

Whitehaven Solar Farm Project

Environmental Impact Statement



WHITEHAVEN COAL



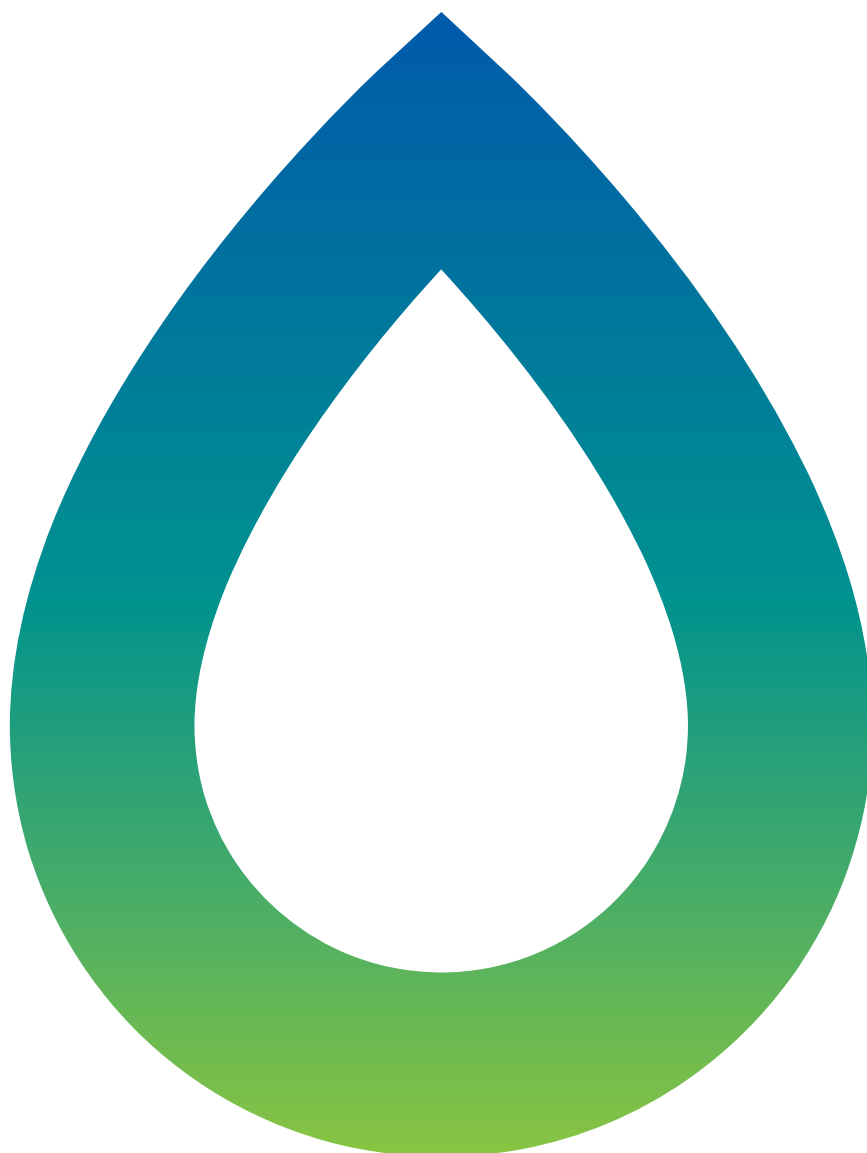
WHITEHAVEN SOLAR FARM

Water Resources Impact Assessment

Whitehaven Energy (Australia) Pty Ltd

9 December 2024

0189-02-B3



DETAILS

Report Title	Water Resources Impact Assessment
Client	Whitehaven Energy (Australia) Pty Ltd

THIS REVISION

Report Number	0189-02-B3
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Author	Lindsay Millard / Todd Carlsson
Reviewer	Greg Roads

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NOTE ON FLOOD FREQUENCY TERMINOLOGY

A design flood is a probabilistic or statistical estimate, being generally based on some form of probability analysis of flood or rainfall data. An Annual Exceedance Probability (AEP) is attributed to the estimate. The frequency of flood events is expressed as an AEP, for example, a flood magnitude having 10% AEP, there is a 10% probability (or 1 in 10 chance) that there would be floods of that magnitude or greater each year. While a related concept, Annual Recurrence Interval (ARI) is now outmoded due to the confusion it generates. A flood with a 10 year ARI, refers to floods that equal or of greater magnitude once in ten years on average. For very frequent events, the concept is referred to as Exceedances per Year (EY). The approximate correspondence between terminology, in particular the relationship between AEP and ARI applies to this study (ARR, 2019). The frequency of flood events can be grouped into five broad descriptive categories, as shown below.

Frequency Descriptor	EY	AEP (%)	AEP	ARI
			(1 in x)	
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	0.5
	1	63.21	1.58	1
Frequent	0.69	50	2	1.44
	0.5	39.35	2.54	2
	0.22	20	5	4.48
	0.2	18.13	5.52	5
	0.11	10	10	9.49
Rare	0.05	5	20	19.5
	0.02	2	50	49.5
	0.01	1	100	99.5
Very Rare	0.005	0.5	200	199.5
	0.002	0.2	500	499.5
	0.001	0.1	1000	999.5
	0.0005	0.05	2000	1999.5
Extreme	0.0002	0.02	5000	4999.5
			↓	
			PMP/ PMP Flood	

Source: Australian Rainfall and Runoff Guidelines (Ball et al, 2019)

In this report, the frequency of flood events is referred to in terms of AEP for floods categorised as very rare, for example 1%, 0.2% or 0.5% AEP. These floods were calculated using the historical climate records. Over recent years, the climate record is showing the influence of non-stationarity. Evidence now exists that the magnitude of floods, i.e. those based on the historical record, are becoming more frequent. It is considered that this would continue as a warming climate will lead to more moisture being held in the atmosphere. For planning purposes, it is prudent to consider a 0.5% AEP based on the historical record as a proxy of the 1% AEP flood event based on future climate depths.

The 1 in 2000 (0.05%) AEP event is considered the limit of credible extrapolation of the historical record. These floods are categorised as extreme with the limit being the concept of the Probable Maximum Flood (PMF). The PMF occurs as a result of the Probable Maximum Precipitation (PMP) and The PMP is the result of the maximum atmospheric carrying capacity of moisture and the efficiency of the storm mechanism to produce rainfall in a region. A PMF flood is not shown above as it is extreme and beyond the statistical limit. A PMF flood cannot have an AEP assigned to its magnitude as it applies the most conservative assumptions related to temporal patterns, losses and so on. Note also, that the PMF is not the same as the PMP Flood.

Very rare design events floods are useful for the purposes of planning as there is a remote chance that it may occur. Extreme floods are considered so far beyond the credible limit of record and contain so much inherent uncertainty that they exist only to provide a theoretical limit.

The approach to estimating an actual (or historic) flood from a particular rainfall event is quite different in concept and is of a deterministic nature. All causes and effects are directly related to the specific event under consideration. The actual antecedent conditions prevailing at the time of occurrence of the rain are directly reflected in the resulting flood and must be allowed for in its estimation. No real information on the probability of the historic flood can be gained from consideration of a single actual flood event.

ABBREVIATIONS 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).
ADWG	Australian Drinking Water Guidelines
AHD (mAHD)	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.
ASC	Australian Soil Classification (Isbell, R. F., 2021)
BESS	Battery Energy Storage System.
BGL (mBGL)	Below Ground Level. A relative datum used in bore holes to measure depth to groundwater.
BSAL	Biophysical Strategic Agricultural Land
CEMP	Construction Environment Management Plan
DEM	Digital Elevation Model
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).
EIS	Environmental Impact Statement
ELVIS	Elevation Information System
EV	Environmental Value
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 tsunamis.

Term/ Abbreviation	Definition
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.
GDE	Groundwater Dependent Ecosystem
GW	Gigawatt.
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.
kL	Kilolitre, one thousand litres.
km	Kilometres.
kV	Kilovolt.
LSC	Land and Soil Capability
mAHD	Metres Australian Height Datum (AHD).
m/s	Metres per second. Unit used to describe the velocity of floodwaters.
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.
ML	Megalitre, one million litres.

Term/ Abbreviation	Definition
MNES	Matters of National Environmental Significance.
MW	Megawatt.
OEMP	Operational Environmental Management Plan.
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.
PMP (Probable maximum precipitation)	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 100 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.
RUSLE	Revised Universal Soil Loss Equation.
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.
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.

1 INTRODUCTION

1.1 OVERVIEW

The Whitehaven Solar Farm Project (the Project) is located approximately 25 kilometres (km) south-east of Narrabri and approximately 60 km north-west of Gunnedah, within the Narrabri Shire Council Local Government Area, in the New England North West region of New South Wales (NSW) (Figure 1).

The Project would be located adjacent to the existing Narrabri Mine on Whitehaven Coal Limited (Whitehaven)-managed land and would include approximately 26 megawatts (MW) direct current (DC) of solar electricity generation and the construction of a 10 Megawatt Hour DC Battery Energy Storage System (BESS). The Project would provide behind-the-meter electricity supply to the Narrabri Mine via the existing 66 kilovolt (kV) electricity transmission line (ETL).

Topography in the vicinity of the Project is characterised by the vegetated, hilly country of both Jacks Creek State Forest and Pilliga East State Forest to the west. The Project Area itself is located on relatively flat land, falling easterly to the alluvial plains of the Namoi River, the average elevation of the Project Area is 254 metres Australian Height Datum (mAHD). The Project is also located immediately north of Kurrajong Creek, and Kurrajong Creek Tributary 2 traverses the site. Both Kurrajong Creek and Kurrajong Creek Tributary 2 flow into the Namoi River.

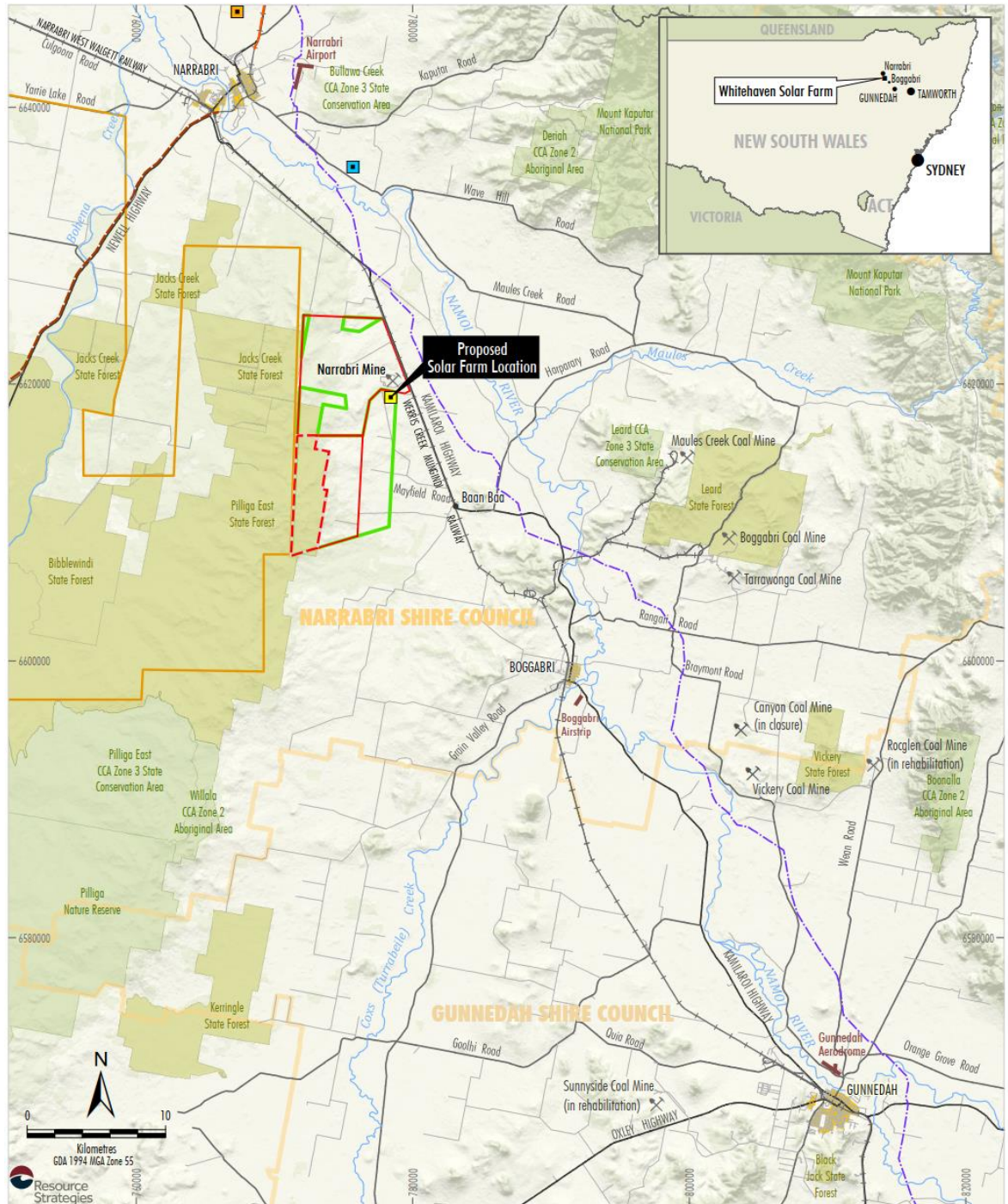
1.2 PROJECT OVERVIEW

Whitehaven Energy Pty Ltd (Whitehaven Energy), a wholly owned subsidiary of Whitehaven, is the proponent of the Project and is seeking approval for the Project as a State Significant Development (SSD) under Section 4.36 of the *Environmental Planning and Assessment Act 1979*.

The Project would include the following primary components and activities (Figure 2):

- construction and operation of approximately 50,000 solar photovoltaic (PV) panels to provide electricity supply for the Narrabri Mine;
- construction of a substation that facilitates connection to the existing 66 kV overhead ETL;
- construction of an overhead ETL to connect the proposed substation to the existing 66 kV overhead ETL, north of Kurrajong Creek Rd;
- construction and operation of ancillary infrastructure including access roads, inverter stations, temporary staging areas, perimeter fencing and operations and maintenance buildings;
- construction and operation of a BESS;
- ongoing maintenance activities; and
- decommissioning and rehabilitation of the Project area.

Table 1 provides a summary of the key attributes of the Project.



- LEGEND**
- | | |
|---|---|
|  Proposed Whitehaven Solar Farm |  Other Major Projects |
|  Mine Site |  Narrabri South Solar Farm |
|  Exploration Licence (EL 6243) |  Silverleaf Solar Farm |
|  Mining Lease (ML 1609) |  Narrabri Gas Project (Santos NSW [Eastern] Pty Ltd) |
|  Provisional Mining Lease Application Area |  Inland Rail (Narrabri to North Star - Phase 1) |
|  Local Government Boundary |  Proposed Inland Rail (Narramine to Narrabri) |
|  State Forest |  Proposed Queensland Hunter Gas Pipeline Alignment |
|  State Conservation Area, Aboriginal Area | |

WHITEHAVEN COAL
WHITEHAVEN SOLAR FARM
 Regional Location

Figure 1.1 Locality of Project Area

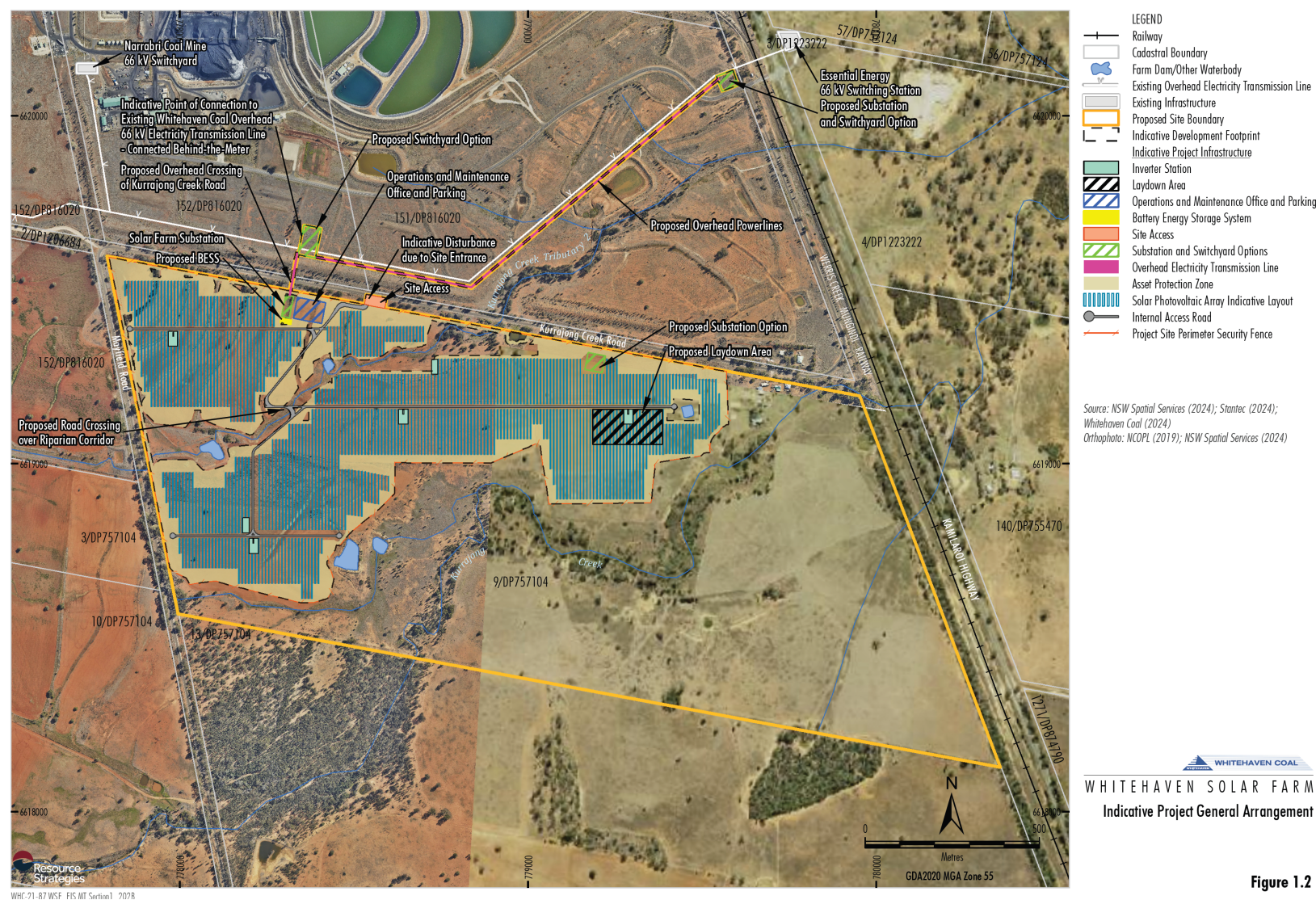


Figure 1.2

Figure 1.2 Conceptual Layout

Table 1.1 provides a summary of the key attributes of the Project.

Table 1.1 Summary of the key attributes of the Project

Project Component	Summary Description
Size and Purpose	26 MW DC, 20 MW alternating current (AC) for behind-the-meter electricity supply to the Narrabri Mine.
Project Area	Development site footprint of approximately 100 ha.
Solar Configuration	Approximately 50,000 PV panels in a north to south alignment. East to west tracking system (single axis).
Access Route	The proposed access route is via the Kamilaroi Highway and Kurrajong Creek Road.
Power Infrastructure	Substation and switchyard. 66 kV connector to the existing 66 kV ETL.
BESS	10 Megawatt Hour DC. Centralised system. Lithium battery.
Site Entry	Site entry would be via a constructed access point on Kurrajong Creek Road.
Construction	Construction period of approximately six to nine months. Employment of approximately 30 personnel on average during its construction, with peak construction requiring approximately 65 personnel. Construction undertaken during daylight hours.
Operational Life	The design operational life is approximately 50 years.
Decommissioning and Rehabilitation	Decommissioning at the end of the of Project life, involving the removal of all infrastructure with a proposed final land use to comprise a combination of native vegetation and agricultural (pasture).

1.3 PURPOSE AND SCOPE

This Water Resources Impact Assessment (WRIA) was prepared by WRM Water & Environment Pty Ltd (WRM) in accordance with the Secretary's Environmental Assessment Requirements (SEARs) (Application Number SSD-66542218, issued on 14 February 2024) issued by the Department of Planning, Housing and Infrastructure (DPHI) and as presented in Table 1.2.

The WRIA provides an assessment of the potential impacts of the Project on the water resources in the vicinity of the Project Area. The assessment considers surface water, groundwater, water quality and hydrology impacts associated with the construction and operation of the Project and includes the following scope:

- assessment of the potential impacts on:
 - flooding for the 10%, 1%, 0.5%, 0.2% Annual Exceedance Probability (AEP) events and Probable Maximum Flood (PMF) for the current climate;
 - future 1% AEP flood risk under a changing climate projected over 30 years depending on the actual emissions trajectory;
 - erosion and sedimentation;

- surface water and groundwater quality; and
- water users and supply;
- confirming the environmental values and water quality objectives associated with surface water resources; and
- describing appropriate mitigation measures to manage the potential impacts.

The SEARs for the Project identify key issues and referenced guidelines that must be addressed in the Environmental Impact Statement (EIS). Table 1.2 outlines where the specific SEARs requirements for water resources are addressed in this report. Appendix A summarises Agency Advice appended to the SEARs and outlines how this advice has been addressed in this Report.

Table 1.2 Planning Secretary's Environmental Assessment Requirements (SEARs)¹

SEARs Key Issues - Water:	Location
an assessment of the likely impacts of the development (including flooding and flood modelling) on surrounding watercourses (including their Strahler Stream Order), groundwater resources and surface water movements, and measures proposed to monitor, reduce and mitigate these impacts including water management issues having regard to the Solar Guideline;	Sections 4 to 7
a site water balance for the development and details of water requirements and supply arrangements for construction and operation;	Sections 4.2 to 4.5
where the project involves works within 40 metres of the high bank 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 <i>Guidelines for Controlled Activities on Waterfront Land</i> (2018) and (if necessary) <i>Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings</i> (DPI 2003); and <i>Policy & Guidelines for Fish Habitat Conservation & Management</i> (DPI, 2013);	Sections 5 to 7
a description of the erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with <i>Managing Urban Stormwater: Soils & Construction</i> (Landcom, 2004).	Sections 4.5 and 4.6

¹ <https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-66542218%2120240213T195412.168%20GMT>

1.4 REPORT STRUCTURE

This report is structured as follows:

- Section 2 provides details of the regulatory framework.
- Section 3 provides details of the existing surface water environment.
- Section 4 describes water management and demand for the Project.
- Section 5 describes the methodology and results of the flood assessment.
- Section 6 presents an assessment of the impacts of the Project.
- Section 7 outlines the proposed management and mitigation measures.
- Section 8 presents the conclusions of the assessment.
- Section 9 is a list of references.
- Appendix A outlines and addresses Agency Advice on the Project SEARs.
- Appendix B contains flood maps.
- Appendix C provides soil data for the Project Area.

2 REGULATORY FRAMEWORK

2.1 OVERVIEW

This section describes the regulatory framework (legislations, policies and standards) at Commonwealth and State level that would apply to surface water management at this Project²:

- *Water Management Act 2000* (WM Act).
- *Water Act 1912* (Water Act).
- Flooding:
 - Australian Rainfall and Runoff Guidelines 2019 (Commonwealth of Australia (Geoscience Australia), 2019).
 - Floodplain Risk Management Manual and Guideline LU01³ (Department of Planning and Environment [DPE], 2023) known as "*Flood Risk Management Manual, 2023*"
- Surface Water:
 - NSW Government Water Quality and River Flow Objectives⁴
 - 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 Volume 1 (Landcom, 2004) and Volume 2 (Department of Environment and Climate Change [DECC], 2008).
 - Storing and Handling Liquids: Environmental Protection – Participants Handbook (DECC, 2007).
- Policy & Guidelines for Fish Habitat Conservation & Management (Department of Primary Industries, 2013).
- Guidelines for Controlled Activities on Waterfront Land:
 - Guidelines for riparian corridors on waterfront land (DPE Water, 2022a).
 - Guidelines for instream works on waterfront land (DPE Water, 2022b).
 - Guidelines for vegetation management plans on waterfront land (DPE Water, 2022c).
 - Guidelines for watercourse crossings on waterfront land (DPE Water, 2022d).
 - Controlled Activities on Waterfront Land: Controlled activity exemptions on waterfront land (DPE Water, 2022e).

² <https://www.planning.nsw.gov.au/Policy-and-Legislation/Planningreforms/Rapid-Assessment-Framework/Improving-assessment-guidance>

<https://www.planningportal.nsw.gov.au/major-projects/assessment/policiesand-guidelines>

<http://www.environment.gov.au/epbc/publications#assessments>

³ <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Floodplains/flood-risk-management-impact-risk-assessment-230234.pdf>

⁴ <http://www.environment.nsw.gov.au/ieo/>

- Groundwater:
 - NSW State Groundwater Policy Framework Document and component policies.
 - *NSW Aquifer Interference Policy 2012* (Department of Primary Industries Office of Water).
 - National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (Agriculture and Resource Management Council of Australia and New Zealand/Australia and New Zealand Environment and Conservation Council).
- Planning for Bushfire Protection NSW Rural Fire Service (November 2019)

2.2 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) outlines the requirements relating to the management and protection of matters of national environmental significance (MNES).

‘Controlled actions’ are those actions that the Minister decides have, will have or are likely to have a significant impact on one or more protected matters and therefore require assessment and approval under the Act. The protected matters upon which the action may have a significant impact are called the ‘controlling provisions’ or ‘triggers’ for assessment and approval under the Act, for that controlled action.

2.3 Water Management Act 2000

The WM Act is the primary legislation for the management of water in the Project Area. The WM Act establishes licensing regimes for the management of water resources in NSW. The licensing and approvals provisions of the WM Act apply to water sources that are the subject of a Water Sharing Plan (WSP).

With respect to surface water, the Project is located in the Lower Namoi River Water Source and Eulah Creek Water Source under the WM Act, as identified in the WSP for the *Upper Namoi and Lower Namoi Regulated River Water Sources 2016* (NRRWSP) and *Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources 2012* (NPUWSP), respectively. The WM Act is therefore relevant to the Project.

Groundwater quality protection is also achieved through consideration of both the objects and principles of the WM Act. Additional groundwater sources and WSPs under the upper-most groundwater source and WSP. However, these deeper groundwater sources and WSPs are not applicable as Project works are not proposed at depths of greater than a few metres below ground level and are unlikely to influence these deeper groundwater systems.

2.3.1 Water Sharing Plans: Upper Namoi and Lower Namoi Regulated River Water Sources 2016

The NRRWSP, which is made under section 50 of the WM Act. The NRRWSP area is shown on Figure 2.1. The NRRWSP area comprises two water sources in the Namoi River catchment. The Lower Namoi Water Source (in which the Project is located) is located downstream of Keepit Dam.

The NRRWSP allows for some extraction of water from the river and groundwater without a WAL to provide basic landholder rights, which include domestic and stock rights as well as Native Title rights.

All water extraction that is not for basic landholder rights must be authorised by a WAL. Each WAL specifies a share component. The share components of specific purpose licences, such as town water supply, stock and domestic are expressed as megalitres per year (ML/yr). The share components of high security, general security and supplementary WALs are expressed as a number of unit shares. Table 2.1 shows the categories of access licences in the Lower Namoi Water Source and their total share components in the NRRWSP (as given in the 1 July 2020 version).

Table 2.1 Lower Namoi River water source share components for different licence categories

Access Licence Category	Lower Namoi River Water Source Share Component	Total Share Component in the NRRWSP Water Sources
Domestic and Stock Access (ML/yr)	1,998	2,088
Regulated River (High Security) Access (Unit Shares)	3,904	3,984
Regulated River (General Security) Access (Unit Shares)	245,074	256,528
Supplementary WALs (Unit Shares)	115,479	115,479
Local Water Utility (ML/yr)	2,271	2,786

2.3.2 Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012

The NPUWSP, which is made under section 50 of the WM Act, commenced on 4 October 2012 and the current version is dated 1 July 2020. The NPUWSP area comprises 30 water sources in the Namoi River catchment. The water sources of the Namoi Unregulated Rivers Extraction Management Unit of the Namoi Unregulated and Alluvial Water Sources, including the Eulah Creek Water Source (in which the Project is located), are shown in Figure 2.2.

The NPUWSP identifies the requirements for water from these water sources for basic landholder rights (Division 2) and for extraction under access licences (Division 3). The amounts of water specified in the NPUWSP represent the estimated water requirements of persons entitled to basic landholder rights in these water sources and the total volumes or unit shares specified in the share components of all access licences in these water sources.

For basic landholder rights (Division 2), the NPUWSP provides 28.4 ML/yr for stock and domestic purposes in the Eulah Creek water source from a total share across the entire plan area of 2,480.2 ML/yr. The requirement for water under harvestable rights in these water sources is equal to the total amount of water that owners or occupiers of landholdings are entitled to capture and store, pursuant to a harvestable rights order made under Division 2 of Part 1 of Chapter 3 of the WM Act.

The order by which a harvestable rights area is constituted must specify the method for calculating the maximum harvestable right volume for works constructed or used in exercise of harvestable rights on landholdings in the area by reference to a proportion (not being less than 10 percent [%]) of the average regional overland flow waters for that area.

Table 2.2 shows the share components for water extraction under access licences (Division 3) in the Eulah Creek Water Source and their total share components in the NPUWSP (as given in the 1 July 2020 version). The actual volumes of water available for extraction in these water sources at any time would depend on factors such as climatic variability, access licence priority and the rules in the NPUWSP.

Table 2.2 Eulah Creek water source share components for different licence categories (Division 3)

Access Licence Category	Eulah Creek Water Source Share Component	Total Share Component in the NPUWSP Water Sources
Domestic and Stock Access (ML/yr)	35	993
Unregulated River Access (Unit Shares)	2,034	153,386
Unregulated River (Special Additional High Flow) Access (Unit Shares)	0	729
Aquifer Access Licences (Unit Shares)	0	4,968
Aquifer (General Security) Access (Unit Shares)	0	2,311
Local Water Utility (ML/yr)	0	8,333

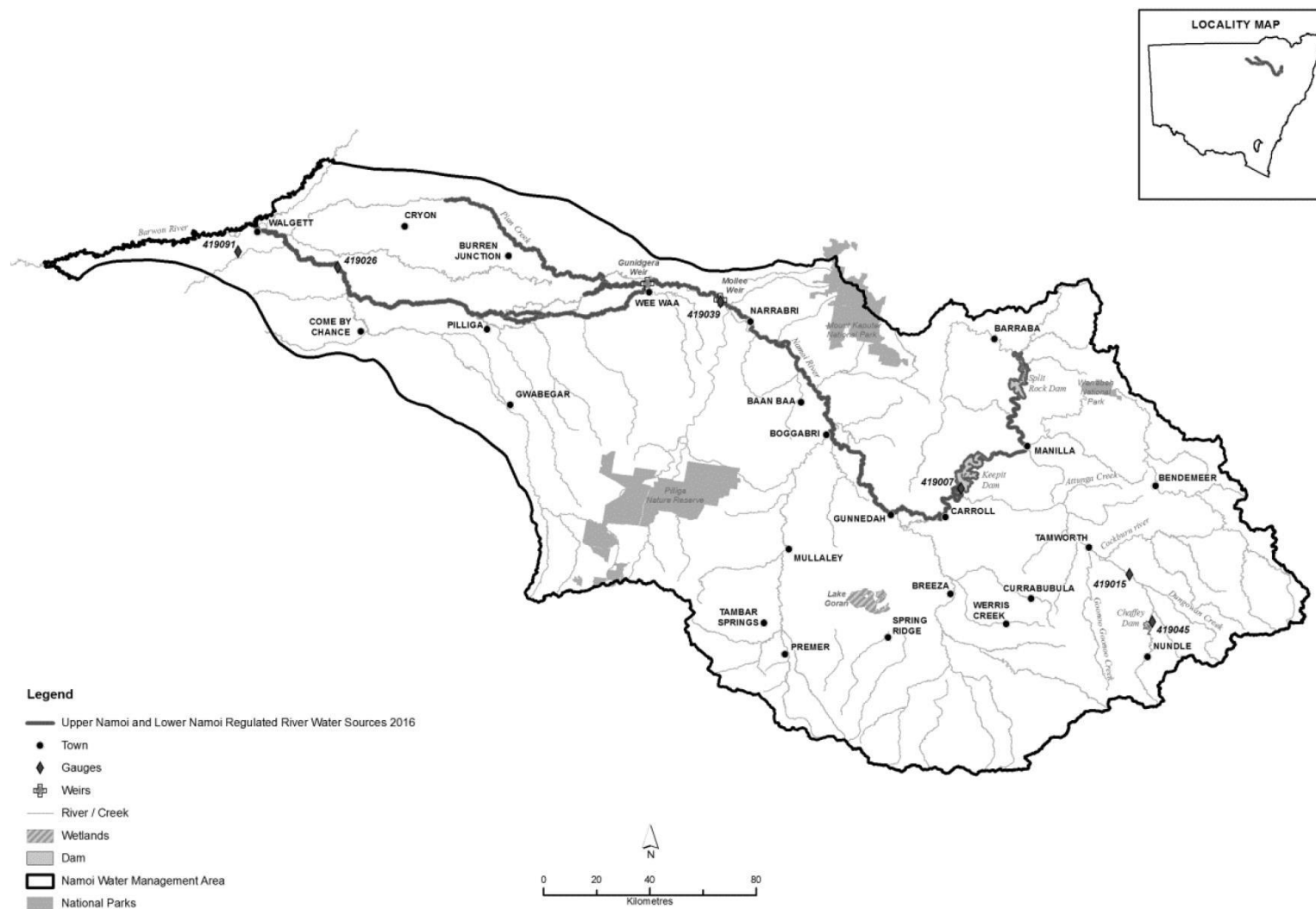


Figure 2.1 Upper and Lower Namoi regulated water sources

Source: NRRWSP

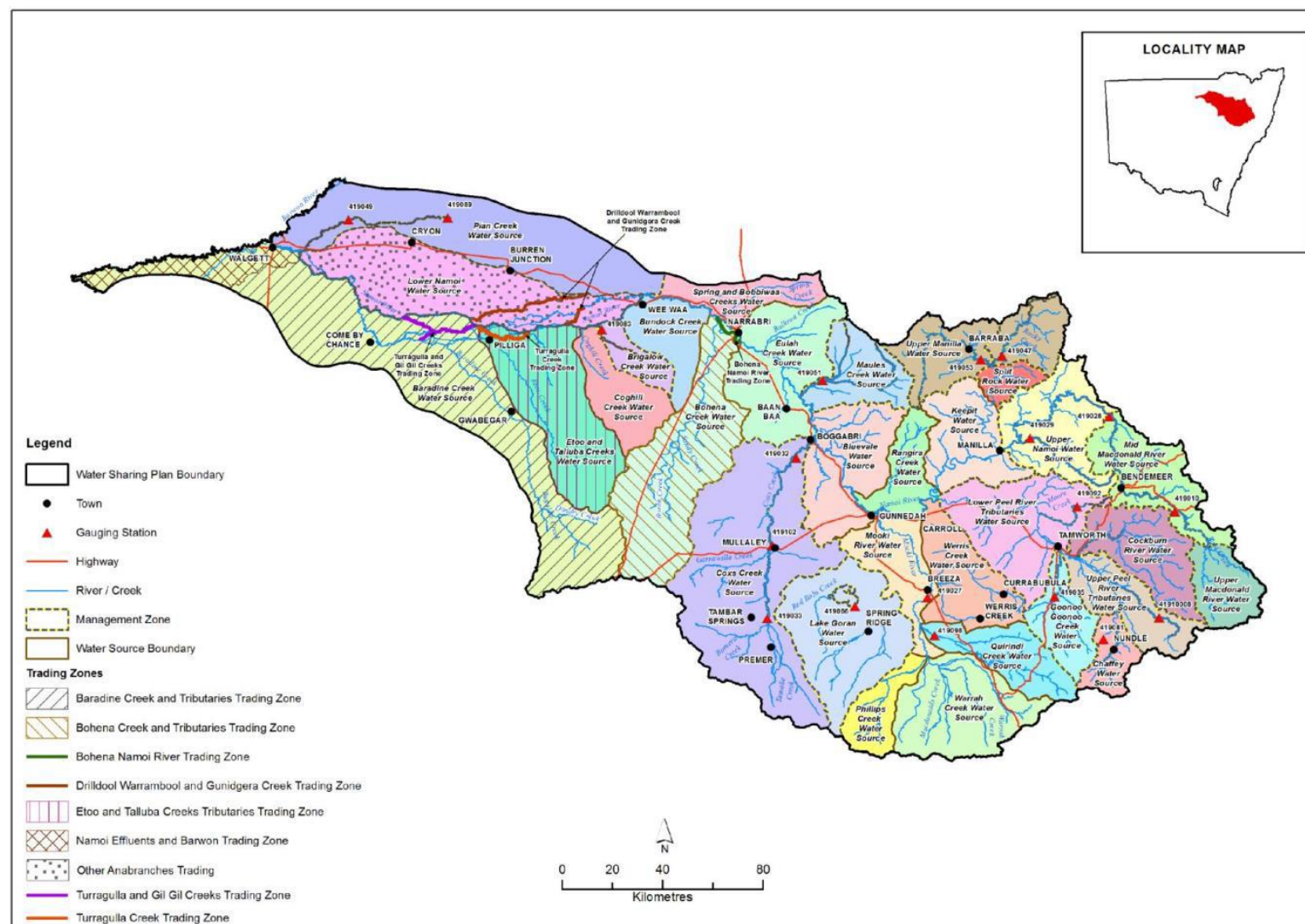


Figure 2.2 Namoi and Peel unregulated water sources

Source: NPUWSP

3 EXISTING SURFACE WATER ENVIRONMENT

3.1 CATCHMENT CHARACTERISTICS

3.1.1 Regional Drainage

The Project Area is located in the Namoi River catchment and within the tributaries of Kurrajong Creek. The Namoi River flows in a north westerly direction at a distance of approximately six km to the northeast of the Project Area.

The Namoi River stretches for over 350 km, with a catchment extending from the Great Dividing Range in the east to Walgett in the west where the Namoi River discharges into the Barwon River. Some of the Namoi River's major tributaries include the Peel River, Mooki River, Manilla River, Coss Creek, Baradine Creek and Pian Creek. It has a total catchment area of approximately 42,000 square kilometres (km²) to Walgett.

The Namoi River catchment has been used extensively for agricultural activities for over 100 years. It is one of Australia's most developed irrigation areas, supporting significant cotton and broad acre cropping (mainly sorghum, sunflower and wheat) as well as other crops, and some sheep and cattle grazing.

3.1.2 Local Drainage

Kurrajong Creek originates to the west of the Project within the Pilliga East State Forest. Kurrajong Creek drains in a north easterly direction and is a third order watercourse under the Strahler stream ordering system (see Figure 3.1). Across the Project Area, Kurrajong Creek consists of a well-defined (incised) channel that has a base width of about 4 m with eroded vertical banks about 1 m high.

Kurrajong Creek Tributary 2 commences immediately upstream of the Project Area within the Narrabri Mine lease. It drains in a northeasterly direction across the Project Area and is a first order watercourse under the Strahler stream ordering system. The tributary has no defined bed and banks with flows draining as an overland flow path. Contour banks have been constructed as part of historical agricultural practices to divert catchment flow into the tributary.

The combined catchment area of Kurrajong Creek and Kurrajong Creek Tributary 2 to the confluence point downstream of the Project Area boundary is approximately 35 km² (refer to Figure 3.1).

3.1.3 Farm Dams

There are five farm dams located in the Project Area with two located on Kurrajong Creek Tributary 2. There are numerous farm dams located upstream of the Project Area (see Figure 3.1). The farm dams are relatively small, with a full supply volume of less than one megalitre (ML).

3.1.4 Topography

The local topography of the Project Area based on 1 m LiDAR dated 2017 as shown in Figure 3.2. The Project Area's elevation varies between 245 m AHD and 274 m AHD. The average elevation of the Project Area is 250 m AHD.

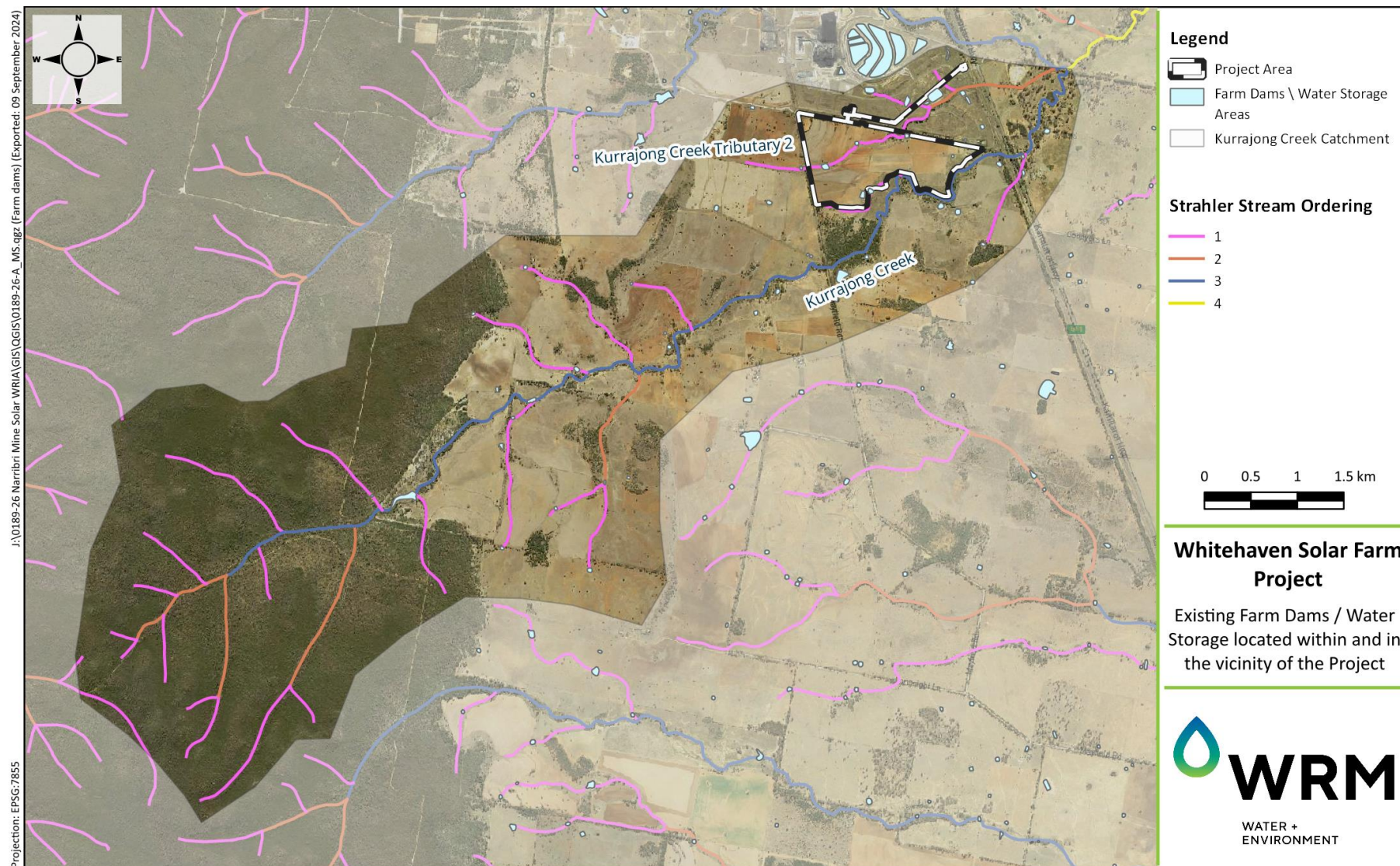


Figure 3.1 Existing Farm Dam locations

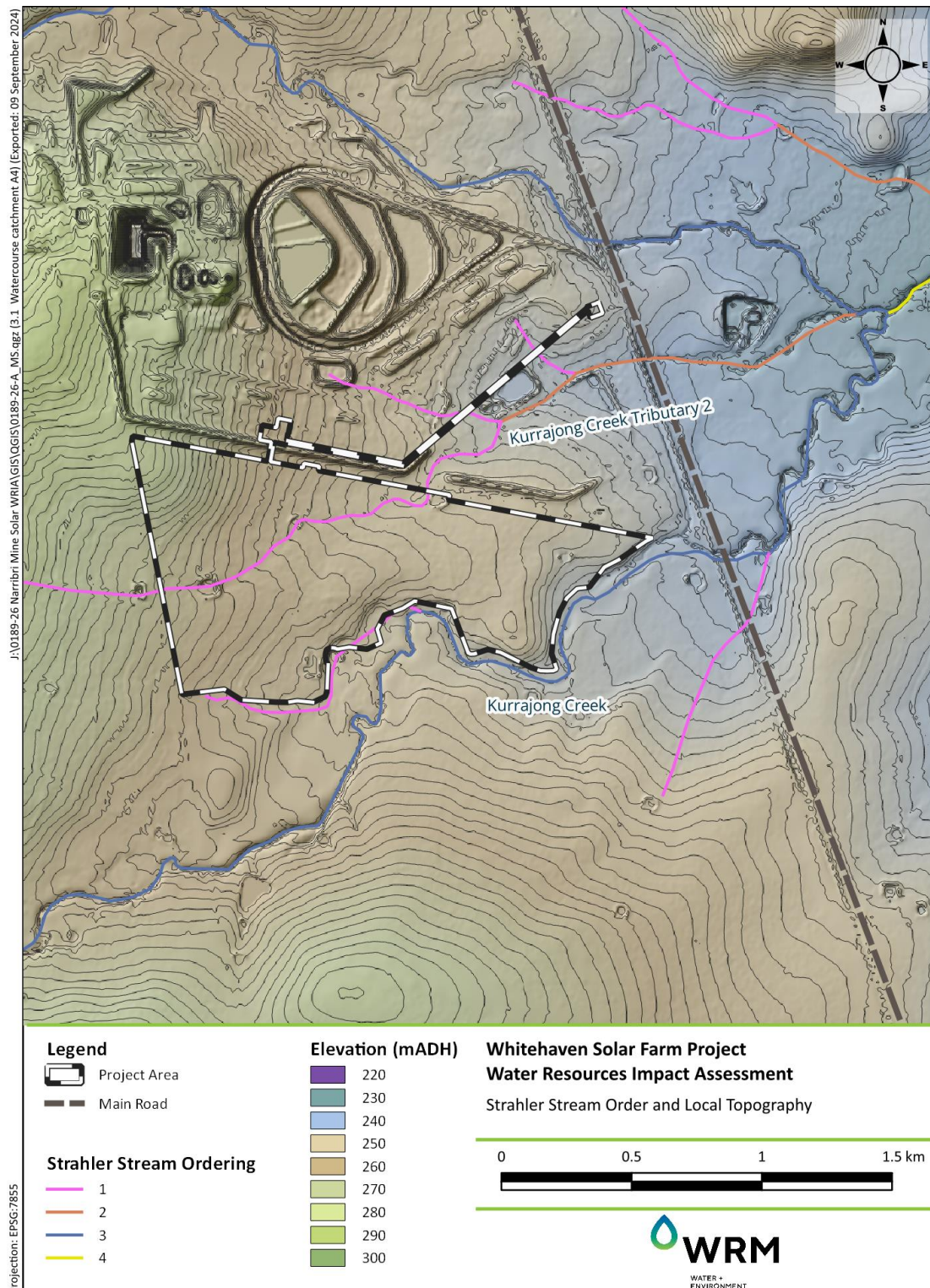


Figure 3.2 Strahler Stream Order and Local Topography

3.2 CLIMATE

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 -30.528 Latitude and 149.9038 Longitude which is the grid point closest to the Project Area between 01/01/1889 to 31/01/2024.

Table 3.1 and Figure 3.3 present the annual rainfall and evaporation statistics based on the Project Area climate data sourced for SILO grid point. Table 3.2 and Figure 3.4 present the monthly rainfall and evaporation statistics based on data for the SILO grid point. The median annual rainfall is 619 millimetres (mm) and median evaporation is 1881 mm.

Table 3.1 Annual Rainfall and Evaporation (mm) for Project Area

Statistic	Rainfall	Evaporation (Class A Pan)
10 th percentile	374.9	1810.3
50 th percentile	618.7	1881.1
90 th percentile	828.5	2038.9

^a Data source: <https://www.longpaddock.qld.gov.au/silo/>

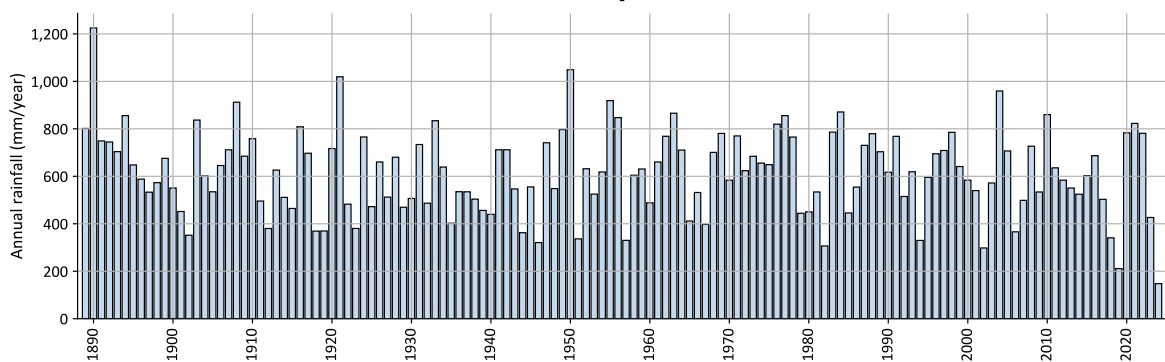


Figure 3.3 Annual rainfall totals for Project Area

Source: SILO, 2024

Utilising the climate database, the average total rainfall for each calendar month from 1889 to 2024 was calculated and is summarised in Table 3.2. Figure 3.4 shows there is only a moderate level of seasonality to rainfall within the Project Area, and that rainfall is typically low in most months. Lowest average rainfall is recorded in April and August. Highest monthly rainfall is recorded in December, January and February.

Figure 3.5 presents a timeseries of daily rainfall accumulation starting on 1 October each year to represent the water year. There is minimal variance between the 25th to 75th percentile annual rainfall total. It is possible for annual rainfall sequences to generate four times the median rainfall as occurred in the 1955/56 water year.

Table 3.2 Monthly climate statistics (mm), 1890 to 2024

Month	Evaporation (Class A Pan)	Rainfall
October	184.2	50.4
November	220.5	62
December	261.3	66.5
January	259.6	77.9
February	209.9	62.1
March	191.9	52.3
April	131.6	35.1
May	85.6	44.9
June	58.9	46.7
July	64.4	42.8
August	92	38.1
September	132.4	39.6

Source: SILO, 2024

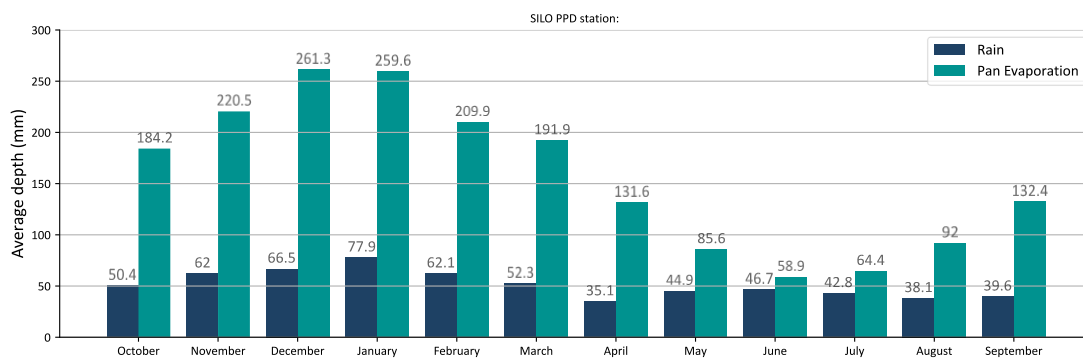


Figure 3.4 Monthly rainfall and evaporation

Source: SILO, 2024

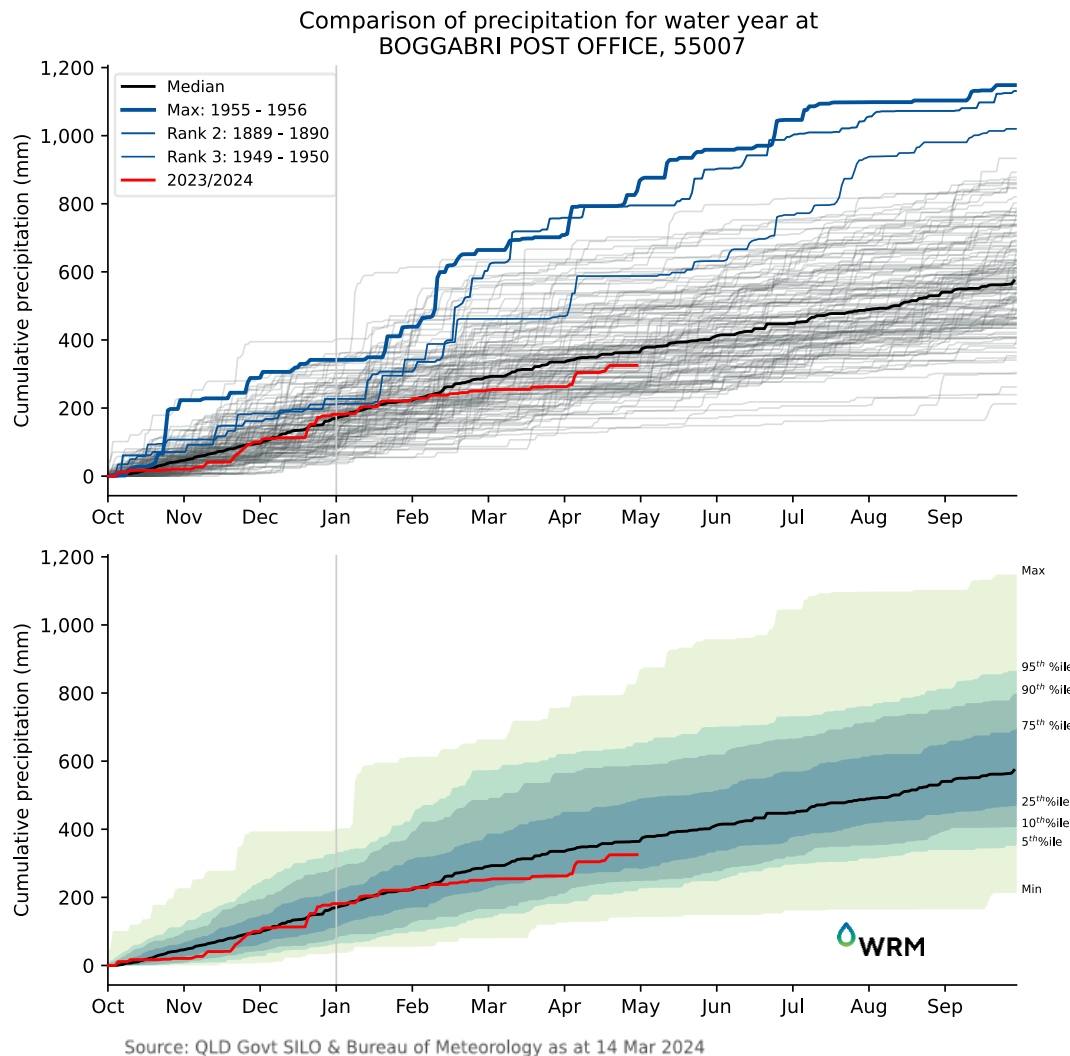


Figure 3.5 Rainfall variability at Project Area

3.3 SOIL LANDSCAPES

Minesoils (2024) prepared a site verification and Agricultural Impact Assessment for the Project. A summary of the Minesoils description of soil types in the area is given below.

3.3.1 Soil Types

The soil survey undertaken by Minesoil (2024) found the Project Area to contain two dominant soil mapping units, Sodosols and Dermosols.

Sodosols are defined as soils with a clear or abrupt textural B horizon and in which the major part of the upper 0.2 m of the B2 horizon (or the major part of the entire B2 horizon if it is less than 0.2 m thick) is sodic and not strongly acid.

Sodosols are defined as soils with a clear or abrupt textural B horizon and in which the major part of the upper 0.2 m of the B2 horizon (or the major part of the entire B2 horizon if it is less than 0.2 m thick) is sodic and not strongly acid.

3.3.2 Inherent Soil Fertility

NSW regional mapping provides an estimation of the inherent fertility of soils in NSW. It uses the best available soils and natural resource mapping developed for LSC dataset. The mapping describes soil fertility in NSW according to a five-class system: Low (1), Moderately Low (2), Moderate (3), Moderately High (4), High (5).

Minesoils found that the Study Area is dominated by soils with moderate fertility (3), moderately high fertility (4) and high fertility (5), and a limited area of Moderately low fertility (2) soils at the southern extend of the Study Area.

3.3.3 Land and Soil Capability

Land capability, as detailed in the LSC Guideline, is the inherent physical capacity of the land to sustain a range of land uses and management practices in the long term without degradation to soil, land, air and water resources.

The NSW regional mapping indicates that the majority of the Project Area is listed as class 3, with the northwest section is listed as class 4, while a class 5 area is located to the south of the project area.

3.3.4 Biophysical Strategic Agricultural Land

Regionally mapped Biophysical Strategic Agricultural Land (BSAL) extends throughout a large portion of the eastern half of the Study Area. Minesoils was engaged to undertake a BSAL assessment to determine the presence and extent of site verified BSAL. The Study Area was found to have no verified BSAL (Minesoils 2023).

3.3.5 Soil Erodibility

Minesoils undertook laboratory testing and site investigations of the project area. The following has been extracted from the Minesoils (2024) report and describes the erosion potential for the Project Areas.

“Based on site observations, which included assessment for indicators of erodibility, such as sheet or gully erosion, it can be concluded that there is a minimal erosion and sedimentation risk associated with the topsoils currently present in the Study Area with evidence of minor sheet erosion. However, as the dispersion risk status of the tested soils indicate, there is a consistently high potential risk for dispersion throughout the Study Area.

The representative laboratory tested soils also indicate high levels of sodicity primarily in the clay subsoils. This sodicity is generally consistent throughout the Study Area. While sodic soils are generally dispersive, it is important to acknowledge that not all sodic soils disperse, and that not all dispersive soils are sodic. However, given the ranges in salinity of the soils tested, all sodic soils should be considered dispersive.

Based on these results, there is a high potential risk for dispersion where subsoils are disturbed within the Study Area. Higher impact activities such as where earthworks are necessary for construction of sub-station pads or site facilities are very likely to result in increased dispersive behaviour when soil is remoulded, compacted or pulverised.

Over the majority of the Project Area, soils would be subject to minor disturbance as part of the construction or maintenance of solar arrays and electrical cabling trenches. In areas where earthworks are necessary for construction of site facilities or access tracks, soils would be subject to higher impact disturbance.

Overall, the impacts to the soils of the Project Area are expected to be minimal and temporary. There would be no direct or indirect impacts to the soil resources of the Project locality outside the Project Area.”

3.3.6 Acid Sulphate Soils

The NSW Acid Sulfate Soil Planning Map does not show any acid sulphate soils (ASS) classes within the Project Area.

3.4 WATER QUALITY

3.4.1 Water Quality Objectives

The NSW Water Quality Objectives (WQOs) have been developed to guide plans and actions to achieve healthy waterways. The WQOs are based on measurable environmental values (EVs) for protecting aquatic ecosystems, recreation, primary industries, drinking water and industrial water. The site is located in the Namoi River Water Quality and River Flow catchment and has its own specific Water Quality Objectives (WQOs)⁵. The Objectives include the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses.

Specific environmental values for uncontrolled streams in the Namoi River catchment, including the Project area, are protection of:

- aquatic ecosystems;
- visual amenity;
- primary and secondary contact recreation;
- livestock water supply;
- irrigation water supply;
- homestead water supply;
- drinking water at point of supply - disinfection only;
- drinking water at point of supply - clarification and disinfection;
- drinking water at point of supply - groundwater;
- aquatic foods (cooked); and
- industrial water supplies.

Default trigger values for water quality indicators relevant to the various environmental values from the Namoi River Water Quality and River Flow Objectives are shown in Table 3.3.

Based on the likely construction activities and operations for the Project and the environmental values listed above, the water quality objectives are considered relevant to the Project. An assessment of the potential impact on water quality is presented in Section 6.1 and considers the estimated pollutant concentrations and loads in stormwater discharging from the Project Area.

⁵ <https://www.environment.nsw.gov.au/ieo/Namoi/index.htm>

Table 3.3 Water quality trigger values

Parameter	Unit	Trigger Value						
		Irrigation	Livestock Drinking	Ecosystem ¹	Recreation	Homestead Water Supply	Drinking Water for Disinfection	Aquatic Foods
pH	pH	6.0 - 9.0	-	6.5 - 8.0	5.0 - 9.0	6.5 - 8.5	6.5 - 8.5	-
Electrical Conductivity (EC) (uncompensated)	µS/cm	1,000 ²	-	-	-	-	-	-
EC (25C)	µS/cm	-	-	30 - 350	-	-	<1500	-
Dissolved Oxygen (% Saturation)	%	-	-	90 - 110	-	-	-	-
Total Dissolved Solids (TDS)	mg/L	-	2,000 ²	-	1,000	<500 - 1000	-	-
Turbidity	NTU ⁷	-	-	2 - 25	6	5	-	-
Calcium (Ca)	mg/L	-	1,000	-	-	-	-	-
Sodium (Na)	mg/L	115 ³	-	-	300	-	-	-
Magnesium (Mg)	mg/L	-	2,000 ⁴	-	-	-	-	-
Sulphate as SO ₄	mg/L	-	1,000	-	400	-	-	-
Chloride as Cl	mg/L	175 ³	-	-	400	-	-	-
Aluminium	mg/L	5 ⁶	5	-	0.2	-	-	-
Arsenic	mg/L	0.1 ⁶	0.5 ²	0.013 ^{2, 5}	0.05	-	-	-
Barium	mg/L	-	-	-	1	-	-	-
Beryllium	mg/L	0.1 ⁶	-	-	-	-	-	-
Cadmium	mg/L	0.01 ⁶	0.01	0.0002 ⁵	0.005	-	-	-
Chromium	mg/L	0.1 ⁶	1	0.001 ⁵	0.05	-	-	-
Cobalt	mg/L	0.05 ⁶	1	-	-	-	-	-
Copper	mg/L	0.2 ⁶	0.4 ²	0.0014 ⁵	1	-	-	0.005
Iron	mg/L	0.2 ⁶	-	-	0.3	-	-	-
Lead	mg/L	2 ⁶	0.1	0.0034 ⁵	0.05	-	-	-

Parameter	Unit	Trigger Value						
		Irrigation	Livestock Drinking	Ecosystem ¹	Recreation	Homestead Water Supply	Drinking Water for Disinfection	Aquatic Foods
Manganese	mg/L	0.2 ⁶	-	1.9 ⁵	0.1	-	-	-
Mercury	mg/L	0.002 ⁶	0.002	0.0006 ⁵	0.001	-	-	0.001
Nickel	mg/L	0.2 ⁶	1	0.011 ⁵	0.1	-	-	-
Selenium	mg/L	0.02 ⁶	0.02	0.011 ⁵	0.01	-	-	-
Vanadium	mg/L	0.1 ⁶	-	-	-	-	-	-
Zinc (Zn)	mg/L	2 ⁶	20	0.008 ⁵	5	-	-	0.005
Ammonia	mg/L	-	-	0.013	-	-	-	-
Total phosphorus (Total P)	mg/L	0.056	-	0.02	-	-	-	-
Total nitrogen (Total N)	mg/L	5 ⁶	-	0.25	-	-	-	-
NOx	mg/L	-	-	0.015	-	-	-	-
Nitrate-N	mg/L	-	400	0.7 ⁵	10	-	-	-
Nitrite-N	pH	-	30	-	1	-	-	-

Source: Namoi River Water Quality and River Flow Objectives (<https://www.environment.nsw.gov.au/ieo/Namoi/index.htm>.)

Notes: - No Trigger Value recommended

¹ Upland River

² Lowest recommended value

³ Sensitive crops

⁴ Cattle (insufficient information on other livestock)

⁵ 95% of species protected

⁶ Long term Trigger Value

⁷ NTU = Nephelometric Turbidity Units

3.4.2 Namoi River water quality

Basic water quality indicators such as EC, turbidity, TSS, and nutrients were monitored on a monthly basis for the five-year Namoi Water Quality Project study, starting in July 2002 (Mawhinney, 2011). Residues of herbicides and insecticides were also measured. The study found the following:

- The majority of sites had median EC results that did not meet the default trigger values for the protection of aquatic ecosystems of southeastern Australia. Median EC values were below 650 micro-Siemens per centimetre ($\mu\text{S}/\text{cm}$) below Boggabri, which is suitable for irrigation water.
- Median total phosphorus and total nitrogen in excess of the ANZECC and ARMCANZ default trigger values in conjunction with low flows were also experienced.
- All sites in the Namoi River basin were found to have high enough total phosphorus concentration present to encourage algae growth.

Water quality of the Namoi River is generally characterised by moderate alkalinity and elevated EC relative to the default trigger values for ecosystem protection in upland rivers (>150 m altitude) in the ANZECC/ARMCANZ Guidelines. EC values in the Namoi River at Gunnedah (Station 419001) have ranged between 200 $\mu\text{S}/\text{cm}$ and 900 $\mu\text{S}/\text{cm}$ every year since 2001 and there is no significant trend to the data (Advisian, 2018).

3.4.3 Local catchment Water Quality

Surface water quality monitoring has been undertaken by the adjacent Narrabri Coal Operations Pty Ltd (NCOPL) at ten sites on the watercourses draining the Narrabri Mine since July 2007 in accordance with the Water Management Plan. Figure 3.6 shows these surface water monitoring locations. The closest monitoring location to the Project Area is KC2US, which is located at the northern Project Area Boundary on Kurrajong Creek Road. Monitoring location KCDS is located approximately 480m downstream of the project area adjacent to the Kamilaroi Highway.

Sampling has been undertaken during or immediately following flow events, for EC, pH, TSS, oil and grease and total organic carbon (TOC). Note that there is minimal disturbance due to the existing Narrabri Mine operations within the catchment areas draining to monitoring sites KCUS, KCDS, KC1US, KC2US, UT1DS and UT2DS other than minor disturbance for exploration works.

Table 3.4 shows the recorded surface water quality monitoring data with the Namoi River Water Quality and River Flow Objectives 'Ecosystem' trigger values (Table 3.3) The surface water quality in the watercourses draining from the Project area at monitoring location KC2US and KCDS can be characterised as follows:

- A neutral pH, with a median laboratory measured pH value of approximately 7.0 (KC2US) and 7.4 (KCDS) [within the 'Ecosystem' trigger value range];
- freshwater, with a median EC value of approximately 63 $\mu\text{S}/\text{cm}$ (KC2US) to 203 $\mu\text{S}/\text{cm}$ (KCDS) [within the 'Ecosystem' trigger values range];
- Total Suspended Solids with a median value of approximately 26 mg/L (KC2US) and 34 mg/L (KCDS);
- not affected by oil and grease contamination; and
- exhibiting low levels of TOC, with a median value of approximately 12 mg/L (KC2US) and 10 mg/L (KCDS).

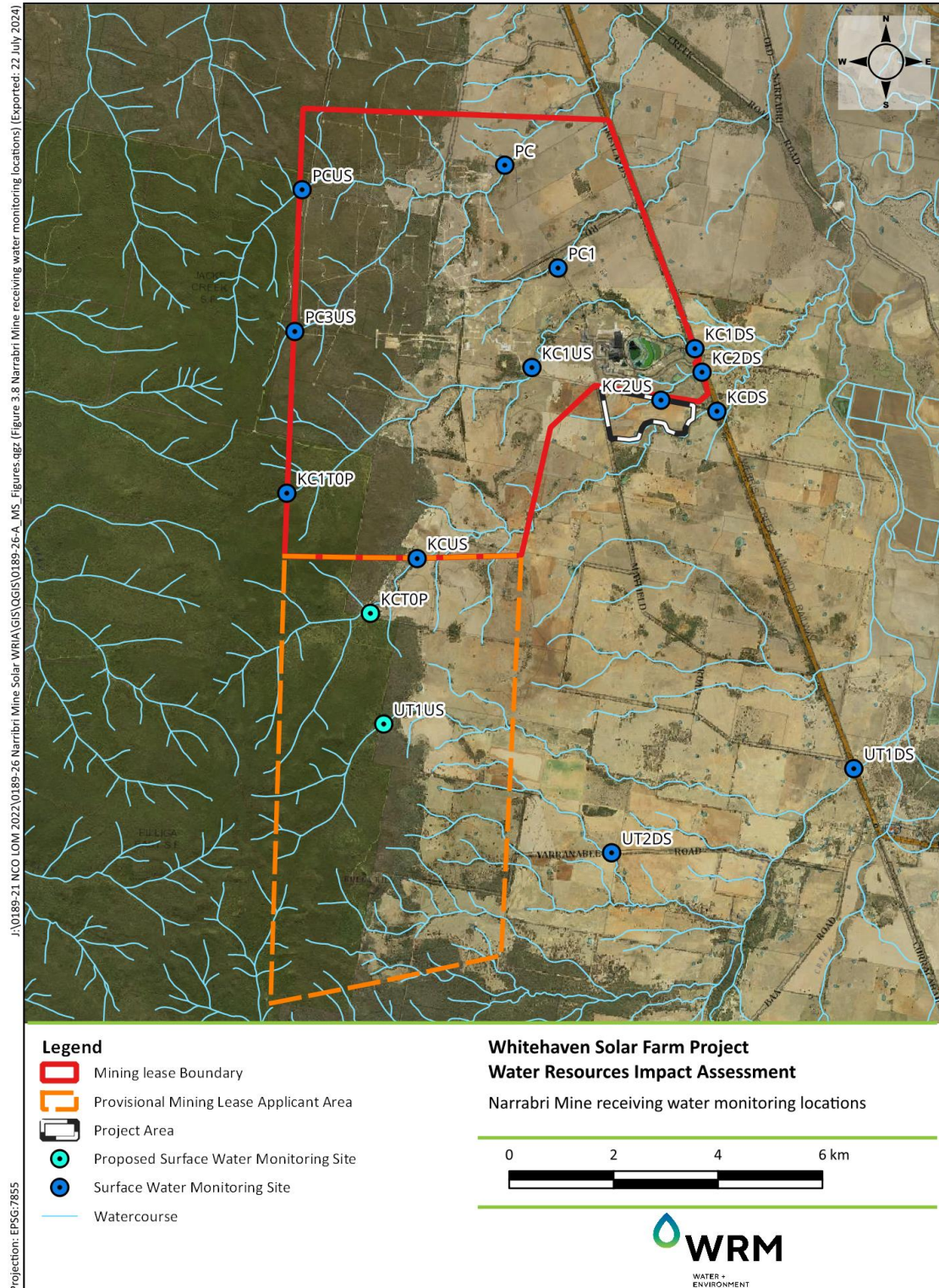


Figure 3.6 Narrabri Mine receiving water monitoring locations

Table 3.4 Comparison of background and receiving water quality (July 2007 to March 2020) with Namoi River Water Quality and River Flow Objectives ‘Ecosystem’ trigger values

Water Quality Parameter		Sampling Site										WQO Trigger Value ^a
		Kurrajong Creek						Pine Creek		Tulla Mullen Creek		
		KCUS	KCDS	KC1US	KC1DS	KC2US	KC2DS	PC	PC1	UT1DS	UT2DS	
pH	20 th %ile	7.1	7.1	7.1	7.1	6.7	6.8	6.9	7.2	-	-	6.5 – 8.0
	Median	7.4	7.4	7.3	7.5	7.0	7.1	7.2	7.4	7.7	7.1	
	80 th %ile	7.6	7.6	7.6	7.7	7.3	7.4	7.4	7.7	-	-	
	N	50	39	32	54	47	47	56	55	1	1	
Electrical Conductivity (µs/cm)	20 th %ile	72.0	121.0	83.0	114.0	45.4	71.2	58.0	59.0	-	-	30 - 350
	Median	206.5	203.0	125.0	171.0	63.0	95.0	90.5	99.0	148	54	
	80 th %ile	490.2	440.4	192.0	322.6	85.2	162.4	148.0	160.0	-	-	
	N	50	39	32	54	47	47	56	55	1	1	
Total Suspended Solids (mg/L)	20 th %ile	25.0	16.8	18.6	21.2	8.2	16.0	16.8	31.6	-	-	NA
	Median	132.0	64.0	54.0	57.0	26.0	30.5	82.0	74.0	20	124	
	80 th %ile	373.0	241.2	192.6	121.4	46.8	94.2	206.0	205.6	-	-	
	N	48	39	32	54	47	44	55	55	1	1	
Oil and Grease (mg/L)	20 th %ile	<5	<5	<5	<5	<5	<5	<5	<5	-	-	NA
	Median	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	
	80 th %ile	<5	<5	<5	<5	<5	<5	5.4	<5	-	-	
	N	48	37	30	51	45	44	55	55	1	1	
Total Organic Carbon (mg/L)	20 th %ile	7.0	7.0	8.0	9.0	9.0	12.0	7.4	7.0	-	-	NA
	Median	10.0	10.0	11.0	11.0	12.0	15.0	10.0	10.0	10	15	

Water Quality Parameter	Sampling Site										WQO Trigger Value* ^a
	Kurrajong Creek						Pine Creek		Tulla Mullen Creek		
	KCUS	KCDS	KC1US	KC1DS	KC2US	KC2DS	PC	PC1	UT1DS	UT2DS	
80 th %ile	13.0	14.2	12.0	15.0	16.0	20.0	14.0	14.0	-	-	
N	46	35	30	51	44	43	53	51	1	1	

^a Namoi River Water Quality and River Flow Objectives (<https://www.environment.nsw.gov.au/ieo/Namoi/index.htm>) 'Ecosystem' trigger values (**Error! Reference source not found.**).

N = Number of samples. NA = No WQO trigger value provided for this parameter

3.5 GROUNDWATER

There are no registered groundwater bores located within the Project Area (Figure 3.7). Measurements of the regional water table near the Project Area are not available on Bureau of Meteorology Groundwater Atlas.

3.5.1 Groundwater Dependent Ecosystem

A Groundwater Dependent Ecosystem (GDE) is an ecosystem which is dependent on the availability of groundwater to maintain structure and function. Terrestrial (including riparian vegetation) GDEs are dependent on the subsurface presence of groundwater to a depth of 10 m below ground level (BGL). Aquatic GDEs are dependent on surface water's interaction with groundwater. Ecosystems are classified as:

- High potential ecosystems which have a high (strong possibility) of groundwater interaction
- Moderate potential ecosystems which have a moderate potential for groundwater interaction.
- Low potential ecosystems which have a low (unlikely) potential for groundwater interaction.

According to the GDE Atlas (BoM, 2018), the Project Area is not mapped as containing any GDEs, see Figure 3.7.

3.5.2 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 was reviewed for groundwater vulnerability within and surrounding the Project Area. There are no groundwater vulnerability areas mapped for the Project Area (DPE, 2014). The geologic units are shown in Figure 3.8.

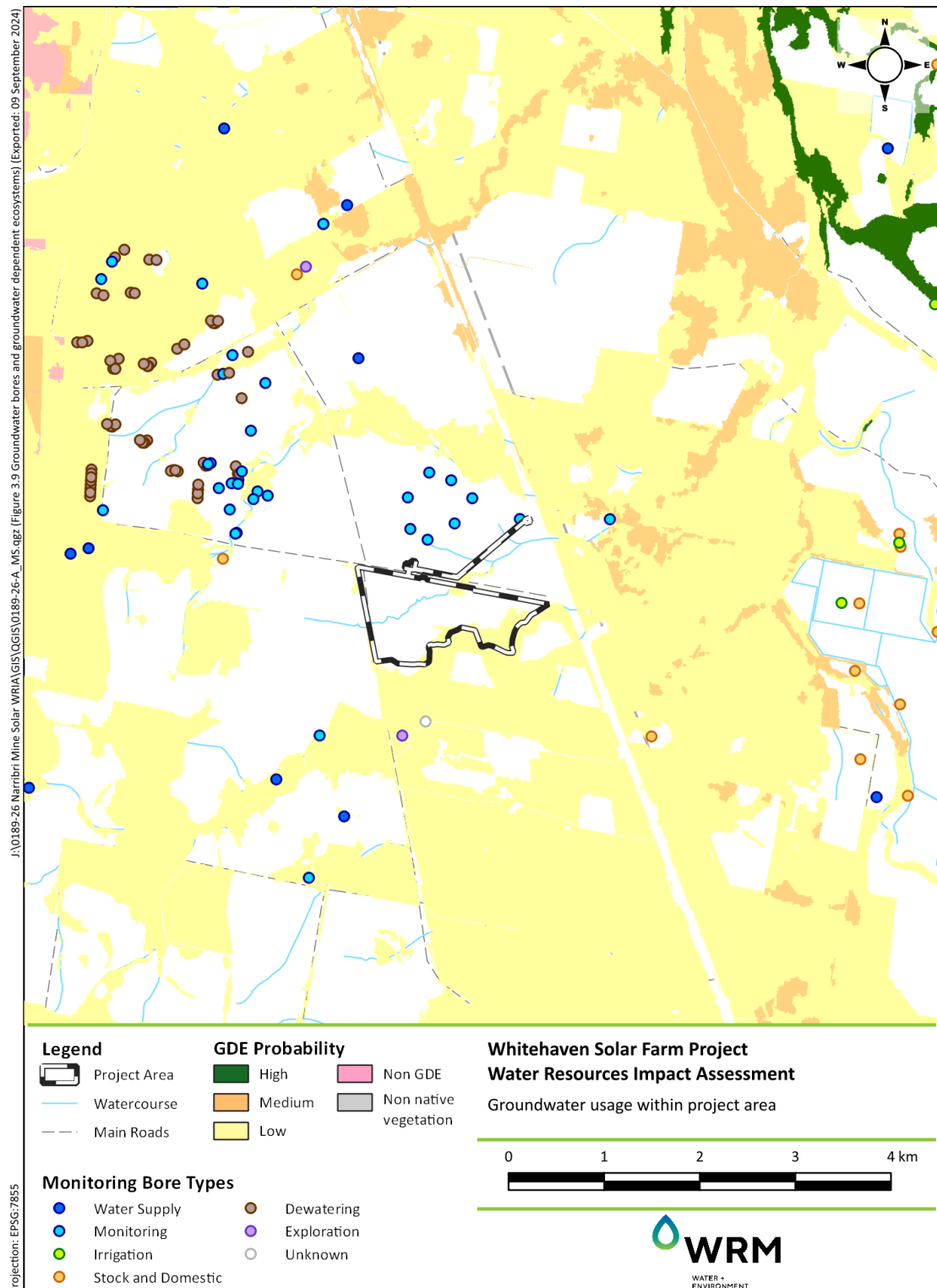


Figure 3.7 Groundwater bores and Groundwater Dependent Ecosystems

Source: bom.gov.au/water/groundwater/explorer

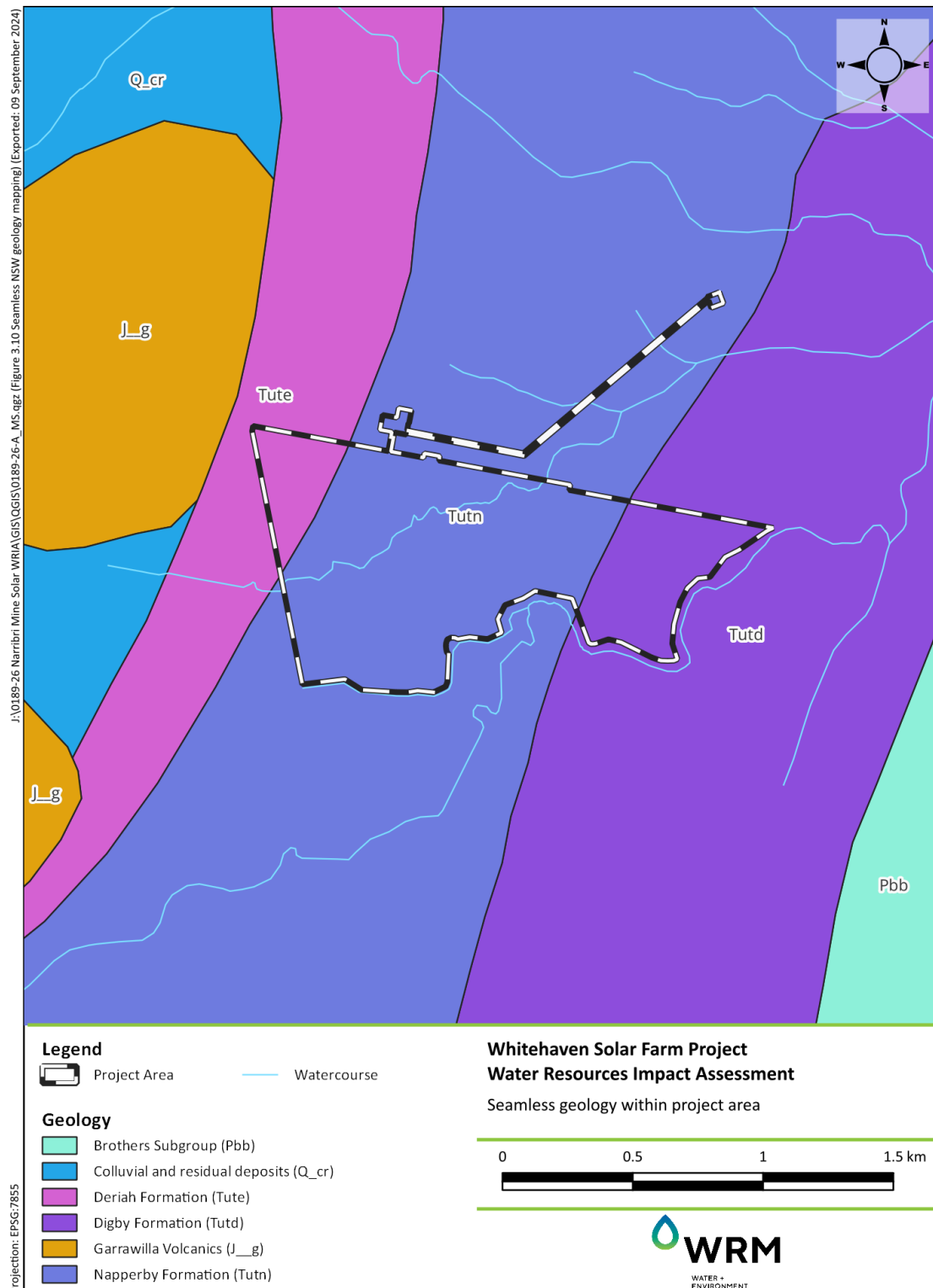


Figure 3.8 Seamless NSW geology mapping

Source: NSW 2024a

4 WATER MANAGEMENT

4.1 OVERVIEW

The Project would require a water supply during the construction, operational and decommissioning phases. During construction, water would primarily be used for revegetation and dust suppression. The associated water demand during the construction phase is estimated to be approximately 12 ML for the entire duration of construction. The water demand during operations and decommissioning is expected to be significantly lower in the range of 1 to 3 ML per annum.

4.2 WATER DEMAND

4.2.1 Construction Water Demand

The greatest water demand would be during the construction phase of the Project. Key Project water demands are likely to include:

- washing and cleaning of solar PV modules and array;
- soil stabilisation and fill conditioning, where required;
- dust suppression;
- concrete production;
- concrete washout;
- vehicle and equipment wash down; and
- amenities.

Table 4.1 provides a preliminary assessment of the construction phase water demands. The assumptions used for the assessment are listed in Table 4.2.

Water demand during construction phase would increase gradually, peak and then decline gradually as the Project reaches practical completion. Construction is expected to take approximately 9 months. Maximum water demand is expected towards the end of the first six months of construction. This coincides with the main period of construction of access tracks, foundations and hardstand areas. Over the first half of the construction phase, the average monthly demand is approximately twice the consumption expected in the final half. Water demand during the initial operational phase would be lower again comprising mainly Solar Array cleaning.

Table 4.1 Construction Phase Total Water Demand (indicative only)

Water Demand	Total Water Usage (kL)
Dust suppression (nett. evaporation)	7000
Construction – stabilised road /hardstands	2554
Construction – concrete	70
Washdown – Vehicle	1100
Potable	950
Total demand	11.8 ML

Table 4.2 Construction water balance assumptions

Water Demand	Water Usage Assumptions
Dust suppression	Active work areas only - assume at 25% of total tracks at any one time Assume balanced with pan evaporation, refer Section 3.2
Construction – road	5m wide by 3 km. Rip to 500mm and re-compact - add 8% water content to condition. 300mm road base - add 12% water content to condition pro-rata over period of road construction
Washdown – concrete	Approx. 125 L per 1 cubic metre (m ³) of concrete poured
Washdown – vehicle	Allowance 5 kL/day typical (dry days), 10 kL/day (wet days), refer Section 3.2
Construction – Concrete	120 m ³ to cover footings, BESS, substations
Potable	Construction workforce: Median 30 personnel, Peaking at 65 personnel Allowance 40 litres per person per day - 6 day week
Operational allowance	Allowance 1 litre per square metre of solar array area for every wash (washed every 6 months)

The assumed average and maximum daily breakdown of water requirements for the construction period:

- Peak daily demand of 50 kilolitres per day (kL/day) raw with 40 kL/day potable water; and
- Average daily demand of 30 kL/day raw with 20 kL/day of potable water.

These values are indicative only for the purposes of impact assessment. Detailed assessment of water demands would be undertaken during detailed design of the Project.

4.2.2 Operational Water Demand

During operations, the washing of 1743 arrays at 92 metres squared (m²) twice a year would require up to 3 ML each year. Other water would be required for ongoing maintenance activities such as amenities and potable purposes by operational staff, and equipment washing down, if required. Washing would not require any detergent or cleaning agents. A static water supply, with the capacity to be determined during the detailed design phase, would also be established and maintained for fire protection.

4.3 WATER SUPPLY SOURCES

The majority of water required to meet Project water demands would be imported and would most likely be sourced through an arrangement with local suppliers, including Whitehaven Coal's Narrabri Coal Mine. Raw water would be utilised for construction, and potable supplies would be sourced for site offices and amenities. Water for construction and operational phase non-potable water demands would be supplied from one or a combination of the following sources:

- commercial suppliers in the nearby region (e.g. Narrabri Mine) via water truck;
- harvested runoff from farm dams under agreement with host or local landholders;
- harvested runoff from disturbed areas captured in excavations or sediment basins/traps constructed to prevent sediment transport off-site; and

- recycling and reusing water.

Based on the total Project Area of 109 ha, the Maximum Harvestable Right Dam Capacity (MHRDC), from which water can be used for any purpose, is 7.15 ML based on a Project Area of 1.1 km² at - 30.530097, 149.907335. This value was calculated using WaterNSW's MHR calculator⁶.

The largest water demands, such as for dust suppression, soil conditioning, and concrete batching, are all nonrecoverable water uses. Where possible, water uses, such as for concrete facilities and vehicle washdown, would be recycled and reused as far as practical.

During construction, there may also be opportunities to utilise water collected in sediment retention ponds, or locally sourced from farm dams or private bores. Local water supply from private dams and bores would need to be with harvestable water rights and water access licencing conditions.

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

Water sources would be determined prior to the commencement of construction in consultation with suppliers and landholders. Town water supplies would generally be avoided for use in construction but may be used where appropriate and available.

4.3.1 Potable Water Supply

Potable water demands for the Project would be supplied via water tanker and stored in on-site water tanks. Potable water storages would be routinely tested to ensure water quality meets the requirements of the Australian Drinking Water Guidelines (ADWG) (National Health and Medical Research Council, 2011) and an appropriate maintenance regime would be implemented to ensure water quality ADWG water quality standards are maintained.

4.3.2 Amenities Wastewater

Wastewater from amenities during all phases of the Project would be captured in a tank and transferred periodically by a suitably licensed contractor to an appropriate wastewater treatment facility.

4.4 FIRE FIGHTING

The proponent has an agreement with Whitehaven Coal's Narrabri Mine to supply water for firefighting, as per the correspondence provided from the General Manager of Whitehaven Coal's Narrabri Mine dated 28 Nov 2024, which states:

I am confirming that Narrabri Mine can provide water to the Whitehaven Solar Farm for firefighting purposes, and the Narrabri Mine water management system has sufficient capacity to facilitate this. I note that the Whitehaven Solar Farm is located on land owned by Narrabri Coal Operations Pty Ltd close to the Narrabri Mine, and in the event of a bushfire, the Narrabri Mine would utilise water for firefighting purposes in the area regardless of the presence of the Solar Farm.

Narrabri Coal currently has the capacity to store 605 megalitres of water on site, which is located less than 500 m from the Project Area, for use in firefighting. Narrabri Coal also owns several Water Access Licenses under the Namoi River Regulated Water Sharing Plans and has direct access to the Namoi River. Further to this, recent amendments to the *Water Management (General) Regulation 2018* allow for the taking and storage of 100 kilolitres for firefighting purposes.

⁶ <https://www.waternsw.com.au/customer-services/water-licensing/maximum-harvestable-rights-calculator>

The Narrabri Solar Farm's bushfire management is aligned and in accordance with the procedures outlined in the current Narrabri Mine Mining Operations Plan (MOP) and Bushfire Management Strategy (LW201-202 EP). The characteristics of the firefighting systems and related management procedures are outlined in those documents. In particular, water supplies and related firefighting equipment are checked monthly.

Bushfire management is outlined in the Narrabri Mine Rehabilitation Management Plan, the Bushfire Prevention Standard and the Bushfire Emergency Response Procedure. The bushfire management strategy for Narrabri Mine is to identify all hazards and risks associated with bushfires for all properties owned by Whitehaven Coal's Narrabri Mine. The following are potential causes of bushfires at The Project:

- Inappropriate staff behaviour i.e. smoking on-site (which is in breach of site rules) and/or undertaking activities without adequate controls;
- Unrelated incidents such as lightning strikes and ember attacks; and
- Fire from adjacent land holdings.

Narrabri Mine is equipped to attend to emergency fire situations with appropriate machinery and personnel. Narrabri Mine has also met with the NSW Rural Fire Service (RFS), Namoi/Gwydir team, and other industry representatives during the reporting period. Information on equipment available onsite, locations of watering points/access tracks/infrastructure areas and Geographic Information System (GIS) mapping information have been provided to the RFS for the Narrabri Mine.

4.5 SITE WATER BALANCE

The Project would require water to be supplied from a variety of sources and qualities. The water demands were quantified in Section 4.2 and the possible supply sources were outlined in Section 4.3. An indicative summary detailed site water balance is shown in Table 4.3.

Table 4.3 Detailed site water balance

	Construction Phase (kL)	Operation (annual) (kL)
Water Demands		
Dust suppression (nett. Evaporation)	7000	Neg.
Construction – stabilised road /hardstands	2554	n/a
Construction – concrete	70	n/a
Washdown	1100	3207
Fire fighting	refer Section 4.4	As required
Potable	950	100
Water Supply		
External potable water	950 (Purchased)	100 (Purchased)
Harvested project water	7150 (max.)	1600
Neighbouring Narrabri Coal Mine	Balance acquired	1607 + firefighting

4.6 EROSION AND SEDIMENT CONTROL

Throughout the construction phase of the Project, erosion and sediment controls would be established in general accordance with *Managing Urban Stormwater – Soils and Construction Volume 1* (Landcom, 2004) and *Volume 2C: Unsealed Roads* (DECC, 2008) (i.e. the 'Blue Book'). The following sections outline the Project erosion and sediment controls design standards and anticipated erosion and sediment controls to be implemented at the Project. Should the Project be approved and constructed, soil and water management measures would be prepared to facilitate implementation of best practice erosion and sediment controls during all phases of the Project.

4.6.1 Construction on Waterfront Land

Approved SSD projects are 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 waterway) under s.4.41(1)(g) of the *Environmental Planning and Assessment Act 1979*. While an exemption from CAAs, all works on waterfront land for the Project would be undertaken in accordance with DPEs *Guidelines for Controlled Activities on Waterfront Land*.

4.6.2 Erosion hazard assessment

An erosion hazard assessment has been undertaken in accordance with Chapter 4.4.1 of Volume 1 of the 'Blue Book'. The Australia Natural Resource Atlas provides gridded factor values within the Project Area. The Project Area slope was estimated based on the geospatial analysis to determine the average site slope of the existing landform. These gridded values were averaged and are presented in Table 4.4 and were used to assess erosion hazard for the entire Project Area. Appendix C contains Figures that show the gridded factors with the Project Area.

The annual soil loss for the Project Area was estimated from the Revised Universal Soil Loss Equation (RUSLE). The annual soil loss rate is classified as a high or low erosion hazard. The erosion hazard assessment for the Project Area predicts that it can be classified as very low erosion hazard. As such, standard erosion control measures would be applied during construction.

Table 4.4 Annual soil loss calculation

	Description	Value	Range
R	Annual average rainfall erosivity factor	1407.4	-
k	Soil erodibility factor	0.037	0.030 - 0.047
LS	Slope length gradient factor based on Table A1 of <i>Managing Urban Stormwater Volume 1</i> (Landcom, 2004)	0.294	0.040 - 1.280
C	Ground cover factor sourced from Figure A5 of <i>Managing Urban Stormwater Volume 1</i> (Landcom, 2004)	0.031	0.025 - 0.038
P	Erosion control practise factor sourced from Table A2 of <i>Managing Urban Stormwater Volume 1</i> (Landcom, 2004).	1.3	Compacted and smooth
A	Calculated annual soil loss rate (RUSLE), tonnes/ha/year	0.565	0.121 - 2.008

The calculated annual soil loss rate for the Project Area corresponds to a very low erosion hazard, (soil loss class 1). Classification of soil loss is provided in Volume 1 of the Blue Book (Landcom, 2004) at Table 4.2. The Blue Book's Figure 4.9 indicates that the Project Area is located in rainfall distribution zone 6. Consulting *Lands where special erosion control measures apply* in the Blue Book's Table 4.3 indicates that for zone 6 and soil loss class 1, there are no time of year restrictions applicable to the Project Area.

The Blue Book instructs that all land within 40 m of the bank of a defined watercourse is to be considered as a very high erosion hazard (soil loss class 6). As such, timing restrictions apply to any works on these lands between November and March. Table 4.5 presents the recommended timing restrictions for soil loss class 6 lands in rainfall distribution zone 6 adapted from the *Table 4.3* of the 'Blue Book'.

Table 4.5 Timing Restrictions for Soil Loss Class 6 Lands in Rainfall Distribution Zone 6

Half of Month	1 st	2 nd
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	No	No
November	Yes	Yes
December	Yes	Yes

Source: Adapted from Table 4.3 of Managing Urban Stormwater Volume 1 (Landcom, 2004)

Where scheduling of works during periods where the three-day forecast indicates that rain is likely, erosion control measures should aim to protect disturbed lands with 60% ground cover. Where non-forecast rainfall arrives, site management techniques should endeavour to ensure that site erosion is minimised and mitigated.

4.7 GENERAL EROSION AND SEDIMENT CONTROL STRATEGY

The detailed design phase would finalise drainage sizing and alignments. Once this information is known, and prior to construction, erosion and sediment control measures would be developed and included in a Construction Environmental Management Plan (CEMP). This would specify the locations of all necessary erosion and sediment controls to achieve the principles outlined below. The erosion and sediment controls are to be installed, managed and maintained in general accordance with the Blue Book Volume 1 (Landcom, 2004) and Volume 2C (DECC, 2008). This would be achieved using the following principles and strategies.

4.7.1.1 Principles of Site Management

- Clean water flows would be diverted and prevented from entering the active construction areas.
- Maintain a suitable ground cover across the construction and operational phases.
- Stockpiles of erodible material that have the potential to cause environmental harm if displaced would be located away from concentrated surface flow and excessive up-slope stormwater surface flows.
- Sediment removed from any trapping device is to be disposed of in locations where further erosion and consequent pollution to downslope lands and waterways would not occur.
- Temporary soil and water management structures are to be removed only after the Project Area is stabilised appropriately.
- Refuelling of plant and equipment is to be undertaken in an impervious bunded area, where practical, located a minimum of 50 m from drainage lines or waterways.
- 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.
- All fuels, chemicals and liquids would be stored in an impervious bunded area.
- Any concrete washout undertaken on site (during construction phase) would be in a bunded area that is not on waterfront land and at least 10 m from drains.

4.7.1.2 Erosion Sediment Controls strategy

The following erosion and sediment control management strategies would be implemented within the Project Area.

- To minimise ground disturbance, construction and operational activities including vehicle and machinery movements, stockpiling, temporary vehicle parking and material laydown would be restricted to designated work areas. The disturbance boundary is to be clearly delineated.
- Where possible, topsoil would be stripped and handled only when it is moist (not wet or dry) to avoid decline of soil structure.
- Topsoil stockpiles would be stabilised with vegetation (seeded) if they are to be inactive for long periods.
- 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.

As the Project Area is predominantly flat and the annual soil loss rate is very low, the Blue Book considers sediment basins as having limited practicality to drain and protect disconnected areas. The use of sediment basins would depend on the practicality of draining flat, disconnected and disturbed areas to a single sediment basin. The Blue Book suggests a contiguous disturbance area threshold of around 2 ha. Other more effective sediment controls are possible, and they would protect receiving waters from sediment generated within the Project Area.

4.7.1.3 Drainage Controls

- All temporary drainage controls are to be designed to have non-erosive hydraulic capacity to convey runoff from a 10% AEP critical duration storm event.
- 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.

5 EXISTING FLOOD BEHAVIOUR

5.1 MODELLING APPROACH

The purpose of the flood modelling was to assess the current climate flood behaviour within the Project Area to inform siting of flood vulnerable infrastructure and assessment of Project impacts. The 2023-03-AC version of the two-dimensional TUFLOW hydrodynamic model (BMT, 2018a) was used to simulate the flow behaviour in the vicinity of the Project Area for the 10% (1 in ten (10)), 1% (1 in 100), 0.5% (1 in 200) and 0.2% (1 in 500) AEP flood events for the current climate records. The PMF was modelled to estimate extreme flood conditions.

Inundation within the Project Area could occur, exclusively or as a combination of two (2) mechanisms:

- Site runoff: Short duration (< 60 minutes) intense rain falling directly on the Project Area
- Local catchment flooding: Medium duration (one (1) hour – six (6) hours) rain falling on land draining to the Project Area.

The site is not located on the Namoi River floodplain and would not be impacted by Namoi River flooding.

Site runoff and local catchment flooding were modelled using a direct rainfall model to determine the extent of the surrounding floodplain that drains to the Project Area. The required extent of the hydraulic model domain was assessed by applying direct rainfall and assessing flow directions across the floodplain and interconnected watercourses. The hydraulic model domain was defined by the extent of rainfall that was assessed as likely to reach the Project Area. This ensured that model run times and file sizes provided optimal coverage of the local catchment flood behaviour.

The modelled flood events are indicative of conditions as outlined below:

- 10% AEP event – representative of a frequent-rare flood event.
- 1% AEP event – representative of the principal flood planning event.
- 0.5% and 0.2% AEP events – representative of a future climate's 1% AEP flood risk.
- PMF – representative of the extreme flood event. This is based on the probable maximum precipitation (PMP) estimate and does not have a design event probability.

5.2 DESIGN EVENTS

Recommended design rainfall parameters were based on Australian Rainfall and Runoff (ARR) ARR2019 guidelines⁷. Key design rainfall parameters include:

- initial and continuous loss rates;
- design storm pre-burst depths;
- areal reduction factors; and
- design storm temporal patterns.

⁷ <https://arr.ga.gov.au/arr-guideline>

Design rainfall depth data, as well as design losses, and storm pre-burst details were obtained from ARR2019 datahub, in accordance with the current ARR guidelines. Preliminary TUFLOW hydraulic model runs for a range of durations and temporal patterns were used to identify the critical storm duration for the Project Area, and relevant design storm temporal patterns. Design flows were estimated by applying design rainfall directly to the TUFLOW model grid. Details of the process and inputs are provided in the following sections.

Design event modelling results were post-processed to derive design flood parameters (e.g. peak flood depths and extents) for each AEP and design scenario. Existing and proposed developed conditions results were compared to determine the location and magnitude of predicted impacts.

5.2.1 Design Rainfall

Design rainfall depths were obtained from Design Rainfall Data System based on a single point location at the centroid of the Project Area. These depths are summarised in Table 5.1.

For the purpose of the local catchment investigation, no areal reduction factors were applied to the design rainfalls. This approach is considered conservative for the purpose of this study.

Table 5.1 Design Rainfall Depths (mm) for Event Durations and AEPs

Duration (min)	10% AEP	1% AEP	0.5% AEP	0.2% AEP	PMP
60	35.8	54.8	60.7	69.1	320
90	41.4	62.8	69.5	78.9	370
120	45.5	68.6	75.8	85.8	410
180	51.8	77.6	85.5	96.4	460
270	59.4	89.2	98.7	111.8	530
360	65.8	100.4	111.5	127.5	590
540	75.8	117.2	129.9	149.7	
720	83.5	129.2	143.8	164.6	725
1080	95.8	149.9	167.7	193	
1440	105.3	168.1	188.4	216.4	540
1800	114.3	182.1	203.4	233.4	
2160	120.4	194.1	216.4	249.4	660
2880	131.4	214.2	239.5	276.5	770
4320	146.6	240.4	271.6	315.6	1090

5.2.2 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 with median pre-burst depths obtained from the Data Hub used to adjust the initial loss with 1% AEP.

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

- ILs for infrequent events were derived based on the Probability Neutral Burst ILs provided by ARR2019 datahub. This approach results in a unique Initial Loss for each duration; and

- CLs for infrequent events were derived based on the suggested data hub and regional flood study CLs.

Table 5.2 provides the initial and continuing losses used for the 1% AEP event rainfall losses. Table 5.3 provides the Probability Neutral Burst Initial Loss values referred to by Table 5.2. As ARR2019 datahub does not provide values beyond 1% AEP. The values were extrapolated and using the PMF value of zero as the limit.

Table 5.2 Losses Used in the Developed Hydraulic Model

Losses	Frequent and infrequent ($\leq 1\%$ AEP)	Rare ($> 1\%$ AEP)	PMF
IL (mm)	Probability Neutral Initial Loss	Probability Neutral Initial Loss interpolated	0
CL (mm/h)	0.6	0.6	1

Table 5.3 Probability Neutral Burst Initial Loss

Storm duration (min)	Probability Neutral Initial Loss (mm)	
	1% AEP	10% AEP
60	20.2	20.4
90	22.0	20.9
120	20.3	20.7
180	16.8	24.0
360	15.4	23.6
720	13.3	27.5
1080	12.5	29.3
1440	17.1	32.7
2160	20.0	36.8
2880	26.2	41.0

Source: ARR2019 datahub

5.2.3 Temporal Patterns

Temporal patterns are the distribution of the total rainfall in different periods within a given duration. The suite of ten (10) temporal patterns appropriate to the Project Area were downloaded from ARR2019 datahub and used to simulate the temporal distribution of rainfall depths during each storm duration modelled. The suite of temporal patterns has been applied to estimate the critical design event for flood estimation in accordance with ARR 2019 procedures.

5.2.4 Critical Storm Durations

A range of storm durations and temporal patterns were simulated using the TUFLOW model (using ARR 2019 inputs) to identify the critical storm duration and temporal pattern results providing the design peak discharges at the Project Area. The usage of a direct rainfall model resulted in numerous critical duration events at various locations within the Project Area. However, while different durations were identified based on various catchments sizes, they were of similar depths. As running numerous duration storms would ultimately produce similar depths, the overall critical duration

event was selected on the basis of the storm duration that produced the greatest depth in the main flow path through the Project Area. This simplification may have the impact that shorter duration (intense) storms may result in slightly higher (~10mm) water levels in localised areas. This approach was considered appropriate given the broadscale nature of this assessment.

5.3 VALIDATION OF DESIGN DISCHARGE ESTIMATES

The Regional flood frequency estimation model (RFFE) is an online tool⁸ developed for Australian Rainfall and Runoff to estimate design flows for ungauged catchments. It is based on gauged data and at-site flood frequency estimates using a region-of-influence approach. The catchment's centroids and outlets used to generate the RFFE values and are summarised in Table 5.4.

Table 5.4 Summary of RFFE Input data

RFFE Input Parameters						
Catchment Area (km ²)	Centroid Coordinates	Outlet Coordinates	Shape Factor	Mean elevation	50% AEP 6h (mm/h)	2% AEP 6h (mm/h)
30.6	-30.553, 149.866	-30.529 149.913	1.010	310	7.1	16.1

The peak modelled flow was extracted from the TUFLOW model at the catchment's outlet. The resulting peak discharge are compared to the RFFE estimative values in Table 5.5. Overall, TUFLOW model results and RFFE estimates of the 10% AEP flood agree. However, for the 1% AEP the TUFLOW model results are lower than the RFFE estimates but still within the confidence limits.

A comparison of the RFFE results with the 1% AEP estimates available from the at-site flood frequency analysis at nearby gauges in the region is shown in Figure 5.1. The at-site flood frequency analysis values are returned as an accompanying dataset when using the RFFE website.

Table 5.5 Comparison of TUFLOW design peak discharges with RFFE

AEP (%)	RFFE design peak discharge (m ³ /s)			Modelled peak discharge (m ³ /s)
	Expected parameter quantile	5 th %ile confidence limit	95 th %ile confidence limit	
50	13	4	49	NA
20	52	18	140	NA
10	93	32	240	71
5	140	44	385	NA
2	207	56	655	NA
1	259	63	957	150

The comparison indicates that the RFFE estimates are based on at-site FFA values from comparator catchments that are:

- steeper than the Project Area, shown in Figure 5.2; and
- experience greater rainfall intensities for the 1% AEP event as shown in Figure 5.3.

⁸ <https://rffe.arr-software.org/>

The modelling of the Project Area was based on the suggested ARR datahub values and standard TUFLOW model parameter values were adopted. Given the soil types and flat nature of this catchment and the fact that there are a number of farm dams, the estimated design discharges are considered reasonable.

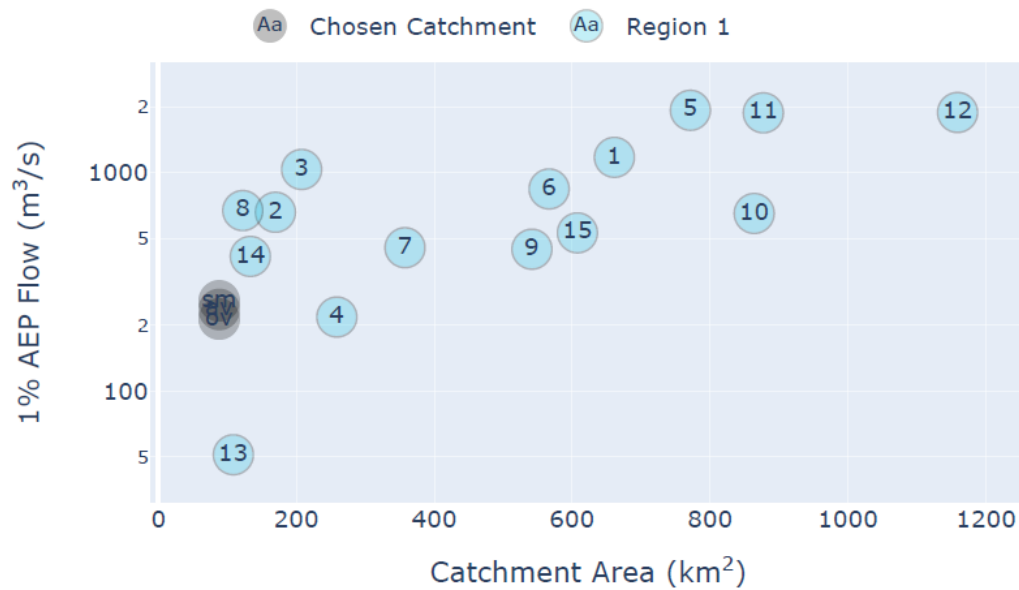


Figure 5.1 Comparison of FFA estimates with Project Area's RFFE 1% AEP flows

Source: ARR Regional Flood Frequency Estimation⁹

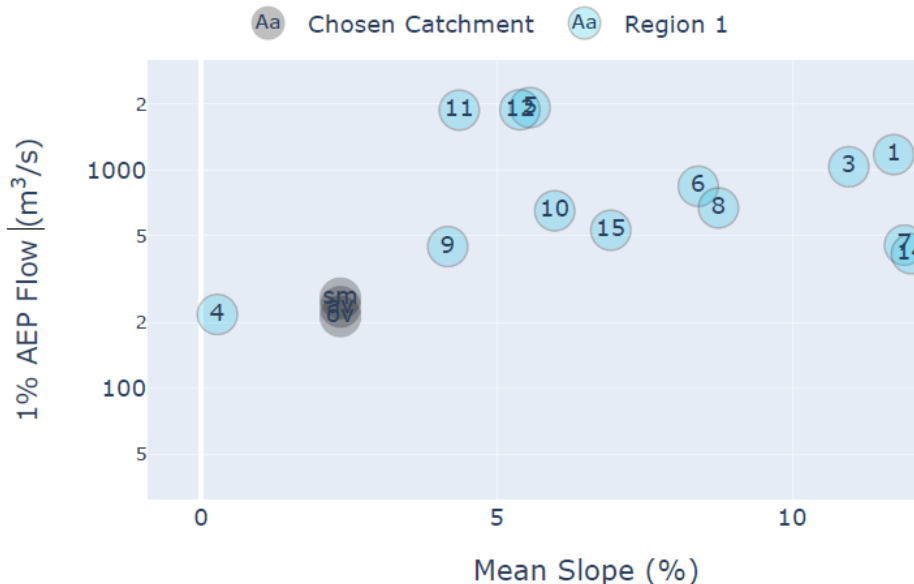


Figure 5.2 Comparison of catchment slopes with Project Area's slope

Source: ARR Regional Flood Frequency Estimation

⁹ rffe-2021.wmawater.com.au

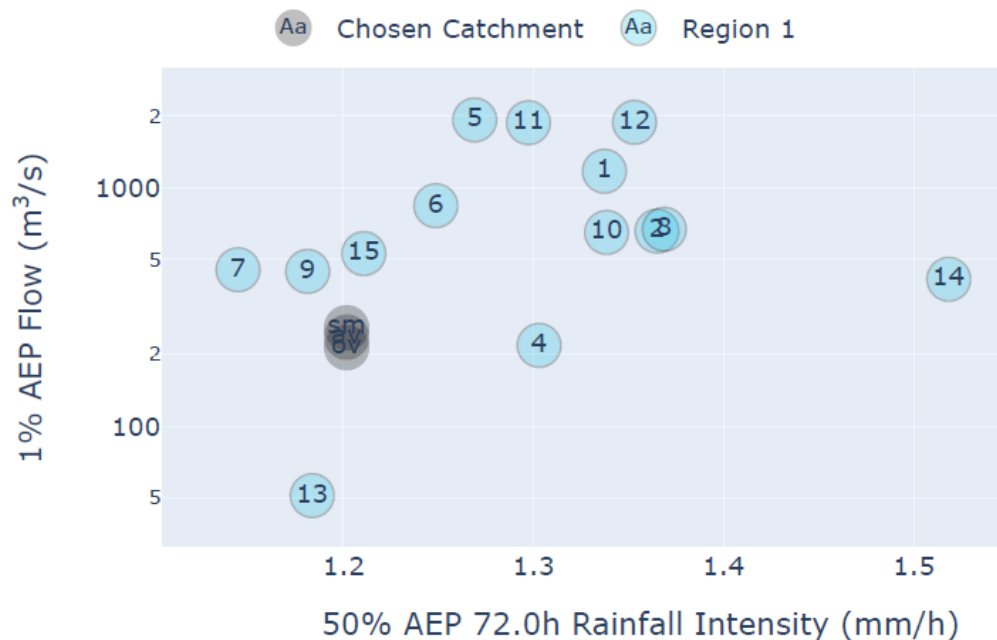


Figure 5.3 Comparison of rainfall intensities with Project Area's intensity

Source: ARR Regional Flood Frequency Estimation¹⁰

5.4 HYDRAULIC MODELLING

5.4.1 Topography and grid cell size

The one (1) m topographic data obtained from ELVIS database was adopted as the base model topography across the Project site. The data was flown in 2013 and has a vertical accuracy of $\pm 0.3\text{m}$. A 10 m grid size resolution was adopted for hydraulic modelling. In combination with TUFLOW's sub-grid sampling functionality, the 10 m cell size provides adequate resolution to capture key drainage features and overland flow paths, while maintaining reasonable simulation times. A 5 point sub grid sampling frequency was applied.

5.4.2 Boundary conditions

Figure 5.4 shows the locations of rain on grid extent and outflow boundaries in the local catchment TUFLOW model. The model includes:

- direct rainfall boundary covering the entire hydraulic model extent; and
- a single normal depth rating flow boundary.

Normal depth rating (HQ) type boundary conditions were implemented for the downstream model boundaries. The flows through the downstream boundary is controlled by a normal depth rating curve. 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

¹⁰ rffe-2021.wmawater.com.au

conditions assumed a slope of 0.67 m/m, calculated from the river water surface slope relative to the sloping topography. This normal depth slope is typical of the water surface slopes.

5.4.3 Hydraulic resistance

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance. Analysis of available aerial imagery showed that there are two (2) general land use classifications of relevance in the vicinity of the Project Area. Adopted Manning's 'n' values for each land use classification are listed in Table 5.6. The values adopted correspond to the values adopted in nearby flood studies.

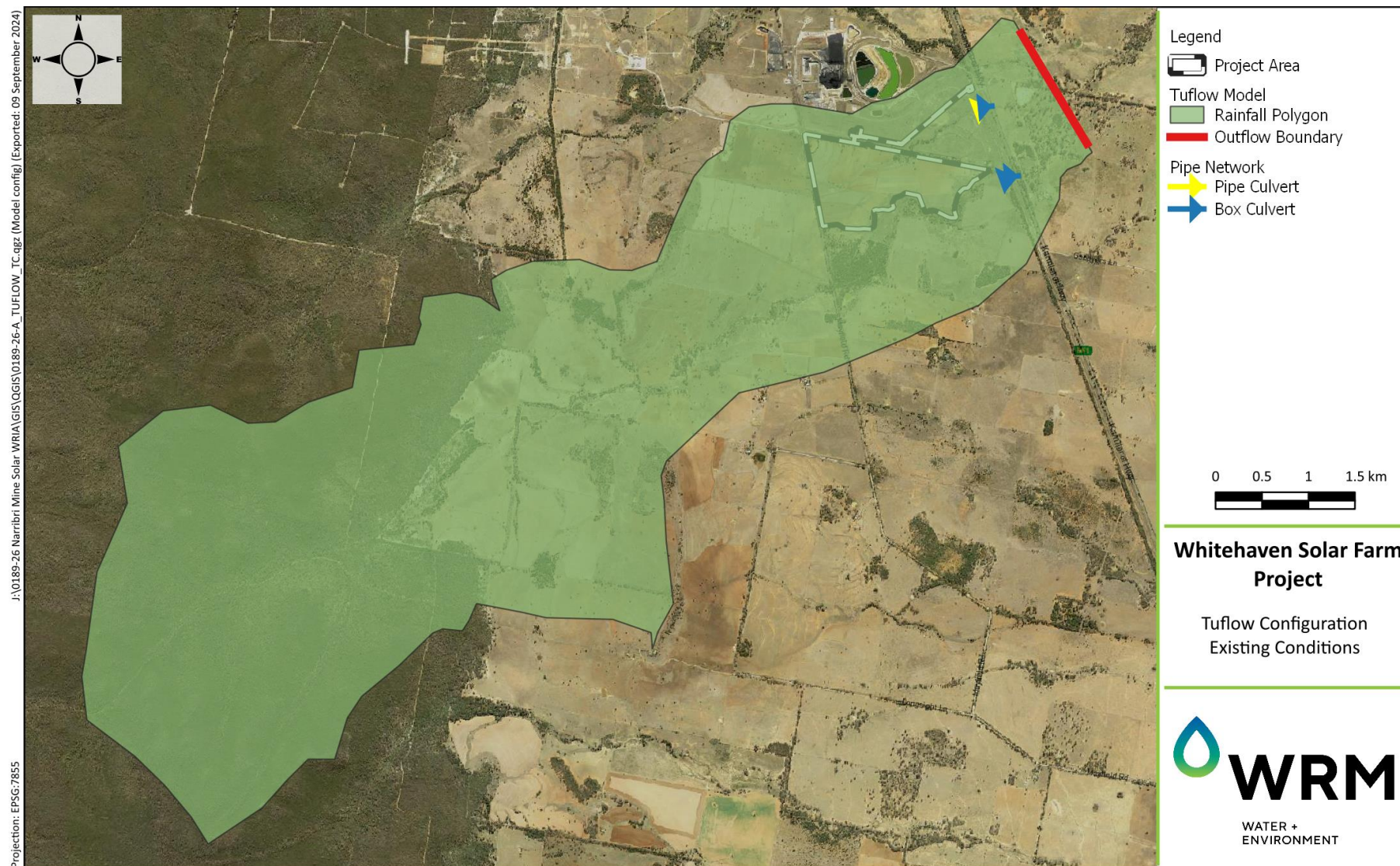


Figure 5.4 Hydraulic model configuration

Depth varying Manning's 'n' values were adopted as recommend by the TUFLOW manual for the direct rainfall (rain on grid) approach. Between flood depths of 50 mm and 100 mm, hydraulic roughness values are linearly interpolated by the TUFLOW software.

Table 5.6 Depth-Varying Manning's Roughness used in the Hydraulic Model

Land Use	Manning's 'n'	
	Depth < 50 mm	Depth > 100 mm
Light vegetation / Grass	0.080	0.045
Dense vegetation / residential	0.080	0.080

5.4.4 Hydraulic structures

Hydraulic structures were modelled at railway and highway downstream of the project site. Culverts used in the modelling are presented in Table 5.7. Figure 5.4 shows the structure locations.

Table 5.7 Hydraulic Structures

Location	Culvert
Railway	1 x 2.4 m Dia. (16 m length)
	2 x 2.4 m H x 1.5 m W (4.8 m length)
Highway	2 x 2.4 m H x 1.5 m W (12.3m length)
	3 x 2.4 m H x 1.5 m W (12.3m length)

5.5 EXISTING FLOOD BEHAVIOUR

5.5.1 Overview

The flood model results provide the distribution of peak flood levels, depths, velocities and hazards across the Project Area for each modelled design magnitude flood event. Areas where the modelled flood depths are less than 50 mm have been filtered from the results. Note that this does not affect the hydraulic computations.

The suite of detailed flood mapping of the simulated depth, velocity and flood hazard distributions for all modelled events is provided in Appendix B. The figures show that the peak flood extent is largely confined to the watercourse alignments, with some moderate inundation beyond the channel corridors.

5.5.2 Flood Hazard

The flood hazard at the Project Area was assessed in accordance with ARR 2019. Flood hazard occurs due to the vulnerability of the public and assets interacting with floodwaters. ARR 2019 adopted the combined flood hazard classification based on research presented in the *Australian Disaster Resilience Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR, 2017). The flood hazard categories according to the AIDR definition are summarised in the Table 5.8 and flood hazard colour coded curves are shown in Figure 5.5. The flood hazard mapping is provided in Appendix B.

Table 5.8 Hazard Classification

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)	Description
H1	$D \cdot V \leq 0.3$	0.3	2.0	Generally safe for vehicles, people and buildings.
H2	$D \cdot V \leq 0.6$	0.5	2.0	Unsafe for small vehicles.
H3	$D \cdot V \leq 0.6$	1.2	2.0	Unsafe for vehicles, children, and the elderly.
H4	$D \cdot V \leq 1.0$	2.0	2.0	Unsafe for vehicles and people.
H5	$D \cdot V \leq 4.0$	4.0	4.0	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	$D \cdot V \geq 4.0$	-	-	Unsafe for vehicles and people. All building types considered vulnerable to failure.

Source: AIDR, 2017

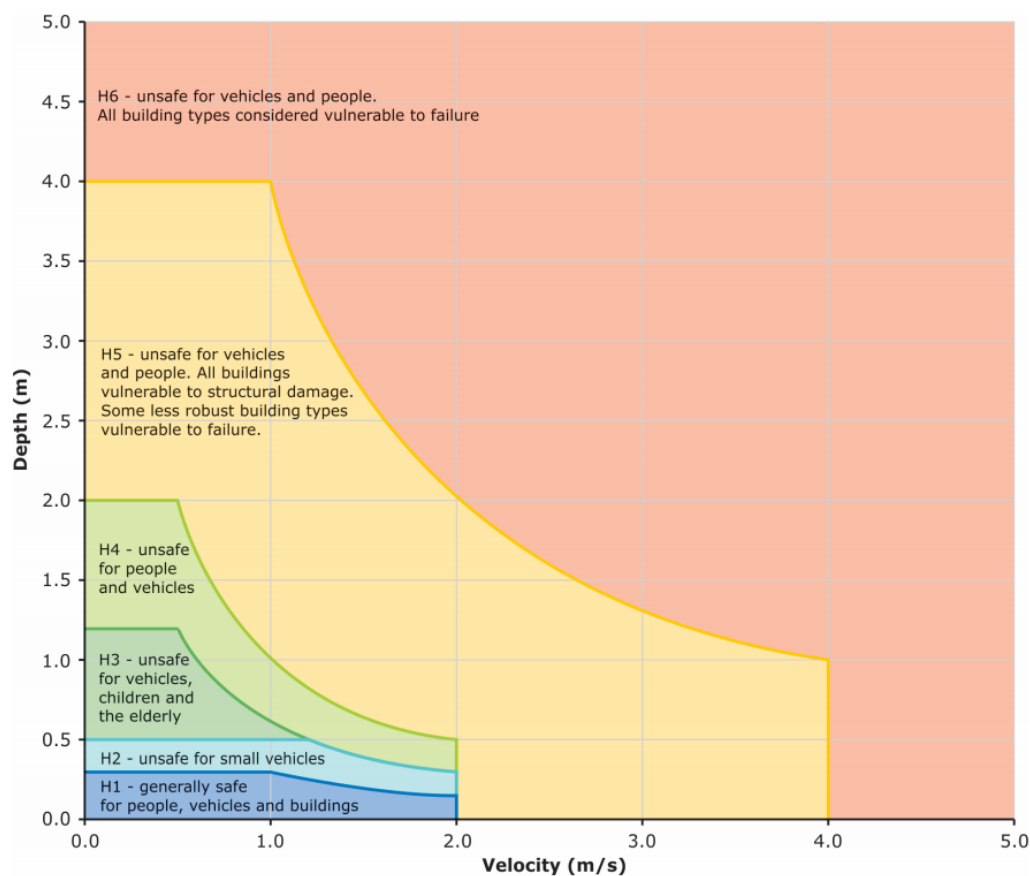


Figure 5.5 Combined Flood Hazard Curves

Source: Smith et al. 2014

5.5.3 Design Flood Events

The flood modelling results are discussed below, mapped results are available in Appendix B. The modelled flood behaviour within the hydraulic model's domain is shown in Appendix B. Summary observations about flood behaviour are as follows:

- 10% AEP: Results show there is generally no widespread flooding within the Project Area, with active flow paths confined within the Kurrajong Creek tributary 2 and local depressions. Kurrajong Creek flooding generally does not inundate the asset protection zone. General overland flood flow depths outside of the main watercourse alignments are typically shallow at less than 0.07 m. The greatest depths within the watercourses within the Project Area are up to 0.25 m with the exception of 1.5 m deep in existing farm dams.
- 1% AEP: The general flood inundation extents are increased from the 10% AEP event, with increasing depths and velocities associated with the higher flows. 1% AEP results show there is generally no widespread flooding within the Project Area, with active flow paths confined within the watercourses and local depressions. General overland flood flow depths outside of the main watercourse alignments within the asset protection zone along Kurrajong Creek Tributary 2 are typically shallow at less than 0.1 m. The greatest depths within Kurrajong Creek Tributary 2 within the Project Area are up to 0.40 m excluding the existing farm dams. Kurrajong Creek flooding generally does not inundate the asset protection zone. *This is the parameter adopted for planning purposes, and utilised here to derive all necessary mitigation measures. Based on the Project design utilised for this assessment the 1% AEP flood extents has minimal interaction with the Project disturbance area, and the hazard assessment has identified that the inundated areas of the Project Area are primarily classified as 'generally safe' (H1), with only isolated pockets H2 hazard in the watercourse that traverses the site are predicted, and the hazard in existing farm dams ranges from H3 to H5, refer Section 6.2 of this report.*
- 0.5% AEP and 0.2% AEP: The flood depths are only marginally larger than those of more frequent conditions, with an increase in depth within the main watercourse and existing farm dams within the Project Area of approximately 0.1 m. Higher AEP events show similar results, indicating the inundation impact of climate change is not anticipated to be a significant issue for the Project.
- PMF: The PMF is the extreme upper limit of the design event window. Under PMF conditions the central, southwestern and eastern areas of the Project Area are inundated. The main watercourse within and adjacent to the Project Area has broken out of banks, resulting in depths of flow ranging from 0.08 m to 0.22 m. These predicted depths would not impact the solar panels as flow can pass beneath. Other site infrastructure is inundated. *It is reiterated that the PMF defines the upper limit of flooding that could reasonably be expected to occur and is much rarer than the 1% AEP flood which is the parameter adopted for planning purposes, and utilised here to derive all necessary mitigation measures.*

6 ASSESSMENT OF POTENTIAL IMPACTS

The Project has the potential to impact receiving surface water and groundwater quality, flood regimes, soil resources, available water supply to existing users and aquatic habitat and GDEs. However, the potential impacts listed below would be contained to a small area, and there are numerous mitigation measures possible that reduce the risk to an acceptable level. In the absence of appropriate controls and assuming the worst possible case, the potential impacts to surface water resources associated with the Project may include:

- degradation of downstream surface water quality (primarily during construction and decommissioning but also potentially during operation) due to:
 - elevated concentrations of sediment and nutrients bound to sediment in any runoff;
 - chemical spills/leaks entering streams (e.g. diesel fuel or hydraulic oils from mobile plant);
- increased erosion within watercourses 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;
 - runoff being concentrated by impervious areas associated with the Project;
- potential for obstruction of fish passage associated with 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 to mitigate these risks.

6.1 SOIL AND WATER QUALITY IMPACTS

Potential impacts relating to soil and water quality are proportional on land disturbance. Minimising total land disturbed significantly reduces the risk of the following impacts. The impacts listed here are intended to provide an exhaustive summary and are not intended to indicate likely outcomes relating to this Project.

6.1.1 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, potentially leading to sediments and/or pollutants being entrained in rainfall runoff and entering local waterways. Discharge of polluted rainfall runoff from the Project has the potential to result in the deterioration of EVs and WQOs, for example:

- Pollutants such as sediments, pH, oils/grease and other nutrients bound to sediment or dissolved form. The Project would implement the above site water management measures to achieve as far as practicable the Namoi River catchment WQOs for protection of aquatic ecosystems.
- Works within or near a watercourse are a risk to downstream water quality due to the disturbance of the stream bed and the mobilisation of sediments and pollutants. Work occurring outside of watercourse may also indirectly mobilise sediment and pollutants via the action of wind then rainfall. Construction of the Project would not require controlled discharges to waterways and works would not occur within the 1% AEP flood extent of Kurrajong Creek.
- Mobilised high concentration nutrients (fertilisers) may trigger algal blooms that result in anoxic conditions within fish habitats. Mobilised heavy metals and contaminant concentration could result in degradation for aquatic habitats, irrigation and drinking water.
- Soils within the Project Area may contain residual herbicides/pesticides from historical or present day farming practices.
- Loss of topsoil resources on the land and ongoing erosion reducing the area of usable land and/or damage to private property for involved 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 waterways.

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 potential construction-related stormwater pollution impacts can be appropriately managed and are expected to be negligible.

During the construction phase, there may be a requirement to construct a waterway crossing on Kurrajong Creek Tributary 2 (a first order watercourse) to enable access across the broader Project Area. A waterway crossing of Kurrajong Creek is not proposed. Provided waterway crossings are designed and constructed in accordance with relevant guidelines and in consultation with DPI Fisheries, the Project waterway 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 7, the potential water quality impacts would be adequately managed during the Project's construction and decommissioning phases.

6.1.2 Operation

During the operational phase the potential impacts on water quality relate to establishment of additional infrastructure, hardstands and roads. 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 conserved 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 would 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 7.0, water quality impacts during the operational phase are expected to be negligible.

6.2 FLOODING IMPACTS

6.2.1 Operation, Construction and Decommissioning

The 10 %, 1 %, 0.5 %, 0.2 % AEP and PMF events were assessed to quantify flood depth, velocity, and hazard levels. Modelling has shown the Project Area to be of low flood risk with minimal risk to changes in internal or external waterway flows.

The access into the Project Area from the east via the Kamilaroi Highway and Kurrajong Creek Road has a low flood risk. Design of waterway crossings (across Kurrajong Creek Tributary 2) for access points and crossings within the Project Area would be undertaken at the detailed design phase. Although Kurrajong Creek Tributary 2 is a first order watercourse, waterway crossings are to be designed in consideration of requirements of *Guidelines for Controlled Activities on Waterfront Land*, to reduce construction impacts to the riparian corridors within the Project Area.

The results of the 1% AEP flood hazard assessment have identified that the Project Area is classified as Generally safe (H1). Isolated pockets of H2 hazard in Kurrajong Creek Tributary 2 that traverses the site are predicted, and the hazard in existing farm dams ranges from H3 to H5. The peak modelled velocities were generally less than 1 metres per second (m/s) within Kurrajong Creek Tributary 2 and up to 0.25 m/s across the asset protection area.

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 considered likely to be minimal due to the relative size of the Project Area in relation to the size of the receiving catchments. New impervious areas within the Project Area comprises:

- 50,000 PV panels (although the area below the panels would remain vegetated);
- footings for transmission lines, substations and switchyards;
- roof areas relating to operation and maintenance buildings; and
- access and hardstand area.

The existing and post development peak flows for the catchment were assessed using the Rational Method. While the site is rural, the urban method was used as it allows for an assessment of increase in runoff due to an increase in impervious areas. The rainfall intensities were extracted from the 2016 Intensity Frequency Duration (IFD) tool as provided by the Bureau of Meteorology and discussed in Section 5.2.

The PV module size is approximately 2.3 m x 1.1 m and each array contains approximately 25 to 30 modules. The total number of arrays is approximately 1,743 arrays (representing 50,000 PV modules) which represent 16 ha of impervious solar surface. The panels are aligned in rows of two (2) metres wide, and nominal seven-metre space was assumed for distance between each row. The Project Area is 100 ha which means that only 14% of the Project Area is covered by the solar panels. The total size of the Kurrajong Creek catchment is 3,000 ha. Therefore, the proportion of the catchment potentially covered by solar panels is a negligible 0.5%. A review of the peak flow calculations indicates an increase of 1.1 m³/s. This is approximately 0.7% of the 1% AEP peak flow of 150 m³/s in Kurrajong Creek, as shown in Table 5.5. Again, this ignores the fact that the surface below the panels would remain pervious. Consequently, the hydrologic impacts of the Project at the catchment scale are likely to be undetectable.

Minimal changes to the land topography, impervious fraction and therefore runoff and groundwater infiltration are expected due to the nature and extent of proposed infrastructure. If the management and mitigation measures outlined in Section 7.0 are implemented the Project is unlikely to have any residual impacts on surface water. This will require the development of a CEMP prior to construction.

6.3 IMPACTS ON STREAM STABILITY, RIPARIAN HEALTH AND FISH PASSAGE

6.3.1 Construction, Operation and Decommissioning

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 waterway) 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 will be undertaken in accordance with DPEs *Guidelines for Controlled Activities on Waterfront Land*.

All streams traversing the project and adjacent are ephemeral with minimal to no baseflow. The Project design avoids works close to or within waterways this allows for fish passage and riparian health to be retained via 40 m buffers at around the water way banks. Project considers minimisation of impacts on stream stability and fish passage 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).

For works on waterfront land, the following construction soil and water management measures would be incorporated into the design of the works and controls included in the CEMP:

- a site specific erosion and sediment control sub-plan would be prepared for all works on waterfront land;
- where practicable, infrastructure would 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; and
- 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 3.1).

For any crossings that require consideration of fish passage, the relevant DPI Fisheries guidelines would be considered during the detailed design process.

6.4 IMPACTS ON WATER SUPPLY

6.4.1 Construction, Operation and Decommissioning

Water required for the Project would be sourced from one or a combination of the following sources:

- commercial suppliers in the nearby region (e.g. Narrabri Mine) via water truck;
- harvested runoff from farm dams under agreement with host or local landholders;
- harvested runoff from disturbed areas captured in excavations or sediment basins/traps constructed to prevent sediment transport off-site; and
- recycling and reusing water.

The maximum water demand would be during construction (refer Section 4.2). The bulk of water will be supplied by the neighbouring Narrabri Coal Mine. Additional water can also be sourced from the allowable harvestable right within the Project Area or the neighbouring Narrabri Mine. No water would be abstracted from Kurrajong Creek. As such, 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 would be temporary during the construction and decommissioning phases. As such, impacts on surface water availability to downstream water users are expected to be negligible.

The maximum water demand would occur during construction with the bulk of water to be supplied from adjoining Narrabri Coal Mine 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.

6.5 GROUNDWATER QUALITY

6.5.1 Construction and Decommissioning

Generally, impacts to groundwater resources, including GDEs, are not expected given the groundwater table would not be intercepted during Project construction. Further, the anticipated depth to groundwater (i.e. at least 10 m BGL) within the Project Area means that any hydrocarbon/chemical spills are unlikely to infiltrate to the groundwater table, noting that appropriate spill management measures would be implemented during all phases of the Project.

6.5.2 Operation

There is limited scope and no conceivable mechanism for the Project to alter groundwater behaviour. Project operation and maintenance is not anticipated to intersect the regional water table. Footing excavations are also unlikely to have an impact on groundwater level drawdown. Should interception of localised perched groundwater occur during construction, groundwater is expected to recover by the time the Project reaches its operational phase. As such, no impacts to groundwater resources, registered bores or GDEs are expected during the operational phase of the Project.

6.6 RELATED DEVELOPMENT AND CUMULATIVE IMPACT

Related development, as outlined in the NSW Government State Significant Development Guidelines, refers to any existing or approved development that would be incorporated into, or operated in conjunction with the Project. Related development can also include development by a Proponent that is required for a Project; but is subject to a separate development approval process. At this stage the following related developments are:

- Narrabri Stage 3 Coal Mine (Approved as SSD-10269) and incorporating existing/previously approved operations, which is owned by Whitehaven, the owner of the Project.

The Narrabri Stage 3 project mining area will cross Kurrajong Creek (but not Kurrajong Creek Tributary 2). Given that the changed flow regime in Kurrajong Creek due to the Narrabri Stage 3 project was predicted to be negligible (WRM, 2020) and there are no changes predicted for this project, the cumulative impact of both projects on Kurrajong Creek is expected to be insignificant.

Further, these projects have either been approved or will require an approval through *State Significant Development* as defined under *State Environmental Planning Policy 2021* and will require development consent under Part 4 of the EP&A Act. Therefore, any cumulative impacts in receiving water quality are expected to be negligible.

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

7 MANAGEMENT AND MITIGATION MEASURES

Table 7.1 lists the principal management measures required to manage the potential surface water impacts that are considered likely for the Project. The primary objective is ensuring downstream waterways are protected during construction and operation of the Project. The proposed erosion and sediment controls, as part of the broader management measures and strategies, are necessary to achieve this objective.

For the construction phase of the Project, measures are to be captured in the CEMP. This would include the preparation of sub-plans relating to construction soil water management and erosion and sediment control.

For the operational phase of the Project, the measures outlined are to be documented in the Operational Environmental Management Plan (OEMP). This document would be developed for the Project's operational phase. The OEMP would address potentially adverse impacts on the receiving environment surface water quality and flooding during the operational phase, and would outline the flood hazards, evacuation and warning procedures to ensure the safety of all onsite.

Table 7.1 Management and Mitigation Measures relating to Water Resources

Potential Risk	Proposed Management and Mitigation Measure	Owner
6.1 Soil and water quality	Maintaining the natural state of the drainage flow paths whenever possible. Internal access roads, where crossing watercourses, would be designed for 10% AEP design flow and may include compacted rock causeways to provide low maintenance access with limited impact on the waterway or culvert structures.	Detailed design & Construction
6.1 Soil and water quality	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 <i>Guidelines for controlled activities on waterfront land – riparian corridors, Guidelines for watercourse crossings on waterfront land and Guidelines for laying pipes and cables in watercourses on waterfront land</i> .	Detailed design & Construction
6.1 Soil and water quality	Construction soil water management measures would be prepared to manage soil and water impacts associated with the construction and decommissioning works.	Prior to construction
6.1 Soil and water quality	Creation of catch/diversion drains and sediment fences at the downstream boundary of construction activities where practicable to support containment of sediment-laden runoff.	Prior to construction
6.1 Soil and water quality	Erosion and sediment control measures would be implemented and maintained at all work sites in accordance with the principles and requirements in <i>Managing Urban Stormwater – Soils and Construction, Volume 1 and Volume 2D</i> of Blue Book.	Prior to construction
6.1 Soil and water quality	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 measures for all progressive stages of construction.	Prior to construction

Potential Risk	Proposed Management and Mitigation Measure	Owner
6.1 Soil and water quality	Foundations for the 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 should be designed to provide a minimum of 300 mm freeboard for the lowest edge above the maximum 1% AEP flood level.	Prior to construction & Detail design
6.1 Soil and water quality	The best practice principles for stormwater and sediment control outlined in the <i>Managing Urban Stormwater</i> Blue Book guidelines would be incorporated into the design, construction and operation phases as part of a CEMP and OEMP prepared for the Project.	Construction & Operation
6.1 Soil and water quality	BESS components would be located on hardstand areas and would 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.	Operation
6.1 Soil and water quality	Inspection and monitoring requirements including receiving water quality monitoring.	Operation
6.1 Soil and water quality	Maintenance of stormwater infrastructure including any stormwater treatment devices (e.g. bioretention basins and culverts (e.g. clearing debris).	Operation
6.1 Soil and water quality	Maintenance of suitable ground cover and grassed table drains near access tracks to minimise the potential for erosion and export of sediment.	Operation
6.2 Flooding	Operations staff would have access to the following facilities for early severe weather warnings:	Operation
6.2 Flooding	Evacuation routes would be designed during the detailed design phase and would take into account zones of flood hazard.	Detailed design
6.2 Flooding	Foundations for the solar farm and transmission lines would be located away from areas that exceed both flood depths of 0.3 m and flow velocities greater than 1.5 m/s in the 1% AEP scenario. Detailed design of the Project would consider the results of the flood models, in particular the 1% AEP scenario.	Detailed design
6.3 Stream stability, riparian health and fish passage	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 Project Area, raising these small fill pads is highly unlikely to result in any adverse impacts offsite.	Detailed design
6.3 Stream stability, riparian health and fish passage	No sensitive infrastructure (e.g., substation, BESS) would be placed within 20 m of any Strahler 3 or above order streams. Sensitive infrastructure would be placed outside the 0.2% AEP flood extent.	Detailed design
6.3 Stream stability, riparian health	Controls for receiving waterways which may include designation of 'no go' zones for construction plant and equipment.	Prior to construction
6.4 Water supply	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

8 CONCLUSION

This Water Resources Impact Assessment has considered the potential impacts and appropriate measures to mitigate any potential impacts on water resources associated with the Project.

The Project would have minimal impact on water resources as it involves limited ground disturbance, does not store or handle large volumes of pollutants, and once constructed does not consume significant quantities of water.

For these reasons, the key potential risks to surface water are only associated with the Project's construction. These risks can be adequately managed through the application of well established construction environmental management practices and appropriate design.

Key issues relevant to the water resources impacts of the Project are summarised below:

- Impacts to surface water resources occur during the construction. These potential impacts can be mitigated to represent negligible risk as detailed in Section 7.
- Operational phase of the Project presents minimal risk provided that by the conclusion of the construction phase appropriate groundcover and drainage is established.
- The Project would not interact with the groundwater table and therefore, no impacts to groundwater resources or GDEs are expected.
- The Project Area does not contain any areas of major flood hazard.
- The large extent of the Project Area and distributed nature of minor impacts (if any) does not pose a risk to drainage features, downstream watercourses or receiving waters.

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DPE-Water, 2022b	<i>Guidelines for instream works on waterfront land</i>
DPE-Water, 2022c	<i>Guidelines for vegetation management plans on waterfront land</i>
DPE-Water, 2022d	<i>Guidelines for watercourse crossings on waterfront land</i>
DPE-Water, 2022e	<i>Controlled Activities on Waterfront Land: Controlled activity exemptions on waterfront land</i>
DPI, 2003	<i>Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings</i>
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APPENDIX A SEARS AGENCY ADVICE TABLE

Table A.1 SEARs Agency Advice Table

SEARS Advice- F&R	Nothing related to water
Agency Advice – Council (Water)	Location
A detailed Assessment report on both Groundwater and Surface water should be prepared including: i) Impacts of the development (including flooding and flood modelling) on surrounding watercourses, groundwater resources and surface water movements should be assessed, and measures proposed to monitor, reduce and mitigate these impacts. ii) Detailed information on site water balance for the project as well as the water supply requirements for the life of the project (both construction and operation phases). Note: Suitable Water sources for the project should not be reliant on Council. iii) Detailed information on erosion and sediment control measures proposed to mitigate potential increased stormwater impacts (will stormwater be directed to Kurrajong Creek or Kurrajong Creek Road easement?).	
SEARs Advice -TfNSW	-Nothing related to water.
Sears advice – MEG	-Nothing related to water
SEARs Key Issues: Biodiversity, Conservation and Science Recommendations - Water and Soils	Location
7. The EIS must map the following features relevant to water and soils including: a. Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map) b. Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method) c. Wetlands as described in s4.2 of the Biodiversity Assessment Method. d. Groundwater e. Groundwater dependent ecosystems f. Proposed intake and discharge locations	
9. The EIS must describe background conditions for any water resource likely to be affected by the development, including: a. Existing surface and groundwater b. Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations 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. d. Where locally derived indicators and guideline values are not available for the relevant Water Quality Objectives, the EIS must refer to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).	

SEARs Key Issues: Biodiversity, Conservation and Science Recommendations - Water and Soils	Location
---	-----------------

10. 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 development 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, using the Risk-based framework for considering waterway health outcomes in strategic land use planning decisions.
 - b. Identification of proposed monitoring of water quality or required changes to existing monitoring programs
-

11. EIS must assess the impact of the development on hydrology, including:
- a. Water balance including quantity, quality and source
 - b. Effects to downstream rivers, wetlands, estuaries, marine waters (including marine protected areas) and floodplain areas
 - c. Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems
 - 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)
 - e. Changes to environmental water availability, both regulated/licensed and unregulated/rulesbased sources of such water
 - 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
 - g. Identification of proposed monitoring of hydrological attributes
-

SEARs Key Issues: Biodiversity, Conservation and Science Recommendations - Water and Soils

Location

12. The EIS shall include a flood impact and risk assessment (FIRA). As a minimum the FIRA must:

- a. Consider the relevant provisions of the NSW Flood Risk Management Manual (2023) and associated guides, and existing council and government studies, information and requirements.
- b. Identify and describe existing flood behaviour on the site and its surrounding areas for the full range of events, including 5% AEP, 1% AEP, PMF and 0.5% AEP or 0.2% AEP and provide an assessment of the compatibility of the development and its users with flood behaviour. This may require flood modelling where existing flood information is not available.
- c. Determine and describe changes in post development flood behaviour, impacts of flooding on existing community and on the development and its future community for full range of events, 5% AEP, 1% AEP, PMF and 0.5% AEP or 0.2% AEP. This will typically require flood modelling.
- d. Consider impacts of climate change due to both sea level rise and increase in rainfall intensities considering relevant Council and government advice. The 0.5% AEP or 0.2% AEP events can be used to provide an understanding of the scale of change of flood behaviour relative to the 1% AEP event.
- e. Propose and assess the effectiveness of management measures required to minimise the impacts and risks of flooding to the development and its users and existing community.

Note:

- The scope of a FIRA is intended to be consistent with the Draft EHG FIRA Guide, which is being finalised currently.
 - The FIRA will need to be tailored to suit the project being considered, whilst maintaining consistency with the FIRA guide.
-

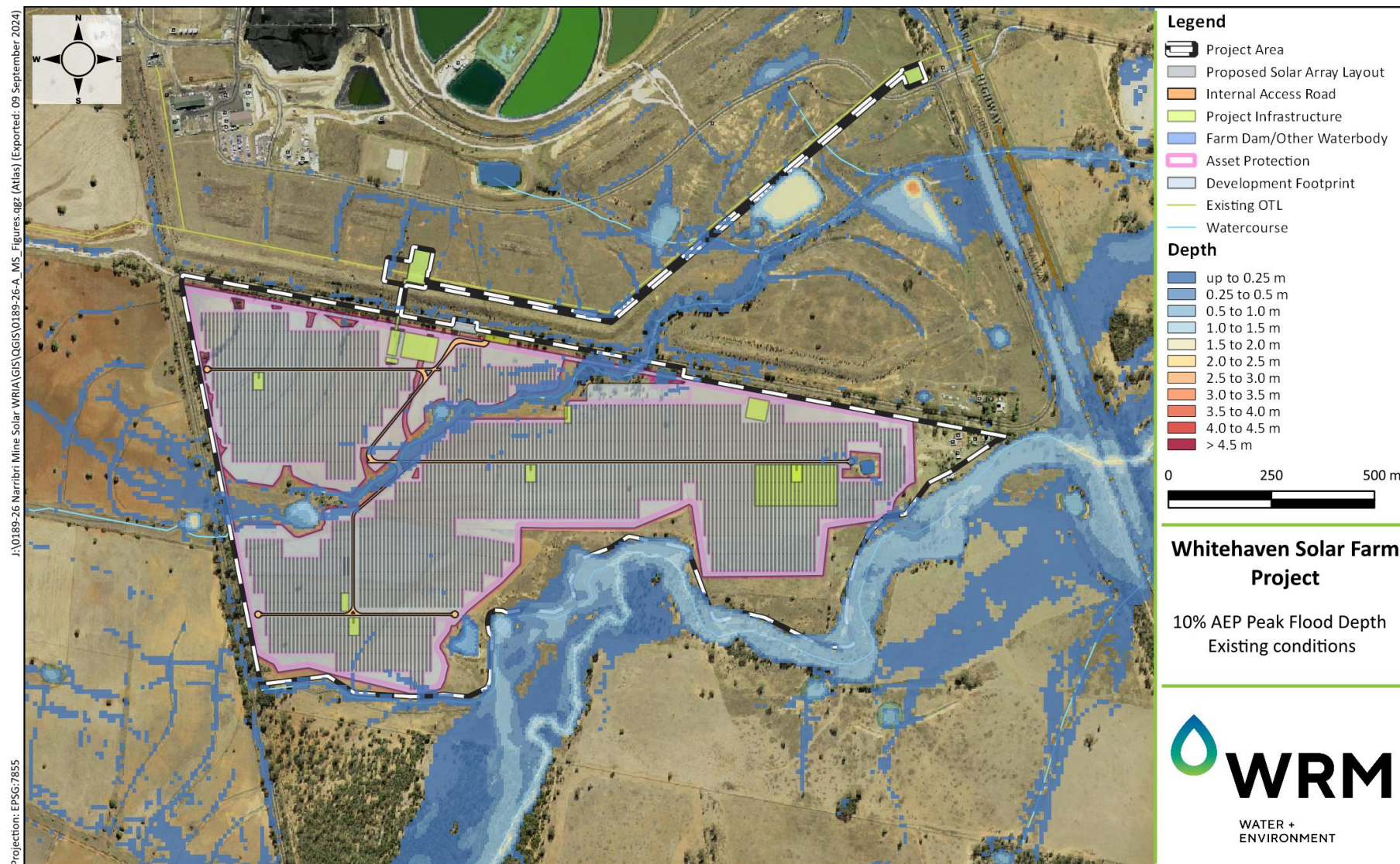
SEARs Advice – Crown Lands	-Not applicable to water.
SEARs Advice – DPI Agriculture	-Not applicable to water.
SEARs Advice – Heritage NSW	-Not applicable to water.
SEARs Advice – DPI Fisheries	-Not applicable to water.

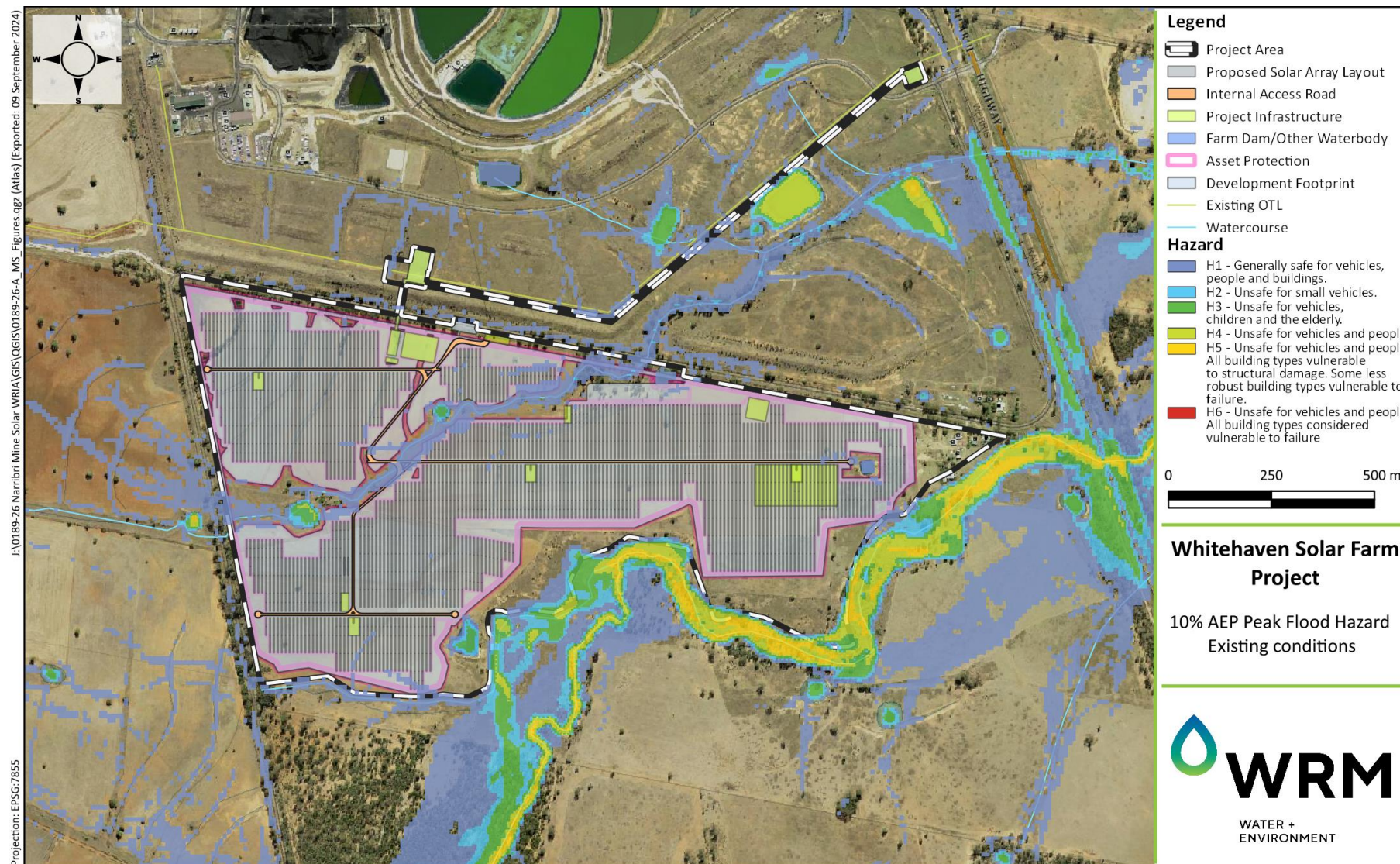
Sears Advice: DPI Fisheries – Waterway Crossings
Location

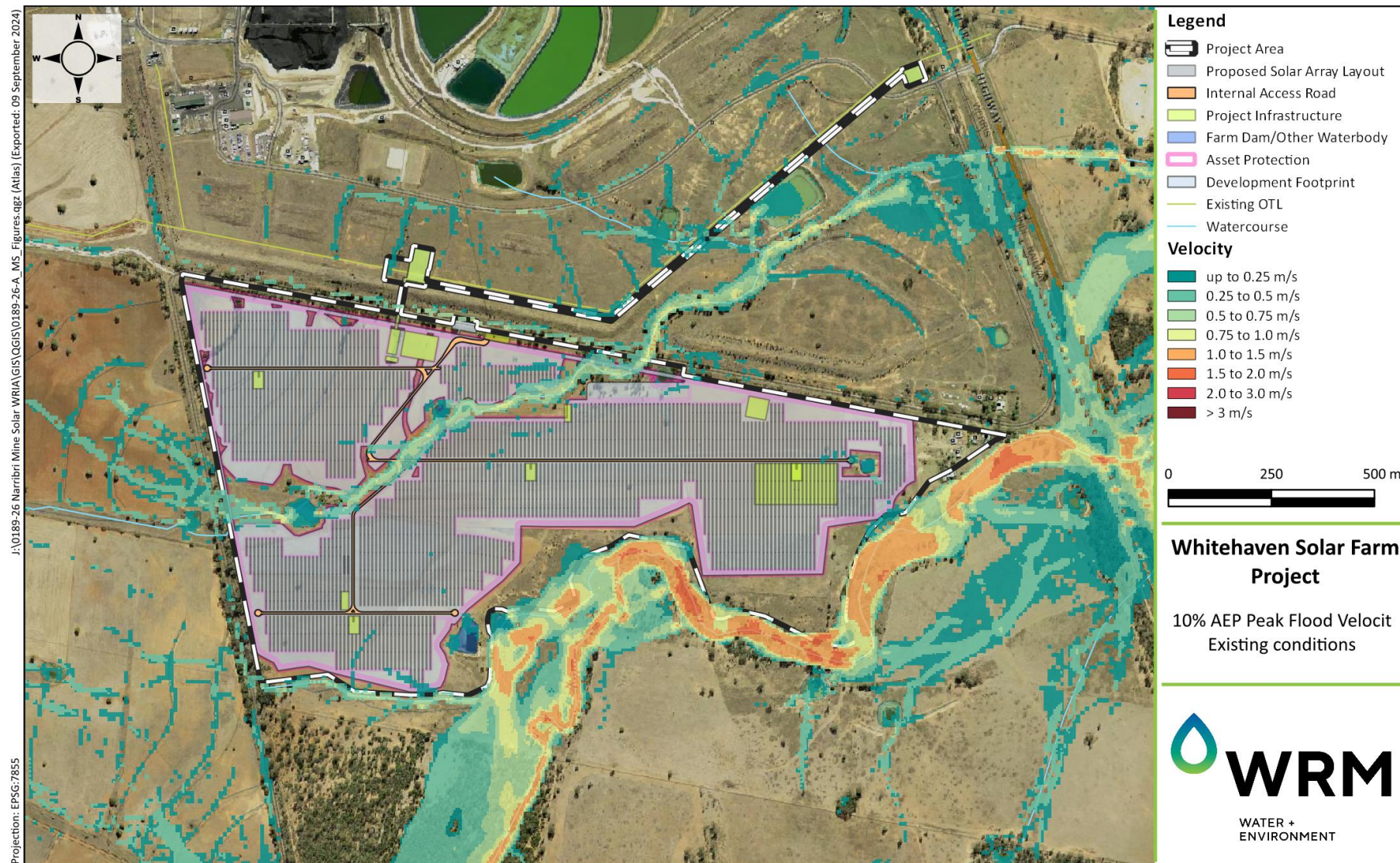
The construction of permanent or temporary access tracks or underground cables through Key Fish Habitat should be in accordance with DPI Fisheries Guideline document: Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013), and the Policy and Guidelines for Fish Friendly Waterway Crossings (DPI 2003). This is to ensure that the works are designed and constructed in accordance with best management practice and with minimal impact on the aquatic environment and fish passage requirements.

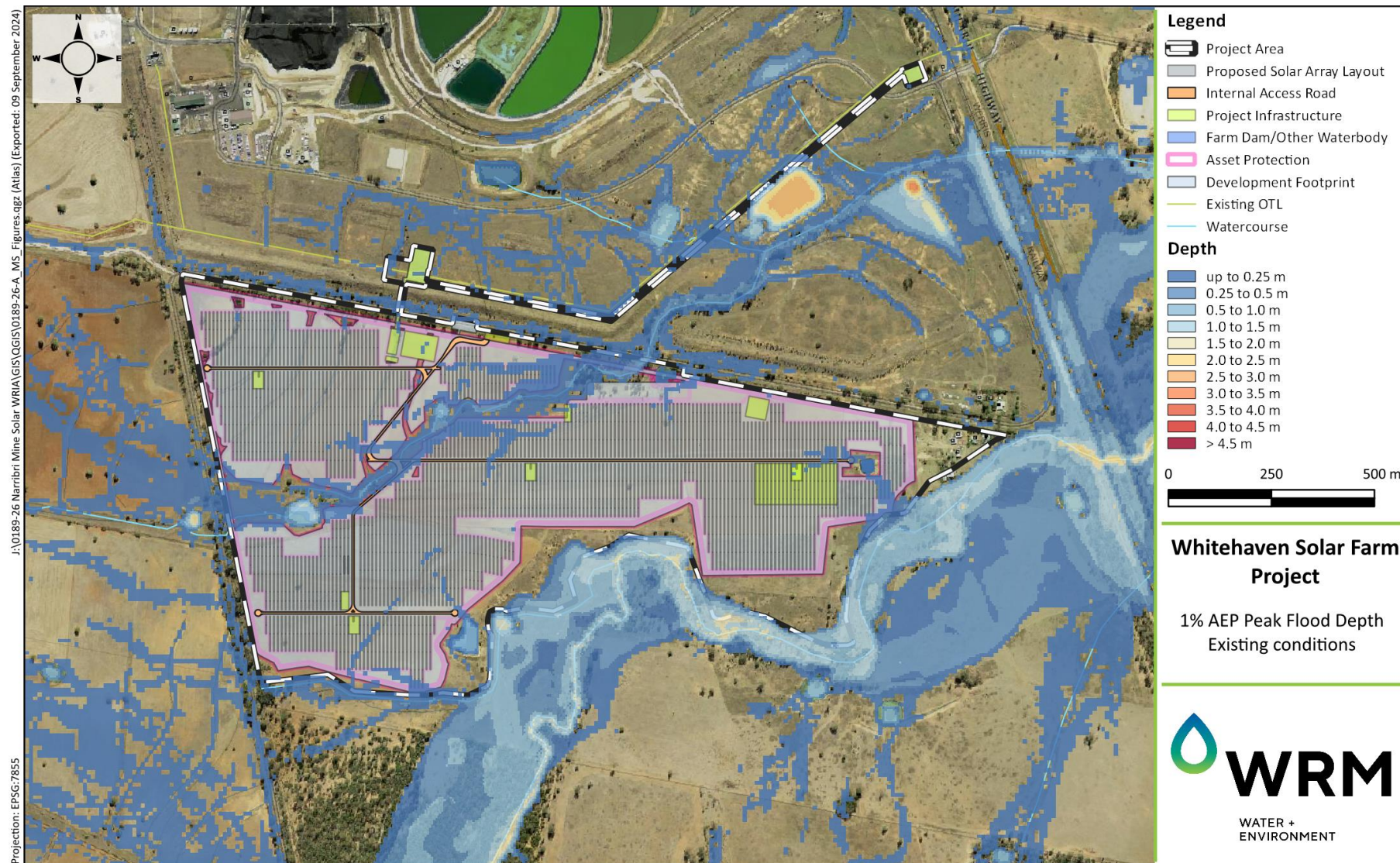


APPENDIX B FLOOD MAPS

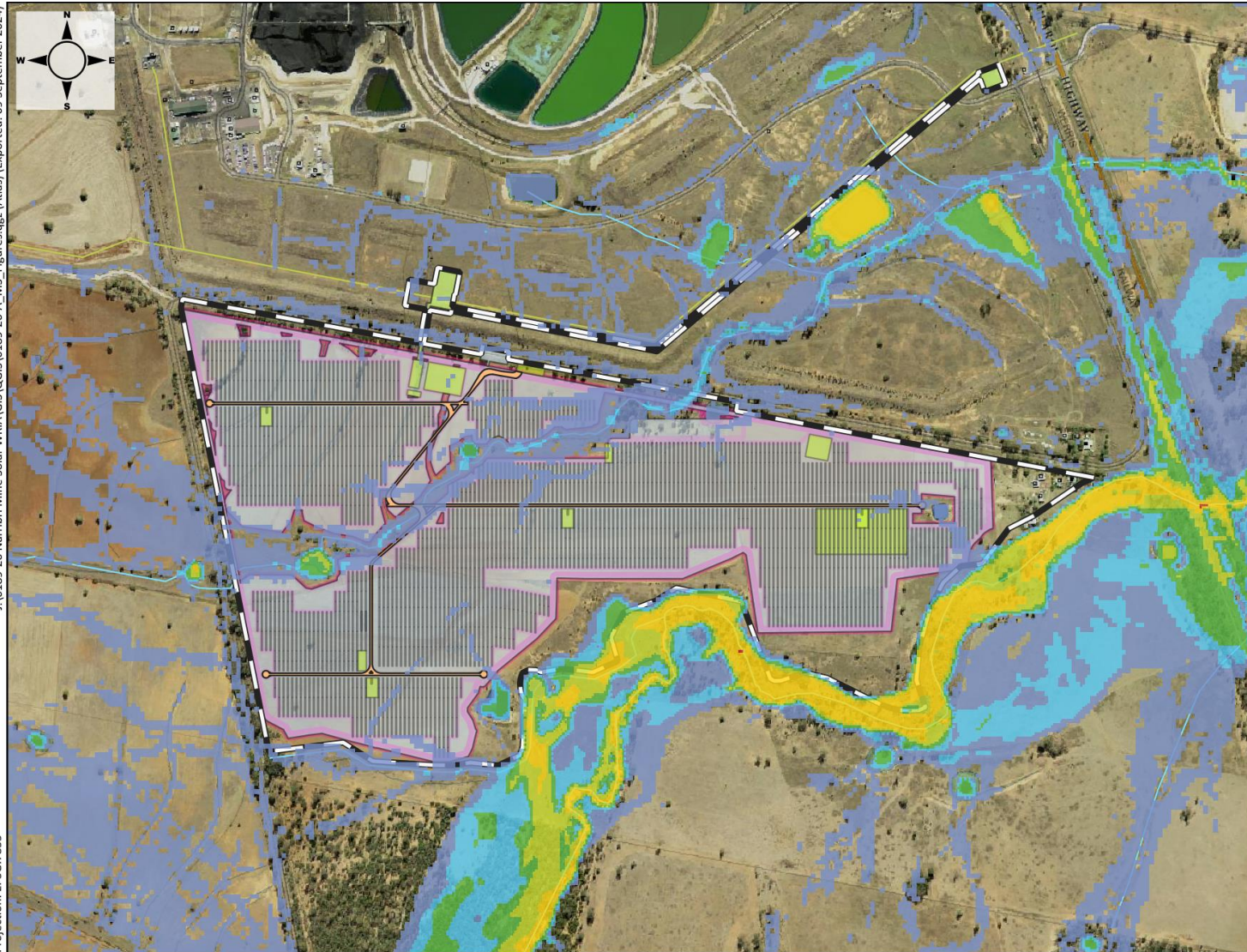








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 Projection: EPSG:7855



Legend

-  Project Area
-  Proposed Solar Array Layout
-  Internal Access Road
-  Project Infrastructure
-  Farm Dam/Other Waterbody
-  Asset Protection
-  Development Footprint
-  Existing OTL
-  Watercourse

Hazard

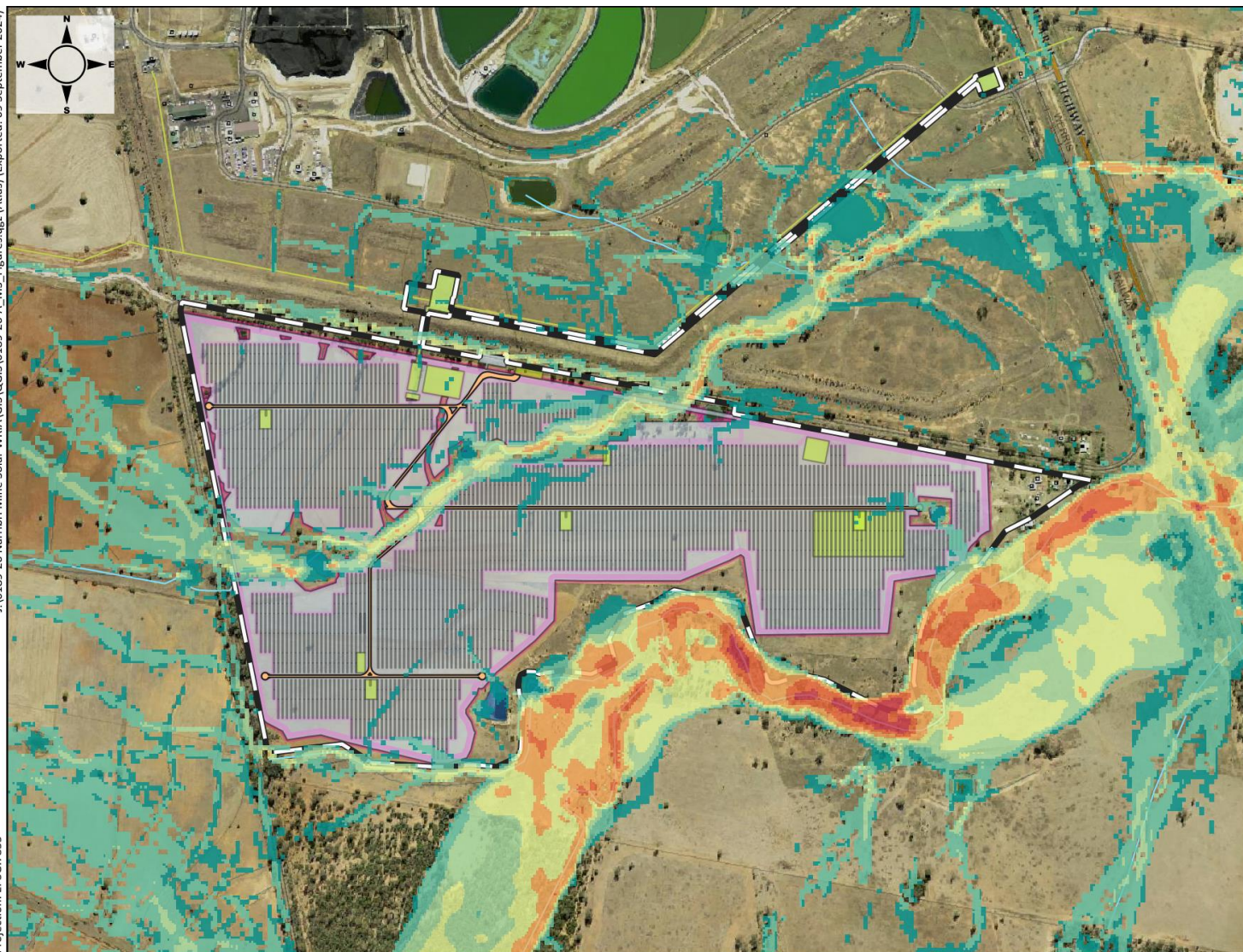
-  H1 - Generally safe for vehicles, people and buildings.
-  H2 - Unsafe for small vehicles.
-  H3 - Unsafe for vehicles, children and the elderly.
-  H4 - Unsafe for vehicles and people.
-  H5 - Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure.
-  H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.

0 250 500 m

Whitehaven Solar Farm Project

1% AEP Peak Flood Hazard
 Existing conditions

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 Projection: EPSG:7855



Legend

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-  Farm Dam/Other Waterbody
-  Asset Protection
-  Development Footprint
-  Existing OTL
-  Watercourse

Velocity

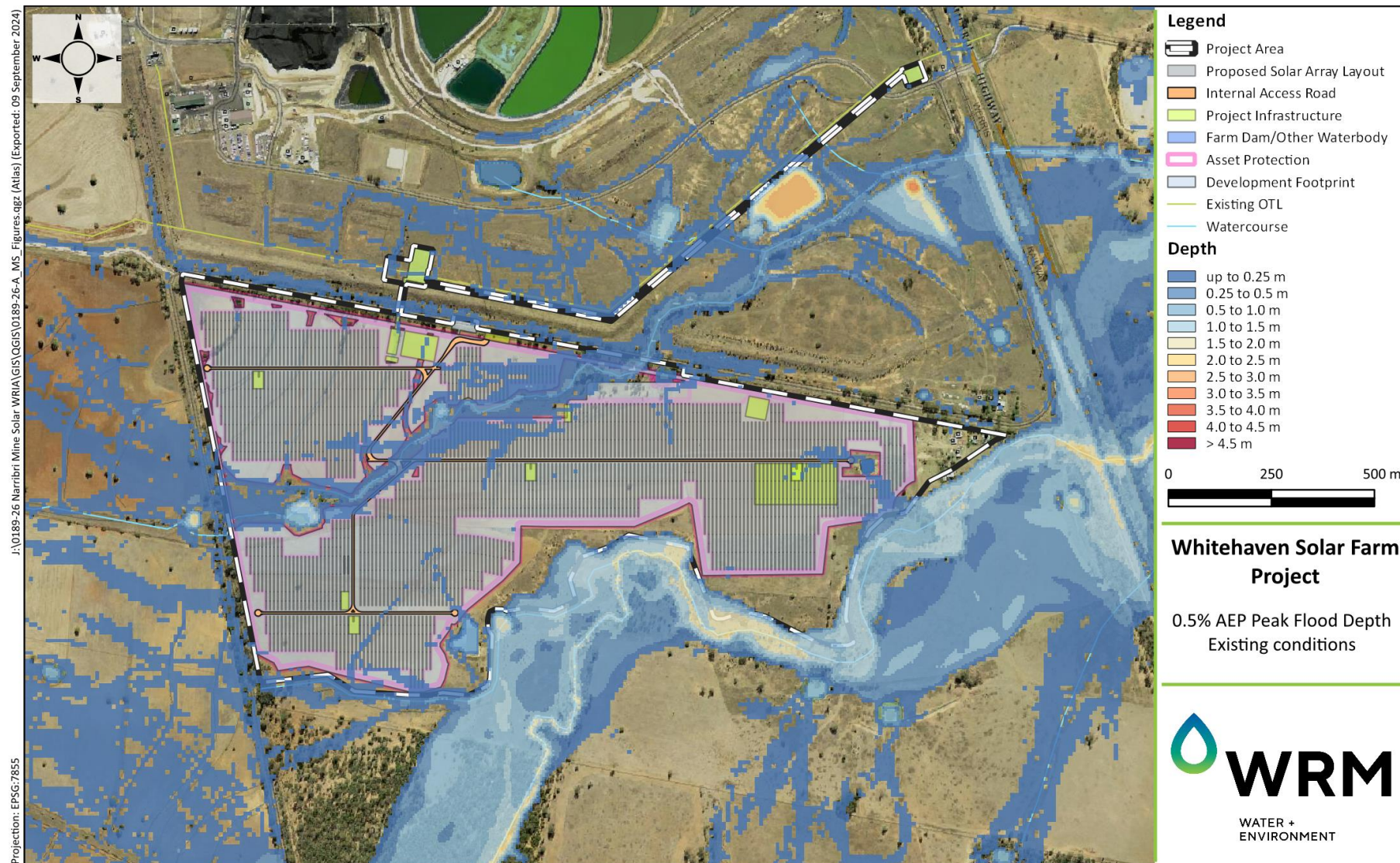
-  up to 0.25 m/s
-  0.25 to 0.5 m/s
-  0.5 to 0.75 m/s
-  0.75 to 1.0 m/s
-  1.0 to 1.5 m/s
-  1.5 to 2.0 m/s
-  2.0 to 3.0 m/s
-  > 3 m/s

0 250 500 m

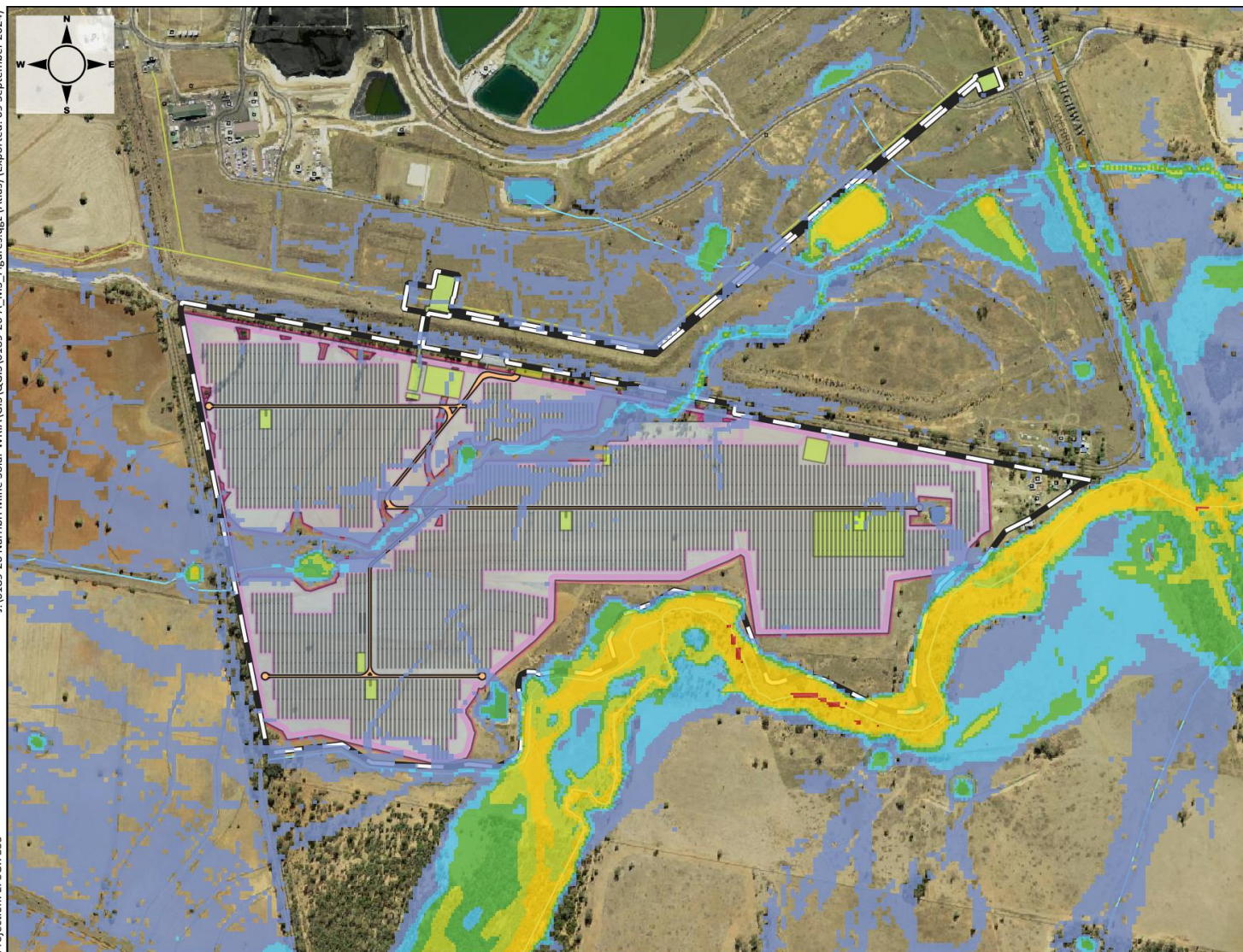


Whitehaven Solar Farm Project

1% AEP Peak Flood Velocity
Existing conditions



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 Projection: EPSG:7855



Legend

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-  Asset Protection
-  Development Footprint
-  Existing OTL
-  Watercourse

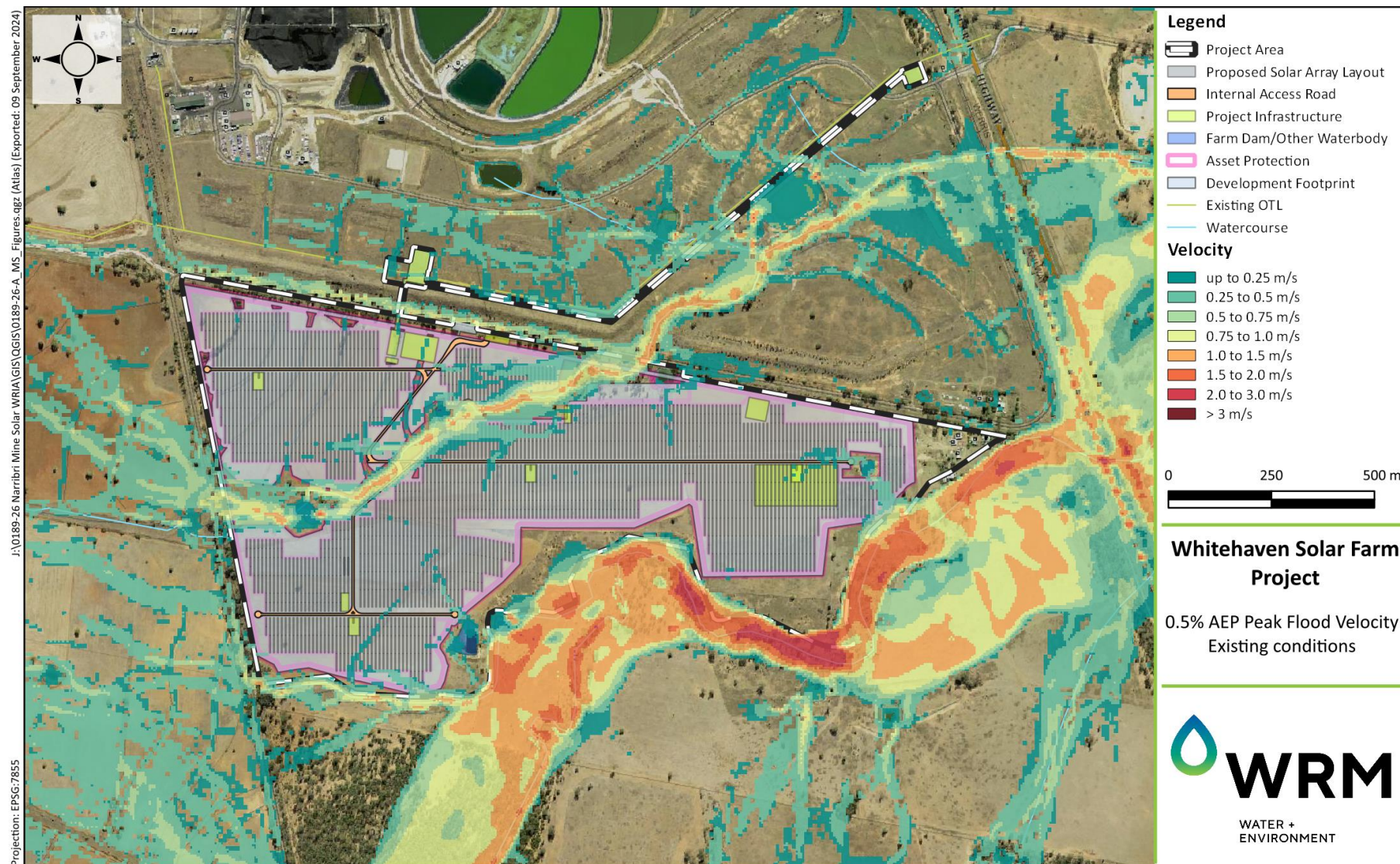
Hazard

-  H1 - Generally safe for vehicles, people and buildings.
-  H2 - Unsafe for small vehicles.
-  H3 - Unsafe for vehicles, children and the elderly.
-  H4 - Unsafe for vehicles and people.
-  H5 - Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure.
-  H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.

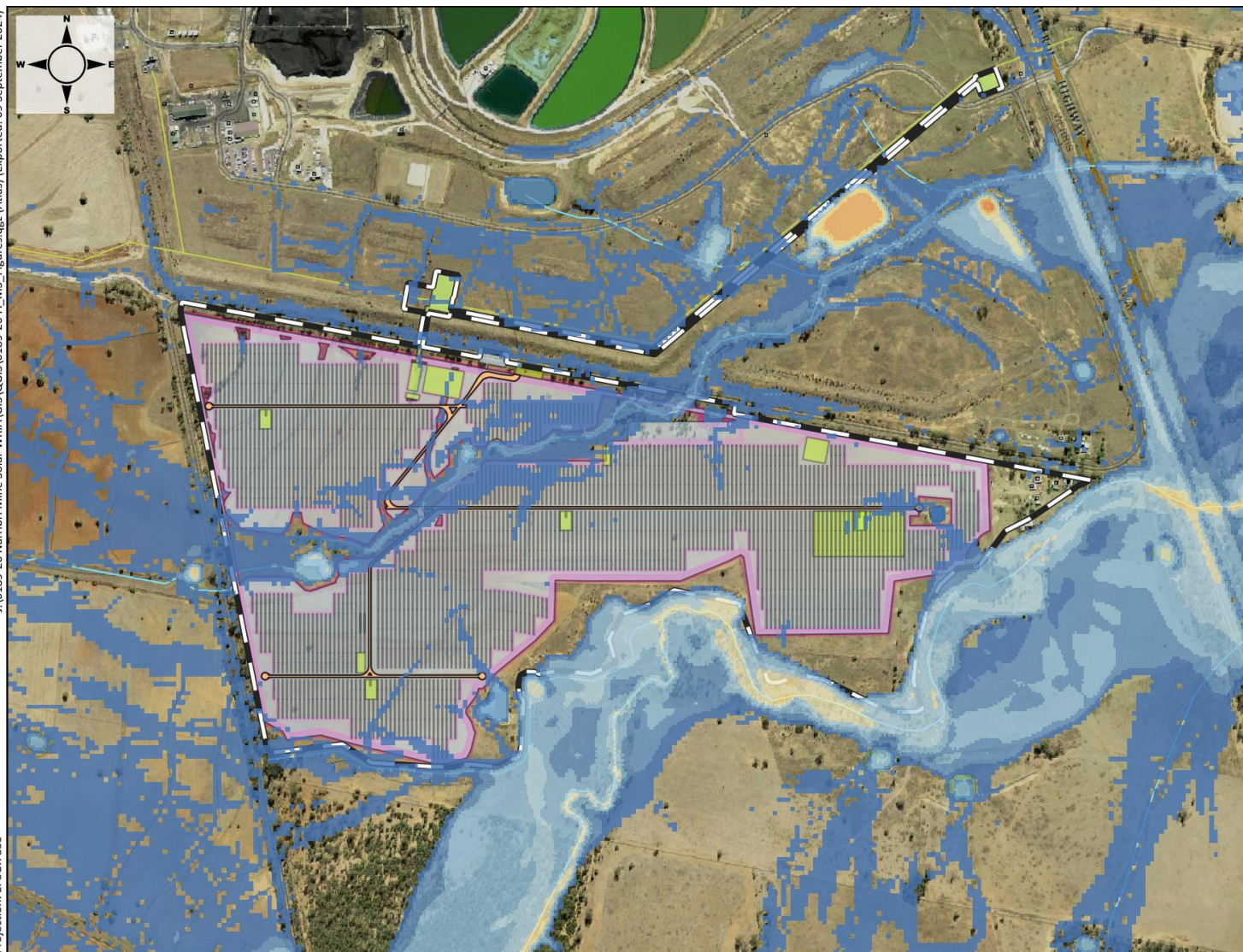
0 250 500 m

Whitehaven Solar Farm Project

0.5% AEP Peak Flood Hazard
Existing conditions



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 Projection: EPSG:7855



Legend

-  Project Area
-  Proposed Solar Array Layout
-  Internal Access Road
-  Project Infrastructure
-  Farm Dam/Other Waterbody
-  Asset Protection
-  Development Footprint
-  Existing OTL
-  Watercourse

Depth

-  up to 0.25 m
-  0.25 to 0.5 m
-  0.5 to 1.0 m
-  1.0 to 1.5 m
-  1.5 to 2.0 m
-  2.0 to 2.5 m
-  2.5 to 3.0 m
-  3.0 to 3.5 m
-  3.5 to 4.0 m
-  4.0 to 4.5 m
-  > 4.5 m

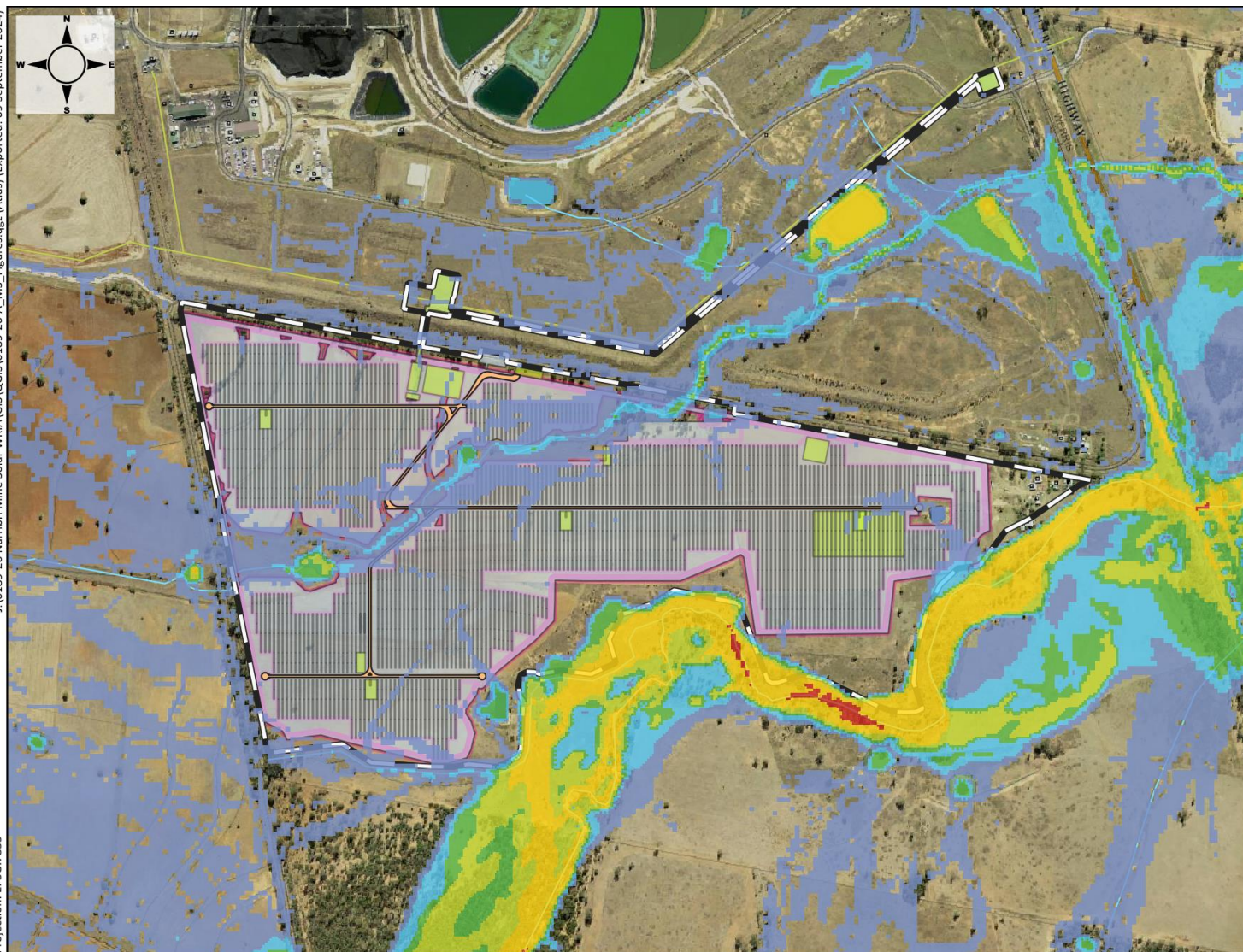
0 250 500 m



Whitehaven Solar Farm Project

0.2% AEP Peak Flood Depth
Existing conditions

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 Projection: EPSG:7855



Legend

-  Project Area
-  Proposed Solar Array Layout
-  Internal Access Road
-  Project Infrastructure
-  Farm Dam/Other Waterbody
-  Asset Protection
-  Development Footprint
-  Existing OTL
-  Watercourse

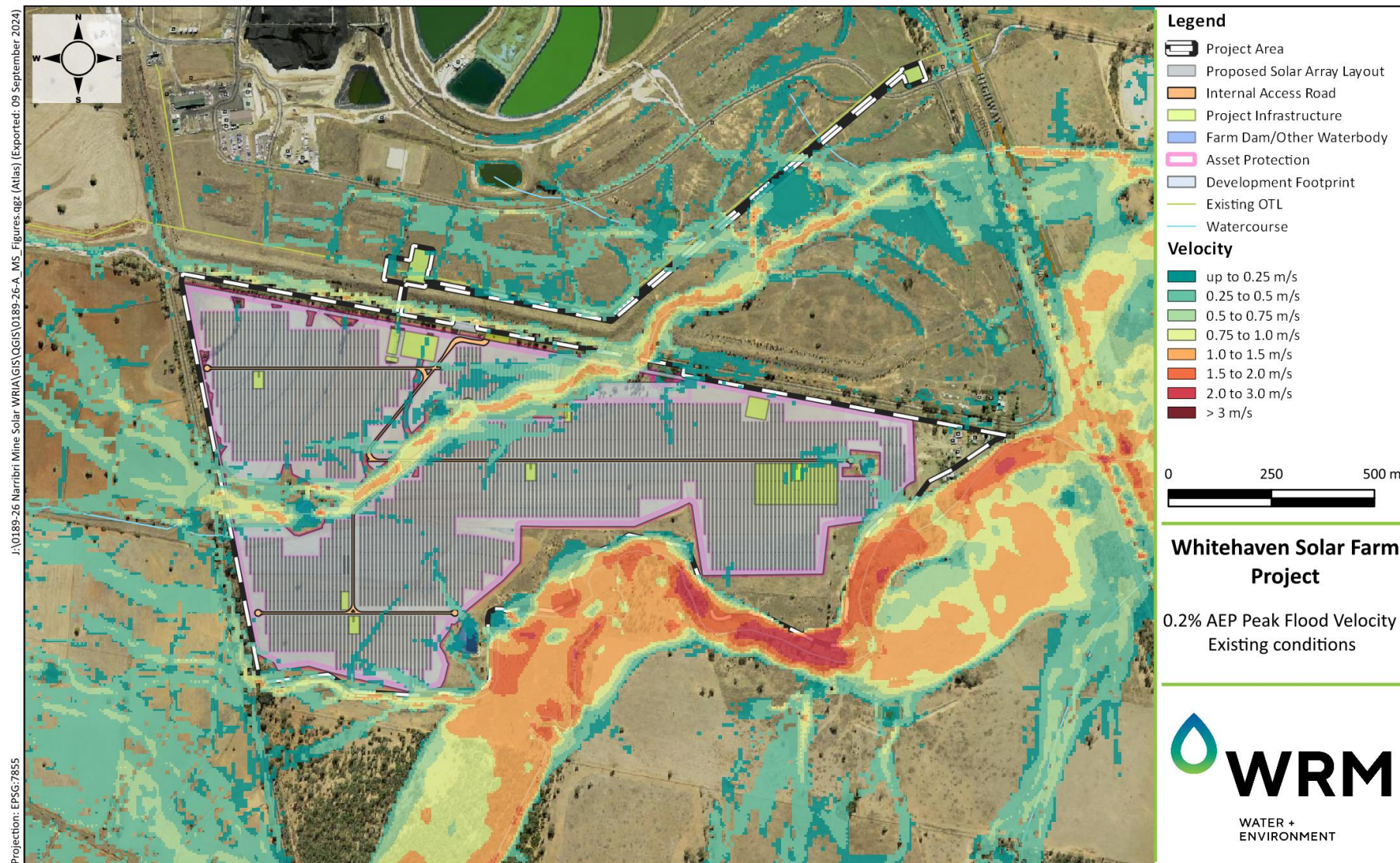
Hazard

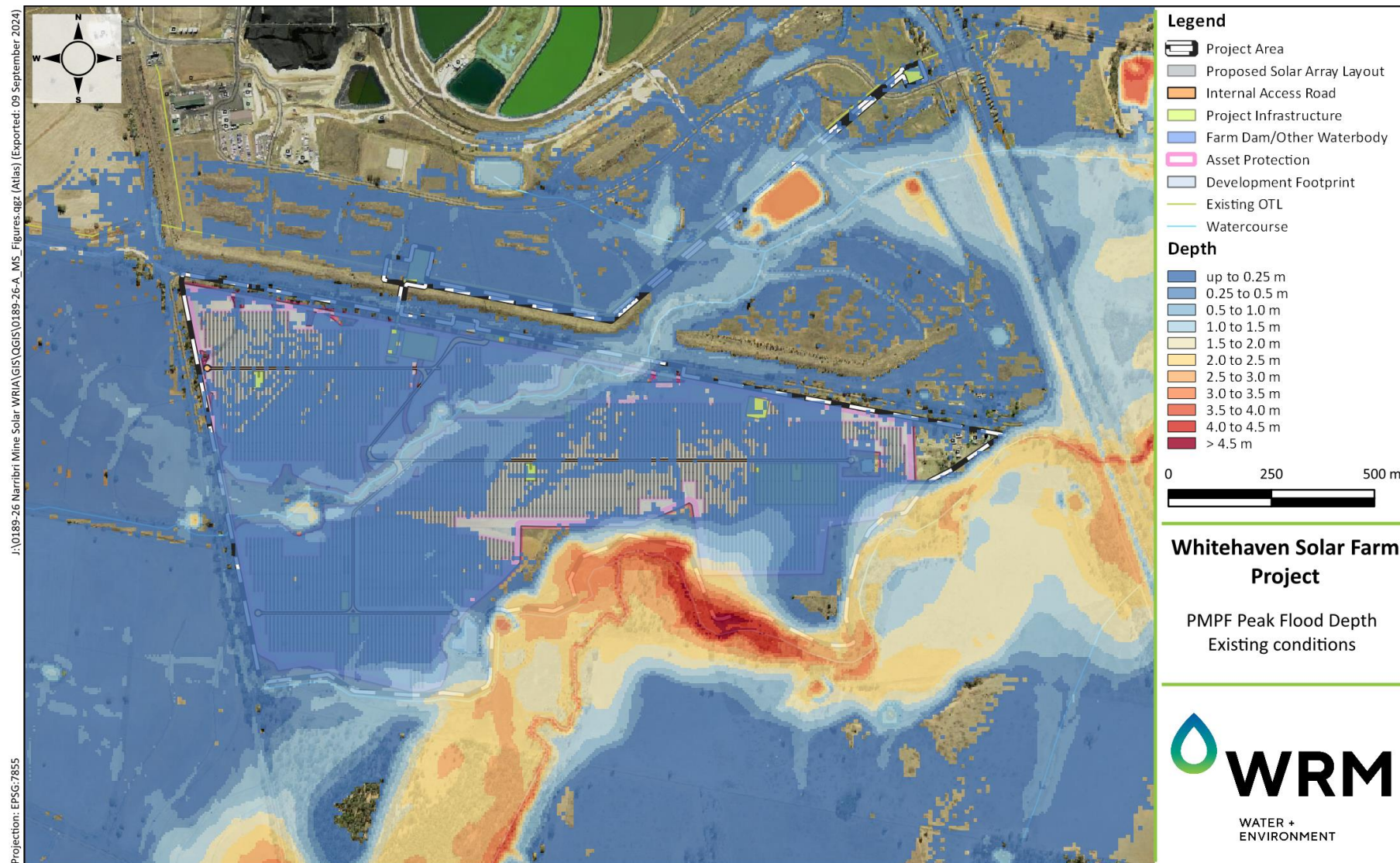
-  H1 - Generally safe for vehicles, people and buildings.
-  H2 - Unsafe for small vehicles.
-  H3 - Unsafe for vehicles, children and the elderly.
-  H4 - Unsafe for vehicles and people.
-  H5 - Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure.
-  H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.

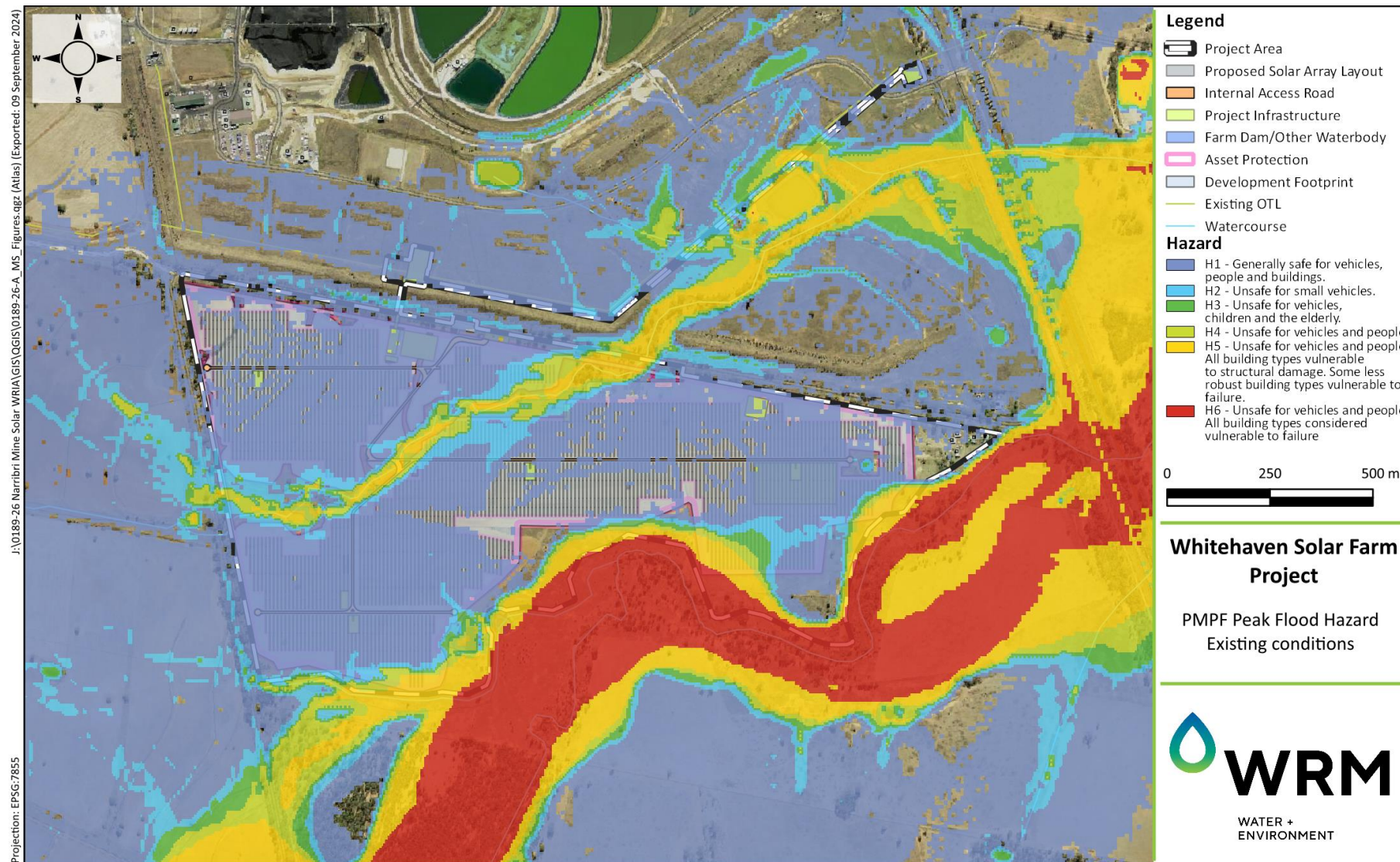
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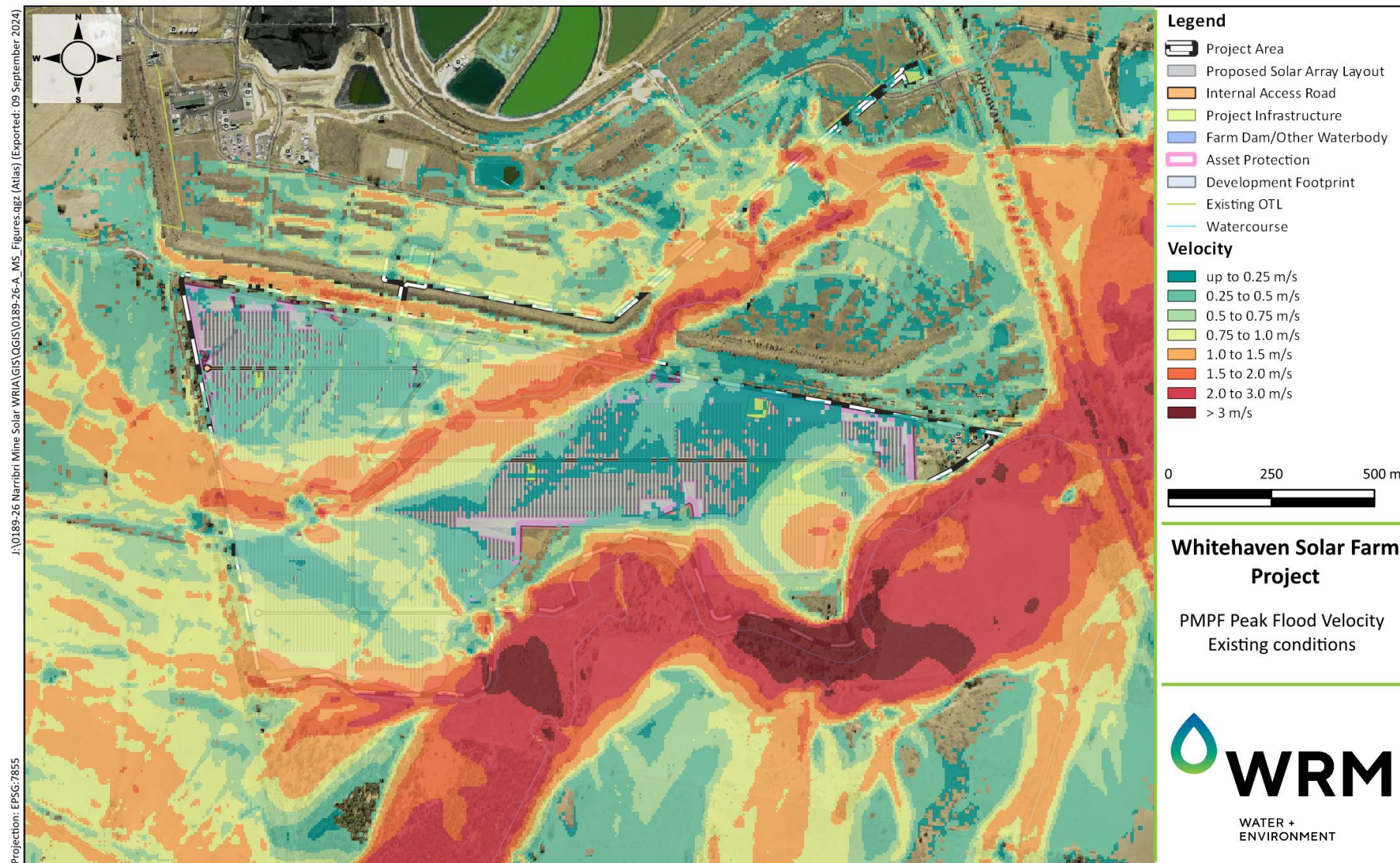
Whitehaven Solar Farm Project

0.2% AEP Peak Flood Hazard
Existing conditions









APPENDIX C PROJECT AREA RUSLE DATA



Figure C.1 RUSLE R-factor map

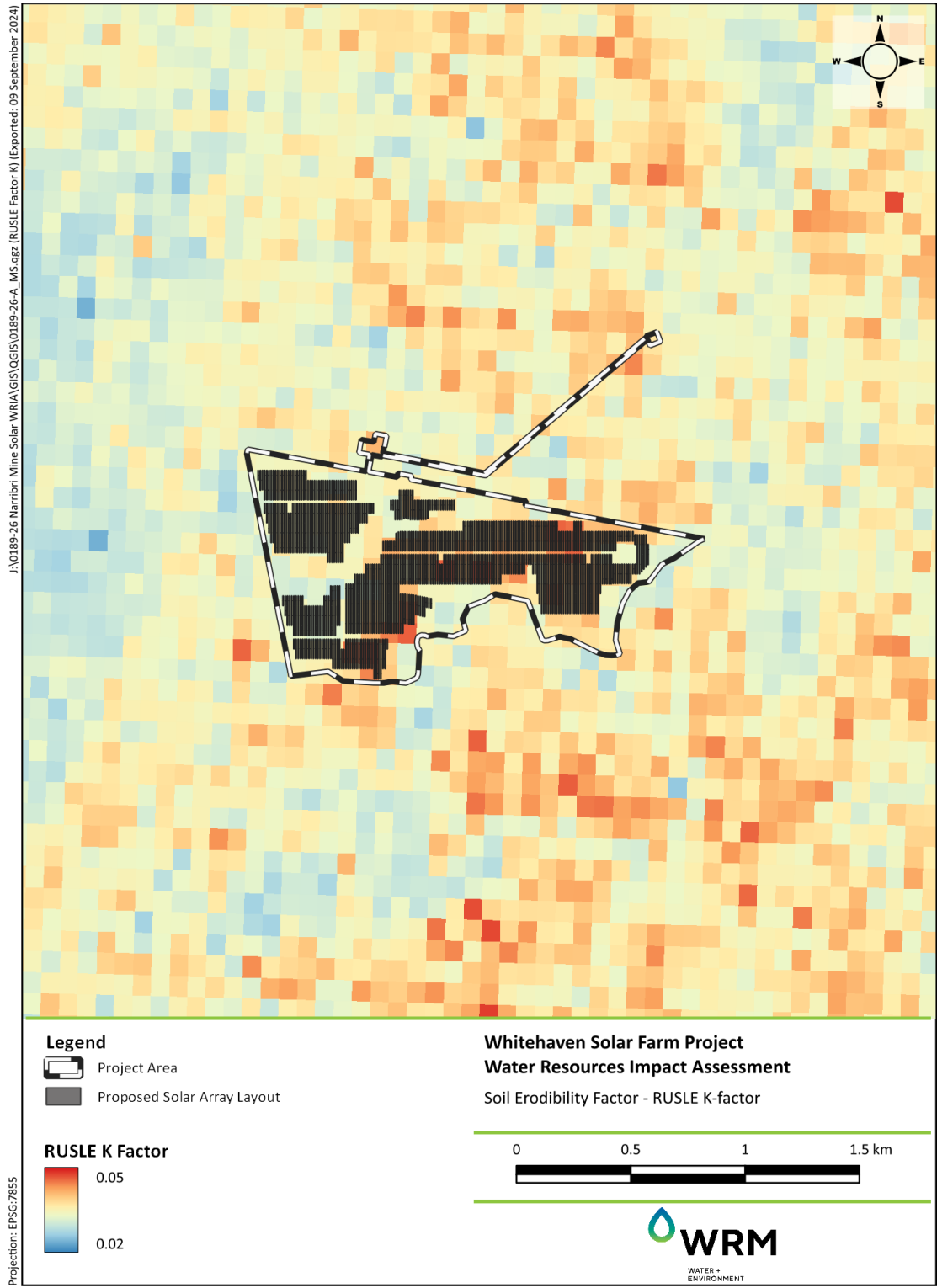


Figure C.2 RUSLE K-factor map

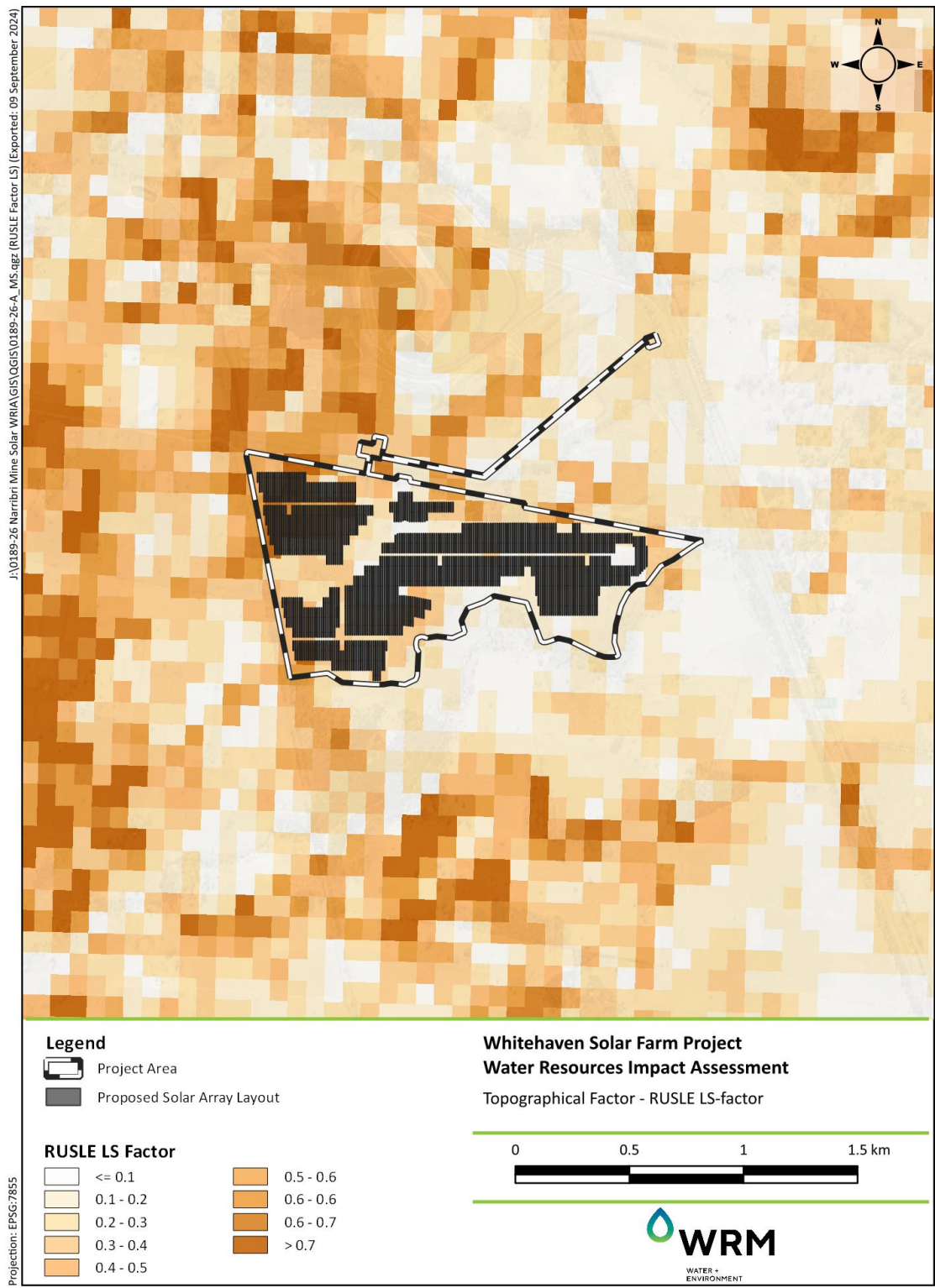


Figure C.3 RUSLE LS-factor map



Figure C.4 RUSLE C-factor map



Level 1, 369 Ann Street Brisbane
PO Box 10703 Brisbane Adelaide Street Qld 4000
07 3225 0200

Level 5, 93 Mitchell Street Darwin
GPO Box 43348 Casuarina NT 0811
08 8911 0060

wrm@wrmwater.com.au
wrmwater.com.au

ABN 96 107 404 544