APPENDIX 15

Water Resources Impact Assessment, including Flooding

umwelt
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GUNDARY SOLAR FARM

Water Resources Impact Assessment

FINAL

July 2024

GUNDARY SOLAR FARM

Water Resources Impact Assessment

FINAL

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Lightsource bp

Project Director:	Malinda Facey
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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
Final	Marion O’Neil	02/07/2024	Malinda Facey	02/07/2024

Glossary and Abbreviations

Term/Abbreviation	Definition
AEP (Annual Exceedance Probability)	Annual Exceedance Probability. The change of a flood of a given or large size occurring in any one year, usually expressed as a percentage. In this study AEP has been used consistently to define the probability of occurrence of flooding. The following relationships between AEP and ARI applies to this study (ARR, 2019).

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI
Very frequent	12			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.50
	1	63.2	1.58	1.00
Frequent	0.69	50.00	2	1.44
	0.5	39.35	2.54	2.00
	0.22	20.00	5	4.48
	0.2	18.13	5.52	5.00
	0.11	10.00	10.00	9.49
Infrequent	0.05	5.00	20	20.0
	0.02	2.00	50	50.0
	0.01	1.00	100	100
Rare	0.005	0.50	200	200
	0.002	0.20	500	500
	0.001	0.10	1000	1000
	0.0005	0.05	2000	2000
Extremely Rare	0.0002	0.02	5000	5000
			↓	
Extreme			PMP	

Term/Abbreviation	Definition
AHD	Australian Height Datum. A common national surface level datum approximately corresponding to mean sea level.
ARR	Australian Rainfall and Runoff. Guidelines prepared by the Institute of Engineers Australia for the estimation of design floods.
ASS / PASS	Acid Sulfate Soils or Potential Acid Sulfate Soils.
BESS	Battery Energy Storage System.
CEMP	Construction Environmental Management Plan.
Development footprint	The maximum extent of ground disturbance associated with the construction and operation of the Project. The development footprint would cover an area of up to 512 ha within the Project Area.
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).

Term/Abbreviation	Definition
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below: Existing flood risk: the risk a community is exposed to as a result of its location on the floodplain. Future flood risk: the risk a community may be exposed to as a result of new development on the floodplain. Continuing flood risk: the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
Flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is flood prone land.
GW	Gigawatt.
GWh	Gigawatt-hour.
Hazard	A source of potential harm or situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community.
Hydrology	The study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
ICNIRP	International Commission on Non-Ionizing Radiation Protection.
Involved Dwelling	Dwelling located on land owned by landholders involved in the Project.
Involved landholder	A landholder whose property would have Project infrastructure located on it.
kL	Kilolitre, one thousand litres.
km	Kilometres.
kV	Kilovolt.
m AHD	Metres Australian Height Datum (AHD).
m/s	Metres per second. Unit used to describe the velocity of floodwaters.

Term/Abbreviation	Definition
m^3/s	Cubic metres per second or "cumecs". A unit of measurement of creek or river flows or discharges. It is the rate of flow of water measured in terms of volume per unit time.
MHRDC	Maximum Harvestable Right Dam Capacity.
ML	Megalitre, one million litres.
MNES	Matter of National Environmental Significance.
MW	Megawatt.
Non-involved dwelling	Dwelling located on land owned by landholders not involved in the Project.
Non-involved landholder	A landholder whose property is located in proximity to the Project Area but would not have Project infrastructure located on it. Potential impacts to non-involved landholders are investigated in the EIS.
NVR Map	Native Vegetation Regulatory Map.
PMF (Probable maximum flood)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The probable maximum flood defines the extent of flood prone land, that is, the floodplain.
Project Area	The total area in which the Project would be developed. The Project Area covers approximately 702 ha.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual, it is the likelihood of consequences arising from the interaction of floods, communities, and the environment.
Runoff	The amount of rainfall which ends up as a streamflow, also known as rainfall excess.
Scour	Erosion by mechanical action of water, typically of soil.
Sensitive receiver	Non-involved dwellings in proximity to the Project Area that may be sensitive to noise, visual, traffic and other impacts. Potential impacts to sensitive receivers are investigated in the EIS.
Solar farm site	The parcels of land where the solar farm would be located, covering an area of approximately 702 ha.
TUFLOW	TUFLOW is a computer program which is used to simulate free-surface flow for flood and tidal wave propagation. It provides coupled 1D and 2D hydraulic solutions using a powerful and robust computation. The engine has seamless interfacing with GIS and is widely used across Australia.
WAL	Water Access Licence.
WSP	Water Sharing Plan.

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1.0 Introduction

1.1 Project Overview

Lightsource Development Services Australia Pty Ltd (Lightsource bp) proposes to develop the Gundary Solar Farm (the Project) in the Southern Tablelands region of New South Wales (NSW), approximately 10 kilometres (km) southeast of Goulburn within the Goulburn Mulwaree Local Government Area (LGA) (see **Figure 1.1**).

The Project will include the construction, operation, maintenance and decommissioning of a 400 Megawatt peak (MWp) solar photovoltaic (PV) generation facility with a Battery Energy Storage System (BESS) and ancillary infrastructure, including an onsite substation and connection to an existing 330 kilovolt (kV) transmission line (the Project). The Project's conceptual layout is provided in **Figure 1.2.** The Project will gain access via the existing driveway at 961 Windellama Road. Intersection works on Windellama Road are proposed as part of the Project in order to upgrade the Project access to accommodate heavy vehicles.

Subject to the final design process, the Project would comprise the following key elements:

- approximately 660,000 solar panels bifacial flat plate solar PV modules in single-axis tracking arrangement with a maximum height of 3 metres (m) above ground level, occasionally reaching up to 4 m depending on the topography
- a centralised and/or de-centralised lithium-ion BESS of up to 555MWp (1,570 MWh) capacity, to store energy generated by the Project
- onsite 33/330 kV switchyard and substation, with underground electrical conduits and cabling leading from the solar panels into the substation yard, and overhead lines reaching above to the existing 330 kV transmission line
- internal and perimeter gravel access tracks, including a number of watercourse crossings (via culverts and bed level crossings) within the Project Area, where required, to manage existing surface water flows and access points
- temporary ancillary facilities, including a construction compound (including office amenities, parking and storage) and laydown areas
- permanent site office, operations and maintenance building with parking for the operations team
- primary access point from the existing driveway off Windellama Road, with proposed intersection works on Windellama Road to upgrade the Project access to accommodate heavy vehicles
- an emergency access point proposed on the east, via the existing entrance off Kooringaroo Road
- perimeter security fencing and water tanks.

The Project is expected to operate for up to 40 years. After its operational life, the Project would either be decommissioned (by removing all infrastructure and returning the site to its existing land capability) or repurposed with new PV equipment subject to technical feasibility and planning consents.

The conceptual layout for the Project provided in **Figure 1.2** has been designed through an iterative process to avoid impacts to main watercourses traversing through the Project Area (namely Gundary Creek and Bullamalito Creek), areas prone to flooding and high-quality biodiversity values (such as Threatened Ecological Communities (TECs) and habitat for threatened species). The layout has also maintained appropriate setbacks of approximately 20 m to 40 m from all second order and higher streams in accordance with the *Guidelines for riparian corridors on waterfront land* (DPE, 2012a).

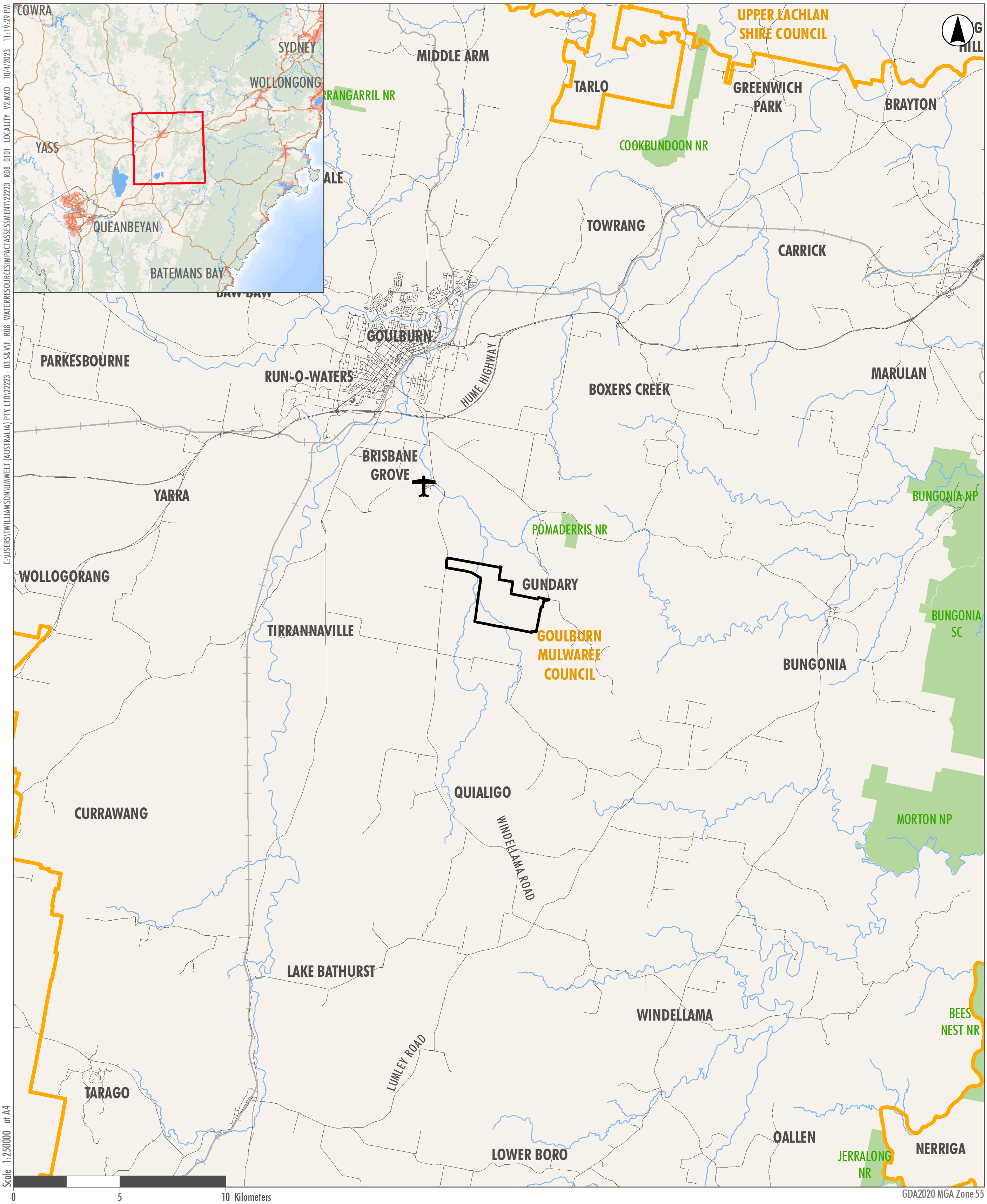
The Project is a State Significant Development (SSD) under *State Environmental Planning Policy (Planning Systems) 2021* (Planning Systems SEPP), as the Project is development for the purposes of electricity generating works and the capital investment value of the Project is over $30 million. A development application (DA) for the Project is required to be submitted under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.2 Purpose and Scope

This Water Resources Impact Assessment (WRIA) has been prepared by Umwelt in accordance with the Secretary's Environmental Assessment Requirements (SEARs) (issued on 10 November 2022) issued by the then Department of Planning and Environment (DPE) (now the Department of Planning, Housing and Infrastructure (DPHI)), as presented in **Section 1.3**. A standalone Flood Impact and Risk Assessment has been undertaken by WRM Water and Environment (WRM, 2024) in support of this WRIA. The Flood Impact and Risk Assessment is provided in full in **Appendix A**, with the key findings summarised in this report.

This WRIA provides an assessment of the potential surface water, groundwater, water quality and hydrology impacts associated with the construction and operation of the Project and includes the following scope:

- Identifying relevant regulatory requirements for the Project with respect to water resources in the Project Area.
- Confirming the environmental values and water quality objectives associated with surface water resources.
- Assessing the impacts of the Project on groundwater aquifers and groundwater dependent ecosystems, having regard to the NSW Aquifer Interference Policy and relevant Water Sharing Plans.
- Assessing the risk of potential impacts on surface water resources and flood regimes in the Project Area and identifying appropriate mitigation measures to manage the potential impacts.
- Assessing the potential impacts of the Project on the Sydney drinking water catchment, and whether the Project can be constructed and operated to have a neutral or beneficial effect on water quality consistent with the provisions *of State Environmental Planning Policy (Biodiversity and Conservation) 2021*.



Legend

- Goulburn Airport
- Project Area
- Local Government Area
- NPWS Estate
- Roads
- Railway
- Watercourses

FIGURE 1.1

Locality and Regional Context

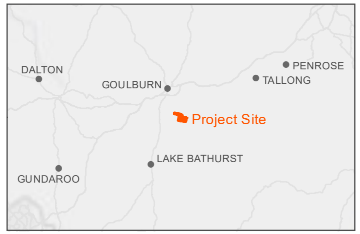
Data source: NSW DSFI (2022); Lightsource BP (2022)

FIGURE 1.2

Gundary Solar Farm Indicative Layout

Legend

- Access Roads
- Security Fence
- Existing Transmission Line
- Roads
- Watercourses
- Watercourse / Bed Level Crossing
- Water Tank (40,000L)
- Water Tank (10,000L)
- Primary Access
- Emergency Access
- Emergency Gate
- Project Area
- Proposed Road Upgrade
- Solar Panels
- Landscaping Buffer (5m)
- Transgrid Line Works
- Centralised AC BESS
- Substation and O&M Facility Area
- Construction Compound Area
- Decentralised DC BESS



0 500 1,000

Metres

Scale: 1:0 at A4

GDA2020 MGA Zone 55

Image Source: ESRI Basemap (2023) | **Data Source:** NSW DFSI (2023)

1.3 Assessment Requirements

The SEARs for the Project identify key issues and referenced guidelines that must be addressed in the Environmental Impact Statement (EIS). **Table 1.1** references the relevant requirements for water and where these have been addressed in this report.

The Agency Advice and where in the WRIA it has been addressed is included in **Appendix B**.

Table 1.1 SEARs Items and Responses

Requirement	Section where addressed
Water – including: a detailed and consolidated site water balance and an assessment of the likely impacts of the development (including flooding) on surrounding watercourses (including their Strahler Stream Order) and groundwater resources and measures proposed to monitor, reduce and mitigate these impacts including water management issues having regard to the Solar Guideline;	**Section 4.0** **Section 5.0, Section 6.0 and Section 7.0**
details of water requirements and supply arrangements for construction and operation; and	**Section 4.3**
an assessment of the potential impacts of the development on the Sydney drinking water catchment, including consideration of Water NSW's current recommended practices and standards, stormwater quality modelling (MUSIC), and whether the development can be constructed and operated to have a neutral or beneficial effect on water quality consistent with the provisions of *State Environmental Planning Policy (Biodiversity and Conservation) 2021;*	**Section 5.0 and Section 7.0**
where the project involves works within 40 metres of any river, lake or wetlands (collectively waterfront land), identify likely impacts to the waterfront land, and how the activities are to be designed and implemented in accordance with the DPI *Guidelines for Controlled Activities on Waterfront Land* (2018) and (if necessary) *Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (DPI 2003), and *Policy & Guidelines for Fish Habitat Conservation & Management* (DPE, 2013);	**Section 4.2 and Section 7.0**
a description of the erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with *Managing Urban Stormwater: Soils & Construction* (Landcom, 2004);	**Section 4.1 and Section 8.0**
assessing the impacts of the development, including any changes to flood risk and overland flows on-site or off-site, and detail design solutions and operational procedures to mitigate flood risk where required.	**Section 6.0, Section 7.2 and Section 8.0**

This report has been prepared in accordance with the following guidelines and legislative requirements:

- *Large-Scale Solar Energy Guideline* (DPE, 2022).
- *NSW Water Management Act 2000* (WM Act).
- NSW *Water Act 1912* (Water Act).
- Relevant Water Sharing Plans within the Project Area.

- Groundwater:
  - NSW State Groundwater Policy Framework Document and component policies (DPE).
  - NSW Aquifer Interference Policy 2012 (DPE).
  - National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC).
- Flooding:
  - Floodplain Development Manual (OEH).
  - Floodplain Risk Management Guideline (OEH).
  - Australian Rainfall and Runoff Guidelines 2019.
- Surface Water:
  - NSW Government Water Quality and River Flow Objectives at http://www.environment.nsw.gov.au/ieo/.
  - Australian Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia, 2018) (ANZG, 2018).
  - Managing Urban Stormwater: Soils and construction (Landcom, 2004) and Volume 2 (Department of Environment and Climate Change, 2008).
  - Developments in the Sydney Drinking Water Catchment – Water Quality Information Requirements (WaterNSW, 2023).
  - Neutral or Beneficial Effect on Water Quality Assessment Guideline (WaterNSW, 2022).
  - Using MUSIC in the Sydney Drinking Water Catchment (WaterNSW, 2023)
  - Storing and Handling Liquids: Environmental Protection – Participants Handbook (Department of Environment and Climate Change, 2007).
- Guidelines for Controlled Activities on Waterfront Land:
  - Guidelines for riparian corridors on waterfront land (DPE Water, 2018).
  - Guidelines for instream works on waterfront land (DPE Water, 2022).
  - Guidelines for vegetation management plans on waterfront land (DPE Water, 2022).
  - Guidelines for watercourse crossings on waterfront land (DPE Water, 2022).
  - Controlled Activities on Waterfront Land: Controlled activity exemptions on waterfront land (DPE Water, 2022).

2.0 Assessment Methodology

2.1 Surface Water Quality

The methodology for assessment of potential surface water quality impacts arising from the Project has broadly included:

- Desktop review and analysis of existing surface water quality information to understand the existing environment and identify potential watercourse-specific risks.
- A qualitative assessment of the quality and quantity of pollutants that may be introduced during construction and operation of the Project, and the impact that this may have on surface water quality (with reference to the ANZG (2018) *Water Quality Guidelines* and with regard to relevant environment values as identified in the DECCW (2006) *NSW Water Quality and River Flow Objectives.*
- Recommendations for appropriate treatment measures to mitigate the impacts of construction and operation on surface water quality, including erosion and sediment controls, water quality controls and water quality monitoring program during construction and operation of the Project.

The methodology for assessing water quality impacts included:

- Collating existing water quality data (where available).
- Undertaking a Neutral or Beneficial Effects (NorBe) assessment using the Model for Urban Catchment Improvement Conceptualisation (MUSIC) based on the Neutral or Beneficial Effect on Water Quality Assessment Guideline (WaterNSW, 2022).
- Undertake MUSIC modelling and reporting the results of the MUSIC modelling and comparing the pre-development and post-development annual pollutant loads and the estimated percentage reduction in pollutant loads discharged from the Project Area post-development.

2.2 Groundwater

The following tasks have been completed as part of the groundwater impact assessment:

- A desktop study of existing hydrogeological conditions at the Project Area including:
  - Description of aquifers, depth to groundwater, groundwater quality and groundwater flow directions.
  - Existing groundwater users, groundwater dependent ecosystems and groundwater-surface water interaction.
  - Review of relevant previous investigations.
- A bore census (i.e. WaterNSW records) has been undertaken to confirm the location of the bores and record total depth and depth to standing water level.
- Assess any potential dewatering requirements and associated drawdown impacts due to construction dewatering and any proposed ongoing water take associated with the Project.

2.3 Hydrology and Flooding

2.3.1 Watercourse Inspection

A site inspection of the Project Area was undertaken on the 17th and 18th of April 2023 by Umwelt to observe the baseline condition of the more significant watercourses within the Project Area, including the extent of existing erosion, vegetation type and cover, and structure of the watercourse channels. The site inspection was also undertaken to ground truth the mapped lower order hydrolines draining to Bullamalito Creek and the 4th order unnamed tributary of Bullamalito Creek, as shown in **Figure 3.1**, and confirm the presence of a watercourse based on the presence of defined bed and banks.

The site inspection provides for a baseline condition of the watercourses to inform potential impacts from the Project with respect to erosion and sedimentation and inform the hydrology of the local catchment. Ground truthing of hydrolines further informed the layout of infrastructure by identifying the true location of drainage lines and watercourses.

2.3.2 Flood Modelling

Flood modelling was undertaken as part of a Flood Impact and Risk Assessment by WRM (refer **Appendix A**) to identify potential impacts on surface water resources and flood regimes associated with the Project. Design flood discharges and flood levels in watercourses draining the Project Area were estimated using a RORB hydrologic model and a TUFLOW hydraulic model**.** RORB simulates the catchment rainfall-runoff process in the contributing catchments, producing the design discharges used for inflows to the hydraulic model. TUFLOW represents hydraulic behaviour on a fixed grid by solving the full two-dimensional depth-averaged momentum and continuity equations for free surface flow. Further detail about the approach to flood modelling appears in **Section 6.0**.

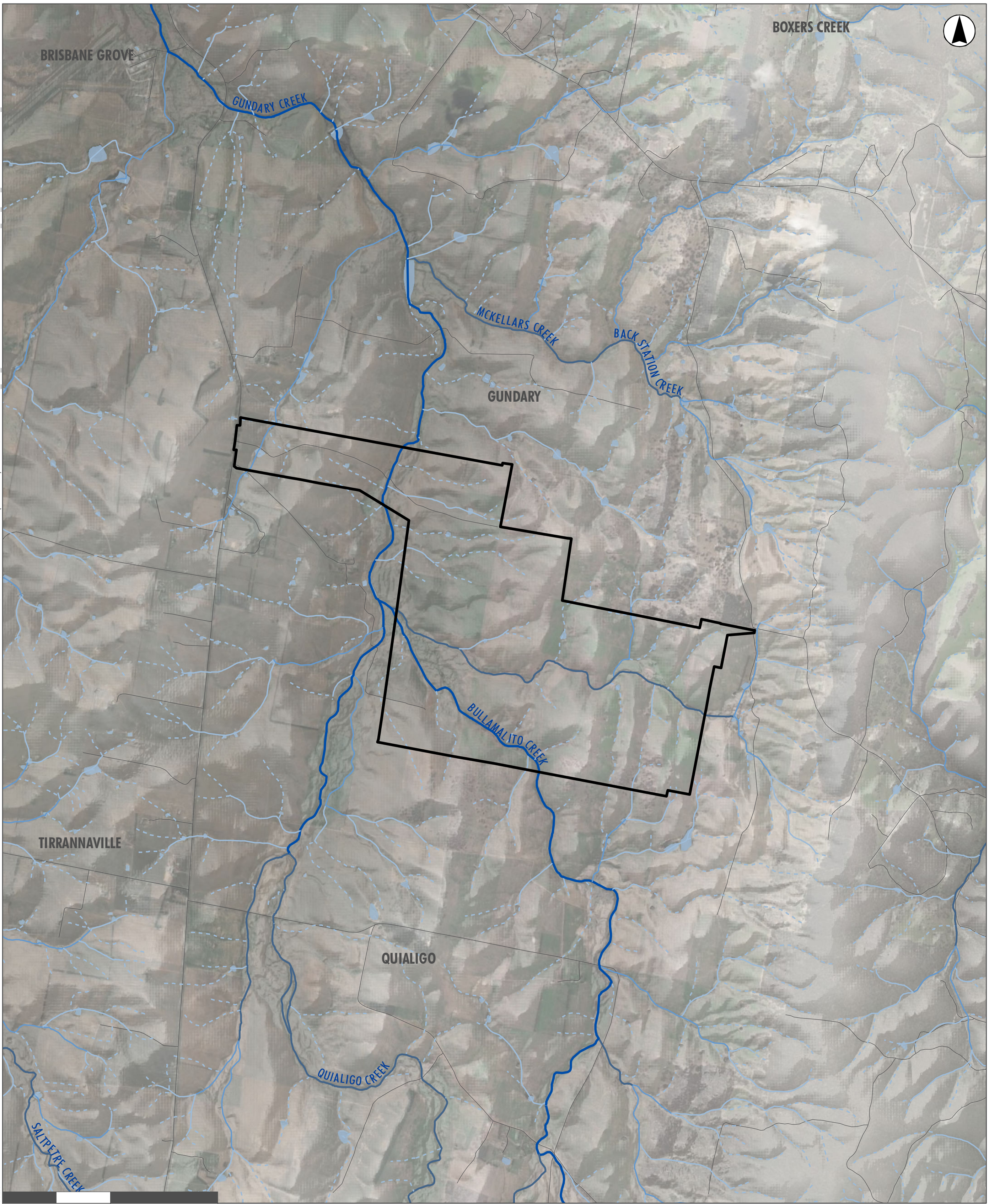
3.0 Existing Environment

3.1 Hydrology and Topography

The Project Area is located within the Gundary Creek catchment which is within the Hawkesbury-Nepean catchment and is within the Sydney drinking water catchment. Elevations within the Project Area range between 710 m AHD from the ranges along the eastern boundary, to approximately 645 m AHD on the Gundary Creek floodplain at the northern boundary. As shown in **Figure 3.1**, watercourses within the Project Area range from 1st to 6th order streams (based on the Strahler stream ordering system) and include the 6th order Gundary Creek (perennial), the 5th order Bullamalito Creek (perennial) and an unnamed 4th order tributary of Bullamalito Creek (non-perennial) draining from east to west across the southern portion of the Project Area. Two unnamed 3rd order streams are also present in the Project Area, one draining from south to north across the northwestern extent of the Project Area and the other a southerly flowing tributary of the unnamed 4th order stream in the southeastern portion of the Project Area.

Gundary Creek is formed at the confluence of the 5th order Quialigo Creek (perennial) and Bullamalito Creek, immediately to the west of the Project Area, and drains in a northerly direction through the northern portion of the Project Area. Gundary Creek flows into the Mulwaree River approximately 10 km north northwest of the Project Area at the southern end of Goulburn. The identified watercourse alignments within the Project Area are shown in **Figure 3.1**.

In reviewing the site watercourse mapping, it is evident that some of the hydroline data is inconsistent with the watercourse alignments identified by aerial imagery and the topographical data. These inconsistencies are largely limited to a small number of 1st order watercourses. The alignment and Strahler stream order of the mapped watercourses throughout the site have some significance with respect to potential development constraints and the requirement for appropriate riparian corridor widths to be maintained. Baseline monitoring of the more significant watercourses within the Project Area was undertaken by Umwelt in April 2023 to establish the general condition of the watercourses as well as ground truthing (alignments and confluence locations) mapped 1st order watercourses draining to Bullamalito Creek and the 4th order unnamed tributary of Bullamalito Creek. The outcomes of the baseline monitoring are provided in **Section 2.3**.



Legend

- Project Area
- Roads
- Waterbody

Strahler Stream Order

- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th Order Stream
- 5th Order Stream or Higher

Figure 3.1

Hydrological Context

3.1.1 Watercourse Condition Observations

Watercourses inspected within the Project Area included the 4th order unnamed tributary of Bullamalito Creek and Bullamalito Creek (refer to **Section 3.1** and **Figure 3.1**). Access to Gundary Creek was not available at the time of the site inspection. A summary of the observations made during the site inspection is provided below. **Figure 3.2** shows the locations (i.e. Location A to S) of where the site inspection photos (shown in **Appendix C**) were taken.

4th Order Unnamed Tributary of Bullamalito Creek

The 4th order unnamed tributary of Bullmalito Creek which flows from east to west through the Project Area was inspected on the 17th of April 2023. General observations are noted below:

- Areas of erosion were observed throughout the watercourse channel, particularly on the walls and on the watercourse bank, facing incoming flows from associated lower order tributaries, as shown in photo at Location A (refer to **Figure 3.2** and **Appendix C**). Significant erosion was observed on the outside radius of some bends in the watercourse channel, as shown in the photo at Location B (refer to **Figure 3.2** and **Appendix C**). Erosion within the watercourse is expected to be due to high soil erodibility (refer to **Section 3.3**), minimal vegetative cover and livestock movements within the riparian corridor and through the watercourse. An example of the erosion observed along the unnamed 4th order watercourse is shown in the photo at Location C (refer to **Figure 3.2** and **Appendix C**).

- In the upstream reaches of the watercourse there is low density vegetative cover on the channel bed and banks. Vegetative cover increases in density downstream as the watercourse converges with Bullamalito Creek and into the surrounding floodplain. Vegetation consists of grass cover of varying height and density. The photo at Location D shows the vegetation observed within the upstream region of the watercourse while the photo at Location E shows the vegetation observed within the downstream reaches of the watercourse (refer to **Figure 3.2** and **Appendix C**). The dense vegetation within the floodplain made it difficult to determine the location of the watercourse channel, however, based on a review of aerial imagery it is expected that the watercourse diverges into a network of braided channels in this area.

- A concrete weir is located in the watercourse, in the upstream eastern region of the Project Area, shown in the photo at Location F (refer to **Figure 3.2** and **Appendix C**).

- The width and depth of the channel varied throughout the length of the watercourse, with depths up to approximately 2 m and widths up to approximately 15 m, as shown in photos at Locations G, H and I (refer to **Figure 3.2** and **Appendix C**). The upstream reaches of the watercourse generally have a well-defined main channel with steep bank slopes while in other sections of the watercourse, the main channel was not as clearly defined, with gentle sloping banks on one side of the channel, as shown in the photos contained in **Appendix C**.

- Ponded water was observed throughout the watercourse channel, however, at the time of the inspections there was no flow of water through the channel.

Bullamalito Creek

The region of Bullamalito Creek that flows through the Project Area was inspected on 18th of April 2023. General observations are noted below:

- There was minimal existing erosion within and along the bank of the watercourse channel, this was due to ground cover by grasses and rock cover.

- Vegetation within the channel included tall reeds observed in the upstream reaches of the watercourse where the channel was deeper. The photo at Location J (refer to **Figure 3.2** and **Appendix C**) shows the vegetation upstream within the watercourse channel.

- Rocks ranging in diameter from approximately 100 mm – 500 mm observed in the downstream reaches of the channel and along the banks of the watercourse, where the channel was shallower and wider, as shown in the photo at Location K (refer to **Figure 3.2** and **Appendix C**). The vegetation within the downstream region of Bullamalito Creek is denser, as shown in the photo at Location L (refer to **Figure 3.2** and **Appendix C**), as the watercourse flows into the surrounding floodplain environment where the 4th order unnamed watercourse and Bullamalito Creek converge.

- The channel width varied throughout the length of the watercourse, increasing from approximately 2 – 3 m in the upstream regions of Bullamalito Creek up to approximately 10 m downstream, as shown in the photos at Location M and N (refer to **Figure 3.2** and **Appendix C**).

- At the time of the inspection, a slow flow was observed in the watercourse.

Gundary Creek

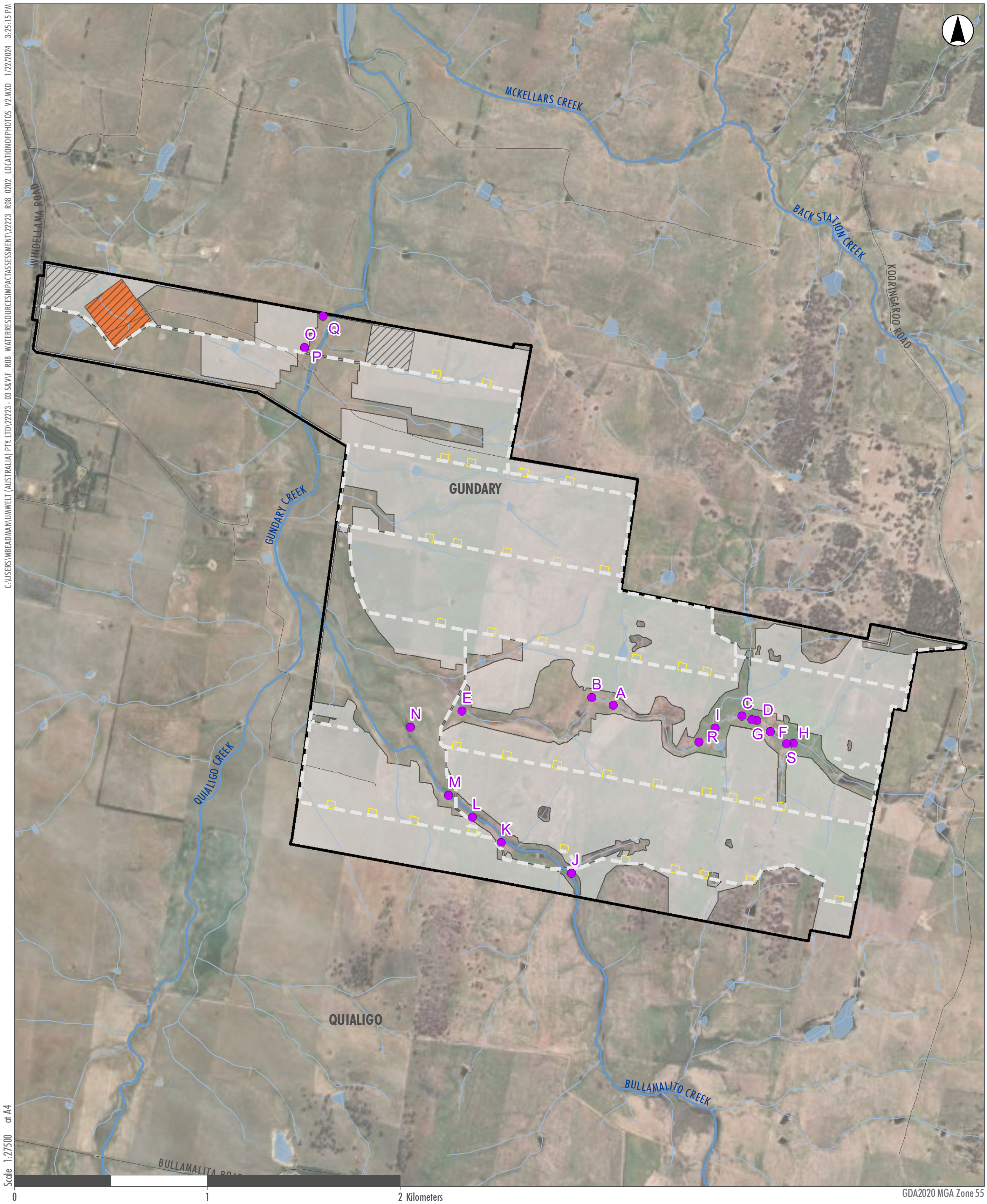
Gundary Creek was unable to be accessed during the site inspection. However, an observation on the general area of the watercourse was undertaken on 18th of April 2023. General observations are noted below:

- At the time of the inspection, water was observed throughout the watercourse channel.

- The topography of the land surrounding the watercourse was observed to be relatively flat, as shown in the photo at Location O (refer to **Figure 3.2** and **Appendix C**).

- Vegetation surrounding the watercourse was observed to be dense grass cover, as shown in the photo at Location P (refer to **Figure 3.2** and **Appendix C**).

- The channel width was observed to be relatively consistent within the Project Area and was approximately 10 m, as shown in the photo at Location Q (refer to **Figure 3.2** and **Appendix C**).



Legend

- Site Inspection Photo Location
- Project Area
- Development Footprint
- Construction Laydown Areas
- Indicative area for Substation, BESS Option 2 (centralised) and Construction Laydown
- Inverter stations (decentralised)
- Access Roads
- Road
- Watercourse (Perrenial)
- Watercourse (Non-perrenial)
- Waterbody

FIGURE 3.2

Location of Photos

Image Source: ESRI Basemap (2022) Data source: NSW DFSI (2021); Lightsource BP (2022); NSW DPIE (2020)

3.1.2 Ground Truthing of Watercourses

During the site inspection, the lower stream order watercourses were inspected to determine the presence of defined bed and banks, evidence of flow and geomorphic features and the presence of aquatic/riparian vegetation. In addition, the alignments of the 4th order unnamed tributary of Bullamalito Creek and Bullamalito Creek were checked against the hydroline mapping data. This was undertaken using a Tablet and the application 'Fieldmaps', a geographical information system application which is equipped with GPS tracking and is used on site to identify where hydrolines are located and to record locations of where photos are taken. The *Water Management Act 2000* defines waterfront land as being within 40 m of the top of bank of a watercourse and imposes constraints on development on waterfront land.

The channel bed and banks of hydrolines which flowed directly into the 4th order unnamed watercourse and Bullamalito Creek were inspected during the site inspection. Some stream alignments and confluence locations did not correspond with the mapped hydrolines, such as the stream draining from the northwest into Bullamalito Creek as presented in **Figure 3.3** and Location R in the site inspection photos (refer to **Figure 3.2** and **Appendix C**). However, the majority of the hydrolines mapped within the Project Area were observed to be present on the mapped alignment, with clearly defined bed and banks, as shown in Location S in the site inspection photos (refer to **Figure 3.2** and **Appendix C**).

Legend

- Project Area
- Development Footprint
- Inverter stations (decentralised)
- Access Roads
- Ground-truthed Confluence Location
- Watercourse (Non-perrenial)
- Waterbody

FIGURE 3.3

Comparison of the Hydroline Mapping and Location of Watercourse

Image Source: ESRI Basemap (2022) Data source: NSW DFSI (2021); Lightsource BP (2022); NSW DPIE (2020)

3.2 Climate

The closest active Bureau of Meteorology (BoM) daily rainfall gauge to the Project Area is Goulburn Airport AWS (Gauge 070330), approximately 3.5 km to the northwest of the Project Area. Given the proximity of the gauge to the Project area, the recorded data is considered representative of the local region rainfall patterns. The period of record for the Goulburn Airport AWS gauge covers a continuous record of 28 years from 1994 to 2023, with consistent daily records starting in 1996.

Climate data was obtained from the SILO database of historical climate records for Australia hosted by the Queensland Government's Department of Environment and Science (DES). This service interpolates raw rainfall and evaporation records obtained from the Bureau of Meteorology (BOM) to provide a spatially and temporally complete climate dataset. Climate data was obtained for SILO grid point -34.85 Latitude and 149.80 Longitude which is the grid point closest to the Project Area between 01/01/1900 to 31/12/2022.

Table 3.1 and **Table 3.2** present the annual and monthly rainfall and evaporation statistics based in the Project Area climate data sourced for SILO grid point -34.85 Latitude and 149.80 Longitude.

Table 3.1 Annual Rainfall and Evaporation (mm), 1900 to 2022

Statistic	Rainfall	Evaporation
10^{th} percentile	453	1110
50^{th} percentile	630	1216
90^{th} percentile	901	1343
Average	656	1230

Table 3.2 Monthly Average Daily Rainfall and Evaporation (mm), 1900 to 2022

Month	Rainfall	Evaporation
January	2.0	5.9
February	2.0	4.9
March	1.9	3.9
April	1.5	2.5
May	1.5	1.6
June	1.8	1.1
July	1.5	1.2
August	1.7	1.9
September	1.6	2.9
October	2.0	3.8
November	2.0	4.9
December	1.9	5.7

3.3 Soils

3.3.1 Soil Landscapes

Soil landscape mapping is sourced from the Seed Dataset provided by the Department of Planning and Environment (2021). A review of the dataset indicates the majority of the Project Area is located within the 'Bullamalita', 'Collector Creek' and 'Gundary' soil landscapes. There are no known occurrences of acid sulfate soils (ASS) within the Project Area (Hird, 1991). The soil landscapes at the site are shown in **Figure 3.4**.

The 'Bullamalita' soil landscape covers an area of 160 km^2 of undulating rises and valleys between low hills (Hird, 1991) and is prone to moderate to severe gully erosion, with moderate sheet erosion. The soil landscape drainage capacity is poor due to the high water-holding capacity of the soil. This landscape, which tends to be hard setting upon drying, provides for a localised flood hazard (Hird, 1991).

The 'Collector Creek' soil landscape is located within the eastern region of the Project Area and consists of "moderately deep, grey and yellow mottled duplex soils" (Hird, 1991). Soil erosion within the landscape includes stream bank erosion, as well as gully erosion of drainage lines. Similarly to the 'Bullamalita' soil landscape, the 'Collector Creek' soil landscape drainage capacity is very poor due to the high water-holding capacity of the soil, as well as being hard setting upon drying, providing for a localised flood hazard (Hird, 1991).

The 'Gundary' soil landscape consists of "moderately deep, acid or neutral, red, orange or yellow duplex soil" (Hird, 1991). Soil erosion within the landscape is low, with gully erosion of drainage lines being insignificant, and sheet and wind erosion expected to occur following drought periods (Hird, 1991). The drainage capacity of the soil landscape is moderate to poor with moderate water-holding capacity and is considered to have a localised flood hazard (Hird, 1991).

The site inspection (detailed in **Section 3.1.1**) identified existing erosion occurring along the banks of the watercourse alignments and drainage lines and is consistent with the characteristics described within each of the soil landscapes.

Refer to the Soil, Land and Agriculture Assessment report (Minesoils, 2024) for more information on the soils, issues identified and recommended management measures.

3.3.2 Modelled Soil Properties

Table 3.3 presents the modelled soil properties for the Project Area, sourced from the SEED Database (DPE, 2021).

Table 3.3 Modelled Soil Properties

Parameter	Value	
	0 – 30cm Depth	30 – 100cm Depth
Soil Erodibility, k factor (as used in the Revised Universal Soil Loss Equation (RUSLE))	0.048 – 0.07	
Clay Percentage	15 – 25%	28 – 48%
Silt Percentage	13 – 32%	13 – 21%

Parameter	Value	
	0 – 30cm Depth	30 – 100cm Depth
Sand Percentage	43 – 66%	30 – 50%
pH (CaCl2)	4.6 – 5.2	4.8 – 5.7
Electrical Conductivity (dS/m)	0.04 – 0.10	0.03 – 0.12
Cation Exchange Capacity (cmolc/kg)	6 – 13	7 – 14
Soil Organic Carbon	1 – 2%	0.36 – 0.68%
Exchangeable Sodium Percentage (ESP)	2.2 – 5.4%	2.6 – 6.9%

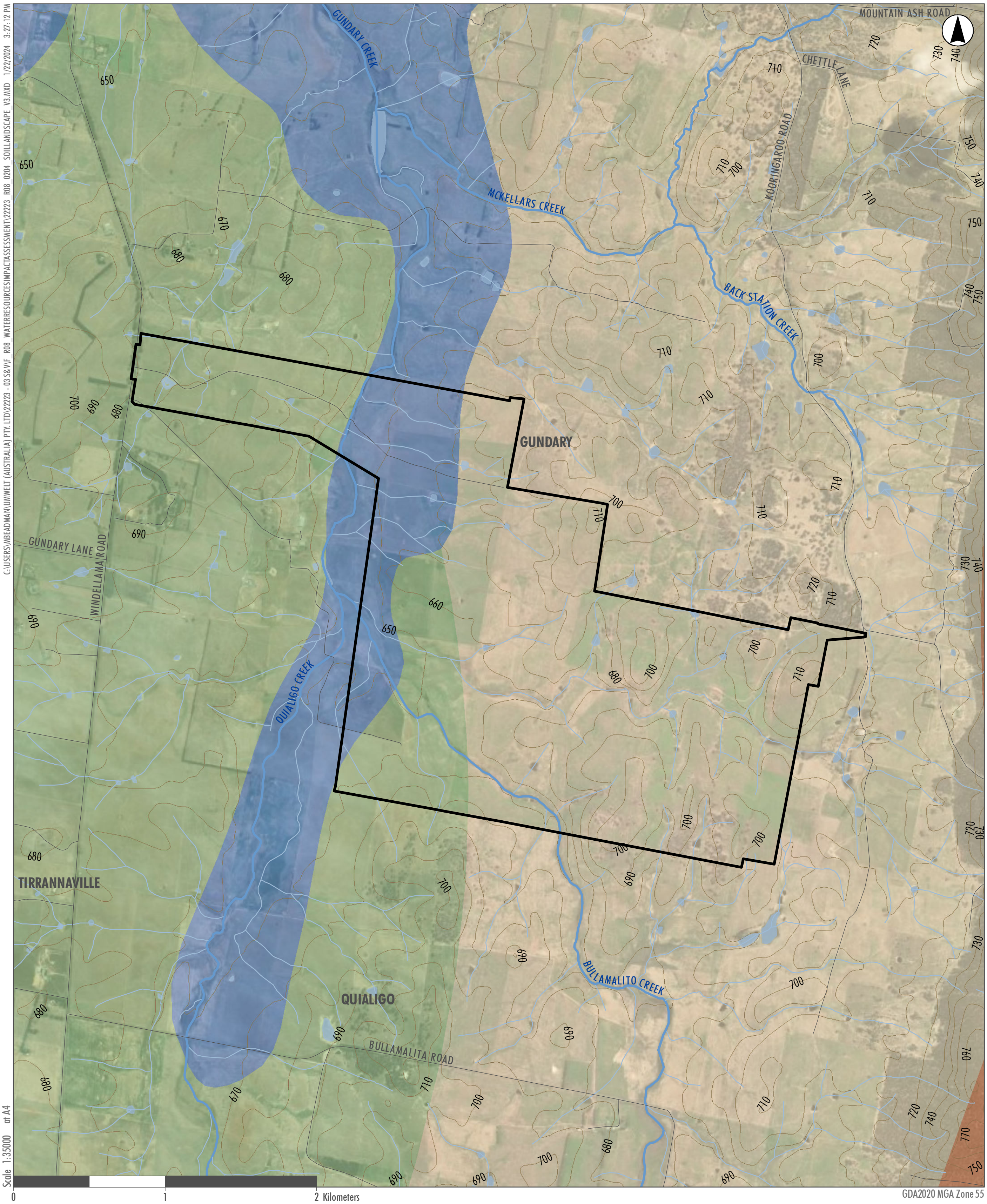
The parameters presented in **Table 3.3** indicate the Project Area soil:

- May have a coarse texture in the topsoil and subsoil.
- Are moderately to highly erodible.
- Are moderately acidic in the topsoil and subsoil.
- Are non-saline.
- Are considered to be non-sodic in the topsoil, with an ESP <6%. Subsoils are considered sodic, with ESP >6% and are expected to be dispersive.

Minesoils Pty Ltd (Minesoils) has conductied a Soil and Agricultural Impact Assessment of the Project Area (2024). A soil survey undertaken by Minesoils found the Project Area to contain three dominant soil mapping units:

- Soil Unit 1: Sodosols – covering 570 ha.
- Soil Unit 2: Chromosols – covering 87 ha.
- Soil Unit 3: Dermosols – covering 45 ha.

Site observation and laboratory testing results indicate there is moderate to very high potential risk for dispersion of the subsoils of Soil Unit 1, and moderate to high potential risk for dispersion of the subsoils of Soil Unit 3 (Minesoils, 2024). Soil Unit 2 presents a negligible to moderate potential dispersion risk and is generally non-sodic, however, caution must be taken over the entire Project Area including Soil Unit 2 despite the range in chemical and physical properties or landscape location of specific soil test sites, as this unit also displays sodicity and moderate dispersion risk in the lower profile at one test site. Direct disturbance activities such as where earthworks are necessary for construction of hard stands or site facilities are therefore very likely to result in increased dispersive behaviour when soil is remoulded, compacted or pulverised. Notwithstanding, there is a high level of confidence regarding the Project activities, surface disturbance requirements and erosion and sediment control management options available to mitigate this risk (Minesoils, 2024).



Legend

- Project Area
- Road
- Contours (10m)
- Watercourse (Perrenial)
- Watercourse (Non-perrenial)
- Waterbody

Soil Landscapes

- Bullamalita
- Collector Creek
- Gundary
- Midgee

FIGURE 3.4

Soil Landscape

Image Source: ESRI Basemap (2022) Data source: NSW DFSI (2021); Lightsource BP (2022); NSW DPIE (2020)

3.4 Water Quality

3.4.1 NSW Water Quality Objectives

The NSW Water Quality Objectives (WQOs) have been developed to guide plans and actions to achieve healthy watercourses. The WQOs are based on measurable environmental values (EVs) for protecting aquatic ecosystems, recreation, primary industries, drinking water and industrial water. There are no specific WQOs for the Hawkesbury-Nepean catchment. In the absence of regionally defined objectives, the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC & ARMCANZ, 2000) was assessed to provide a guide for the WQOs for the Project Area. The WQOs have been developed to achieve suitable water quality for the protection of:

- aquatic ecosystems
- visual amenity
- primary and secondary contact recreation
- livestock water supply
- irrigation water supply
- homestead water supply
- drinking water
- aquatic foods.

Based on the likely construction activities and operations for the Project and the environmental values listed above, the water quality objectives presented in **Table 3.4** are considered relevant to the Project.

Table 3.4 Project Relevant Water Quality Objectives

Parameter	Units	Value/Range
pH	-	6.5 to 8.0
Salinity (Electrical conductivity)	µS/cm	30 to 350
Turbidity	NTU	2 to 25
Total Phosphorus	µg/L	20
Total Nitrogen	µg/L	250
Visual clarity and colour	-	Natural visual clarity should not be reduced by more than 20 %. Natural hue of the water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50 %.
Surface films and debris	-	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter.

3.4.2 Neutral or Beneficial Effect on Water Quality

As indicated in **Section 3.1** the Project is located within the Sydney drinking water catchment and as such must have a Neutral or Beneficial Effects (NorBE) on water quality.

Neutral or Beneficial Effect on Water Quality Assessment Guideline (WaterNSW, 2022) indicates that a development is considered to have a NorBE on water quality if the development:

a. has no identifiable potential impact on water quality, or

b. will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or

c. will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority.

An assessment of the potential impact on water quality is presented in **Section 7.1.2** and considers the estimated pre- and post-development (operational phase of the Project, not construction) pollutant concentrations and loads in stormwater discharging from the Project Area based on water quality modelling (refer to **Section 5.0**).

3.5 Water Extraction

Water Sharing Plans (WSPs) have been developed under the *Water Management Act 2000* to protect the environmental health of water sources, whilst securing sustainable access to water for all users. The WSPs specify maximum water extractions and allocations and provide licensed and unlicensed water users with a clear picture of when and how water will be available for extraction.

- Surface water within the region of the Project Area is managed under the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2023, for the Mulwaree River Water Source, within the Upper Nepean and Upstream Warragamba Extraction Management Unit (DPE, 2023).

- Groundwater within the region of the Project Area is managed under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2023 for the Lachlan Fold Belt Greater Metropolitan Groundwater Source (DPE, 2023).

3.6 Water Users

Licensed surface water users potentially impacted by the Project are located within the Mulwaree River water source. A search of the NSW Water Register indicates that for the 2021/2022 financial year there were 27 Water Access Licences (WALs) with a total of 1,226 unit shares allocated in the Upper Nepean and Upstream Warragamba Management Area, for the Mulwaree River water source. There are no WALs allocated for the Mulwaree River water source on the land which the Project is located or immediately downstream of the Project Area.

There is one WaterNSW registered groundwater bore (GW068697) within the Project Area located within the southern region of the Project Area on Lot 1 DP 870101 (refer to **Figure 3.5**). The bore is described as being drilled to 30 m in depth with a standing water level of 21 m below ground level (mbgl), last recorded in 1990 and is used for domestic water supply purposes under the basic landholder rights works approval 10WA115059, for extraction of water from the Lachlan Fold Belt Greater Metropolitan Groundwater Source.

There are five groundwater bores within the vicinity of the Project Area, one to the east (GW115731) with a standing water level of 10 metres below groundwater level (mbgl), and three to the southwest (GW037097, GW104082, GW110622), with drilled depths greater than 50 m (refer to **Figure 3.5**). The standing water level for GW110622 was last recorded as 22 mbgl in 2009. The purpose of these bores is indicated as for stock and domestic usage.

3.7 Groundwater

3.7.1 Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) are present within the Project Area, along the channels of Bullamalito Creek and Gundary Creek. These are aquatic GDEs, recorded as high potential from a national assessment (DPE, 2012), as shown on **Figure 3.5**. There are also a high potential terrestrial GDE approximately 670 m east of the Project Area.

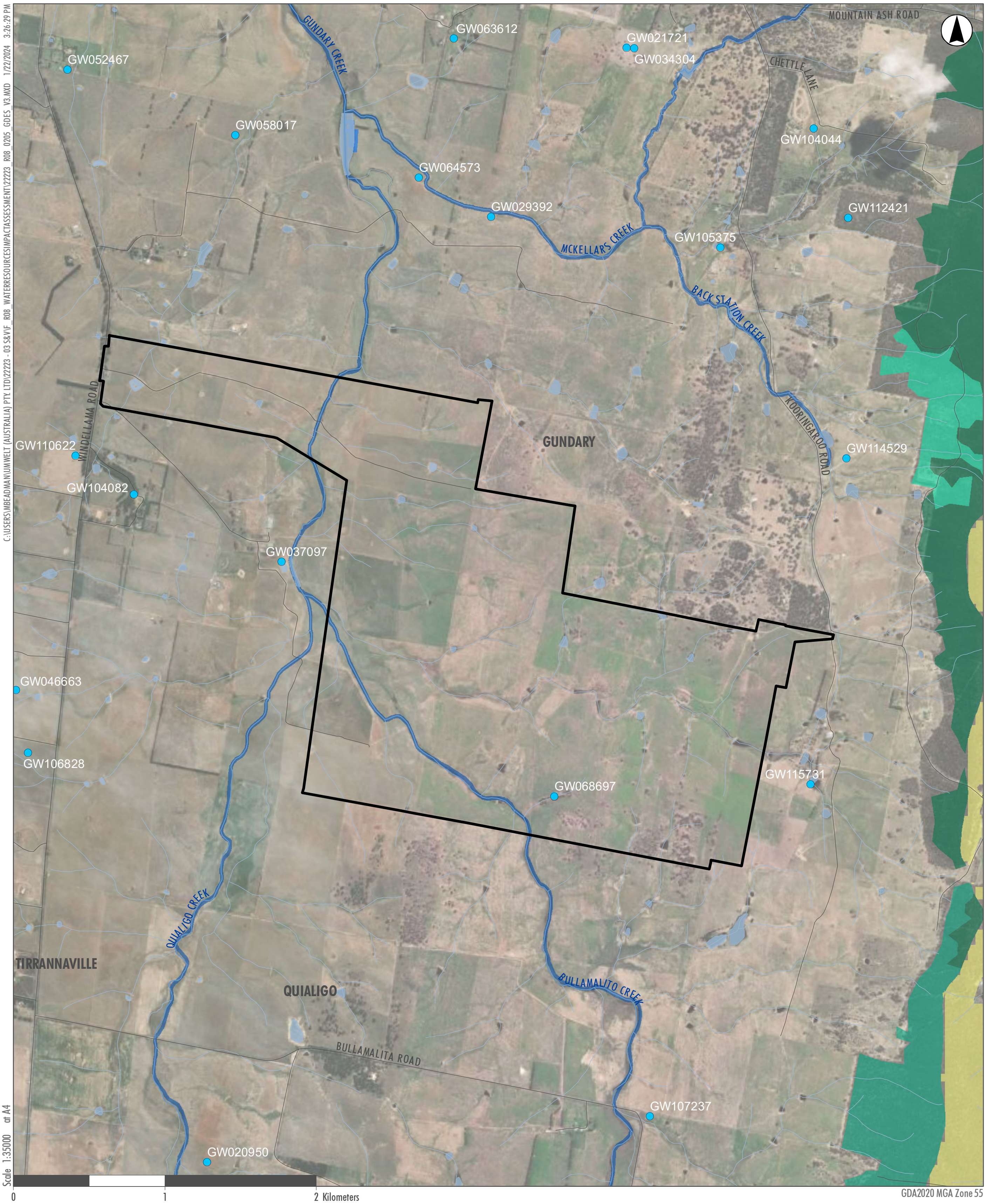
It is considered that within the Lachlan Fold Belt Greater Metropolitan Groundwater Source, the risk to GDEs associated with a change in groundwater levels on GDEs is high. A reduction in groundwater level(s) or piezometric pressure beyond seasonal variation within this region may result in the permanent loss of defined habitat types (DPE, 2011).

Impacts to GDEs as a result of the Project is discussed in **Section 7.4**.

3.7.2 Groundwater Vulnerability

Groundwater vulnerability is described by the NSW Government (2023) as the vulnerability or risk of aquifers to contamination, relating to physical characteristics of the location, such as the depth to the water table and soil type.

Mapping provided by the NSW Government (via the SEED portal) was reviewed for groundwater vulnerability within and surrounding the Project Area. There are no groundwater vulnerability areas mapped for the Project Area (DPE, 2014).



Legend

- Groundwater Borehole
- Project Area
- Road
- Watercourse (Perrenial)
- Watercourse (Non-perrenial)
- Waterbody

Groundwater Dependant Ecosystem - Aquatic

- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment

Groundwater Dependant Ecosystem - Terrestrial

- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Low potential GDE - from national assessment
- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies

FIGURE 3.5

Groundwater Dependant Ecosystems and Groundwater Bores

Image Source: ESRI Basemap (2022) Data source: NSW DFSI (2021); Lightsource BP (2022); NSW DPIE (2020)

3.8 Flooding

The Flood Impact and Risk Assessment (**Appendix A**) notes that flooding at Goulburn due to the Wollondilly and Mulwaree Rivers is an infrequent occurrence. No long-term gauge data is available in the region on either river. However, historic newspaper articles indicate that major flood events, known to have caused flooding of properties at Goulburn, occurred in April 1870, July 1900, June 1925, June 1950, October 1959, November 1961 and August 1974. More recently, significant flooding in Goulburn has occurred in August 1990, December 2010, March 2012 and June 2012.

Flooding within the Project Area is not recorded and no anecdotal information, such as surveyed flood debris marks on landmarks such as fencing, were available for the Flood Impact and Risk Assessment (WRM, 2024). Gundary Creek, which drains in the Project Area, is a tributary of the Mulwaree River. Ground levels in the Project Area are about 15 m above the bank level of the Mulwaree River, at the Gundary Creek confluence.

Flooding impacts are discussed in **Section 7.2**.

3.9 Aquatic Habitat

Aquatic habitats within the Project Area are predominantly associated with Gundary Creek and Bullamalito Creek, including their unnamed ephemeral tributaries and farm dams across the Project Area. The watercourses throughout the Project Area are degraded as a result of the historical and current agricultural practices.

Under the fish habitat classes and types in accordance with the *Policy and guidelines for fish habitat conservation and management* (DPI 2013), the habitat has been assessed as Type 3, Class 3 (minimal key fish habitat) as the watercourses are ephemeral tributaries with intermittent flow and sporadic refuge for aquatic fauna.

Gundary Creek and Bullamalito Creek are mapped as Key Fish Habitat, with the fish status for Gundary Creek being mapped as ‘poor’ on the Fisheries NSW Spatial Data portal (DPI, 2024).

Impacts to aquatic habitat, including Key Fish Habitat, as a result of the Project are discussed in **Section 7.5**.

4.0 Water Resources Management

4.1 Erosion and Sediment Control

Throughout the construction phase of the Project, erosion and sediment controls (ESCs) will be established in general accordance with *Managing Urban Stormwater – Soils and Construction Volume 1* (Landcom, 2004) and *Volume 2C: Unsealed Roads* (Department of Environment and Climate Change, 2008) (i.e. the 'Blue Book'). The following sections outline the Project ESC design standards and anticipated ESCs to be implemented at the Project. Should the Project be approved and constructed, a detailed construction soil and water management plan (CSWMP) will be prepared by a suitably qualified person to facilitate implementation of best practice ESCs during all phases of the Project.

4.1.1 Design Standard

4.1.1.1 Erosion Controls

An erosion hazard assessment has been undertaken in accordance with Chapter 4.4.1 of Volume 1 of the 'Blue Book'. The R-factor (rainfall erosivity) for the site was calculated using Equation (2) in Appendix A of Volume 1 of the 'Blue Book':

$$R = 164.74 \times 1.1177^{S} \times S^{0.6444}$$

where

S	**is the 2 year, 6 hour duration storm event intensity (based on Australian Rainfall and Runoff 1987 Intensity Frequency Duration data)**	**7.09 mm/h**

$$R = 164.74 \times 1.1177^{7.09} \times 7.09^{0.6444}$$

$$R = 1{,}281$$

The erosion hazard calculated for the entire Project Area is 1,281. Plotting the site slope using contours, measured to be approximately 3% and the R-factor on *Figure 4.6* from *Volume 1* of the 'Blue Book' determines whether the site has a high or low erosion hazard. The Project Area slope was estimated based on the geospatial analysis to determine the average site slope of the existing landform. **Figure 4.1** presents the erosion hazard assessment plot for the Project Area demonstrates that the site has a low erosion hazard. As such, standard erosion control measures (refer to **Section 4.1.2**) will be applied during construction.

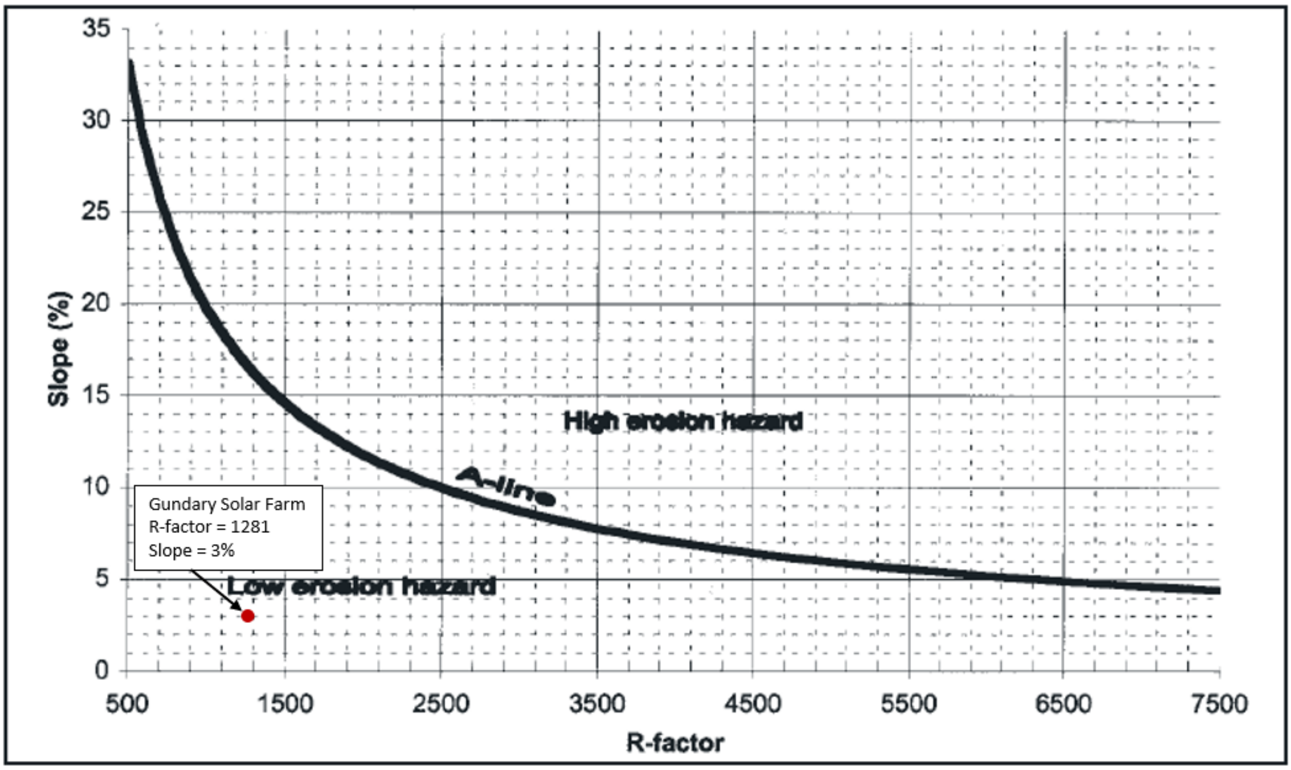


Figure 4.1 Erosion Hazard Assessment Plot

The annual soil loss for the Project Area has been estimated using the Revised Universal Soil Loss Equation (RUSLE) and *Table 4.2* of *Volume 1* of the 'Blue Book, as presented below.

RUSLE:

$$A = R \times k \times LS \times C \times P$$

where

		Value	Units
A	is the annual soil loss rate	to be calculated	tonnes/ha/year
R	is the annual average rainfall erosivity calculated based on the 2 year, 6 hour duration ARI storm event intensity (refer to **Section 4.1.1.1**)	1,281	-
k	is the soil erodibility (increased by 20% due to dispersive subsoil, refer to **Table 3.3**)	0.084	-
LS	is the slope length gradient factor based on Table A1 of *Managing Urban Stormwater Volume 1* (Landcom, 2004) and is dependent on the slope length	0.65	-
C	is the ground cover factor sourced from Figure A5 of *Managing Urban Stormwater Volume 1* (Landcom, 2004) (no ground cover in this case)	1.0	-
P	is the erosion control practise factor sourced from Table A2 of *Managing Urban Stormwater Volume 1* (Landcom, 2004) and is	1.3	-

dependent on level of compaction and roughness of the disturbed surface (assume compacted and smooth)

$$A = 1{,}281 \times 0.084 \times 0.65 \times 1.0 \times 1.3$$

$$A = 91\,\frac{tonnes}{ha.year}$$

According to *Table 4.2* of *Volume 1* of the 'Blue Book' the Project Area has a soil loss class of 1, a very low erosion hazard. *Figure 4.9* of *Volume 1* of the 'Blue Book' (Landcom, 2004) shows that the Project Area is located in rainfall distribution zone 7. *Table 4.3* of *Volume 1* of the 'Blue Book' indicates that no timing restrictions apply for sites in rainfall distribution zone 7 with soil loss class 1.

However, all waterfront land (i.e. land within 40 m of the top of bank of a defined watercourse) is considered by the 'Blue book' to be of soil loss class 6, have a very high erosion hazard and therefore timing restrictions apply to any works on these lands. **Table 4.1** presents the recommended timing restrictions for soil loss class 6 lands in rainfall distribution zone 7 adapted from the *Table 4.3* of the 'Blue Book'.

Table 4.1 Timing Restrictions for Soil Loss Class 6 Lands in Rainfall Distribution Zone 7[1]

Half of Month	1st	2nd
January	Yes	Yes
February	Yes	Yes
March	Yes	Yes
April	No	No
May	No	No
June	No	No
July	No	No
August	No	No
September	No	No
October	Yes	Yes
November	Yes	Yes
December	Yes	Yes

[1] *Adapted from Table 4.3 of Managing Urban Stormwater Volume 1 (Landcom, 2004) for rainfall Distribution Zone 7*

Where scheduling of works during high rainfall erosivity is not possible or is impractical, erosion control measures should be implemented to ensure disturbed lands have C-factors less than 0.1 (i.e. more than approximately 60% ground cover) when the three day forecast indicates that rain is likely. Management regimes should be established to ensure that the site can be stabilised (i.e. C-factor 0.1 or less) within 24 hours if the forecast is incorrect.

4.1.1.2 Drainage Controls

All temporary drainage controls are to be designed to have non-erosive hydraulic capacity to convey runoff from a 10-year Average Recurrence Interval (ARI) critical duration storm event.

4.1.1.3 Sediment Controls

The 'Blue Book' recommends that sediment basins are used when the soil loss rate exceeds 150 m^3/year (approximately 200 tonnes/year) for the total area to be disturbed. If the disturbance during construction is 2.19 ha or greater, the Project may be required to implement sediment basins for the construction works. However, the use of sediment basins will depend on the practicality of draining disconnected disturbed areas of less than 2.19 ha to a sediment basin (i.e. if the disturbed areas are distributed across catchments where the topography does not facilitate drainage to a single sediment basin).

For discrete works areas where greater than 2.19 ha is to be disturbed, sediment basins should be installed. The design standard for sediment basins for the Project Area (based on Blue Book design criteria) assuming fine/dispersive soils (worst case) and a soil hydrologic group of D (worst case, high runoff potential) is presented in **Table 4.2**.

Table 4.2 Sediment Basin Design Standard

Basin Type	Duration of Disturbance	Storm Event[1]	Storm Event Rainfall Depth (mm)[2]	Volumetric Runoff Coefficient (Cv)[3]	Sediment Basin Embankment & Spillways	Sediment Zone Capacity
D	< 6 months	5 day 80th percentile	17.8	0.39	20-year ARI	6 months soil loss as calculated by RUSLE
D	6 - 12 months	5 day 85th percentile	22.2	0.50	50-year ARI	

[1] *Based on a sensitive receiving environment*
[2] *5 day rainfall depth sourced from Table 6.3a of the 'Blue Book' Volume 2C (DECC, 2008)*
[3] *Refer to Table F2 of Volume 1 of the 'Blue Book'*

All temporary sediment controls will be designed and installed to be structurally sound during a 10-year ARI critical duration storm event.

4.1.2 General Erosion and Sediment Control Strategy

All ESCs are to be installed, managed and maintained in general accordance with the 'Blue Book' Volume 1 (Landcom, 2004) and Volume 2C (DECC, 2008) to:

- divert clean water around site
- prevent sediment moving off-site and sediment laden water entering any watercourse, drainage line, or drain inlet
- reduce water velocity and capture sediment on site
- minimise the amount of material transported from site to surrounding pavement surfaces.

4.1.2.1 General Site Management

The following ESC management strategies will be implemented at the Project:

- To minimise ground disturbance, construction and operational activities including vehicle and machinery movements, stockpiling, temporary vehicle parking and material laydown will be restricted to designated work areas. The disturbance boundary is to be clearly delineated with construction fencing or barrier tape.
- All fuels, chemicals and liquids will be stored in an impervious bunded area, a minimum of 50 m away from drainage lines or watercourses.
- Refueling of plant and equipment is to be undertaken in an impervious bunded area located a minimum of 50 m from drainage lines or watercourses.
- Emergency spill kits are to be kept on site at all times. All workers are to be made aware of the location of the spill kits and trained in their use.
- Any concrete washout undertaken on site (during construction phase) will be in a bunded area that is not on waterfront land and at least 10 m from drains.
- Where possible, topsoil will be stripped and handled only when it is moist (not wet or dry) to avoid decline of soil structure.
- Topsoil stockpiles will be stabilised with vegetation (seeded) if they are to be inactive for long periods.
- Stockpiles of erodible material that have the potential to cause environmental harm if displaced will be located away from concentrated surface flow and excessive up-slope stormwater surface flows.
- Wherever reasonable and practicable, “clean” surface waters must be diverted away from sediment control devices and any untreated, sediment-laden waters.
- All runoff from the works is to be passed through sediment controls.
- Sediment traps should be located as close to the source of the sediment as practicable.
- Sediment control devices must be de-silted and made fully operational as soon as reasonable and practicable after a sediment-producing event. Sediment traps should be maintained to ensure that no more than 30% of their design capacity is lost to accumulated sediment.
- Sediment removed from any trapping device is to be disposed of in locations where further erosion and consequent pollution to downslope lands and watercourses will not occur.
- Temporary soil and water management structures are to be removed only after the Project Area is stabilised appropriately (i.e. a c-factor of 0.05 or greater, equivalent to 70% permanent vegetation cover, is achieved across the catchment).

4.2 Construction on Waterfront Land

As a SSD, the Project, if approved, will be exempt from the requirement to acquire Controlled Activity Approvals (CAAs) for works on waterfront land (works within 40 m of the top of bank of a watercourse) under s.4.41(1)(g) of the *Environmental Planning and Assessment Act 1979*.

Notwithstanding the exemption from requiring CAAs, all works on waterfront land (where required) will be undertaken in accordance with DPEs *Guidelines for Controlled Activities on Waterfront Land.*

There are both ephemeral and perennial streams traversing the Project Area (refer to **Section 3.1** and **Figure 3.1**). While the Project layout has been designed to avoid works on waterfront land within the Project Area, associated with second order and higher streams, a number of watercourse crossings will be required to facilitate access across the Project Area. Watercourse crossings will be designed to minimise impacts on stream stability and fish passage and will be designed with reference to the following documents in addition to DPEs *Guidelines for Controlled Activities on Waterfront Land*:

- *Why Do Fish Cross the Road? Fish Passage Requirements for Waterway Crossings* (NSW Department of Primary Industries (DPI) Fisheries, 2003).
- *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (NSW DPI, 2013).

Where works on waterfront land is required, the following measures will be incorporated into the design of the works and controls included in the Soil and Water Management Plan:

- A site-specific erosion and sediment control plan will be prepared for all works on waterfront land.
- Where practicable, infrastructure will be maintained outside of the vegetated riparian zone.
- Utilise stream crossings for co-location of services to avoid the need to trench through stream beds wherever practicable.
- Rehabilitate disturbed areas and provide scour protection to bed and banks as required to mitigate any areas with increased potential for erosion due to changes in flow regimes associated with Project infrastructure.
- Where practicable, undertake works on waterfront land during periods of low rainfall erosivity from April to September when construction timing restrictions are recommended (refer to **Table 4.1**).

Umwelt sought to consult with DPI Fisheries during the early stages of the EIS, however no response was received. DPI Fisheries will be consulted further throughout the assessment process. In addition to this, during detailed design, consultation will be undertaken with DPI Fisheries to determine if any of the proposed watercourse crossings require consideration of fish passage. For any crossings that do require consideration of fish passage, the relevant DPI Fisheries guidelines will be considered during the detailed design process.

Project infrastructure (excluding required watercourse crossings) will be located outside of the riparian corridor in accordance with *Controlled activities – Guidelines for riparian corridors on waterfront land* (DPE, 2022).

4.3 Water Supply and Licensing

The Project will require a water supply during the construction, operational and decommissioning phases. During construction, water would primarily be used for the establishment of hard-standing areas (linking to compaction requirements) and dust suppression.

The associated water demand would likely be in the order of 12.26 megalitres (ML) for the 18-24 month construction period. Water for construction would be sourced from commercial suppliers in the nearby region (via water trucks) and farm dams located within the Project Area, if required. Whilst the preference is for commercial water supply, water sources would be confirmed prior to the commencement of construction in consultation with Council, suppliers and landholders. Town water supplies will be generally avoided for use in construction but may be used where appropriate and available. It is anticipated that during construction 3,000 L would be used on site daily at the construction compound.

During operations, approximately 3 ML of water per year would be required for ongoing maintenance activities such as firefighting, amenities and potable purposes by operational staff, and washing of the PV solar panels, if required. Washing of the panels would not require any detergent or cleaning agents. A static water supply (i.e. two water tanks each with a minimum capacity of 40,000 L, one at each access point, and additional 10,000 L tanks distributed throughout the site at strategic points) would also be established and maintained for fire protection. Water for construction and operational phase demands will be supplied from one or a combination of the following sources:

- Commercial suppliers in the nearby region via water truck (preferred).
- The existing groundwater bore within the Project Area (refer to **Section 3.6**).
- Farm dams within the Project Area.
- Goulburn Mulwaree Council.

Any water supplied to the Project from the existing groundwater bore or farm dams will be sourced under agreement with relevant landholders while ensuring any WALs, works approvals and water use approvals required under the WM Act (2000) are obtained.

There are up to 24 small man-made farm dams within the Project Area used for livestock watering. The aggregate capacity of the farm dams has been estimated to be approximately 48 ML using aerial imagery (to estimate aggregate farm dam surface area) and an assumed average depth of 1.2 m. Water from harvestable rights dams with a capacity of up to 10% of the average annual runoff for the landholding in coastal draining catchments may be used for any purpose. The Maximum Harvestable Right Dam Capacity (MHRDC), from which water can be used for any purpose (i.e. MHRDC based on 10% of average annual runoff), for the Project Area landholding is 49.56ML. As such, any water sourced from the existing harvestable rights dams within the Project Area will not require licensing unless the aggregate capacity of the dams is increased to above 49.56 ML.

Water sources would be confirmed prior to the commencement of construction in consultation with Council, suppliers and landholders. Town water supplies will generally be avoided for use in construction but may be used where appropriate and available. It is anticipated that during construction 3,000 L of potable water would be used on site daily at the construction compound for amenities.

There is no discharge of water proposed as part of the Project.

4.4 Amenities Wastewater

There is no sewer access in the Project Area. For the construction phase, an on-site amenities sewer disposal system will be provided, which would be collected in a tank and removed by a licensed waste contractor to the nearest sewage treatment facility, or as agreed with Goulburn Mulwaree Council. Lightsource bp or its contractors would consult with Goulburn Mulwaree Council prior to commencement of construction to reach an agreement.

It is likely that a septic system would be installed for the operational amenities. This would be constructed and managed in accordance with the relevant Goulburn Mulwaree Council requirements.

5.0 Water Quality Modelling

5.1 Overview

The water quality assessment for the Project was undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) developed by the Cooperative Research Centre for Catchment Hydrology to estimate the pollutant loads and concentrations in stormwater runoff discharged from the Project catchment prior to and post Project development. The assessment has been undertaken to assess whether the Project will have a NorBE on receiving environment water quality given the Project is located within the Sydney Drinking Water Catchment (refer to **Section 3.4.2**).

MUSIC modelling assumed that the Project Area is an independent sub-catchment, without runoff from surrounding catchments.

5.1.1 NorBE Criteria

Given the uncertainty in MUSIC modelling outcomes, WaterNSW requires modelling to aim for a 10% improvement in post-development pollutant (total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP)) loads on comparison of the pre- and post-development scenarios to demonstrate the NorBE on water quality can be met (WaterNSW, 2023).

Further to the criteria relating to pollutant loads, TN and TP concentrations must be equal to or better compared to the pre-development case for between the 50th and 98th cumulative frequency percentiles over the five year modelling period when runoff occurs.

5.1.2 Meteorological Data

The development is within the Mulwaree River sub-catchment and is indicated as being in Climate Zone 1 in Figure 3.1 of the *Using MUSIC in the Sydney Drinking Water Catchment* (WaterNSW, 2023). The meteorological MUSIC input data file data for Zone 1 was sourced from the WaterNSW website (*https://www.waternsw.com.au/water-services/catchment-protection/councils-and-developers*, 2023).

5.2 Pre-development

MUSIC modelling of the pre-development model was undertaken to estimate the pollutant loads discharged from the five catchments (as indicated in **Figure 5.1** and **Table 5.1**) to the environment downstream of the Project Area for the existing environment.

5.2.1 Catchments

The Project Area has been divided into five catchment areas, corresponding with the drainage channels for the 4th order unnamed tributary of Bullamalito Creek which flows east to west through the Project Area, Bullamalito Creek, lower order tributaries of Gundary Creek (two of the catchments) and Gundary Creek (refer to **Figure 5.1**). These catchments are shown in **Figure 5.1** and catchment areas provided in **Table 5.1**. These catchment areas will be a source for modelling the pre and post development scenarios to represent the appropriate pollutant loads for these areas.

Table 5.1 MUSIC Model Catchments

Catchment	Area (ha)
1	40.50
2	33.74
3	144.12
4	179.30
5	310.38

5.2.2 Land Use

All sub-catchments within the Project Area are considered to be agricultural land use. Agricultural land use source node model parameters adopted for modelling a pre-development scenario are provided in **Table 5.2**.

Table 5.2 Agricultural Land Use Soil and Groundwater Parameters

Rainfall-Runoff Parameters	Value
Soil Storage Capacity (mm)	119
Initial Storage (% of Capacity)	25
Field Capacity (mm)	99
Infiltration Capacity Coefficient - a	180
Infiltration Capacity Coefficient - b	3
Groundwater Properties	Value
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	25
Daily Deep Seepage Rate (%)	0

5.2.3 Results

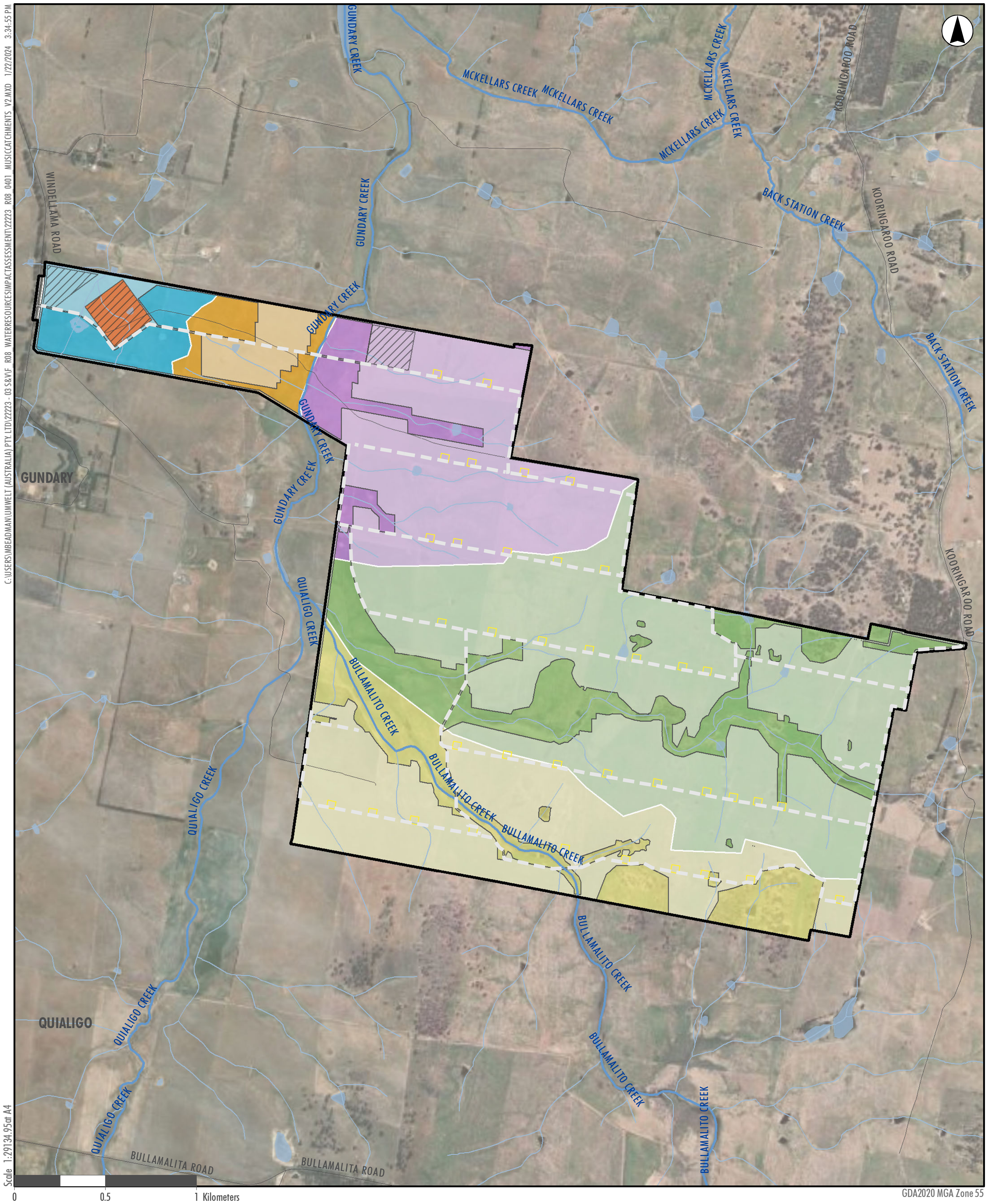
Table 5.3 presents the predicted mean pre-development pollutant loads discharging from the five modelled catchments within the Project Area.

Table 5.3 Pre-development Pollutant Loads

Catchment	Area (ha)	Land Use Type	Mean Annual Pollutant Loads (kg/year)		
			TSS	Total Phosphorus	Total Nitrogen
1	40.5	Agriculture	2970	12.7	66.6
2	33.7	Agriculture	2470	10.6	55.4
3	144.0	Agriculture	1100	47.2	235.0
4	179.3	Agriculture	1370	52.7	295.0
5	310.5	Agriculture	2340	113.0	516.0
Total	**708.0**[1]	**Agriculture**	**10,250**	**236.2**	**1,168.0**

As shown in **Table 5.3** across the five modelled catchments the estimated mean pre-development total suspended solids (TSS) ranges from 1100 kg/year to 2970 kg/year, the estimated mean pre-development total phosphorus ranges from 10.6 kg/year to 113 kg/year and the estimated mean pre-development total nitrogen loads range from 55.4 kg/year to 516.0 kg/year.

[1] It is noted that the MUSIC modelling was conservatively based on a slightly larger Project Area (i.e. 708ha) including a Crown Land paper road to the north of Lot 12/DP1016332.



Legend

- Project Area
- Development Footprint
- Laydown Areas
- Indicative area for Substation, BESS Option 2 (centralised) and Construction Laydown
- Inverter stations (decentralised)
- Access Roads
- Road
- Watercourse (Perrenial)
- Watercourse (Non-perrenial)
- Waterbody

MUSIC Catchments

- Catchment 1
- Catchment 2
- Catchment 3
- Catchment 4
- Catchment 5

FIGURE 5.1

MUSIC Model Catchments

Image Source: ESRI Basemap (2022) Data source: NSW DFSI (2021); Lightsource BP (2022); NSW DPIE (2020)

5.3 Post-development

MUSIC modelling of the post-development scenario was undertaken to estimate the discharged pollutant loads and stormwater discharge concentrations that would be produced from each of the five modelled catchments with inclusion of the proposed Project infrastructure.

5.3.1 Land Use and Stormwater Treatment

Stormwater treatment measures were included in the modelled post-development scenario. **Table 5.4** presents the land use types and associated parameters applied to the post-development infrastructure surfaces (other than agriculture land use type).

Table 5.4 Post-development Land Use Types

Project Design Feature	Applied Land Use Type	Effective Impervious Area	Rainfall Threshold (mm)
Substation, BESS (centralised and decentralised) and inverter substations	Unsealed Road	50%	1.5
Solar Panels	Roof	Variable[1]	0.3
Access Tracks	Unsealed Road	50%	1.5

[1] The majority of the area covered by solar panels does not drain directly to the Project stormwater drainage system. Rainfall running off solar panels to the impervious agricultural land beneath drains via sheet flow to the stormwater drainage system and therefore, only the panels adjacent to the Project stormwater drainage features have been considered and modelled as effective impervious area.

The following stormwater treatment measures were applied within the post-development MUSIC model:

- Vegetated swales along the full length of downslope side of solar panel arrays; and
- Bioretention basins (40 m^2, 0.8 m filter depth, no exfiltration) to treat runoff from the Centralised BESS compound and the sub-station/operations and maintenance facility compound with bioretention discharge draining to vegetated swales.

5.3.2 Catchments

The catchments for the pre-development scenario have been applied to the post-development scenario but with a breakdown into sub-catchments (refer to **Table 5.5**) to account for the different post-development land use types. Catchment areas for access tracks and other permanent infrastructure (e.g. substations, BESS units) were estimated based on the conceptual Project layout with access tracks assumed to be 8 m in width.

Table 5.5 Post-development Catchments

Catchment	Sub-catchment	Area (ha)
1	Access Tracks	0.69
	Substation and Operations and Maintenance Facility	6.24
	Agricultural (not draining to swale)	33.57
Catchment 1 Total		40.50
2	Access Tracks	0.55
	Solar Panels (draining directly to swales)	0.12
	Agricultural (draining to swales)	14.34
	Agricultural (not draining to swales)	18.73
Catchment 2 Total		33.74
3	Access Tracks	3.52
	Decentralised BESS and Inverter Substations	1.33
	Centralised BESS	4.53
	Solar Panels (draining directly to swales)	0.35
	Agricultural (draining to swales)	100.87
	Agricultural (not draining to swales)	33.52
Catchment 3 Total		144.12
4	Access Tracks	3.77
	Decentralised BESS and Inverter Substations	1.99
	Solar Panels (draining directly to swales)	0.81
	Agricultural (draining to swales)	95.77
	Agricultural (not draining to swales)	76.96
Catchment 4 Total		179.3
5	Access Tracks	7.24
	Decentralised BESS and Inverter Substations	2.82
	Solar Panels (draining directly to swales)	1.22
	Agricultural (draining to swales)	209.36

Catchment	Sub-catchment	Area (ha)
	Agricultural (not draining to swales)	89.74
Catchment 5 Total		310.38
Total Catchment		**708.4[2]**

5.4 Pre-development and Post-development Comparison

5.4.1 Pollutant Loads

Table 5.6 presents a comparison of the modelled mean annual pollutant loads for the pre- and post-development (with treatment) scenarios and the estimated percentage reduction in pollutant loads discharged from the Project Area post-development. Modelling predicts reductions in all pollutants for the post-development scenario due to the implementation of treatment train measures (i.e. vegetated swales and bioretention basins as discussed in **Section 5.3.1**), however, the reduction associated with TP is less than 10% which is required by WaterNSW for the comparison of the pre- and post-development scenarios to account for MUSIC modelling uncertainty and demonstrate that a NorBE on water quality can be achieved (WaterNSW, 2023).

As such, additional treatment train measures (not modelled for the purposes of this assessment and examples of which include filtration systems, sediment basins, gross pollutant traps etc) may be required to satisfy NorBE criteria for TP. It is therefore recommended that Project stormwater treatment measures be considered during the Project detailed design phase with a refined MUSIC model that reflects the detailed Project design.

Table 5.6 Pre-development and Post-development Comparison: Mean Annual Pollutant Loads

Pollutant	Pre-development (kg/year)	Post-development (kg/year)	% Load Reduction
TSS	57,600	37,100	35.6
TN	232	162	30.2
TP	1,190	1,110	6.7

5.4.2 Pollutant Concentrations

Figure 5.2, **Figure 5.3** and **Figure 5.4** present comparisons of the predicted TSS, TN and TP concentrations respectively for the pre- and post-development (with treatment) scenarios and indicate:

[2] It is noted that the MUSIC modelling was conservatively based on a slightly larger Project Area (i.e. 708ha) including a Crown Land paper road to the north of Lot 12/DP1016332.

- Post-development TSS concentrations achieve the NorBE criteria of being better than the pre-development scenario between the 50th and 98th percentiles.
- Post-development TN concentrations do not achieve the NorBE criteria of being better than the pre-development scenario between the 50th and 98th percentiles. TN concentrations are better for the post-development scenario above the 82.5th percentile result.
- Post-development TP concentrations do not achieve the NorBE criteria of being better than the pre-development scenario between the 50th and 98th percentiles. TP concentrations are better for the post-development scenario above the 95th percentile result.

As such, additional treatment train measures (not modelled for the purposes of this assessment and examples of which include filtration systems, sediment basins, gross pollutant traps etc) may be required to satisfy NorBE criteria for TN and TP. It is recommended that Project stormwater treatment train measures be considered during the Project detailed design phase with a refined MUSIC model that reflects the detailed Project design.

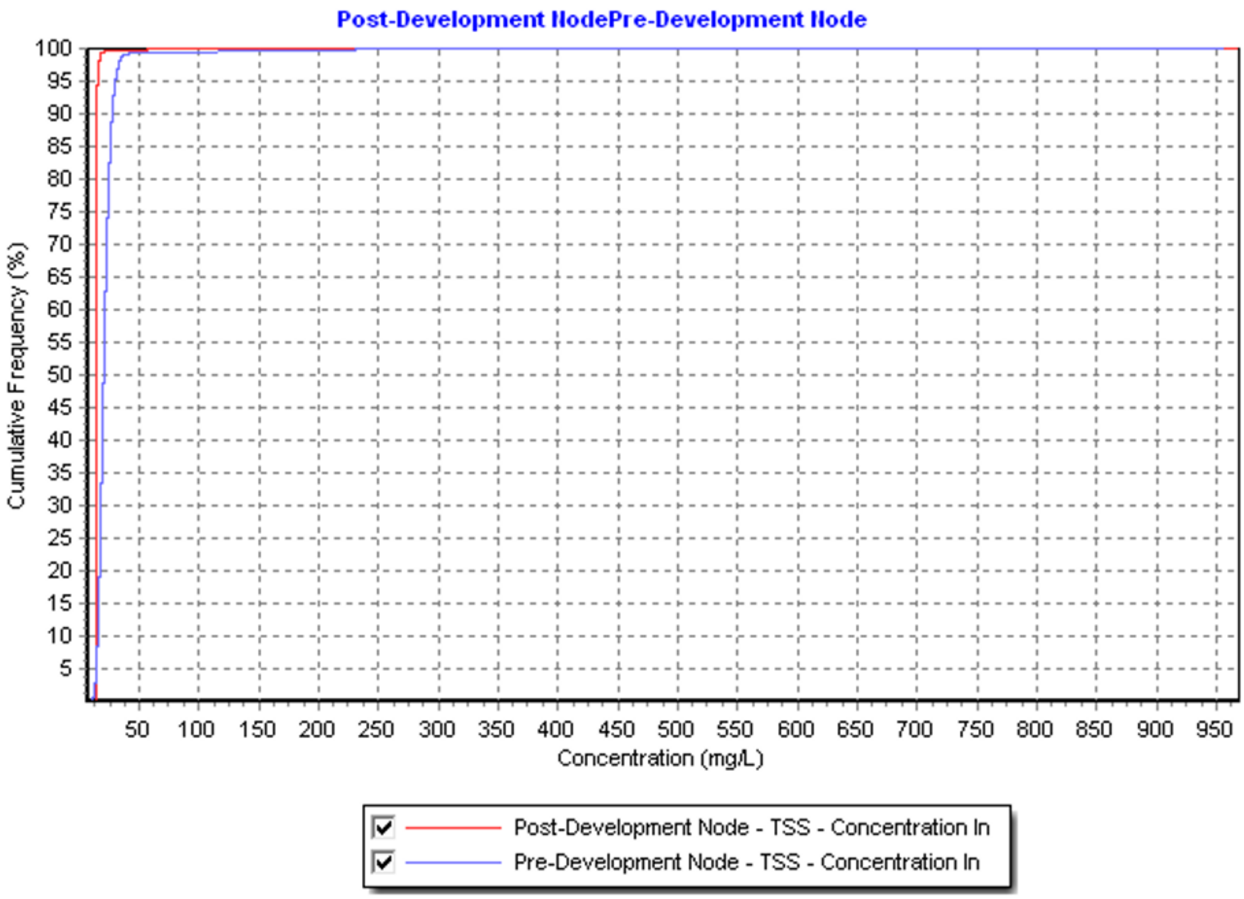


Figure 5.2 Pre-development and Post-development Comparison: Predicted TSS Concentrations

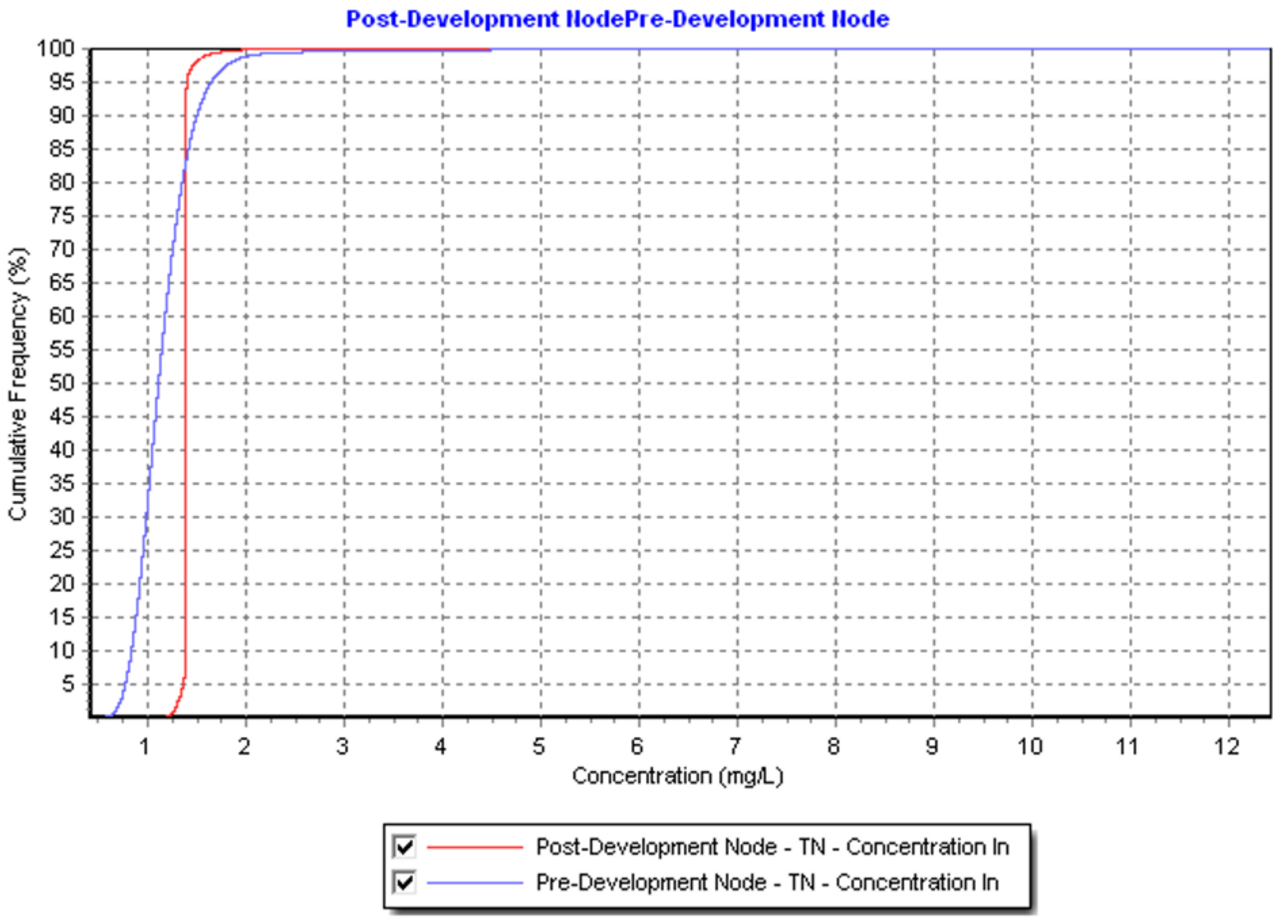


Figure 5.3 Pre-development and Post-development Comparison: Predicted TN Concentrations

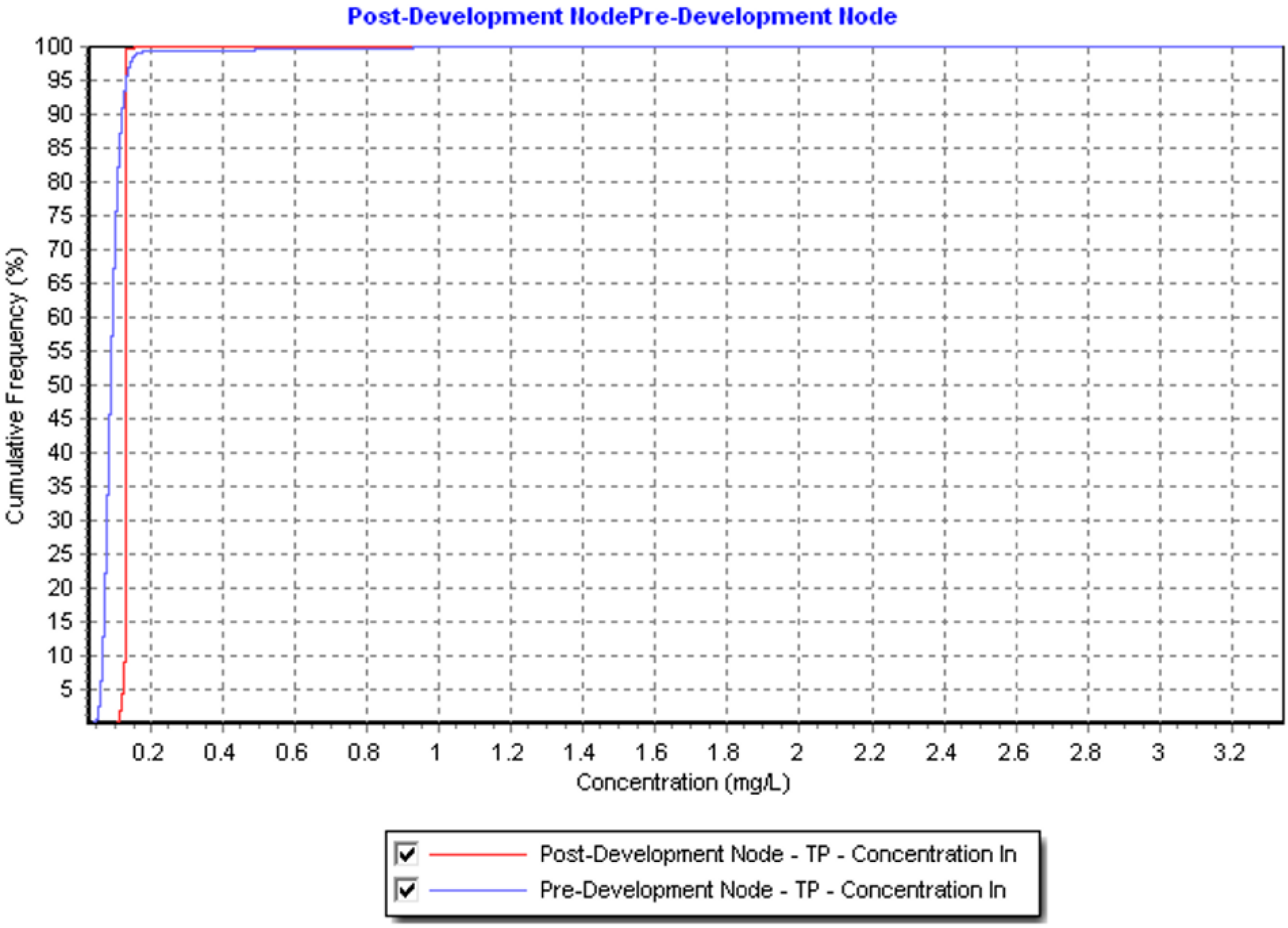


Figure 5.4 Pre-development and Post-development Comparison: Predicted TP Concentrations

6.0 Flood Modelling Methodology

Flood modelling was undertaken as part of a Flood Impact and Risk Assessment by WRM (2024) to identify potential impacts on surface water resources and flood regimes associated with the Project (refer to **Appendix A**). This section summarises the flood modelling methodology, including the approach used to estimate design discharges, and the approach used to develop the hydraulic model.

6.1.1 Estimation of Design Discharges

Design flood discharges and flood levels in watercourses draining the Project Area were estimated using a RORB hydrologic model (detailed below) and a TUFLOW hydraulic model (refer to **Section 6.1.2**). The hydrologic model was used to estimate discharges from the contributing catchments outside the Project Area. Discharges within the Project Area were estimated by applying rainfall directly to a topographic surface developed for the hydraulic model. The hydrologic model was developed using the RORBwin v6.45 (RORB) software. RORB simulates the catchment rainfall-runoff process in the contributing catchments, producing the design discharges used for inflows to the hydraulic model.

Design discharges were determined using the ensemble methodology defined in Australian Rainfall & Runoff (ARR) (Ball et al., 2019). An ensemble of 10 temporal patterns was modelled for each storm duration to derive a range of estimated peak discharges for storms of different severity, represented by an annual exceedance probability (AEP). The storm duration with the highest median peak discharge of the ensemble was selected and the temporal pattern that produces the peak discharge just above the ensemble median is used for design event modelling.

The design discharges were used to select the storm duration producing the maximum discharge (referred to as the critical duration) for each AEP at the downstream boundary of the Project Area on Gundary Creek. The representative event was then used to inform the direct rainfall applied within the hydraulic model domain.

Design discharges were determined for the 10%, 5%, 1%, 0.5% and 0.2% AEPs and the probable maximum flood (PMF) for current climatic conditions. Design rainfall intensities were derived in accordance with ARR. In the absence of site-specific calibration data, the RORB predicted flood discharges were validated using the Regional Flood Frequency Estimation (RFFE) model.

6.1.2 Hydraulic Model Development

The two-dimensional TUFLOW hydraulic model was used to simulate the flow behaviour through the Project Area. TUFLOW represents hydraulic behaviour on a fixed grid by solving the full two-dimensional depth-averaged momentum and continuity equations for free surface flow. TUFLOW has the capacity to represent complex hydraulic structures, floodplain storage and floodplain/channel interaction. The model was compiled and simulated with build version: 2023-03-AA-iSP-w64 using subgrid sampling. The model automatically calculates breakout points and flow direction. An adaptive time step is used by the computational engine to maintain simulation stability.

The hydraulic model was run for the 10%, 1%, 0.5%, and 0.2% AEP design events and PMF for their respective critical durations. The model results were used to assess flooding behaviour for the existing conditions. The existing conditions model was then adapted to represent the proposed developed conditions, to assess the potential extent and magnitude of impacts of the Project.

The results of the flood modelling are discussed in further detail in **Section 7.2**.

7.0 Impact Assessment

The Project has the potential to impact on:

- receiving surface water and groundwater quality
- flood regimes including flow rates, velocities and depths
- soil resources
- available water supply to existing and downstream users
- aquatic habitat and GDEs.

In the absence of appropriate controls, the potential impacts to soil and water resources associated with the Project will involve:

- increased rate of loss of topsoil resource as a consequence of increased erosion during construction and decommissioning (at end of Project life) and during operation should site stabilisation (e.g. soil amelioration, revegetation and other permanent erosion control measures such as rock armouring of drainage channels) be ineffective
- degradation of downstream surface water quality (primarily during construction and decommissioning but also potentially during operation) due to:
  - elevated concentrations of sediment in runoff
  - elevated concentration of nutrients in runoff (primarily associated with nutrients adhered to sediment)
  - chemical spills/leaks entering streams (e.g. diesel fuel or hydraulic oils from mobile plant).
- increased erosion and scour in stream due to:
  - damage to stream bed and bank from construction activities adjacent to and in-stream (e.g., stream crossings)
  - damage to riparian vegetation from construction activities on waterfront land
  - increased runoff volumes due to the increase in impervious areas associated with the Project.
- potential for obstruction of fish passage associated with impact to aquatic habitat, GDEs and construction of stream crossings
- potential for alteration of flood flows and levels due to infrastructure located in close proximity to streams
- loss of catchment yield during construction due to capture of water in sediment dams
- depressurisation of groundwater aquifers and a reduction in bore yields to existing groundwater source users due to project water use (if groundwater is used to supply Project demands)
- degradation of groundwater quality due to chemical spills/leaks during construction

- loss of catchment yield associated with sourcing water (licensed harvesting on-site or via agreement with host or local landholders) to meet construction water demands.

This WRIA has considered and assessed each of these potential impacts and where there is the potential for impacts to occur, has identified appropriate management measures outlined in **Section 8.0** to mitigate these risks.

7.1 Surface Water Quality

7.1.1 Construction and Decommissioning

During construction and decommissioning of the Project, soils would be subject to disturbance, during the removal of vegetation, excavation works and stockpiling of materials, leading to sediments and/or pollutants being entrained in rainfall runoff and entering local watercourses. Discharge of polluted rainfall runoff from the Project has the potential to result in the deterioration of EVs and WQOs (refer to **Section 3.4.1**), for example:

- loss of topsoil resources on the land and ongoing erosion reducing the area of usable land and/or damage to private property for landholders

- water quality in farm dams is impacted and not suitable for stock watering, health or aquatic fauna and flora, as well as increased turbidity and decrease in water quality to downstream watercourses.

With the implementation of erosion and sediment control measures as well as appropriate measures to manage hazardous materials such as oils, fuels and other chemicals (outlined in **Section 4.1.2** and **Section 8.0**) potential construction-related stormwater pollution impacts can be appropriately managed and are expected to be negligible.

During the construction phase, a number of watercourse crossings (via culverts and bed level crossings) would be required within the Project Area to enable access across the site. Watercourse crossings will be designed and constructed in accordance with relevant guidelines and in consultation with DPI Fisheries (refer to **Section 4.2**), the Project watercourse crossings are not expected to result in any measurable impacts to stream health including water quality and fish passage.

With the implementation of measures outlined in **Section 8.0**, the potential water quality impacts would be adequately managed during the Project's construction and decommissioning phases.

7.1.2 Operation

Water quality modelling was undertaken to estimate pre- and post-development stormwater discharge concentrations and loads (refer to **Section 5.0**) for the purpose of determining whether the Project will have a NorBE on water quality. The modelling results indicated that:

- post-development mean annual TSS, TN and TP loads discharged in stormwater would be lower than the pre-development loads discharged with the proposed stormwater treatment train (refer to **Sections 5.3.1** and **5.4.1**).

- while post-development means annual TP loads were lower than pre-development loads, the reduction was <10% and therefore, does not achieve WaterNSW NorBE criteria (refer to **Section 5.1.1**).

- TSS concentrations for the post-development scenario were better than the pre-development scenario between the 50th and 98th percentile results, however, TN and TP concentrations, while lower than pre-development loads, were not and therefore, do not achieve WaterNSW NorBE criteria (of being better than between the 50th and 98th percentile results) (refer to **Section 5.1.1**).

While the water quality modelling indicates that WaterNSW NorBE criteria is not achieved for mean annual TP loads, TN concentrations and TP concentrations, the impacts to receiving water quality downstream of the Project are expected to be negligible provided effective rehabilitation of Project Area disturbance is undertaken post-construction. However, refinement of the MUSIC water quality model will be undertaken during the detailed design phase of the Project to ensure the model reflects the detailed design and to optimise the operational Project stormwater treatment train. An additional measure that will be considered as part of the Project detailed design is to identify eroding gullies within the Project Area and rehabilitating them as part of the Project which will improve post-development stormwater quality.

Other potential water quality impacts during the operational phase associated with the day-to-day activities during this phase would be limited to:

- Stormwater runoff from impervious surfaces resulting in localised erosion.
- Accidental spills or discharge through use and storage of chemicals such as fuel.

The potential for ongoing erosion post construction is considered to be low provided appropriate rehabilitation of disturbed areas is undertaken and any areas identified as exhibiting signs of erosion above expected background levels are addressed.

All hazardous materials and chemicals will be stored in accordance with relevant Australian standards and other state and local guidelines including the NSW EPA's Storing and Handling Liquids: Environmental Protection – Participants Handbook.

Based on the above, and with the implementation of management measures outlined in **Section 8.0**, water quality impacts during the operational phase are expected to be negligible.

7.2 Flooding

The flood modelling considered the impacts of the Project on flood hazard, depth and velocity for the 10%, 1%, 0.5%, 0.2%, and 0.05% AEP events and PMF event by considering pre-developed (existing) and post-developed conditions.

7.2.1 Flood Hazard and Risk

Flood hazard results for pre-developed (existing) and post-developed conditions show that high flood hazard is reached within the deeper central flow path locations in the Project Area, with shallower and overbank areas being considered low hazard.

There was minimal change in flood risk to the internal and external watercourse flows between pre-developed (existing) and post-developed conditions. Access points to the Project Area were predicted to be of low flood hazard.

Project fencing is likely to become a trap for loose vegetation in high flow events and may put an additional structural loading on the fence which may cause damage. To reduce the likelihood of debris loading, Lightsource bp is proposing to install riparian fencing, consisting of a flood permeable configuration, at each watercourse crossing. This would also ensure low afflux at the fence and that upstream water levels are not raised. With the implementation of measures outlined in **Section 8.0**, it is expected that the fence would be of low flood hazard.

The results further show that the infrastructure and solar panels within the Project Area are located outside areas of major flood hazard. Peak stormwater discharges from the Project Area for impervious areas may increase slightly through the creation of compacted gravel roads and some small operational buildings. However, potential impacts to drainage features and downstream watercourses are likely to be minimal due to the relative size of the Project Area in relation to the size of the receiving catchments, and the distributed nature of minor impacts.

7.2.2 Flow Rates, Depth and Velocity

7.2.2.1 Overview

The flood modelling indicated that the Project is predicted to result in minimal flooding impacts, including flow rates, velocities and depths.

The Project infrastructure is not predicted to increase flood depths or velocities due to the interaction with diffuse flows and use of unsealed roads in the post-developed case. The Project infrastructure is also not predicted to increase runoff, provided that groundcover is established and maintained to a similar level as with the pre-developed (existing) case, to provide similar levels of infiltration.

The minor increase in imperviousness within the Project Area does not create offsite impacts. Earthworks associated with the Project do not involve any infilling or reduction in floodplain storage. The filling and levelling of small farm dams within the Development Footprint is not anticipated to impact peak flows as these fill early in a storm event and are located outside the floodplain in overland flow paths. Furthermore, filling the farm dams would not adversely impact flood behaviour of receiving watercourses.

The modelling predicted that due to the minor modifications to landform and hydrological regime, the overall impact of the Project on flood depth and velocities is negligible. For proposed infrastructure outside the primary flow paths, flood impacts are considered to be minor in all modelled events.

The Project is not predicted to cause external impacts in terms of water surface levels and peak discharges.

7.2.2.2 Flood Impacts relating to Project Access, Solar Arrays, Substation and BESS

Additional runoff from solar panels is unlikely. While solar panels are wholly impervious, runoff from panels will drain onto the existing pervious landform and soils and is therefore not connected to the downstream drainage system.

Modelling results show that the location of the solar panels, substation, BESS and access from Windellama Road are outside of the flood extent and considered suitable in terms of flooding constraints. The panels have been designed with a 500 mm freeboard for the lowest edge above the maximum 1% AEP flood event. Furthermore, areas where the overland flow path exceeds depth and velocity values expected to be high risk for Project infrastructure have been ‘excluded’ from the Development Footprint. For the remaining areas, the probability of erosion and scour is expected to be minimal.

Refer to **Appendix A** for modelled peak existing depths, velocities and impacts, and complete flood mapping for the pre-developed (existing), post-developed and impact mapped cases.

7.2.2.3 Flood Impacts relating to Other Infrastructure and Access Roads

Access tracks, watercourse crossings (i.e. culvert crossings or causeways) and buried cable reticulation are the only works proposed within or near to the watercourses. Peak flood velocities crossing access tracks will be managed during construction to ensure sediment is not mobilised in a significant rain event. Inspection after storm events will be required to ensure erosion does not impact the access roads through the life of the Project. Erosion and sediment controls will be implemented during construction in accordance with the *Landcom guidelines for Managing Urban Stormwater: Soils and construction* (Landcom, 2004) that provide for industry to reduce the impacts of land disturbance activities on watercourses.

Security fencing around the perimeter of the Development Footprint has the potential to trap and accumulate flood debris and impede flows. This may result in minor increases in water level upstream of the blockage and potential redistribution of flow at the boundary. Given the local topography, proposed fence design at watercourse crossings and measures outlined in **Section 8.0**, any redistribution of flow through fence blockage would be localised and the risk of any potential blockages is low. Any inundation outside of the mapped flood extents is predicted to be minor.

7.3 Water Supply and Impact to Downstream Users

As indicated in **Section 4.3**, water will be supplied to the Project from a combination of the following sources:

- Commercial suppliers (potable water) (all phases) – this is the preferred water source for the Project.
- Farm dams and existing groundwater bore within the Project Area (all phases).

The maximum water demand will occur during construction (18-24 months estimated at approximately 12.26 ML) with the bulk of water to be supplied from commercial suppliers in the nearby region (via water trucks) and/or farm dams located within the Project Area. A similar volume of water is likely to be required during the decommissioning phase.

As surface water or groundwater used by the Project will be sourced under agreement with the landholder and in accordance with the relevant water source WSP, no impacts to surface water or groundwater availability in the vicinity of the Project are anticipated.

Loss of catchment yield associated with containment of runoff from disturbed areas is expected to be negligible and will be temporary during the construction and decommissioning phases. As such, impacts on surface water availability to downstream water users are expected to be negligible.

7.4 Groundwater Resources

7.4.1 Construction and Decommissioning

Generally, impacts to groundwater resources, including GDEs, are not expected given the groundwater table is unlikely to be intercepted during Project construction. As discussed in **Section 3.7.1**, the fence to be constructed where Bullamalito Creek crosses the southern boundary of the Project Area will be a latched tube watercourse crossing, designed to avoid interference with Bullamalito Creek and the high potential aquatic GDE. Further, the anticipated depth to groundwater (i.e. at least 10 mbgl) within the Project Area (refer **Section 3.6**) means that any hydrocarbon/chemical spills are unlikely to infiltrate to the groundwater table, noting that appropriate spill management measures will be implemented during all phases of the Project (refer to **Section 8.0**).

Should the final Project design identify that construction activities will result in the interception of the groundwater table, further assessment will be undertaken in accordance with the *NSW Aquifer Interference Policy* (NSW Government, 2012) and appropriate management measures be developed to mitigate any potential impacts.

7.4.2 Operation

Interactions with the groundwater table are not expected at the decommissioning phase of the Project. As such, no impacts to groundwater resources or Groundwater Dependent Ecosystems (GDEs) are expected during the operational phase of the Project.

7.5 Aquatic Habitat

As discussed in **Section 3.9,** aquatic habitats within the Project Area have been degraded and impacted as a result of historical and current agricultural activities. Apart from a number of watercourse crossings required to facilitate access across the Project Area and potential closure of a number of manmade farm dams, no other disturbance is proposed to watercourses and the associated aquatic habitats. Watercourse crossings will be designed in consultation with the DPI Fisheries, to minimise impacts on stream stability and fish passage and with reference to the *Guidelines for Controlled Activities on Waterfront Land.* In light of this, it is not anticipated that the Project would impact the passage of fish over the long term nor obstruct the movement of fish or other aquatic species.

Furthermore, the Project layout incorporates riparian buffers of approximately 20 m to 40 m around second order and higher streams to avoid and minimise impacts to the habitat associated with the riparian zone. As discussed in **Section 7.1**, the potential impacts on water quality are also anticipated to be limited due to the Project Layout and design avoiding tributaries of Gundary Creek and Bullamalito Creek.

With the implementation of management and mitigation measures outlined in **Section 8.0,** impacts to aquatic habitat within the Project Area is expected to be negligible.

7.6 Cumulative Impacts

Given the Project will incorporate appropriate stormwater treatment measures to as far as practicable to achieve a NorBE on water quality and all other developments within the Sydney Drinking Water Catchment are also required to achieve a NorBE on water quality, any cumulative impacts to receiving water quality are expected to be negligible.

High Project water demands will be limited to relatively short periods of time with respect to the overall Project lifespan during the construction and decommissioning phases. Water demands during the operational phase will be relatively small and therefore, cumulative impacts to surface water or groundwater availability are not anticipated.

8.0 Management and Mitigation Measures

Table 8.1 presents the proposed measures to be implemented as part of the Project to manage and minimise impacts on water resources.

Table 8.1 Management and Mitigation Measures relating to Water Resources

ID	Management and Mitigation Measure	Timing	Relevant Impacts
WR1	Complete detailed water quality modelling to inform Project design with respect to required stormwater treatment measures to ensure stormwater discharging from the Project Area post-development is acceptable for discharge to the Sydney Drinking Water Catchment.	Detailed design	Surface Water Quality, Refer to **Section 7.1**
WR2	A Construction Soil and Water Management Plan (CSWMP) will be prepared to outline measures to manage soil and water impacts associated with the construction and decommissioning works. The CSWMP will provide: • Measures to minimise/manage erosion and sediment transport both within the construction footprint and offsite including requirements for the preparation of erosion and sediment control plans (ESCP) for all progressive stages of construction. • Measures to manage waste including the classification and handling of spoil. • Procedures to manage unexpected, contaminated finds. • Measures to manage stockpiles including locations, separation of waste types, sediment controls and stabilisation. • Measures to manage accidental spills including the requirement to maintain materials such as spill kits. • Controls for receiving watercourses which may include designation of 'no go' zones for construction plant and equipment. • Creation of catch/diversion drains and sediment fences at the downstream boundary of construction activities where practicable to support containment of sediment-laden runoff. • Inspection and monitoring requirements including receiving water quality monitoring. • Erosion and sediment control measures will be implemented and maintained at all work sites in accordance with the principles and requirements in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008b), commonly referred to as the "Blue Book". • A water sourcing and monitoring strategy to manage potential availability impacts on downstream water users and ensure compliance with legislation relating to water extraction.	Prior to construction	Surface Water Quality and Groundwater, Refer to **Section 7.1** and **Section 7.4**.

ID	Management and Mitigation Measure	Timing	Relevant Impacts
WR3	An Operational Environmental Management Plan (OEMP) will be developed for the Project to address potentially adverse impacts on the receiving environment surface water quality and flooding during the operational phase. This will include: • Inspection and monitoring requirements including receiving water quality monitoring. • Maintenance of suitable ground cover around solar panels, and grassed table drains near access tracks to minimise the potential for erosion and export of sediment. • Maintenance of stormwater infrastructure including any stormwater treatment devices (e.g. bioretention basins and culverts (e.g. clearing debris).	Operation	Surface Water Quality and Groundwater, Refer to **Sections 7.1** and **7.4**
WR4	The security fence at watercourse crossings to consist of a latched tube watercourse crossing.	Construction and operation	Groundwater Quality, Refer to **Section 7.4**
WR5	Operations staff will have access to the following facilities for early severe weather warnings: The Bureau of Meteorology's "MetEye" and The Bureau of Meteorology's "RSS feeds". Radio and Bureau of Meteorology information will be reviewed frequently for potential major flooding and road closures.	Operation	Flooding and Stream Stability, Refer to **Section 7.2**
WR6	Facility members and visitors to be notified of potential flooding, road and facility closure.	Construction and operation	Flooding and Stream Stability, Refer to **Section 7.2**
WR7	Evacuation routes will be designed during the detailed design phase and will take into account zones of flood hazard.	Detailed design	Flooding and Stream Stability, Refer to **Section 7.2**
WR8	A detailed Flood Emergency Management Plan (FEMP) will be incorporated into the Fire Management and Emergency Response Plan (FMERP). The FEMP will include roles and responsibilities, and procedures for before, during and after a flood.	Prior to construction	Flooding and Stream Stability, Refer to **Section 7.2**
WR9	Lightsource bp will commit to maintaining the natural state of the drainage flow paths whenever possible. Internal access roads, where crossing watercourses, will be designed for 10% AEP design flow and may include compacted rock causeways to provide low maintenance access with limited impact on the watercourse or culvert structures.	Detailed design, construction and operation	Flooding and Stream Stability, Refer to **Section 7.2**
WR10	Foundations for the photovoltaic arrays and transmission lines will be located away from areas that exceed both flood depths of 0.3 m and flow velocities greater than 1.5 m/s. Detailed design of the Project will consider the results of the flood models, in particular the 1% AEP scenario.	Detailed design	Flooding and Stream Stability, Refer to **Section 7.2**

ID	Management and Mitigation Measure	Timing	Relevant Impacts
WR11	Solar panels will be designed with a 500 mm freeboard above the maximum 1% AEP flood level.	Detailed design	Flooding and Stream Stability, Refer to **Section 7.2**
WR12	BESS components will be located on hardstand areas and will be aligned with local overland flow paths to prevent flows being redirected which could lead to localised increased in flood level and higher risk of scour and erosion.	Detailed design	Flooding and Stream Stability, Refer to **Section 7.2**
WR13	The design and construction of watercourse tracks and cable crossings and all internal tracks crossing watercourses within the proposed development footprint should be generally in accordance with relevant guidelines (refer to Section 7.3 of **Appendix A**).	Detailed design	Flooding and Stream Stability, Refer to **Section 7.2**
WR14	The best practice principles for stormwater and sediment control outlined in the *Managing Urban Stormwater: Soils and construction* (Landcom, 2004) guidelines will be incorporated into the design, construction and operation phases of the solar farm site as part of a Stormwater Management Plan and Erosion and Sediment Control Plan.	Construction and Operation	Flooding and Stream Stability, Refer to **Section 7.2**
WR15	Fencing will be designed to consider flood levels across the site through construction of floodways to reduce the likelihood of fence blockage due to loss of vegetation in storm events.	Construction	Flooding and Stream Stability, Refer to **Section 7.2**

9.0 Conclusion

This Water Resources Impact Assessment considered the potential impacts and appropriate measures to mitigate any potential impacts on water resources associated with the Project. The following conclusions are made with respect to the potential Project impacts on water resources:

- Impacts to surface water resources during the construction and decommissioning phases of the Project can be adequately managed to ensure negligible impacts by implementation of a SWMP as described in **Table 8.1**.
- The Project is predicted to result in minimal impacts on flooding, including flow rates, velocities and depths. Notwithstanding, a suite of flood management and mitigation measures have been proposed as outlined in **Table 8.1**.
- Potentially adverse impacts on soil and surface water resources during the operational phase are not expected provided:
  - appropriate stormwater treatment measures are implemented
  - rehabilitation following ground disturbance in the construction phase is undertaken to minimise the risk of ongoing erosion and appropriate groundcover is maintained throughout the operational phase of the Project.
- No interaction with the groundwater table is anticipated throughout all phases of the Project and therefore, no impacts to groundwater resources or GDEs are expected.
- The potential for adverse impacts on the receiving surface water quality from point sources such as chemical storage and the on-Project Area wastewater management system can be adequately managed by implementation of appropriate hazardous materials storage and handling measures (that will be documented in an OEMP) and appropriate design and siting of the on-site wastewater management system.
- No impacts to the availability of supply to downstream and nearby water users (groundwater and surface water) as all water sourced for the Project will be undertaken in accordance with the WM Act 2000 and relevant WSPs.

10.0 References

Babister, M., Trim, A., Testoni, I. & Retallick, M. (2016). *The Australian Rainfall & Runoff Datahub, 37th Hydrology and Water Resources Symposium Queenstown NZ*. http://data.arr-software.org/

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.

BoM (2017). Groundwater Dependent Ecosystems Atlas (GDE Atlas) version 2.1. http://www.bom.gov.au/water/groundwater/gde/map.shtml

BoM (2023). Design Rainfall Data System (2016), Commonwealth of Australia. http://www.bom.gov.au/water/designRainfalls/revised-ifd/

Department of Environment, Climate Change and Water (2006). *NSW Water Quality and River Flow Objectives.* https://www.environment.nsw.gov.au/ieo/

DPE (2011). *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*

DPE (2011). *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011.*

DPE (2021). *eSPADE* v2.1. https://www.environment.nsw.gov.au/eSpade2WebApp#

DPE (2022). *Large-Scale Solar Energy Guideline.*

Minesoils (2024). *Gundary Solar Farm - Soil, Land and Agriculture Assessment.*

NSW Government (2013). 2kmx2km 5 metres Resolution Digital Elevation Model. NSW Government, Spatial Services.

Landcom (2004). *Managing Urban Stormwater: Soils and Construction.* 4th Edition.

Hird C. (1991). *Soil Landscapes of the Goulburn 1:250,000 Sheet map* and report, Soil Conservation Service of NSW, Sydney.

Queensland Government (2023). *SILO – Australian Climate Data From 1889 to Yesterday*.

WRM (2024). *Gundary Solar Farm – Flood Study Report.*

WaterNSW (2021). Australian Groundwater Explorer. Retrieved March 2022 from National Groundwater Information System: http://www.bom.gov.au/weave/explorer.html?max=true

WaterNSW (2023). Maximum Harvestable Right Dam Capacity Calculator. https://www.waternsw.com.au/customer-service/water-licensing/blr/harvestable-rights-dams/maximum-harvestable-right-calculator

WMA Water (2019) Review of ARR design inputs for NSW. Report for the NSW, Office of Environment and Heritage. Authors: Podger, S., Babister, M., Trim, A., Retallick, M. and Adam, M. 9 https://rffe.arr-software.org/

APPENDIX A

Flood Impact and Risk Assessment

GUNDARY SOLAR FARM

Flood Impact and Risk Assessment

Umwelt (Australia) Pty Ltd

2 July 2024

2067-02-B4

DETAILS

Report Title	Gundary solar farm, Flood Impact and Risk Assessment
Client	Umwelt (Australia) Pty Ltd

THIS REVISION

Report Number	2067-02-B4
Date	2 July 2024
Author	Lindsay Millard
Reviewer	David Newton

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1 INTRODUCTION

1.1 OVERVIEW

The Gundary Solar Farm (the Project) involves the construction, operation and decommissioning of a renewable energy generation facility and associated transmission infrastructure. The Project Area is near Gundary, approximately 10 kilometres south of Goulburn in the Goulburn Mulwaree local government area (refer to Figure 1-1).

The Project Area falls within the Hawkesbury-Nepean catchment and drains into Lake Burragorang (Warragamba Dam) some 120 km downstream. Lake Burragorang is a key water supply for the Sydney drinking water catchment. On a local scale, the Project Area falls within the 107 km^2 Gundary Creek catchment. There are a number of mapped creeks traversing the Project Area. Existing flood mapping for the Goulburn Mulwaree Local Government Area (LGA) does not extend to the Project Area.

As shown in Figure 2-1, Bullamalito Creek and Quialigo Creek converge just outside the south-western boundary of the Project Area to form Gundary Creek, which flows to the Mulwaree River, then to the Wollondilly River and eventually to the Hawkesbury-Nepean Rivers. Both Gundary Creek and Bullamalito Creek flow in a northerly direction through the Project Area.

This report details the methodology and results of a flood impact assessment of the Project, including flood modelling of drainage paths through the Project Area, with and without the Project in place.

1.2 PROJECT DETAILS

The Project's conceptual layout is provided in Figure 3-2. The main access point for the Project is the existing entrance at 961 Windellama Road. Intersection works on Windellama Road are proposed as part of the Project to upgrade the Project access. The Project will include the construction, operation, maintenance and decommissioning of:

- 400 Megawatt peak (MWp) solar photovoltaic (PV) generation
- A Battery Energy Storage System (BESS) of up to 555 MW and 1570 Megawatt hour (MWh) capacity
- Ancillary infrastructure, an onsite substation and connection to an existing 330 kilovolt (kV) transmission line.

The Project is expected to operate for up to 40 years. After its operational life, the Project would either be decommissioned (by removing all infrastructure and returning the site to its existing land capability) or repurposed with new PV equipment subject to technical feasibility and planning consents.

The conceptual layout for the Project has been designed to maximise solar efficiency whilst avoiding impacts on areas of high biodiversity value and minimising impacts to surface water resources (including flooding), cultural heritage constraints and proximal landholders in regard to noise and visibility.

1.3 REPORT STRUCTURE

This report is structured as follows:

- Section 2 provides details of the drainage network and catchment characteristics;
- Section 3 provides details of the Project configuration and flood-related requirements;
- Section 4 outlines the hydrological modelling undertaken to estimate design discharges;
- Section 5 describes the hydraulic modelling development;
- Section 6 presents the modelling results and impacts of the Project;
- Section 7 summarises the key risks to be managed;
- Section 8 contains the summary of findings;
- Section 9 is a list of references;
- Section 10 is a list of abbreviations and definitions;
- Appendix A contains flood maps for existing conditions.
- Appendix B contains flood maps for developed conditions.
- Appendix C contains flood maps showing the impacts of the Project.
- Appendix D contains the SEARs agency advice table.

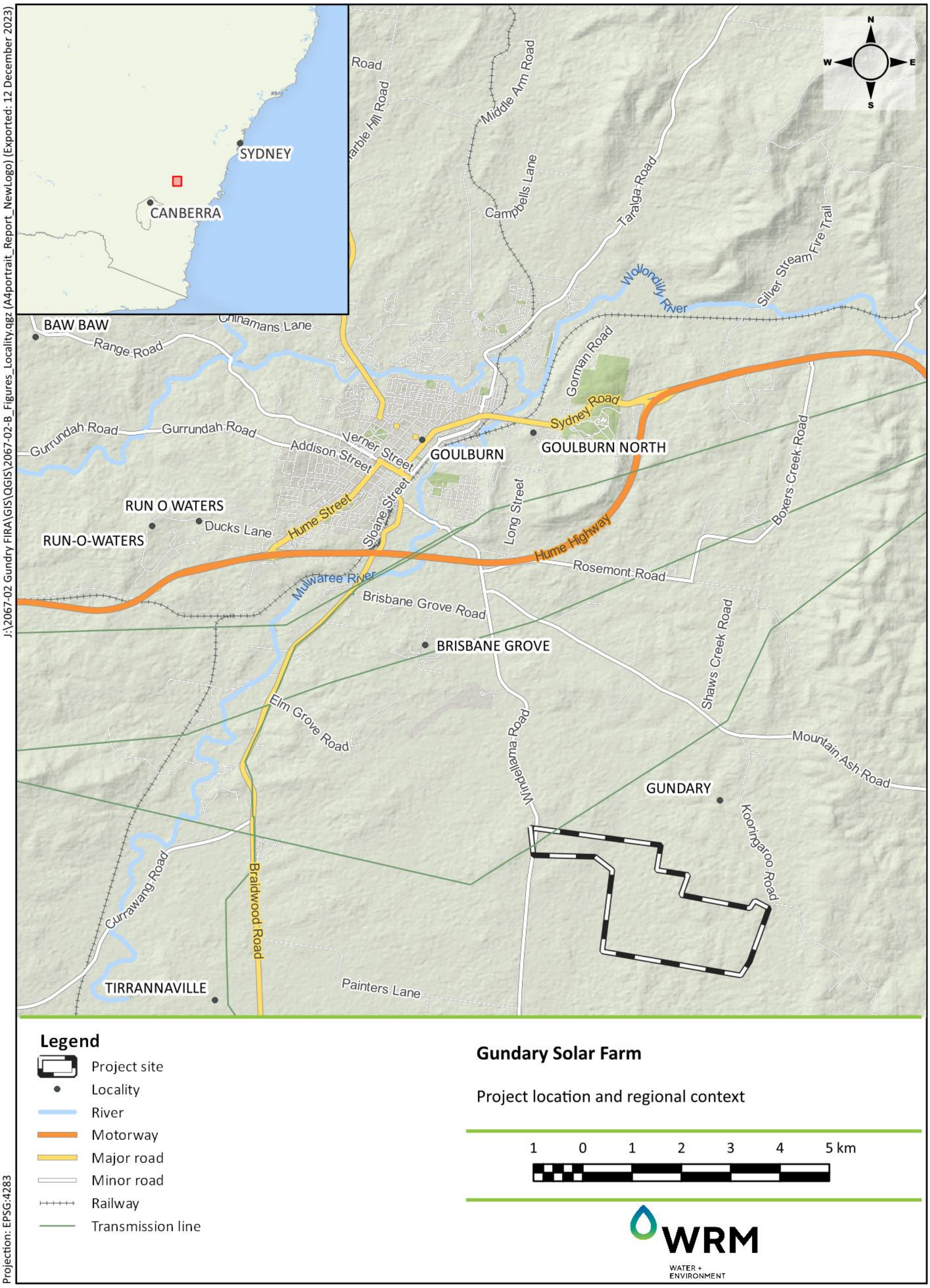

Figure 1-1 Location map

2 CATCHMENT AND DRAINAGE NETWORK

2.1 CATCHMENT AND STUDY AREA

The Project Area is located within the Gundary Creek catchment within the Hawkesbury-Nepean catchment and is within the Sydney drinking water catchment. Elevations within the Project Area range between 710 mAHD from the ranges along the eastern boundary, to approximately 645 mAHD on the Gundary Creek floodplain. Gundary Creek (perennial), Bullamalito Creek (perennial) and an unnamed 4^{th} order tributary of Bullamalito Creek (non-perennial) drain from east to west across the southern portion of the Project Area.

Gundary Creek is formed at the confluence of the Quialigo Creek (perennial) and Bullamalito Creek, immediately to the west of the Project Area, and drains in a northerly direction through the northern portion of the Project Area. Gundary Creek flows into the Mulwaree River approximately 10 km north-northwest of the Project Area at the southern end of Goulburn. The drainage network in the vicinity of the Project is shown in Figure 2-1.

2.2 REGIONAL FLOOD HISTORY

Flooding at Goulburn due to the Wollondilly and Mulwaree Rivers is an infrequent occurrence. No long-term gauge is available in the region on either river. However, historic newspaper articles indicate that major flood events, known to have caused flooding of properties at Goulburn, occurred in April 1870, July 1900, June 1925, June 1950, October 1959, November 1961 and August 1974. More recently, significant flooding in Goulburn has occurred in August 1990, December 2010, March 2012 and June 2012.

Flooding within the Project Area is not recorded and no anecdotal information, such as surveyed flood debris marks on landmarks such as fencing, were available for this study. Gundary Creek, which drains in the Project Area, is a tributary of the Mulwaree River. Ground levels in the Project Area are about 15 m above the bank level of the Mulwaree River, at the Gundary Creek confluence and therefore, the Project Area would not be impacted by river flooding.

2.3 AVAILABLE INFORMATION

Flood studies have been undertaken for the Goulburn Local Government Area (LGA) in Wollondilly and Mulwaree Rivers (WMA 2016, GRC 2022), as shown in Table 2.1. However, the extent of the existing flood mapping for these studies only extends to a location about 8 km downstream of the Project Area.

Table 2.1 Available flood studies

GRC Hydro, 2022	Goulburn Floodplain Risk Management Study and Plan
WMAwater, 2016	Wollondilly and Mulwaree Rivers Flood Study Final Report

2.3.1 Topographic data

LiDAR topographic data for the Project Area was obtained from the ELVIS spatial data service (https://elevation.fsdf.org.au/). The data was available in GeoTIFF grid format with a resolution of two metres. This data was used for catchment delineation and catchment slope calculations.

2.3.2 Rainfall and stream flow data

There are no streamflow gauges or rainfall stations within the Project Area. As such, there is no streamflow gauge data to enable model calibration.

2.3.3 Relevant guidelines

This report was prepared as part of the broader Water Resources Impact Assessment (WRIA) completed by Umwelt. Both document should be read in conjunction as they were prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) (issued on 10 November 2022) issued by the then Department of Planning and Environment (DPE) (now the Department of Planning, Housing and Infrastructure (DPHI)) in respect to flood risk. In particular the SEARs require:

assessing the impacts of the development, including any changes to flood risk and overland flows on-site or off-site, and detail design solutions and operational procedures to mitigate flood risk where required.

The SEARs agency advice and where in this report it has been addressed is included in Appendix D.

This Flood Impact and Risk Assessment was undertaken in accordance with the associated technical guides listed in **Table 2.2**.

Table 2.2 Guidelines and References utilised as part of scope of works

NSW, 2023	Flood risk management guideline LU01[1]
NSW, 2022	State significant infrastructure guidelines
NSW, 2022	Large scale Solar Energy Guideline
NSW, 2023	Flood Risk Management Manual

[1] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Floodplains/flood-risk-management-impact-risk-assessment-230234.pdf

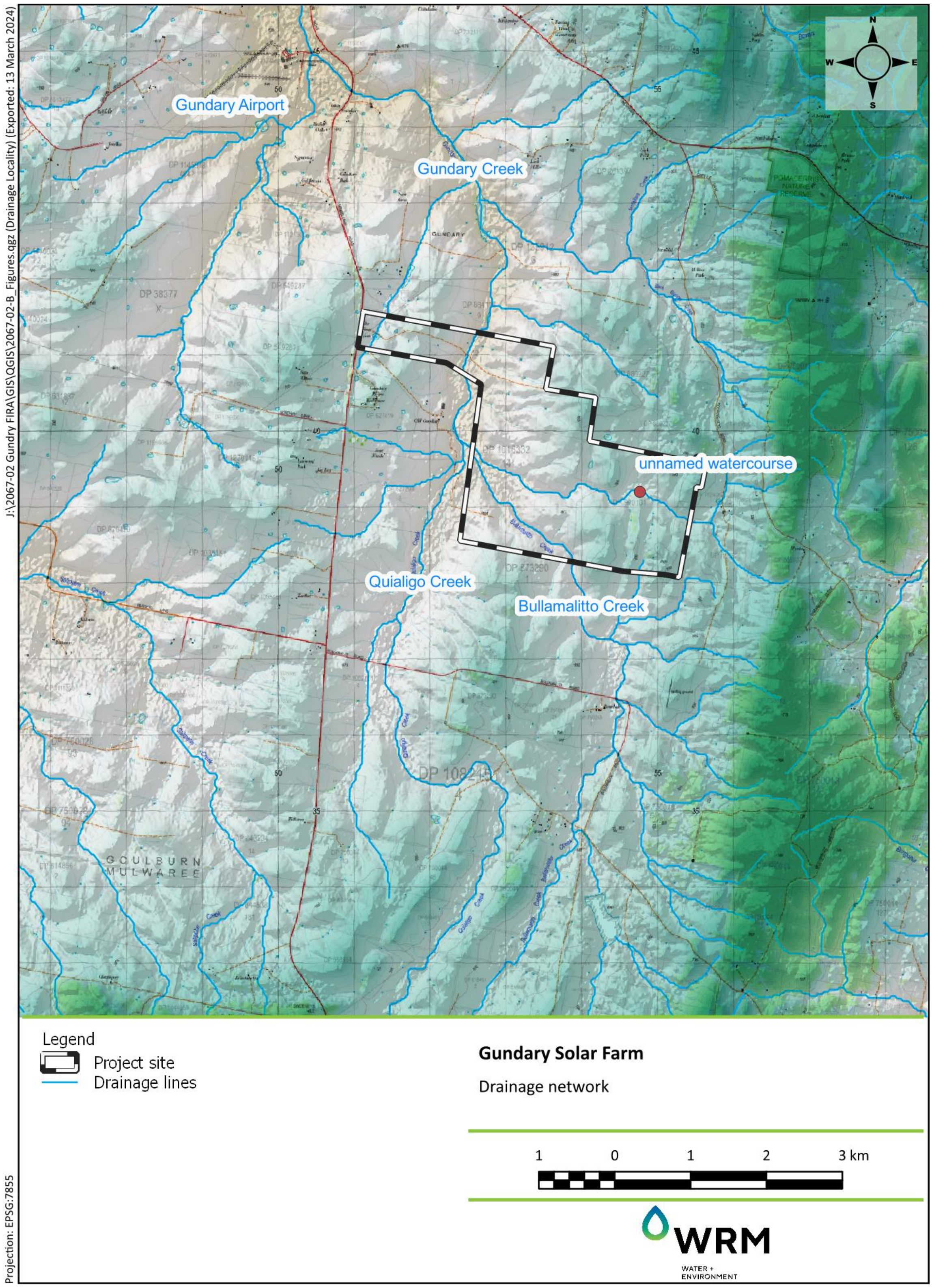

Figure 2-1 Drainage network

3 PROJECT CONFIGURATION

3.1.1 Overview

Section 3 presents the site configuration and highlights key aspects of the Project. The following provides a brief explanation of the key aspects of the Project as they relate to flooding. The elevation of the lowest edge on the solar panel arrays were designed to provide 500 mm of freeboard to the peak modelled 1% AEP flood event.

3.1.2 Substation / switching station

A site substation and switch yard will be located at the north-western corner of the Project Area. A switching station is proposed to be located adjacent to the substation near the existing high voltage transmission line.

The substation will feature a busbar, circuit breakers, current transformers, voltage transformers, switchgear/electrical protection, and a step-up transformer. The substation will be surrounded by security fencing to restrict access.

3.1.3 Access and internal tracks

The Project's primary access point would be via the existing driveway at 961 Windellama Road. Intersection works are proposed to upgrade the primary access to accommodate heavy vehicles. There would be an emergency access point on the eastern side of the Project Area via the existing access at 400 Kooringaroo Road. This access would only be used for emergencies.

Approximately 20 km of internal all weather access tracks would be constructed within the Project's development footprint to provide access to the various areas of the site for construction as well as on-going operations and maintenance.

The access tracks, comprising of compacted gravel, would be approximately 4 m wide with a main access track of 6 m wide to the substation/switchyard to allow for the safe delivery, unloading and installation of key components.

The access tracks will enable access throughout the site during construction and operational life of the project. The access tracks would be designed and constructed to ensure that it is capable of accommodating construction vehicles and fully loaded firefighting appliances.

During the construction phase, there would be a requirement to construct watercourse crossings (in the form of culverts and bed level crossings) to allow for access across creek lines within the Project Area. In particular, the watercourse crossings over Gundary Creek and Bullamalito Creek would involve installing culverts designed to accommodate heavy vehicles, including 19 m semi-trailer vehicles and various farm machinery.

3.1.4 Ancillary facility and construction compound

Ancillary facilities include:

- Temporary material laydown areas;
- Temporary construction site offices;
- Vehicle parking areas for construction workers' transportation;
- Staff amenities including chemical sanitary modules, water tank, administrative office, undercover storage area, emergency muster point and Parking for staff and visitors.

3.1.5 Security fencing

The perimeter of the site is to be fenced with an approximately 2.3 metre-high security fence around the Project infrastructure, subject to final design. Double gates are to be installed at the primary access point to the site.

A security barrier will be constructed along the perimeter of the project infrastructure. For locations where the security fence will traverse a waterway, a flood permeable configuration will be utilised to ensure low afflux. The selection of security fencing arrangement reduces the likelihood that debris will be captured. The minimisation of trapped debris is a mitigation of the risk that debris loading resulting in afflux. The proposed design is called a latched tubes waterway crossing and an indicative configuration is shown in Figure 3-1.

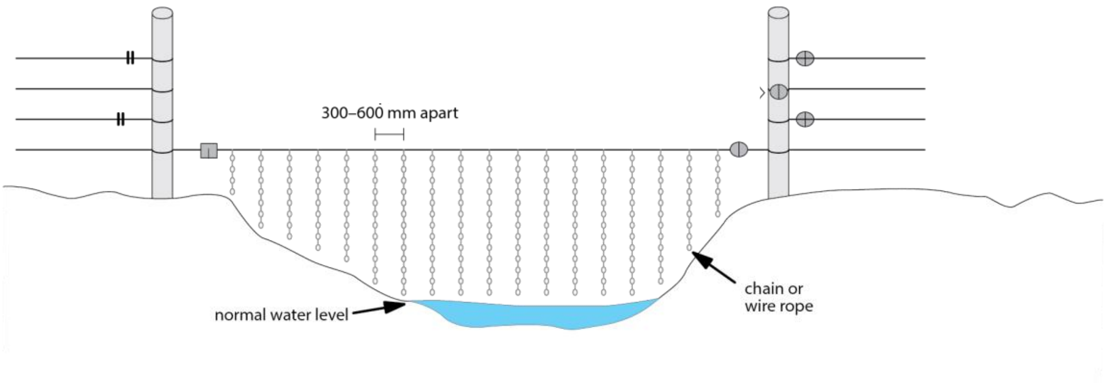

Figure 3-1 Latched tubes waterway crossing – indicative

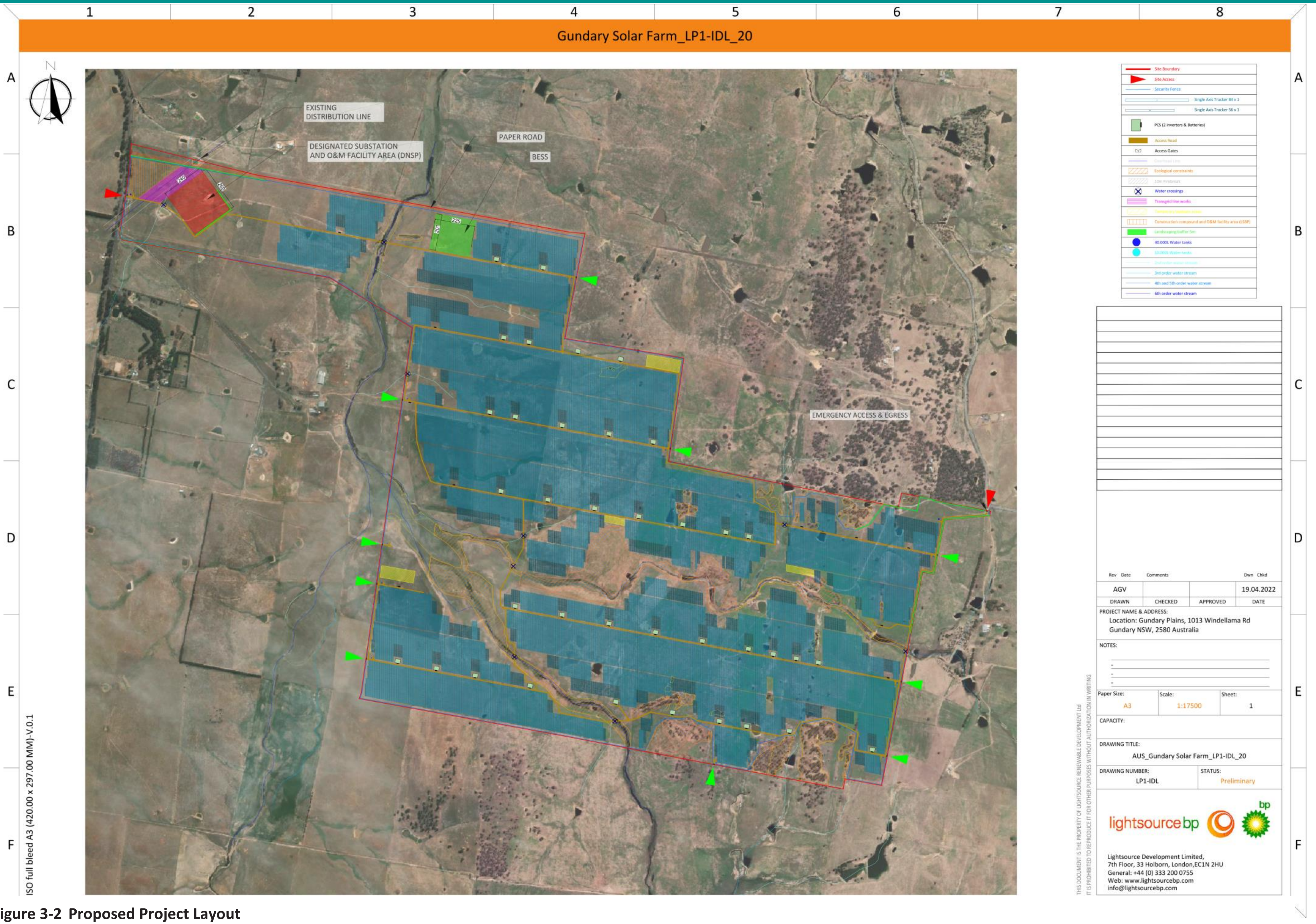

Figure 3-2 Proposed Project Layout

Source: AUS_Gundary_LP1-IDL_20.pdf 20 May 2024

4 ESTIMATION OF DESIGN DISCHARGES

4.1 METHODOLOGY

Design flood discharges and flood levels in watercourses draining the Project Area were estimated using a RORB hydrologic model (detailed below) and a TUFLOW hydraulic model (detailed in Section 5). The hydrologic model was used to estimate discharges from the contributing catchments outside the Project Area. Discharges within the Project Area were estimated by applying rainfall directly to the topographic surface in the hydraulic model.

The hydrological model was developed using the RORBwin v6.45 (RORB) software. RORB simulates the catchment rainfall-runoff process in the contributing catchments, producing the design discharges used for inflows to the hydraulic model.

Design discharges were determined using the ensemble methodology defined in Australian Rainfall & Runoff (ARR) (Ball et al., 2019). An ensemble of 10 temporal patterns is modelled for each storm duration to derive a range of estimated peak discharges for storms of different severity, represented by an annual exceedance probability (AEP). The storm duration with the highest median peak discharge of the ensemble is selected and the temporal pattern that produces the peak discharge just above the ensemble median is used for design event modelling.

The design discharges were used to select the storm duration producing the maximum discharge (referred to as the critical duration) for each AEP at the downstream boundary of the Project Area on Gundary Creek. The representative event was then used to inform the direct rainfall applied within the hydraulic model domain.

Design discharges were determined for the 10%, 5%, 1% (1 in 100), 0.5% (1 in 200) and 0.2% (1 in 500) AEPs and the Probable Maximum Flood (PMF) for current climatic conditions. Design rainfall intensities were derived in accordance with ARR. In the absence of site-specific calibration data, the RORB predicted flood discharges were validated using the Regional Flood Frequency Estimation (RFFE) model[2] .

4.2 HYDROLOGIC MODEL DEVELOPMENT

4.2.1 Subcatchment configuration

Figure 4-1 shows the hydrologic model's configuration. The model consists of 16 sub-catchments. The subcatchment parameters are presented in Table 4.1. The model covers a catchment area of approximately 107 km^2, primarily covered by light vegetation. Topographical maps at 1:100,000 scale and Hydro-enforced SRTM data at approximately 30 m grid resolution were used to delineate the sub-catchments draining to the study area.

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

Table 4.1 Subcatchment area

Catchment ID	Area (ha)
1	1422
2	672
3	369.5
4	1062
5	1103
5-1a	179
5-2a	325
5-2b	1047
5-2c	285
5-2c-1	670.8
5-2d	589
6	509
7	792
7-1	223
7-2	1269

4.2.2 Adopted RORB model parameters

Table 4.2 shows the adopted RORB modelling parameters. Catchment slopes and percentage of rural area were determined from available topographic data and aerial imagery. The adopted RORB model parameters are based on the recommended guidance equation provided within ARR (Ball, 2019) for usage within NSW catchments.

Table 4.2 Hydrologic model parameters

RORB Parameter	Adopted Value
M (Catchment non-linearity)	0.8
kc	10

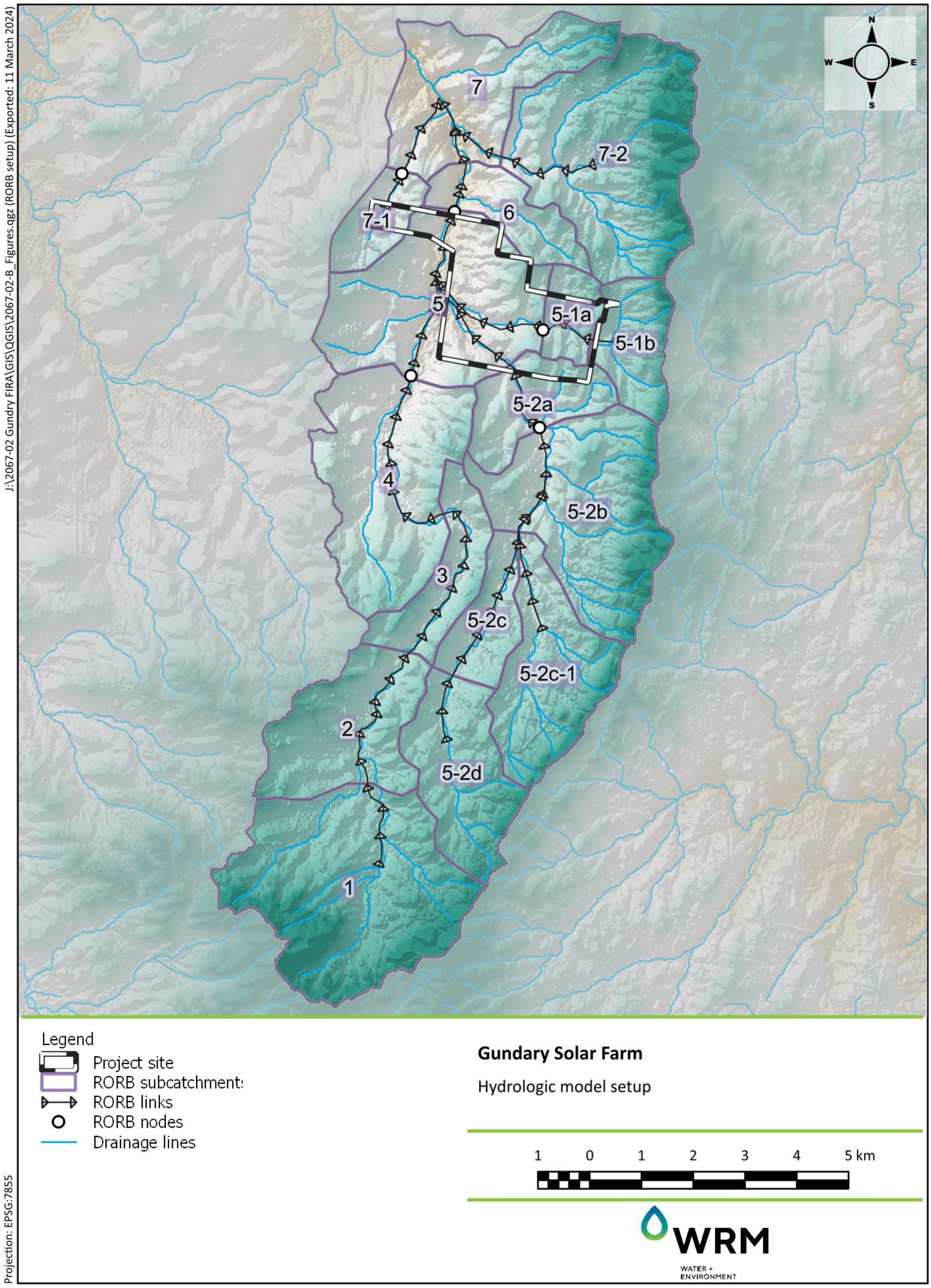

Figure 4-1 Hydrologic catchments

4.3 DESIGN RAINFALL DEPTHS

Design rainfall depths were obtained using the following methodology:

- Design rainfalls for the 10% (1 in 10) to 0.2% (1 in 500) AEP were obtained from Design Rainfall Data System[3] based on a single point location at the centroid of the Project Area.
- Rainfall depths for the 0.1% (1 in 1,000) and 0.05% (1 in 2,000) AEP events were obtained from the Bureau of Meteorology (BOM) for the point location at the catchment centroid of the Project Area. Areal reduction factors derived for the total Project Area catchment were applied to these design rainfalls.
- Probable Maximum Precipitation (PMP) rainfall depths were estimated based on the total Project Area River Dam catchment, using the methodologies given in:
    - *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method* - GSDM (BoM, 2003) for durations up to 6 hours
- The AEP of the PMP was estimated based on a relationship between catchment area and AEP recommended by Laurenson and Kuczera (1999) in Book 8 Chapter 3 of ARR 2019 (Ball et al, 2019) and shown on Figure 4-2. Based on the Project's catchment area of 107 km^2, the AEP of the PMP was estimated to be approximately 1 in 10 million AEP event.

Table 4.3 shows the design rainfall depths for the 10% (1 in 10) to 0.2% (1 in 500) AEP and the PMP for durations from 60 minutes to 24 hours.

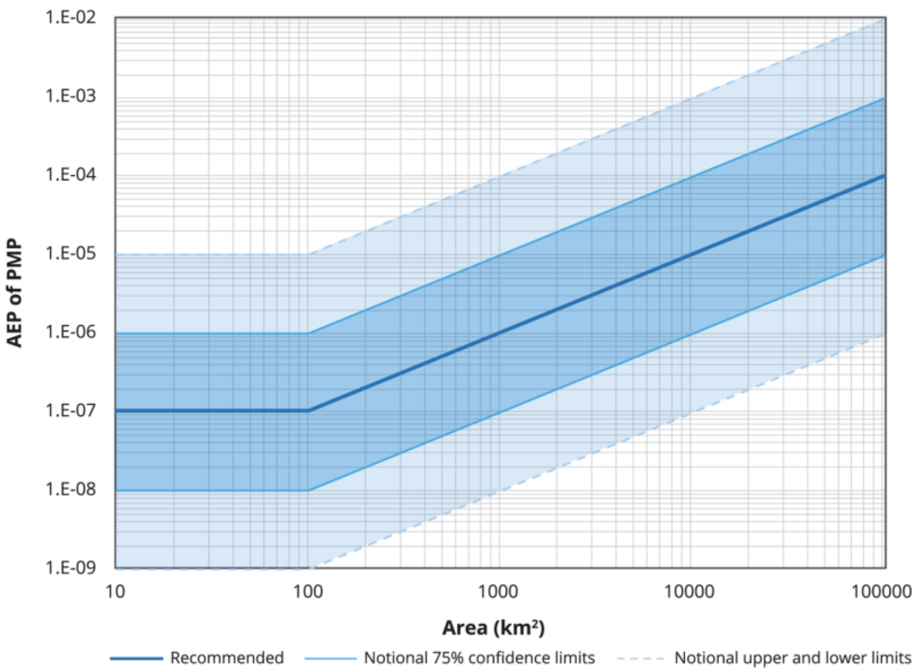

Figure 4-2 Recommended regional estimates for the AEP of PMP (Ball et al, 2019)

[3] http://www.bom.gov.au/water/designRainfalls/revised-ifd/

Table 4.3 Adopted design rainfall depths

Duration (hrs)	Areally reduced design rainfall depths (mm)						
	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP	0.2% AEP	PMP*
1	30.9	35.5	41.5	46.1	51.9	60	260
2	37.8	43.2	50.5	56.1	63.1	72.9	380
3	43.1	49.2	57.5	64	72	83.2	460
6	55.4	63.6	74.9	84	94.4	109	520
9	65.3	75.3	89.4	101	113	131	570
12	73.7	85.4	102	115	129	150	610
18	87.4	102	122	139	156	181	790
24	98.2	115	139	158	178	205	880

Source: BOM.gov.au, 25.172S, 151.746E

*Hours 1-6 represent GSDM PMP rainfall depths while 24-96 hours represent GSAM coastal

4.3.1 ARR data hub

Recommended design rainfall parameters were based on current ARR guidelines (referred to as ARR 2019) (Ball et al, 2019), available from the ARR Data Hub portal[4]. Key design rainfall parameters include:

- Initial and continuous loss rates;
- Design storm pre-burst depths;
- Areal reduction factors; and,
- Design storm temporal patterns.

4.3.2 Design rainfall losses and pre-burst rainfall

Storm initial loss (IL) and continuing loss (CL) method of accounting for rainfall losses was adopted based on ARR Data Hub recommendations. An initial loss (IL) and a continuing loss (CL) were adopted, the median pre-burst depths, obtained from the Data Hub, wereused to adjust the initial loss for the 1% AEP.

IL and CL losses were derived by interpolating between rainfall losses adopted for infrequent events (up to 1% AEP) and the PMP rainfall losses, noting that:

- Initial losses (ILs) for infrequent events were derived based on the Probability Neutral Burst ILs provided by ARR datahub. This approach results in a unique Initial Loss for each duration;
- Continuing losses (CLs) for infrequent events were derived based on the suggested data hub and regional flood study CLs; and

[4] https://data.arr-software.org/

- For the PMF event, an IL of zero and CL of 1 mm/h were adopted.

Table 4.4 provides the initial and continuing losses used for the infrequent events and PMP used to interpolate the 0.5% and 0.2% AEP rainfall losses. Table 4.5 provides the Probability Neutral Burst Initial Loss values referred to by Table 4.4

Table 4.4 Adopted design rainfall losses

Losses	Infrequent (to 1% AEP)	PMP
Initial loss (mm)	Probability Neutral Burst Initial Loss	0
Continuing loss (mm/h)	1.96	0.1

Table 4.5 Probability Neutral Burst Initial Loss

Storm duration	Probability Neutral Burst Initial Loss (mm)	
	2% AEP	1% AEP
1 hour	7.9	4.2
1.50 hour	8.5	4.8
2 hours	7.7	3.5
3 hours	6.9	1.7
6 hours	7.1	2.3
12 hours	6.0	3.0
18 hours	7.0	3.6
24 hours	7.9	4.3

4.3.3 Design temporal patterns

Temporal patterns were obtained from the ARR data hub based on a point location at the centroid of the catchment. As per ARR guidelines, 10 temporal patterns which result in 10 design storms for each critical duration for each AEP were used. The hydrologic model was run for all 10 temporal patterns for storm durations between 1 hours and 24 hours for the 10% to 0.2% AEP events. The critical storm duration was identified as the duration which produces the highest median peak discharge from the 10 design storms for each storm duration.

Design event hydrology was undertaken using the ensemble of temporal patterns approach in accordance with ARR 2019. The design temporal patterns were adopted from the following sources:

- Up to the 1% AEP event:
  - The areal temporal patterns from ARR 2019 were used;
- For events rarer than 1% AEP up to the PMF:
  - for durations up to 6 hours, the ten ensemble temporal patterns were adopted from Jordan et al (2005) and the GSDM pattern were used for each duration.

4.4 SELECTION REPRESENTATIVE DESIGN DISCHARGES

Table 4.6 shows the adopted design discharge, critical durations and temporal patterns adopted for the study area. The temporal pattern that produced the peak discharge just greater than the mean was adopted.

Table 4.6 Design discharge at proposed BESS location, critical durations and temporal patterns

AEP (%)	Design discharge (m^3/s)	Critical duration (hrs)	Adopted temporal pattern
10	122.4	9	TP7
5	152.8	9	TP7
1	237.6	12	TP4
0.5	301.8	12	TP1
0.2	357.3	12	TP1
PMF	2844	4	TP1

4.5 DESIGN FLOW VERIFICATION

4.5.1 Overview

The following section outlines the method used to check the results with independent methods. Validation of the hydrologic model was undertaken by comparing results with more frequent flood events where estimates have greater confidence.

4.5.2 Regional flood frequency estimation method

The Regional flood frequency estimation (RFFE) is an online tool[5] developed for Australian Rainfall and Runoff to estimate design flows for ungauged catchments. It is based on gauged data using a region-of-influence approach. Comparisons between hydrologic model's design peak discharges and RFFE estimates are given in Table 4.7. Overall, the hydrologic model results are in reasonable agreement with the RFFE estimates.

The inputs used for the RFFE were design rainfall intensities of 6 mm/h and 12.5 mm/h for a 6 hour rainfall intensity of the 50% (1 in 2) and 2% (1 in 50) AEP events. The catchment's centroid is located at -34.914, 149.763 and the outlet is at -34.807, 149.752. Distance to the nearest gauged catchment is 21 km.

The RORB model parameters adopted for this study were those recommended by the ARR guidelines for NSW catchments and site specific IFD rainfalls. The methods for calculating the hydrologic model results, were those specified by ARR and OEH guidelines for NSW. As an independent check, the hydrologic model results were compared RFFE. The modelled discharges were comparatively higher, but were within the uncertainty bands for an RFFE peak discharge. These moderately higher values provided a level of conservatism in the assessment.

[5] https://rffe.arr-software.org/

Table 4.7 **Comparison of hydrologic model's design peak discharges at proposed BESS location with RFFE**

AEP (%)	RFFE design peak discharge (m^3/s)			Modelled design peak discharge (m^3/s)
	Expected parameter quantile	5th %ile confidence limit	95th %ile confidence limit	
10	78.9	26.0	219	122
5	110	32.2	325	152
1	189	41.0	714	237

4.5.3 PMPF and PMF relationship

Several relationships exist for undertaking rapid checks of the PMF and PMPF derived from Australian studies. The most recently documented relationship is available in Watt, et al. (2018) that built on the work reported by Malone (2011) and Nathan, et al. (1994).

The Malone (2011) relationship based on 26 dams in Southeast Queensland, many using the GTSMR and GSDM approach with an URBS model. Watt, et al. (2018) revised the relationship above using 52 catchments drawn from eastern Australia. The standard error from the study was -29% to 41%.

$$Q_{PMPF} = 226*Area^{0.586} \quad \& \quad Q_{PMF} = 327*Area^{0.562}$$

Comparisons between hydrologic models peak discharges and quick estimate methods are given in Table 4.8. Overall, RORB model results are in reasonable agreement with these independent PMF estimates.

Table 4.8 **Comparison of PMPF design peak inflows at proposed BESS location with Watt (2018)**

AEP (%)	Watt (2018) quick method peak discharge (m^3/s)			Modelled design peak discharge (m^3/s)
	Expected	-1 standard error	+1 standard error	
PMPF	3494	2480	4927	2844

5 HYDRAULIC MODEL DEVELOPMENT

5.1 OVERVIEW

The two-dimensional TUFLOW hydraulic model (BMT, 2020) was used to simulate the flow behaviour through the Project Area. TUFLOW represents hydraulic behaviour on a fixed grid by solving the full two-dimensional depth-averaged momentum and continuity equations for free surface flow. TUFLOW has the capacity to represent complex hydraulic structures, floodplain storage and floodplain/channel interaction. The model was compiled and simulated with build version: 2023-03-AA-iSP-w64 using subgrid sampling. The model automatically calculates breakout points and flow direction within the study area. An adaptive time step is used by the computational engine to maintain simulation stability.

The hydraulic model was run for the 10%, 1%, 0.5% (1 in 200) and 0.2% (1 in 500) AEP design events and PMF for their respective critical durations. The model results were used to assess flooding behaviour for the existing conditions. The existing conditions model was then adapted to represent the proposed developed conditions, to assess the potential extent and magnitude of impacts of the Project.

A description of the development of the TUFLOW models is outlined below.

5.2 MODEL DEVELOPMENT – EXISTING CONDITIONS

Figure 5-1 shows the adopted TUFLOW model extent. The hydraulic model's domain is 46 km^2. Also shown is the adopted TUFLOW model configuration for the Project Area. The model uses a five-metre cell size with a subgrid sampling distance of one metre. This grid size configuration is to ensure a good representation of major drainage features (including road embankments and channels or gullies), while achieving reasonable model simulation durations.

5.2.1 Topographic data

Model topography was extracted from the available topographic data described in Section 2.3.1 and comprises 1 m and 5 m LIDAR survey data supplied via ELVIS[6].

5.2.2 Structures and blockage

Culverts, bridges and perimeter fencing can block during events and significantly affect peak flood levels both upstream and downstream of these hydraulic structures. Blockage of hydraulic structures can occur with the transportation of materials by flood waters. Near to the Project Area the vegetation is most likely to be logs and fallen trees. While this vegetation debris may mobilise and travel towards the Project Area, the latched tube fencing shown in Figure 3-1 was selected for its ability to avoid capturing or trapping mobilised debris. The debris, if present and generated from the surrounding cleared land, would be conveyed through the latched tube fencing and continue without accumulating.

Current guidance on culvert blockage is dependant on debris loading and size of the culverts. The proposed culverts are located well inside of the Project Area. The Project Area will comprise cleared land that will have solar panel arrays installed. The debris loading reaching the culverts would most likely only be the low vegetation and grass covering that would be maintained around the solar panel

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[6] https://elevation.fsdf.org.au/

https://nsw-elvis.s3-ap-southeast-2.amazonaws.com/elevation/5m-dem/z55/Goulburn201312/metadata/Goulburn201312-PHO3-AHD_7406172_55_0002_0002_5m.html arrays. Assuming the Project adopts reinforced concrete box culverts, the allowance for blockage from this type of debris would be negligible. For this reason, and given the conceptual nature of the project, no structure blockages were assumed.

5.2.3 Hydraulic roughness

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance across the TUFLOW model area. The adopted Manning's 'n' values corresponding to each land use type are the same as detailed in the *Goulburn Mulwaree Flood Study* (GRC, 2022). The adopted Manning's 'n' values are shown in Table 5.1. In the absence of recorded water level data, it was not possible to calibrate the hydraulic model.

The classification of land use areas for hydraulic modelling was based on the aerial imagery (NearMap). The adopted existing conditions land use mapping is shown in Figure 5-2.

Table 5.1 Adopted hydraulic roughness coefficients

Land use description	Manning's 'n' coefficient
Open Areas (grazing, cropping)	0.06
Medium Vegetation	0.08
Thick Vegetation	0.10
Waterways	0.04
Substation and Battery	0.04

Source: Table 33 (WMA, 2016)

5.2.4 Inflow and outflow boundaries

A combination of approaches was utilised to model flow and rainfall arriving at the Project area. The hydrologic model generated catchment flows that reached the extent of the hydraulic model. Within the hydraulic model, excess rainfall was directly applied to every grid cell. This fully distributed approach to applying rainfall is a preferable way to model rainfall over a solar farm. The alternative would require local numerous subcatchments within RORB. Design flow hydrographs produced by the hydrologic model were applied to the TUFLOW model as inflow hydrographs as shown in Figure 5-1, using the 'Flow-Time' (QT) inflow approach. The QT inflow approach was used to apply local catchment inflows at the top of a flow path. Normal flow (HQ) type boundary conditions were adopted for downstream model boundary, based on the downstream channel slope. The downstream boundaries of the models were set well downstream of the Project Area to minimise influence on flood behaviour predicted near the Project Area. The downstream boundary conditions assumed a normal depth slope of 0.01 m/m. This normal depth slope is typical of the bed slopes found in each of the creek systems.

5.3 DEVELOPED CASE CONFIGURATION

Figure 5-2 shows the configuration of the landform for the proposed development configuration including the Project. There are no significant earthworks proposed, and generally there is only minor infill adjustments required, mainly levelling to create a smooth development footprint for solar panel installations. This levelling includes the removal of existing minor farm dams, the model was adjusted for contiguous flow paths. Access roads planned within the development footprint are to be designed to ensure overland flow is not re-directed. Building and infrastructure pads will not be impacted by or positioned near concentrated overland flow.

The key differences from the existing conditions model to represent the proposed development are:

- Smoothing of landform and infill of existing small dams;
- Minor site drains that redirect runoff around the solar panel infrastructure;
- Perimeter security fencing and latched tubes crossing of waterways;
- Gravel pads around substation and entrance works; and,
- Access road from entrance to rest of Project Area including minor culvert crossings.

The proposed conditions use the same hydrologic inputs and locations as the existing conditions hydraulic model. The developed conditions hydraulic model includes the additional culverts and access track configuration. The culverts were represented as one-dimensional network structures in TUFLOW. Blockage of hydraulic structures (culverts and bridges) for design events was determined based on guidelines in Book 6 – Chapter 6 of AR&R 2019 (Ball et al., 2019). The debris potential classification for structures within the model extent was determined as "Low" given the velocities and low vegetation coverage.

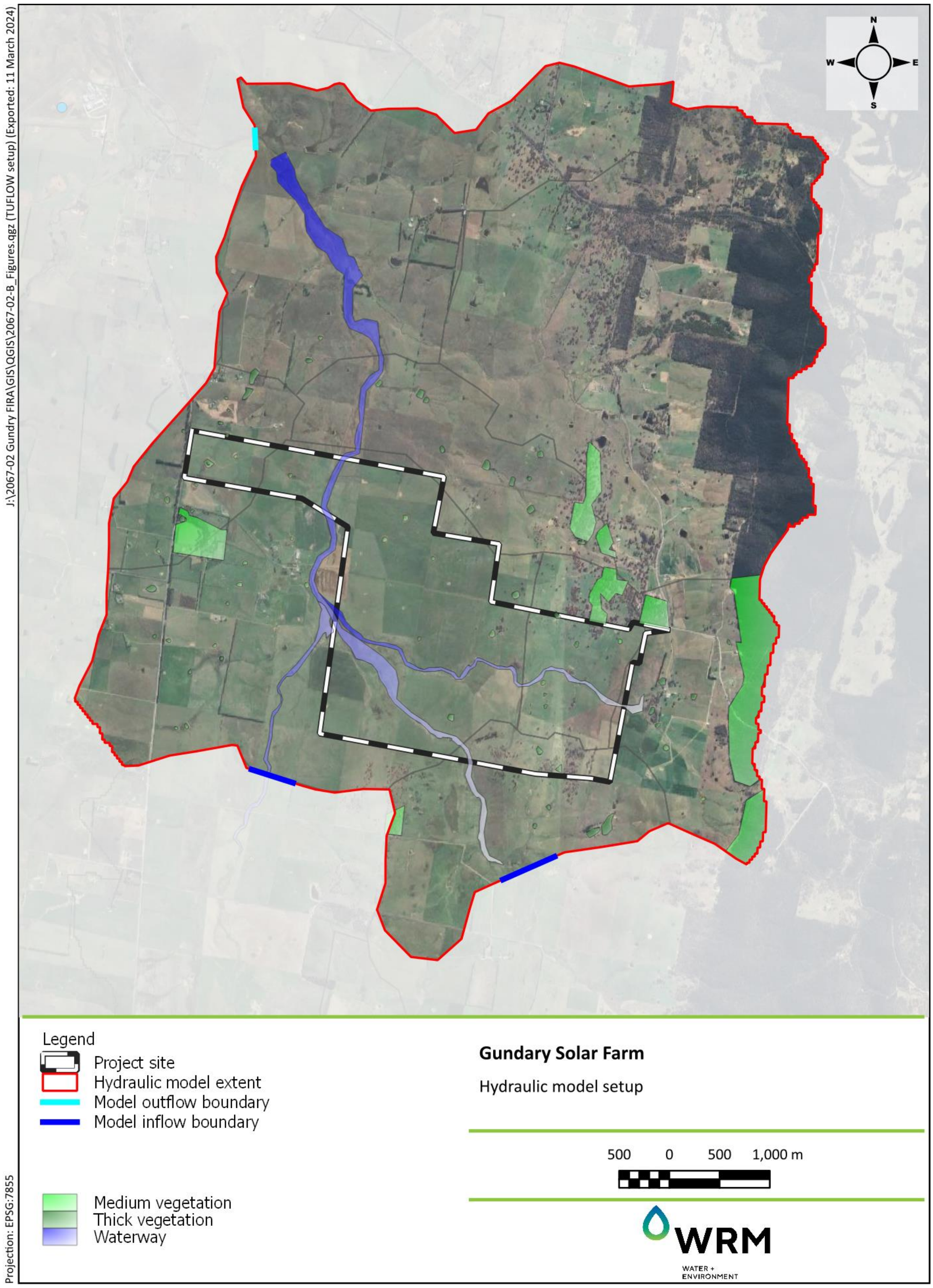

Figure 5-1 TUFLOW model configuration of existing case

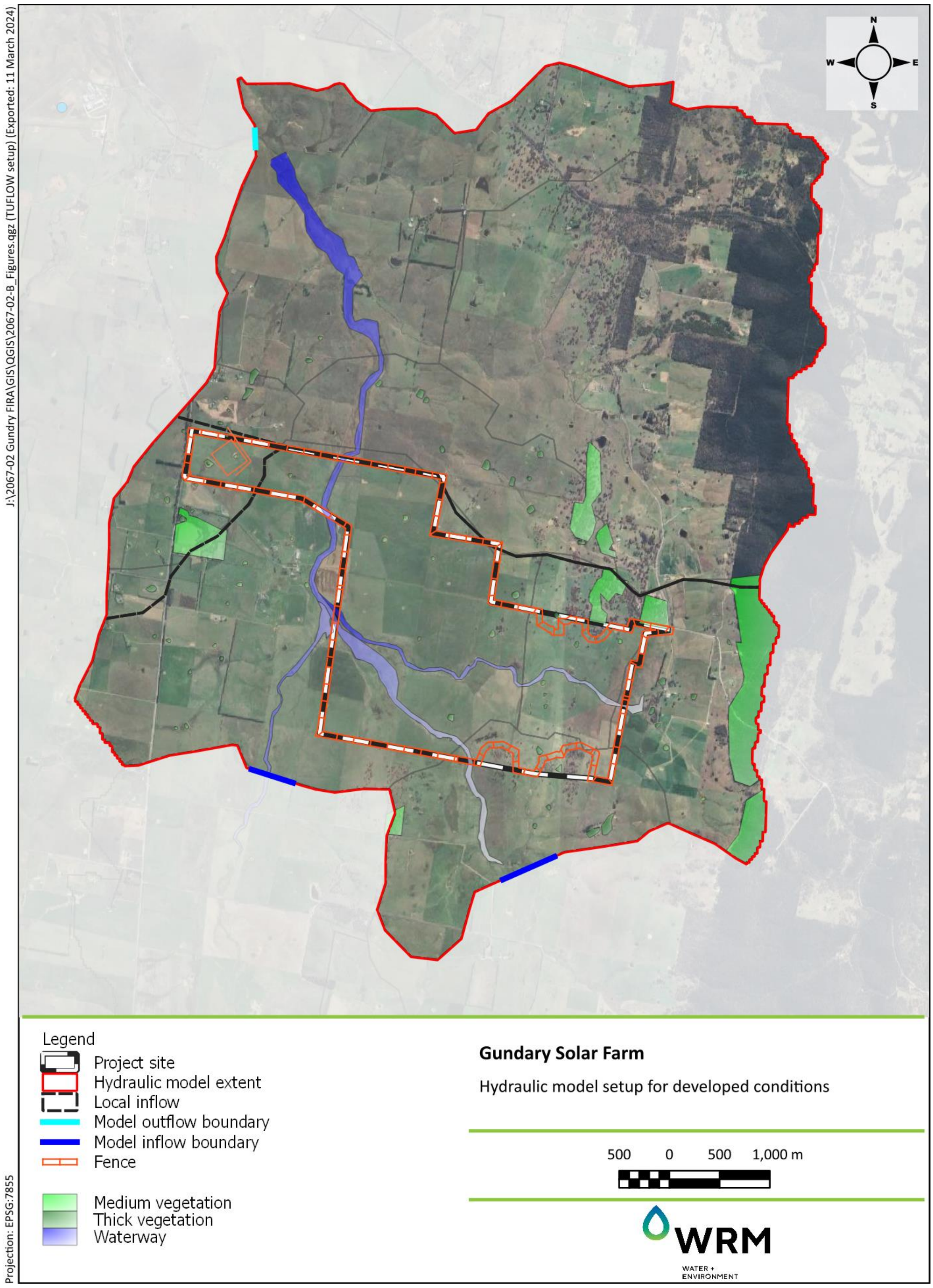

Figure 5-2 TUFLOW model configuration of developed case

6 FLOOD MODEL RESULTS AND ANALYSIS

6.1 OVERVIEW

The assessment considered the impacts of the Project on flood depth, velocity and hazard for the 10%, 1 %, 0.5 %, 0.2 %, and 0.05 % AEP events and PMF event. Due to the minor modifications to landform and hydrological regime, the impacts of the development on flood depth and velocities are negligible. The site infrastructure are proposed to be located outside of the primary flowpaths. As result, flood impacts are considered to be minor in all modelled events.

The peak existing depths and impacts for the 1% AEP event are shown in Figure 6-3 and Figure 6-5 while 1% AEP existing velocities are shown in Figure 6-4. The complete suite of flood mapping for the existing, developed and impact mapped cases are presented in Appendix A through Appendix C.

6.2 FLOOD HAZARD AND FLOOD RISKS

Flood hazards were considered in accordance with NSW Government 2023 *Flood Risk Management Guidelines*, which present several hazard categories for flood modelling results as shown in Figure 6-1. Flood hazard results for existing and developed conditions are presented in Figure 6-6, Appendix A and Appendix B. They show the Project Area's flood hazard reaches high hazard in the deeper central flow path locations, with shallower and overbank areas being considered low hazard. There was minimal change in risk to the internal and external waterway flows between existing and developed conditions.

Access points to the Project Area were also predicted to be of low flood hazard. Design of waterway crossings for access points and crossings within the Project Area will be undertaken at the detailed design phase.

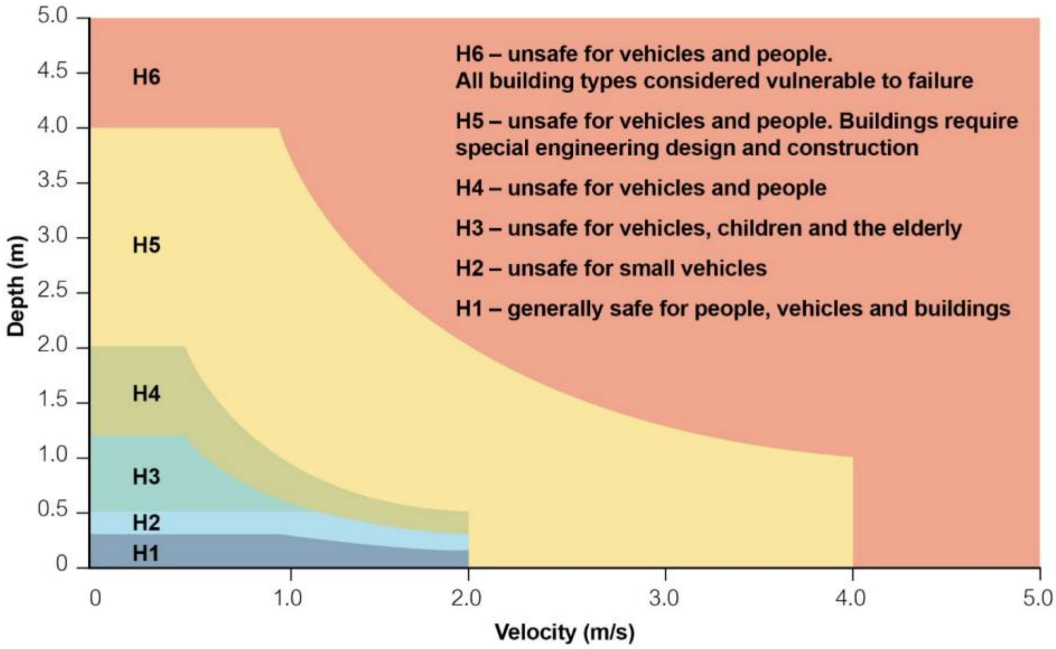

Figure 6-1 Flood hazard map (DPE, 2023)

The creek watercourses are areas of higher flood hazard and the installation of PV arrays in these areas will be avoided in Detailed Design. As such, mitigating the minor flood impacts shown in the flood modelling results is recommended by maintaining a waterway corridor buffer where the baseline hydraulic roughness will remain unchanged. Although the reaches of creeks within the development footprint do not have substantial riparian vegetation, avoiding installation of PV arrays in the waterway corridor will reduce, and likely eliminate, offsite impacts.

There will also be security fencing situated around the perimeter of the site with setbacks from the creeks based on the adopted waterway buffer. Due to the presence of multiple flow paths across the site, the fencing is unlikely to become a trap for loose vegetation in high flow events. In very rare and extreme flood events, coupled with unanticipated debris loading there maybe additional structural loading on the fence which may cause damage.

The results of the flood impact assessment show that the infrastructure and solar panels within the Project Area are located outside areas of major flood hazard. Peak stormwater discharges from the Project Area for impervious areas may increase slightly through the creation of compacted gravel roads and some small operational buildings. However, potential impacts to drainage features and downstream watercourses are likely to be minimal due to the relative size of the Project Area in relation to the size of the receiving catchments, and the distributed nature of minor impacts.

6.3 FLOOD IMPACTS

Based on the outcomes of the flood modelling, the Project is predicted to result in minor impacts on flooding, including flow rates, velocities and depths. Flood impacts are shown in Figure 6-5 and in Appendix C. Typically, infrastructure upgrades for the Project did not increase flood depths or velocities due to the interaction with diffuse flows and use of unsealed roads in the developed conditions.

The proposed infrastructure located within the Project Area is not expected to increase runoff, provided that groundcover established for the developed case provides similar levels of infiltration. The minor increase in imperviousness within the proposed infrastructure area does not create offsite impacts. The project earthworks do not include any infilling or reduction in floodplain storage. The filling and levelling of small farm dams within the development footprint is not anticipated to impact peak flows as they fill early in a storm event and are located outside the floodplain in overland flow paths.

Implementation of standard erosion and sediment control practices will ensure that the Project will not directly or indirectly increase erosion or siltation in watercourses. The volume of runoff and velocity of flow will not change with any significance as the developed case vegetation is expected to provide similar hydraulic roughness to existing conditions.

Areas where layered flow constrictions were applied to represent fenced restrictions and latched tubes interacting on the channels had slight reductions in velocity entering the Project area. No notable increases in water level occurred in the main channel because of layered flow constrictions, however the far eastern creek tributary experiences increase in water level of up to 40 mm, 10 to 30 m upstream of the entrance (shown in Appendix C). Along the far west flow path, redirection of water around the transmission substation has caused a net decrease of downstream water level with a small area of water level increase (shown in Appendix C) due to the realignment of drainage around the substation. In all other modelled events, the location, extent and magnitude of the impacts are very similar. There are no other locations where the development adversely increases or re-directs flooding at neighbouring properties.

6.3.1 Flood impacts relating to Solar Arrays and BESS

Published literature (Muller, 2023) regarding the surface water impact of PV arrays indicates that additional runoff from solar PV project is unlikely. While solar panels are wholly impervious, runoff from panels is not directly connected to the downstream drainage system and will drain onto the existing pervious landform and soils. Therefore, the modelled existing hydrologic conditions are likely to be unaffected by the project infrastructure.

The flood modelling results show that the proposed solar farm is not predicted to cause external impacts in terms of water surface levels and peak discharges.

There is a requirement for the construction of PV arrays to fill/level some minor areas included within the flood inundation extent. In relation to rare event flood volumes, the farm dams within the Project Area do not hold significant volumes of water. Filling these minor dams will not adversely impact flood behaviour of receiving watercourses.

The flood modelling results also show that the location of the proposed solar array and access from Windellama Road are suitable in terms of flooding constraints. Areas with a high flood depth and velocity are considered as inappropriate for solar panel installation. The locations where the overland flow path exceeds depth and velocity values expected to be high risk for infrastructure will be identified as 'exclusion' areas in the development layout. For the remaining areas, the probability of erosion and scour is expected to be minimal.

Panel footings located in high velocity areas create the potential for localised scouring around the solar panel poles which can lead to deflection of the array and cracking of solar panels. To reduce the likelihood for erosion and damage to the solar panels, the foundations for all project infrastructure (in particular the photovoltaic arrays and transmission lines) should be located away from areas that exceed flood depths of 0.3 m and flow velocities greater than 1.5 m/s. However, in areas where higher flood depths are predicted these locations could include solar panels, but they would require raising of the solar panel poles which can be confirmed as part of the detailed design.

The solar panels were designed to provide a minimum of 500 mm freeboard for the lowest edge above the maximum 1% AEP flood level. The panel post and footings should be designed to withstand the flood velocities described in this report, which are mostly low in the areas proposed for solar panels. To provide guidance on the areas that are most appropriate for PV arrays and other site infrastructure (e.g., substation, the operational facility and BESS) the waterways and constraint areas were defined using the flood depths and velocities from the 1% AEP event as described below:

- Area of higher flood hazard: consider flood constraints in the Project's detailed design and avoid installation of PV arrays or BESS infrastructure in this area unless the hazard can be mitigated. This area includes depths above 0.3 m and velocities above 1.5 m/s.
- Area of low flood hazard: the Project's detailed design would adopt a minimum of 300 mm freeboard to the 1% AEP flood level for any infrastructure. This area includes depths above 0.1 m and velocities above 1.0 m/s.
- Unconstrained: All other areas.

Note that existing farm dams were included in the flood model as these are to be filled and levelled meaning that depths will generally be shallow, and most will not form part of the area of higher flood hazard.

The location of the proposed substation is outside of the flood extent and is considered appropriate in terms of flood risk.

6.3.2 Flood impacts relating other Infrastructure and Access Roads

Access tracks, waterway crossings (i.e., minor culvert crossings or causeways) and buried cable reticulation are the only works proposed within or near to the watercourses. Security fencing around the perimeter of the development footprint has the potential to trap and accumulate flood debris and impede flows. The use of a latched tube fencing as shown in Figure 3-1, the maintenance of low vegetation and ground covers, will mitigate the risk of afflux that may result from debris loading. Should minor debris loading occur at the perimeter, this is only likely to result in a localised and minor

(< 10mm) increase in water level upstream of the blockage and potential redistribution of flow at the boundary. Given the local topography and minor nature of the identified watercourses in the Project Area, any redistribution of flow through fence blockage would be localised and the risk of any potential blockages is low. Any inundation outside of the mapped flood extents would be minor. Fence maintenance and clearing of debris after each flood event will further minimise any potential impacts.

6.3.2.1 Access roads

The Project requires construction of a network of internal unsealed all weather roads which will provide access to the solar arrays for construction and ongoing operational maintenance. The location of the roads will be finalised during detailed design for the Project, but the indicative design is presented in Figure 6-2.

The indicative configuration of access roads will require waterway crossings listed in Table 6.1. The locations of these crossings are shown on Figure 6-2. This table summarises the peak depth and flow velocities for the 1% AEP event.

Table 6.1 Waterway crossings

Point ID	Road	Waterway Crossing	Peak modelled 1% AEP depth (m)	Peak modelled 1% AEP velocity (m/s)
1	Internal crossing (south)	Creek	1.5	1.6
2	Internal crossing (centre)	Creek	0.3	0.9
3	Fencing (southwest)	Creek	1.4	1.0
4	Fencing (east)	Creek	0.6	1.7
6	Internal access (main)	Upstream of Dam	1.3	0.1
5	Internal access (minor)	Creek	0.2	0.3
7	Internal crossing (culvert location)	Creek	1.6	1.6
8	Fencing (south)	Creek	1.0	1.3
9	Lateral Fencing (south)	Creek	0.9	1.4

Site specific designs will be finalised during detailed design and constructed generally in compliance with the guidelines listed above, and in accordance with the development consent conditions.

Peak flood velocities crossing access tracks will be managed during construction to ensure sediment is not mobilised in a significant rain event. Inspection after storm events will be required to ensure erosion does not impact the access roads through the life of the Project. Erosion and sediment controls will be implemented during construction in accordance with the Landcom guidelines for *Managing Urban Stormwater: Soils and construction* (Landcom, 2004) that provide for industry to reduce the impacts of land disturbance activities on waterways.

Figure 6-2 Model velocity sampling points

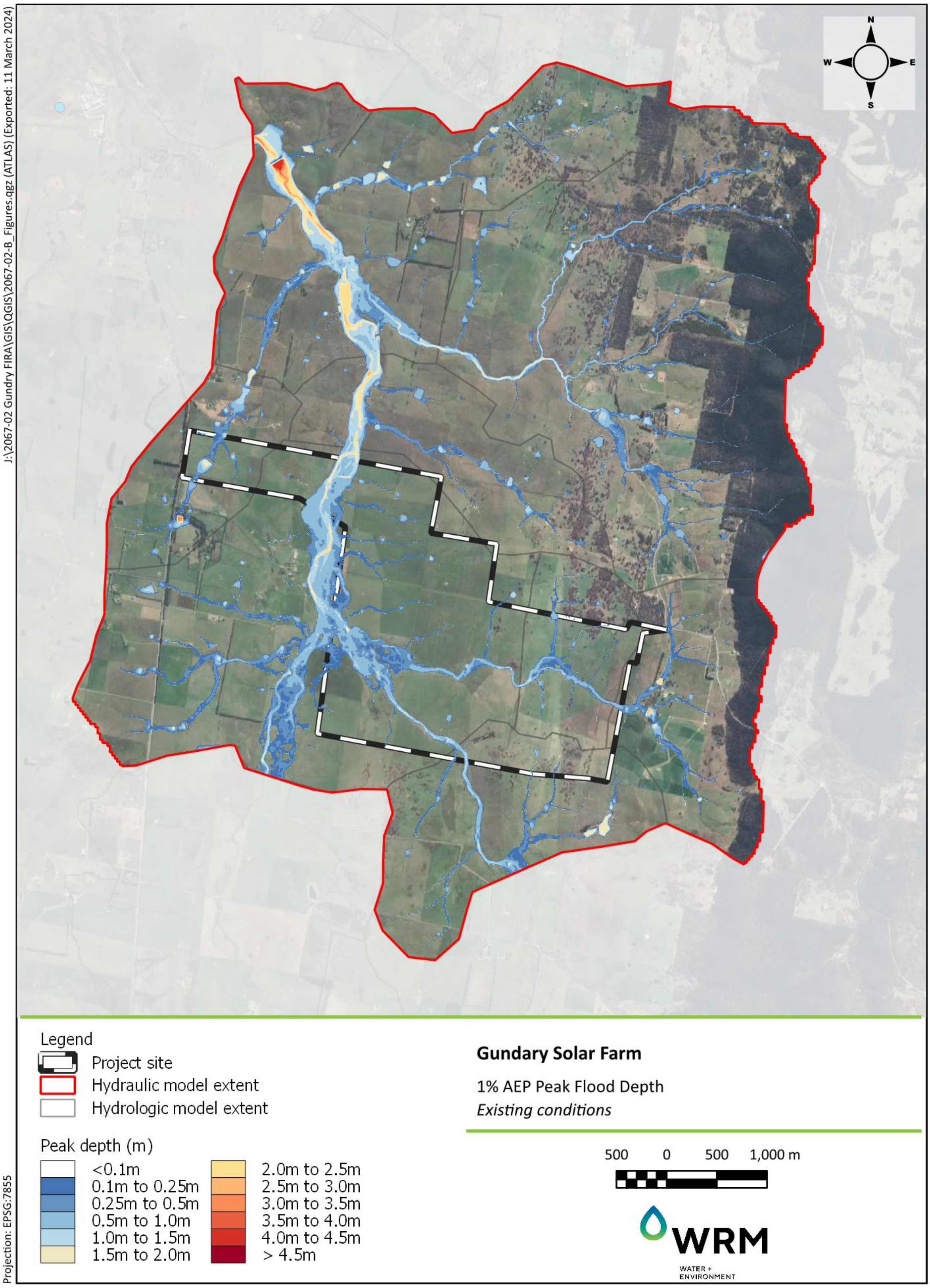

Figure 6-3 Existing case flood mapping 1% AEP depth

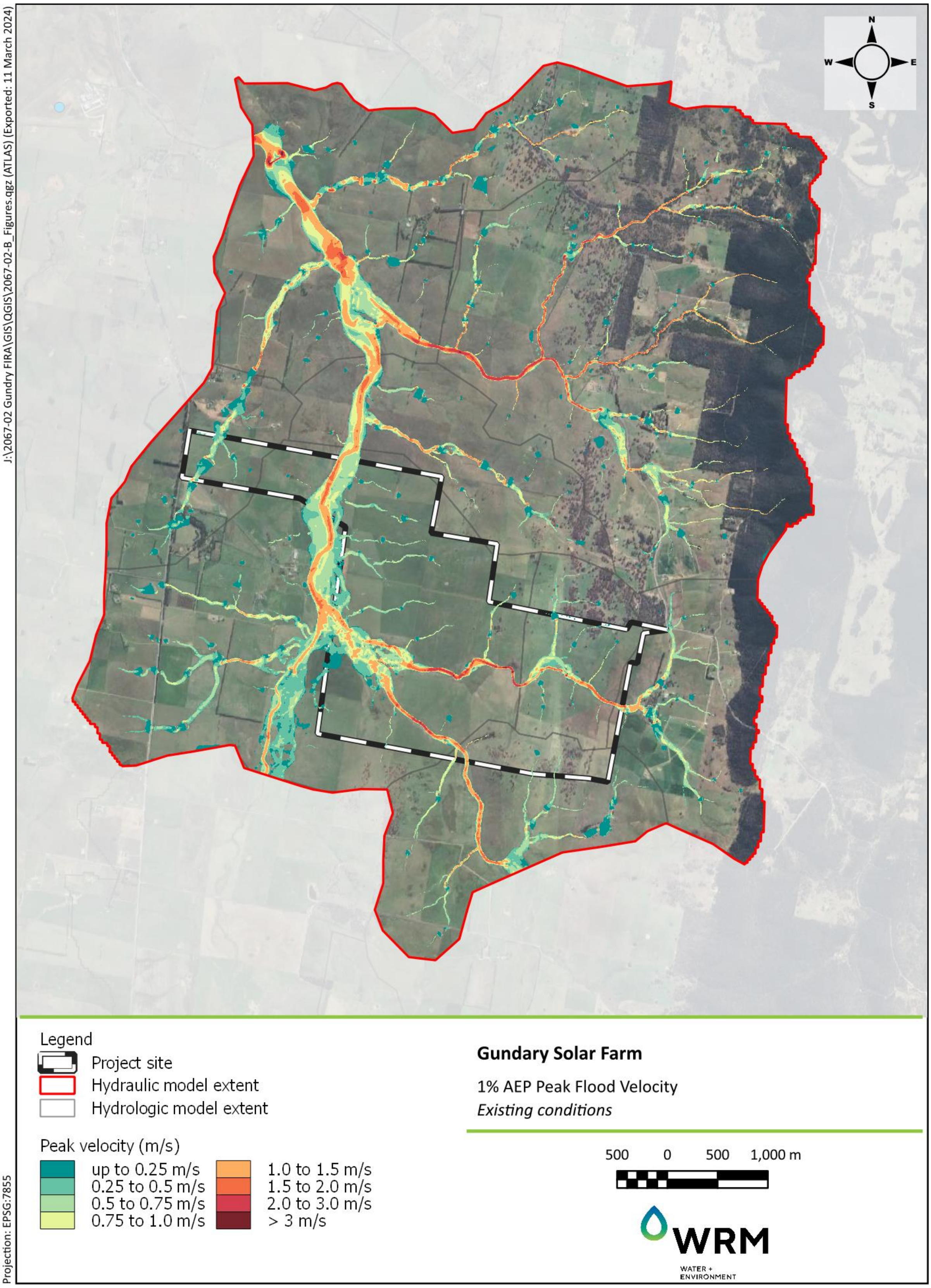

Figure 6-4 Existing case flood mapping 1% AEP velocity

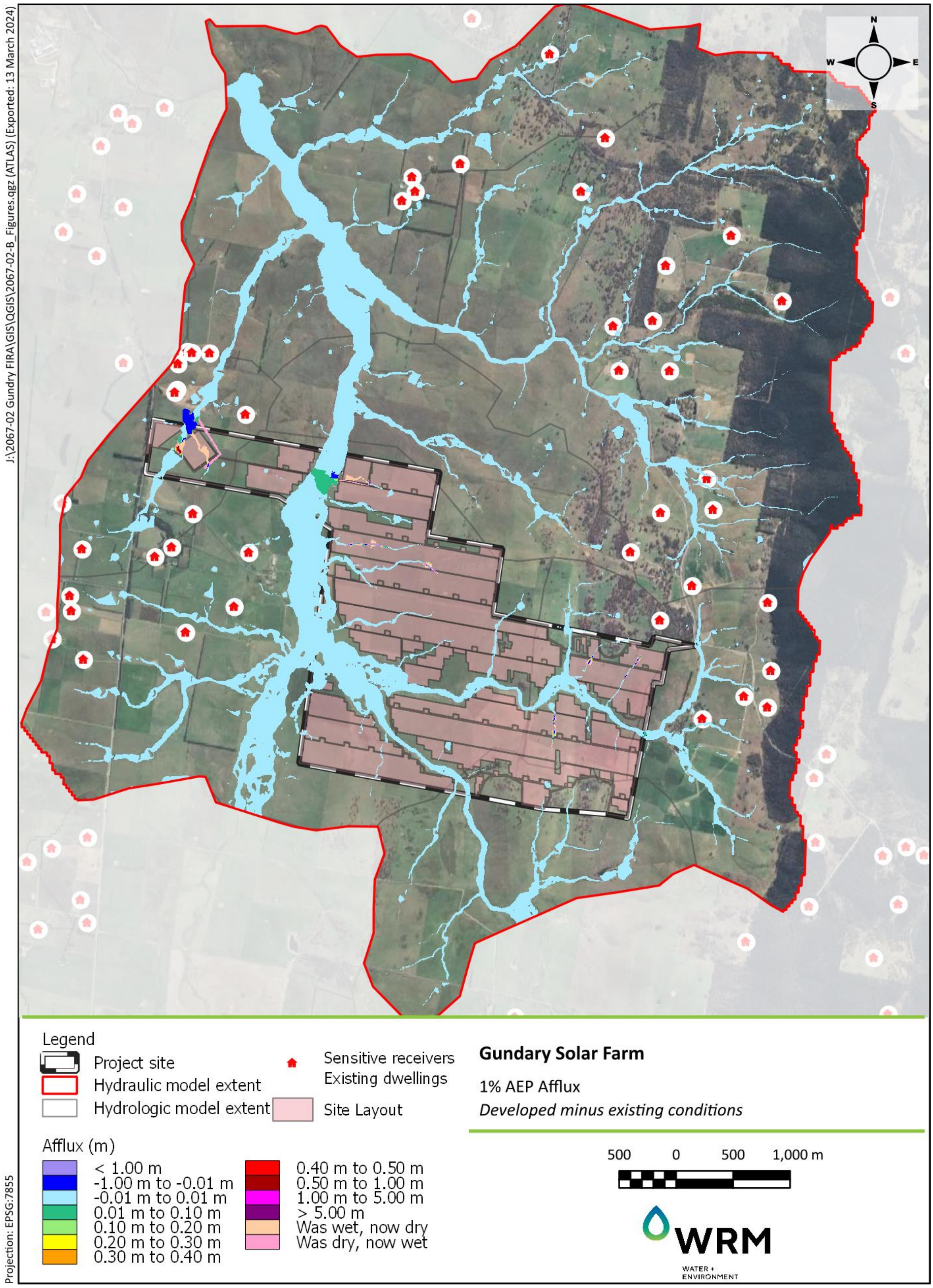

Figure 6-5 Flood level impact mapping 1% AEP

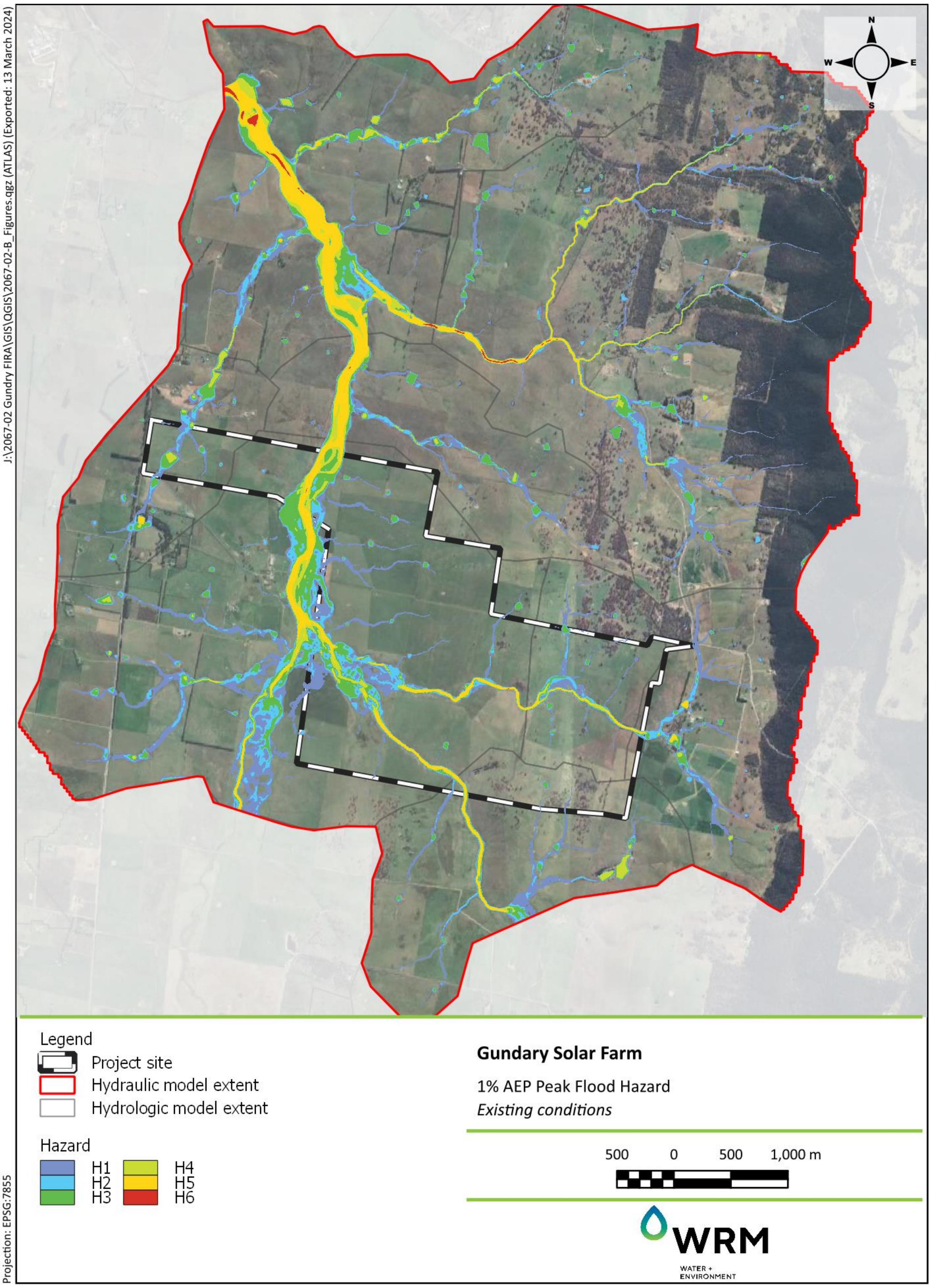

Figure 6-6 Flood Hazard mapping 1% AEP

7 KEY RISKS TO BE MANAGED

7.1 FLOOD EMERGENCY MANAGEMENT

7.1.1 Severe Weather Warnings

The Bureau of Meteorology has a range of severe weather warning systems appropriate for use in the operation of the solar farm. It is recommended that operations staff have access to the following facilities for early severe weather warnings:

- The Bureau of Meteorology "MetEye" provides severe weather warnings, summaries listed by State, and live updates. Other information provided by the application such as radar and forecasts are also useful.
- The Bureau of Meteorology "RSS feeds" (Really Simple Syndication) is an information system which provides the latest weather information and may be issued any time. RSS feeds has a Land Warning feed for NSW, which can provide up-to-date information as soon as it becomes available to desktop and mobile devices. See: http://www.bom.gov.au/rss/

During heavy weather warnings, ABC Radio announces information on flood affected areas and road closures. Radio and Bureau of Meteorology information should be reviewed frequently for potential major flooding and road closures.

7.1.2 Notification of Staff at Risk from flooding

Staff are not required to be present at the Project Area, O&M facility during large flood events. Facility members and visitors can be notified of potential flooding, road and facility closure via several mechanisms:

- Staff access to severe weather applications;
- Message notification via mobile phone, sent to all group members;
- Group email;
- Individual telephone notifications.

7.1.3 Evacuation Route

The Project Area is free from regional riverine flooding from the Wollondilly and Mulwaree Rivers, and flood risks are from flash flooding of the local creeks. This flood assessment confirms that flood evacuation routes are realistically achievable for the Project Area, without placing additional burden on emergency services. The detailed designer will plan the evacuation routes, taking into account zones of flood hazard shown in Appendix B.

7.1.4 Consultation

Consultation with Council's flood engineers were undertaken during the preparation of the Environmental Impact Statement.

7.2 FLOOD EMERGENCY MANAGEMENT PLAN

At this point in time, it is not considered necessary to produce detailed emergency management procedures for flooding. However, it is proposed that a detailed Flood Emergency Management Plan (FEMP) will be incorporated into the Fire Management and Emergency Response Plan (FMERP). The FMERP be developed following project approval and prior to commencement of construction, covering but not limited to the following.

7.2.1 Roles and Responsibilities

Further details and specific procedures need to be developed for the Study Area, and this report clearly lays the foundation for these procedures and demonstrates that flood warning and evacuation of the Project Area is realistically achievable. The initial requirement for the procedures will need to identify roles and responsibilities:

- Who has legal responsibility for the maintenance and implementation of the FMERP;
- The specific roles and responsibilities of the business owner or facility manager;
- Whether there are Flood Duty Officers on-site and their roles and responsibilities;
- Roles and responsibilities of all facility users including public and members.

7.2.2 Procedures for Before, During and After a Flood

Flood emergency management procedures and training should be provided for staff and management working at the facility. A formalised induction will also be required for new members. The development of future Workplace Health and Safety (WHS) Procedures (recommended to be undertaken by a WHS specialist), Staff Training and Inductions should include:

1. At all times

- Annual testing (e.g., drills) of FMERP procedures, including annual review and update;
- Adequate resourcing of the FMERP, including designated trained flood duty officers;
- Staff and club member induction accreditation;
- Monitoring of weather conditions and warnings, weather forecasts;
- Create and annually update the emergency contact list;
- Ensure all equipment and resources to implement the FMERP are available and in working order.

2. When a flood is likely

- The FMERP manager monitors the official warnings, selected response triggers and warning system;
- Facility occupants are notified of the possibility of flooding and reminded of actions and procedures should an emergency response be required;
- If early evacuation is the selected response action, the selected means of transport is provided, and evacuation occurs before cut off time;
- If sheltering in place is the selected response action stocking of food and medications is undertaken by occupants according to the maximum possible duration of isolation;
- Other resources are brought in as required by the FMERP;
- Movable objects are secured;
- Outdoor activities are suspended;
- Safety equipment is checked.

3. During a Flood

- The FMERP manager monitors the official warnings, response triggers and warning system;
- Evacuations cease, and no one leaves the premises until all clear is given by emergency services;

- Members who are not on the premises at the time are notified not to try and reach the premise;
- FMERP manager provides regular updates on the situation to members.

4. After a Flood

- Check the structural integrity of infrastructure before evacuees can return to the premises (a qualified structural engineer may be required);
- Check the safety and function of services before evacuees can return to the premises;
- Organise a safe clean-up;
- Review the FMERP to account for lessons learnt.

7.3 MITIGATION MEASURES

In particular, to withstand potential flood events, the following is recommended:

- Maintaining the natural state of the drainage flow paths whenever possible. Internal access roads, where crossing watercourses, should be designed for 10% AEP design flow and could include compacted rock causeways to provide low maintenance access with limited impact on the waterway or culvert structures.
- Foundations for the all project infrastructure, including photovoltaic arrays and transmission lines, should be located away from areas that exceed both flood depths of 0.3 m and flow velocities greater than 1.5 m/s. Detailed design of the project should consider the results of the flood models, in particular the 1% AEP scenario. For instance, solar panels would be designed to provide a minimum of 300 mm freeboard for the lowest edge above the maximum 1% AEP flood level.
- Infrastructure with the potential to cause pollution to waterways in the event of flooding, such as inverters and battery storage would be located with a minimum 300 mm freeboard above the maximum 1% AEP flood level. Given the shallow depths across the site, raising these small fill pads is highly unlikely to result in any adverse impacts offsite.
- BESS components are located on hardstand areas and are aligned with local overland flow paths to prevent flows being redirected which could lead to localised increased in flood level and higher risk of scour and erosion.
- The design and construction of waterway tracks and cable crossings and all internal tracks crossing watercourses within the proposed development footprint should be generally in accordance with the:
    - *Guidelines for controlled activities on waterfront land – riparian corridors* (NSW 2018),
    - *Guidelines for watercourse crossings on waterfront land* (NSW, Office of Water) and
    - *Guidelines for laying pipes and cables in watercourses on waterfront land* (NSW, 2012).
- The best practice principles for stormwater and sediment control outlined in *the Managing Urban Stormwater: Soils and construction* (Landcom, 2004) guidelines will be incorporated into the design, construction and operation phases of the solar farm site as part of a Stormwater Management Plan and Erosion and Sediment Control Plan.

8 CONCLUSIONS AND RECOMMENDATIONS

This document provides an assessment of existing flood behaviour and impacts relating to the Project in accordance with the SEARs and agency advice. Existing conditions flood modelling was undertaken for a range of events; 10%, 1%, 0.5%, and 0.2% AEP flood events and PMF for the Project Area to guide the planning of infrastructure and assess any external impacts.

The flood impact assessment has been conducted in accordance with the Australian Rainfall and Runoff 2019 guidelines. Comparison of the existing and developed scenarios, refer to mapping provided within Appendix C, which shows no flood impact extends outside the Project Area, aside from:

- Upstream at the eastern flow path;
- Internally where diversion occurs upstream of the BESS; and
- Downstream of the western substation where a net decrease occurs.

There were no impacts on sensitive receptors or existing dwellings located nearby. The modelling indicates that the proposed solar farm does not cause significant external impacts in terms of water surface levels and peak discharges and accordingly no substantial mitigation measures such as detention basins are required. Additionally, proposed solar panels are within the bounds of low flooding risk (depth less than 0.9 metres and velocities less than 1 m/s) and other infrastructure including the substation is outside of the 1% AEP flood extent. The risk of adverse impacts to erosion and scour is considered minimal.

Flood risk of all proposed infrastructure should be assessed as part of detailed design, with infrastructure located outside flood prone areas wherever possible. The proposed design of key infrastructure has located them outside of, or located above, the 1% AEP flood event areas.

9 REFERENCES

Babister, M., Trim, A., Testoni, I. & Retallick, M. 2016	The Australian Rainfall & Runoff Datahub, 37th Hydrology and Water Resources Symposium Queenstown NZ. http://data.arr-software.org/
Ball et al, 2019	'*Australian Rainfall and Runoff: A Guide to Flood Estimation*', Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), © Commonwealth of Australia (Geoscience Australia), 2019
BMT, 2018	*'TUFLOW User Manual Build 2018-03-AD'*, BMT WBM Pty Ltd, 2018
BMT, 2020	'*TUFLOW Release Notes 2020-10-AB*', BMT WBM Pty Ltd, 2021
BoM, 2023	Design Rainfall Data System (2016), Commonwealth of Australia. http://www.bom.gov.au/water/designRainfalls/revised-ifd/
Laurenson, E. 2010	*RORB Version 6 User Manual* revision v0.2 https://www.harc.com.au/software/rorb/
Geoscience Australia, 2019	AR&R Data Hub (software), Geoscience Australia, Version 2019_v1, April 2019, http://data.arr-software.org/.
DPE, 2023	*'Flood hazard – Flood risk management guideline FB03',* NSW Government, Department of Planning and Environment, 2023
Muller, 2023	*Solar Farm Flood Hydraulics*, Engineers Australia, Hydrology and Water Resources 2023 Sydney
WMA Water, 2019	Review of ARR design inputs for NSW. Report for the NSW, Office of Environment and Heritage. Authors: Podger, S., Babister, M., Trim, A., Retallick, M. and Adam, M. 9 https://rffe.arr-software.org/

10 ABREVIATIONS AND DEFINITIONS

Term/ Abbreviation	Definition
AEP (Annual Exceedance Probability)	Annual Exceedance Probability. The change of a flood of a given or large size occurring in any one year, usually expressed as a percentage. In this study AEP has been used consistently to define the probability of occurrence of flooding. The following relationships between AEP and ARI applies to this study (ARR, 2019).

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI
Very frequent	12			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.50
	1	63.2	1.58	1.00
Frequent	0.69	50.00	2	1.44
	0.5	39.35	2.54	2.00
	0.22	20.00	5	4.48
	0.2	18.13	5.52	5.00
	0.11	10.00	10.00	9.49
Infrequent	0.05	5.00	20	20.0
	0.02	2.00	50	50.0
	0.01	1.00	100	100
Rare	0.005	0.50	200	200
	0.002	0.20	500	500
	0.001	0.10	1000	1000
	0.0005	0.05	2000	2000
Extremely Rare	0.0002	0.02	5000	5000
			↓	
Extreme			PMP	

Term/ Abbreviation	Definition
AHD	Australian Height Datum. A common national surface level datum approximately corresponding to mean sea level.
ARR	Australian Rainfall and Runoff. Guidelines prepared by the Engineers Australia for the estimation of design floods.
BESS	Battery Energy Storage System.
Development footprint	The maximum extent of ground disturbance associated with the construction and operation of the Project.
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).

Term/ Abbreviation	Definition
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below: Existing flood risk: the risk a community is exposed to as a result of its location on the floodplain. Future flood risk: the risk a community may be exposed to as a result of new development on the floodplain.
Flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is flood prone land.
Hazard	A source of potential harm or situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community.
Hydrology	The study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
m AHD	Metres Australian Height Datum (AHD).
m^3/s	Cubic metres per second or “cumecs”. A unit of measurement of creek or river flows or discharges. It is the rate of flow of water measured in terms of volume per unit time.
PMF (Probable maximum flood)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The probable maximum flood defines the extent of flood prone land, that is, the floodplain.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual, it is the likelihood of consequences arising from the interaction of floods, communities, and the environment.
Runoff	The amount of rainfall which ends up as a streamflow, also known as rainfall excess.
Scour	Erosion by mechanical action of water, typically of soil.

Term/ Abbreviation	Definition
Sensitive receiver	Non-involved dwellings in proximity to the Project Area that may be sensitive to noise, visual, traffic and other impacts. Potential impacts to sensitive receivers are investigated in the EIS.

APPENDIX A EXISTING CASE RESULTS

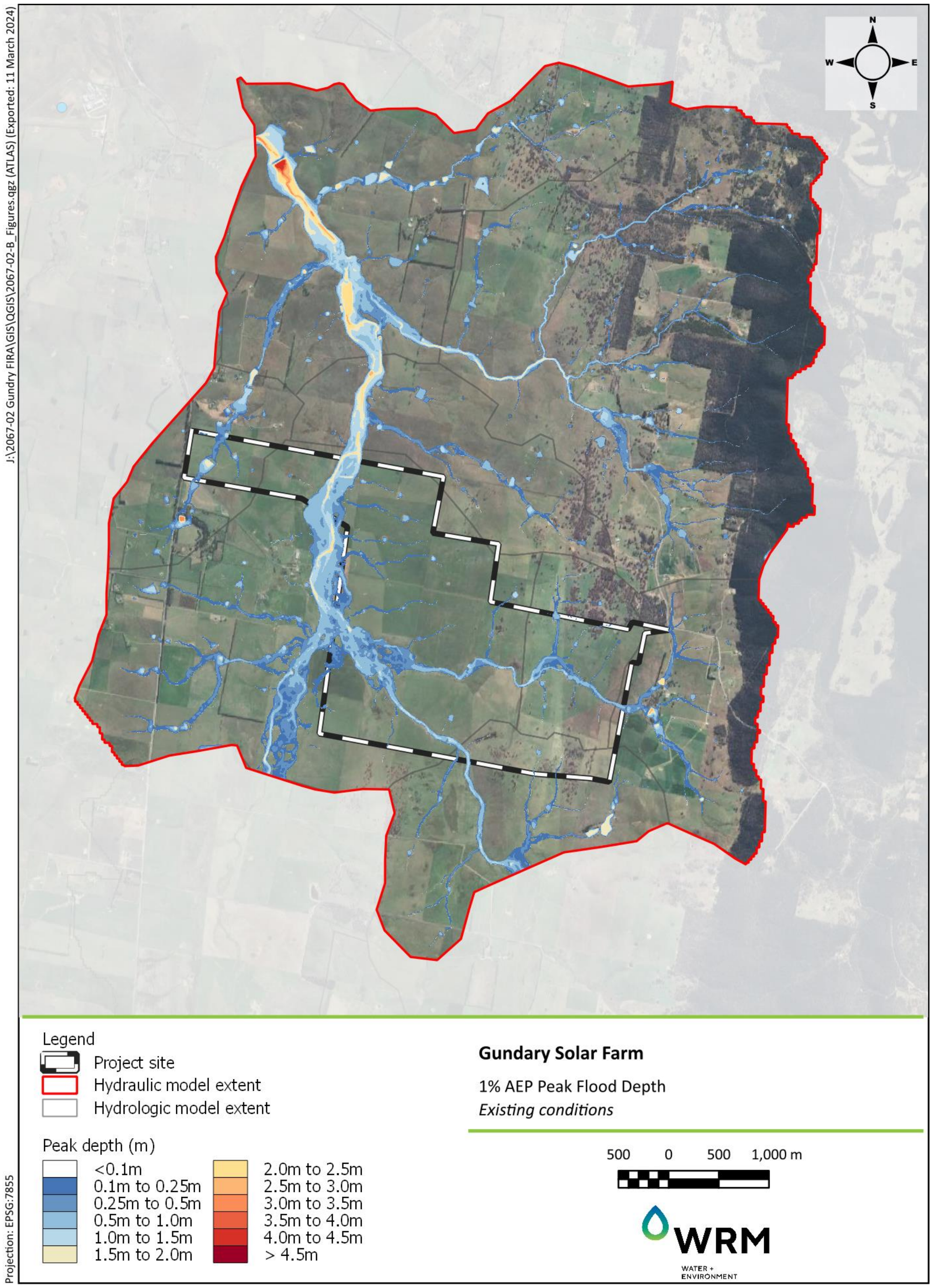

Figure A.1 Existing case flood mapping 1% AEP depth

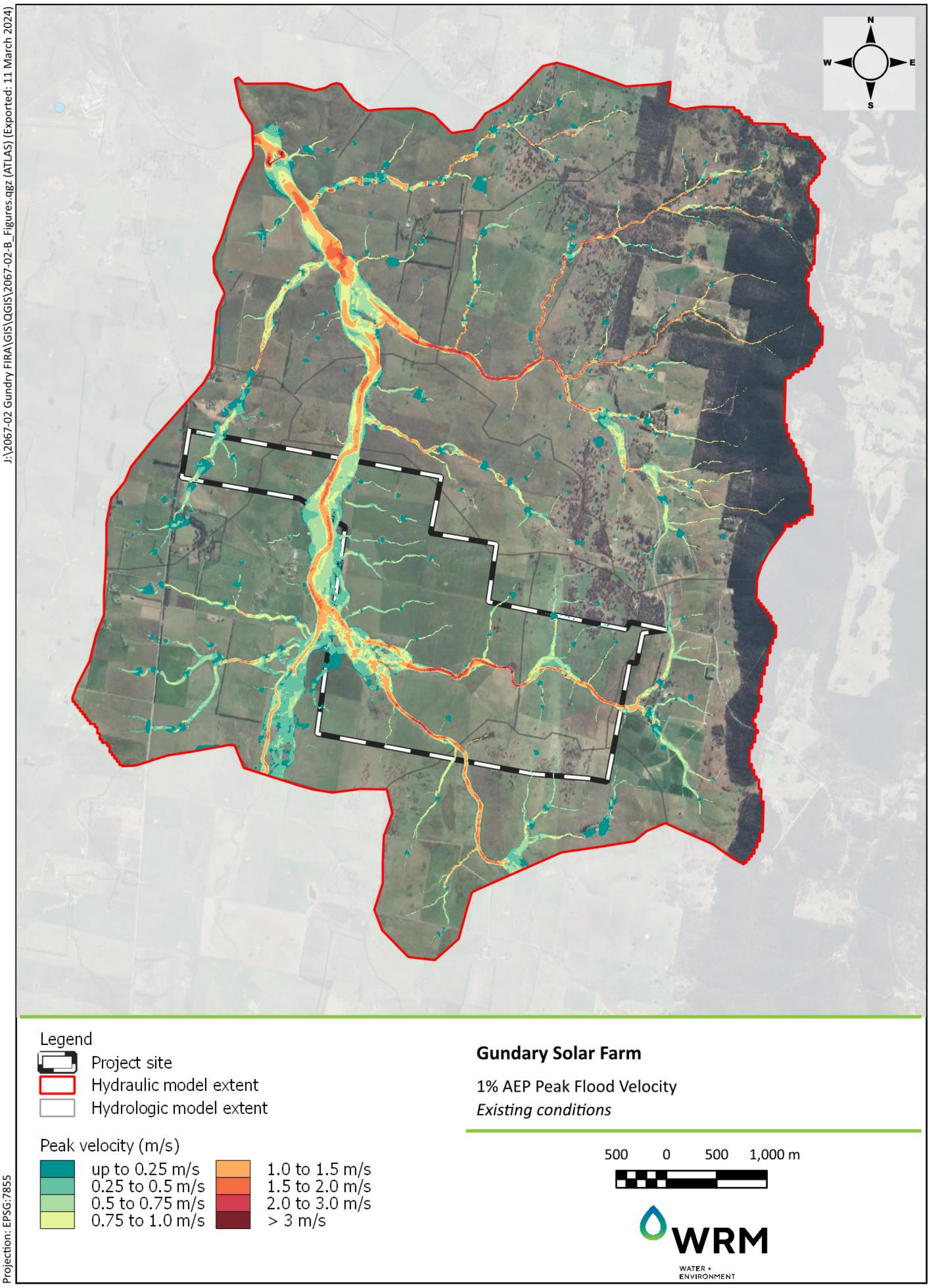

Figure A.2 Existing case flood mapping 1% AEP velocity

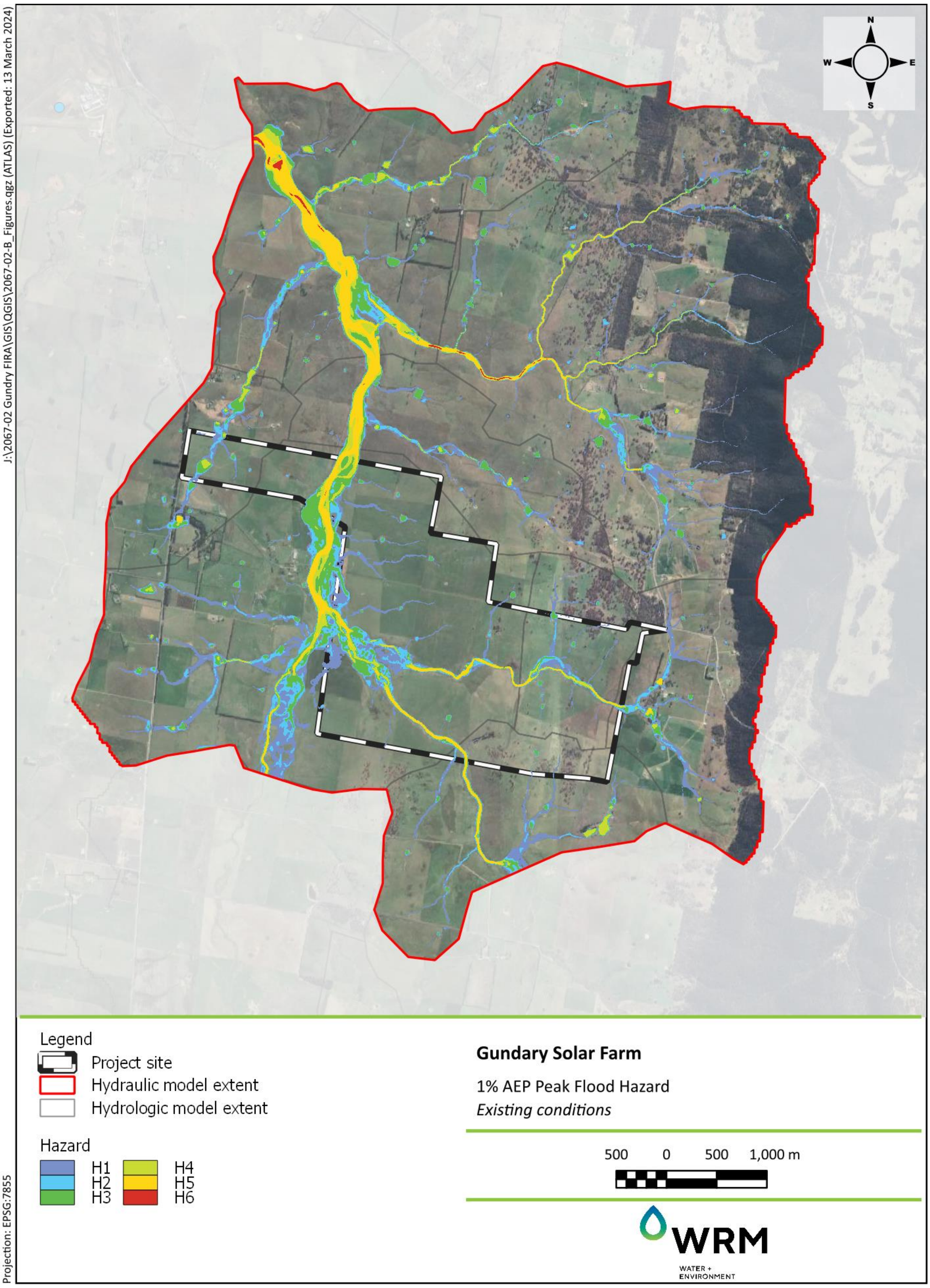

Figure A.3 Existing case flood hazard mapping 1% AEP

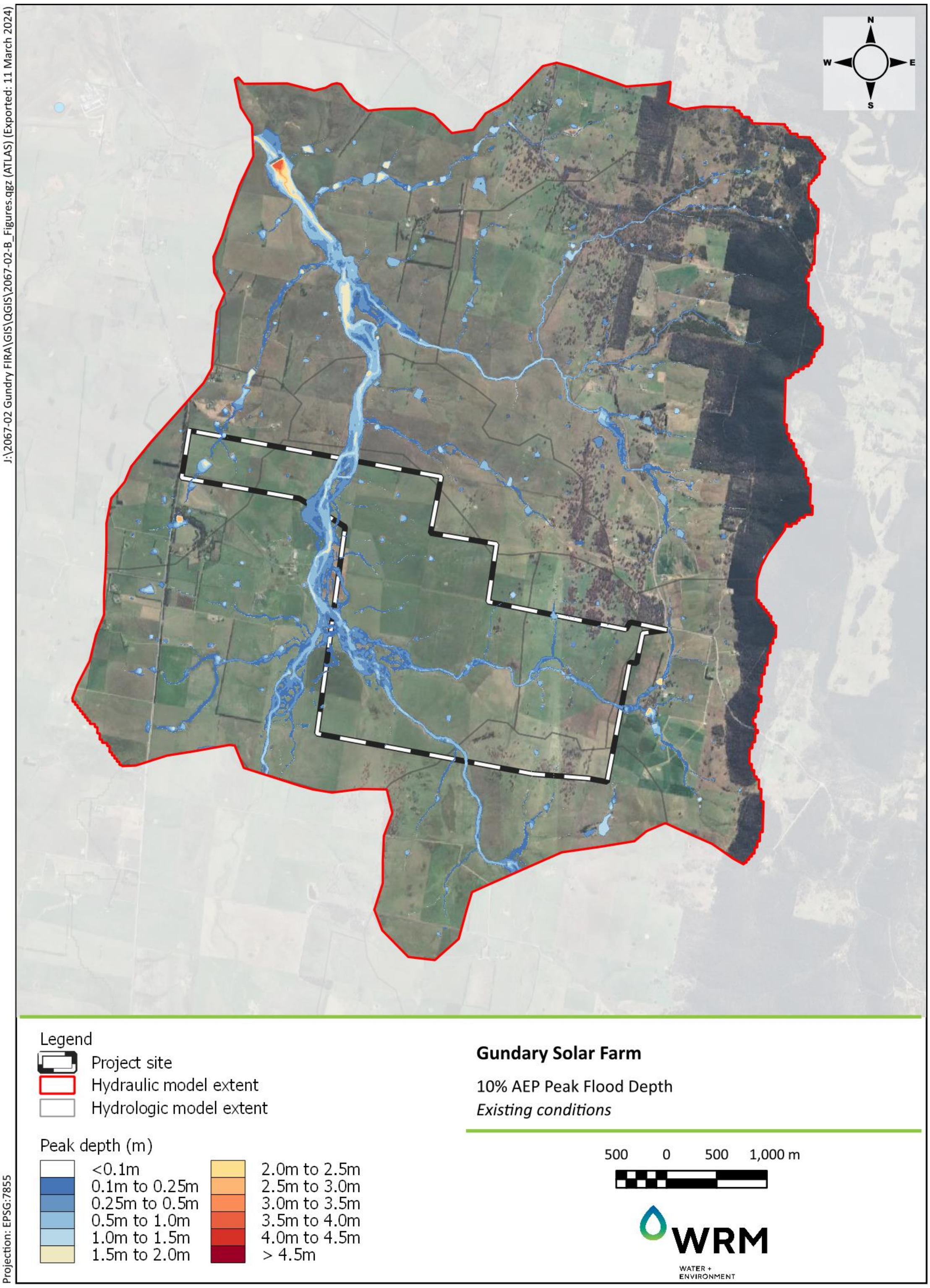

Figure A.4 Existing case flood mapping 10% AEP depth

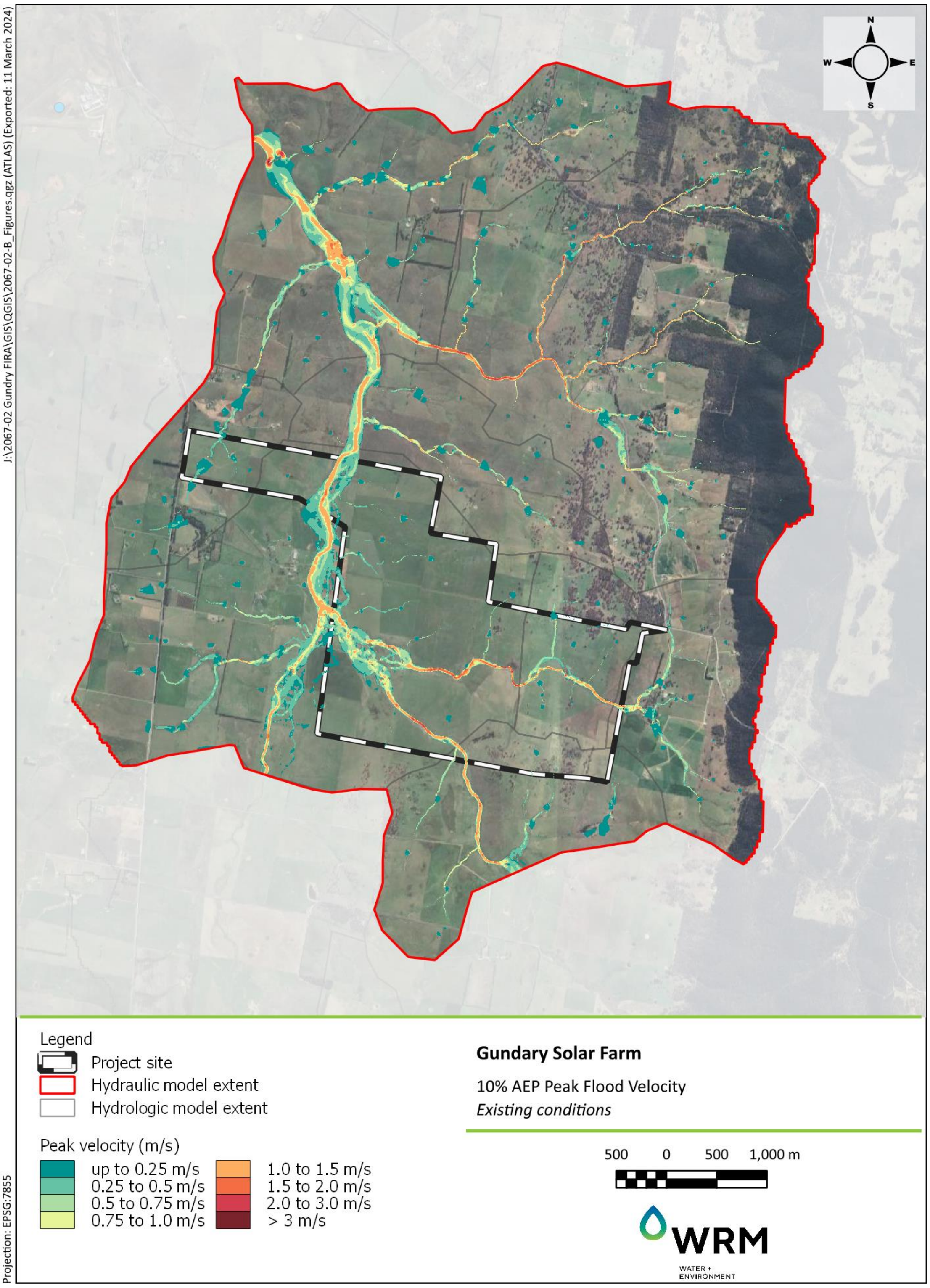

Figure A.5 **Existing case flood mapping 10% AEP velocity**

WRM

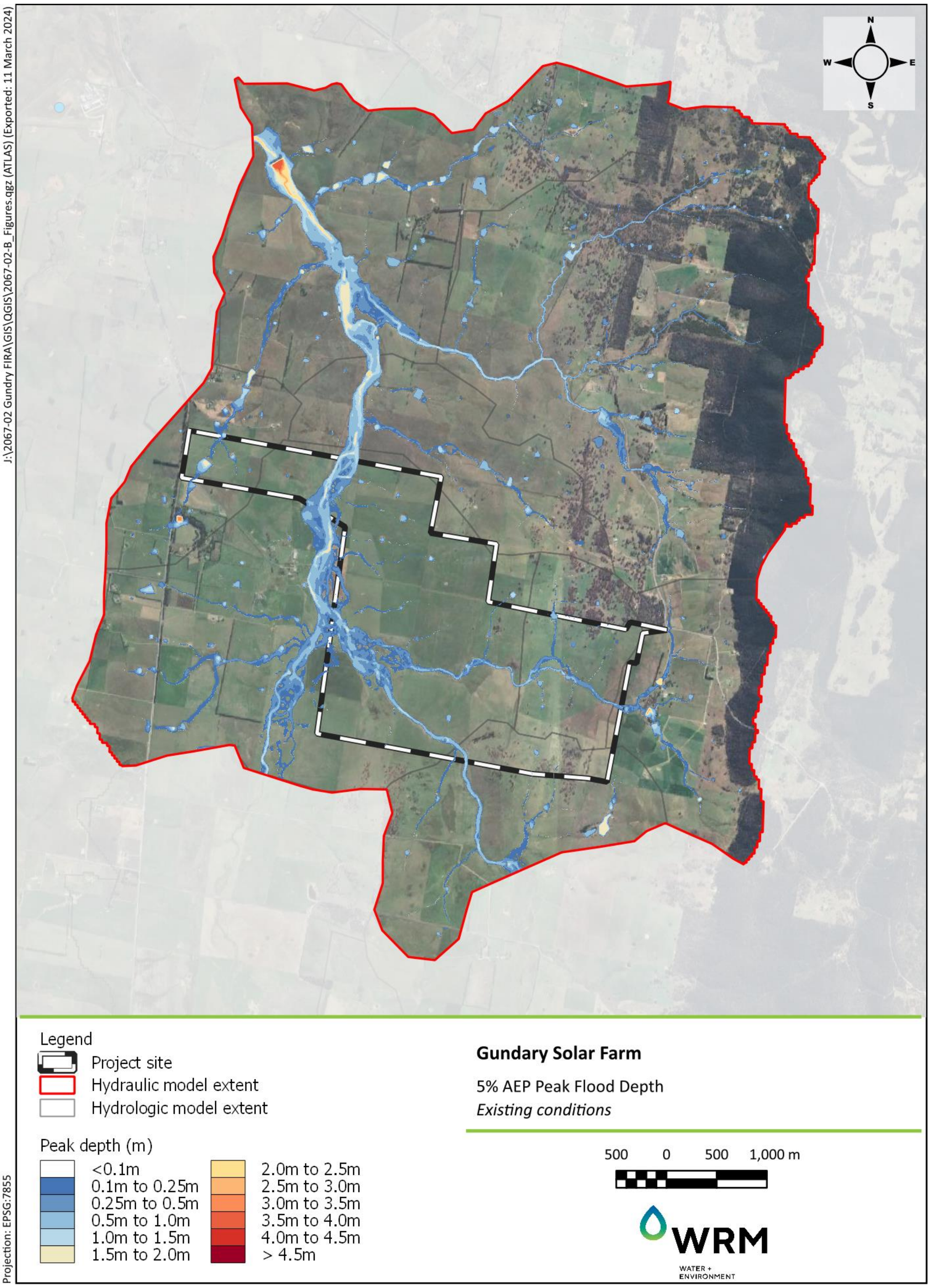

Figure A.6 **Existing case flood mapping 5% AEP depth**

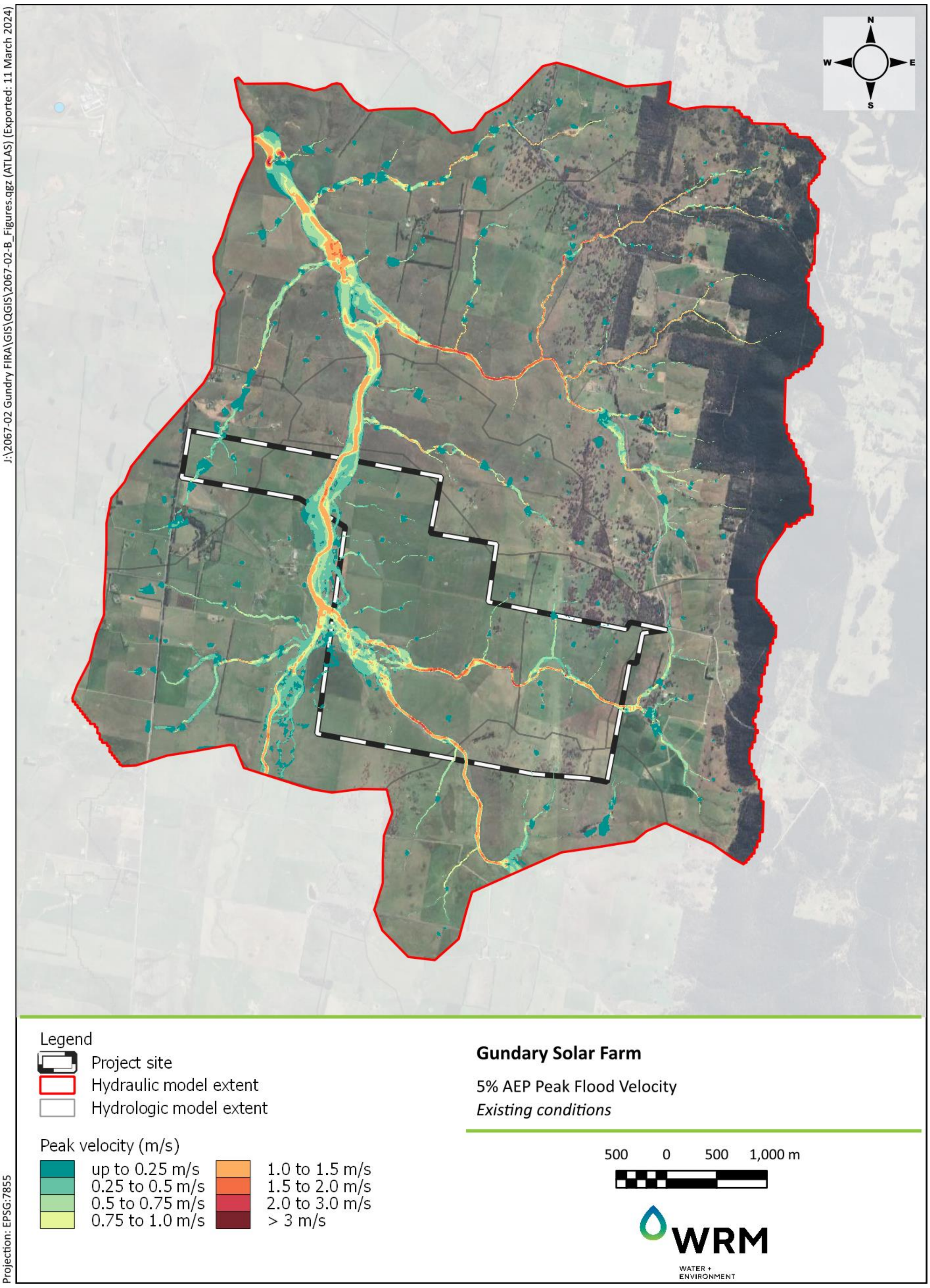

Figure A.7 Existing case flood mapping 5% AEP velocity

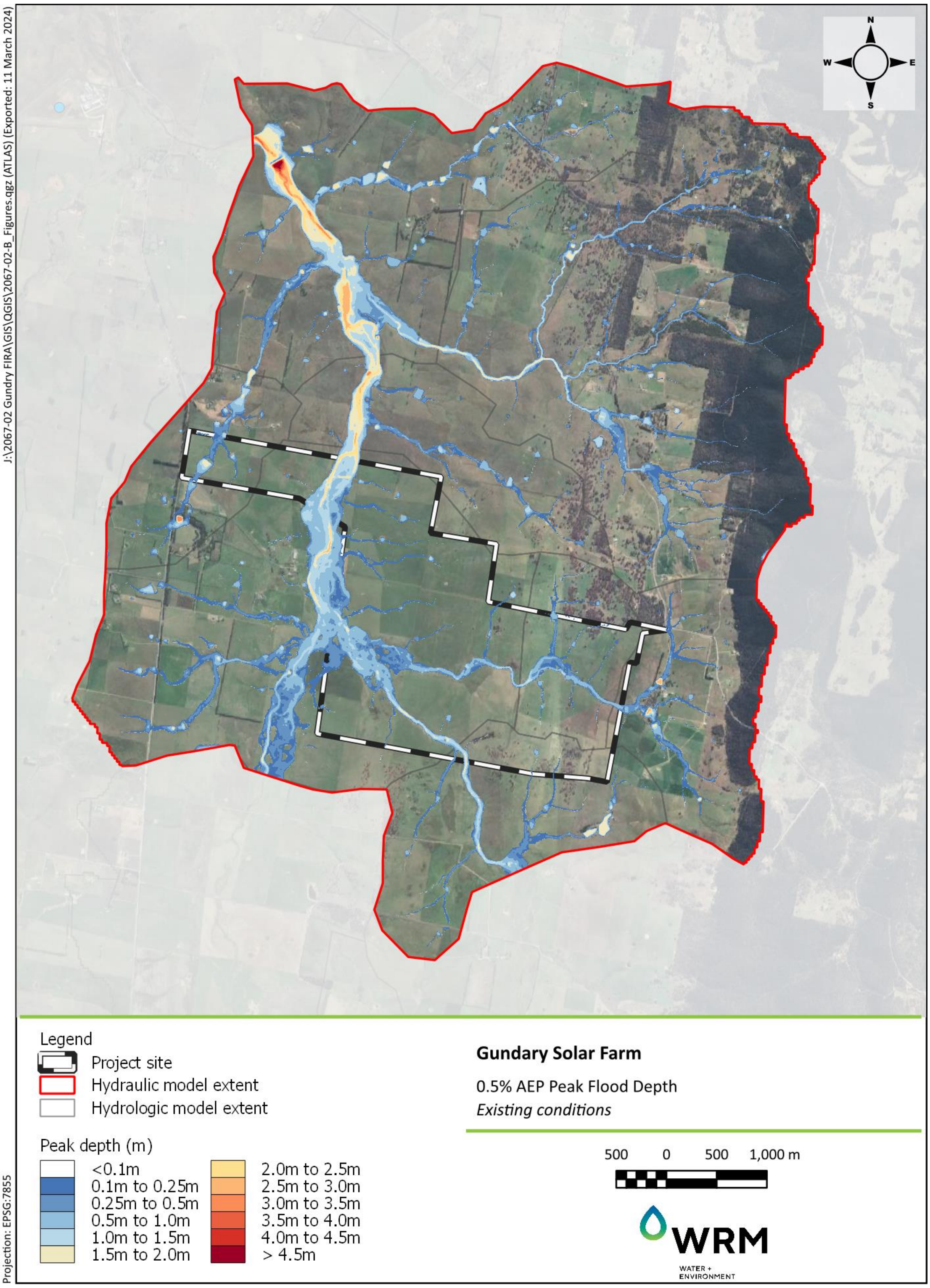

Figure A.8 Existing case flood mapping 0.5% AEP depth

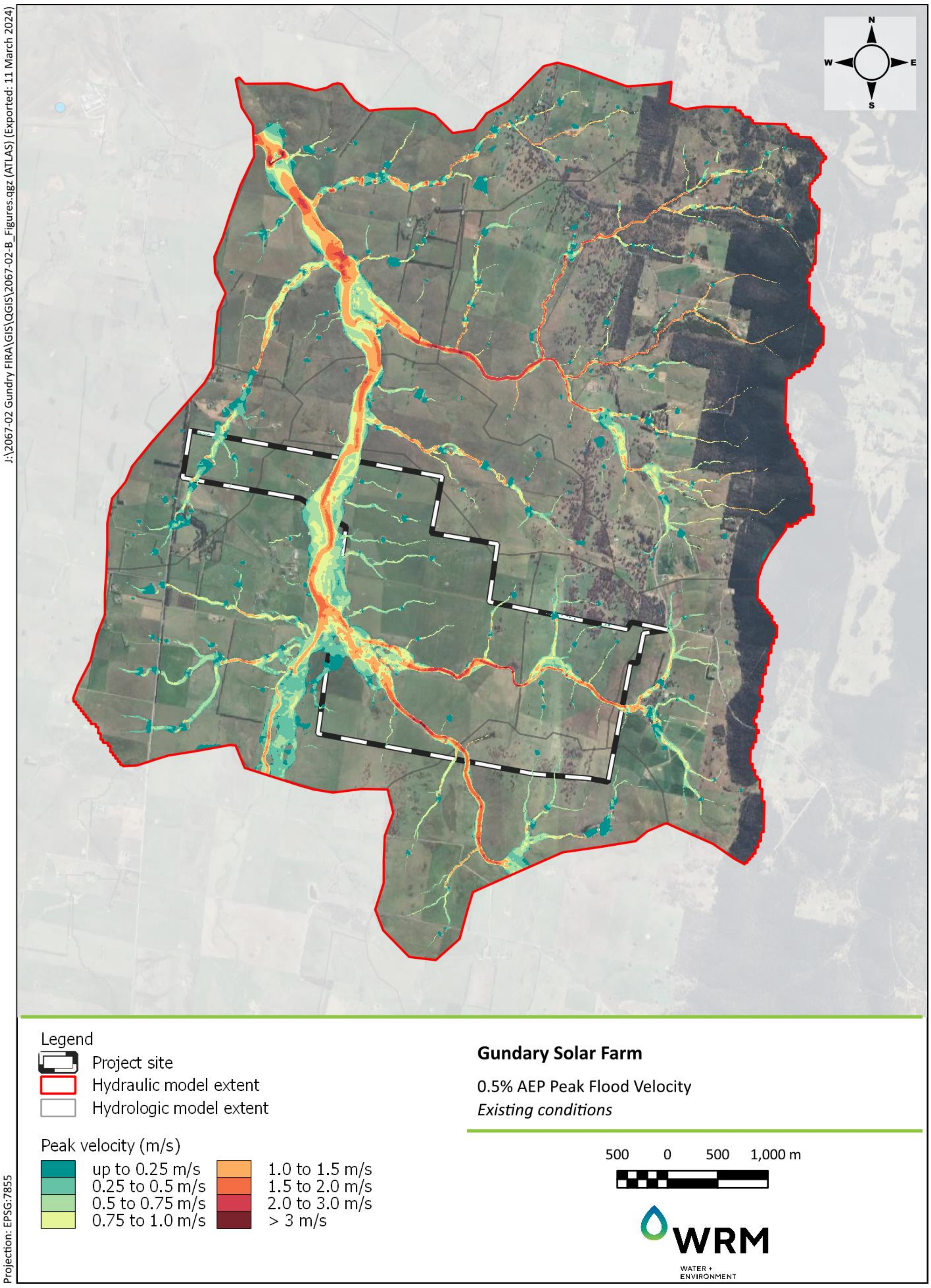

Figure A.9 Existing case flood mapping 0.5% AEP velocity

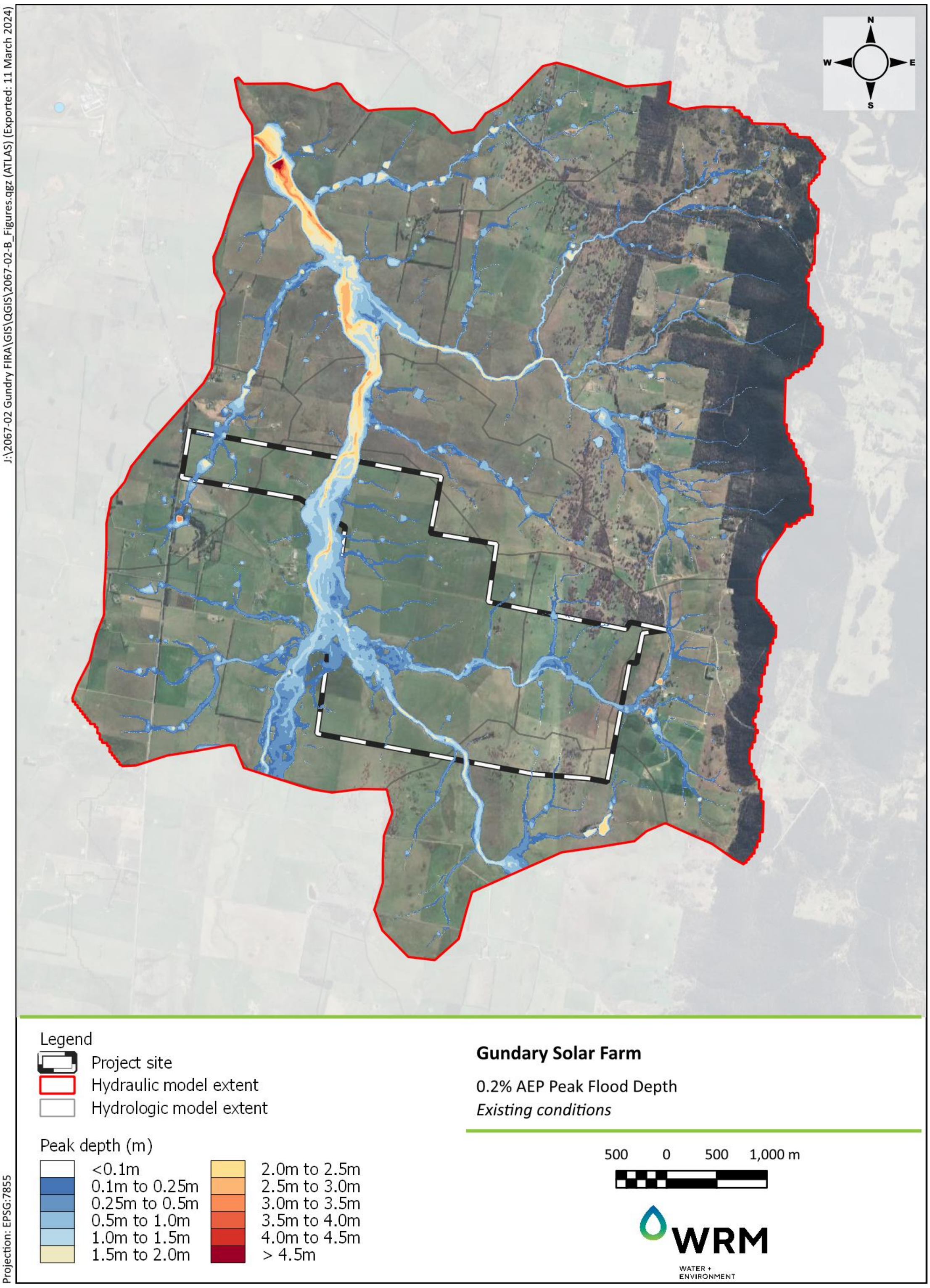

Figure A.10 **Existing case flood mapping 0.2% AEP depth**

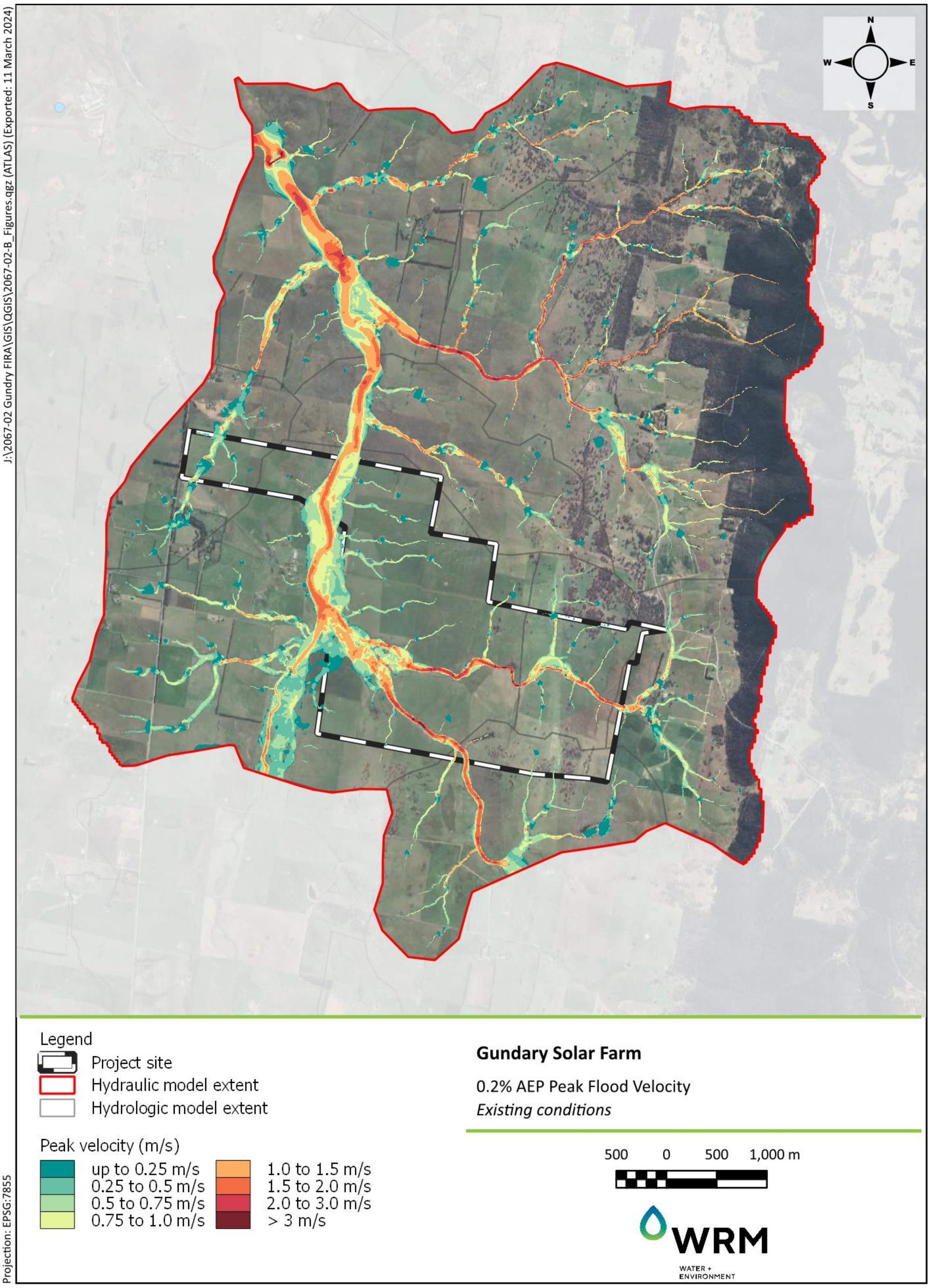

Figure A.11 **Existing case flood mapping 0.2% AEP velocity**

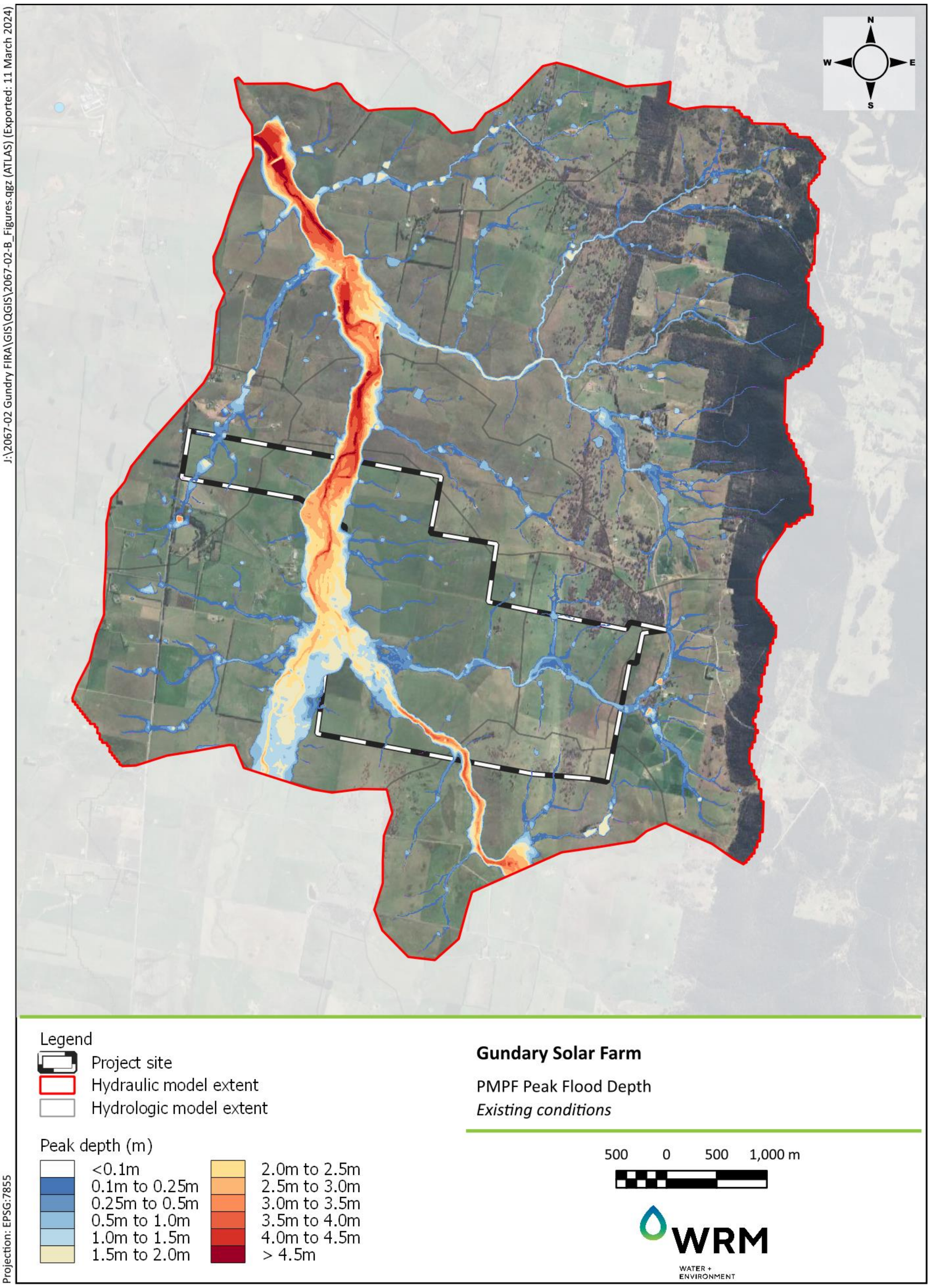

Figure A.12 Existing case flood mapping PMF depth

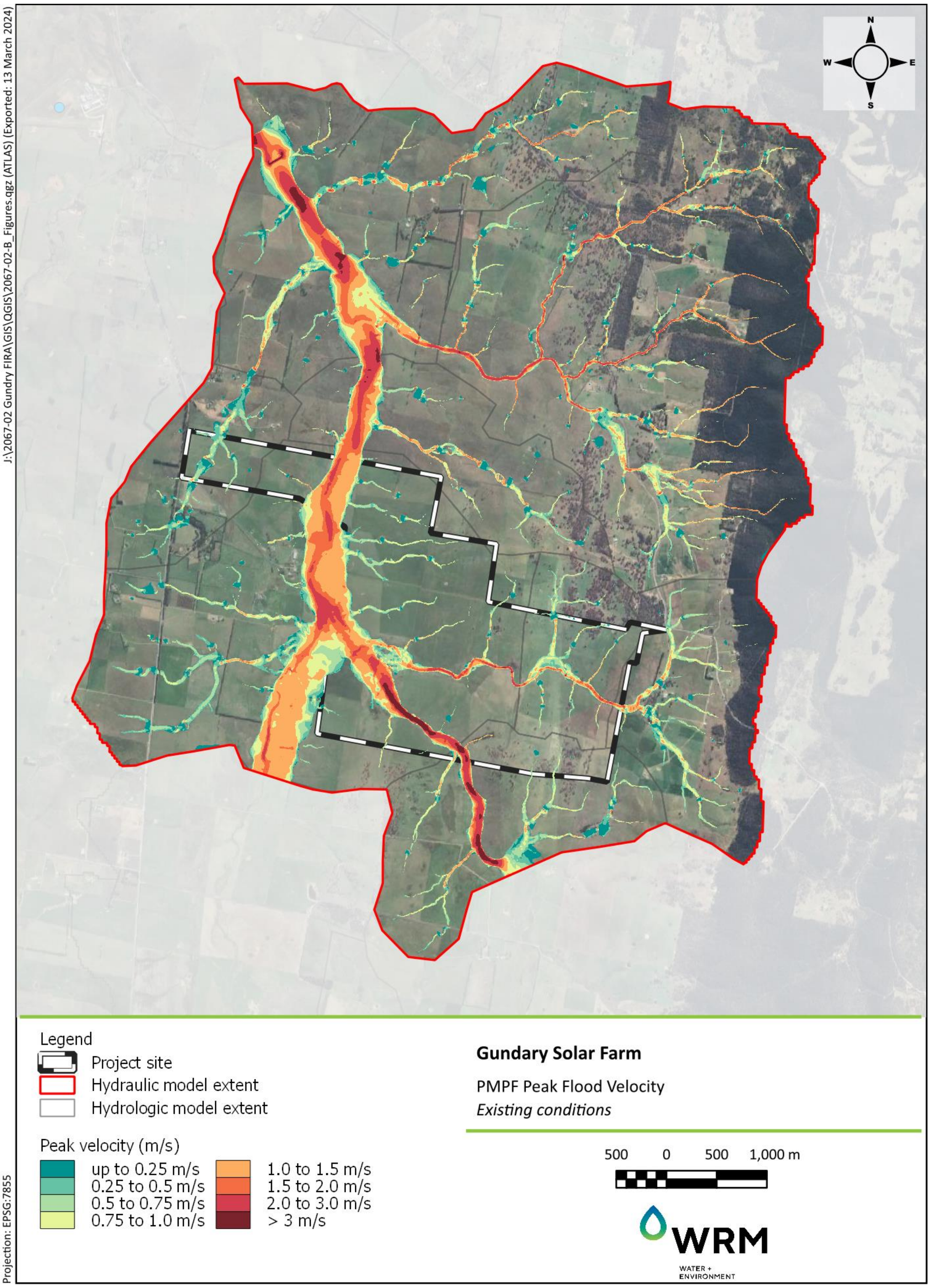

Figure A.13 **Existing case flood mapping PMF velocity**

APPENDIX B DEVELOPED CASE RESULTS

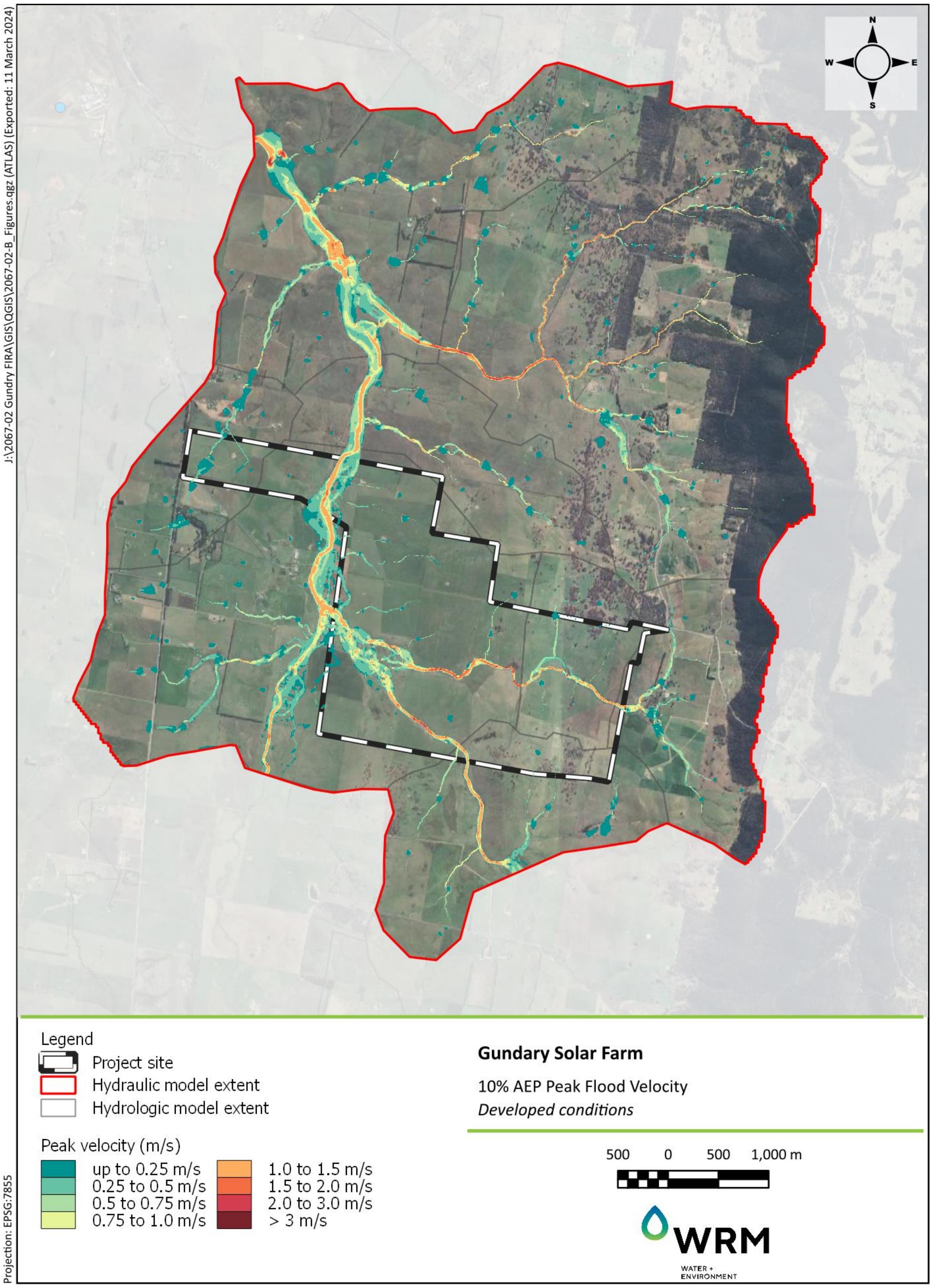

Figure B.1 Developed case flood mapping 10% AEP velocity

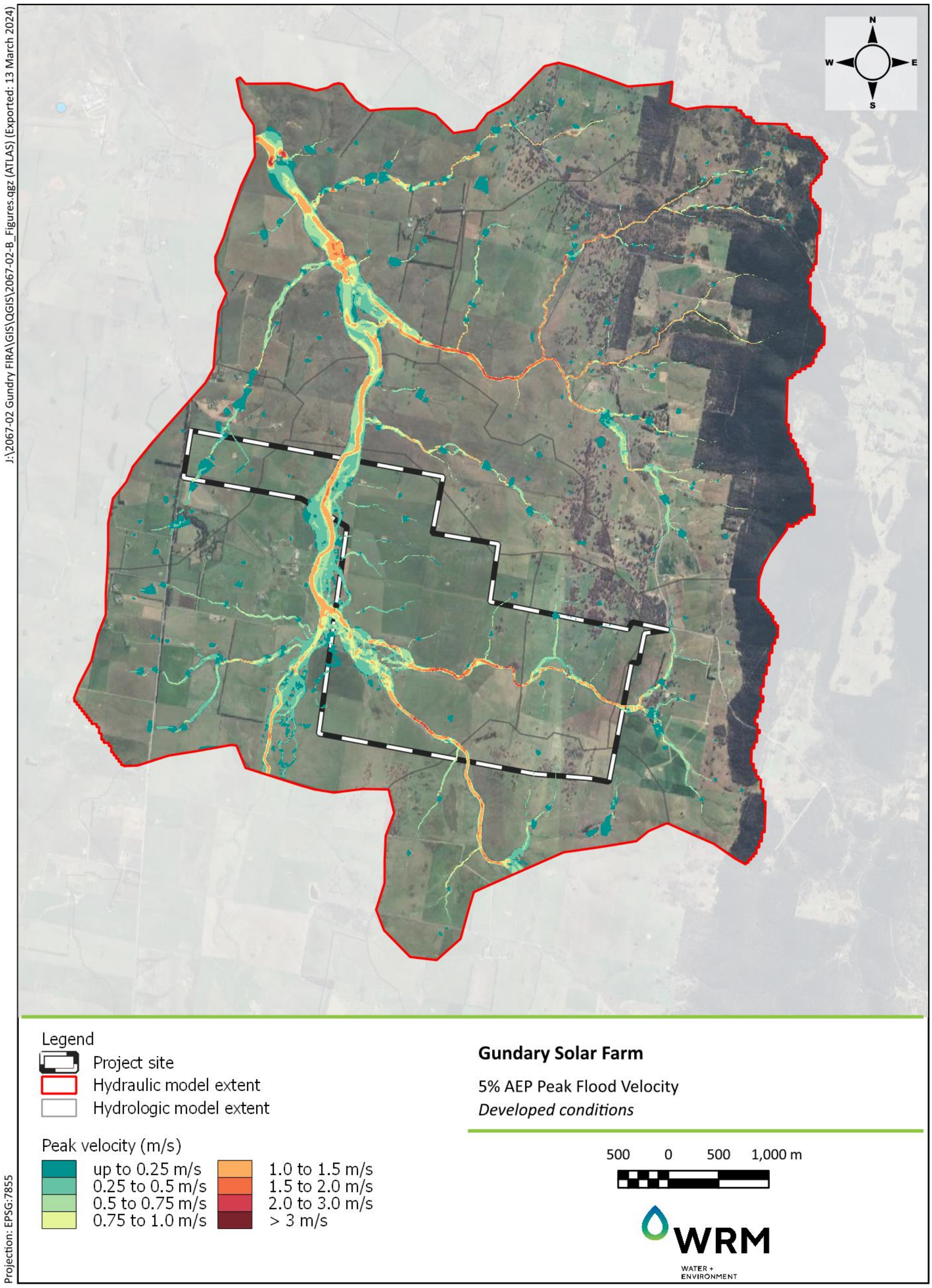

Figure B.2 Developed case flood mapping 5% AEP velocity

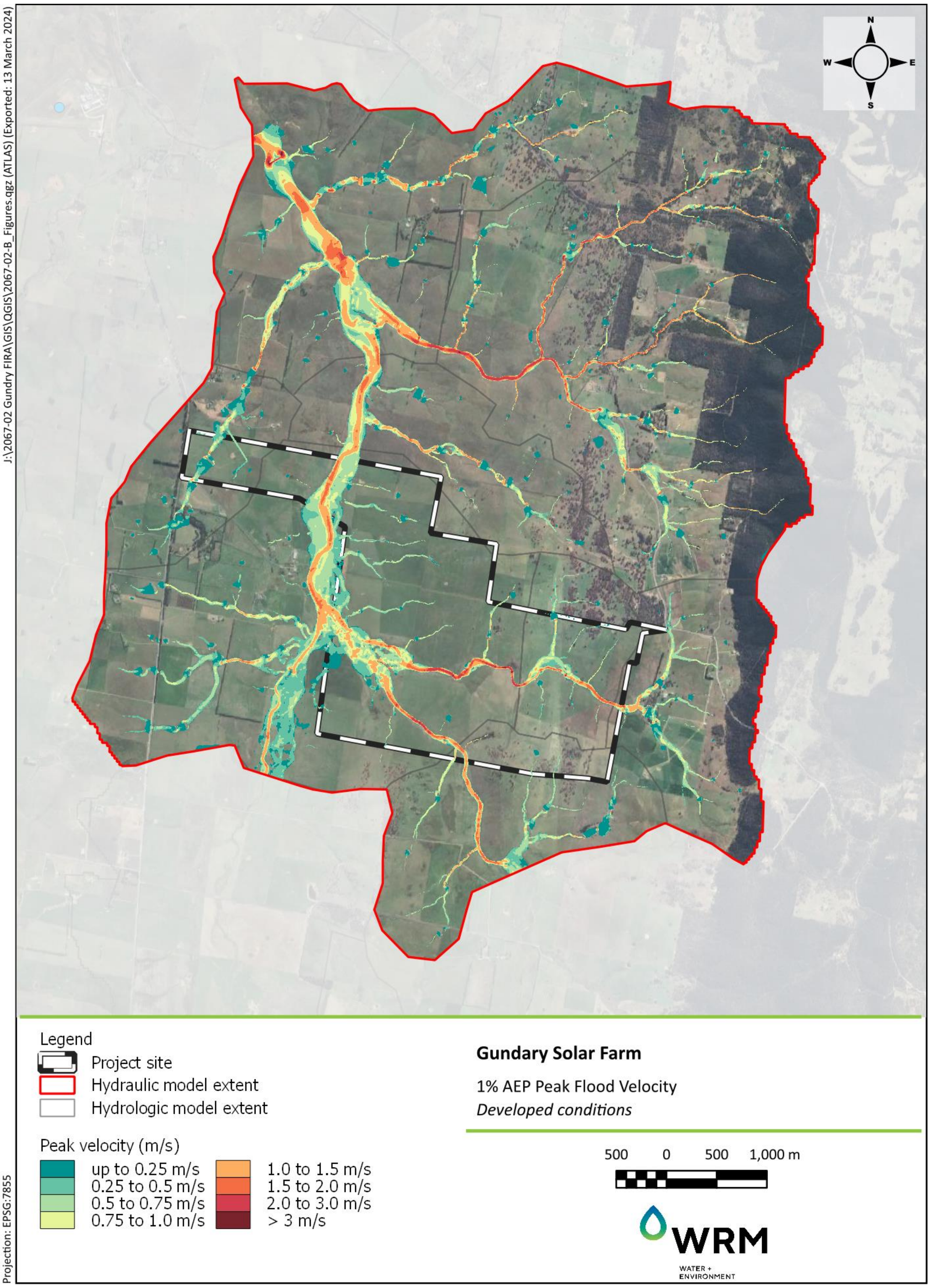

Figure B.3 **Developed case flood mapping 1% AEP velocity**

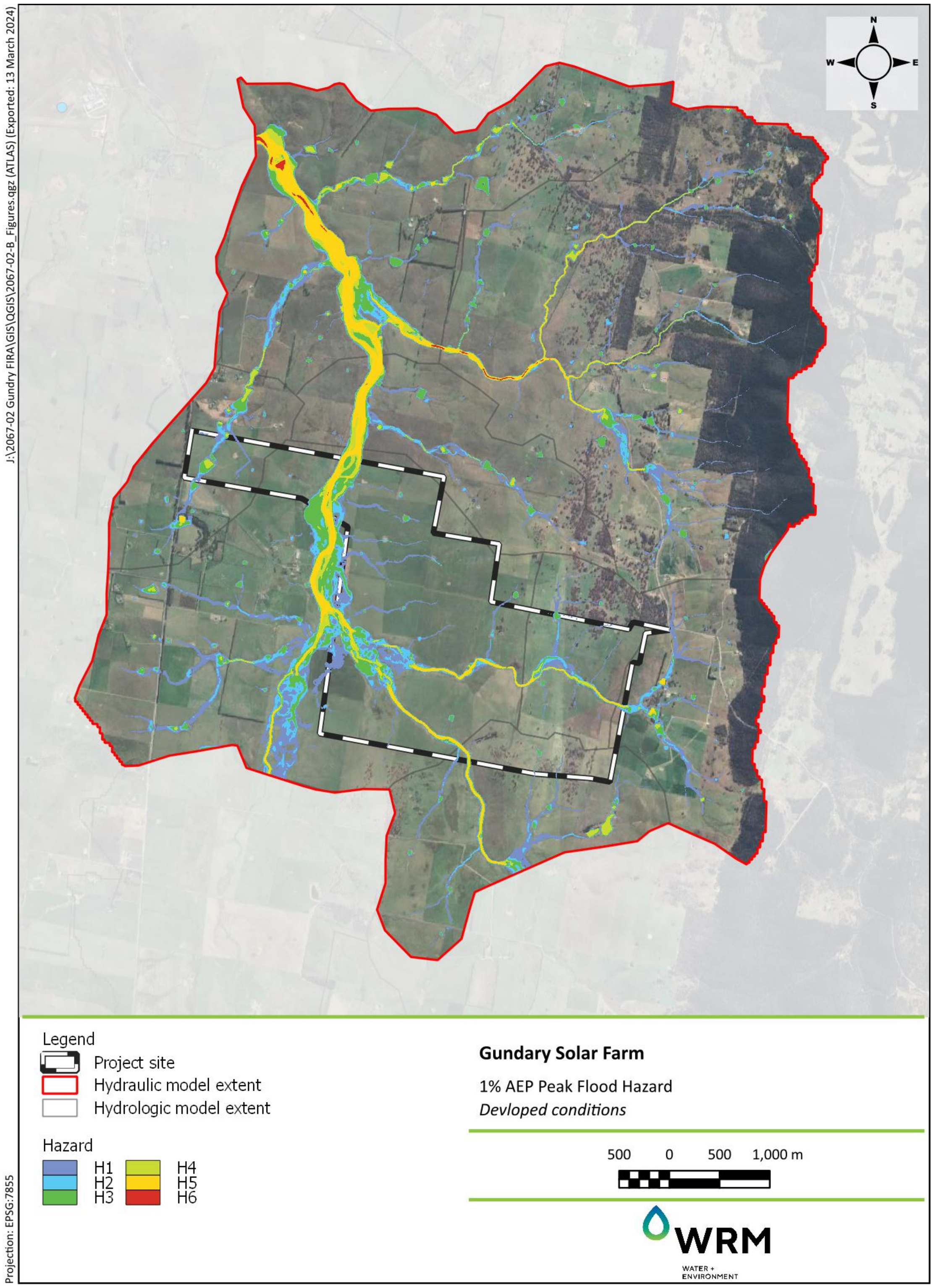

Figure B.4 **Developed case flood hazard mapping 1% AEP**

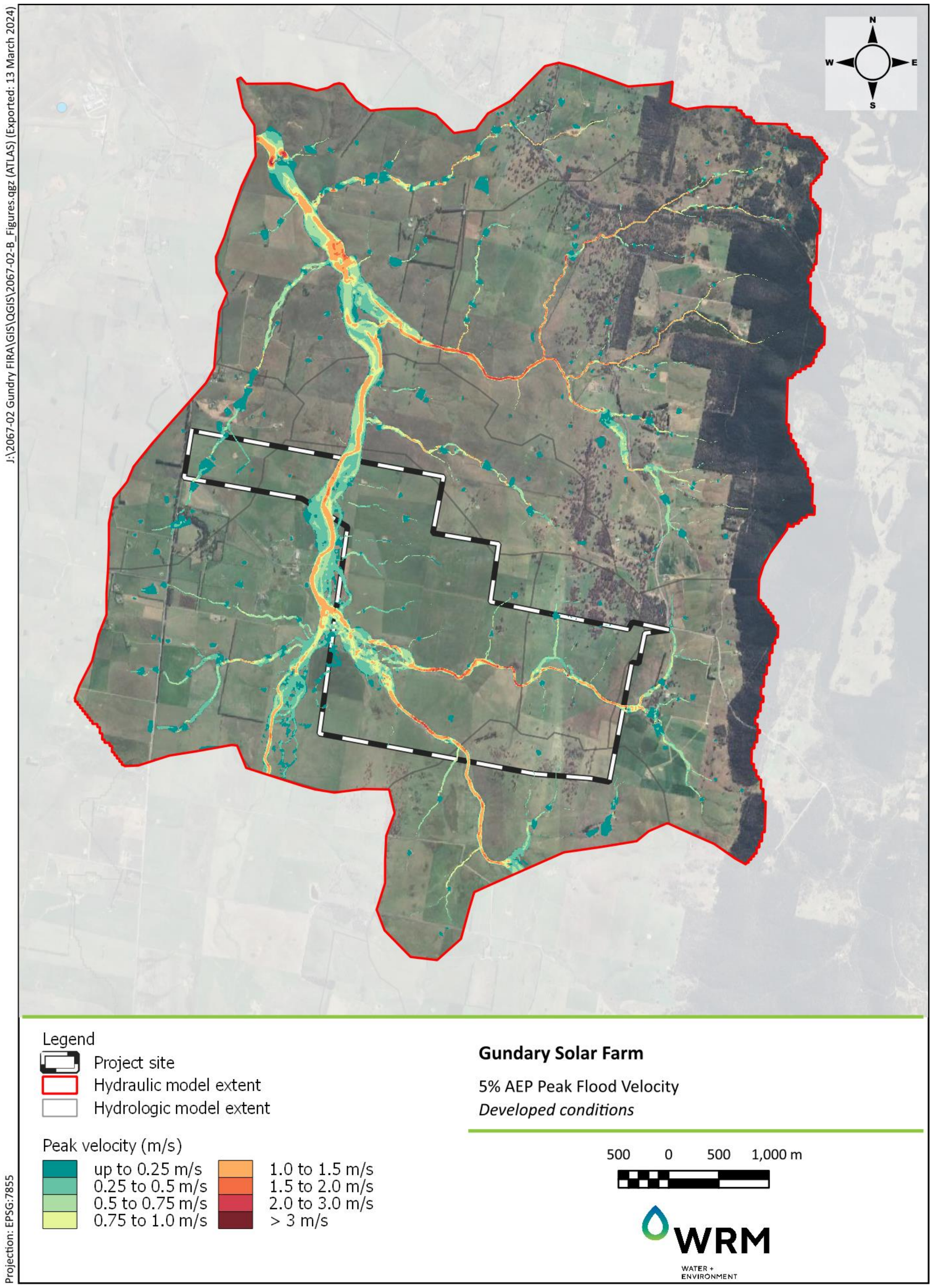

Figure B.5 **Developed case flood mapping 5% AEP velocity**

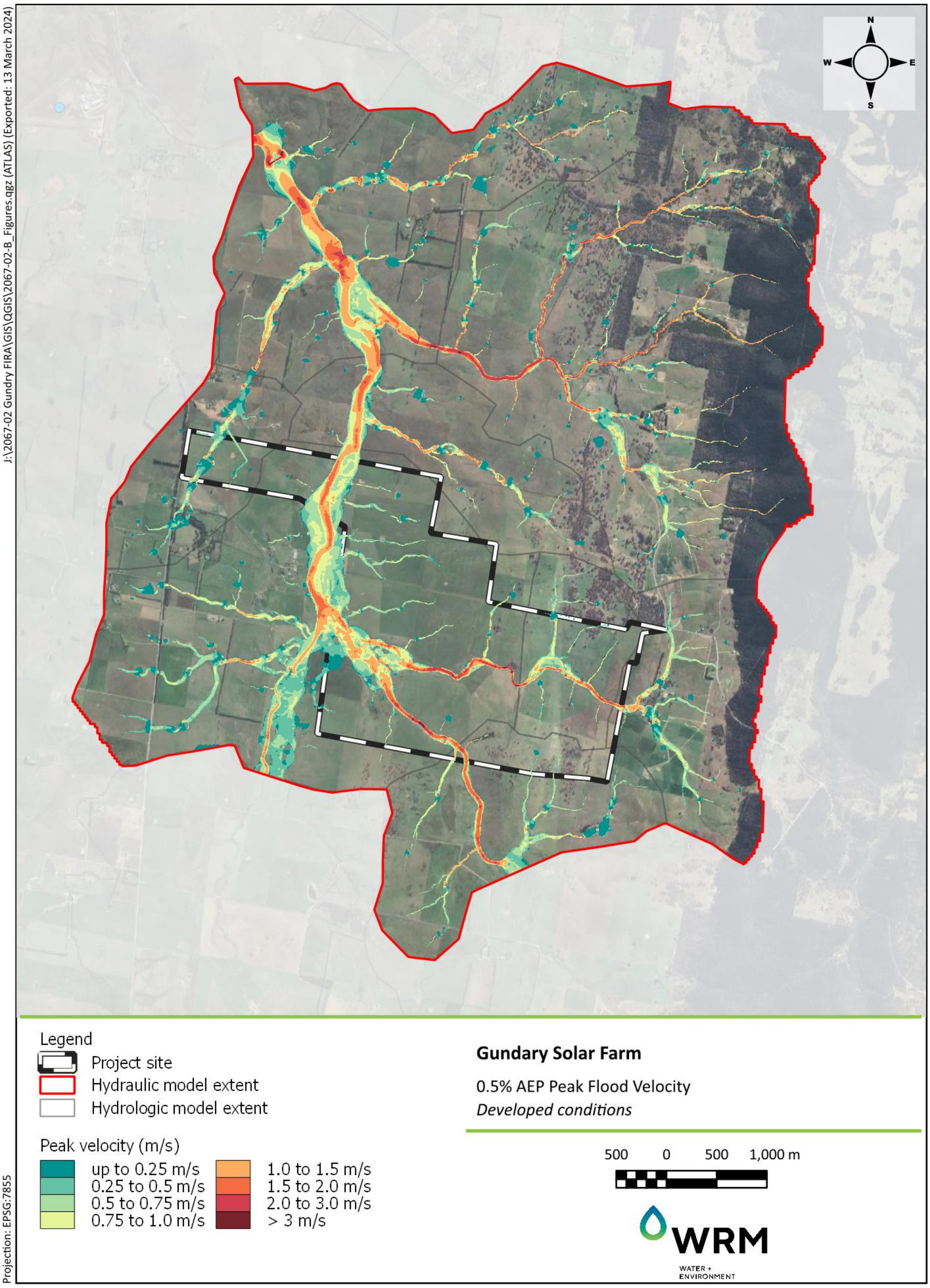

Figure B.6 **Developed case flood mapping 0.5% AEP velocity**

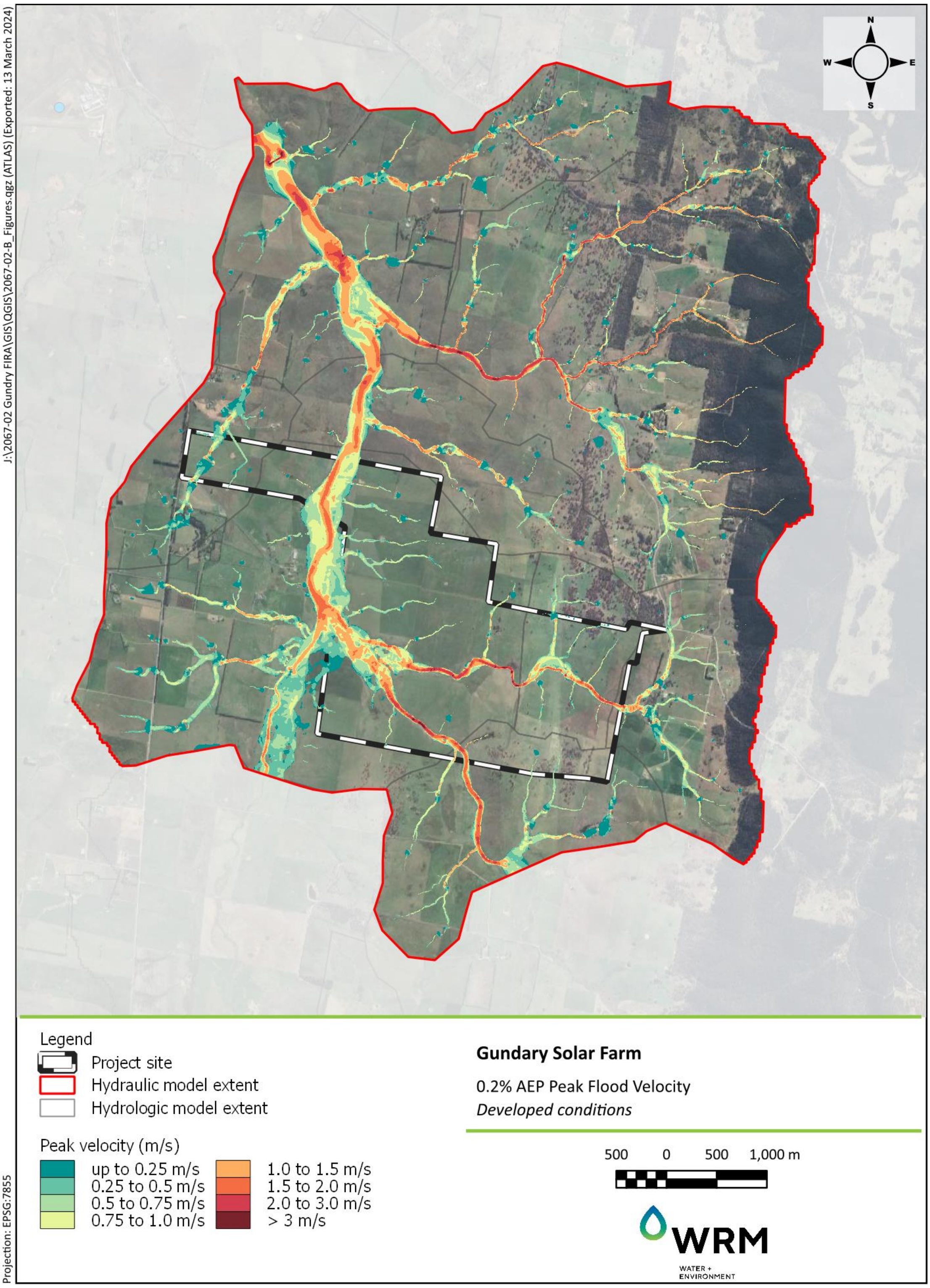

Figure B.7 **Developed case flood mapping 0.2% AEP velocity**

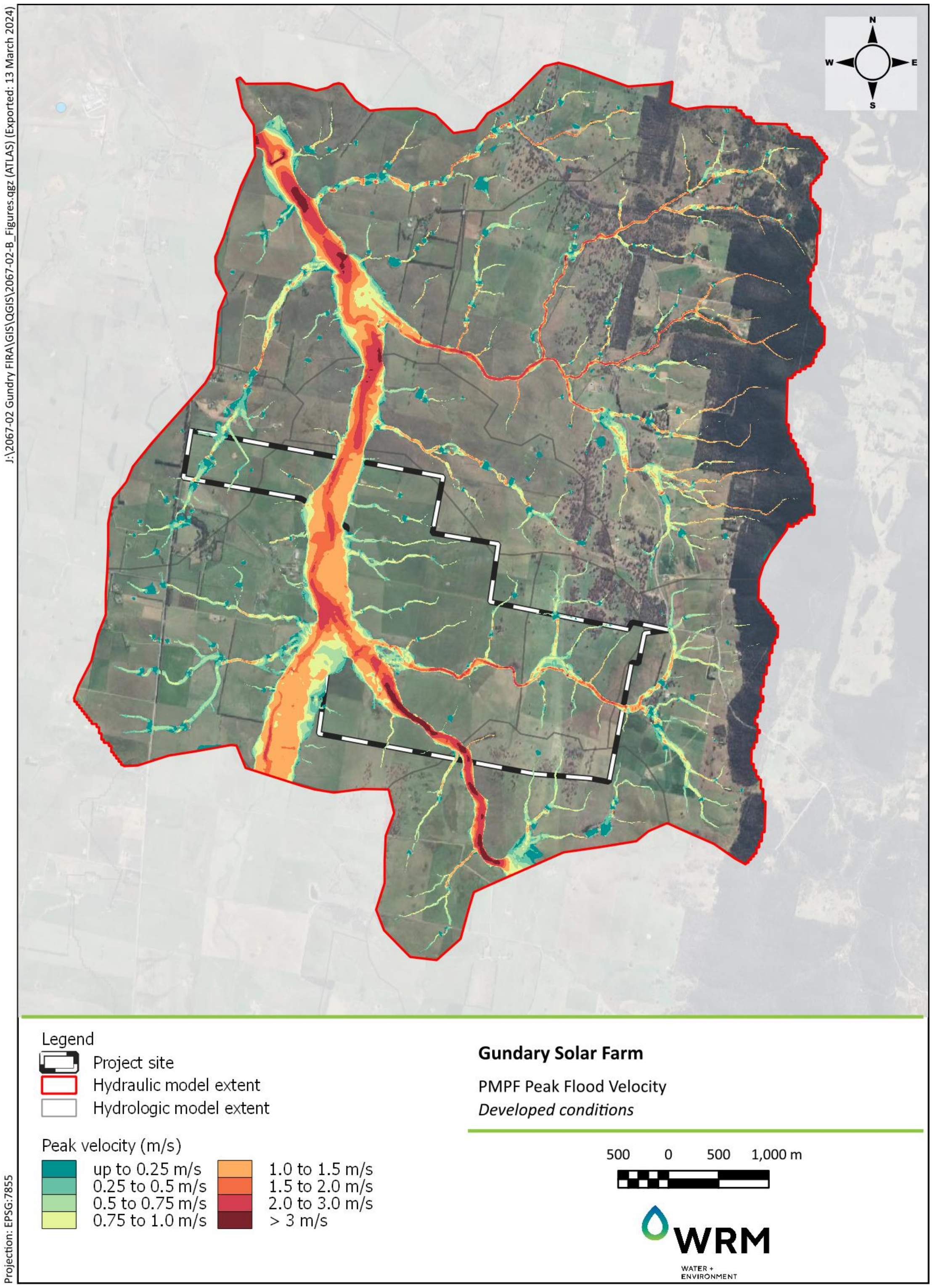

Figure B.8 **Developed case flood mapping PMF velocity**

APPENDIX C FLOOD IMPACT RESULTS

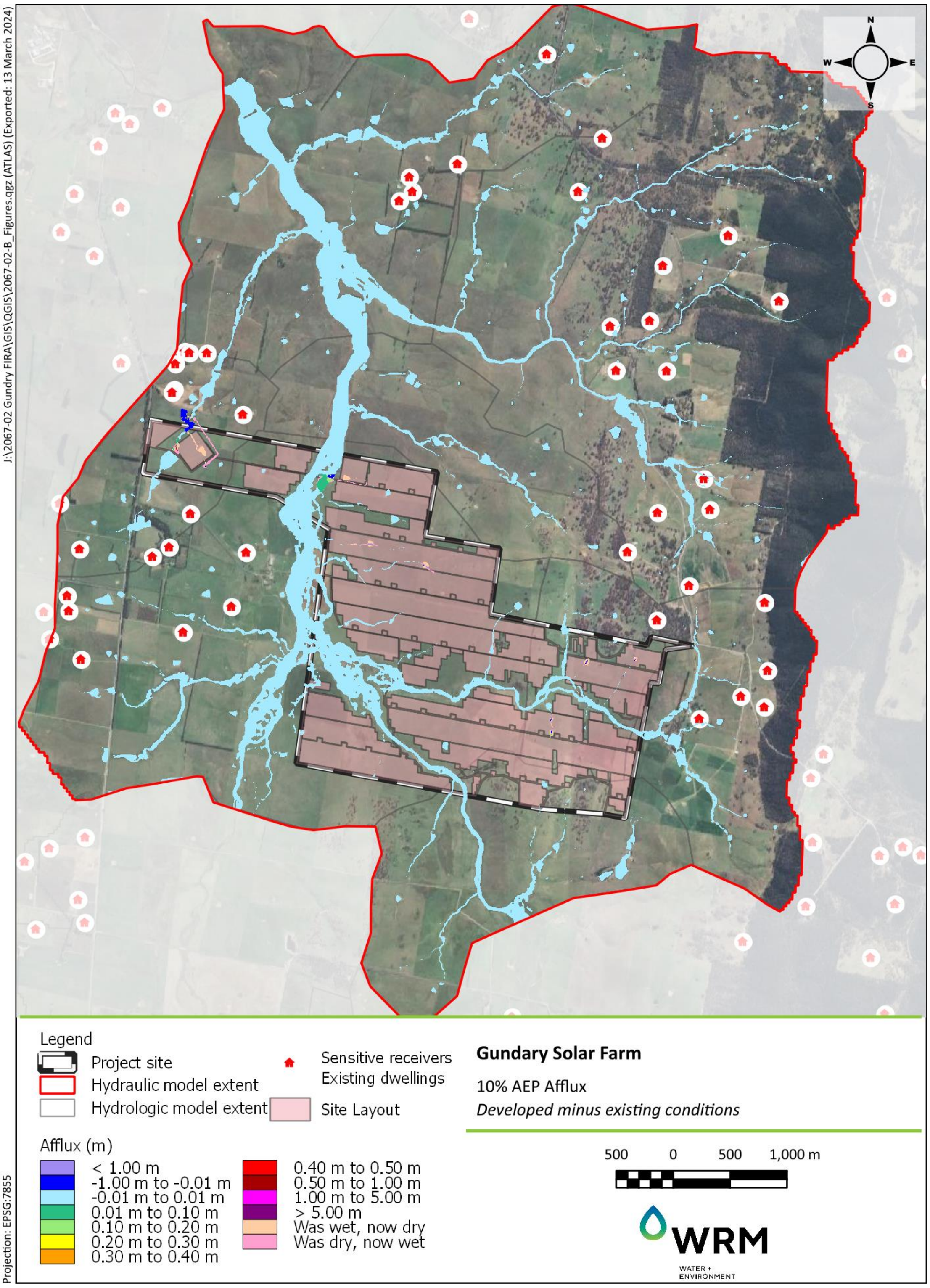

Figure C.1 **Peak water level flood impact mapping 10% AEP**

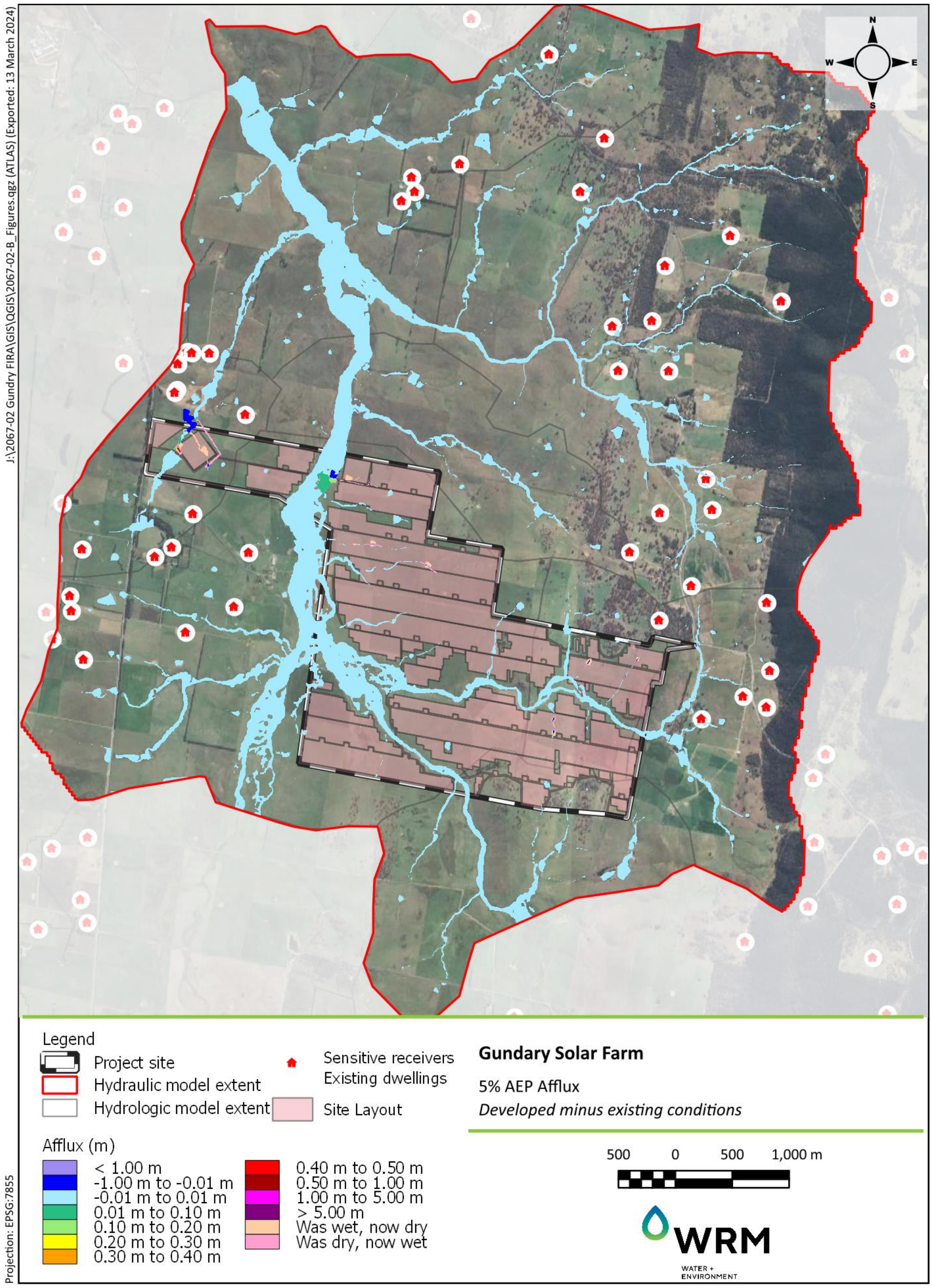

Figure C.2 **Peak water level flood impact mapping 5% AEP**

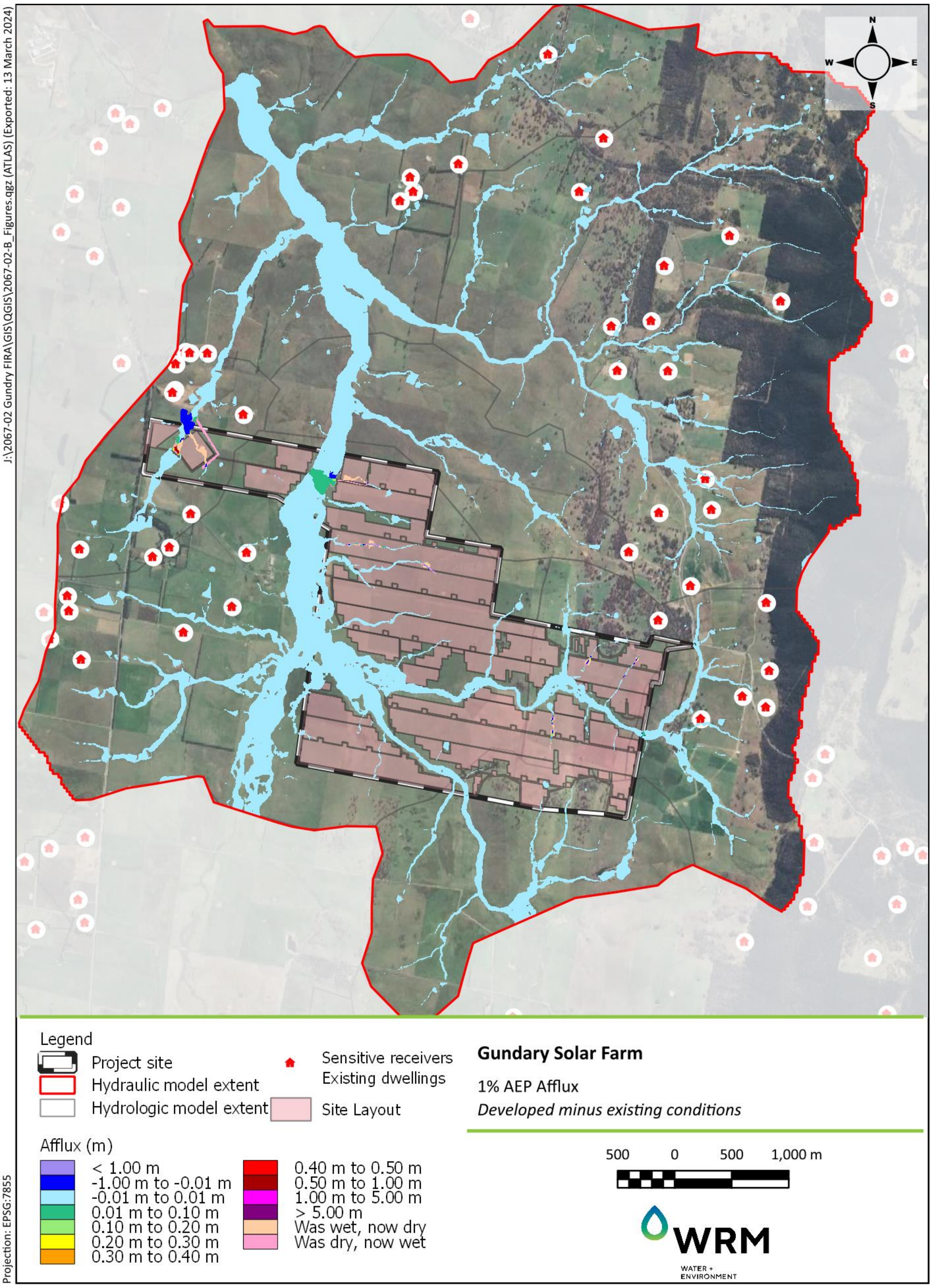

Figure C.3 **Peak water level flood impact mapping 1% AEP**

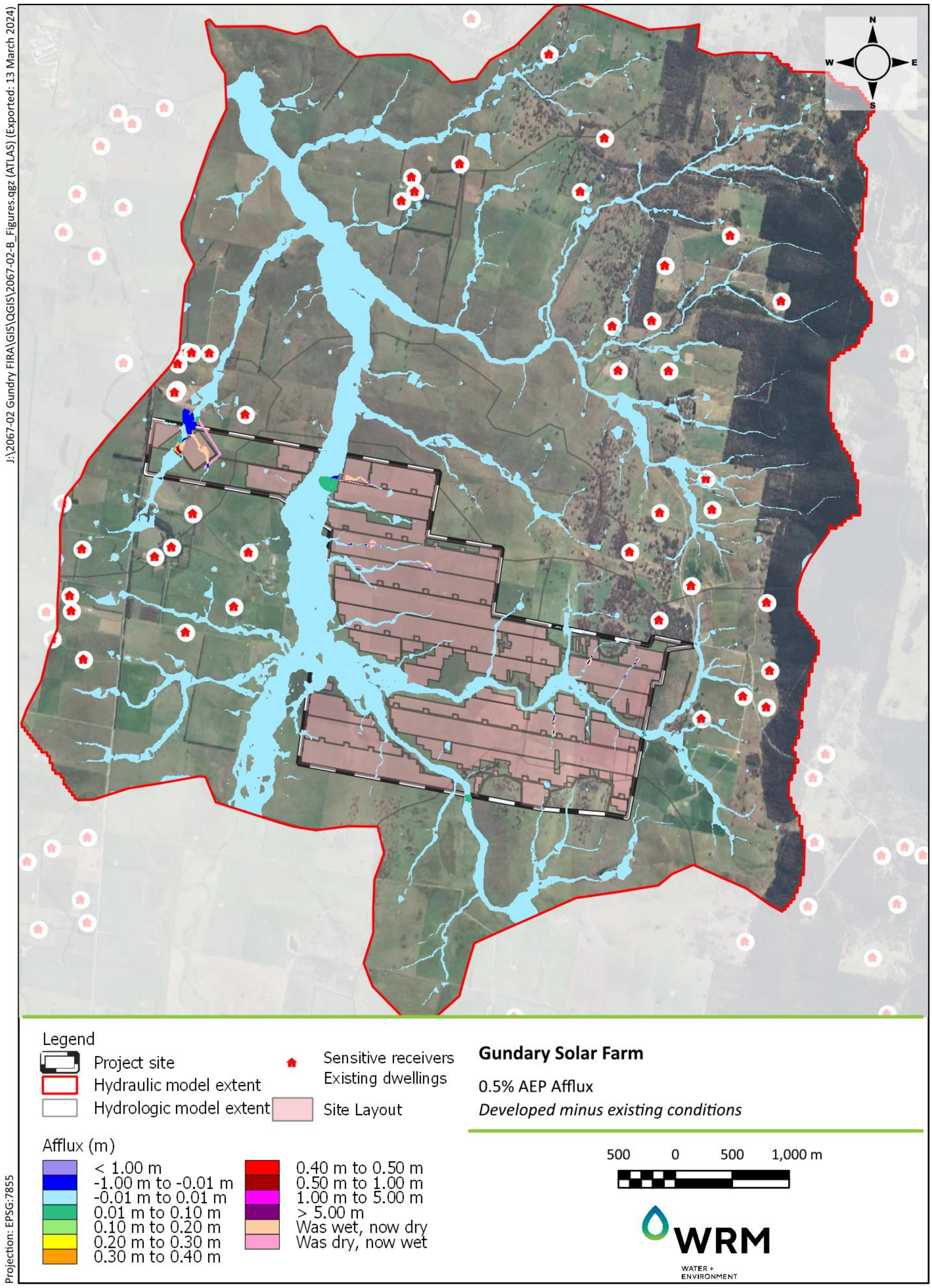

Figure C.4 Peak water level flood impact mapping 0.5% AEP

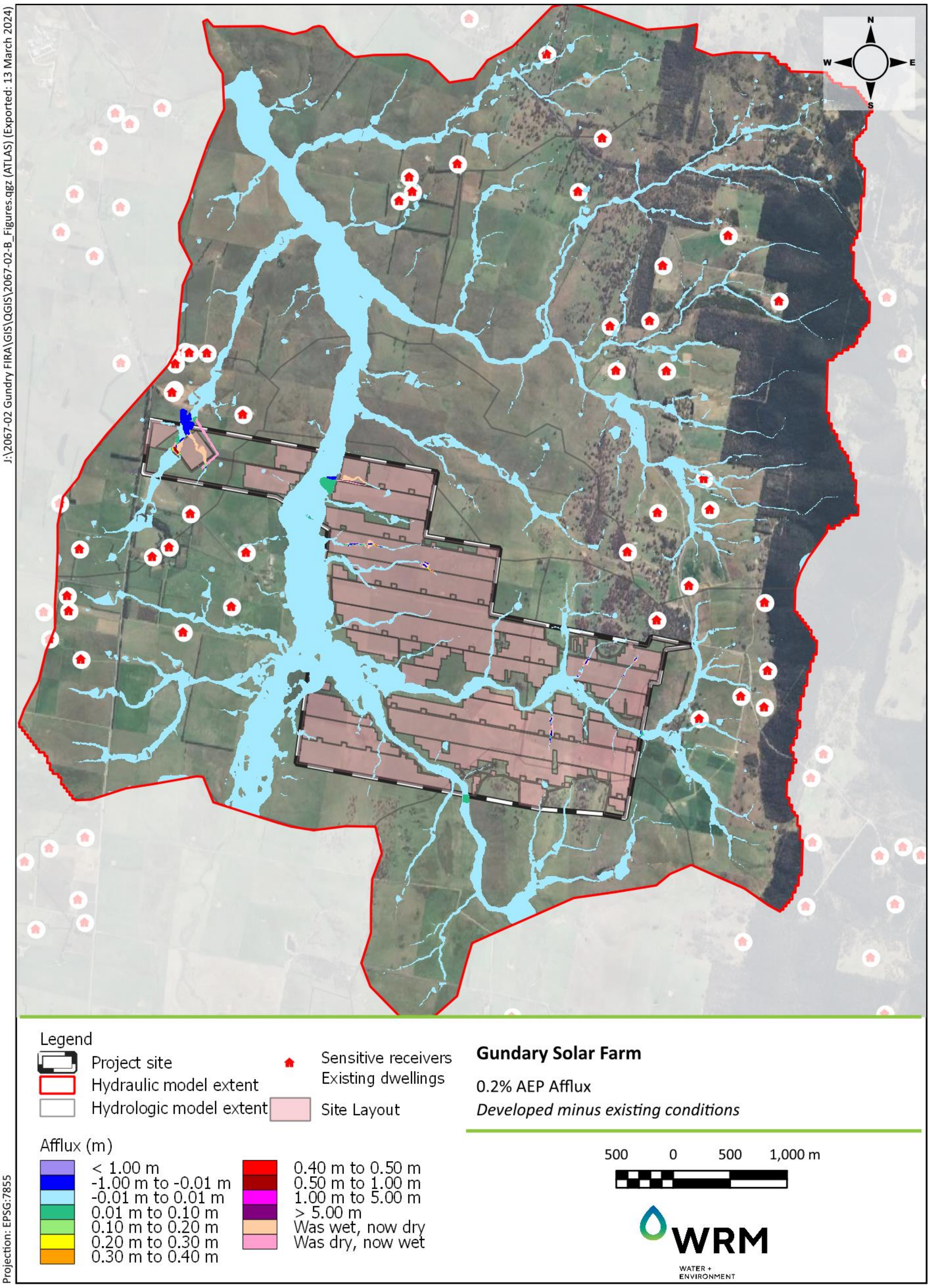

Figure C.5 **Peak water level flood impact mapping 0.2% AEP**

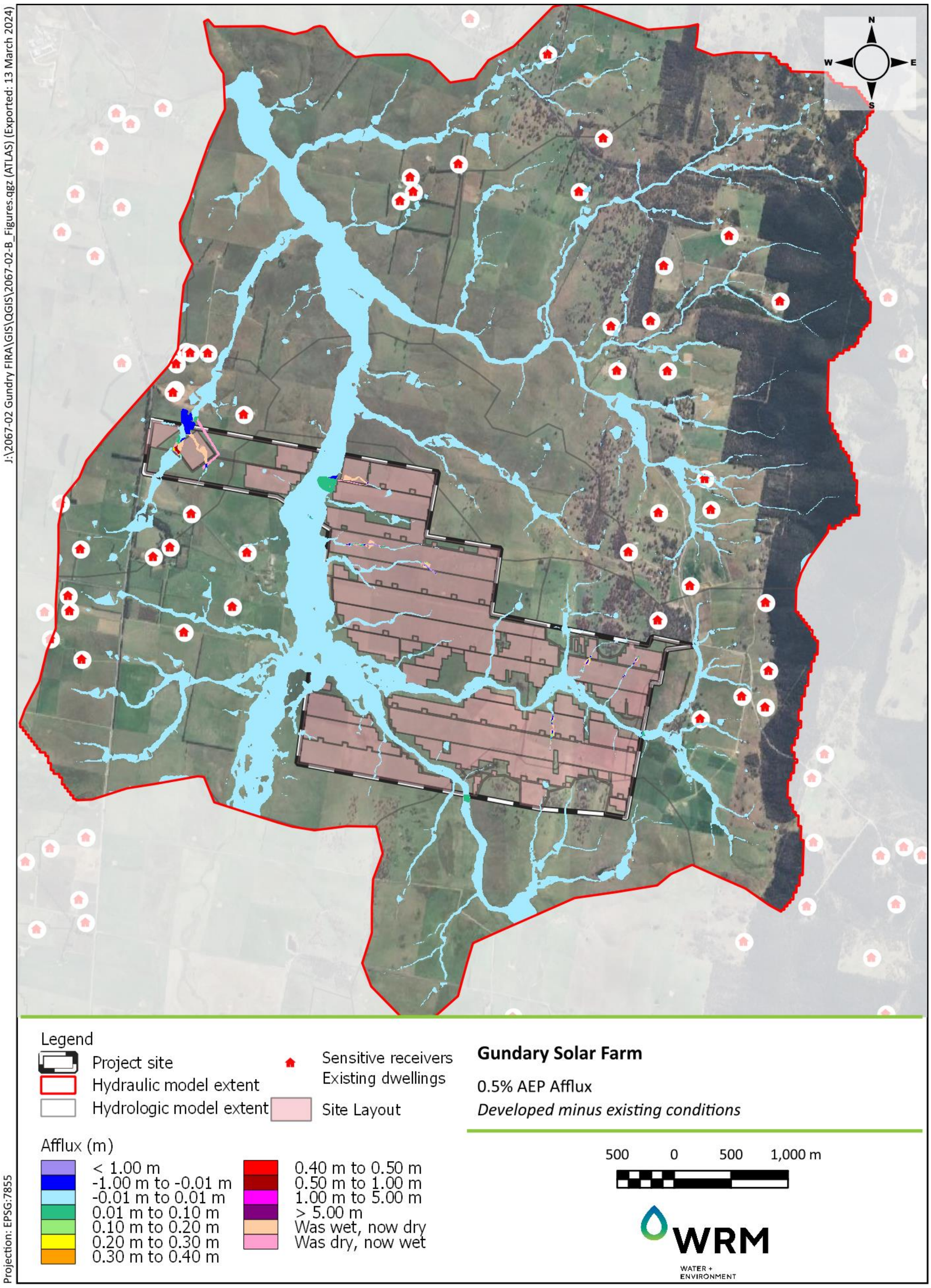

Figure C.6 **Peak water level flood impact mapping 0.5% AEP**

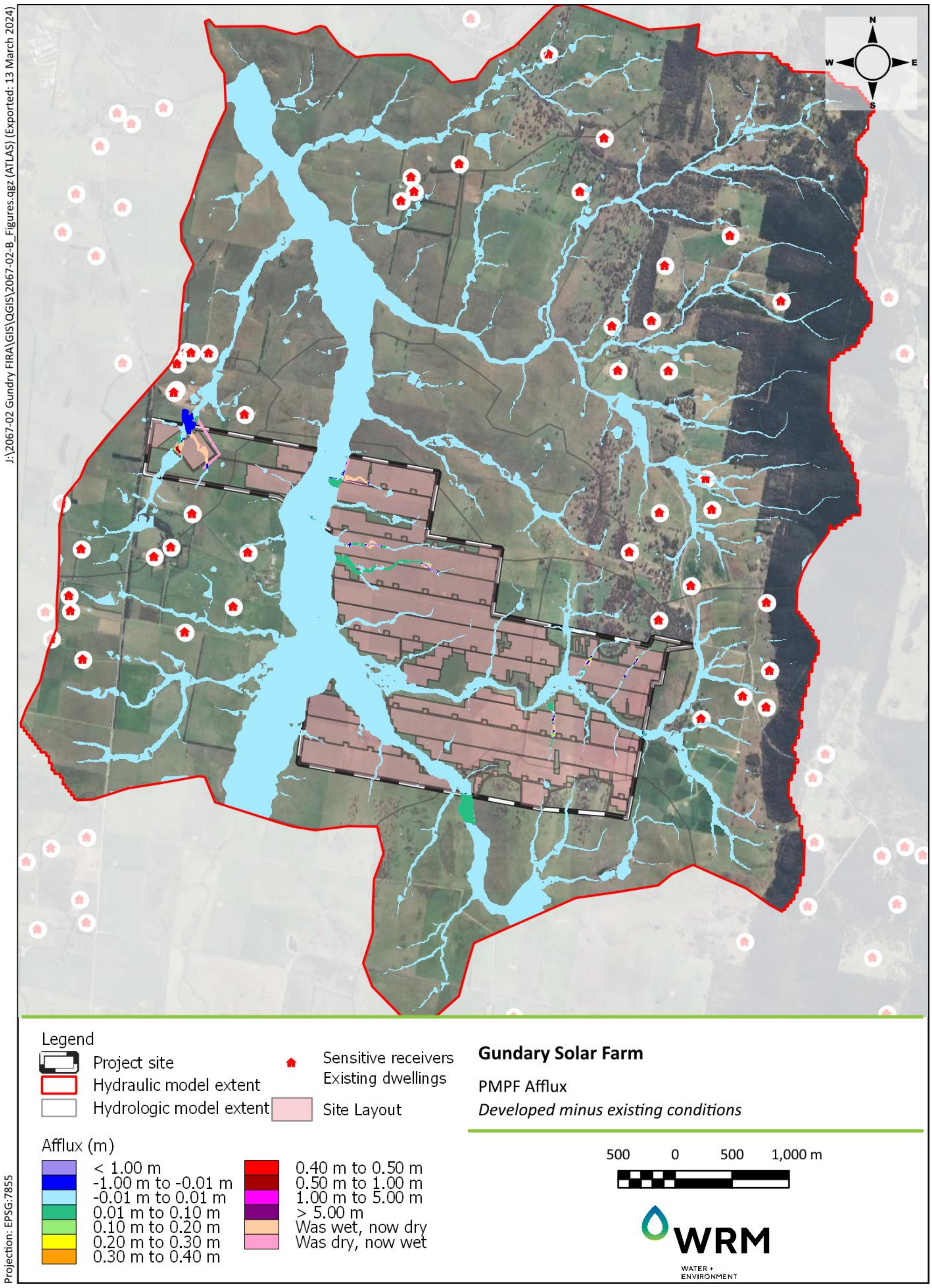

Figure C.7 Peak water level flood impact mapping PMF

APPENDIX D SEARS AGENCY ADVICE TABLE

Table D.1 SEARs Agency Advice Table

Agency Advice and Where it has Been Addressed in the FIRA		
DPE Biodiversity and Conservation Division - Water and Soils		
5	The EIS must map the following features relevant to water and soils including:	
a.	Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method).	Refer WRIA Section 3.1
b.	Wetlands as described in s4.2 of the Biodiversity Assessment Method.	No wetlands identified within the Project Area
c.	Groundwater.	Refer WRIA Section 3.7
d.	Groundwater dependent ecosystems.	Refer WRIA Section 3.7
e.	Proposed intake and discharge locations.	Refer WRIA Sections 3.0, 4.0 and 7.0
6	The EIS must describe background conditions for any water resource likely to be affected by the proposed Gundary Solar Farm, including:	
a.	Existing surface and groundwater.	Refer WRIA Section 3.0
b.	Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations.	Refer WRIA Sections 3.0, 4.0 and 7.0
c.	Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters.	Refer WRIA Section 3.4
d.	Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government.	Refer WRIA Section 3.4
7	The EIS must assess the impacts of the proposed Gundary Solar Farm on water quality, including:	

Agency Advice and Where it has Been Addressed in the FIRA		
a.	The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the proposed Gundary Solar Farm protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction.	Refer WRIA Sections 4.0, 5.0 and 7.0.
b.	Identification of proposed monitoring of water quality or required changes to existing monitoring programs.	Refer WRIA Section 8.0
8	The EIS must assess the impact of the proposed Gundary Solar Farm on hydrology, including:	
a.	Water balance including quantity, quality and source.	Refer to WRIA Section 7.3
b.	Effects to downstream rivers, wetlands, and floodplain areas.	Refer to WRIA Section 7.0
c.	Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems.	Refer to WRIA Section 7.0
d.	Impacts to natural processes and functions within rivers, wetlands, and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches).	Refer to WRIA Section 7.0
e.	Changes to environmental water availability, both regulated/licensed and unregulated/rules based sources of such water.	Refer to WRIA Section 7.3
f.	Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options.	Refer to WRIA Sections 7.0 and 8.0
g.	Identification of proposed monitoring of hydrological attributes.	Refer to WRIA Section 8.0
DPE Biodiversity and Conservation Division - Flooding		
9	The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including:	
a.	Flood prone land.	Refer to Sections 5.0 and Section 6.0
b.	Flood planning area, the area below the flood planning level.	Refer to Sections 5.0 and Section 6.0.

Agency Advice and Where it has Been Addressed in the FIRA		
c.	Hydraulic categorisation (floodways and flood storage areas).	Refer to Section 6.2 and Appendix A and B
10	The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event.	Refer to Section 6 and Appendix A and B
11	The EIS must model the effect of the proposed Gundary Solar Farm (including fill) on the flood behaviour under the following scenarios:	
a.	Current flood behaviour for a range of design events as identified in 11 above. This includes the 1 in 200 and 1 in 500-year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	Refer to Section 6 and Appendix A and B
12	Modelling in the EIS must consider and document:	
a.	The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood.	Refer to Section 6 and Appendix A and B
b.	Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories.	Refer to Section 6 and Appendix C
c.	Relevant provisions of the NSW Floodplain Development Manual 2005.	Refer to Section 6 and Appendix A and B
13	The EIS must assess the impacts on the proposed Gundary Solar Farm on flood behaviour, including:	
a.	Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure.	Refer to Section 6 and Appendix C
b.	Consistency with Council floodplain risk management plans.	Refer to Section 6 and Section 7
c.	Compatibility with the flood hazard of the land.	Refer to Section 6 and Section 7
d.	Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land.	Refer to Section 6 and Section 7

Agency Advice and Where it has Been Addressed in the FIRA		
e.	Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.	Refer to Section 6 and Section 7
f.	Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	Refer to WRIA Sections 5.0 and Section 7.0
g.	Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the SES and Council.	Refer to Section 7
h.	Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council.	Refer to Section 7
i.	Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the SES.	Refer to Section 7
j.	Any impacts the development may have on the social and economic costs to the community as consequence of flooding.	Also refer to WRIA Sections 5.0 and Section 7.0
DPE Water		
Water Take and Licensing		
1	A detailed and consolidated site water balance.	Water sourcing considered in WRIA Section 4.3
2	Description of all works/activities that may intercept, extract, use, divert or receive surface water and/or groundwater. This includes the description of any development, activities or structures that will intercept, interfere with or remove groundwater, both temporary and permanent.	Refer to WRIA Section 1.1
3	Details of all water take for the life of the project and post closure where applicable. This is to include water taken directly and indirectly, and the relevant water source where water entitlements are required to account for the water take. If the water is to be taken from an alternative source confirmation should be provided by the supplier that the appropriate volumes can be obtained.	Refer to WRIA Section 4.3

Agency Advice and Where it has Been Addressed in the FIRA		
4	Details of Water Access Licences (WALs) held to account for any take of water where required, or demonstration that WALs can be obtained prior to take of water occurring. This should include an assessment of the current market depth where water entitlement is required to be purchased. Any exemptions or exclusions to requiring approvals or licenses under the *Water Management Act 2000* should be detailed by the proponent.	Refer to WRIA Section 4.3
5	A description of groundwater conditions that provides an understanding of groundwater level across the site under a range of wet and dry conditions.	Refer to WRIA Section 3.7
6	Assessment of impacts on surface and ground water sources (both quality and quantity) including flooding, related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, groundwater dependent ecosystems, and ground water levels; including measures proposed to reduce and mitigate these impacts.	Refer to WRIA Section 7.0
7	Proposed surface and groundwater monitoring activities and methodologies.	Refer to WRIA Section 8.0
8	A description of the watercourses located within the vicinity of the development, including Strahler Stream Order as mapped by Spatial Services NSW, and appropriate riparian setbacks. Impact assessment of all works/activities located on waterfront land as defined by the Water Management Act 2000, including an assessment against the Guidelines for Controlled Activities.	Refer to WRIA Section 3.1
9	A description of erosion and sediment control measures to mitigate any impacts.	Refer to WRIA Section 3.0 and 7.0
Assessment against Policy and Guidelines		
10	Identification and impact assessment of all works/activities located on waterfront land including an assessment against Guidelines for Controlled Activities on Waterfront Land (NRAR 2018).	Refer to WRIA Section 3.2
11	Assessment of project against relevant policies and guidelines	Refer to WRIA Sections 2.0 and 7.0
DPI Fisheries		

Agency Advice and Where it has Been Addressed in the FIRA	
Protection and revegetation of riparian buffer zones and where/if possible the management/rehabilitation of any eroded gullies on site DPI Fisheries policy advocates the use of terrestrial riparian buffer zone widths as defined in section 6.1.4 of DPI Policy.	Refer to WRIA Section 7.0
Allowing fish passage in the design of waterway crossings and any cable crossings of waterways. The design and construction of crossing across key fish habitat watercourses on site should be undertaken in accordance with NSW DPIs Policy and Guidelines for Fish Friendly Waterway Crossings (2004) and Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (2004).	Refer to WRIA Sections 3.9 and 7.0
Minimising erosion and sediment control impacts to key fish habitat during the construction and operation of the facility. DPI Fisheries recommends the use of best practice sediment and erosion control, and water quality and stormwater management provisions to safeguard and mitigate impacts on water quality at the site and downstream. Note that as this site is situated within the Sydney Drinking Water Catchment Lands, the project should be designed to have a neutral or beneficial impact on water quality.	Refer to WRIA Sections 4.0, 5.0 and 7.0
A clear description of the location of works, including identification of the waterways present and all relevant plans	Refer to WRIA Sections 1.1 and 3.0
A clear description of the works to be undertaken, including timing and duration of the works and all relevant plans. This needs to include detail on the: - location and design of any proposed or upgraded waterway crossings over key fish habitat; and - the methodology (e.g. trenching or underboring) for any underground cabling of transmission lines that pass through key fish habitat.	Refer to WRIA Sections 1.1
Description of aquatic and riparian vegetation and instream aquatic vegetation in the vicinity of the development, particularly the extent and condition of riparian vegetation and instream aquatic vegetation, water depth, permanence of water flow and snags (large woody debris) within the footprint of the proposal area.	Refer to WRIA Section 3.9
Identification and classification of key fish habitat in the area, according to section 3.2 of DPI Policy.	Refer to WRIA Section 3.9

Agency Advice and Where it has Been Addressed in the FIRA	
An assessment of all potential impacts to key fish habitat and riparian zones. The extent of aquatic habitat removal and riparian vegetation removal, modification or improvement that may result from the development is to be clearly defined. Potential impacts to water quality and fish passage must be clearly defined.	Refer to WRIA Section 7.5
An assessment of significance for any threatened species matters listed under the FM Act. Assessment of Significance Guidelines can be found at: Threatened Species Assessment Guidelines - Assessment of Significance (nsw.gov.au)	Refer to Biodiversity Impact Assessment Report for impacts to fauna and flora.
A clear description of all proposed safeguards to mitigate impacts on aquatic habitats, water quality and riparian buffer zones. This can include, but not be limited to: a clear map showing the riparian buffer zone width. a description of any riparian buffer zone revegetation or erosion control works. details on how fish passage will be provided for. a description of proposed erosion and sediment control techniques to be used during construction. detail on any onsite design measures to mitigate impacts on water quality and flow volumes.	Refer to WRIA Sections 7.5 and 8.0
Goulburn Mulwaree Council	
Flooding	
The Goulburn Floodplain Risk Management Study and Plan and overland flow mapping have identified access issues within this precinct (generally south of the Hume Highway) in a range of flood events.	Refer to Section 6 and Section 7
The impacts of the construction period on rural roads with poor drainage should be considered.	Refer to Section 6 and Appendix C
The development will increase runoff from the site due to the increase in impervious surfaces. The next stage of the development process should examine the hydrologic impacts of this development on runoff rates and volumes and how this impacts the local and broader catchment including runoff routing impacts on the town of Goulburn, culvert and bridge capacity and impacts on stream erosion and stability.	Refer to Section 6 and Section 7
WaterNSW	

Agency Advice and Where it has Been Addressed in the FIRA

Regarding vegetation clearance and offsets: specific attention on measures to avoid and/or mitigate impacts to riparian zones and wetland vegetation.	Refer to Section 6 and Appendix C Also refer to WRIA Sections 7.5 and 8.0
Details of any existing erosion control measures (including Catchment Protection Scheme (CPS) works), and any other constraints such as any existing erosion gullies and the location of sodic and saline soils. The impact of any proposed changes to existing CPS works or gullies due to the proposal and possible mitigation measures should be included.	Refer to WRIA Section 3.1
A Water Cycle Management Study (WCMS) detailing:	
Site and Soil Evaluation for On-Site Wastewater Disposal if any on-site wastewater disposal is proposed, especially in the Construction Phase.	Not applicable, refer to Section 3.4
How potential water quality impacts will be avoided and/or minimized through project design, and route and site selections for the hardstand areas (including that required for the proposed construction period).	Refer to Section 7 Also refer to WRIA Section 8.0
Measures to limit the infiltration of water into highly erodible subsoils.	Refer to Section 6 Also refer to WRIA Section 7.0 and 8.0
A layout including water quality design measures that will be employed to treat the increased runoff from the increased impervious area of the panels, internal access tracks and hardstand areas (Substation and Battery Energy Storage System) (e.g. buffers, swales, dams, wetlands, rehabilitation/fencing off).	Conceptual stormwater treatment train described in WRIA Section 5.3.1 Conceptual Project layout presented in WRIA Figure 1.2. Detailed layout showing water management measures to be prepared during detailed design phase.
Stormwater quality modelling using MUSIC software showing a comparison of pre- and post-development scenarios on water quality parameters of key concern (Total Suspended Solids, Total Phosphorus and Total Nitrogen). WaterNSW will require an electronic copy of the MUSIC file in .sqz file, and	Refer to WRIA Section 5.0
Concept design plans of any stormwater quality treatment measures and required watercourse crossings (both temporary and permanent).	Conceptual stormwater treatment train described in WRIA Section 5.3.1 Watercourse crossings shown on Figure 1.2 within WRIA

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APPENDIX B

Agency Advice Addressed in This Report

Agency Advice		Section where addressed in the WRIA
Biodiversity and Conservation Division		
Water and soils		
5	The EIS must map the following features relevant to water and soils including:	
a.	Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method).	Section 3.0
b.	Wetlands as described in 4.2 of the Biodiversity Assessment Method.	Section 3.0 There are no wetlands within the Project Area
c.	Groundwater.	Section 3.0
d.	Groundwater dependent ecosystems.	Section 3.0
e.	Proposed intake and discharge locations.	Section 3.0 and Section 4.3
6	The EIS must describe background conditions for any water resource likely to be affected by the development, including:	
a.	Existing surface and groundwater.	Section 3.0 and Section 7.0
b.	Hydrology, including volume, frequency, and quality of discharges at proposed intake and discharge locations.	Section 3.0 , Section 4.0 and Section 7.0
c.	Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters.	Section 5.0 and Section 7.0
d.	Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government.	Section 5.0 and Section 7.0
7	The EIS must assess the impacts of the development on water quality, including:	
a.	The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the proposed Gundary Solar Farm protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction.	Section 7.0
b.	Identification of proposed monitoring of water quality.	Section 8.0

Agency Advice		Section where addressed in the WRIA
8	The EIS must assess the impact of the development on hydrology, including:	
a.	Water balance including quantity, quality, and source.	Section 4.0 and Section 7.0. A detailed water balance was not deemed required due to the nature of the Project, final water sources still to be confirmed with the preference to be via commercial suppliers. Assessment of flows from the Project Area during flood events were undertaken using TUFLOW models.
b.	Effects to downstream rivers, wetlands, estuaries, marine waters, and floodplain areas.	Section 4.0 and Section 7.0. Assessment of flows from the Project Area during flood events were undertaken using TUFLOW models.
c.	Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems.	Section 7.5. Refer to Biodiversity Development Assessment Report for impacts to fauna and flora.
d.	Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g., river benches).	Section 7.0.
e.	Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water/	Section 4.0 and Section 7.0.
f.	Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options.	Section 5.0, Section 6.0 and Section 7.0. No major stormwater and wastewater infrastructure proposed for the Project Area.
g.	Identification of proposed monitoring of hydrological attributes.	See Section 7.0 and Section 8.0.
Flooding		
9	The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including:	
a.	Flood prone land.	Refer to Appendix A for the Flood Risk and Impact Assessment Report
b.	Flood planning area, the area below the flood planning level.	Appendix A
c.	Hydraulic categorization (floodways and flood storage areas).	Appendix A
10	The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP, flood levels and the probable maximum flood, or an equivalent extreme event.	Section 6.0 Appendix A

Agency Advice		Section where addressed in the WRIA
11	The EIS must model the effect of the proposed Gundary Solar Farm (including fill) on the flood behaviour under the following scenarios:	Section 6.0 Appendix A
a.	Current flood behaviour for a range of design events as identified in 11 above. This includes the 1 in 200 and 1 in 500 year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	Section 6.0 Appendix A
12	Modelling in the EIS must consider and document:	
a.	The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood, or an equivalent extreme flood.	Section 6.0 and Section 7.2 Appendix A
b.	Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of the developments or land. This may include redirection of flow, flow velocities, flood levels, hazard categories and hydraulic categories.	Section 6.0 and Section 7.2 Appendix A
c.	Relevant provisions of the NSW Floodplain Development Manual 2005.	Appendix A
13	The EIS must assess the impacts on the proposed development on flood behaviour, including:	
a.	Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure.	Section 6.0 and Section 7.2 Appendix A
b.	Consistency with Council floodplain risk management plans	Section 6.0 and Section 7.2 Appendix A
c.	Compatibility with the flood hazard of the land.	Section 6.0 and Section 7.2 Appendix A
d.	Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land.	Section 6.0 and Section 7.2 Appendix A
e.	Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.	Section 6.0 and Section 7.2 Appendix A
f.	Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses.	Section 6.0 and Section 7.2 Appendix A
g.	Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the NSW SES and Council.	Section 6.0 and Section 7.2 Appendix A
h.	Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the NSW SES and Council.	Section 6.0 and Section 7.2 Appendix A
i.	Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the NSW SES.	Section 6.0 and Section 7.2 Appendix A
j.	Any impacts the development may have on the social and economic costs to the community as consequence of flooding.	Section 6.0 and Section 7.2 Appendix A

Agency Advice		Section where addressed in the WRIA
Department of Planning and Environment: Water		
Water take and Licensing		
1	A detailed and consolidated site water balance.	Section 4.0 and Section 7.0. A detailed water balance was not deemed required due to the nature of the Project, final water sources still to be confirmed with the preference to be via commercial suppliers.
2	Description of all works/activities that may intercept, extract, use, divert or receive surface water and/or groundwater. This includes the description of any development, activities or structures that will intercept, interfere with or remove groundwater, both temporary and permanent.	Section 1.1, Section 3.0, Section 4.0 and Section 7.0
3	Details of all water take for the life of the project and post closure where applicable. This is to include water taken directly and indirectly, and the relevant water source where water entitlements are required to account for the water take. If the water is to be taken from an alternative source confirmation should be provided by the supplier that the appropriate volumes can be obtained.	Section 4.0 and Section 7.0
4	Details of Water Access Licences (WALs) held to account for any take of water where required, or demonstration that WALs can be obtained prior to take of water occurring. This should include an assessment of the current market depth where water entitlement is required to be purchased. Any exemptions or exclusions to requiring approvals or licenses under the Water Management Act 2000 should be detailed by the proponent.	Section 4.0 and Section 7.0
5	A description of groundwater conditions that provides an understanding of groundwater level across the site under a range of wet and dry conditions.	Section 3.0
6	Assessment of impacts on surface and ground water sources (both quality and quantity) including flooding, related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, groundwater dependent ecosystems, and ground water levels; including measures proposed to reduce and mitigate these impacts.	Section 7.0
7	Proposed surface and groundwater monitoring activities and methodologies.	Section 7.0 and Section 8.0
8	A description of the watercourses located within the vicinity of the development, including Strahler Stream Order as mapped by Spatial Services NSW, and appropriate riparian setbacks. Impact assessment of all works/activities located on waterfront land as defined by the Water Management Act 2000, including an assessment against the Guidelines for Controlled Activities.	Section 3.0
9	A description of erosion and sediment control measures to mitigate any impacts.	Section 4.1 and Section 8.0

Agency Advice		Section where addressed in the WRIA
Assessment against Policy and Guidelines		
10	Identification and impact assessment of all works/activities located on waterfront land including an assessment against Guidelines for Controlled Activities on Waterfront Land (NRAR 2018).	Section 7.0
11	Assessment of project against relevant policies and guidelines.	Section 1.3, Section 2.0 and Section 7.0
DPI Fisheries		
The environmental assessment should address the following matters:		
A clear description of the location of works, including identification of the waterways present and all relevant plans		Section 1.1, Section 3.0, Section 4.0 and Section 7.0
A clear description of the works to be undertaken, including timing and duration of the works and all relevant plans. This needs to include detail on the: • location and design of any proposed or upgraded waterway crossings over key fish habitat; and • the methodology (e.g. trenching or underboring) for any underground cabling of transmission lines that pass through key fish habitat.		Section 1.1, Section 3.0, Section 4.0 and Section 7.0
Description of aquatic and riparian vegetation and instream aquatic vegetation in the vicinity of the development, particularly the extent and condition of riparian vegetation and instream aquatic vegetation, water depth, permanence of water flow and snags (large woody debris) within the footprint of the proposal area.		Section 3.0 and Section 7.0
Identification and classification of key fish habitat in the area, according to section 3.2 of DPI Policy.		Section 3.0 and Section 7.0
An assessment of all potential impacts to key fish habitat and riparian zones. The extent of aquatic habitat removal and riparian vegetation removal, modification or improvement that may result from the development is to be clearly defined. Potential impacts to water quality and fish passage must be clearly defined.		Section 7.0
An assessment of significance for any threatened species matters listed under the FM Act. Assessment of Significance Guidelines can be found at: Threatened Species Assessment Guidelines - Assessment of Significance (nsw.gov.au)		Section 7.5. Refer to Biodiversity Development Assessment Report for impacts to fauna and flora.
A clear description of all proposed safeguards to mitigate impacts on aquatic habitats, water quality and riparian buffer zones. This can include, but not be limited to: • a clear map showing the riparain buffer zone width. • a description of any riparian buffer zone revegetation or erosion control works. • detals on how fishpassage will be provided for. • a description of proposed erosion and sediment control techniques to be used during construction. o detail on any onsite design measures to mitigate impacts on water quality and flow volumes.		Section 8.0

Agency Advice	Section where addressed in the WRIA
Goulburn Mulwaree Council	
Flooding	
The Goulburn Floodplain Risk Management Study and Plan and overland flow mapping have identified access issues within this precinct (generally south of the Hume Highway) in a range of flood events. The impacts of the construction period on rural roads with poor drainage should be considered. The development will increase runoff from the site due to the increase in impervious surfaces. The next stage of the development process should examine the hydrologic impacts of this development on runoff rates and volumes and how this impacts the local and broader catchment including runoff routing impacts on the town of Goulburn, culvert and bridge capacity and impacts on stream erosion and stability.	Section 6.0, Section 7.2 Appendix A
Water NSW	
Regarding vegetation clearance and offsets: specific attention on measures to avoid and/or mitigate impacts to riparian zones and wetland vegetation.	Section 7.5. Refer to Biodiversity Development Assessment Report for impacts to fauna and flora.
Details of any existing erosion control measures (including Catchment Protection Scheme (CPS) works), and any other constraints such as any existing erosion gullies and the location of sodic and saline soils. The impact of any proposed changes to existing CPS works or gullies due to the proposal and possible mitigation measures should be included.	Section 3.0, Section 4.0, Section 5.0 and Section 7.0
A Water Cycle Management Study (WCMS) detailing: • Site and Soil Evaluation for On-Site Wastewater Disposal if any on-site wastewater disposal is proposed, especially in the Construction Phase • How potential water quality impacts will be avoided and/or minimized through project design, and route and site selections for the hardstand areas (including that required for the proposed construction period) • Measures to limit the infiltration of water into highly erodible subsoils • A layout including water quality design measures that will be employed to treat the increased runoff from the increased impervious area of the panels, internal access tracks and hardstand areas (Substation and Battery Energy Storage System) (eg buffers, swales, dams, wetlands, rehabilitation/fencing off) • Stormwater quality modelling using MUSIC software showing a comparison of pre- and post-development scenarios on water quality parameters of key concern (Total Suspended Solids, Total Phosphorus and Total Nitrogen). WaterNSW will require an electronic copy of the MUSIC file in .sqz file, and • Concept design plans of any stormwater quality treatment measures and required watercourse crossings (both temporary and permanent).	Section 4.0, Section 5.0, Section 7.0 and Section 8.0

APPENDIX C

Site Inspection Photos

Photo	Location
	Location A Unnamed Watercourse – looking south Easting: 754066.0 Northing: 6139269.4

Photo	Location
	Location B Unnamed Watercourse – looking upstream Easting: 753955.5 Northing: 6139309.2

Photo	Location
	Location C Unnamed Watercourse – looking downstream Easting: 754735.2 Northing: 6139212.7

Photo	Location
	Location D Unnamed Watercourse – looking downstream Easting: 754812.5 Northing: 6139189.6

Photo	Location
	Location E Unnamed Watercourse – looking downstream Easting: 753283.3 Northing: 6139238.7

Photo	Location
	Location F Unnamed Watercourse – looking upstream Easting: 754881.3 Northing: 6139131.3

Photo	Location
	Location G Unnamed Watercourse – looking downstream Easting: 754786.3 Northing: 6139194.2

Photo	Location
	Location H Unnamed Watercourse – looking downstream Easting: 754999.7 Northing: 6139070.3

Photo	Location
	Location I Unnamed Watercourse – looking downstream Easting: 754596.5 Northing: 6139150.7

Photo	Location
	Location J Bullamalito Creek – looking downstream Easting: 753850.7 Northing: 6138399.7

Photo	Location
	Location K Bullamalito Creek – looking downstream Easting: 753484.3 Northing: 6138557.2

Photo	Location
	Location L Bullamalito Creek – looking downstream Easting: 753335.3 Northing: 6138688.5

Photo	Location
	Location M Bullamalito Creek – looking downstream Easting: 753213.0 Northing: 6138802.0

Photo	Location
	Location N Bullamalito Creek – looking downstream Easting: 753015.0 Northing: 6139155.0

Photo	Location
	Location O Gundary Creek – looking south-east (upstream) Easting: 752465.4 Northing: 6141125.2

Photo	Location
	Location P Gundary Creek – looking east Easting: 752465.4 Northing: 6141125.2

Photo	Location
	Location Q Gundary Creek – looking north-east (downstream) Easting: 752560.1 Northing: 6141286.4

Photo	Location
	Location R Tributary of Unnamed Watercourse – looking north Easting: 754512.7 Northing: 6139078.2

Photo	Location
	Location S Tributary of Unnamed Watercourse – looking south Easting: 754966.6 Northing: 6139069.1

umwelt

Environmental & Social Consultants

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