

WATER ASSESSMENT

Petersons Solar Farm

October 2019





About ITP Renewables

ITP Renewables (ITP) is part of the ITP Energised Group which, established in 1981, specialises in renewable energy, energy efficiency and carbon markets consulting. The Group has offices and projects throughout the world.

ITP was established in Australia in 2003 and has undertaken a wide range of projects, including designing grid-connected renewable power systems; providing advice for government policy; feasibility studies for large, off-grid power systems; developing micro-finance models for community-owned power systems in developing countries; and modelling large-scale power systems.

The staff at ITP have backgrounds in renewable energy and energy efficiency, research, development and implementation, managing and reviewing government incentive programs, high-level policy analysis and research, engineering design and project management.



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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 (ITP) is proposing to develop the Petersons Solar Farm (also referred to as ARM1B), as described in the solar farm summary sheet for this proposal (see Table 1). It will be located approximately 4km southeast of the town of Armidale, NSW (see Figure 1). Details of the layout are contained in the drawing ARM1B-G-210.

Table 1: Site information

Parameter	Description
Site name	Petersons Solar Farm
Lot/DP(s)	494/66672, 2/569410
Street address	347 Dangarsleigh Rd, Armidale, NSW 2350
Council	Armidale District Council
AC capacity	5 MW
DC capacity	6.05 MW
Project area	12.6 ha
Current land use	Grazing

ITP is proposing to construct a solar farm with a DC capacity of 6.05 MW and AC output of 5 MW, on an approximately 100.5 ha site that is currently used for grazing.

There are to be approximately 16,000 solar modules installed on around 200 mounting structures running north to south. Each row of solar photovoltaic (PV) modules will rotate to track the sun across the sky from east to west each day. The spacing between each row is 6m. The hub height of each tracker is around 2m, with the peak of the modules reaching a height of approximately 2.5m when the array is fully tilted to 60 degrees from horizontal. The general arrangement of the solar farm and the array tracker details are shown in drawing ARM1B-G-210.

The solar farm will also include two 2.5 MW inverter stations. The station is to be located within the array and each are mounted on a 20-foot skid. Each of these inverter stations incorporates the high/medium voltage switchgear and transformers. The arrangement of the inverter station skid is shown in drawing ARM1B-G-430.

The mounting system is constructed on piles that are driven into the ground. During construction, there is expected to be 50 personnel on site working from 7 am – 4 pm, Monday to Friday. The construction is anticipated 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.

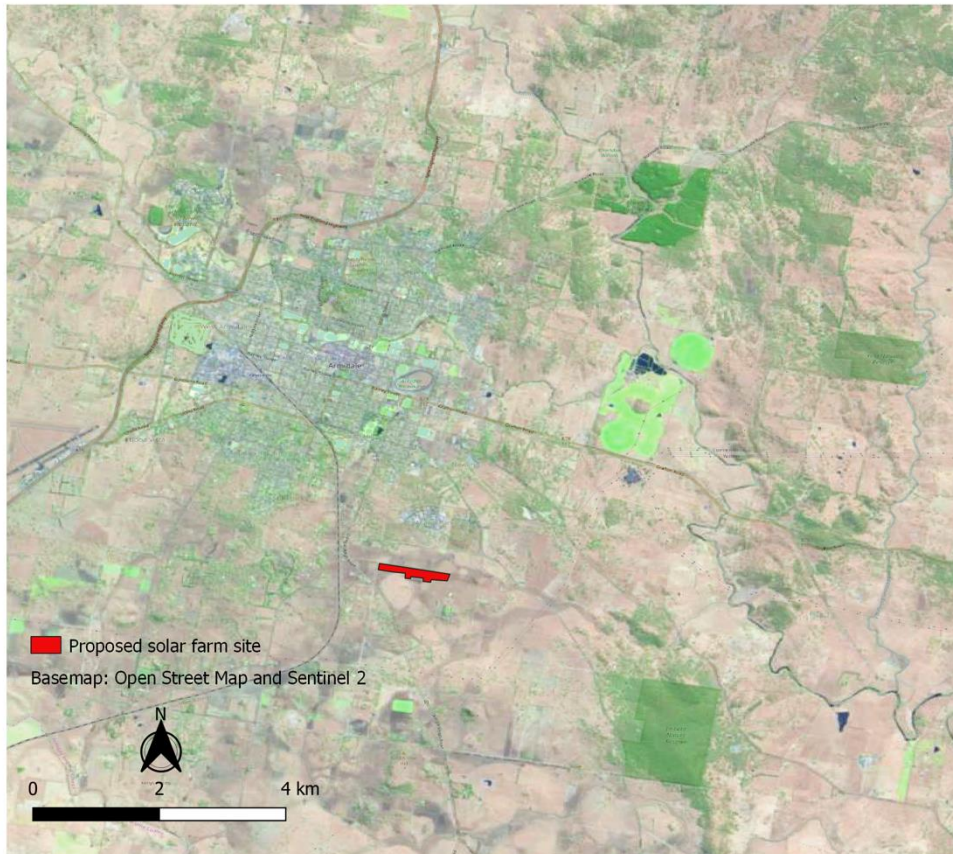


Figure 1: Proposed solar farm site and surrounding area

2.2 Hydrology, climate and topographic conditions

NSWDPIE (2019) provides an overview of climatic and topographic conditions of the area. The project area for the Petersons Solar farm is within the Armidale Regional Council Area.

Armidale (980m AHD) along with Tenterfield (850m AHD), Glenn Innes (1062m AHD) and Inverell (582m AHD) form the major townships within the Northern Tablelands region of Northern New South Wales. The high elevation of the northern tablelands means cool summers and cold winters with occasional snowfalls.

The tablelands have relatively high rainfall with an average annual rainfall around 770mm at Armidale and 902mm at Glen Innes, with about 60 percent of this rainfall occurring during the summer months. Drainage runoff from these areas includes the headwaters of the Macintyre River, Gwydir River and Namoi River catchments. The city of Armidale is located on the eastern side of the watershed that runs along the top of the Great Dividing Range (NSW Government, 2019) and is within catchment of the Dumaresq Creek system, which discharges into Commissioners Waters to the east of the urban area.

The topography of Armidale is characterised by relatively flat areas along Dumaresq Creek with moderate to steep hills surrounding most areas around the town.



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.

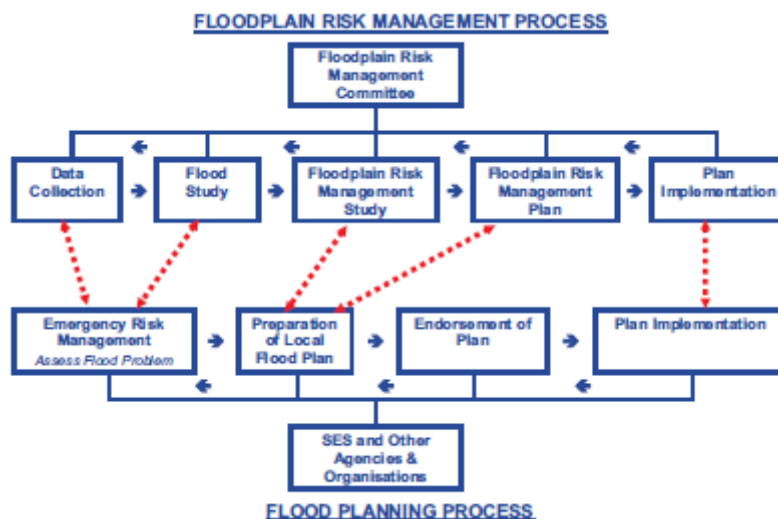


Figure 2: Floodplain risk management and planning process

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 Environmental 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 3.43 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 Armidale Dumaresq Local Environmental Plan 2012

The Armidale Dumaresq Local Environmental Plan 2012 aims to make local environmental planning provisions for land in the Armidale Dumaresq area in accordance with the relevant standard environmental planning instrument. The regional area includes specific information for residents in the towns of Armidale and Guyra.

The Plan provides the 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 6.2) 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 cause significantly adverse impacts to other developments, the environment and the community, and incorporates measures to manage risk to life. According to the accompanying flood planning map (figures 7 and 8), the site is not considered to be part of the flood planning area (see 8 with the location for the project area marked in red). The closest flood planning area is located 1.1km to the north of the project area.

3.4.1 Armidale Dumaresq Development Control Plan

The Armidale Dumaresq Development Control Plan 2012 (DCP) provides guidance for developments and supports the statutory planning controls of the Local Environmental Plan. The guidance provides proponents assistance with criteria to address in development applications, however this relates mostly to housing developments.

The DCP provides guidance on flood protection from natural watercourses and local flooding and design solutions that consider the future impacts of flooding and stormwater runoff (Armidale Dumaresq Council, 2012). The DCP states that, “Generally, planning restrictions will apply to development on land below the ‘flood planning level’ of such watercourses. The ‘flood planning level’ refers to the flood level established by the 1% Annual Exceedance Probability (AEP) flood (commonly referred to as the ‘1 in 100-year flood’) plus 0.5 metres freeboard” (page 1). Figure 8 (section 4) provides an indication of the proposed solar farm on the AEP map for the town.

The DCP also provides guidance on stormwater drainage systems for rural lots and large residential lots, which are relevant to the proposed solar farm site. The guidelines suggest that, “In some circumstances... drainage easements over downstream properties may be required. Consent from the owner(s) of the downstream properties is to be submitted with the development application” (section 5.2). Further guidelines are also provided for minor and major flow systems.

3.4.2 Armidale Regional Council Community Strategic Plan 2027

Regional Council Community Strategic Plan 2027 is planned and executed under key themes identified through extensive community consultation (Armidale Regional Council, 2019). These include:

- Enjoying the unique culture and offerings of the region, such as the openness of the environment, the friendly atmosphere, access to education and the local arts.



- More needs to be done to grow and create a strong, diverse and sustainable regional economy.

The themes do not contain specific flood or water management aspects. However, within the first theme above, the strategies include minimising the impact on the environment from development, maintaining and managing water quantity and quality (keeping waterways clean).

3.5 State Environmental Planning Policy (Infrastructure) 2007

Part 3, Division 7 of the State Environmental Planning Policy (Infrastructure) 2007 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 policy 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.

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 Industries¹ 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 Armidale District Council Area, 4km south-east of Armidale. According to spatial data from the Australian Hydrological Geospatial Fabric (Geofabric), the proposed facility is located within a sub-catchment that flows into the Commissioners Waters and Dumaresq Creek systems (see figure 5 below). A minor drainage line flows through the project area towards the Commissioners Waters located 4.5km to the east. Commissioners Waters then flow to the south-east away from the town of Armidale.

The Project area is situated upon a relatively flat area, with a slightly sloping north-easterly aspect (figure 6). The centre of the site has an elevation of 1072m (AHD), with the nearest intersecting stream in Commissioners Waters having an elevation of 948m (AHD)². The land is mostly cleared of native vegetation and is currently used for farming.

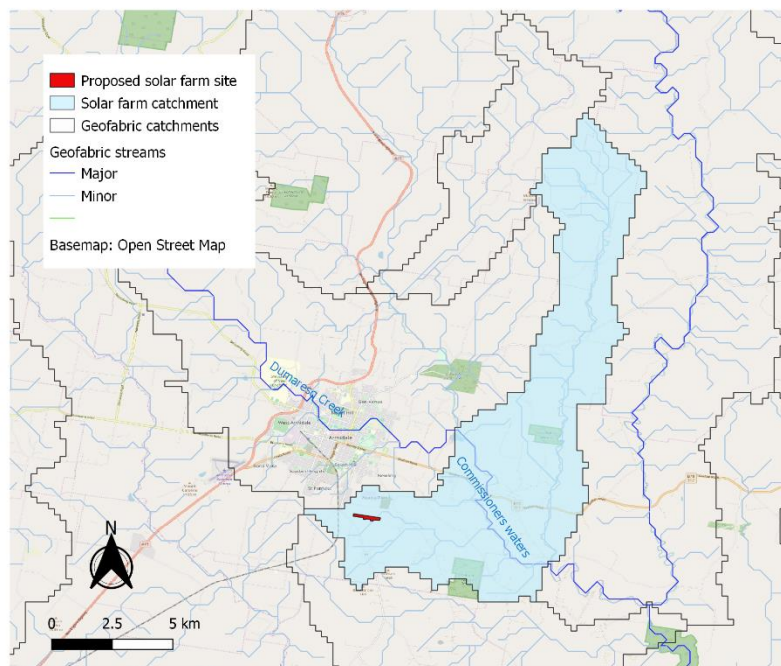


Figure 3: Streams and catchments of the project area identified in Geofabric

² Elevation values sourced from ELVIS - Elevation and Depth - Foundation Spatial Data (locations: -30.54760°/151.67765° and -30.55264°/151.72992°)

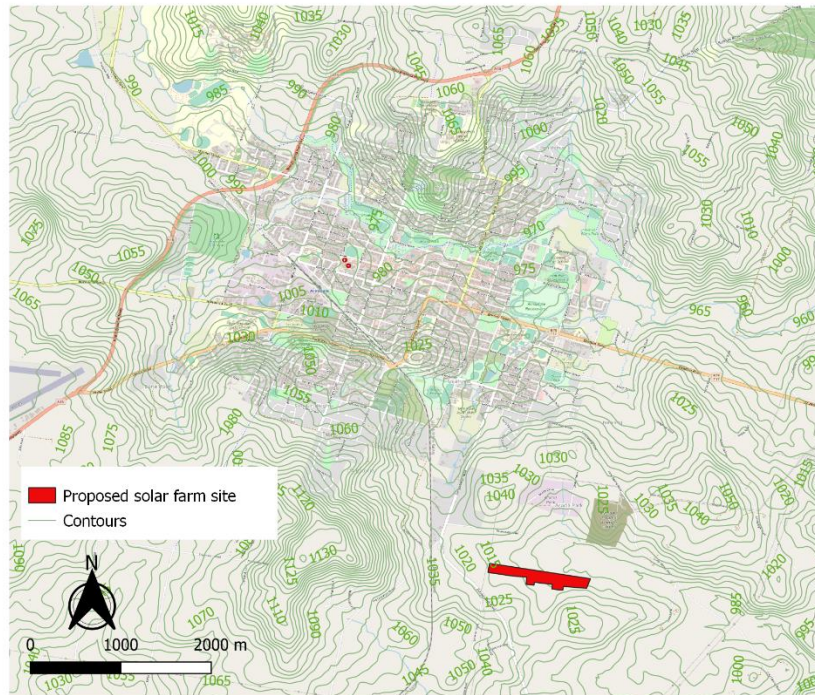


Figure 4: Site topography

4.1 Armidale local creeks flood study 2015

The Armidale Regional Council provides localised information on potential flood events including a report (undated) on the history of flooding in town creeks, a 1% Annual Exceedance Probability (AEP) Flood Extent Map, and a Flood Planning Level Map³. The flood history reports that, “*Armidale has never been subjected to the major flooding experienced in areas such as the Hunter Valley and the North Coast,*” but that flooding impacts have occurred within the town along Dumaresq Creek including, “*...damaged properties on the creek lands, destroyed or damaged bridges, footbridges and crossings and prevented access to South or North Armidale respectively*” (page 1). Figures 8 and 9 provide an indication of the location of the project site in relation to the 1% AEP Flood Extent and Flood Planning Level Maps. Given that the project site is elevated in relation to the flood-prone areas in figures 8 and 9 (see site topography – figure 9), it seems highly unlikely that the site is vulnerable to flooding.

³ Sourced from <https://www.armidaleregional.nsw.gov.au/living-here/your-neighbourhood/floods-fires> [October 2nd, 2019].



Figure 6: Project site in relation to the Armidale Flood Planning Level Map



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) has a station at the Armidale Airport (station number 056238). Table 2 outlines the average annual and maximum daily, monthly and annual rainfall for the Armidale Airport station and two other selected stations (i.e., station number 056034, Uralla and station number 057028, Hillgrove (Hillview)). Average monthly values for the 3 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
056238	ARMIDALE AIRPORT	1993 - 2019	763.2	1060.4	97.0	267.4
056034	URALLA	1901 - 2019	794.0	1348.0	164.3	307.6
057028	HILLGROVE (HILLVIEW)	1889 - 2019	825.5	1465.8	172.7	377.9

Table 3: Average Monthly Rainfall

Station Number	Rainfall (mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
056238	90.6	90.5	61.4	34.7	39.2	48.9	40	43.2	50.2	72.8	98	96.7
056034	103.9	82.5	59.8	39.6	44.3	53	55.6	54	52.8	71.8	85	87.3
057028	318.8	296	373.9	245.6	342	377.9	158.4	281.9	211.1	196.6	331.8	278.2

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 are two government surface water monitoring sites located within 10km of the site. Streamflow records (Table) for these sites are available for various locations in the region from the WaterNSW Real-time portal.

Table 4: Stream Gauging Stations

Station Number	Station Name	Available/Relevant Data	Distance from project area
206032	DUMARESQ CREEK AT STEPHENS BRIDGE	Stream Water Level, Discharge Rate & Volume	3.3km northwest
206008	COMMISSIONERS WATERS AT TIVERTON (EATHORPE)	Stream Water Level, Discharge Rate, Volume & Electrical Conductivity @ 25deg C	6.2km west

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

AECOM (2016) provided a comprehensive Water Quality Monitoring Plan to the Armidale Regional Council in relation to the Armidale Regional Landfill (approximately 7kms to the east of the proposed site for the Petersons Solar Farm). The report provides details on existing surface water quality and groundwater conditions relevant to the project area. Key aspects of the AECOM (2016) report are reproduced below.

Hydrogeological investigations were conducted by EA Systems (2005) and RCA (2006-2007). These studies established hydrogeological conditions in the region of the Armidale Regional Landfill. EA Systems drilled and logged five bore holes, into which five piezometers were installed to monitor groundwater level fluctuations. Groundwater monitoring was then carried out from November through to December 2005 (AECOM, 2016, page 16). Table 5 below shows gauged groundwater depths between 5.2-46.7m from top of pipe for these five bore holes.



Table 5: Groundwater depths for five bore holes in the vicinity of the Armidale Regional Landfill (source: AECOM, 2016: page 9)

Bore No.	RL (m AHD)	Stickup (m)	GW Depth from top of pipe (m)	Screen depth (m) below ground level	GW RL (m, AHD)
4	954.11	0.74	6.35	6.0-18.0	947.76
5	953.13	0.75	5.27	3.6-9.5	947.86
9	1014.03	0.95	46.7	53.5-59.5	967.33
10	993.78	0.67	37.0	41.0-47.0	956.78
11	977.58	0.72	28.0	30.0-36.0	949.58
12	969.79	0.62	21.3	34.0-40.0	948.49
13	961.70	0.60	13.3	16.0-22.0	948.40

RCA (2007) described hydrogeological conditions for this area as follows:

- The southern or upper section is steep and heavily vegetated, and
- The northern or lower section is more gently sloping, consists of an open paddock and is defined by a ridge running east-west at the northern extremity.

Groundwater in the upper or southern section of the site was generally assumed to be toward the north-north-east, whereas in the lower or northern section of the site flow was assumed to be more directly north-east. Collectively groundwater is considered to be leaving the site in a predominantly north-easterly flow direction, towards the Gara River (AECOM, 2016, page 11). Based on previous hydrogeological investigations carried out at the site, it is understood groundwater is present as both a series of shallow perched aquifers and within a deeper regional aquifer. The perched aquifer is located at the interface of the gravelly - clayey residual soils and/or weathered bedrock, typically within the upper 5.0m. The presence of perched groundwater is likely to be intermittent following rainfall until the water either discharges to the Gara River or infiltrates into the deeper regional aquifer and is likely to form isolated pockets of groundwater above the regional water table (AECOM, 2016, page 16).

5.4 Surface Water Conditions

AECOM (2016, page 16) summarise surface water conditions based on five monitoring sites in relation to the Armidale Regional Landfill. Figure 10 shows the location of these water quality monitoring sites in relation to the proposed solar farm site. Water quality of surface water bodies upstream and downstream of the landfill site has been characterised through baseline monitoring undertaken at the five locations since 2007. Two of the sampling locations (GARA3 and GARA5) are situated in an ephemeral stream characterised by low and intermittent flows. Cattle grazing upgradient of the Armidale Landfill site also influences surface water quality in the ephemeral stream as well as the Gara River, evidenced by the presence of elevated organic nitrogen in background samples.

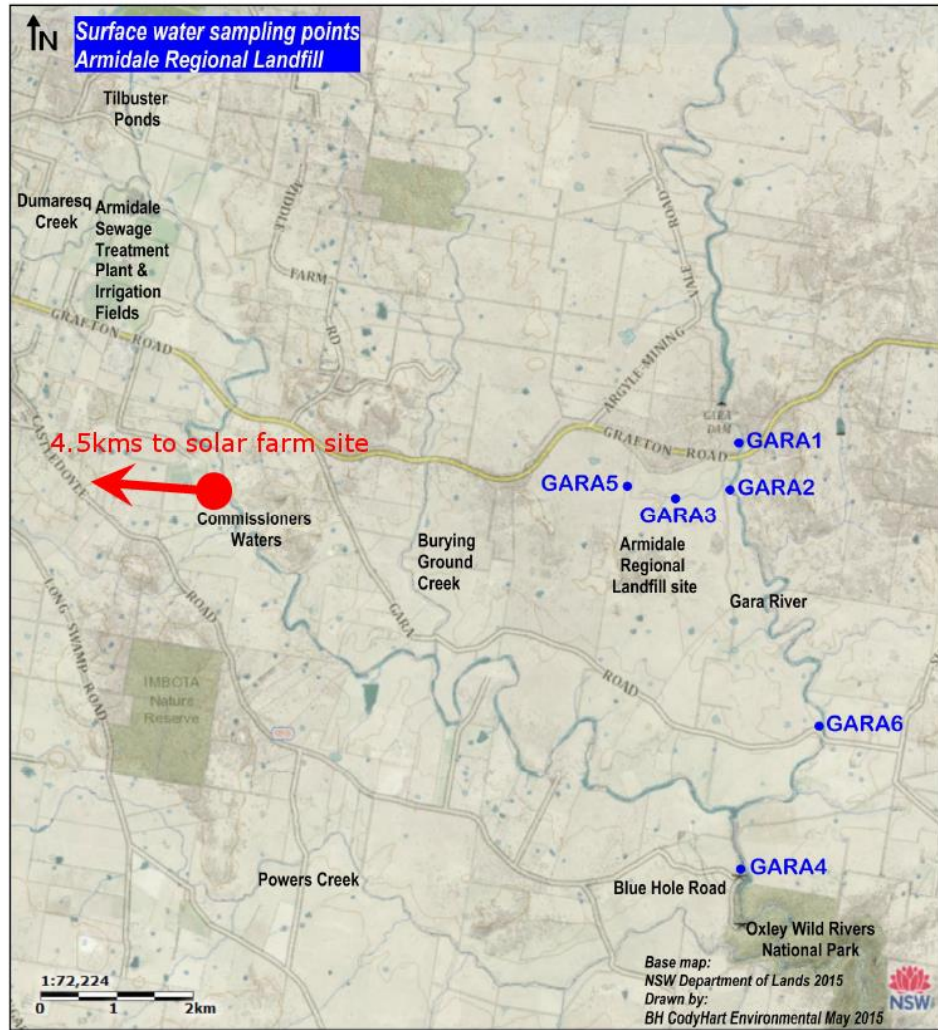


Figure 7: Surface water quality monitoring sites in relation to the proposed solar farm site (map source: AECOM, 2016: page 8)



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

Flood planning maps referenced by the Armidale Regional Council indicate that the site is not within an area likely to flood. However, heavy rainfall during storm events (or flash flooding) may cause disruption during construction activities or for material suppliers.

As a drainage line exists at the site there is potential for overland flow during rainfall. The water will flow into the existing tributaries towards the Commissioners Waters.

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 (NSW OEH, 2019), provides a Soils Essential Report for the Arthurs Seat Site Location (see figure 8 and table 6 below).

Table 6. Site details for Arthurs Seat location

SITE DETAILS

Site Location:	ARTHURS SEAT
Map Reference:	MGA Grid Reference: Zone 56, 374105E, 6617078N. 9236 ARMIDALE (1:100000) map sheet.
Profile Details:	Soil Landscapes of the Armidale 1:100 000 Sheet Survey (1001020), Profile 103, collected by Mr Dacre King on 25 May, 1999
Physiography:	footslope on basalt lithology and used for improved pasture. Slope 20% (not recorded), local relief low (30-90 m), elevation 1050.0 m, aspect south. profile drainage is mod. well drained, erosion hazard is high, and no salting evident
Soil Type:	Haplic Eutrophic Red Ferrosol (ASC), Euchrozem (GSG)
Base of observation:	layer continues
Profile Field Notes:	Footslope - 20% measured - upper slope >25%. Parent material - mixture of basalt, ferricrete. Total soil depth probably about 80cm.

SOIL DESCRIPTION

Layer 0

Coarse fragments are common (10-20%), as rock outcrop, coarse gravel (20-60 mm), cobbles (60-200 mm), stones (200-600 mm)

Layer 1

0.00 - 0.10 m
A1 Horizon

dark red (dark reddish brown) (2.5YR 3/6) [moist] light clay with moderate pedality (angular blocky, 5 - 10 mm, smooth-faced peds), field pH is 6.5. Coarse fragments are very few (< 2%), as parent material, fine gravel (2-6 mm), gravel (6-20 mm), coarse gravel (20-60 mm), pans are not evident; clear (20-50 mm) boundary to ...

Layer 2

0.10 - 0.60 m
B2 Horizon

red (reddish brown) (2.5YR 4/8) [moist] medium heavy clay with moderate pedality (angular blocky, 10 - 20 mm, smooth-faced peds), field pH is 7.5. Coarse fragments are not evident, pans are not evident

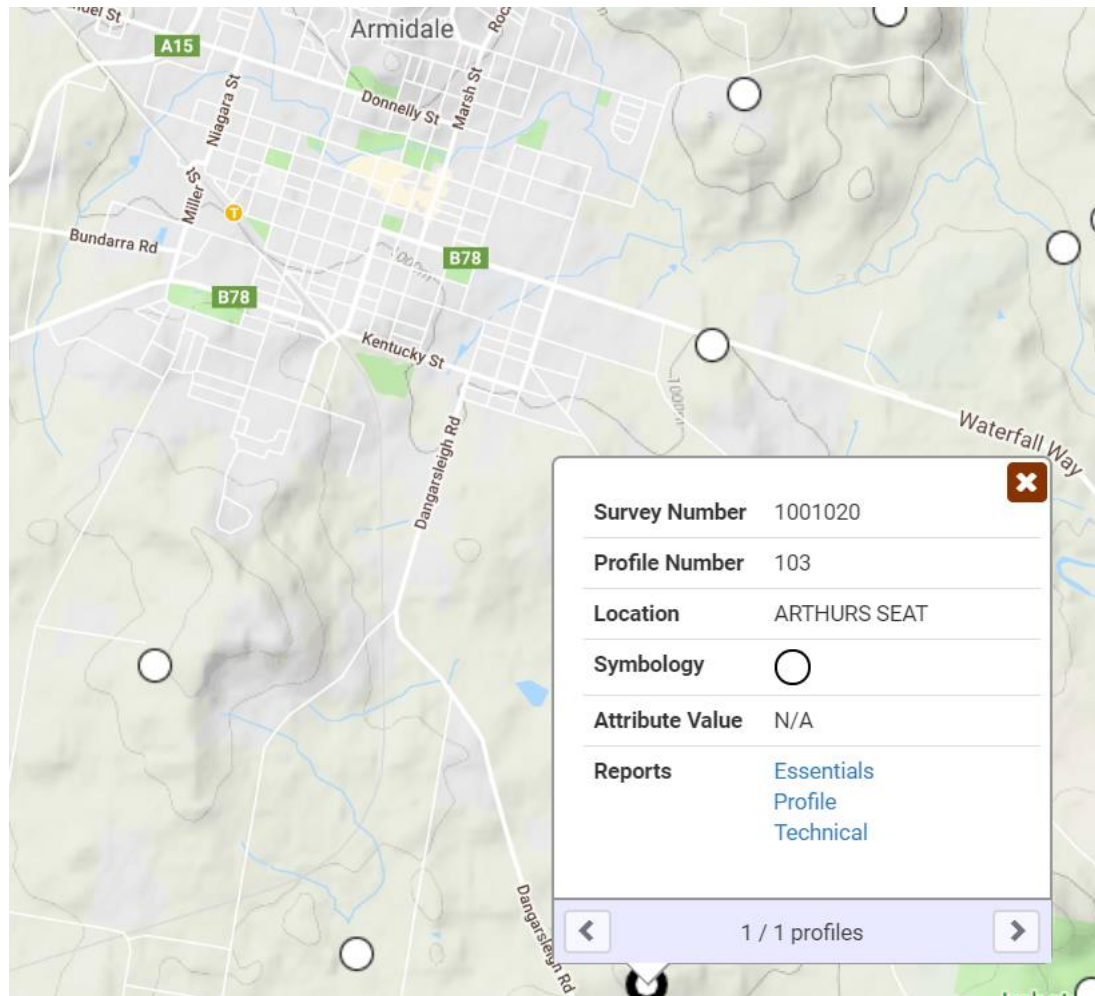


Figure 8. The location of the Arthurs Seat location (source: espade.environment.nsw.gov.au © State of NSW and Office of Environment and Heritage 2019)

There is the potential that site runoff will contain sediments and increase turbidity or other water quality parameters in downstream water ways.

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 .

Table 7: 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 rinsate⁴ 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.
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⁴ 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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