Surface Water Impact Assessment

Willogoleche 2 Battery Energy Storage System (BESS)

ERM

16 December 2025

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ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work. In particular, we acknowledge the Bungandidj People as the Traditional Custodians of the waters and lands upon this project is undertaken.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present.

CONTENTS

1 INTRODUCTION

1.1 Overview

This report details the findings of a flood impact assessment for the proposed Willogoleche 2 Battery Energy Storage System (BESS) development southwest of the town of Hallett, South Australia. ERM engaged Water Technology on behalf of ENGIE to prepare a surface water assessment to assist with regulatory approvals.

1.2 Site location and layout

The site is located approximately 10 km southwest of Hallett, adjacent to Willalo Creek at Ashby Road. The upstream catchment area for the BESS development area is approximately 13.35 km^2, with the study site shown in Figure 1-1.

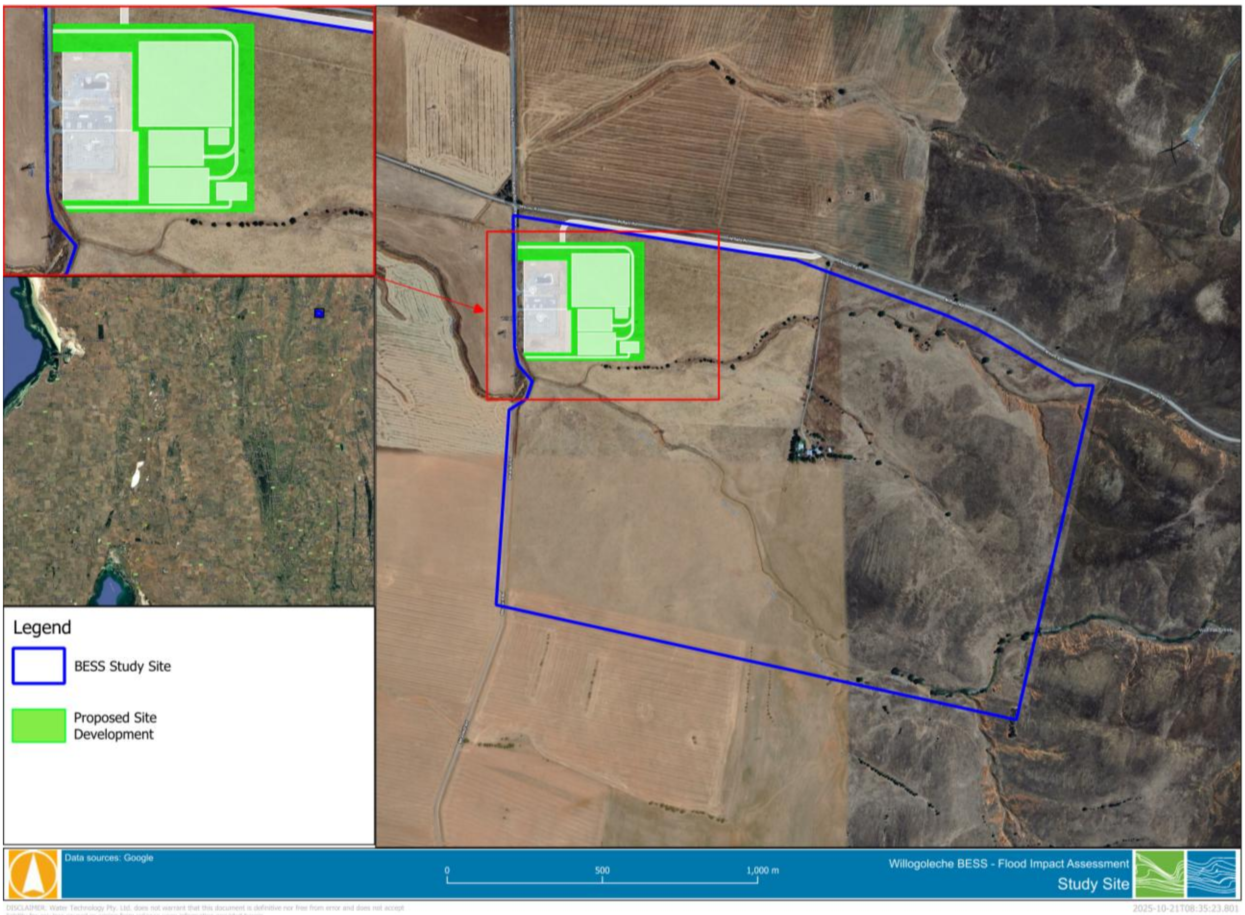

Figure 1-1 Project Site

1.3 Scope

The key purpose of this assessment is to address the requirements of the Hydrogen and Renewable Energy Act 2023 and the Planning, Development and Infrastructure (General) Regulations 2017 related to potential effects of the Project on surface water hydrology.

The work undertaken has involved:

- Characterisation of surface water in the BESS Site, including compilation of the available surface water information and conducting a baseline characterisation (flow paths, depths, velocities, water levels) of the hydrological environment.
- Identification of potential impacts of the development on surface water; including effects on flooding (water levels, depths, velocities).

2 MODELLING METHODOLOGY

This flood impact assessment has been undertaken in two key steps. The methodology adopted was as follows:

- **Hydrological Modelling** - A RORB hydrological model used to assess catchment hydrology and extract river flows for use within TUFLOW design flooding. 1% AEP flow was estimated in accordance with the Australian Rainfall and Runoff Guidelines 2019 (ARR19), with rainfall and losses for the climate scenario.
- **Hydraulic Modelling** – Riverine flooding was modelled using 1% AEP inflow hydrograph derived from the RORB hydrological assessment.
  - The potential impact of site inundation was assessed through the development of a TUFLOW hydraulic model. The model identified existing overland flow paths, depths and velocities of water flowing into and within the BESS Site.
  - The model was then modified to represent developed conditions and assess the potential for developments to impact surface water flow paths, depths, duration of inundation and extents.

2.1 Hydrological Modelling

A hydrological RORB model was built drawing information and datasets from National 10m LiDAR and the Australian Rainfall and Runoff 2019 *Guidelines for Flood Estimation*. The upstream catchment is 1335 ha, and Figure 2-1 shows the RORB model catchments, subareas, nodes, and reaches:

- Reaches were defined as natural, and
- A fraction impervious of 0.1 was assigned across the catchment as the catchment is fully rural comprised of pervious farming land with roads.

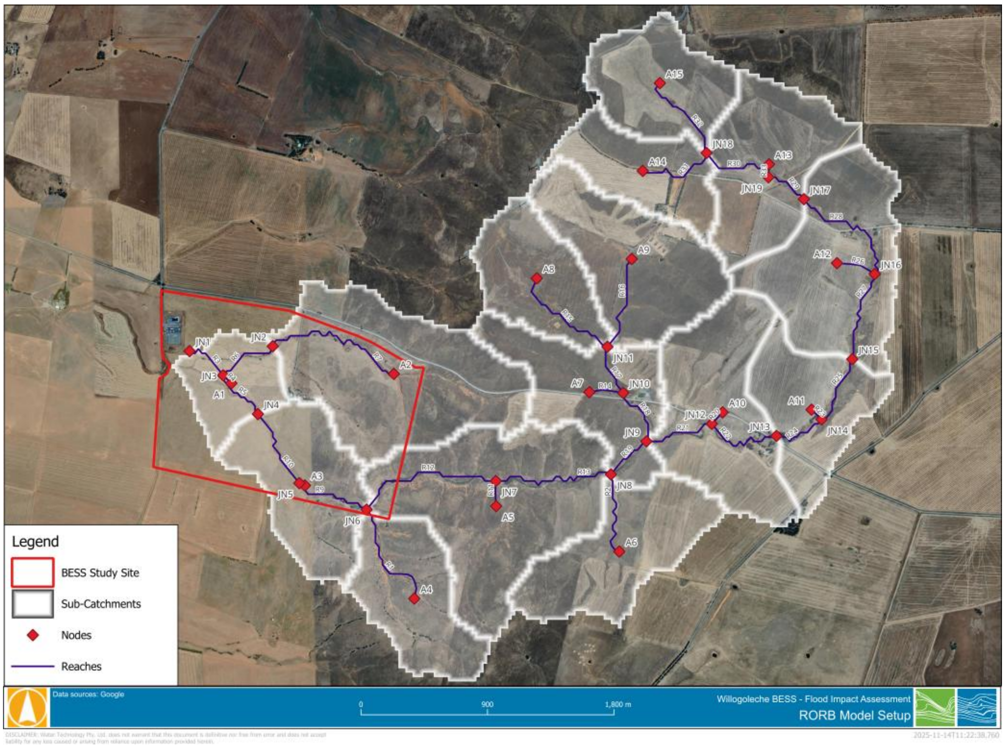

Figure 2-1 RORB Model

2.1.1 Rainfall & IFD data

The average annual rainfall at Hallett is 422 mm, with most rain falling in August. The lowest rainfall occurs in summer from January through to March. The highest recorded daily rainfall total was 98 mm, recorded in February 2011, at the Hallett gauge.

Daily and sub-daily rainfall gauges exist across Australia at relatively high densities. Rainfall data was accessed via the Bureau of Meteorology (BoM) for several gauges nearby the site. This data is used to generate an Intensity Frequency Duration (IFD) curve for the 1% AEP event. The available gauges closest to the BESS Site utilised for IFD curves is located roughly 11km northeast of the site. The IFD curve is presented in Figure 2-2, showing the relationship between rainfall duration and intensity for the 1% Annual Exceedance Probability (AEP) event.

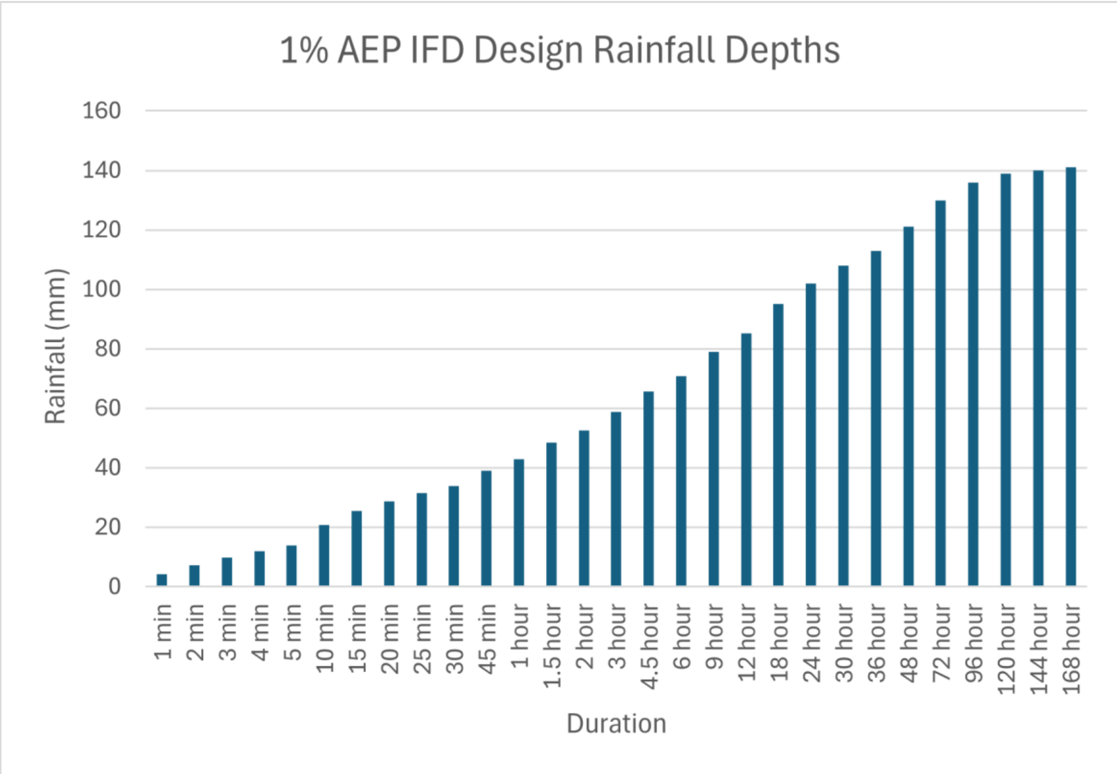

Figure 2-2 1% AEP IDF Curve

2.1.1.1 Climate Change

Consideration of future climate change scenarios have been included in this assessment by modelling the 2100 horizon for the SSP5 under 4.5°C. It is understood that these climate change parameters are in-line with South Australia's current standing on the approach of considering climate change conditions under ARR Version 4.2. The 1% AEP event has been scaled to the current climate conditions, (year 2030), in order to represent the present day risk.

For climate change modelling, IFD data was scaled to 2100 predictions under SSP5-8.5. Under this scenario, rainfall is scaled up by 86-55% (depending on duration); and Initial Loss (mm) and Continuing Loss (mm/hr) were scaled up by 18.8% and 44.4% respectively.

Rainfall IFD's were scaled for the 2100 conditions using the above the parameters and the methodology recommended by ARR Version 4.2, with the factor's summarised in Table 2-1 below adopted.

Table 2-1 2100 SSP5 (GWL 4.5°C) Rainfall Factors

≤1-hr	1.5-hr	2-hr	3-hr	6-hr
1.86	1.78	1.72	1.65	1.55

Variable losses for the climate change conditions were used and obtained from the ARR QGIS plugin. The durations and their corresponding initial and continuing loss value is highlighted in Table 2-2 below.

Table 2-2 2100 SSP5 (GWL 4.5ºC) Initial and continuing losses

Duration	Initial loss (mm)	Continuing loss (mm)
0.25 hour	6.2	5.2
0.5 hours	12.4	5.2
0.75 hours	18.7	5.2
1 hours	24.9	5.2
1.5 hours	26.8	5.2
2 hours	26.5	5.2
3 hours	24.9	5.2
6 hours	24.6	5.2

2.1.1.2 Probable Maximum Flood (PMF)

The probable maximum flood (PMF) flows were determined for this site in accordance with the method outlined in Book 8 of ARR2019. As the catchment is less than 1,000km^2, both the Generalised Short Duration Method (GSDM) and the Generalised Southeast Australia Method (GSAM) were used to determine the depth, temporal and spatial distribution of the probable maximum precipitation (PMP) event. The PMP rainfall depths specific to this site are shown in Table 2-3.

Table 2-3 PMP Rainfall Parameters

Duration (hours)	PMP Depth (mm)
4	470
5	500
6	530

2.1.2 RORB Parameterisation

A sensitivity analysis was undertaken in RORB to determine the most appropriate Kc value for the site. Validation of outputs flows were assessed using the Australian Rainfall and Runoff Regional Flood Frequency Analysis tool; which provides a guidance range for river discharge at outlet locations based on data from 853 gauged catchments across Australia. Previous modelling undertaken by Water Technology at Broughton

River[1] also provided validation of the selection of RORB parameters as this waterway is within the Broughton River catchment. The adopted model inputs are shown in Table 2-3Table 3-2-4.

Table 2-1 Adopted RORB Modelled Parameters

RORB Parameter	Current Climate	SSP5-8.5 2100	PMF	Comment
Initial Loss (mm)	25	29.7	25	Datahub
Continuing Loss (mm)	3	4.33	3	Datahub
Runoff coefficient (Kc)	5.72	5.72	5.72	1.14 x DAV (Dyer, 1994; Pearse et al, 2002)
1% AEP Peak Flow (m^3) (Outlet)	22.31	42.95	233	RORB Output
RFFE Estimate (m^3/s)	6.81 – 1131.21	N/A	N/A	6.81 – 1131.21 Range for 90% confidence interval

2.2 Hydraulic Modelling

2.2.1 Approach

TUFLOW was adopted for the modelling of 1% AEP event inundation across the project area. TUFLOW is an industry standard modelling package which has been used across numerous flood modelling projects across Australia.

Development of the TUFLOW model for the project area was parameterised based on these key components:

- Model extent and boundaries:
  - A Direct Inflow modelling approach based on the 1% AEP flow hydrograph derived from the RORB model (as discussed in Section 2.1)
- Topography
- Material layer – representing hydraulic roughness.

2.2.2 Input Data

A flow assessment of a RORB ensemble operation was used to identify the critical duration and temporal pattern (TP) at the BESS site. A critical duration of 6 hours was identified at the area of interest, having a peak flow of 22.3 m/s^3. Models were run with durations of 3, 4.5, 6, and 9 hours in TUFLOW with their respective critical TPs (as identified in RORB) to create flood extent maximums for the site.

2.2.3 Topography

Site topography utilised a 1m DEM provided by ERM. Topography under the developed conditions was established through raising the land around of development to prevent flow onto the site, following the same configuration as seen in the existing conditions.

[1] Flood Study Report Broughton River at Redhill, Water Technology, 2024

2.2.4 Losses and Land use – hydraulic roughness/infiltration losses

A land use layer was created based on aerial imagery. The hydraulic roughness coefficients (i.e. Manning's 'n') were assigned to each land use type. The values adopted were based on recommendations from ARR2019. Table 3-2-4 summarises the adopted model parameters and Figure 3-2-3 presents the hydraulic model land use layers between the existing and developed models.

Table 3-2-4 Summary of hydraulic roughness

Land Uses	Manning's 'n'
Industrial or large buildings on site	0.3
Open pervious areas, minimal vegetation	0.04
Waterways/channels, minimal vegetation	0.03
Paved roads/carparks/driveways	0.025

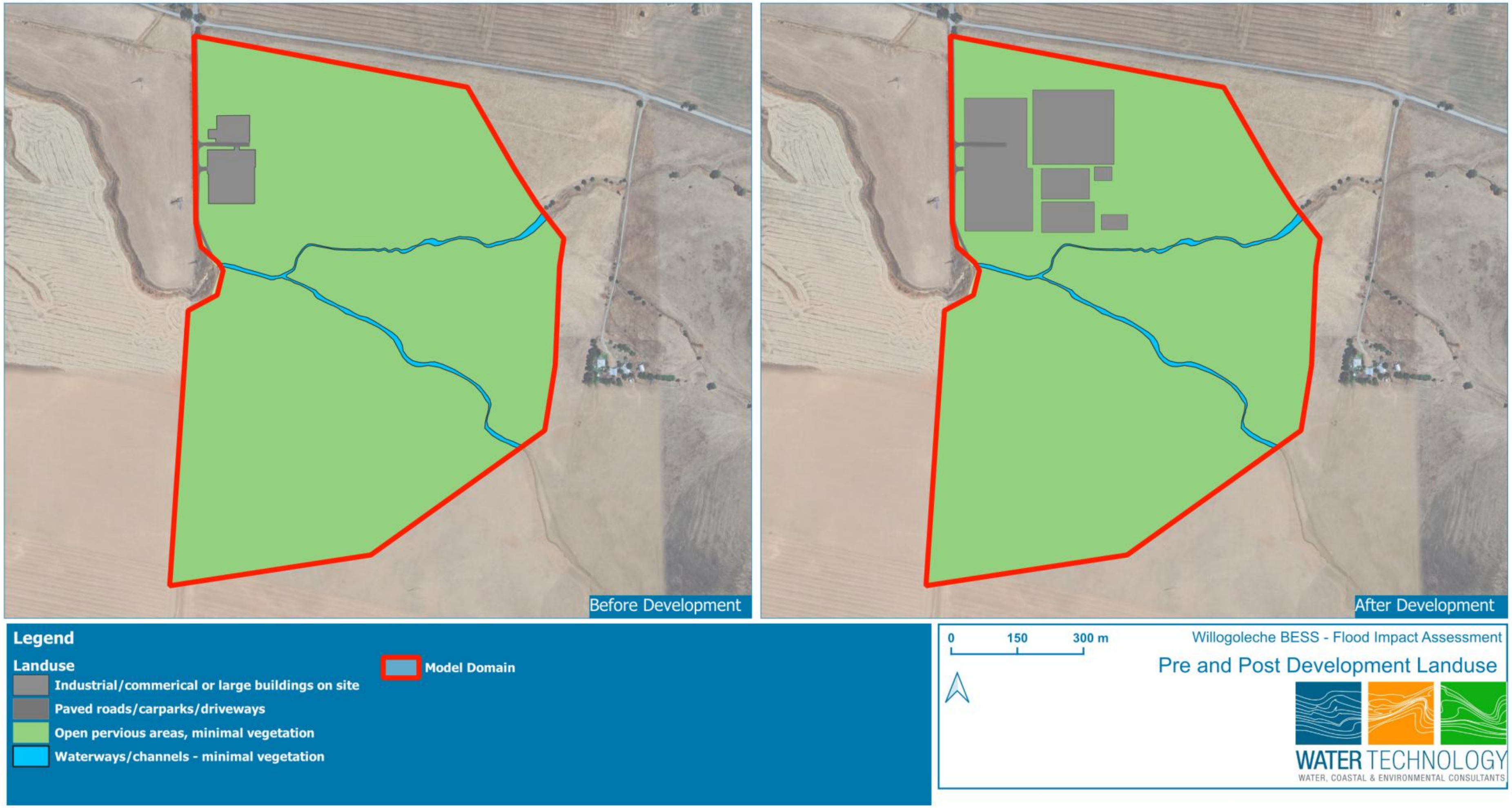

Figure 3-2-3 Land use layer and model extent

2.3 Results

The 1% AEP depths and velocities under existing conditions are shown in Figure 2-4 and Figure 2-5 respectively. An overland flow path is present west of the site, although depths do not exceed 30mm and can be considered insignificant. Topographic barriers present on the site prevent flows from inundating the existing BESS site.

Velocities across the modelled area are generally high across the BESS Site due to the steep terrain, with the overland flow path present seeing flows approaching 0.8 m/s. Under developed conditions, seen in Figure 2-6 and Figure 2-7, the north-east to north-west flood path is blocked off, resulting in higher in-channel depths and velocities. Impacts to the western edge of the domain are not visible in depth and velocity maps.

Flooding under 1% AEP with climate change and PMF (Figure 2-8 to Figure 2-15) following the same spatial distribution of inundation at higher magnitudes, with a 1.5m berm able to prevent flows onto the site under developed conditions.

The water levels across the site are shown in Figure 2-16 to Figure 2-21. In the developed case, the 1% AEP with climate change grades from 476.34m AHD to 473.74m AHD. Therefore, the site will be required to achieve levels from 476.64m AHD to 474.04m AHD including 300mm freeboard.

Figure 2-4 1% AEP Depths Existing Conditions

Figure 2-5 1% AEP Velocities Existing Conditions

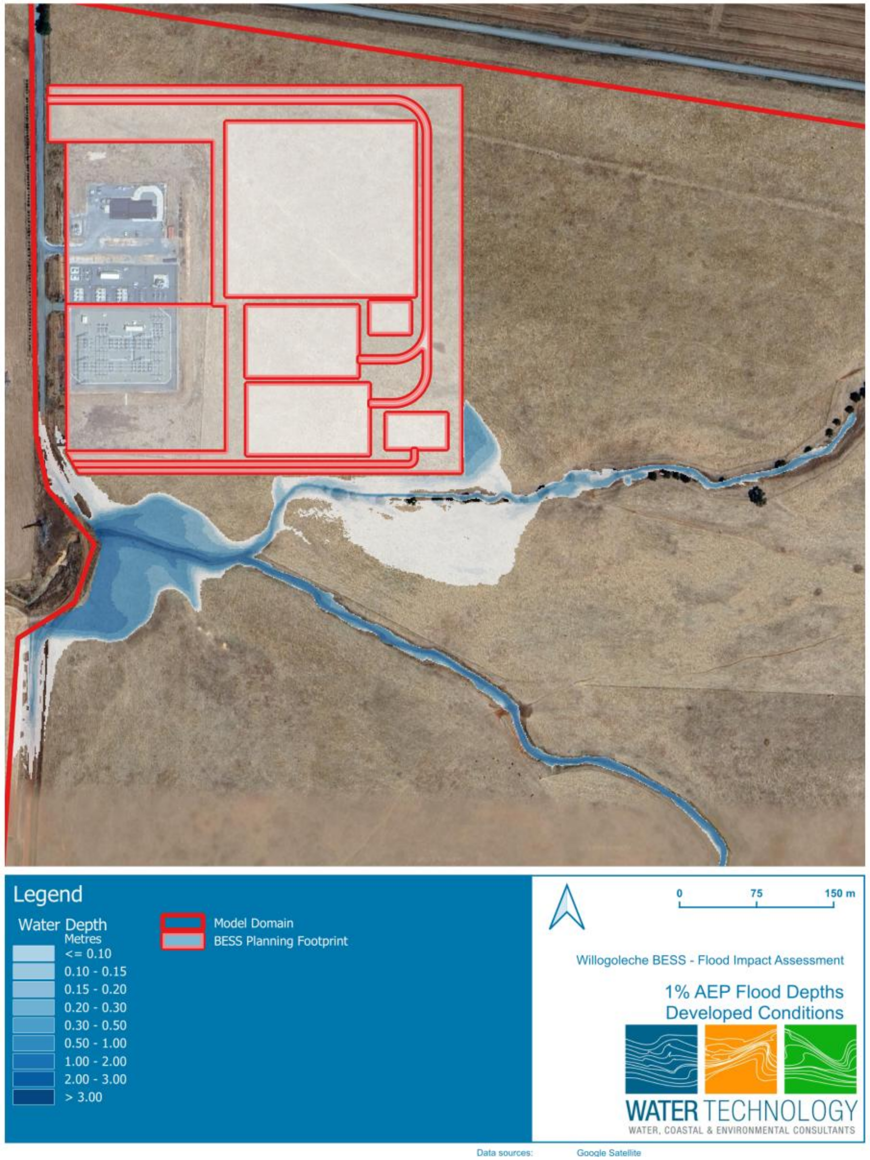

Figure 2-6 1% AEP Depths Developed Conditions

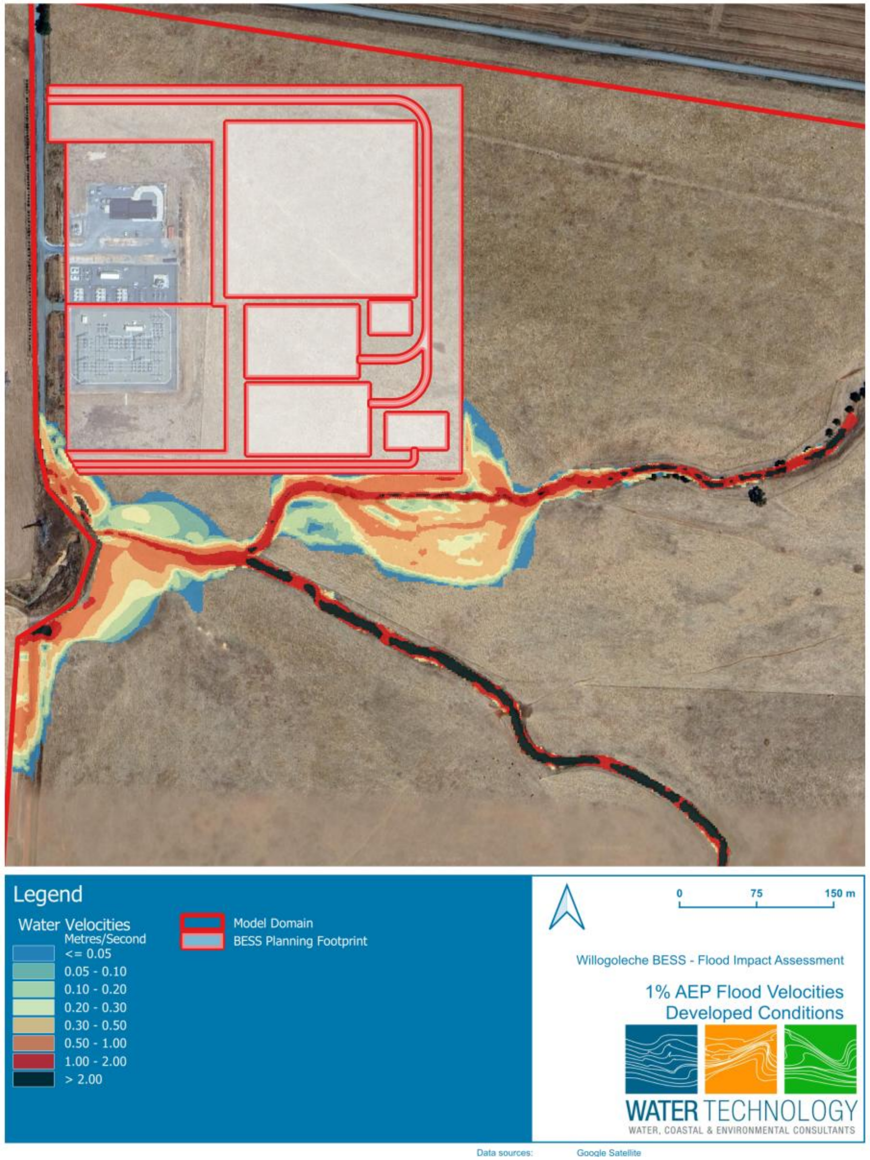

Figure 2-7 1% AEP Velocities Developed Conditions

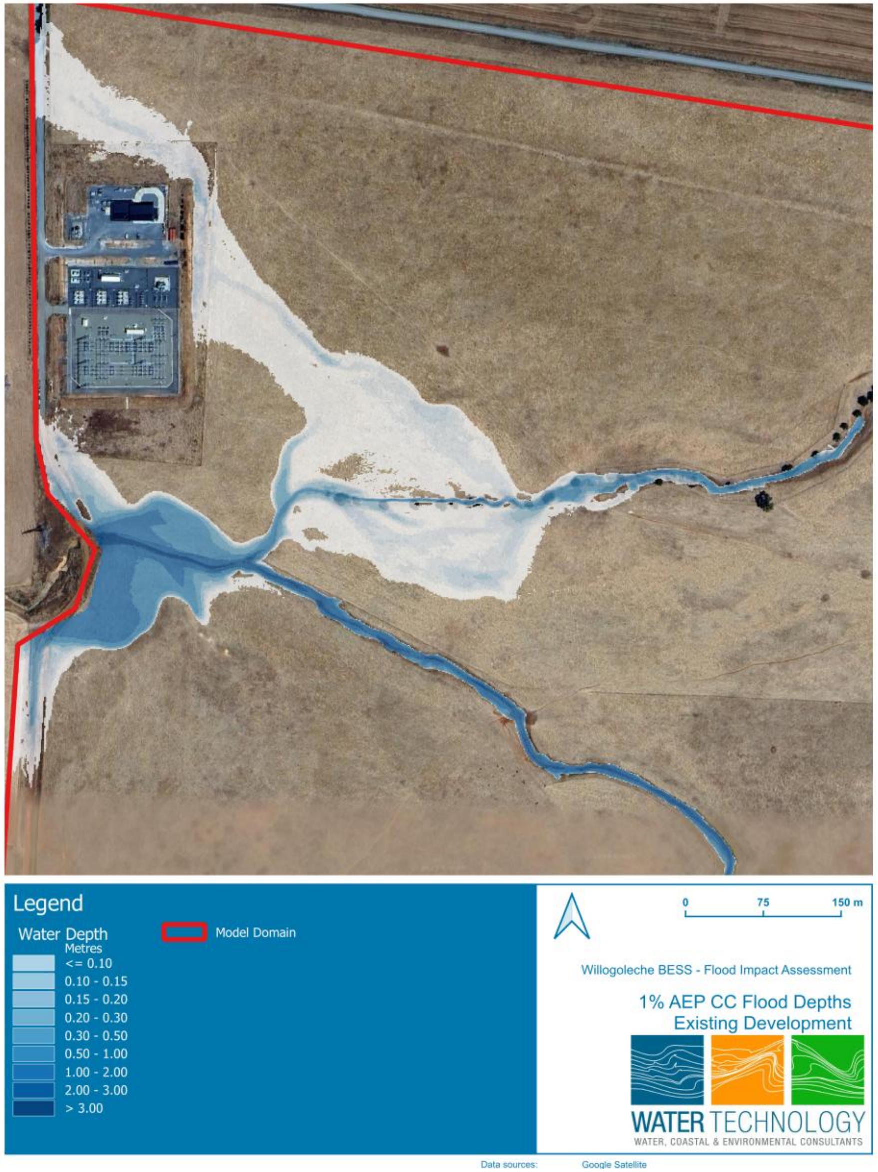

Figure 2-8 1% AEP CC Depths Existing Conditions

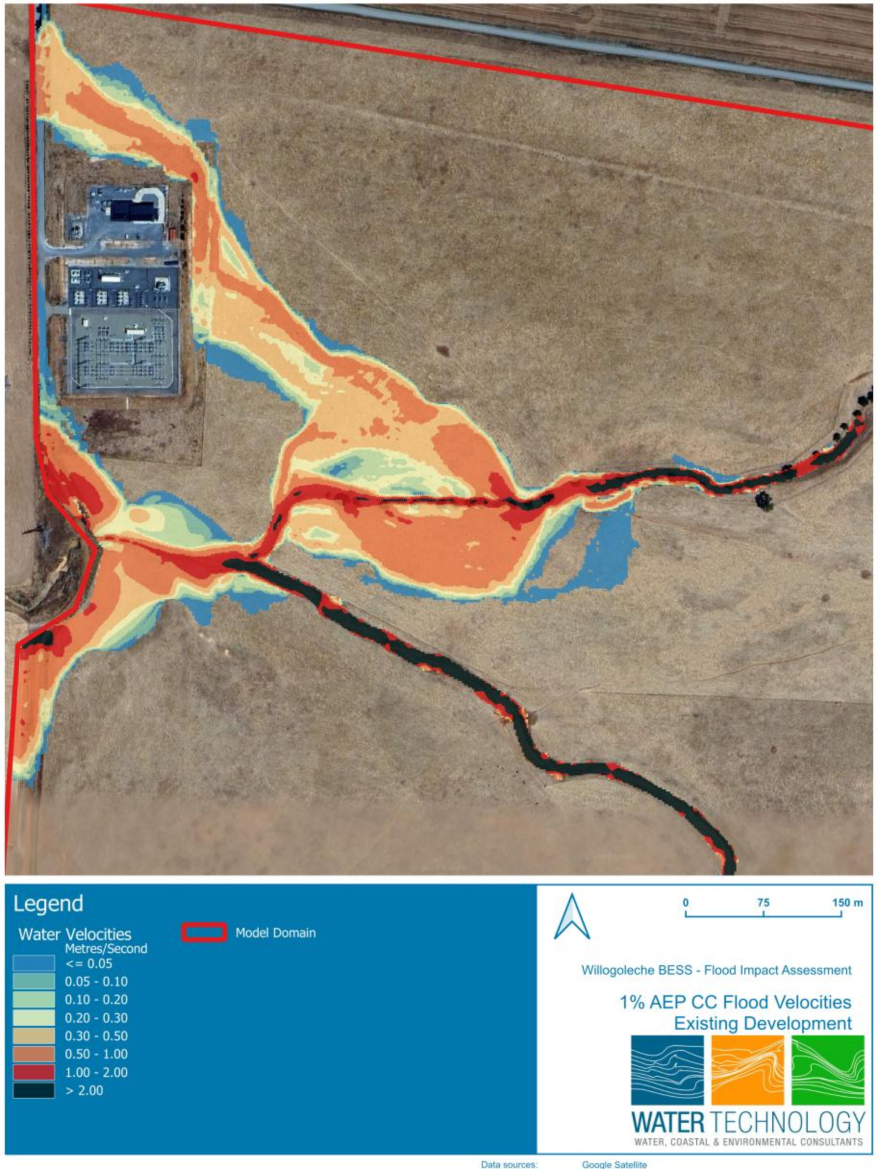

Figure 2-9 1% AEP CC Velocities Existing Conditions

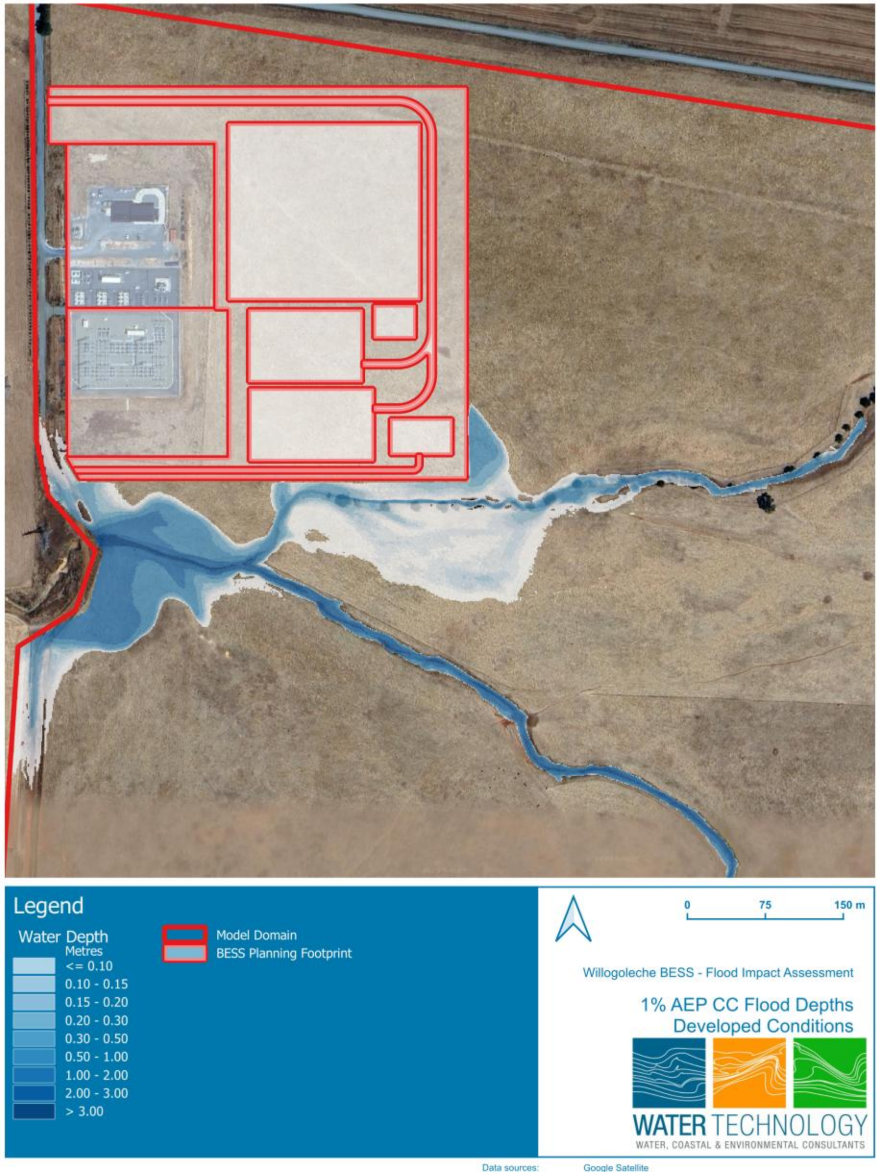

Figure 2-10 1% AEP CC Depths Developed Conditions

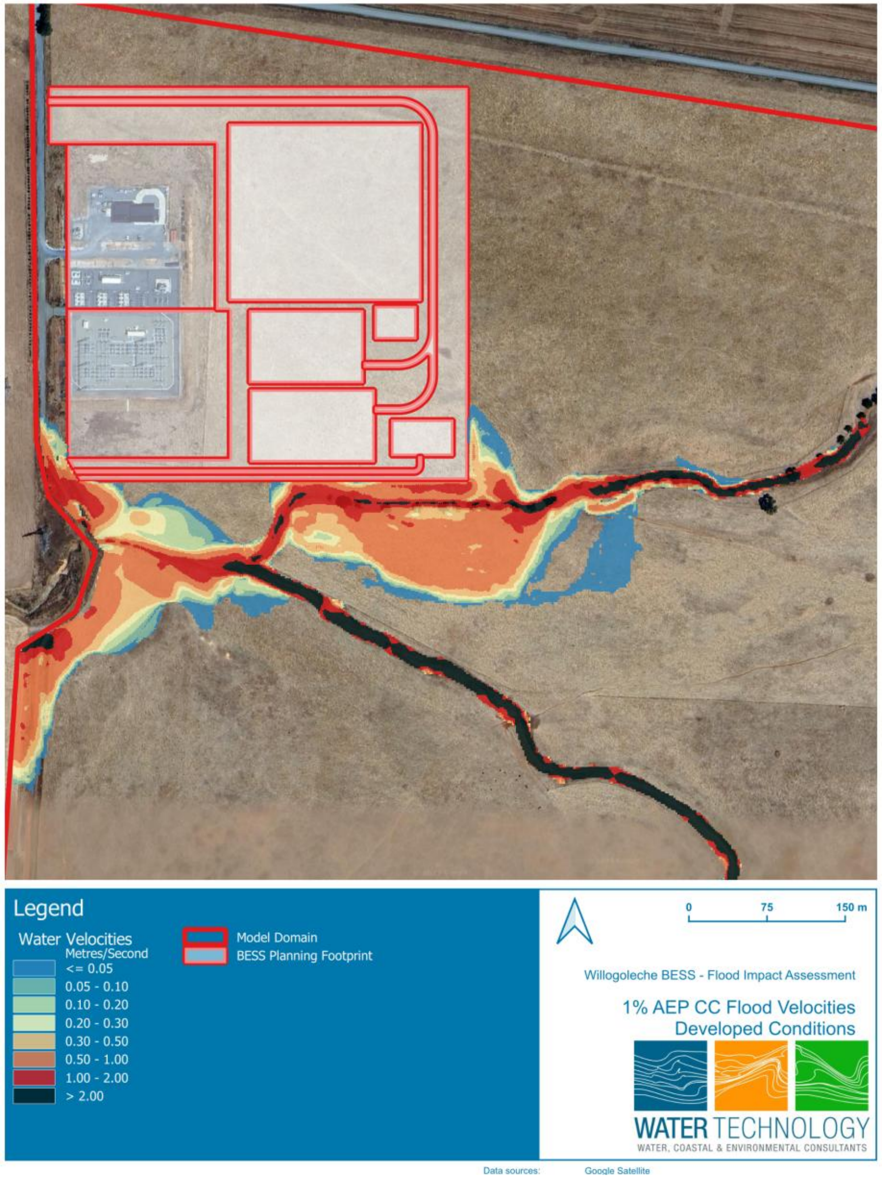

Figure 2-11 1% AEP CC Velocities Developed Conditions

Figure 2-12 PMF Depths Existing Conditions

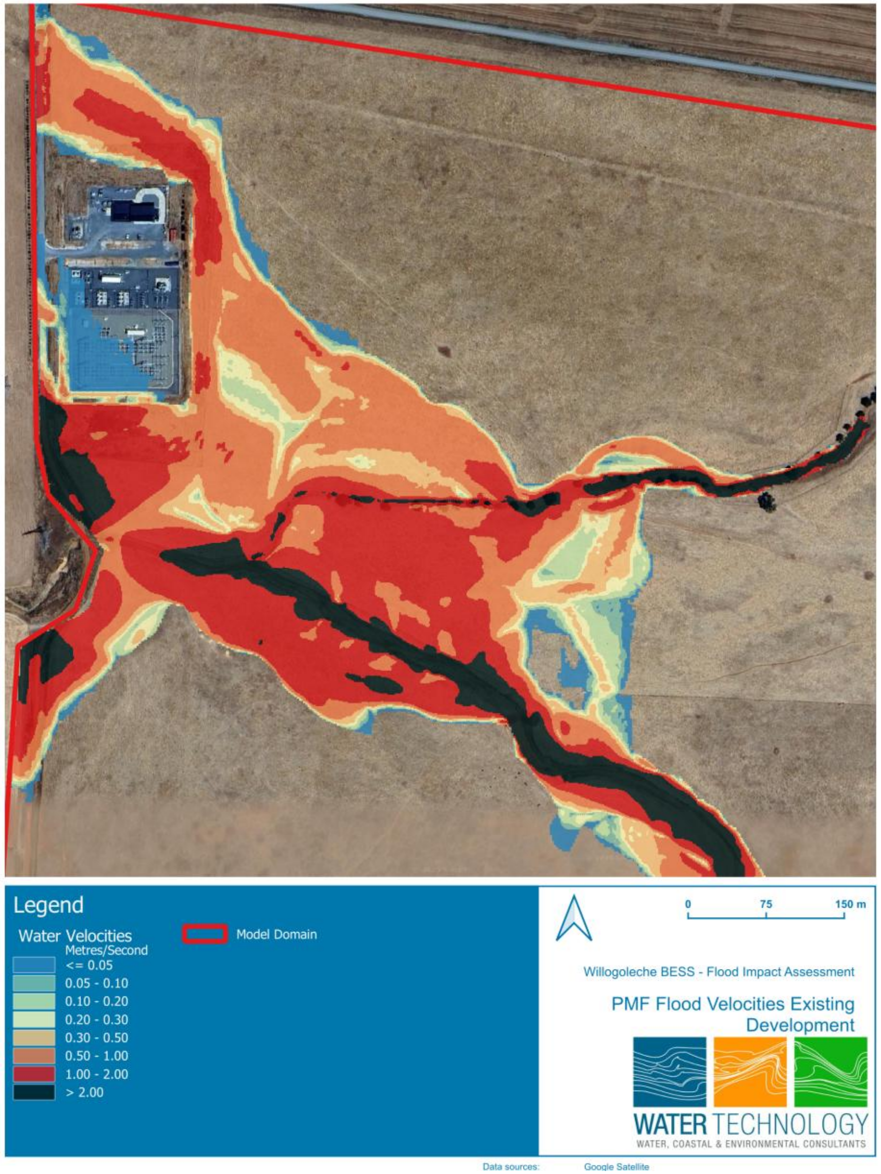

Figure 2-13 PMF Velocities Existing Conditions

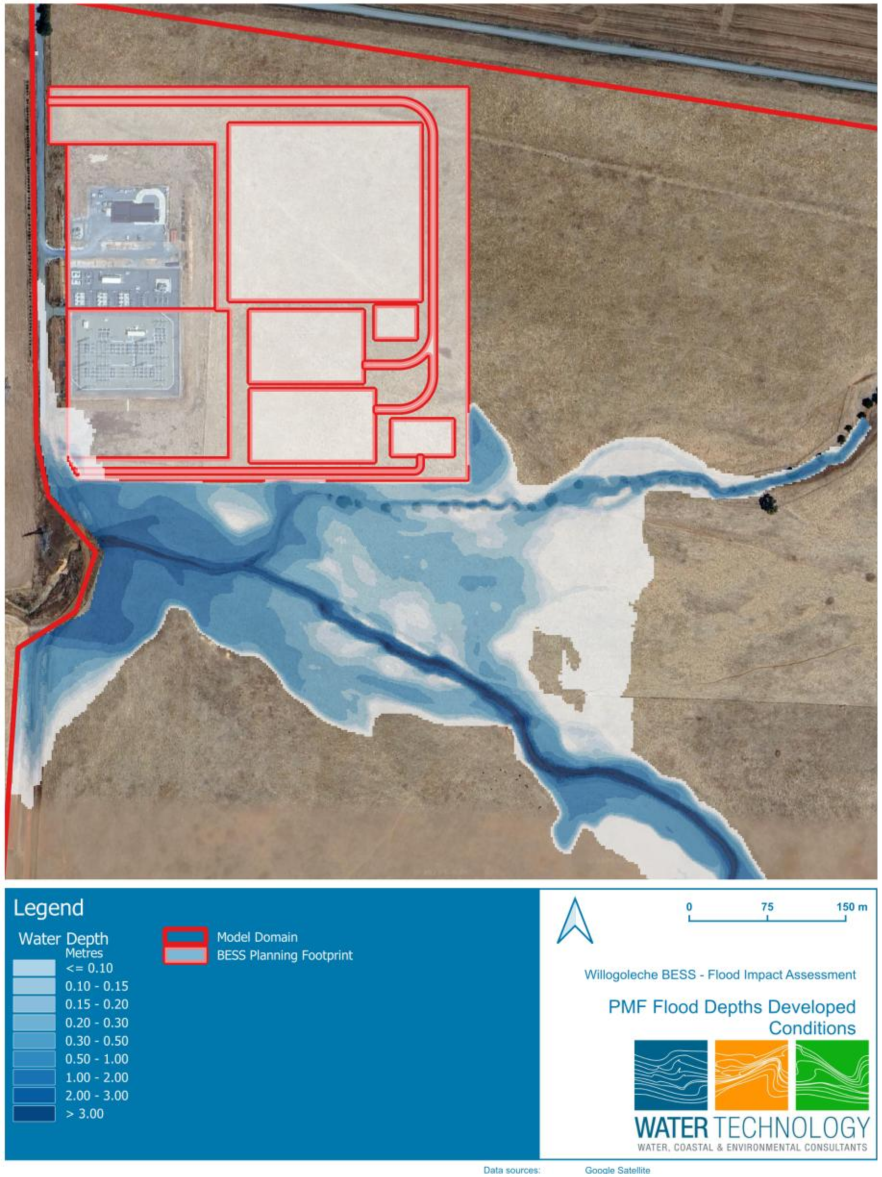

Figure 2-14 PMF Depths Developed Conditions

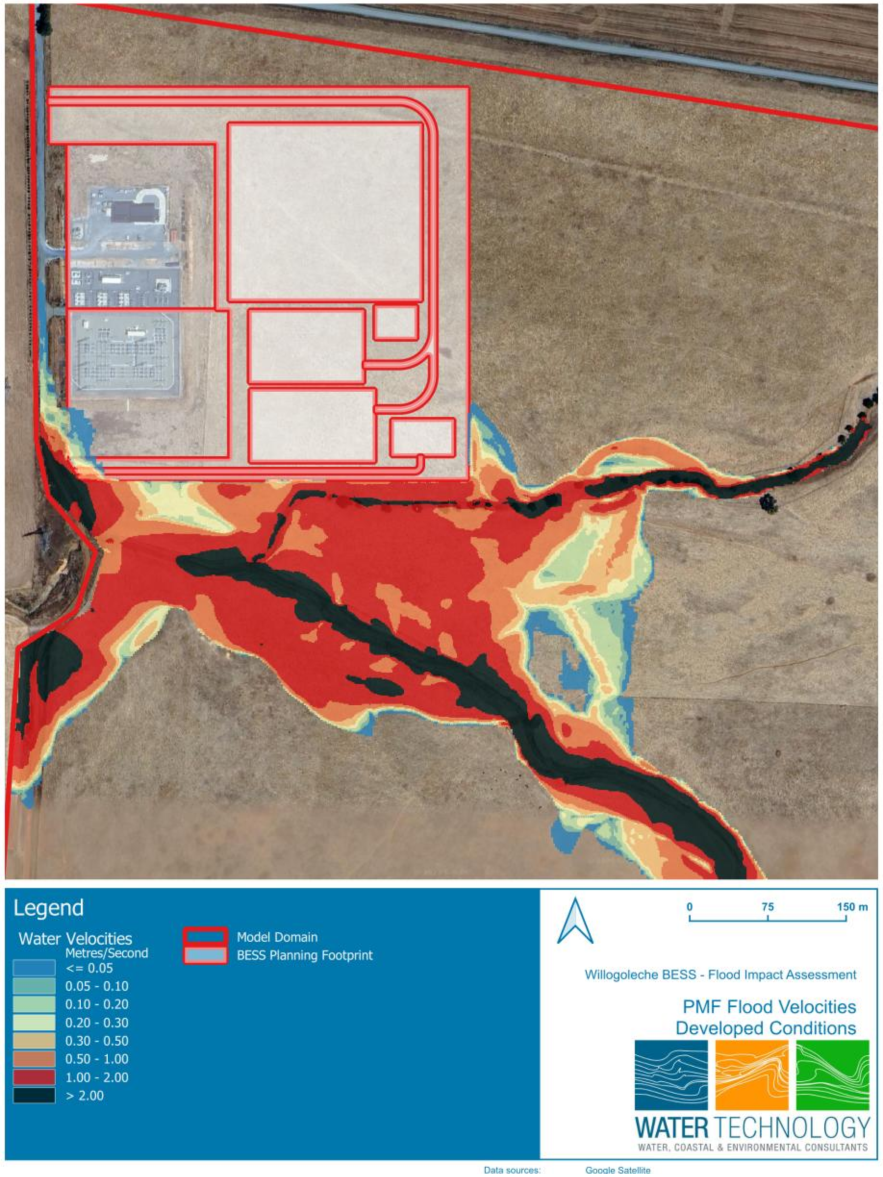

Figure 2-15 PMF Velocities Developed Conditions

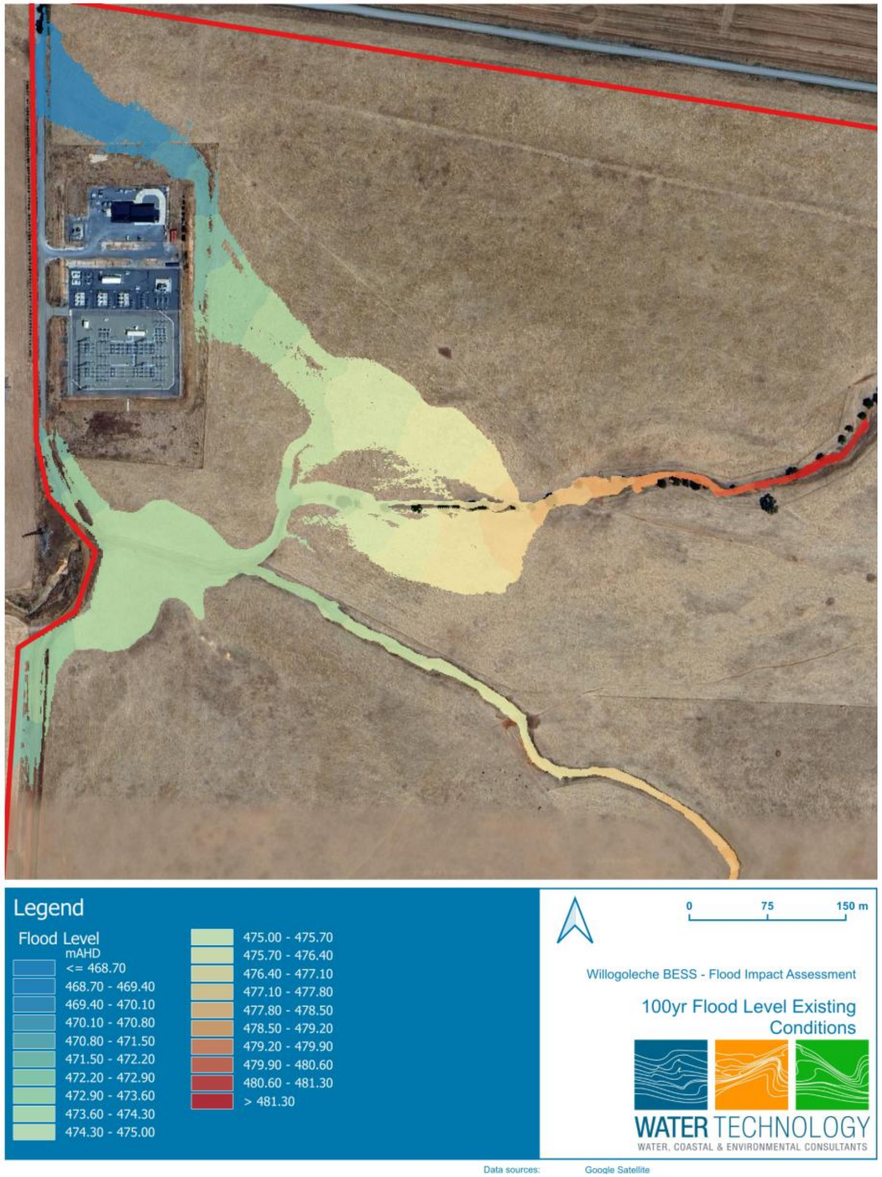

Figure 2-16 1% AEP Water Level Existing Conditions

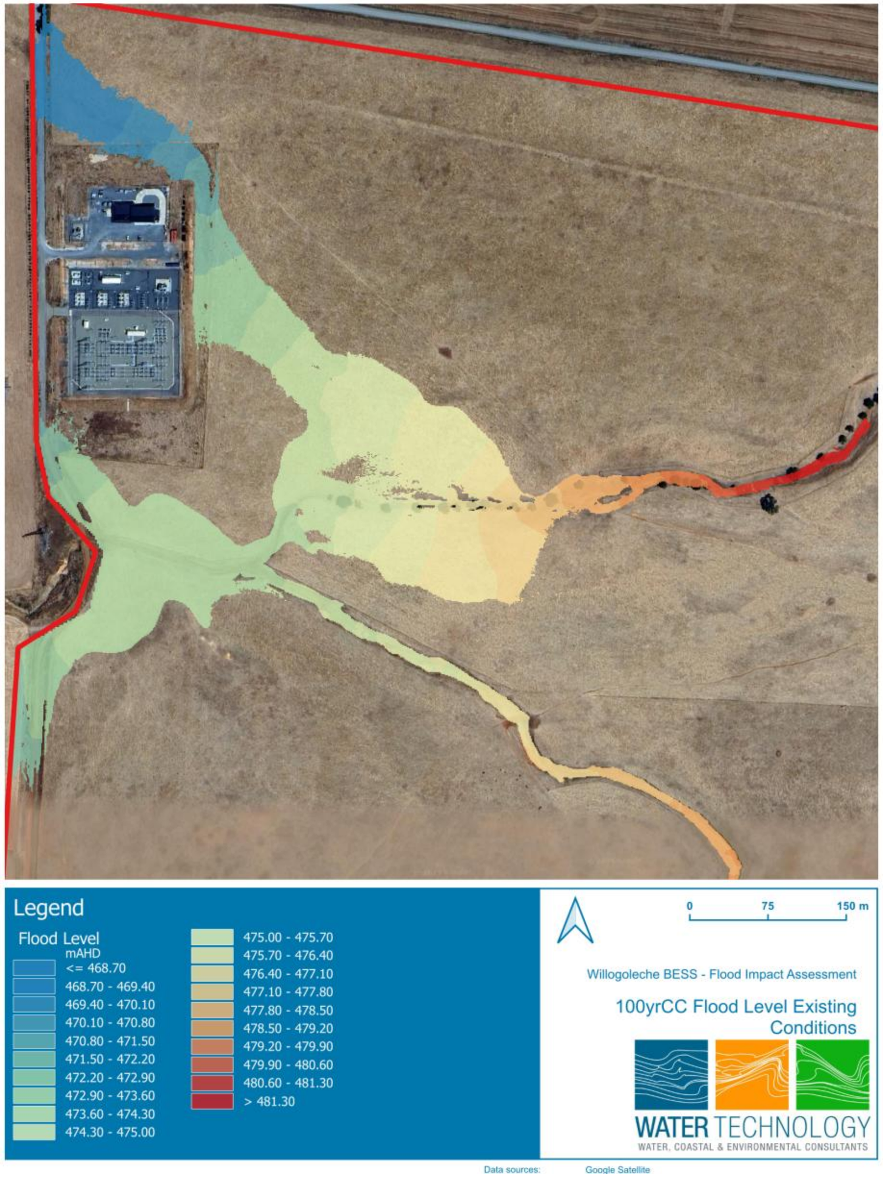

Figure 2-17 1% AEP CC Water Level Existing Conditions

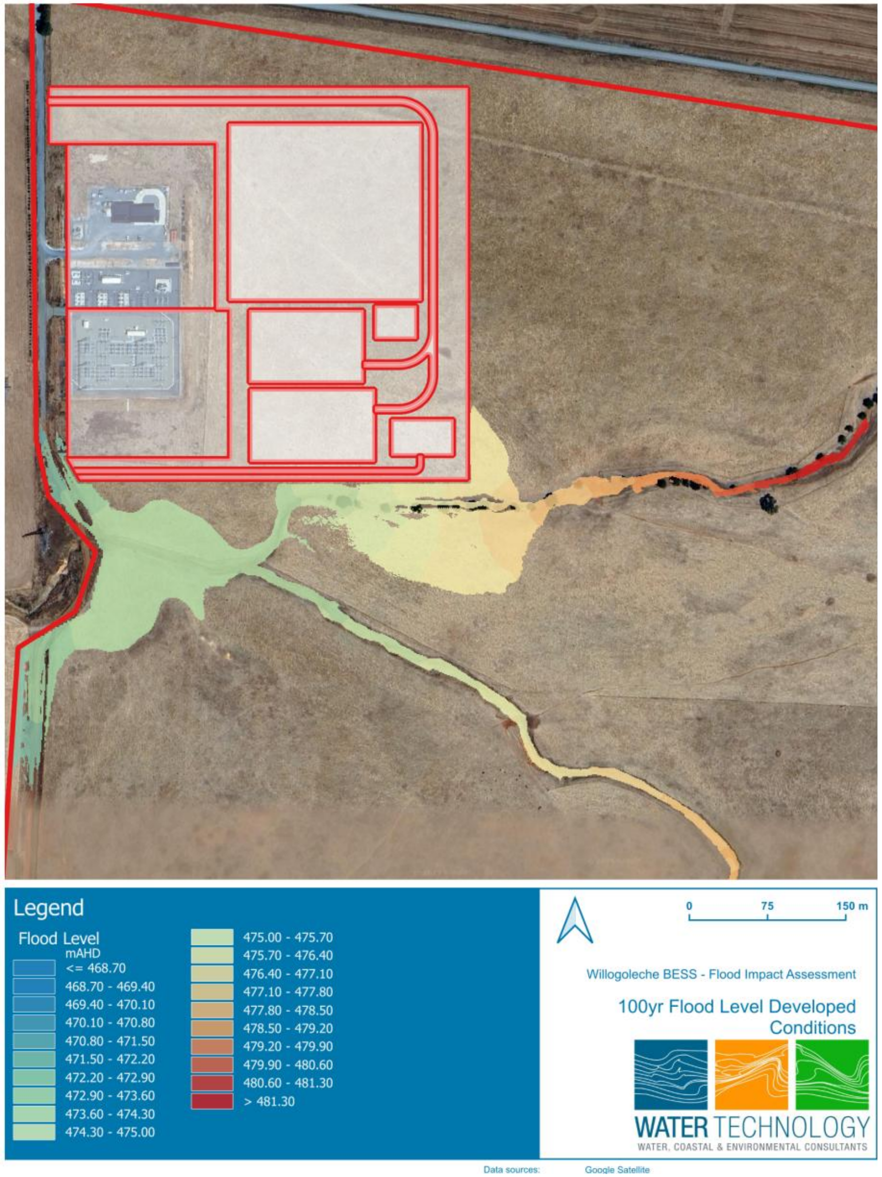

Figure 2-18 1% AEP Water Level Developed Conditions

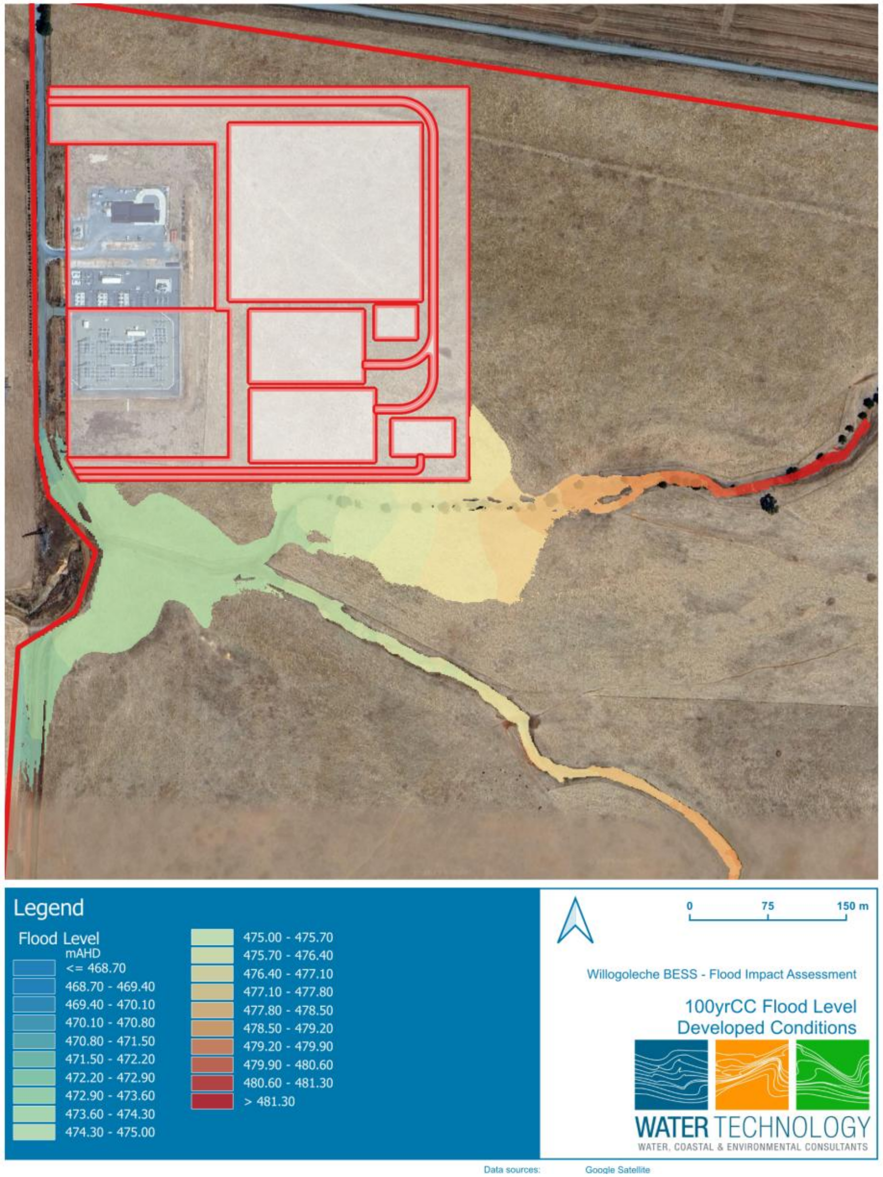

Figure 2-19 1% AEP CC Water Level Developed Conditions

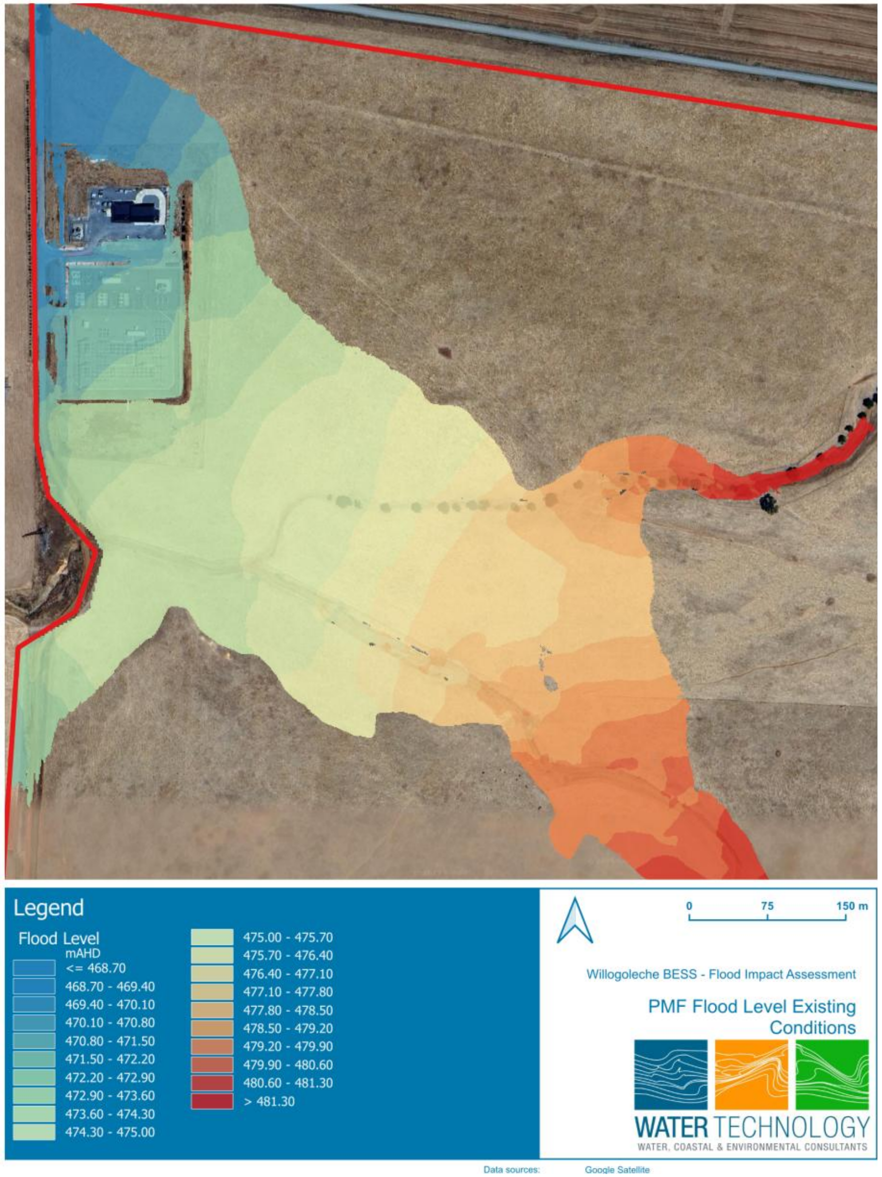

Figure 2-20 PMF Water Level Existing Conditions

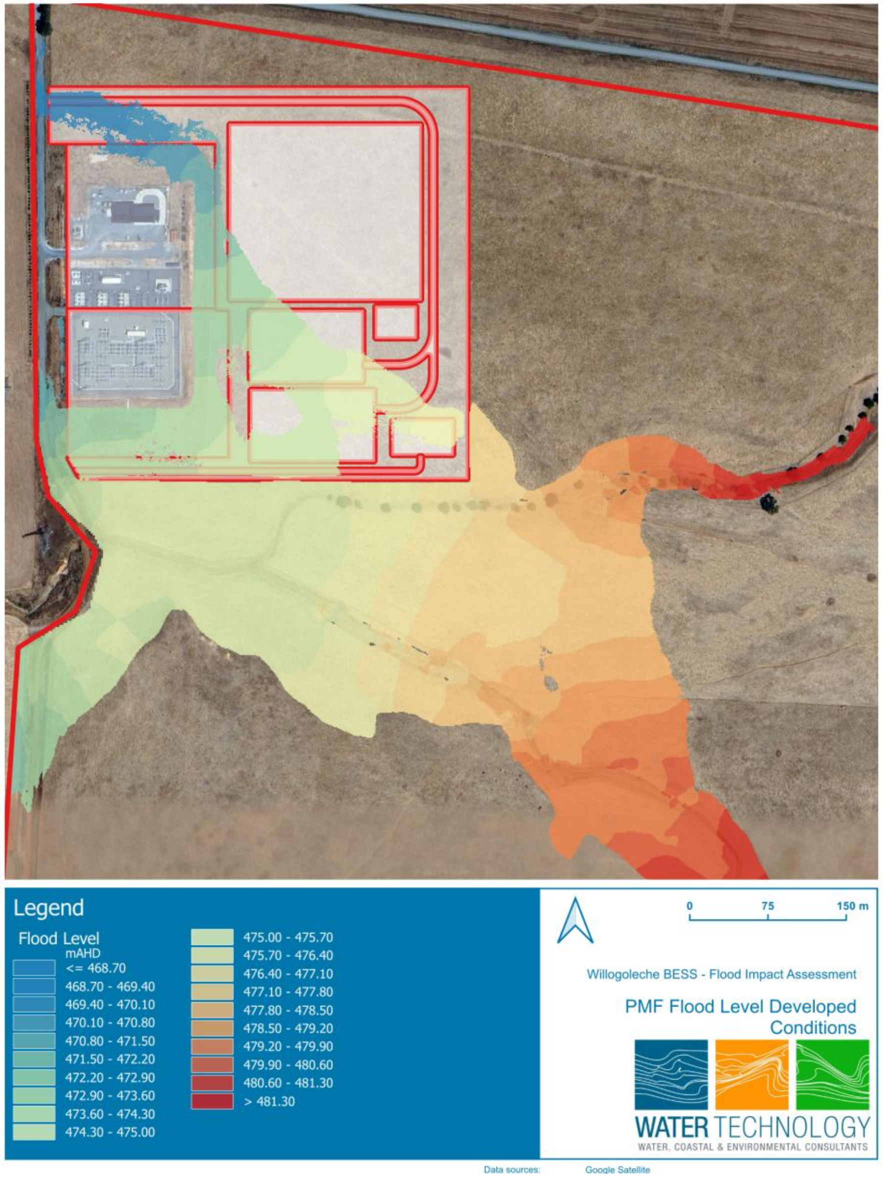

Figure 2-21 PMF Water Level Developed Conditions

2.3.1 Impact Assessment

Difference mapping of developed and existing conditions during 1% AEP flooding seen in Figure 2-22 shows moderate displacement of water due to the developed site (green). This displacement has resulted in more extensive flooding around the south-east of the BESS site, with increased flood depths locally. Downstream impacts of the development are minimal (less than 100mm), with impacts contained to an 150m envelope in the channel adjacent to the site.

1% AEP flooding under climate change, seen in Figure 2-23, shows similar spatial patterns with a higher volume of water displaced, leading to higher water depths under the developed condition near the south-east boundary of the BESS site and the downstream boundary of the model.

The PMF, seen in Figure 2-24, witnesses the most significant displacement of water due to the extremely high flows, with water depths increasing above 300mm adjacent to the site, and impacts less than 300mm can be conservatively extrapolated to around 500-1000m downstream of the model area.

There are no impacts at the model boundary and immediately upstream (up to 40m) in the 1% AEP events under existing and current climate conditions, providing confidence that any impacts are contained to the immediate vicinity of the BESS study site. Additionally, the existing overland flowpath which is to be disrupted by the BESS development could be re-instated with boundary channels however, the model results suggest that it is not necessary.

The PMF is shown to demonstrate the worst-case flood event. Mitigation infrastructure is only suggested to be designed to mitigate against the 1% AEP event inclusive of Climate Change in line with requirements for relevant authorities.

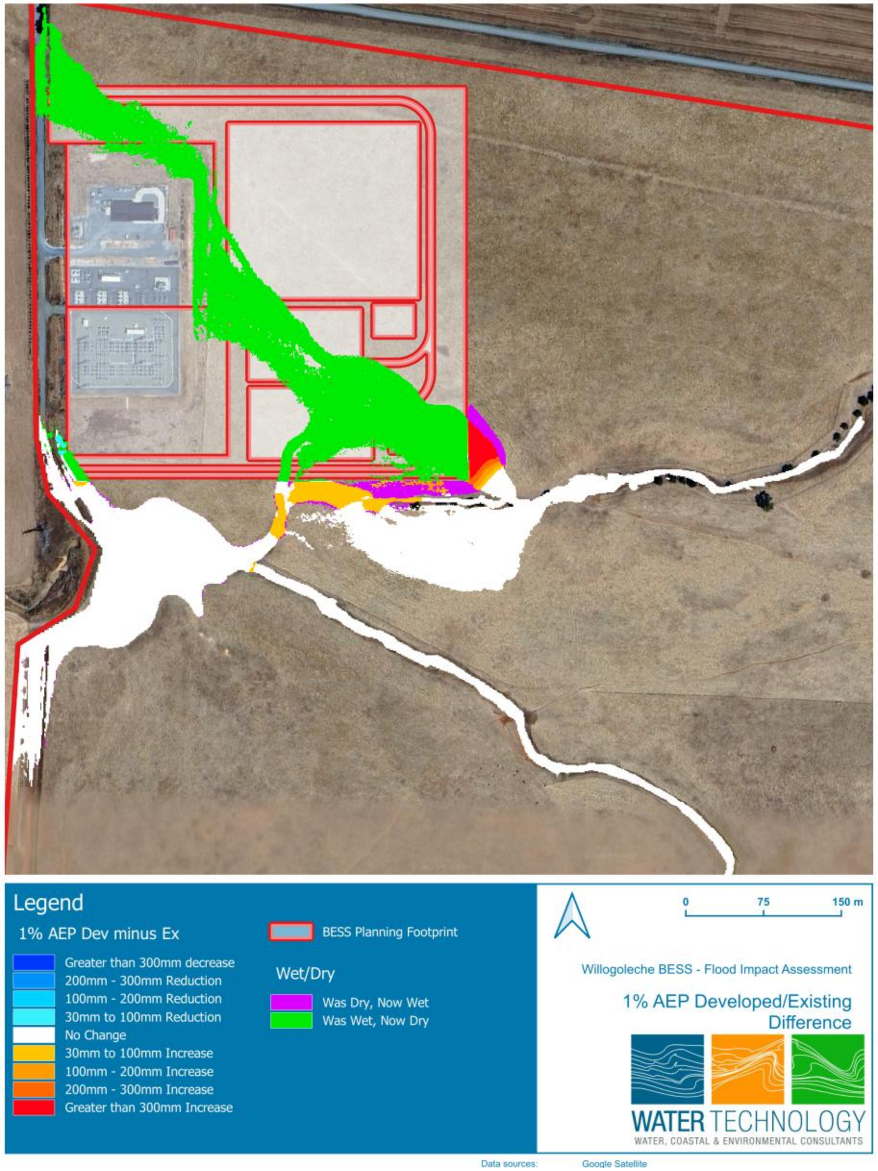

Figure 2-22 1% AEP Developed and Existing Difference

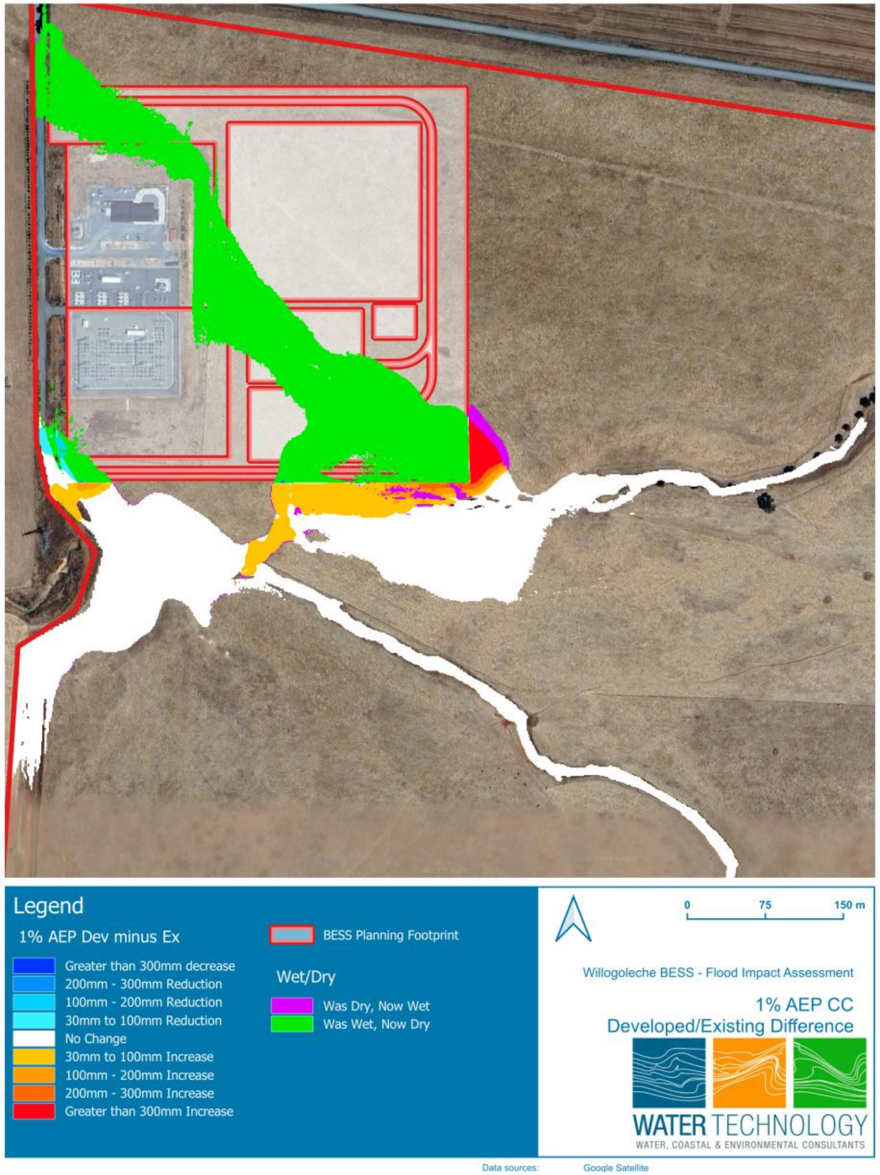

Figure 2-23 1% AEP CC Developed and Existing Difference

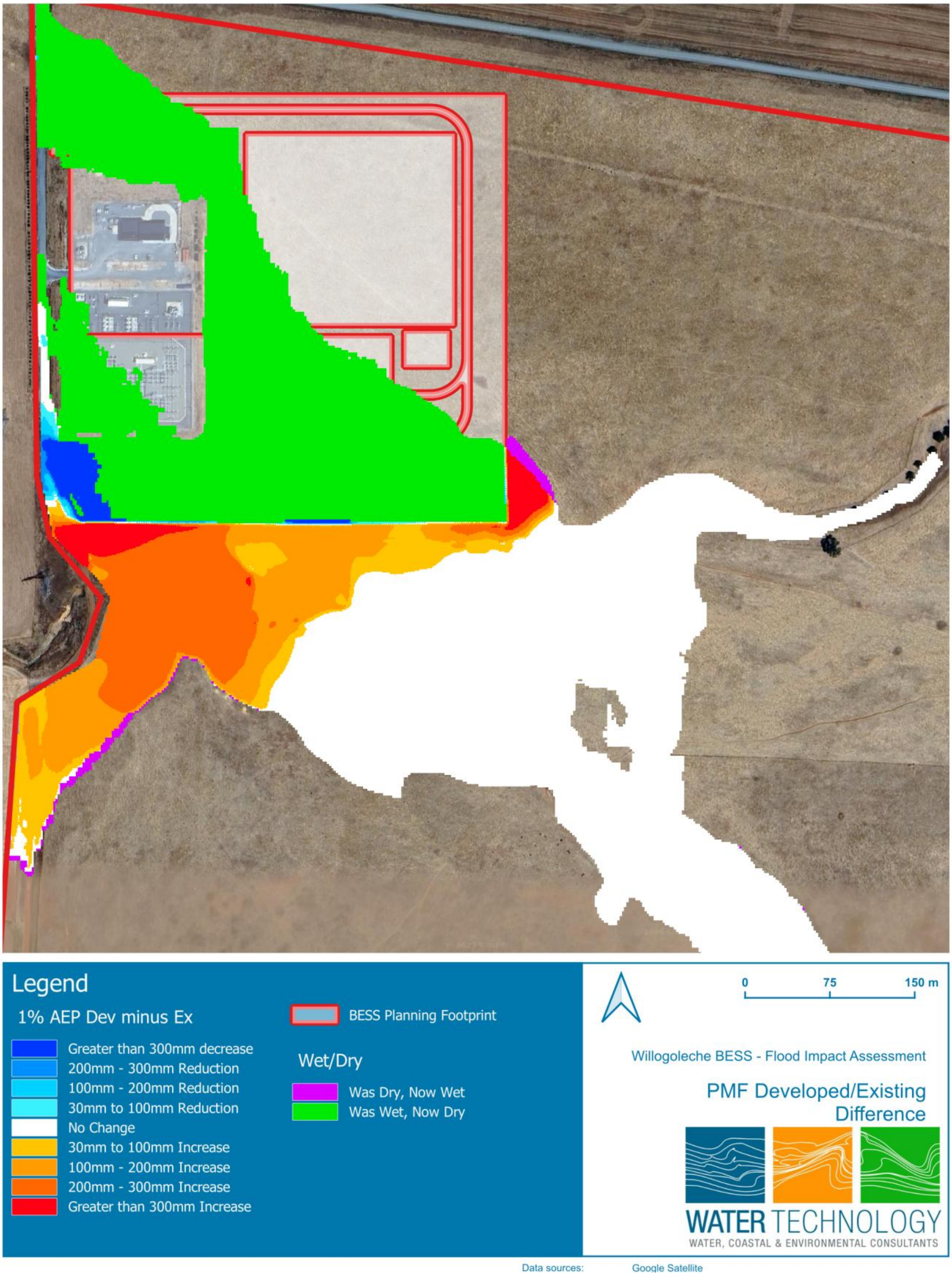

Figure 2-24 PMF Developed and Existing Difference

3 SUMMARY

Overall, flood impacts due the proposed BESS development under 1% AEP with and without climate change would be insignificant, with impacts above 300mm difference limited to 50m away from the site, and minimal impacts up to 100m away. The site will be required to achieve levels from 476.64m AHD to 474.04m AHD including 300mm freeboard in the 1% AEP with climate change case.

Increased impacts are observed under the PMF due to higher flows, resulting in more significant impacts due to the BESS site. Mitigation infrastructure is not proposed for events greater than the 1% AEP inclusive of Climate Change. The PMF is presented as the worst case scenario for information purposes.

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