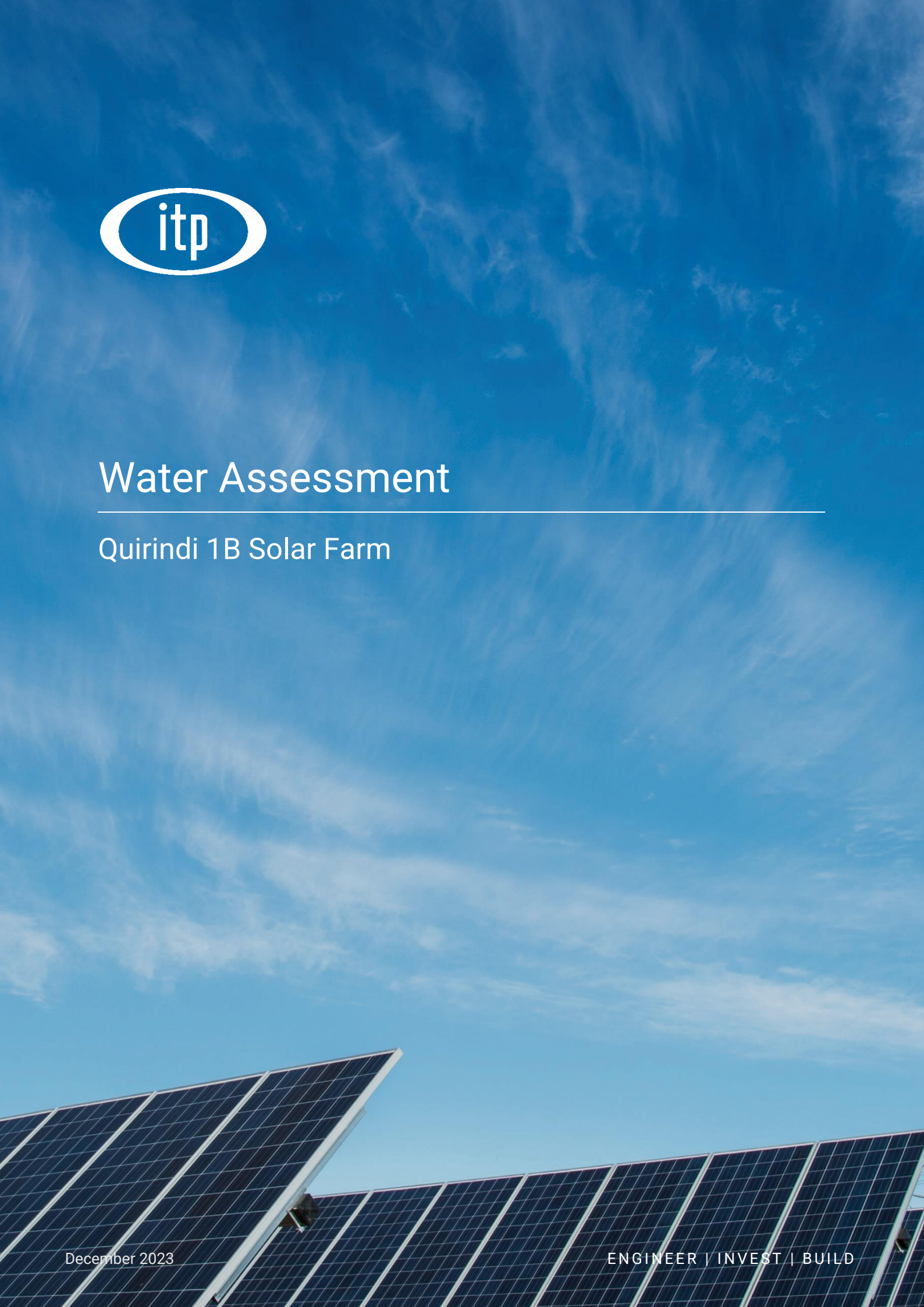
Water Assessment

Quirindi 1B Solar Farm



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ENGINEER | INVEST | BUILD

DOCUMENT CONTROL

Report Title		Water Assessment – Quirindi 1B Solar Farm			
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ABOUT ITP DEVELOPMENT

ITP Development Pty Ltd (ITPD) is a developer of town-scale solar farms in regional Australia, typically in the 5MW to 20MW range. We undertake solar farm landholder engagement, system design, planning approvals, financing, electrical connection approvals and commissioning. ITPD maintains relationships with multiple stakeholders to ensure projects are successfully delivered in accordance with their expectations.

We are part of the international ITPEnergised Group, one of the world's largest, most experienced and respected specialist engineering consultancies focussing on renewable energy, energy efficiency, and carbon markets. The Group has undertaken over 2,000 contracts in energy projects encompassing over 150 countries since it was formed in 1981.

ABBREVIATIONS

AC	Alternating Current
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARI	Average Recurrence Interval
BESS	Battery Energy Storage System
BoM	(Australian) Bureau of Meteorology
DC	Direct Current
DCP	Development Control Plan
EPI	Environmental Planning Instrument
Ha	Hectare
ITPD	ITP Development
LEP	Local Environmental Plan
MW	Megawatt, unit of power (1 million Watts)
NDWI	Normalized Difference Water Index
NSW	New South Wales
PV	Photovoltaic
SES	State Emergency Service
SEPP (T&I)	State Environmental Planning Policy (Transport and Infrastructure) 2021

TABLES

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1 INTRODUCTION

1.1 Overview

This report, which provides a desktop water assessment to support the Development Application for the project, includes a:

- Desktop review of local hydrology and catchment and water quality data.
- Desktop review of surface and groundwater quality data.
- Desktop review of the flood risk potential against the Local Environmental Plan.
- Desktop impact assessment against NSW policies and referenced industry standards for solar arrays.
- Desktop management assessment with mitigation measures recommended for construction and operation.

1.2 Limitations of Assessment

The assessment is based on publicly available information and data and does not include a site inspection, sampling, or any additional hydrological and/or hydraulic modelling.

2 PROJECT DESCRIPTION

2.1 Solar Farm

ITP Development (ITPD) is proposing to develop a town-scale solar farm (referred to as Quirindi 1B), as described in the summary sheet in **Table 1** below. The site is located approximately 5.3 km north-east of Quirindi town centre within the Liverpool Plains local government area (see **Figure 1**).

Table 1 – Site Information

Parameter	Description
Site name	Quirindi 1B 5MW Solar Farm and BESS
Site reference	Quirindi 1B (QDI1B)
Lot/DP(s)	130 & 134 / DP751009
Street address	Borah Creek Road, Quirindi NSW 2343
Council	Liverpool Plains Shire Council
AC capacity	5.0 MW
Property area (total parcel)	141.75 ha
Development fenced area	11.09 ha
Current land use	Cropping

ITPD is proposing to construct a solar farm with an AC output of 5.0 MW on an approximately 11.09 ha site that has been used for cropping.

There are to be approximately 10,750 solar modules installed in 128 rows (each row being approximately 92 m long) running east to west. There is approximately 6.0 m spacing between each row. The height of each module is approximately 2.60 to 2.75 m and the mounting system is constructed on piles that are driven into the ground, typically within the depths of 1.5 m to 3 m. Each row of solar photovoltaic (PV) modules will rotate to track the sun across the sky from east to west each day.

The solar farm will also consist of an inverter station. The inverter station incorporates the high/medium voltage switchgear and transformers and two 3.4 MW inverters. The inverter station is ground mounted and incorporated on a 12.19 m skid. Allowance is made for a 2.9-metre-high battery energy storage system (BESS), on a 12.1m skid, alongside the inverter stations.

During construction, there is expected to be up to 50 workers with only approximately 30 on site at any one time working from 7 am – 4 pm Monday to Friday; and up to 40 light vehicles with only approximately 24 accessing site at any one time. The construction is expected to take approximately 3 months. Once operational the site will be unmanned. Maintenance is expected to be carried out quarterly by a crew of 2 – 3 people.

Solar panels and related infrastructure will be decommissioned and removed upon cessation of operations. This is likely to occur within two years of the end of the project. The site can then be returned to the pre-development land use.

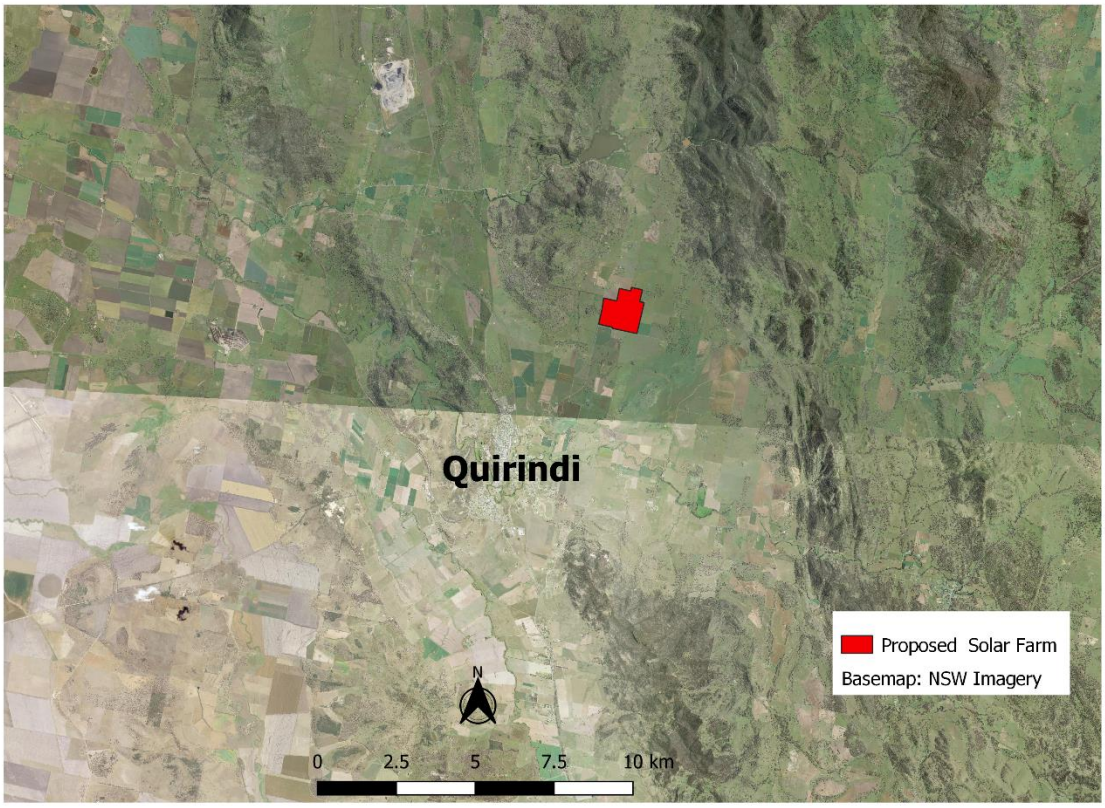

Figure 1 – Proposed solar farm site and surrounding area

2.2 Hydrology, climate and topographic conditions

The proposed site for the Quirindi Solar farm is within the Liverpool Plains Shire Council Area.

Quirindi in NSW (394m AHD) is located in the southeastern part of Namoi Water Resource Plan Area. Other towns in the broad vicinity include Tamworth (264m AHD) to the northeast, Gunnedah (264m AHD) to the north and Nundle (599m AHD) to the east. Within the town area of Quirindi, Quirindi Creek confluences with Jacob and Joseph Creek (GHD, 2011). The broader Namoi River catchment area occupies 4% of the Murray-Darling Basin. Major tributaries include the Macdonald, Manilla, Peel, Mooki and Cockburn rivers; Coxs, Baradine and Bohena creeks. The topography of the Namoi River catchment is characterised by mountainous ranges with cool temperatures and high rainfall areas in the east to low rainfall areas on extensive riverine plains to the west. The Keepit Dam is a major irrigation storage facility located upstream of Gunnedah with a capacity of 426 GL (MDBA, 2020a). Agriculture is the main land use in the region and is dominated by cattle and sheep grazing, along with wheat, cotton and other broadacre crops on the alluvial floodplains (MDBA 2010). These land use practices are dependent on the waterways of the catchment, especially for irrigation purposes (NSWDPI, 2006).

3 LEGISLATIVE CONTEXT

NSW has a comprehensive legislative and policy framework for the management of floodplain risk and flood prone areas of the state with clear areas of responsibility, as outlined below in **Figure 2**.

Figure 2 – Floodplain risk management and planning process

3.1 Local Government Act 1993

The Local Government Act provides the legal framework for the system of local governments of the state of NSW. Specific to this project is Section 733, which exempts councils from liability in relation to flood prone land under the provision that they have undertaken substantial assessments in accordance with the latest approval manual.

The 2005 gazetted Floodplain Development Manual is the current approved manual and supports section 733 and the NSW Government's Flood Prone Land Policy. Both the manual and the policy provide councils with the framework to implement processes, and sustainable strategies to manage the floodplain risks that specifically impact human occupation.

3.2 Environment Planning and Assessment Act 1979

This is an Act to instate an environmental planning system and assessment arrangement for NSW. In 2017, there were major amendments passed with a view to improving the planning system through simpler processes, improved strategic planning and community participation, in order to enable more balanced and transparent decision making. Section 3.4 makes provision for the preparation of development control plans by relevant authorities (outlined further in Section 3.4.1).

3.3 Water Management Act 2000

The Act offers sustainable and integrated management of the State's water sources for the benefit of both present and future generations. Water management principles are intended to guide decision-making under the Act in relation to floodplain management. They require the existing and future risk to human life and property, arising from occupation of the floodplain, to be minimised.

3.4 Liverpool Plains Local Environmental Plan 2011

The Liverpool Plains Local Environmental Plan 2011 (current version for December 2023) aims to make local environmental planning provisions for land in the shire in accordance with the relevant standard instrument. The LEP includes specific information for residents in the town of Quirindi.

The Plan identifies prohibited and permitted types of development within the local area. Some types of development are also regulated by specific state environmental planning policies. The Plan (Part 5.2) does provide specific management requirements for flood planning, which applies to land at or below the flood planning level (1 in 100 ARI plus 0.5m freeboard). It requires that development consent cannot be granted unless the proposed development is compatible with the flood hazard of the land, will not significantly cause adverse impacts to other developments, the environment and the community, and incorporates measures to manage risk to life. The site is shown in relation to a series of flood maps showing the flood planning area from the Liverpool Plains LEP (2011) in **Figure 3** and a flood risk study published by GHD (2011) in **Figure 4**. Figure 4 shows the site in relation to contours for a 100-year ARI floodway for the nearest available maps. The site for the proposed solar farm is approximately 4.4 kilometres from the nearest edge of the 100-year ARI inundation area for Jacob and Joseph Creek. During large flood events, Quirindi Creek and Jacob and Joseph Creek have the potential to flood a significant portion of the town and widespread inundation on the edges of the floodplain can also be expected (GHD, 2011). The study site is approximately 3.4 kilometres from the nearest part of Jacob and Joseph Creek, and over 600m from the minor tributaries of Hammond Spring Gully and Jacob and Joseph Gully. The site is not at risk of major flooding. There is potential for some localised (minor) inundation from minor drainage lines running through the site (see **Figure 5** below). Hydrological modelling using 5-metre resolution Digital Elevation Model (DEM) data for the site shows that the drainage channels running through the site are relatively minor, with flow direction mostly towards the south and southeast (see **Figure 5** and **Figure 6**).

Figure 3 – Site in relation to Liverpool Plains LEP Flood Planning Area (Source: NSW Legislation, 2023)

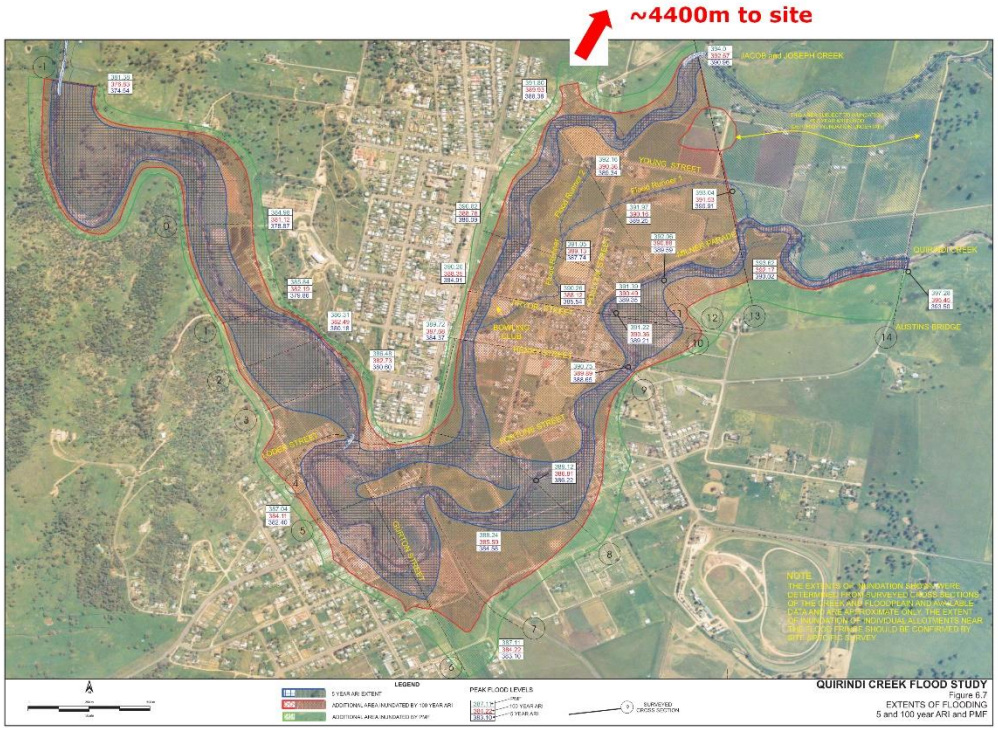

Figure 4 – Site in relation to 100-year ARI flood hazard
(Source: adapted from GHD 2011 – Appendix A:1)

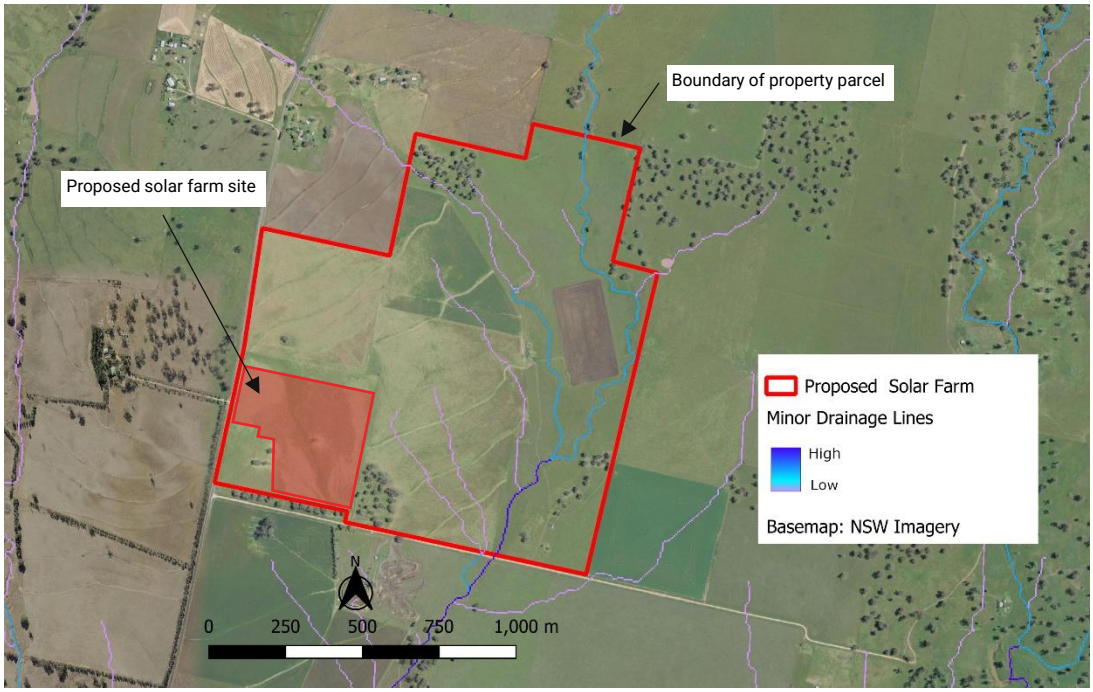

Figure 5 – Localised drainage patterns modelled from 5m DEM data

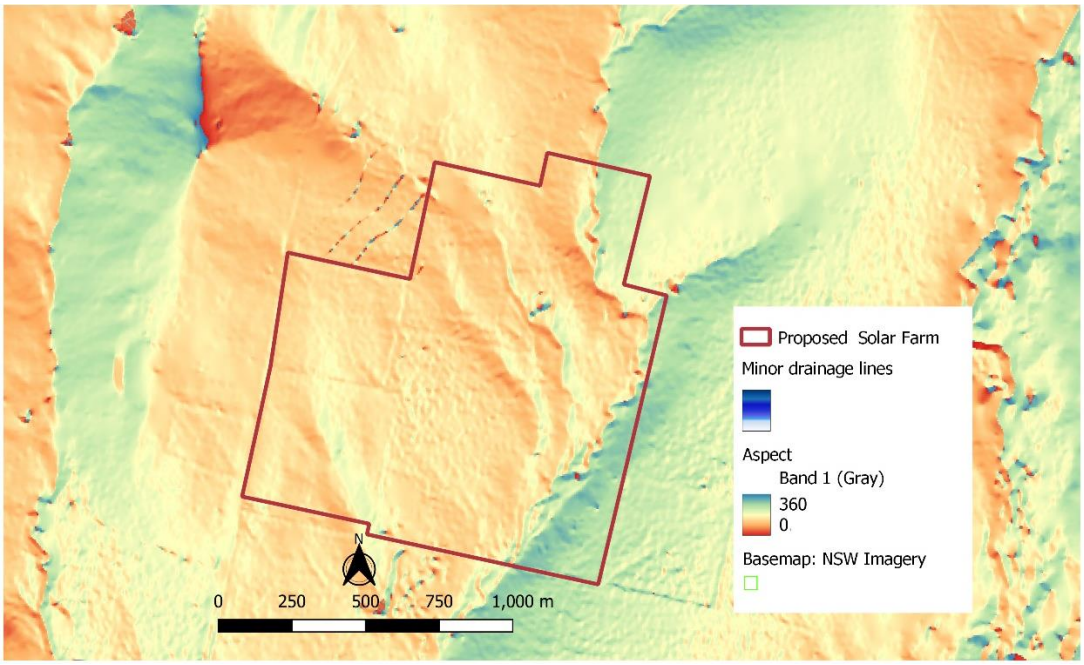

Figure 6 – Flow direction modelled from 5m DEM data

3.4.1 Liverpool Plains Shire Council Development Control Plan 2012

The Liverpool Plains Shire Council Development Control Plan (DCP) 2012 (amendment No. 5) provides guidance for developments and the statutory planning controls of the Liverpool Plains Local Environmental Plan 2011 (NSW Legislation, 2023). The guidance provides proponents assistance with criteria to address in development applications.

The guidance on flood protection states that the consent authority must be satisfied on a number of points regarding developments, including that the development:

a. is compatible with the flood hazard of the land; and
b. is not likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties; and
c. incorporates appropriate measures to manage risk to life from flood;
d. is not likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses.

Development Control Plans typically state that planning restrictions will apply to development on land below the 'flood planning level' of watercourses. The 'flood planning level' refers to "…the level of a 1:100 ARI (average recurrent interval) flood event plus 0.5 metre freeboard" (NSW Legislation, 2020, page 48).

NSW local government DCPs also typically provide guidance on stormwater drainage systems for rural lots and large residential lots, which are relevant to the proposed solar farm site. Guidelines typically suggest that, where drainage easements over downstream properties is required, consent from the owners of the downstream properties is to be submitted with the development application. The Liverpool Plains DCP states that measures to control stormwater flow and water quality are required including "…Location of major flows are to be defined to a designated overland flow path up to a 1:100 ARI flood event and are to be dedicated as a drainage reserve or easement" (Liverpool Plains Shire Council, 2012, section 3.4.4).

3.4.2 Liverpool Plains Community Strategic Plan 2012 - 2032

The Liverpool Plains Community Strategic Plan 2012-2032 is planned and executed under key themes identified through extensive community consultation. It is the Council's highest level of planning and has been developed following an extensive consultation process (Liverpool Plains Shire Council, 2022). The vision is underpinned by four strategic pillars:

- **Community:** A great rural lifestyle with access to quality services;
- **Governance:** Strong community council and business leadership;
- **Environment:** A sustainable environment;
- **Economy:** A thriving economy.

The only theme that specifically mentions flood or water management aspects is "A sustainable environment" where "We have access to affordable, clean water supplies" and "Water quality is improved, water storage has increased, and the quality and quantity of water meets demand" (Liverpool Plains Shire Council, 2022: 15). However, also implicit within the themes above, is the need for strategies that minimize the impact on the environment from development activities and to maintain and manage water quantity and quality.

3.5 State Environmental Planning Policy (Transport and Infrastructure) 2021

Part 2.3, Division 7 of the State Environmental Planning Policy (Transport and Infrastructure) 2021 (SEPP (T&I)) relates to 'Flood Mitigation Work'. This policy provides details on the types of works which may be required for land that is susceptible to flooding by the probable maximum flood event, also known as flood liable land. The SEPP (T&I) states that consultation with the relevant council is required if the proposal will alter flood patterns other than to a minor extent, and their response must be taken into consideration. The Project area is not within the mapped flood planning area under the Local Environmental Plan and does not require additional flood mitigation work.

As noted in Section 3.4 above, there is the potential for some flooding of the project area.

3.6 Protection of the Environment Operations (POEO) Act 1997

The POEO Act aims to protect, restore and enhance the quality of the environment in NSW, while still having regard for the ecologically sustainable development.

With relevance to the site, the Act aims to reduce risks to human health and avoid degradation of the environment by promoting pollution prevention, through the reduction of materials used and advocating the re-use, recovery or recycling of materials. The Act contains the requirements for the management of water discharges and the offences that relate to pollution. Section 148 requires that any pollution incidents, or those that threaten material harm to the environment, must be notified to the relevant authority (e.g., NSW Environment Protection Authority).

3.7 Soil Conservation Act 1938

This Act makes provisions for the conservation of soil resources and mitigation of erosion. The Act allows the Minister for Primary Industries [1] to issue soil conservation notices, declare areas to be sites of erosion hazard, proclaim works in catchment areas and outlines specific regulations regarding the Rural Assistance Act 1989.

Of general relevance to this project is the promotion of sustainable use and prevention of loss of soil resources from a site.

[1] Except Parts 2A, 3 and 4, and sections 15 and 30A insofar as they relate to Parts 2A, 3 and 4, jointly with the Minister for the Environment.

4 CATCHMENT AND FLOOD HISTORY

The Project is located in the Liverpool Plains Shire Council, to the northeast of the town of Quirindi. According to spatial data from the Australian Hydrological Geospatial Fabric (Geofabric), the proposed facility is located within a large sub-catchment that includes Quirindi Creek and Jacob and Joseph Creek (see Figure 7 below) before joining the Mooki River which eventually flows into the Namoi River near Gunnedah. The project site is within a relatively flat area, with heights ranging from approximately 440m (AHD) on the northern side of the site to 420m (AHD) on the southern side. (Figure 8). The surrounding area has some hills to the northeast reaching heights of between 550-650m contour values. The centre of the site has an elevation of 429m (AHD), with the nearest part of the Jacob and Joseph Gulley having an elevation of 411m (AHD) [2]. The land is mostly cleared of native vegetation and is currently used for farming.

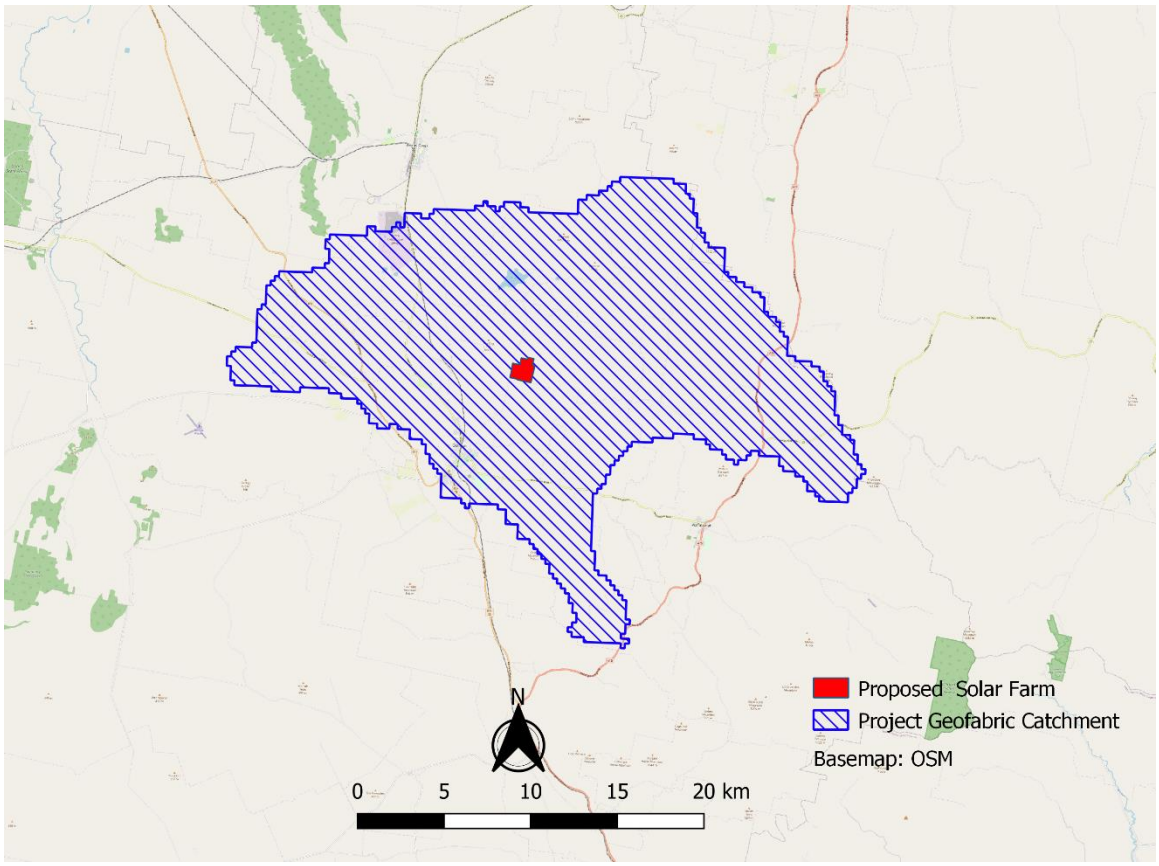

Figure 7 – Catchment of the project area identified in Geofabric

[2] Elevation values sourced from ELVIS - Elevation and Depth - Foundation Spatial Data (locations -31.4614026°/ 150.7196205° and -31.4739104°/ 150.7303787°)

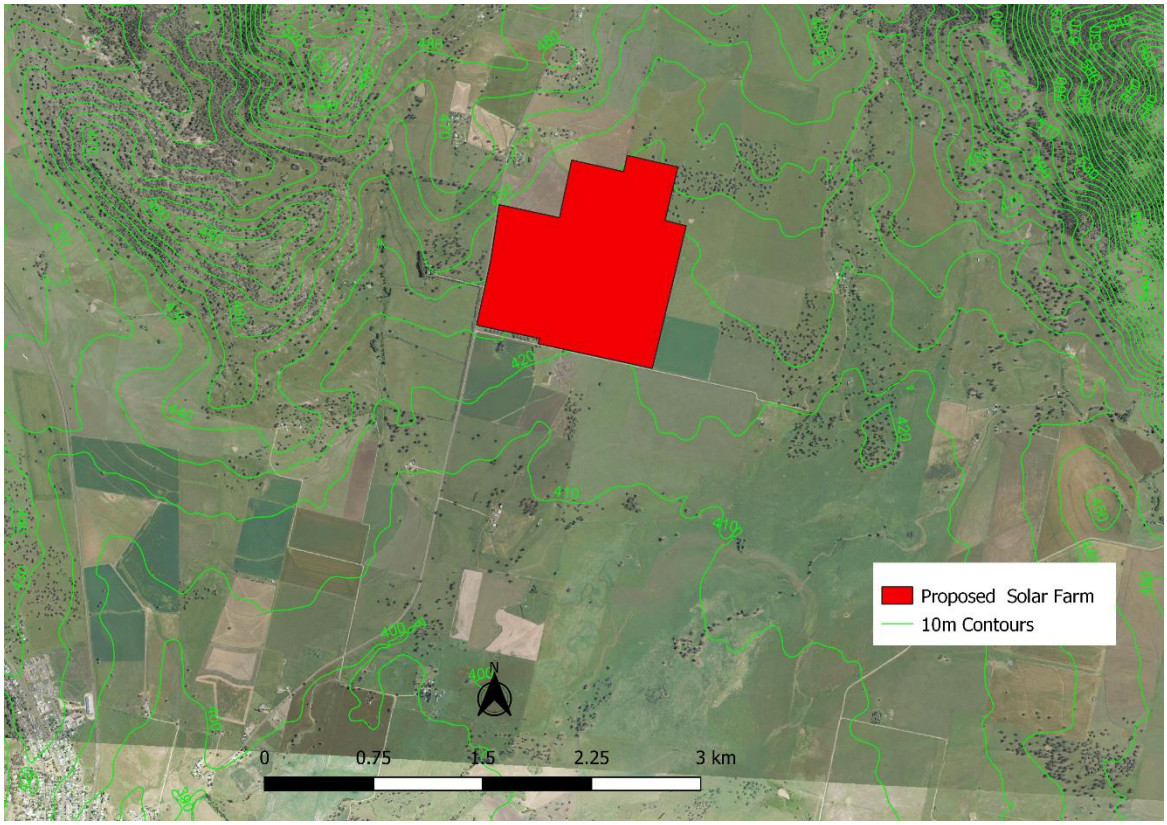

Figure 8 – Site topography

4.1 Historical Floods and the Quirindi Floodplain Risk Management and Plan

As part of a floodplain risk management study for the Liverpool Plains Shire Council, GHD (2011) provide a 1% AEP inundation map for the immediate Quirindi town area which shows the potential for flooding of some areas (GHD, 2011). Flood events occur following major storms which have occurred in 1955, 1971, 1984 and 2000, with the 1995 event being equal to the 100-year ARI event. In all of these floods, houses were inundated (GHD, 2011). At the 100 year ARI, all of the floodplain between Quirindi Creek and Jacob and Joseph Creek would be inundated, with flood runners contributing to the creeks (GHD, 2011 also see Figure 4 above).

Figure 3 and Figure 4 (above – Section 3.4) provide an indication of the location of the project site in relation to the modelled 100-year ARI flood contours and the Liverpool Plains LEP Flood Planning Area. These maps indicate that the project site is unlikely to flood from the direction of Quirindi. The study site is approximately 3.4 kilometres from the nearest part of Jacob and Joseph Creek, and over 600m from the minor tributaries of Hammond Spring Gully and Jacob and Joseph Gully indicating the site is not at risk of major flooding. There is potential for some localised (minor) inundation from minor drainage lines running through the site (see Section 3.4 above and Figure 66); however, there has been negligible occurrence of, or likelihood of, localised inundation from the channel.

5 AVAILABLE DATA

Climatic data and water quality and quantity monitoring information is available in the region as outlined in the following sections.

5.1 Rainfall for selected stations

The Bureau of Meteorology (BOM, 2020) has a station at the Quirindi Post Office (station number 055202). Table 2 outlines the average annual and maximum daily, monthly and annual rainfall for the Quirindi Post Office station and another selected station (i.e., station number 55202 - Wallabadah (Woodton). Average monthly values for these rainfall stations are provided in Table 3.

Table 2 – Rainfall

Station Number	Station Name	Period of Record	Rainfall (mm)			
			Average Annual	Highest Annual	Maximum Daily	Highest Monthly
055049	Quirindi Post Office	1882 - present	683.8	1149.0	136.7	334.5
055066	Wallabadah (Woodton)	1892 - present	770.0	1240.7	115.0	405.4

** Not available via BOM (2020) web portal [24/09/2020]*

Table 3 – Average Monthly Rainfall

Station Number	Rainfall (mm)											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
055049	79.7	64.6	54.8	40.7	43.8	51.3	47.1	44.2	46.5	60.1	67	79.7
055066	83.6	69.1	55.6	46.4	49.2	63.5	58.6	55.1	55.5	70.7	73.9	88.2

Flood-producing weather systems across the region include inland troughs, cold fronts, and thunderstorms. Consequently, each rainfall event is a function of the prevailing meteorological conditions. Therefore, the rainfall data provides useful information about expected seasonal rainfall in the area.

5.2 Streamflow

There is a government surface water monitoring site located on Quirindi Creek within 7.4 km of the site. Streamflow records (Table 4) for this site are available for this location from the WaterNSW Real-time portal. Another water monitoring site further down Quirindi Creek (419098) is listed as having full streamflow records as well.

Table 4 – Stream Gauging Stations

Station Number	Station Name	Available/Relevant Data	Distance from project area
419106	Quirindi @ Dury Bridge	Watercourse Level, Watercourse Discharge, Water Temperature, Electrical Conductivity @ 25deg C	7.4 km northwest
419098	Quirindi @ Greenacre	Watercourse Level, Watercourse Discharge	21.8 km northwest

Generally, data from the available stream gauges do not provide specific information on local site flooding but are more useful in the context of assessing major regional flooding events that may impact on-site access. Information is publicly available from WaterNSW Real-time data portal and could be incorporated into site management plans.

5.3 Groundwater and Hydrogeological Conditions

Quirindi falls within the Namoi Surface Water Resource Plan Area (SWRPA) as shown in

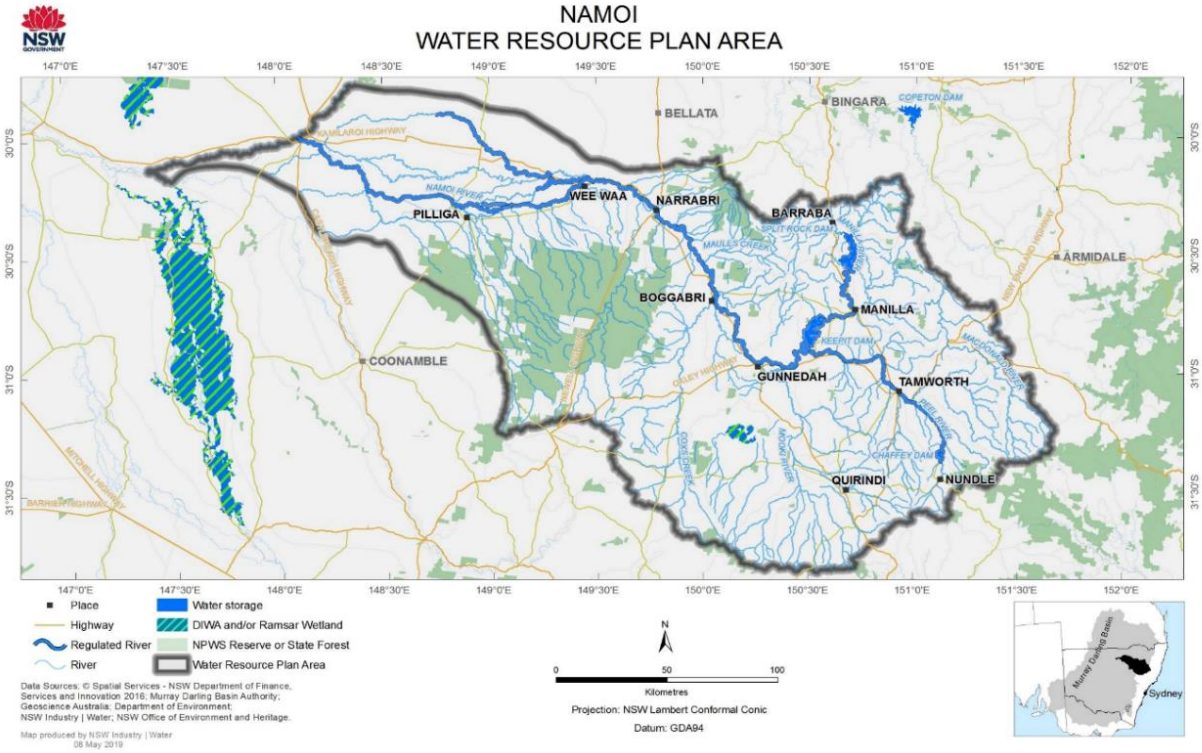

Figure 9 below. The geology of the Namoi SWRPA is characterised by young volcanics and extensive alluvial floodplains which have very productive heavy black and grey clays that are sought after for farming and irrigation (NSWDPI, 2019b: 8). Groundwater is contained in the unconsolidated sediments along the Namoi River and its major tributaries and is managed as two resources – Upper and Lower Namoi Groundwater Sources. The alluvium of the Namoi River is by far the most important in the State in terms of groundwater use, providing water for stock use, domestic supplies, irrigation, industry and town water supplies (NSWDPI, 2019b: 17). Groundwater quality for the SWRPA varies (see Figure 10 below), with the western part of the catchment being mostly saline (7,000 – 14,000 TDS mg/L). The eastern part of the catchment in the Tamworth and Quirindi areas is moderate to fresh (0 – 500 TDS mg/L). A water sharing plan for the Namoi Alluvial Groundwater Sources 2020 is in place, with Upper Namoi Zone 8, Mooki Valley (Quirindi – Pine Ridge Road to Breeza) being a priority area for maintaining salinity levels and having a stock rights allocation of 114 ML/year and a long-term average annual extraction limit of 16,114ML/year (NSW Legislation, 2020). There are groundwater dependent ecosystems along Quirindi Creek of moderate to high potential near Quirindi (see Figure 12 below). The project catchment site does not fall within areas of groundwater vulnerability according to Environmental Planning Instrument (EPI) data (see Figure 13 below and NSW Government, 2020).

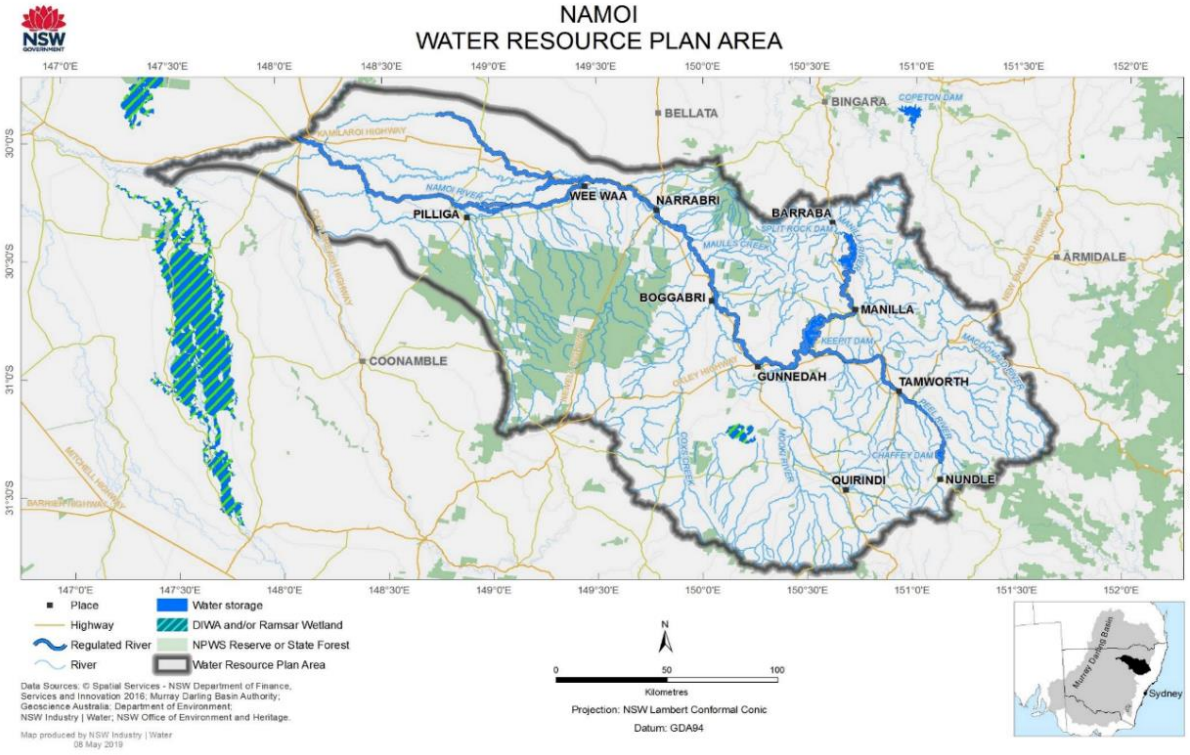

Figure 9 – The Namoi SWRPA (source: NSWDPI, 2019: 12)

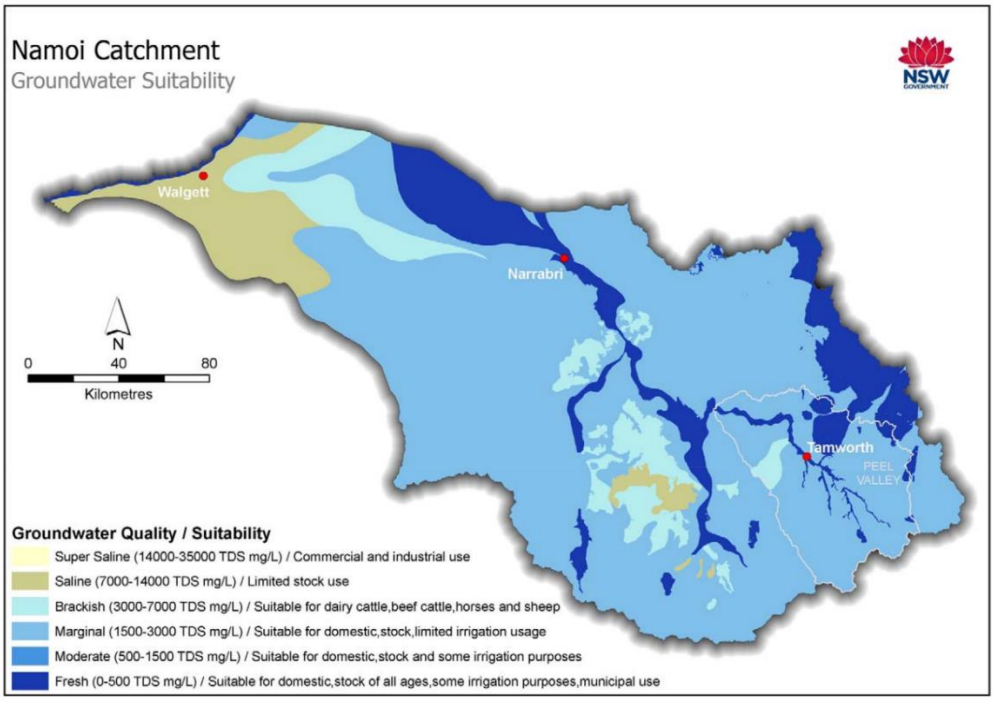

Figure 10 – Groundwater quality and suitability in the Namoi catchment (source: NSWDPI, 2019b: 19)

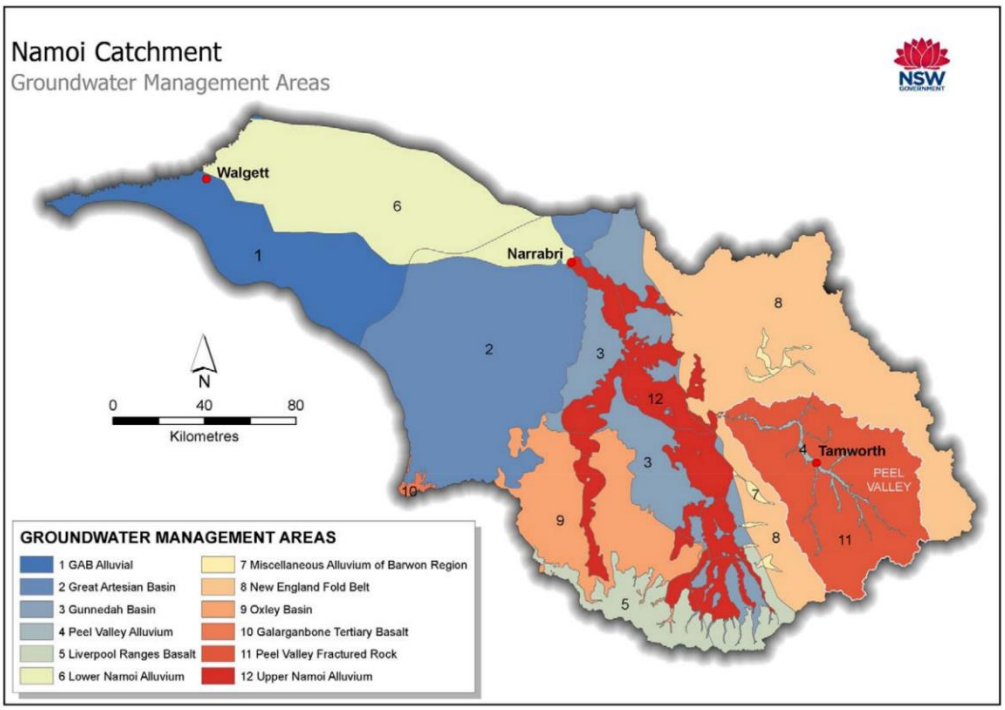

Figure 11 – Groundwater management areas for the Namoi catchments (source NSWDPI, 2019b: 18)

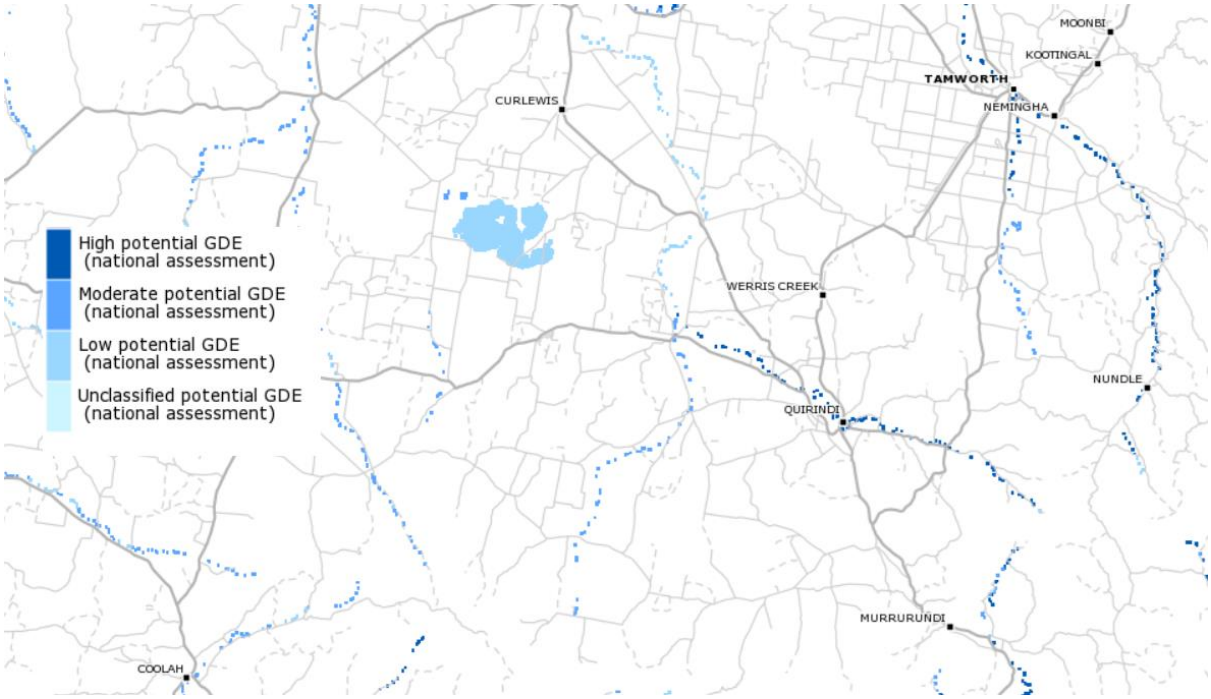

Figure 12 – Groundwater dependent ecosystems near Quirindi (source: BOM, 2020)

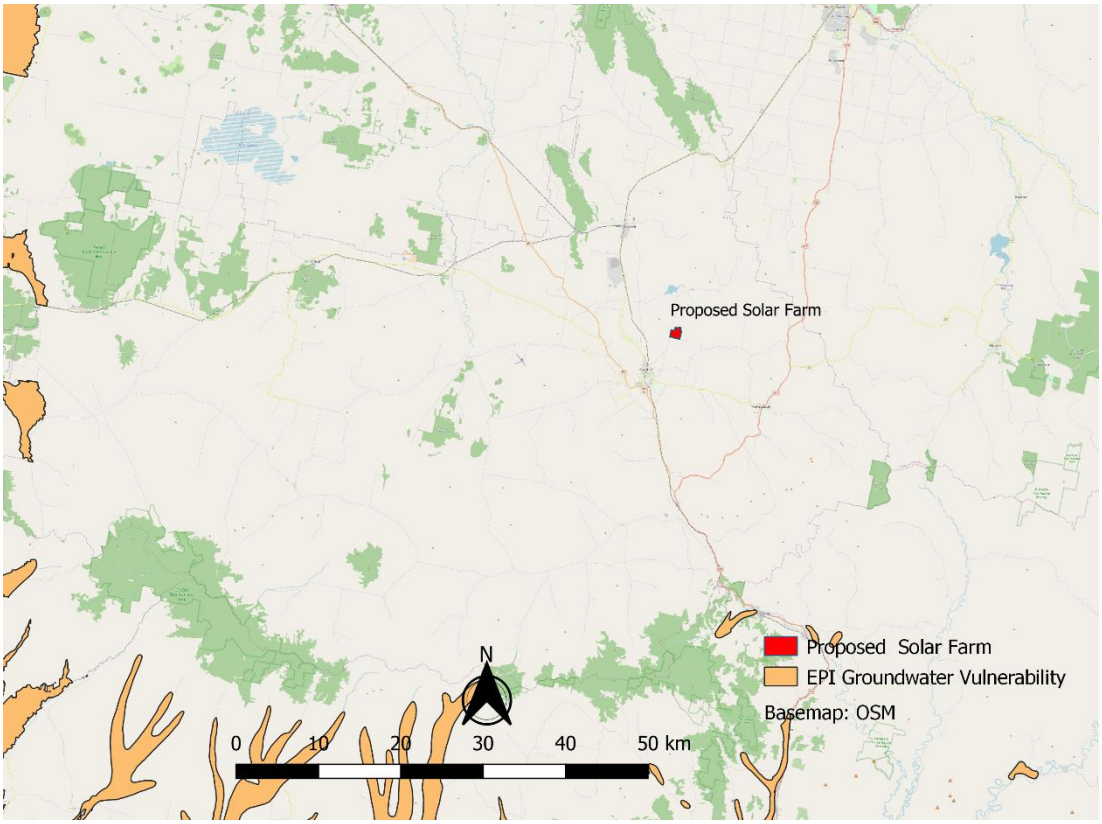

Figure 13 – The Project Geofabric Catchment and EPI Groundwater vulnerability areas

5.4 Surface Water and Riparian Conditions

The Namoi SWRP is designed to set out how the obligations of the Murray-Darling Basin Plan 2012 will be met in the area. NSWDPI (2019a) describes the Namoi SWRPA. Key surface flow characteristics for the Namoi River catchments are summarized below:

- The Namoi River flows in a westerly direction from its headwaters in the Great Dividing Range. Its main tributary, the Peel River, joins the Namoi near Gunnedah;
- The Namoi River contributes on average around 23 per cent of the flow of the Darling River upstream of Bourke;
- Quirindi is located along Quirindi Creek which flows into the Mooki River before entering the Namoi River upstream of Gunnedah;
- The mean daily flow of the Namoi River decreases from around 1,900 ML/day at Gunnedah to around 1,500 ML/d in the lower River at Bugilbone and Walgett;
- The mean daily flow in the Namoi River has decreased following the construction of the Keepit Dam in 1960 (see Figure 14 below);
- The Namoi catchment has a number of significant wetlands. The largest of these is Lake Goran, a large internal drainage basin south of Gunnedah that covers more than 60 km;
- The aquatic and terrestrial environments of the Namoi catchment provide habitat for a large number of threatened species and ecological communities that are protected under the Threatened Species Conservation Act 1995;
- There are 28 threatened plant species, with 11 of these being listed as endangered. There are also 66 threatened animal species found within the catchment, including 4 species of amphibians, 9 bats, 37 birds, 11 mammals and 5 reptiles;
- 4 aquatic species that previously occurred within the Namoi catchment are listed as threatened under the NSW Fisheries Management Act 1994. These are the river snail, silver perch, purple spotted gudgeon, and the olive perchlet.

The majority of the Namoi River riparian area is listed as a key environmental asset with the Mooki River being the main asset with direct connectivity to Quirindi Creek (NSWDPI, 2019b; see Figure 15 below).

The proposed site activity is not expected to materially contribute to any regional groundwater issues, particularly those associated with nearby farming districts.

Based on the current available information, potential adverse surface water-related impacts to the site include:

- Site accessibility and inundation.
- Managing downstream sedimentation.

As there will be no extraction of groundwater or interference with the groundwater table during project activities, potential for impacts have not been considered further.

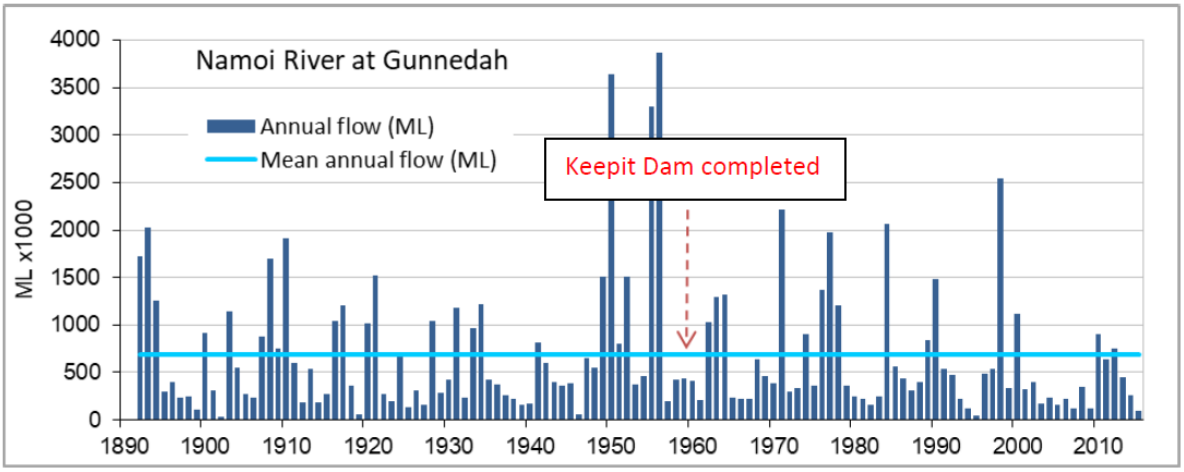

Figure 14 – Annual flow in the Namoi River at Gunnedah 1892-2016 (Source: NSWDPI, 2019:21)

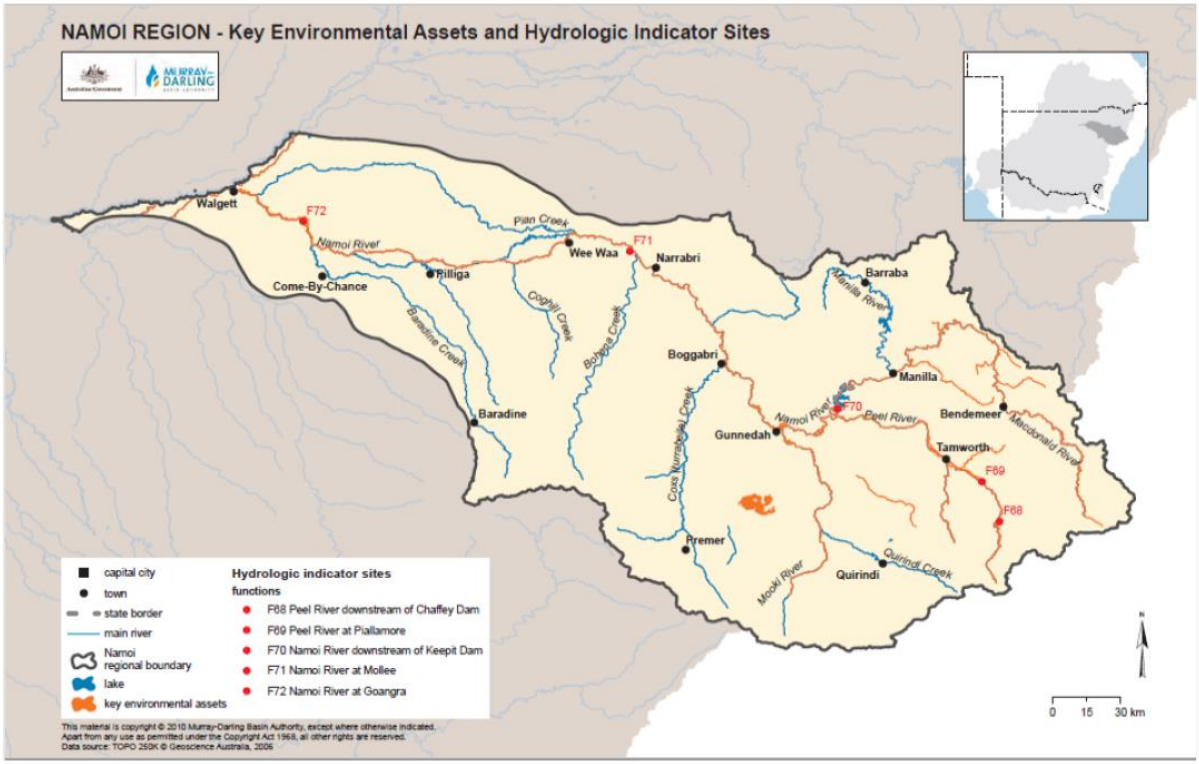

Figure 15 – Key environmental assets and hydrologic indicator sites (Source: NSWDPI, 2019b)

6 POTENTIAL IMPACTS

The proposed site activity is not expected to materially contribute to any regional groundwater issues, particularly those associated with nearby farming districts.

Based on the current available information, potential adverse surface water-related impacts to the site include:

- Site accessibility and inundation.
- Managing downstream sedimentation.

As there will be no extraction of groundwater or interference with the groundwater table during project activities, potential for impacts have not been considered further.

6.1 Flooding

The flood planning area from the Liverpool Plains LEP (2011) and the 100-year ARI floodway modelled by GHD (2011) indicate that the project site is at low risk of flooding from the direction of Quirindi Creek and Jacob and Joseph Creek. There is some potential for localised (minor) inundation from minor drainage lines running through the site (see Figure 5 above). The water will flow in a south-easterly direction towards the Jacob and Joseph Gully which flows into Jacob and Joseph Creek.

6.2 Water quality and erosion

The project has the potential to alter existing water quality conditions within the site. The impervious area of solar facilities is typically only marginally increased owing to associated hardstand and building areas. However, the panels may impact the nature of vegetation/grass coverage on the site, which has the potential to increase surface runoff and peak discharge. Increased flow concentration off the panels also has the potential to erode soil at the base of solar panels (Cook & McCuen, 2013).

Furthermore, as the site has been historically used for farming there is very little natural ground cover vegetation. The eSPADE resource (NSWOEH, 2020), provides a Soils Profile Report (id: 1000493) for a site within 3.1 kilometres to the east of the proposed solar site (see Figure 16 and Table 5 below). Site 1000493 indicates a soil profile of brown light silty clay with minimal cracks in the top horizons and heavy brownish black in the lower horizons. There has been extensive clearing at the site with native pasture in the general area. There is the potential that the proposed solar site runoff will contain sediments and increase turbidity or other water quality parameters in downstream water ways.

Table 5 – Site details for eSPADE site 1000493

SITE DETAILS

Site Location:	QUIPOLLY 100 SE HAYSHED GLENGOWRIE PLN
Profile Details:	Soil Landscapes of the Tamworth 1:100 000 Sheet Survey (1000493), Profile 104, collected from a core sample by Mr Robert Banks on 30 June, 1993
Map Reference:	MGA Grid Reference: Zone 56, 285155E, 6514564N. 9035 TAMWORTH (1:100000) map sheet.
Physiography:	plain in alluvial fan under grassland/herbland on alluvium lithology and used for volun./native pasture. local relief extremely low (< 9m), elevation 410.0 m. Surface condition is self mulched, profile is poorly drained, erosion hazard is slight, and no salting evident
Vegetation/Land Use:	extensive clearing at the site, used for volun./native pasture, with volun./native pasture in the general area
Surface Condition:	self mulched when described, expected to be cracked when dry, ground cover is 100%
Erosion/Land Degradation:	slight; sheet erosion at site is minor, stable; scald erosion at site is stable; no salting evident
Soil Hydrology:	profile is slowly permeable and poorly drained, no free water, run on is moderate and runoff is low
Soil Type:	Endocalcareous Self-mulching Black Vertosol; non gravelly, very fine, very fine, giant (ASC 2nd Edition)
Base of observation:	
Profile Field Notes:	

SOIL DESCRIPTION

Layer 0		
0.00 - 0.00 m		
Layer 1	Horizon: A1	
0.00 - 0.10 m	Texture:	light silty clay
	Colour:	brown (7.5YR 4/3) [moist] with not evident mottles, and not evident subdominant mottles
	Structure:	strong pedality (angular blocky, 10 - 20 mm, fabric is smooth-faced peds), ped coatings are none
	Segregations:	not evident,
	Roots:	many (25-100/10x10cm) (Root size <1 mm),
	Soil fauna:	Activity is low (< 10%), consisting of earthworm casts
	Cracks/Macropores:	Cracks are nil, macropores are nil
Layer 2	Horizon: B21	
0.10 - 0.40 m	Texture:	heavy clay
	Colour:	(brownish black) (10YR 2/3) [moist] with not evident mottles, and not evident grey subdominant mottles
	Structure:	strong pedality (prismatic, 50 - 100 mm, fabric is smooth-faced peds), ped coatings are slickensides, common (10-50%), distinct
	Segregations:	not evident,
	Roots:	common (10-25/10x10cm) (Root size <1 mm),
	Soil fauna:	Activity is low (< 10%), consisting of earthworm casts
	Cracks/Macropores:	Cracks are nil, macropores are nil
	Moisture/Consistence:	moist, disruptive test result was very firm force, shearing test result was crumbly,

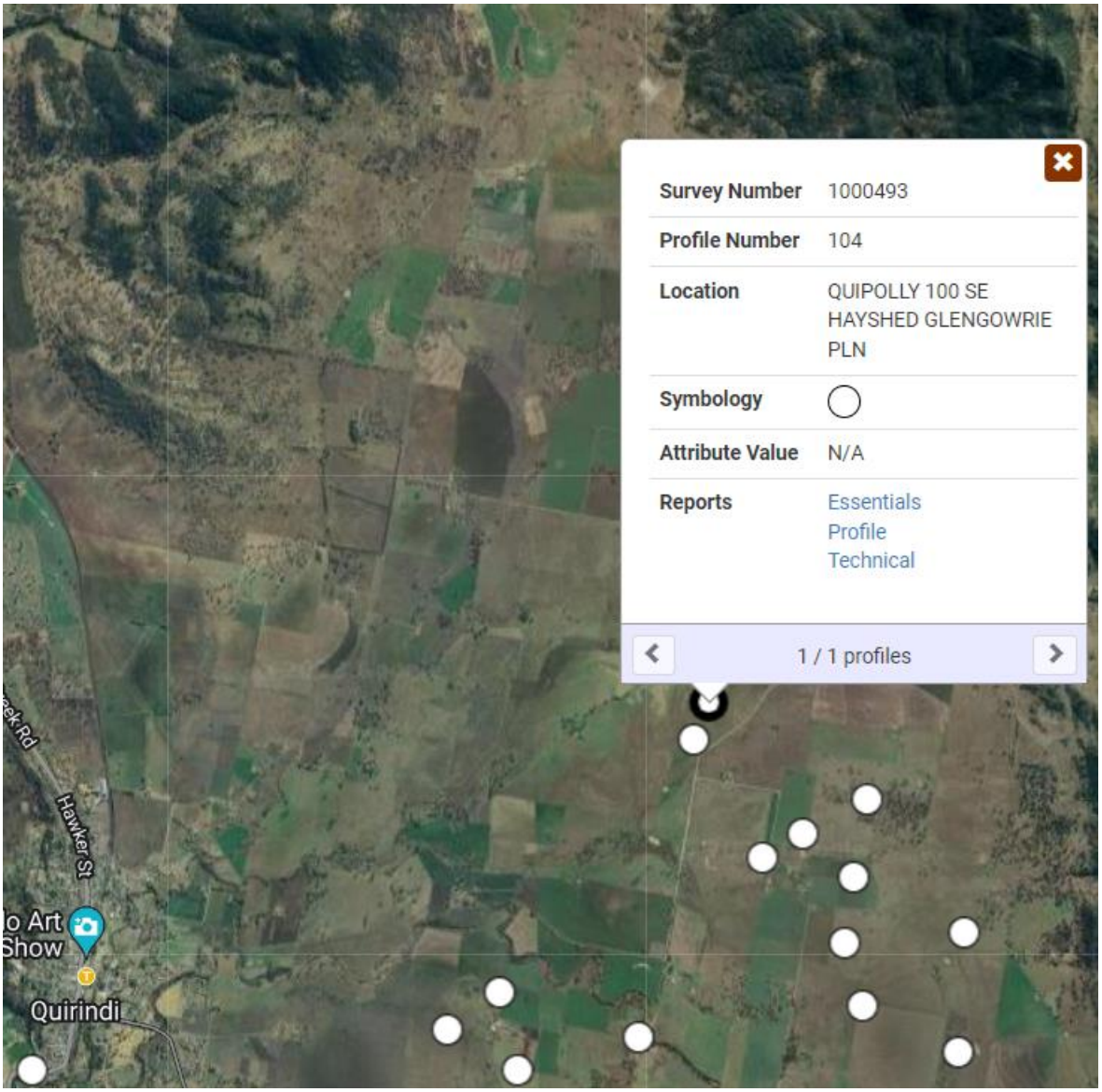

Figure 16 – The location of the eSPADE site 1000493 (Source: espade.environment.nsw.gov.au © State of NSW and Office of Environment and Heritage 2020)

7 PROPOSED MITIGATION MEASURES

7.1 Site accessibility and inundation

The site accessibility and potential for inundation issues may be managed in the project's risk management register(s) owing to the regional nature of the events and the potential to impact whole of site works. There should be procedures in place to halt construction during heavy rainfall to reduce impacts to the project construction and to increase sedimentation downstream.

7.2 Downstream sedimentation

Impacts associated with erosion and sedimentation resulting from construction activities can be minimised by undertaking works in accordance with provisions of the NSW government's best practice sediment and erosion control series, Managing Urban Stormwater: Soils and Construction (DECC, 2008).

Proposed mitigation measures associated with managing downstream actionable nuisance (sedimentation) are outlined in Table 6.

Table 6 – Proposed Mitigation Measures

Stage	Measure	Activities/Approach
Design	Site drainage and water quality controls	Design Basis • Undertake hydrological assessment of the site's catchment in accordance with relevant methods outlined in Australian Rainfall and Runoff. • Determine sediment management targets and drainage control standards in accordance with Managing Urban Stormwater: Soils and Construction Vol 1 (Blue Book) (DECC, 2008). • Develop a site erosion and sediment control plan in accordance with the Blue Book. • Develop site drainage design incorporating detention basins and sedimentation management structures where relevant. • Permanent site drainage should coincide with temporary arrangements where possible.
Construction and/or Demolition	Site drainage and water quality controls	General site works: • Catch drains to be located downslope of any proposed road works. • Install location appropriate sediment fences or other applicable control measures, depending on whether the

		feature is upstream or downstream of a disturbed part of the site or will need to be trafficable. • All stormwater collection points need to have appropriate sedimentation and erosion controls. • Undertake ongoing inspections of stormwater facilities and water control measures to assess their effectiveness. • Vibration grids or wash bays at all construction exits. • Level spreaders at locations where concentrated flow is discharged offsite to ensure sheet flow-like conditions are maintained. • Flat land erosion control options include erosion control blankets, gravelling, mulching, soil binder, turfing and revegetation.
Construction and/or Demolition	Stormwater point source control	In the event of concrete works: • Do not undertake works if chance of heavy rain. • Store rinsate[3] water, if applicable, separately to other water on site and dispose of offsite as appropriate. • Block on site drains in the area of the works and remove any contaminated runoff. In the event that dewatering practices are required: • Pump hose intakes for withdrawing water from excavations will be elevated to minimise sediment pumping and directed to a containment area for settling prior to discharge. • Limit direct discharge offsite (consistent with the design requirements for sediment pond discharge). • Stormwater collected on site should be reused where possible. Controls should be inspected and maintained on a regular basis. All water released from sediment basins should be clear or disposed of offsite by vehicle. • Material and waste storage areas should be designed and operated to minimise interaction with surface waters. • Vehicle washdown areas should be located away from water courses.

[3] A dilute solution of chemical resulting from washing the container and equipment with water, as defined by NSW EPA accessed 20 December 2018 https://www.epa.nsw.gov.au/licensing-and-regulation/licensing/environment-protection-licences/authorised-officers/glossary#r

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