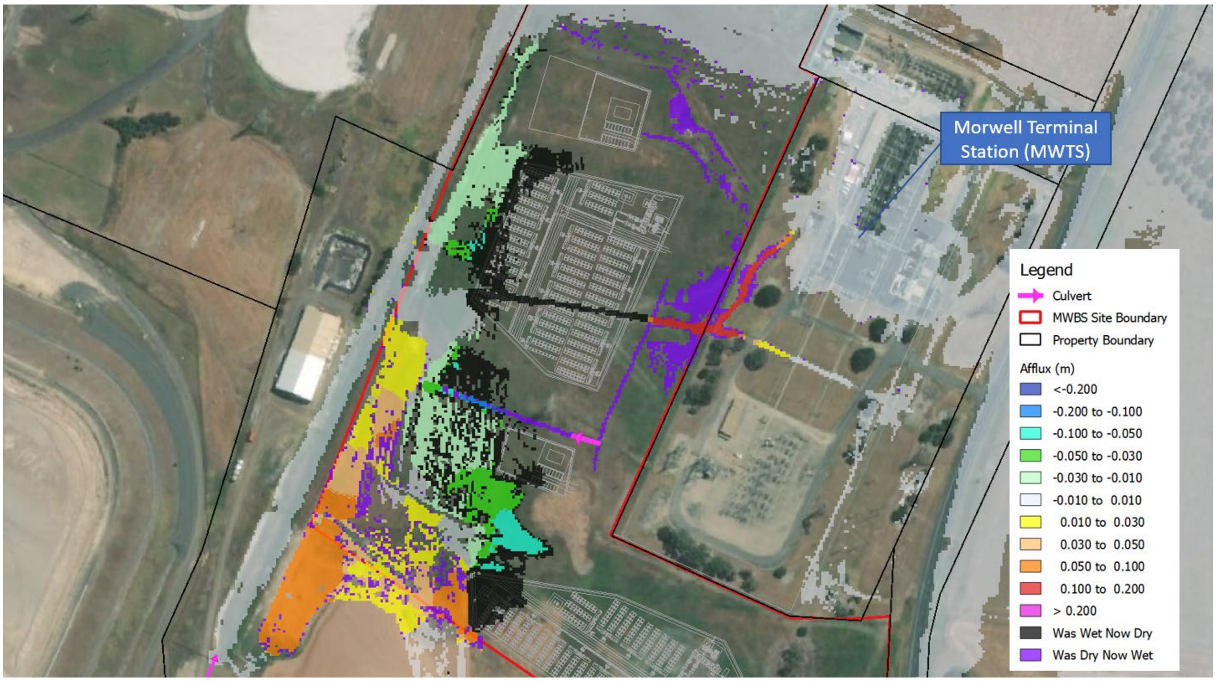


Figure 6-5: Flood impact of the proposed condition - 1% AEP

7 Discussion

The WGCMA provides specialist flood advice and assessment of development, based on the following objectives for development in flood prone areas:

Table 7-1. Measures to achieve the WGCMA flooding guidelines

Objective	Description	Measures
Objective 1: Site safety	Development must not be located where the depth and flow of floodwaters is hazardous.	The BESS infrastructure is positioned outside the areas where flooding may be hazardous. See Table 7-2 and Figure 6-3.
Objective 2: Site access	Development must not be located where the depth and flow of floodwaters along the access to or from the property is hazardous.	The access track alignment is outside the flood prone area. See Figure 6-3.
Objective 3: Flood damage	Development must be designed to minimise the potential damage to property due to flooding.	The BESS infrastructure, car parks, and accessway are positioned almost entirely outside the 1% AEP flood extent. The final surface levels of the earthwork fill pads are 300mm above the 1% AEP event flood level. In addition, a diversion roadside drain is provided to redirect the existing flow path around the site.
Objective 4: Flood flow	Works or structures must not adversely affect floodwater flow capacity or the physical form of a waterway.	The roadside drain diversion maintains the same entry and exit points at the site boundary.
Objective 5: Flood storage	Works or structures must not reduce floodwater storage capacity.	Earthwork filling has resulted in a reduction in flood storage. However, the impact of displacing floodwater is predominantly within the site.
Objective 6: Floodplain and waterway condition	Development must ensure protection of floodplains and the maintenance or improvement of waterway condition including vegetation and physical form.	The BESS infrastructures, car parks, and accessway are positioned almost entirely outside the 1% AEP flood extent. The location of the transformer option within the MWTS should avoid the 1% AEP flood extent if possible.
Objective 7: Water quality	Development must maintain or improve the quality of stormwater and catchment run-off in rural and urban areas.	Inline water quality devices are provided to treat local runoff from BESS site and from car parks.

When assessing development proposals, the WGCMA uses a two-step process. The first step considers Objective 1 and 2, namely the flood hazard at the site and along the access route. This step assesses the proposed development type against the flood hazard criteria presented in Table 7-2. If the proposed development type meets the flood hazard criteria, the second step ensures that appropriate engineering and other mitigation measures will meet the remaining five objectives. The current assessment examines the impact of the proposed BESS development and does not include any mitigation measures in the modelling. Further assessment is necessary should mitigation measures be required.

The primary determinate of flood hazard is the flood depth and velocity. Modelling results indicate that the existing hazard category of the areas adjacent to the development site is H1 which is considered generally safe for people, vehicles and buildings as per Figure 7-1. Moreover, the proposed development is not likely to worsen the current flood hazard categorisation in the area.

The proposed development at the site complies with all objectives of the WGCMA assessment process. In the first consideration, both the BESS infrastructure and the site accessway are positioned outside the areas where flooding may be hazardous as per Table 7-2 and Figure 6-3. In the second consideration, Objectives 3 to 6 are achieved by the BESS infrastructure, car parks, and accessway being positioned almost entirely outside of the 1% AEP flood extent. It should be noted the proposed northern BESS infrastructure position overlays an existing stormwater drain, however, this will be managed by an upstream diversion of this drain (within the site).

The MWTS northern transformer should be located to avoid impacts on the existing swale within the MWTS. Where it obstructs the current flow path, an overland flow diversion is proposed to be provided around the transformer. This shall be designed such that it maintains the existing flow conditions, hence minimising the impact on the surrounding areas.

Table 7-2:Summary of WGCMA flood hazard criteria for commercial and industrial buildings (Flood Guidelines, WGCMA, 2020)

Type	Maximum pre-development flood depth* on site and egress	Required finished floor level if flood depth criteria are met
Commercial and industrial buildings		
Industrial building, office, retail building, or warehouse	0.3 metres	At or above FPL**

* Flood depths in the table above are only applicable when velocities are low. When velocities are greater than 0.5 m/s then shallower depths will apply as per Figure 3-7.
** Flood Protection Level (assumed as the 1%AEP design event)

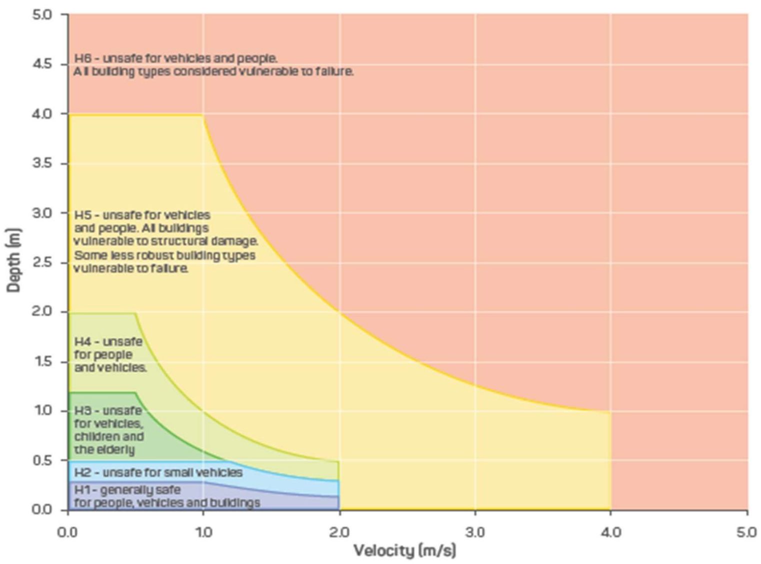


Figure 7-1: General flood hazard vulnerability curves (Flood Guidelines, WGCMA, 2020)

As discussed in Section 6.3, the proposed development has resulted in changes in flooding behaviour as a result of the earthworks and overland flow path diversion. However, the impact is predominantly within the Latrobe Valley BESS site boundary with the exception on the south-west corner of the site where afflux of up to 55mm has been observed just outside the site boundary. It is understood that this is likely caused by the displaced runoff from the western side of the Southern BESS, pushing the water in the westward direction. This is also evident by the reduction in flood levels on its northern side where flows are likely to take the path in the existing condition. This issue can be mitigated by introducing an additional flood storage area within the site to offset the displaced volume. This recommended mitigation measure can be incorporated during detailed design phase of the Project noting that the current Project site has sufficient space to allow for the required flood storage area.

8 Assumptions and Limitations

As with all model representations of predicted flood behaviour, there are limitations as to the accuracy and ability for the model to represent such behaviour as well as assumptions made regarding available data. The key limitations and assumptions associated with the modelling for this study are as follows:

- Since 1m LiDAR information for the whole Waterhole Creek and Bennetts Creek Catchments was unavailable, SRTM terrain data was used for the catchment definition, on which the entire hydrological analysis was based.
- The model represents the catchment topography at a 2 metre square grid arrangement. This resolution is suitable for this assessment, however can be limited in areas where flood behaviour is influenced by smaller features such as table drains or narrow embankments in smaller flood events. In larger flood events, these features have less of an influence.
- Conveyance of flows through channels is represented in 2D based on LiDAR data. In some areas the conveyance may be underestimated due to the influence of vegetation and the accuracy of the LiDAR. This may influence flood levels in areas that are sensitive to water levels such as drainage channels and table drains. The incorporation of detailed ground survey in these areas would provide improved confidence in the channel capacity and performance.
- Fraction impervious in the hydrological model was determined based on aerial imagery and available land zoning information downloaded from Spatial Datamart Victoria.
- The models have not been calibrated as there are no flow, rainfall or water level gauges in the catchment. Modelling has been undertaken in accordance with the methodologies outlined in ARR 2019 for ungauged catchments. The ARR 2019 RFFE tool was used to validate the hydrologic model predictions and provide confidence in the model outputs.
- VicRoads online database provided data for hydraulic structures for major roads downstream of the project. Where information was available, the dimensions of the structures were adopted although, the alignment, length, upstream and downstream inverts were assumed by reviewing the LiDAR data.
- In areas beyond VicRoads asset information, no drainage structure data was available. The cross-drainage structures locations were determined based on drainage flowpath and the 1m LiDAR data. The dimensions of the structures were determined based on the width of the open channel upstream and downstream of the structure was reviewed and an approximate structure width was determined at a height of 1/3 of the channel depth. Secondly, LiDAR data was utilised to ascertain the likely upstream and downstream inverts. Third, the long profile of the structure's alignment was reviewed compared to the road surface level to confirm that the structure achieved approximate 600 mm cover. The modelling has been undertaken based on current site levels as captured by the 2017 1m Lidar data, which is subject to the accuracy of the capture. Changes to the topography or the inclusion of site survey may influence the flood behaviour presented.
- The current assessment identified one cross drainage structure under Monash Way south of the study area based on aerial imagery and the LiDAR. Should there be other cross-drainage structures along Monash Way further south, the flow along Bennetts Creek channel may increase. This may potentially increase the flood extent and depth along the southern end of the site.
- Access to the subject site has only been reviewed for the local catchment area and is not able to predict flooding beyond the assessment area, required access route selected at the time of the event, the origin of the trip, road closures or road failures of connecting roads in the event of a major flood.
- The scope of this report is limited to a hydrology and flood assessment for the subject property and does not include consideration of any detailed local drainage within the BESS site and car parks.

- Climate change has not been considered or accounted for in his assessment. Victoria's Planning Policy Framework (PPF) includes clauses that require assessment of development to consider natural hazards and climate change and the potential impacts of climate change on coastal inundation and erosion. The WGCMA has agreements with each of the Local Government Authorities in the region detailing how the viability of proposals should be assessed in relation to climate change.

9 Conclusions and Recommendations

Based on this flood risk assessment, the subject property is prone to minor local flooding, particularly along the northern boundary of the site. The source of the flooding is Bennetts Creek, and it is generally shallow sheet flow with depths below 250mm in the 1% AEP design flood event. The location of the BESS infrastructure, carparks, and accessway are proposed to sit almost entirely outside of the 1% AEP event flood extent. The areas where these encroach on the flooding will not be hazardous based on WGCMA Flood Hazard Criteria.

The impact of the proposed BESS layout has been modelled. The outcome of the assessment suggests that changes in flooding behaviour occur mainly within the site, however a small area on the south-western corner exhibits an increased flood level up to 55mm. In order to mitigate this afflux, it is proposed to introduce a flood storage area within the site to offset the displaced storage volume as a result of earthwork filling. This requires further investigation to confirm earthworks volumes and effectiveness within the allocated space. It is considered that the current Project site has sufficient space to allow for the required flood storage area.

The MWTS northern transformer should be located to avoid impacts on the existing swale within the MWTS. Where it obstructs the current flow path, an overland flow diversion is proposed to be provided around the transformer. This shall be designed such that it maintains the existing flow conditions, hence minimising the impact on the surrounding areas.

These recommended mitigation measures can be incorporated during detailed design phase of the Project.

10 References

Babister, M., Trim, A., Testoni, I. & Retallick, M. 2016. The Australian Rainfall & Runoff Datahub.

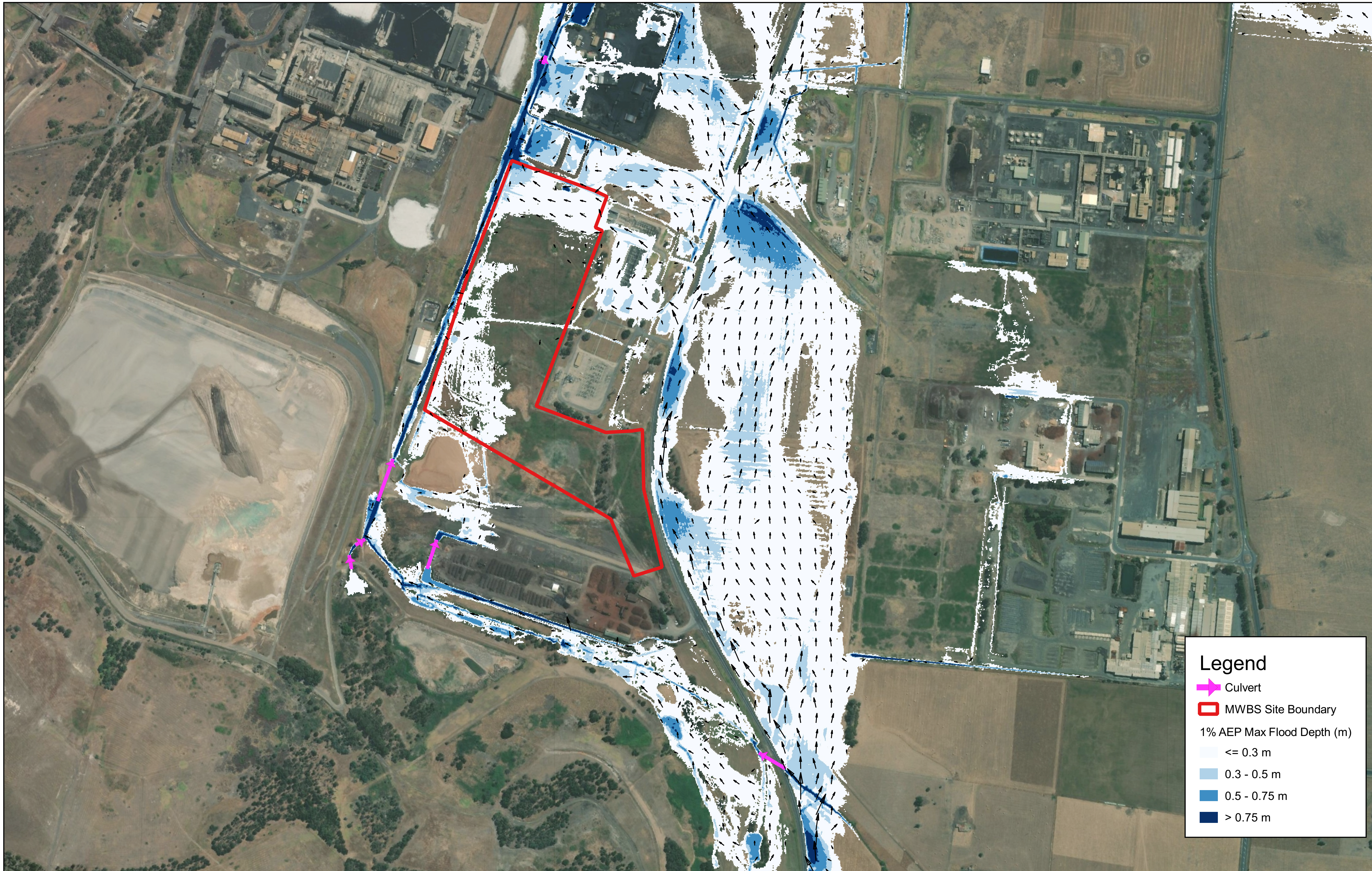
Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia.

TUFLOW User Manual, Build 2016-03-AA, BMT WBM.

Victoria State Government's Spatial Datamart Catalogue, downloaded 2020. LSIO - Land Subject to Inundation GIS flood Extent.

Appendix A

Figure	Title
A1	Existing Condition 1% AEP Event - Maximum Flood Depths (m) and Flow Direction
A2	Proposed Condition 1% AEP Event - Maximum Flood Depths (m) and Flow Direction
A3	Existing Condition 1% AEP Event - Maximum Flood Level (m AHD)
A4	Proposed Condition 1% AEP Event - Maximum Flood Level (m AHD)
A5	Flood Impact of the Proposed Condition - 1% AEP



Map by: Jennyl Estil

0 200 400 m

A3 Scale: 1:7313

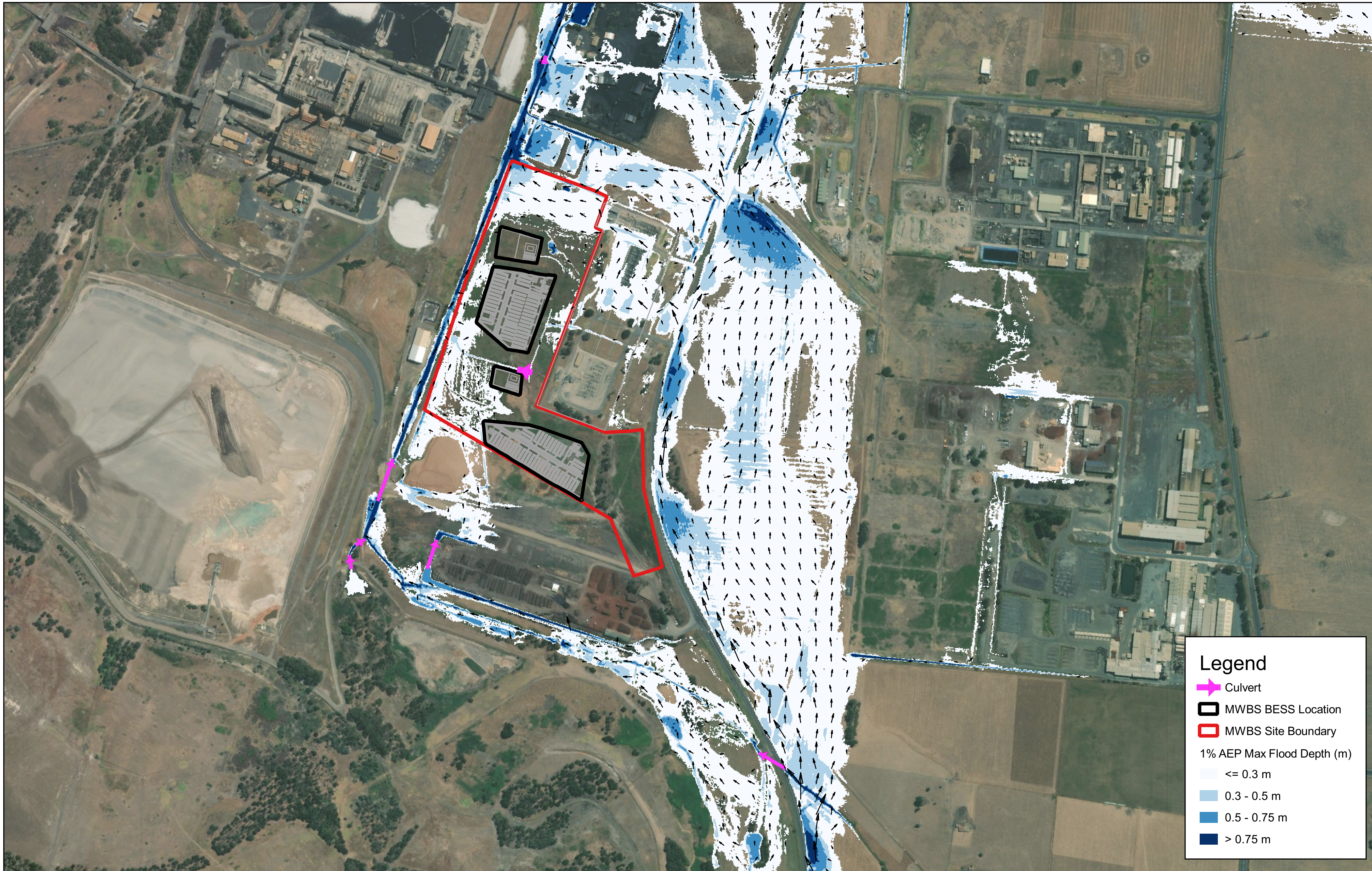
EPSG:28355

9/2/2021

Project Number: 509891

Morwell Battery Energy Storage System (BESS)

Existing Condition 1% AEP Event - Maximum Flood Depths (m) and Flow Direction



0 200 400 m

A3 Scale: 1:7313

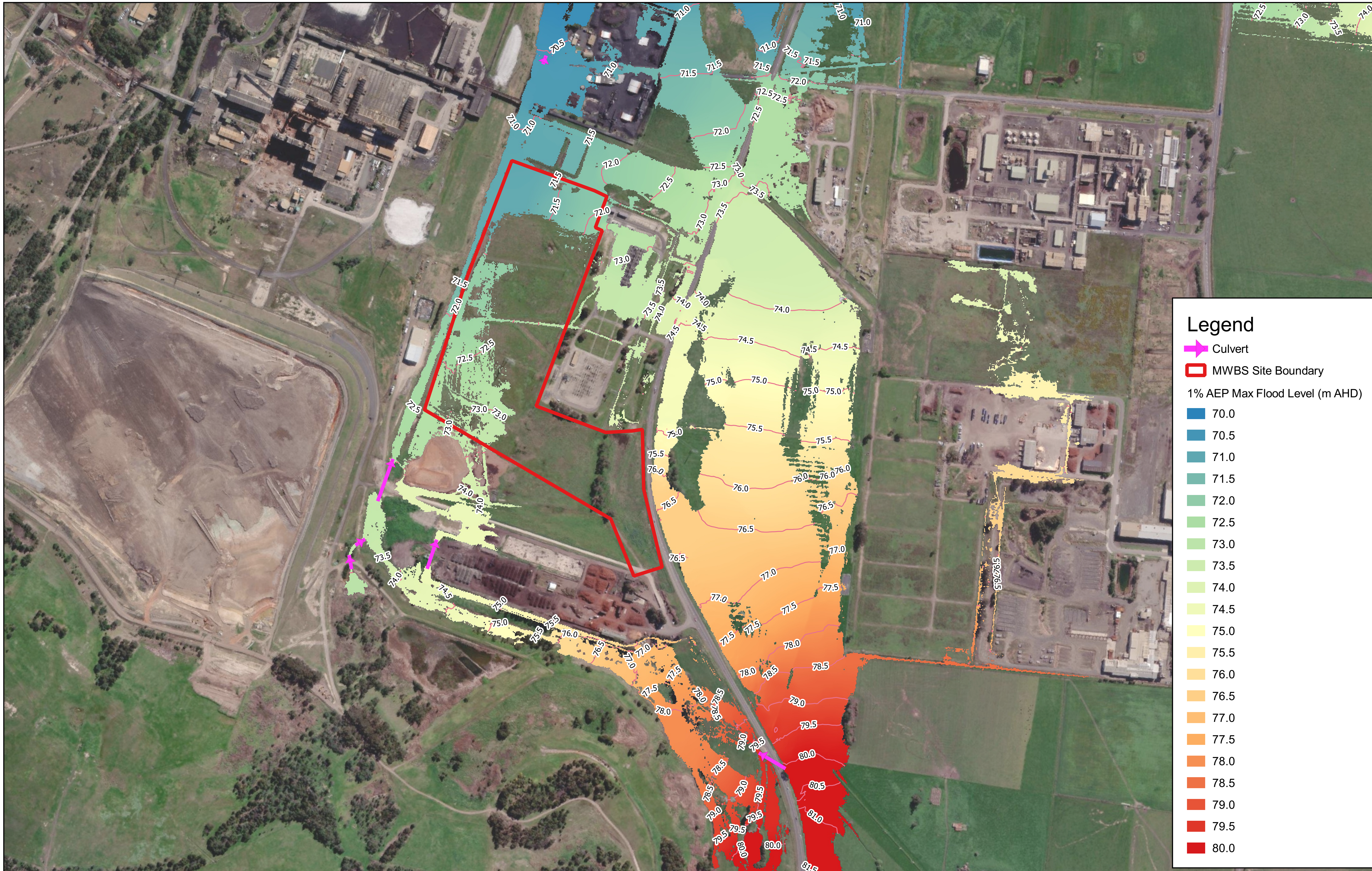
EPSG:28355

9/2/2021

Project Number: 509891

Morwell Battery Energy Storage System (BESS)

Proposed Condition 1% AEP Event - Maximum Flood Depths (m) and Flow Direction

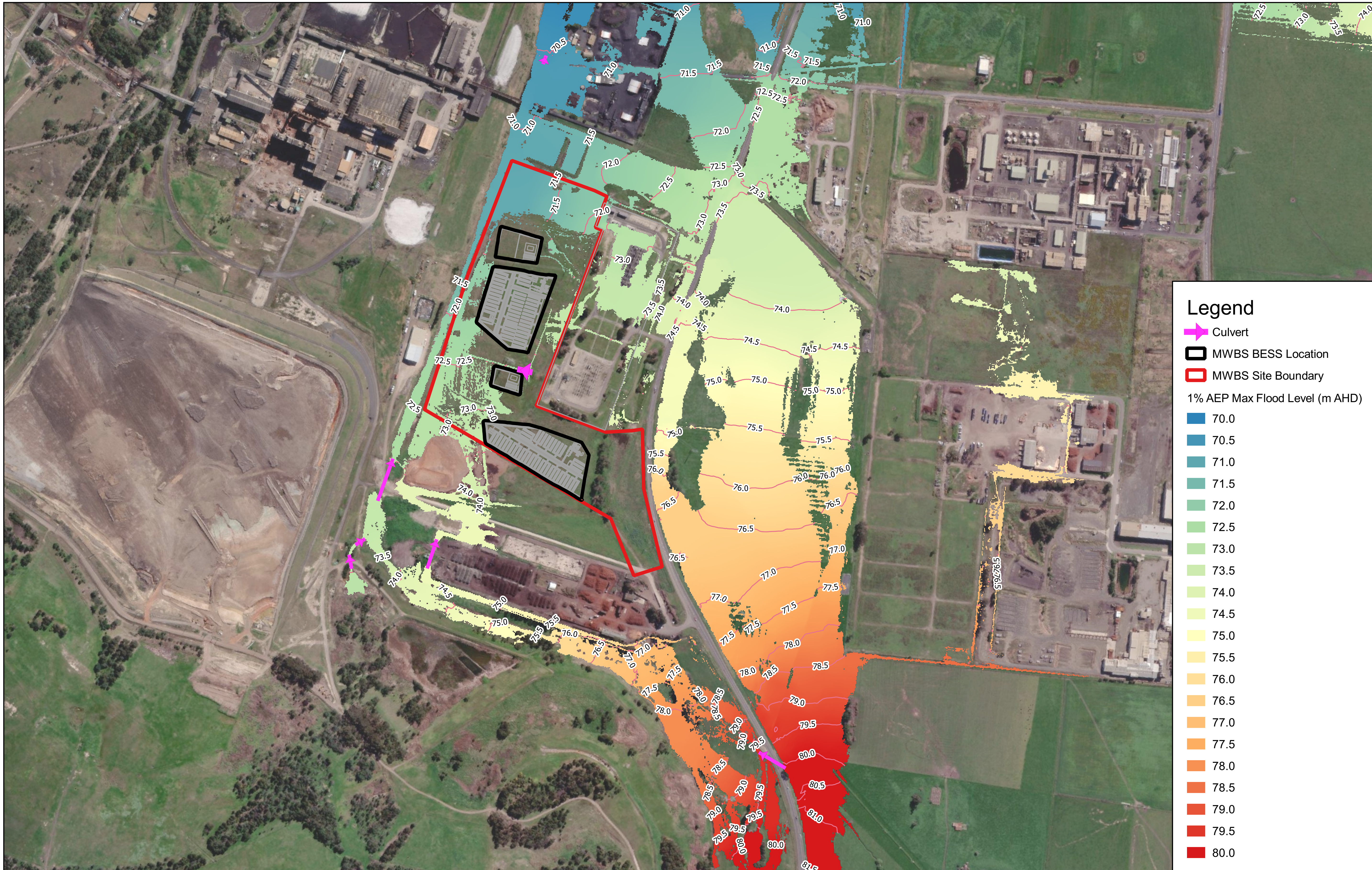


3/6/2021

Project Number: 509891

Morwell Battery Energy Storage System (BESS)

Existing Condition 1% AEP Event - Maximum Flood Level (m AHD)



Map by: Jennyl Estil

0 200 400 m

A3 Scale: 1:7313

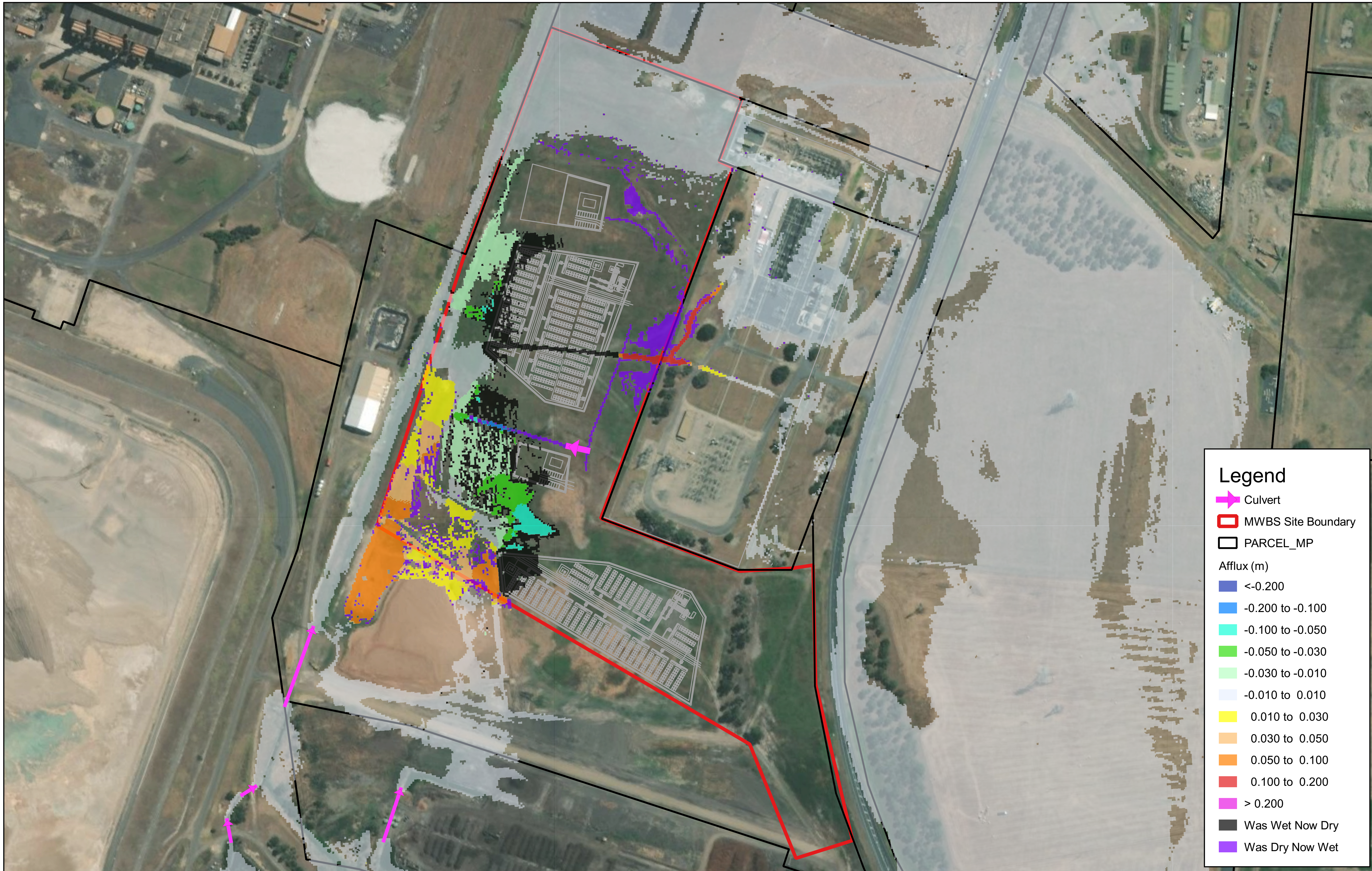
EPSG:28355

3/6/2021

Project Number: 509891

Morwell Battery Energy Storage System (BESS)

Proposed Condition 1% AEP Event - Maximum Flood Level (m AHD)



Map by: Jennyl Estil

0 100 200 m

A3 Scale: 1:3656

EPSG:28355

9/2/2021

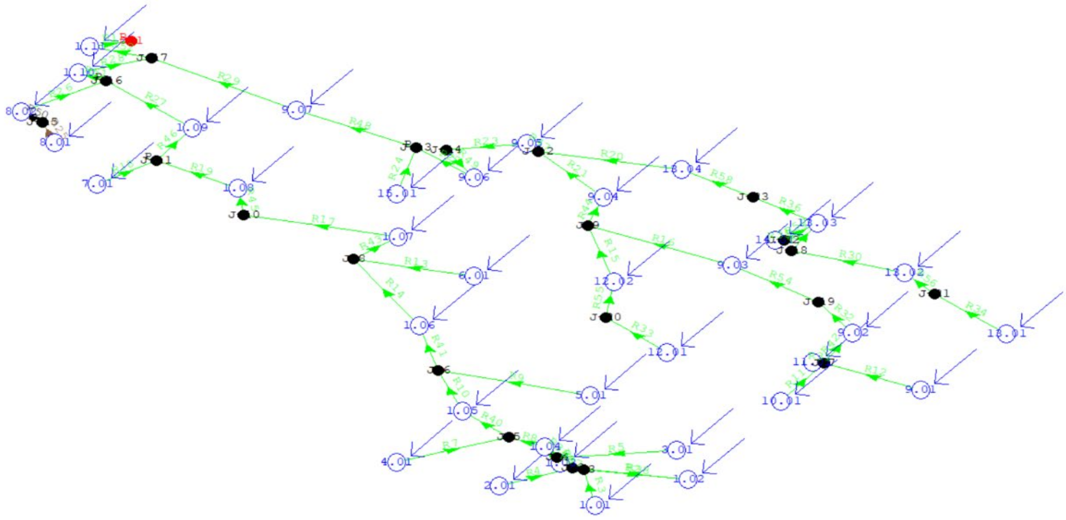
Project Number: 509891

Morwell Battery Energy Storage System (BESS)

Flood Impact of the Proposed Condition - 1% AEP

Appendix B

Figure/Table	Title
B1	RORB Model Schematisation
B2	Adopted Rainfall Depths
B3	Regional Flood Frequency Estimation



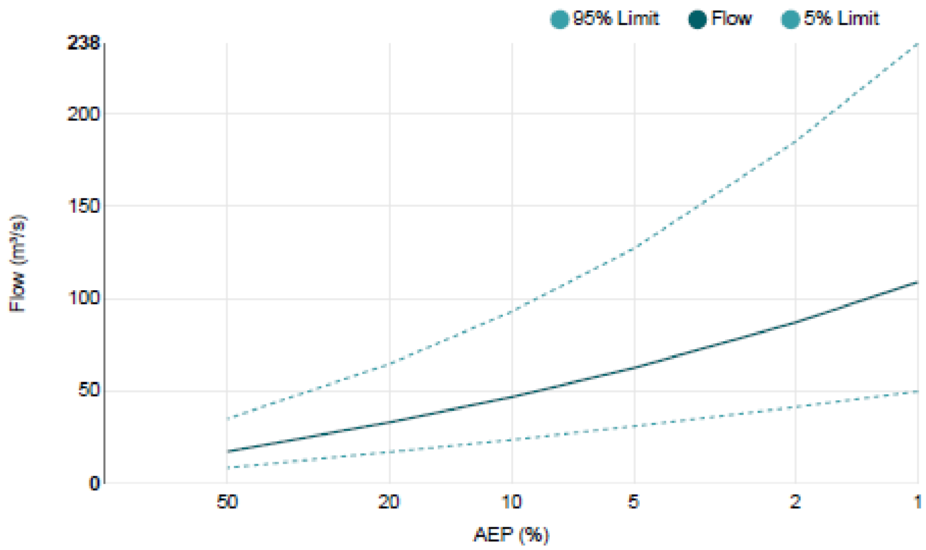
Appendix B1 – RORB Model Schematisation

Appendix B2 Rainfall Depths (mm)

Requested coordinate:		Latitude	-38.239587	Longitude	146.426585
Nearest grid cell:		**Latitude**	38.2375 (S)	**Longitude**	146.4375(E)
Duration (min)	**Duration (hours)**	**Annual Exceedance Probability (AEP)**			
		1%[#]			
1 min	1	4.57			
2 min	2	7.43			
3 min	3	10.1			
4 min	4	12.4			
5 min	5	14.5			
10 min	10	22.3			
15 min	15	27.5			
30 min	30	36.7			
1 hour	60	46			
1.5 hour	90	51.7			
2 hour	120	56			
3 hour	180	62.7			
4.5 hour	270	70.4			
6 hour	360	76.8			
9 hour	540	87.2			
12 hour	720	95.8			
24 hour	1440	120			
48 hour	2880	148			
72 hour	4320	163			
96 hour	5760	171			
120 hour	7200	176			
144 hour	8640	178			
168 hour	10080	178			

Extracted from BOM

Results | Regional Flood Frequency Estimation Model



AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	17.1	8.41	34.9
20	32.9	16.8	64.5
10	46.6	23.5	92.9
5	62.4	30.8	127
2	87.0	41.2	185
1	109	49.7	238

Statistics

Variable	Value	Standard Dev
Mean	3.060	0.412
Standard Dev	0.771	0.170
Skew	0.102	0.029

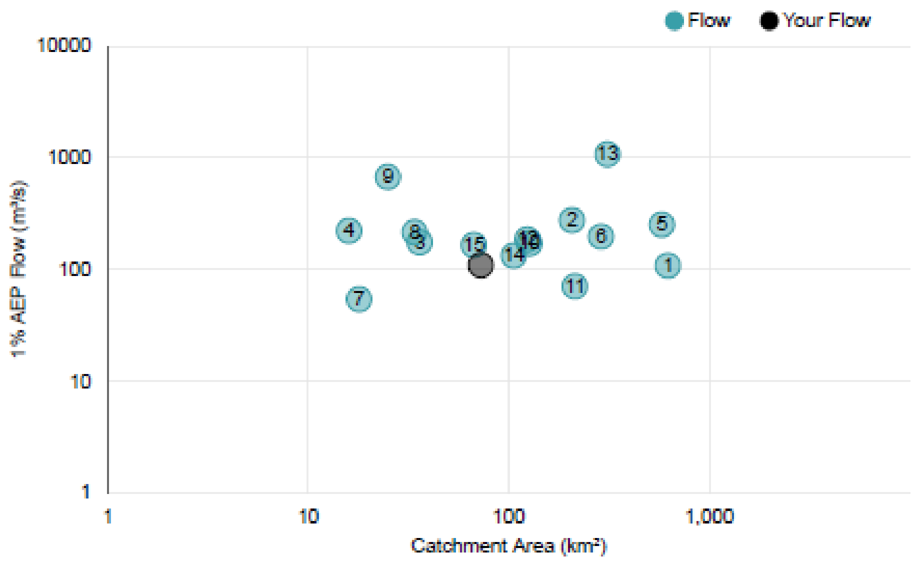
Note: These statistics come from the nearest gauged catchment. Details.

Correlation

Correlation		
1.000		
-0.330	1.000	
0.170	-0.280	1.000

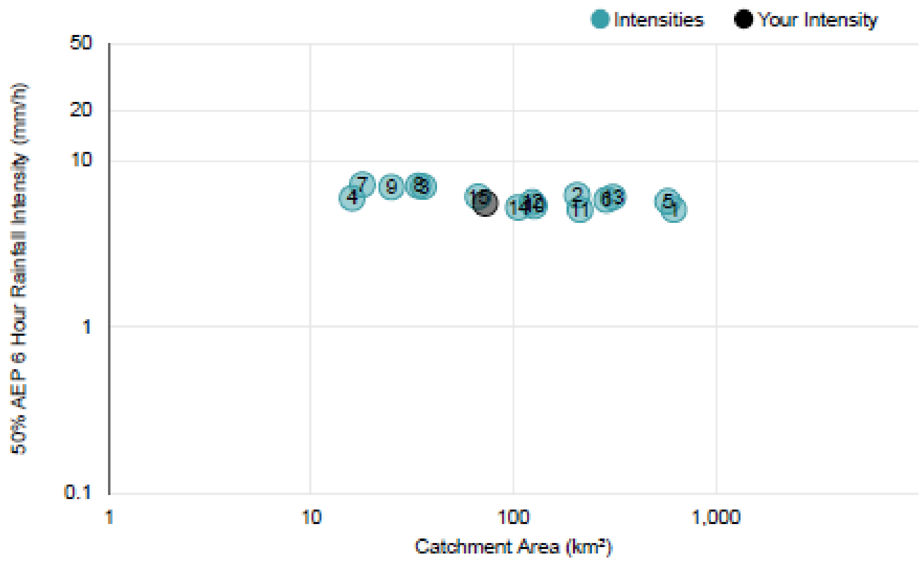
Note: These statistics are common to each region. Details.

1% AEP Flow vs Catchment Area

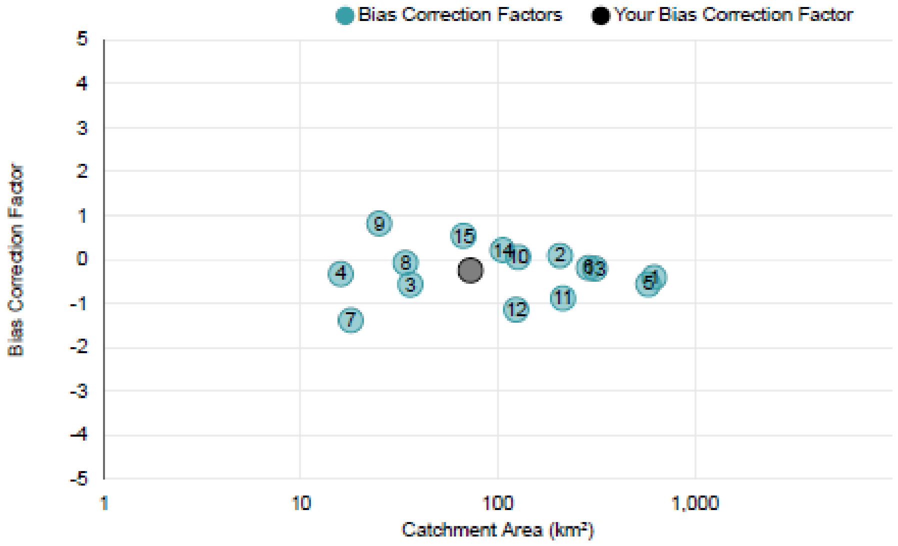


Shape Factor vs Catchment Area

Intensity vs Catchment Area



Bias Correction Factor vs Catchment Area



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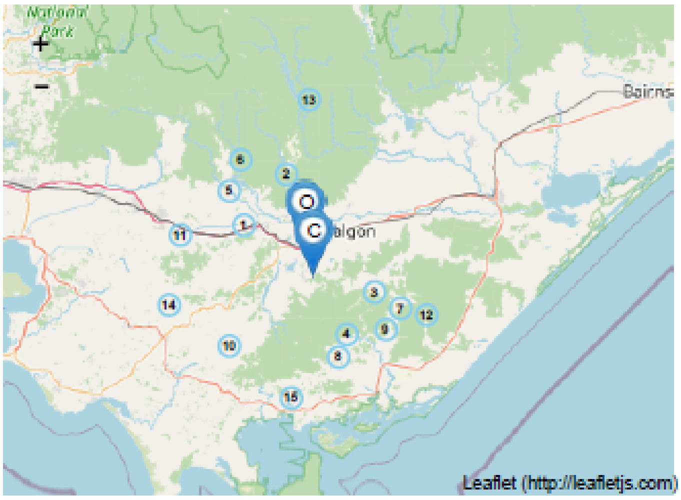
TXT Nearby JSON

Input Data

Date/Time	2020-09-22 16:19
Catchment Name	Morwell
Latitude (Outlet)	-38.239587
Longitude (Outlet)	146.426585
Latitude (Centroid)	-38.31415
Longitude (Centroid)	146.452438
Catchment Area (km^2)	72.73
Distance to Nearest Gauged Catchment (km)	20.05
50% AEP 6 Hour Rainfall Intensity (mm/h)	5.52489
2% AEP 6 Hour Rainfall Intensity (mm/h)	13.232302
Rainfall Intensity Source (User/Auto)	Auto
Region	East Coast

Input Data

Region Version	RFFE Model 2016 v1
Region Source (User/Auto)	Auto
Shape Factor	1.01
Interpolation Method	Natural Neighbour
Bias Correction Value	-0.249



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Method by Dr Ataur Rahman and Dr Khaled Haddad from Western Sydney University for the Australian Rainfall and Runoff Project. Full description of the project can be found at the project page (http://arr.ga.gov.au/revision-projects/project-list/projects/project-5) on the ARR website. Send any questions regarding the method or project here (mailto:admin@arr-software.org).

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