NARRABRI SOLAR FARM

Statement of Environmental Effects

Prepared for:

Providence Asset Group
704/99 Bathurst Street
SYDNEY NSW 2000

SLR Ref: 631.20524-R01
Version No: -v1.0
February 2021

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Suite 2B, 125 Bull Street
Newcastle West NSW 2302

T: +61 2 4940 0442
E: newcastleau@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Providence Asset Group (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
631.20524-R01-v0.4	22 February 2021	Megan Crowhurst	Clare Brennock	Patrick Quinlan

CONTENTS

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1 Introduction

This Statement of Environmental Effects (SEE) is submitted to Narrabri Shire Council (Council) in support of a Development Application (DA) for a solar photovoltaic (PV) power generation plant at 115 Airport Road, Narrabri NSW 2390 (the site).

Specifically, the proposed development includes:

- Establishment of a grid-connected solar photovoltaic (PV) plant including associated electrical generation, supplying no greater than 5 megawatts (MW);
- New 4m to 5m wide access road at the eastern boundary of the site;
- High chain link security fencing 2.3m high; and
- Other associated site improvements as shown on the Plans included as **Appendix A**.

This SEE has been prepared by SLR Consulting (SLR) on behalf of Providence Asset Group (PAG). It describes the site, its environs, the proposed development and provides an assessment of the proposal in terms of the matters for consideration under Section 4.15 (1) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). It should be read in conjunction with the supporting information and Plans prepared by Balance Power and Energy Pty Ltd appended to this report (**Appendix A**).

1.1 Providence Asset Group

Providence Asset Group (PAG) is an Australian innovation led investment and asset management firm focusing on ethical investment within an environmental, social and corporate governance framework. Through collaborative partnerships, PAG supports and invests in projects aligned to new forms of renewable and clean energy.

PAG have now secured over 30 solar farm sites in regional NSW and Victoria, including a partnership with Manilla Community Renewable Energy Inc. to develop Australia's first community owned solar farm. Once constructed the 5MW Manilla project will be able to power the community of Manilla during daylight hours. The project is also a recipient of an NSW Government grant to develop PAG's a world first energy storage technology which will enable PAG's solar projects to provide stable energy well into the early morning and evening peak electricity consumption periods.

1.2 Consultation with Council

Pre-development advice was provided by Narrabri Shire Council representative Erika Dawson via email on 21 December 2020. Overall, the feedback was positive. **Table 1** summarises the matters raised by Council within the pre-lodgement email advice and provides comments on each of the matters raised.

Table 1 Consultation with Narrabri

Matters Raised	Comments
Land Affected by the DA • All land affected by the proposed development is to be included in the DA. This includes any land required for access (excluding public roads). • Provide landowners consent for all land affected by the development. • The impact assessment provided should consider the impacts of the development on all land affected by the development.	This Statement of Environmental Effects provides considers all land affected by the proposed development and the impact the development may have on all affected land. Land owners' consent has also been provided at DA lodgement stage.

DA Plans
 	
The following plans are to be submitted with the DA:
 	
• An existing site plan of all the land to which the DA relates, which is to include the following:
  • Drawn to scale;
  • The location, boundary dimensions, site are and north point of the land;
  • Existing vegetation and trees on the land;
  • The location and uses of existing buildings on the land;
  • Existing levels of the land in relation to buildings and roads; and
  • The location and uses of buildings on sites adjoining the land.
 	
• A proposed site plan of all the land to which the DA relates, which is to include the following:
  • Drawn to scale;
  • The location, boundary dimensions, site area and north point of the land;
	The appropriate plans have been included with this report, see **Appendix A**.
	
	Parking arrangements required to be shown on Development Plans, refer to Section 5.2 below.

Matters Raised	Comments
• Any vegetation and trees on the land to be removed; • The location and uses of all proposed buildings/structures on the land; • Showing proposed access and parking arrangements, entry and exit points for vehicles from the road, driveway location and extent, and provision for movement of vehicles (manoeuvring areas) within the site (including dimensions) and be in compliance with AS2890.1 and AS2890.6 (where applicable); • Showing the location of any new landscaping; • Proposed levels of the land in relation to proposed buildings and roads.	

• A floor plan (of any buildings and structures):
  • Drawn to scale;
  • Showing proposed internal layouts;
  • Showing all proposed openings (windows/doors).
• Elevation Plans (of any buildings and structures):
  • Drawn to scale;
  • Showing all elevations of the building, including any proposed openings (windows and doors);
  • Showing natural ground levels and proposed ground levels;
  • Showing both eave and ridge heights of the building.
	The appropriate plans have been included with this report, see **Appendix A**.

Statement of Environmental Effects • Provides a clear and detailed description of the entire development proposed, and is to include: • Details of all construction related works employee numbers, traffic generated, water requirements;	This Statement of Environmental Effects provides a detailed description of the proposal during both the construction and operational stages. All required legislation is identified within this report. All identified environmental impacts have been addressed.

Matters Raised	Comments
• Details of all operations, including details on maintenance requirements, vegetation management, employee numbers, traffic generated, water requirements; • Any road or other infrastructure upgrade requirements; • Details of remediation of the site post use as a solar farm. • An outline of whether or not the grid connection is part of the development to which the DA applies or not • Consideration of the applicable Environmental Planning Instruments (SEPPs, LEP), DCPs and other applicable legislation. In partial: • SEPP 55 and associated guidelines; • Koala Habitat Protection SEPP; • Infrastructure SEPP; • Narrabri LEP, including Earthworks (Clause 6.1), Flood Planning Area (Clause 6.2), Airspace Operations (Clause 6.3) and Essential Services (Clause 6.5)	
• Identification of the environmental impacts of the development and how the environmental impacts of the development have been identified • Details the measures taken to protect the environment or to lessen the expected harm to the environment.	This Statement of Environmental Effects provides a detailed description of the proposal during both the construction and operational stages. All required legislation is identified within this report. All identified environmental impacts have been addressed.
Traffic A Traffic Impact Assessment (TIA) prepared by a suitably qualified consultant in accordance with Austroads Guide to Traffic Management Part 12 Integrated Transport Assessments for Developments. The TIA is to:	A Traffic Impact Assessment (TIA) has been prepared for the proposal and is provided at **Appendix B**. Within the TIA is an assessment of pre-existing conditions of the roads, traffic generation, vehicle access points, manoeuvring and identification of any road upgrade work required.

Matters Raised	Comments

• Provide an assessment of the existing conditions of the local traffic network to be affected by both construction and operation of the development. This is to include existing traffic volumes (vpd and vph), existing road construction/geometry standards, and safety;
• Outline the traffic generated by the development, including for both construction and operation, including:
  • Identification of transport routes for deliveries,
  • Daily traffic generated and peak hour traffic generated,
  • The size of vehicles required to access the site, including identification of any oversized vehicles required to access the site.
• Consideration of transport impacts of the development including:
  • Impact of development traffic on capacity of local road network and functioning of utilised intersections during the peak hour.
  • Demonstration, via provision of swept paths, that the largest vehicle required to access the site can manoeuvre through all intersections in the local road network and the property access driveway.
  • Identification of any road upgrade works required to facilitate the development from both a geometry perspective and in accordance with Austroads intersection warrants.	

Ecology Advice is to be provided by a suitably qualified ecologist to demonstrate: • Whether the development is likely to significantly affect threatened species or ecological communities, or their habitats, according to the test in section 7.3 of the *Biodiversity Conservation Act 2016* (BC Act);	A Flora and Fauna Assessment Report has been prepared by Kleinfelder and provided at **Appendix C**.

Matters Raised	Comments

• Whether the development exceeds the biodiversity offsets scheme threshold if the biodiversity offsets scheme applies to the impacts of the development on biodiversity values; and
• Whether the development is to be carried out in a declared area of outstanding biodiversity value.
• If the response to any of the items in (i) to (iii) above is in the affirmative, a Biodiversity Development Assessment Report (BDAR) is to be provided in accordance with the requirements of the BC Act.
 	
Advice is to be provided by a suitably qualified ecologist in relation to State Environmental Planning Policy (Koala Habitat Protection) 2019:
• information, prepared by a suitably qualified and experienced person in accordance with the Guideline, to demonstrate that the land subject of the development application—
  • does not include any trees belonging to the koala use tree species listed in Schedule 2 for the relevant koala management area, or
  • is not core koala habitat, or
• information, prepared in accordance with the Guideline, to demonstrate that the land subject of the development application—
  • does not include any trees with a diameter at breast height over bark of more than 10 centimetres, or
  • includes only horticultural or agricultural plantations.	

Glare A Glare Analysis prepared by a suitably experienced consultant to consider potential glare impacts from the development on operation of the airport, residential receptors, road users, rail users, and any airstrips. Noting the DA will be referred to CASA.	A Reflectivity Glare Assessment has also been conducted for the application and is located at **Appendix D**.

Matters Raised	Comments
Visual Impact A Visual Impact Assessment prepared by a suitably experienced consultant to consider potential visual impacts from the development on residential receptors and other potentially affected receptors.	A Visual Analysis and Landscape Concept has been prepared for the proposal and is provided at **Appendix E**.
Agricultural Land Impacts An assessment on the impact of the development on productive agricultural land.	Refer to Section 2.2, the proposal will not have any impact on the productivity of surrounding agricultural lands.
Flood Impact The site is mapped as being within a flood planning area on the LEP. An assessment of flood impact is to be provided, at a minimum, addressing the considerations of clause 6.2 of the LEP.	A Flood Impact Assessment has been prepared for the proposal and is provided at **Appendix F**.
Watercourse Interactions The site contains a watercourses. These are to be clearly shown on the DA site plans. Any works within 40m of the top of the bank of the watercourse (i.e. waterfront land) will require a referral to the Natural Resources Access Regulator (NRAR), as Integrated Development. Full details of any works within waterfront land will be required as part of the DA. It is recommended that consultation be undertaken with NRAR prior to lodgement of the DA to ensure the development is consistent with NRAR requirements.	The appropriate plans have been included with this report, see **Appendix A**. These plans show that works proposed are not within 40m of the top of the bank of any nearby watercourses.
Staff Amenities If any staff amenities are proposed as part of the development, a waste water treatment report will be required to be submitted with the DA, along with details on the site plan of the location of the effluent management system and land application area.	Temporary construction staff amenities will be provided on site. No permanent staff amenities are proposed given the nature of the ongoing operation.
Narrabri Airport Narrabri Airport is subject to a strategic masterplan for future growth and expansion. http://www.narrabri.nsw.gov.au/index.cfm?page_id=1157	The site is not located within the airport's future development area, nor does the proposed development hinder the future development or operation of the airport.

Matters Raised	Comments
Any DA will need to demonstrate that it is not inconsistent with the masterplan and will not hinder attainment of future development in the airport precinct.	

2 The Site and Surrounds

2.1 Site Description

The land is legally known as Lot 489 DP 754944 and is generally referred to as 115 Airport Road, Narrabri, NSW 2390 (refer to **Figure 1** and **Figure 2**). The land is currently used for agricultural purposes including livestock grazing with historical improved pastures. In terms of topography, the site is relatively flat with a gradual slope from the southeast to the northwest at slopes of approximately 0.3%.

The proposed development site is a 5-sided polygon shape which is generally flat and comprises approximately 15 hectares. The development site is located in the south eastern corner of Lot 489 DP754944, with a frontage of approximately 385 metres to Airport Road to the east. Access to the site is via Airport Road, which is a sealed road, two-way road, that connects the site to Kaputar Road to the south. Kaputar Road connects to the north west of the Narrabri township via Old Gunnedah Road. A watercourse runs east to west across the lot, directly above the northern boundary of the proposed development area.

A 'Dial Before You Dig' search showed that there are no underground power lines running or underground gas infrastructure traverse the development area in Lot 489 DP754944. There are electricity poles running through the middle of the lot, along the northern boundary of the development area. Within the wider investigation area there are underground earth or wires located to the south-east of the development area bordering to the east of Lot 21 DP 869574.

As noted within the Certificate of Title for Lot 151 DP755475, a number of easements and restriction are applicable to the site including:

- *Easement for Transmission Line Affecting The Part of The Land above described shown so burdened in the Title Diagram vide notif. in gov. gaz. Dated 23.12.1976, Folio 5757 2031924 Easement vested in New South Wales Electricity Transmission Authority*

An investigation of the obtained Crown Plan 2210.1774 shows an easement running diagonally across the south western corner of the proposed development area. The easement is for the transmission lines which are identified in the title certificate. Based on the above, the location of the solar PV farm is clear of the registered easements, as outlined in the plans provided at **Appendix A**.

Figure 1 Locality Plan (Source: Six Maps)

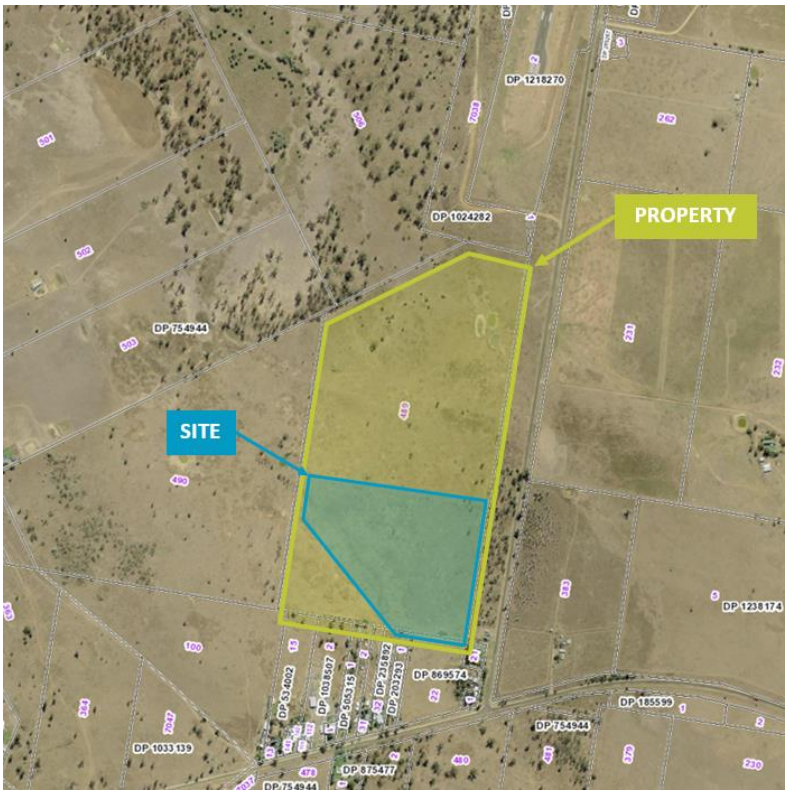


Figure 2 Cadastral Plan (Source: Six Maps)

2.2 Site Location and Context

The site is located approximately 3.6km east of the Narrabri town centre and approximately 3.15km south-east of the Narrabri Shire Council's office, within the Narrabri Shire Council Local Government Area (LGA). Airport Road is a two-lane two-way, sealed road with no kerb or guttering on either side. Entry to the Narrabri Airport is approximately 2km north of the site travelling along Airport Road. The Narrabri Airport runway at its most southern location is approximately 1.1km from the development area.

Surrounding lands are similar to the investigation area consisting of agricultural land with rural dwellings, sheds, dams, and scattered remnant vegetation. There is an unnamed watercourse running through the site east to west, immediately north of the development area. A setback of approximately 100m from the watercourse has been applied to the development plans in **Appendix A**. While the closest residential dwelling to the proposed development site is immediately to the south of the site on Lot 21 DP869574, there is a cluster of rural residential dwellings whose properties share a boundary with the site.

The solar array is designed to minimise impacts on existing farming activities adjacent to the development area. The site has also been located on the extremity of the landholdings whilst providing continued access to the remainder of the lot for agricultural activities. Opportunities for livestock grazing (sheep) is currently being explored with the landowner, which can be easily accommodated through the design proposed.

3 Project Description

The Narrabri Solar Farm project is one of PAG's solar initiatives to be rolled out across regional Australia, with multiple benefits for rural and regional communities.

The proposal includes a no larger than 5MW grid-connected solar PV installation. The solar farm will be connected to the existing Narrabri Substation at 48 Stoney Creek Road, which is approximately 3km north-west of the proposed development site via the current overhead electricity power lines within proximity to the site.

The proposed development aims to erect an estimated 11,592 solar PV panels with a nameplate rating of 540W. Other electrical generation infrastructure is proposed on the site including a skid-mounted MV Power Station consisting of inverters, transformer and switchgear. Due to the capacity of the inverter system, the proposed development will produce less than 5MW. Most of the infrastructure will be pre-fabricated off-site, delivered and assembled on-site.

The PV arrangement will consist of 142 ground mounted single axis trackers. The PV arrays will have a clearance above the existing ground surface and extend to approximately 2.6m at maximum tilt. The PV mounting structure will comprise of steel posts driven to approximately 1.5m below ground using a small pile driver. Additional support structures will be attached to the piles, which will then support the PV panels.

The proposal will require the removal of native vegetation within the development area, including six trees (White Cypress Pine) and three dead stags, two of which contain hallows. A negligible amount of groundcover vegetation is required to be removed. The proposal will not involve clearing of native vegetation that exceeds the Biodiversity Offset Scheme (BOS) threshold for the site.

A 5m wide access road is proposed connecting the solar farm to Airport Road at the south eastern corner of the lot. The solar farm will be fully fenced with a 2.3m security fencing including barbed wire at the top. Gate access is provided on the eastern border of the site. A loading area and temporary construction office are indicatively shown on the General Arrangement Plan (refer to **Figure 3** and **Appendix A**). Motion activated security lighting may be installed at the site.

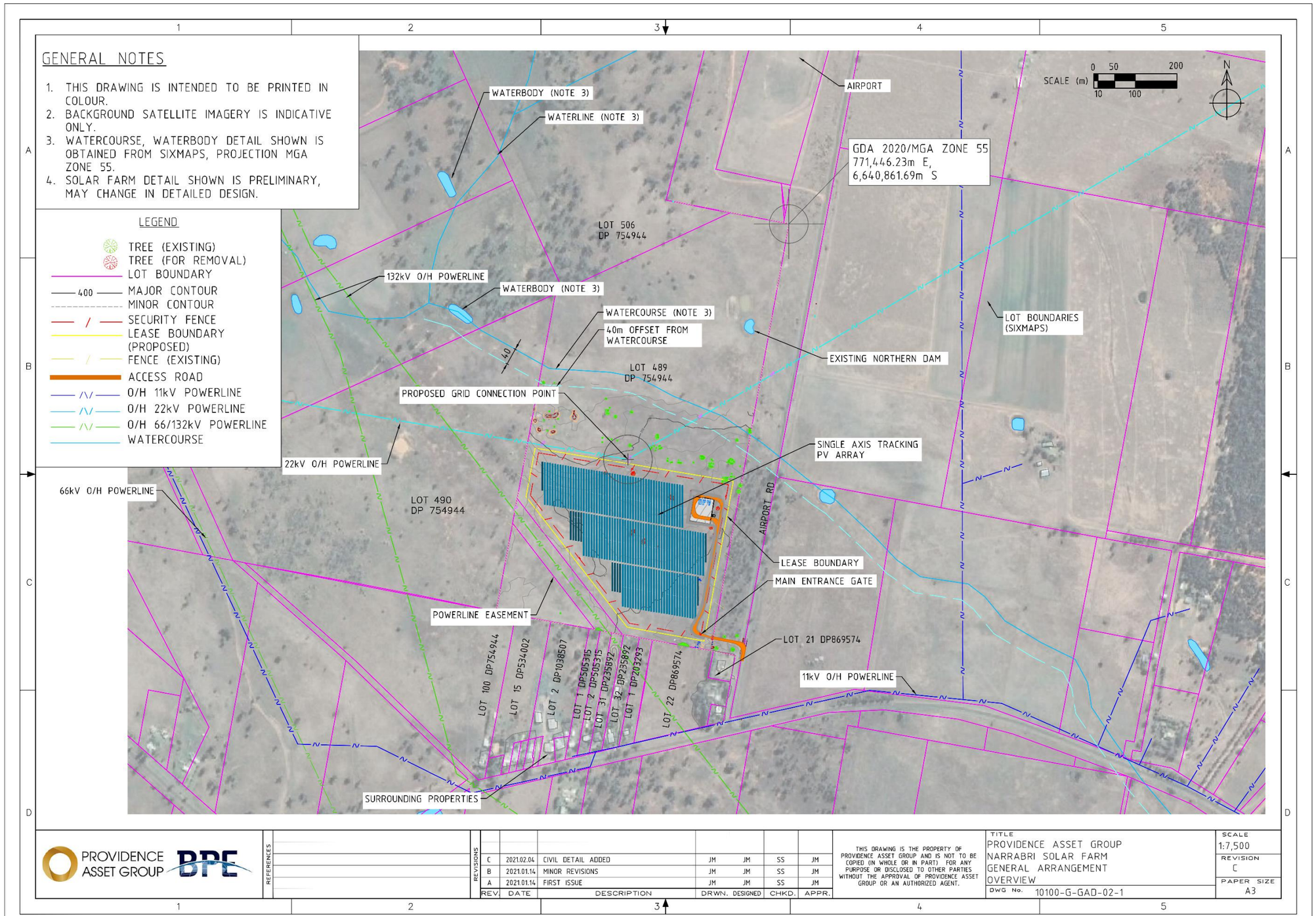
A stormwater management system is proposed including an onsite detention basin holding a total volume of 142m^3 supported with a low flow outlet. Refer to the Stormwater Management Plans at **Appendix G**. Earthworks for the project are generally limited to the establishment of the access road, drainage swales and batters, laydown area, and detention basin.

During the construction period there is estimated to be up to 30 personnel on site for up to 6 months.

The solar PV farm will operate 24 hours a day, 7 days a week, with no permanent staff on site. Maintenance inspections will be undertaken daily or on an as needs basis.

After operation, the site will be re-established as grasslands.

Figure 3 Proposed Development Layout



4 Relevant Legislation and Planning Controls

The following Environmental Planning Instruments (EPIs) and Development Control Plans (DCPs) are relevant to the proposed development as explored within this Section of the report:

- *Environment Protection and Biodiversity Conservation Act 1999*;
- *Environmental Planning and Assessment Act 1979*;
- *Water Management Act 2000*;
- *National Parks and Wildlife Act 1974*;
- *Biodiversity Conservation Act 2016*;
- *Local Land Services Act 2013*;
- State Environmental Planning Policy (Infrastructure) 2007;
- State Environmental Planning Policy (Koala Habitat Protection) 2019;
- State Environmental Planning Policy (State and Regional Development) 2011;
- State Environmental Planning Policy 55 – Remediation of Land;
- Narrabri Local Environmental Plan 2012;
- Narrabri Development Control Plan 1993;
- New England North West Regional Plan 2036; and
- New England North West Strategic Land Use Plan 2012.

4.1 Environment Protection and Biodiversity Conservation Act 1999

Consideration of the EPBC Act 1999 revealed that impacts on Matters of National Environmental Significance (MNES) are unlikely to occur. No EPBC listed species, ecological communities, migratory species or important habitat for such entities was identified within the subject site. The assessment determined that impacts to Matters of National Environmental Significance (MNES) are unlikely; therefore, an EPBC referral to the Commonwealth Minister for the Environment is not recommended.

Full details are included in the Flora and Fauna Assessment Report at **Appendix C**.

4.2 Environmental Planning and Assessment Act 1979

The proposal, as with all development applications, is subject to the provisions of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Section 4.15(1) of the EP&A Act, 1979 provides criteria which a consent authority is to take into consideration, where relevant, when considering a DA. An assessment of the subject DA, in accordance with the relevant matters prescribed under Section 4.15(1), is provided within this SEE.

Clause 4.46 Integrated Development

Development is deemed to be integrated if approvals from other public authorities are required before consent for the development can be granted. This will require Council to refer the application to the relevant authority for their requirements.

As part of the concurrence process, the relevant authority will undertake their respective assessment process providing their consent and required conditions (if in support) to Council at completion. Timeframes for the concurrence process is either 40 days or 21 days in addition to any public notification period, however agencies commonly exceed the timeframes. The proposal is not considered to be integrated development.

4.3 Water Management Act 2000

Under the *Water Management Act 2000*, waterfront land includes the bed and bank of any river, lake or estuary and all land within 40m of the highest bank of the river, lake or estuary (NRAR, 2018). An unnamed watercourse is located in the middle of the Lot, to the north of the development area. The proposed development does not include any works within 40m of the waterway and therefore an activity approval under the *Water Management Act 2000* from the NSW Department of Planning, Industry and Environment Water Division is not required, therefore also not triggering the development as integrated development under clause 4.46 of the EP&A Act.

4.4 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* includes provisions for the protection and recording of Aboriginal objects in NSW.

An Aboriginal site investigation has been undertaken in accordance with the provisions of the *National Parks and Wildlife Regulations 2009* and the accompanying Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (OEH 2010). Refer to **Appendix H** for the Due Diligence Archaeological Assessment prepared by Virtus Heritage. The assessment concludes that no Aboriginal objects were identified during the site visit and no areas of archaeological potential are identified within the project area. There are also no Aboriginal places registered within the project area.

4.5 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) aims to maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development. To achieve its goals, the BC Act governs endangered species and communities and provides a framework for a Biodiversity Offset Scheme (BOS).

An assessment was undertaken by Kleinfelder in accordance with Section 7.3 of the BC Act to determine the significance of potential impacts of the proposed development on any threatened species or communities which are listed within the Act.

No threatened ecological communities or any listed flora or fauna were identified on site with the proposed development unlikely to cause any significant impact to any threatened species, populations or communities listed within the BC Act.

Entry into the NSW BOS is not triggered by the proposed development. Further details are provided in Section 5.4 of this Report.

4.6 Local Land Services Act 2013

60H Category 1 – Exempt Land Mapping

(1) Land is to be designated as category 1-exempt land if the Environment Agency Head reasonably believes that—

(a) the land was cleared of native vegetation as at 1 January 1990, or

(b) the land was lawfully cleared of native vegetation between 1 January 1990 and the commencement of this Part.

(2) Land is to be designated as category 1-exempt land if the Environment Agency Head reasonably believes that—

(a) the land contains low conservation value grasslands, or

(b) the land contains native vegetation that was identified as regrowth in a property vegetation plan referred to in section 9 (2) (b) of the Native Vegetation Act 2003, or

(c) the land is of a kind prescribed by the regulations as category 1-exempt land.

(3) Land is to be designated as category 1-exempt land if the land is biodiversity certified under Part 8 of the Biodiversity Conservation Act 2016 or under any Act repealed by that Act.

(4) However —

(a) land described in subsection (1) or (2) is not to be designated as category 1-exempt land if section 60I (2) requires the land to be designated as category 2-regulated land, and

(b) land described in subsection (1) (a) is not to be designated as category 1-exempt land if the land was unlawfully cleared of native vegetation after 1 January 1990, and

(c) land described in subsection (2) (a) is not to be designated as category 1-exempt land if the land was unlawfully cleared of native vegetation after 1 January 1990.

(5) The regulations may make provision for the purposes of determining whether grasslands are low conservation value grasslands for the purposes of this Division.

The proposed development area in the subject site of Lot 489 DP 754944 has been under regular cropping, grazing and pasture improvement since prior to 1990. Therefore, in accordance with the *Local Land Services Act 2013*, the full project development area can be considered as category 1 - exempt land.

4.7 State Environmental Planning Policy (State and Regional Development) 2011

Regional development classification applies to both local and designated development applications exceeding certain criteria defined by Schedule 7 of the 4.6 State Environmental Planning Policy (State and Regional Development) 2011 (SEPP SRD).

5 Private infrastructure and community facilities over $5 million

Development that has a capital investment value of more than $5 million for any of the following purposes:

> *(a) air transport facilities, **electricity generating works**, port facilities, rail infrastructure facilities, road infrastructure facilities, sewerage systems, telecommunications facilities, waste or resource management facilities, water supply systems, or wharf or boating facilities,*
>
> *(b) affordable housing, child care centres, community facilities, correctional centres, educational establishments, group homes, health services facilities or places of public worship.*

The proposed electricity generating works is considered to be private infrastructure with a capital investment value (CIV) greater than $5 million and as a result the development is deemed to be regionally significant development and the application will be referred to the Regional Planning Panel (RPP) for determination.

4.8 State Environmental Planning Policy (Infrastructure) 2007

Division 4 Electricity generating works or solar energy systems

One of the aims of SEPP (Infrastructure) 2007 is to provide greater flexibility in the location of infrastructure and service facilities. This SEPP identifies certain electricity generating works that are permitted with consent, without consent, as exempt development, as complying development and works that are prohibited.

In this division –

> ***electricity generating works** has the same meaning as it has in the Standard Instrument.*
>
> *Note—*
>
> *The term electricity generating works is defined by the Standard Instrument as follows—*
>
> > ***electricity generating works** means a building or place used for the purpose of—*
> >
> > *(a) making or generating electricity, or*
> >
> > *(b) electricity storage.*

Clause 34 Development permitted with consent

> *(1) Development for the purpose of **electricity generating works** may be carried out by any person with consent on the following land—*
>
> > *(a) in the case of electricity generating works comprising a building or place used for the purpose of making or generating electricity using waves, tides or aquatic thermal as the relevant fuel source—on any land,*
> >
> > *(b) in any other case—any land in a prescribed rural, industrial or special use zone.*

Definition:

> ***prescribed rural, industrial or special use zone*** *means any of the following land use zones or a land use zone that is equivalent to any of those zones—*
>
> *(a) RU1 Primary Production,*
>
> *(b) RU2 Rural Landscape,*
>
> *(c) RU3 Forestry,*
>
> *(d) RU4 Primary Production Small Lots,*
>
> *(e) IN1 General Industrial,*
>
> *(f) IN2 Light Industrial,*
>
> *(g) IN3 Heavy Industrial,*
>
> *(h) IN4 Working Waterfront,*
>
> *(i) SP1 Special Activities,*
>
> *(j) SP2 Infrastructure.*

The development area is zoned RU1 Primary Production, therefore the proposed solar PV project is permitted with consent under Clause 34 of SEPP (Infrastructure) 2007.

Clause 45 Determination of development applications - other development

The proposed development will require works to connect to the overhead electricity power lines and as a result constitutes works within 5m of powerlines. Due to the location and nature of the proposed development referral to the electricity supply authority, Essential Energy, will be required during the assessment period.

Clause 104 Traffic-generating development

The proposed development will not generate greater than 50 vehicle movements per hour and therefore does not trigger traffic generating development under the SEPP. Referral under this clause to Transport for NSW is not required.

4.9 State Environmental Planning Policy 55 – Remediation of Land

This SEPP requires the consent authority to consider the potential contamination status of the land prior to approving a development.

A search of the NSW EPA's 'List of NSW contaminated sites notified to the EPA' and 'POEO Public Register' has been undertaken which revealed no contaminated sites listed on or in the vicinity of the site. A total of 14 licences have been issued under the *Protection of the Environment Operations Act* in Narrabri, however, none are noted within proximity to the site. Environmental protection licences issued within Narrabri include:

- Licence 6957 – Auscott Marketing Pty Ltd – 21154 Kamilaroi Highway, Narrabri – Operational;

- Licence 3778 – Boral Resources (Country) Pty Limited – Wave Hill Road, Narrabri – Operational;
- License 902 – Cargill Processing Limited – Baranbar Street, Narrabri West – Operational;
- Licence 1477 – CSR Limited – Colgoora Road, Narrabri – Surrendered;
- Licence 20236 – G & S Lein Earthmoving Pty Ltd - Sandy Creek Lane, Narrabri – Revoked;
- License 7196 – Hunter and New England Area Health Service – 11 Cameron Street, Narrabri – No Longer in Force;
- License 20139 – Johnstone Concrete and Landscape Supplies Pty Ltd – Wavehill Road, Narrabri – Operational
- License 11572 – Malcolm Francis Gett – Culgoora Road, Narrabri – Surrendered.
- License 200 – Narrabri Shire Council – Newell Highway, Narrabri – Operational;
- License 10697 – Narrabri Shire Council – Namoi Street, Narrabri – Operational;
- License 11760 – Narrabri Shire Council – Wave Hill Road, Narrabri - Highway, Narrabri – Surrendered;
- License 12193 – Narrabri Shire Council – Yarrie Lake Road, Narrabri – Operational;
- License 20350 – Santos NSW (Eastern) Pty Ltd – X Line Road, Narrabri – Operational; and
- License 20378 – Santos NSW (Eastern) Pty Ltd – 300 Yarrie Lake Road, Narrabri – Operational.

The proposed development is not considered to be sensitive in nature and as a result is considered to be appropriate for the site in its current state in accordance with SEPP 55.

4.10 State Environmental Planning Policy (Koala Habitat Protection) 2019

The State Environmental Planning Policy (Koala Habitat Protection) 2019 (Koala SEPP) aims to encourage the conservation and management of areas of natural vegetation that provide habitat to koalas to support a permanent free-living population over their present range and reverse the current trend of koala population decline.

The Flora and Fauna Assessment (**Appendix C**) provides an assessment of Koala habitat within the subject site determined that no *Highly Suitable Koala Habitat*, or *Core Koala Habitat* is present.

4.11 Narrabri Local Environmental Plan 2012

The development area is zoned RU1 Primary Production under the Narrabri Local Environmental Plan 2012 (LEP 2012), see **Figure 4**.

Figure 4 Land Zone Map Extract, Narrabri LEP 2012 (LZN_004K)

Zone RU1 Primary Production

1 Objectives of zone

- *To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.*
- *To encourage diversity in primary industry enterprises and systems appropriate for the area.*
- *To minimise the fragmentation and alienation of resource lands.*
- *To minimise conflict between land uses within this zone and land uses within adjoining zones.*
- *To allow for non-agricultural land uses that will not restrict the use of other land for agricultural purposes.*

2 Permitted without consent

Building identification signs; Environmental protection works; Extensive agriculture; Farm buildings; Forestry; Home occupations; Intensive plant agriculture; Roads

3 Permitted with consent

Air transport facilities; Airstrips; Animal boarding or training establishments; Aquaculture; Bed and breakfast accommodation; Boat launching ramps; Boat sheds; Camping grounds; Cellar door premises; Cemeteries;

Community facilities; Depots; Dual occupancies; Dwelling houses; Environmental facilities; Extractive industries; Farm stay accommodation; Flood mitigation works; Freight transport facilities; Helipads; Home businesses; Home industries; Information and education facilities; Intensive livestock agriculture; Landscaping material supplies; Open cut mining; Plant nurseries; Recreation areas; Recreation facilities (major); Recreation facilities (outdoor); Research stations; Roadside stalls; Rural industries; Rural workers' dwellings; Signage; Turf farming; Water recreation structures; Water supply systems

4 Prohibited

Any development not specified in item 2 or 3

The proposed land use, defined as *electricity generating works* (see below), is prohibited under the Narrabri LEP 2012 within the RU1 zone as *any other development not specified in item 2 or 3.* Notwithstanding, the proposal is permissible under Clause 34 of SEPP (Infrastructure) as discussed in Section 4.7.

LEP 2012 Definition:

electricity generating works *means a building or place used for the purpose of—*

(a) making or generating electricity, or

(b) electricity storage.

While the proposal is not a permitted use under the NLEP, it is within a prescribed zone under the ISEPP and permissible with consent, as outlined in the Sections above.

The proposed development is consistent with the relevant objectives of the RU1 zone, including that it will provide a sustainable rural land use whilst maintaining and enhancing the existing natural resource base.

Clause 4.1 Minimum Subdivision Lot Size

The minimum lot size for subdivision on the property is 100 hectares. No subdivision is proposed as part of this application.

Clause 4.3 Height of Buildings

This clause has not been adopted under the LEP.

Clause 4.4 Floor Space Ratio

This clause has not been adopted under the LEP.

Clause 5.10 Heritage Conservation

The site does not contain a listed heritage item nor are any listed heritage items located in proximity to the area. The area is not mapped as a heritage conservation area under the LEP 2012.

Clause 6.1 Earthworks

The objectives of this clause are:

(1) The objective of this clause is to ensure that earthworks for which development consent is required will not have a detrimental impact on environmental functions and processes, neighbouring uses, cultural or heritage items or features of the surrounding land.

The solar panels themselves retain the natural landform and only minor earthworks are required for the underground cabling and supporting infrastructure (access roads, stormwater management etc). The earthworks proposed will have minimal impact on surrounding lands and will be supported with appropriate sediment and erosion controls.

Clause 6.2 Flood Planning

The site is mapped within a flood prone land area under the LEP 2012 (refer **Figure 5**). The Planning Certificate for the site confirms the site is flood prone and therefore a Flood Impact Assessment has been prepared by Torrent Consulting and included at **Appendix F**.

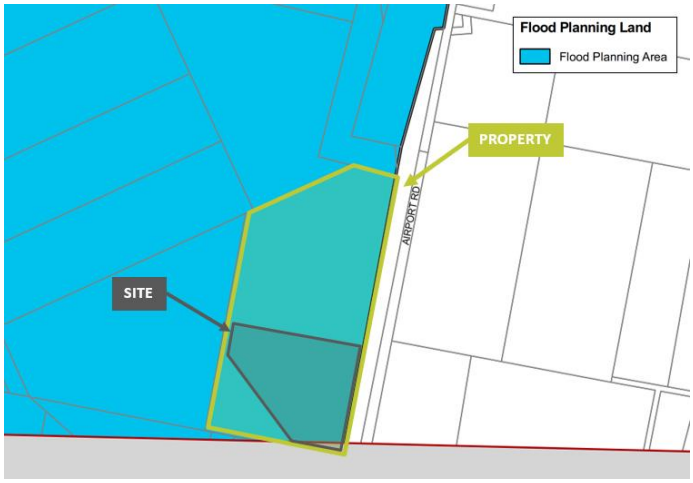
The Flood Impact Assessment has included modelling for the local catchment runoff and has simulated design flood conditions in accordance with the ARR 2019 guidelines, specifically the ensemble method for design flood hydrology. The main river flood conditions of the Namoi River have also been reproduced, using information contained in the Narrabri Floodplain Risk Management Study and Plan.

Flood hazard mapping has been produced that shows that the site is of a low flood risk and is suitable for the proposed solar farm.

The flood modelling results show that at the 1% AEP event (and the 0.5% AEP event) the proposed solar farm infrastructure is unaffected by flooding, with the solar farm area being flood-free. Ample flood-free refuge is available on-site if people are present during a local catchment flood event and all but an extreme flood event of the Namoi River, during which the entire site would be inundated. It is advised that the solar farm be closed to site visitors in the event of a major flood warning being issued by the BoM for the Namoi River to manage this minimal risk. This course of action is advisable regardless of risk to the site, as local and regional roads could be flood-affected, preventing site access.

The Flood Impact Assessment concludes that as the proposed solar farm is only inundated in an extreme flood event, the potential for adverse off-site flood impacts is negligible and therefore further consideration of flood impacts is not required.

Figure 5 Flood Planning Map Extract, Narrabri LEP 2012 (LZN_004G)



Clause 6.3 Airspace Operation

The objective of this clause is to provide for the effective and ongoing operation of the Narrabri Airport and to protect the community for undue risk from that operation. Narrabri Airport is approximately 1.1km north of the proposed site. The Planning Certificate confirms that the site has been identified as being within the Narrabri Airport Obstacle Limitation Surfaces. The maximum height limit for the investigation area is 250m AHD. A Reflective Glare Assessment (RGA) has been undertaken by SLR Consulting and included as **Appendix D**.

Quantitative analysis using the FAA-SGHAT software tool has shown that there will be nil glare from the project at Narrabri Airport with the solar array in normal tracking mode, i.e. panels tilting ±60°. The SGHAT results show potential for glare involving the panels being left at a fixed tilt angle of between 30° (westwards) to 40° (eastwards). Accordingly, such a situation should be avoided, e.g. during construction, during maintenance periods, etc.

Clause 6.5 Essential Services

Provision of services, including stormwater drainage, and vehicular access suitable for the proposed development will be satisfactory provided for the site.

In summary, the proposal is compliant with the relevant clauses and controls contained within LEP 2012 with the exception of permissibility, which is overridden by SEPP Infrastructure.

4.12 Narrabri Development Control Plan 1993

The Narrabri Development Control Plan (DCP) 1993 applies to all land within the Narrabri Local Government Area (LGA), including the subject site. The project has been assessed against the Industrial Development Code and the Parking Code of the DCP 1993.

A full assessment against the relevant components of the DCP is included in table format at **Appendix I**.

4.13 New England North West Regional Plan 2036

The New England North West Regional Plan 2036 (the Regional Plan) provides an overall strategic plan to manage development in the New England region.

The Regional Plan distinctly highlights the role of renewable energy in the growth of the New England region with the plan's visions outlining the need for the area to harness the solar and wind potential. Goal 1 – A strong and dynamic regional economy identifies renewable energy as a priority growth sector. Direction 5 of the Plan further calls for the promotion and growth of the renewable energy sector, specifically the solar sector through supporting and facilitating smaller-scale renewable solar projects.

Furthermore, the Plan outlines the future economic narrative for Narrabri Shire LGA. The Plan states that a priority for the Narrabri LGA is to improve electricity infrastructure to cater for the forecasted population growth. Direction 2.3 of the Regional Plan seeks to increase opportunities for renewable energy generations such as solar, with the Plan identifying 2 solar farms (120MW & 300MW) that were already being developed in Narrabri.

The proposed development on the subject site will align with the goals of the Regional Plan as it will provide an appropriately sized renewable energy project in a location with ready access to the electrical network which will support the regional development of the township of Narrabri and the larger Narrabri LGA and New England Region.

4.14 New England North West Strategic Land Use Plan 2012

The New England North West Land Use Strategy aims to guide future development and land use within the New England region for the next 20 years. The preparation of the strategy provides the basis for future planning decisions and provide certainty to the community whilst encouraging favourable development and the protection of the environment.

The New England region has been identified as one of six renewable energy precincts across NSW. Additionally, the Narrabri LGA has been marked to have excellent conditions for solar power farms due to high solar irradiation levels and a suitable average temperature range for photovoltaic systems.

5 Assessment of Planning Issues

The following is an assessment of the environmental effects of the proposed development as described in the preceding sections of this SEE. The assessment considers only those matters under Section 4.15(1) of the EP&A Act that are relevant to the proposal.

5.1 Compliance with Planning Instruments and Controls

Unless otherwise stated, the proposed development either complies with or is consistent with all relevant planning instruments and controls set out in Section 4 of this SEE, in that:

- The proposed development is permissible under SEPP Infrastructure in the RU1 Primary Production zone;
- The proposed Solar PV Farm is consistent with the relevant objectives of the RU1 zone, including that it will provide a sustainable rural land use whilst maintaining and enhancing the existing natural resource base;
- The proposed solar farm will have minimal impact on any potential listed flora or fauna under the BC Act;
- The development is classified as Regional Development under SEPP State and Regional Development and will therefore be determined by the RPP;
- The proposal complies with the requirements of SEPP Infrastructure and referral to the road authority will not be required as the proposal is not classified as traffic generating development; and
- The proposal is generally consistent with the objectives and relevant controls within Narrabri DCP 1993. A detailed assessment of the proposed development against the relevant provisions of the DCP is provided in the table at **Appendix I**.

5.2 Traffic, Access, and Parking

Traffic

A Traffic Impact Assessment (TIA) has been undertaken by Intersect Traffic and is attached at **Appendix B**. The anticipated rates of traffic likely to be generated from the proposed development (both during construction and once operational) are discussed in the TIA.

The majority of traffic movements associated with the development will occur during the construction of the solar farm (approximate 6-month period) with the delivery of panels and prefabricated structural supports. Deliveries during construction works would be expected to be within rigid and articulated vehicles and the access road has been designed to safely accommodate these vehicles.

Traffic movements generated during operation will include a single staff light vehicle associated with maintenance inspections and specific maintenance work (on an as needs basis) which would be short term and infrequent.

During construction the development will generate up to a predicted peak of 18 vehicle movements (per hour) to and from the site during the weekday AM and PM peak periods consisting of 10 light vehicle movements, 6 roadwork and other plant vehicle movements, and 2 delivery vehicle movements. Based on the data collected from traffic surveys, the surrounding road network has sufficient capacity to cater to the projected construction traffic with capacity to spare for future development in the area. Construction traffic is temporary in nature and will be managed through a future Construction Traffic Management Plan, provided post development approval.

The TIA notes the existing condition of the surrounding roads, including Kamilaroi Highway, Old Gunnedah Road, Kaputar Road and Airport Road. At the time of assessment, all four roads were considered to be in good condition. It is considered the local and state road network would be suitable to cater for the expected construction traffic associated with the development.

The TIA found both Kamilaroi Highway and Old Gunnedah Road are suitable for the heavy vehicle traffic during construction, however Kaputar Road and Airport Road are not a designated B-Double route.

In summary, the additional traffic anticipated from the proposal has been assigned to the road network where it was found that the surrounding road network is capable of accommodating the expected additional traffic from the proposal. Given the construction will be completed within a 6 month period and the peak operational traffic volume from the site is only 2 vehicle trips per hour (vtph) there is no need to do a 2030 (10 year horizon period) assessment of this development.

Access and Internal Circulation

During the construction phase of the development there will be a construction access point off Airport Road at the south eastern corner of the site. Access to the site will be via a new access road which runs inside the eastern boundary of the site. The proposed width at the combined entry/exit access is 3-5.5m wide, however the proposed turning apron off Airport road will be a minimum of 12.5m wide. The proposed driveway will provide for the turning movements of cars and service vehicles, in accordance with Council controls and the Australian Standard for Parking Facilities (Part 1: Off-street car parking and Part 2: Off-street commercial vehicle facilities), AS 2890.1:2004 and AS 2890.2 –2002. Furthermore, sight distance at the proposed access point was observed to be in excess of 250 metres in each direction and therefore complies with the relevant Australian Standards.

Parking

The Narrabri Shire DCP 1993 sets out the relevant on-site car parking rates for land uses within the Narrabri area. No gross floor area is proposed as part of the development.

As no DCP rate is provided specifically for a solar farm, adopting the ‘factories’ rates for this project, the relevant on-site car parking provision during the operation is 1.3 spaces per 100m² GFA.

As no buildings are proposed on site on the site and only 1 employee engaged in the day to day operation of the solar farm, the development is not required to provide any on-site parking space under the DCP calculations. However, with a single maintenance vehicle visiting the site between 1 to 5 times per fortnight, at least one vehicle car park within the development is considered to be satisfactory.

Consideration of construction parking demand has also been considered with potential for up to 30 employees projected. A total of 10 car parks are proposed with additional space afforded for potential onsite overflow if required. The car parking area is to comply with the requirements of Australian Standard AS2890.1-2004 Parking Facilities – Part 1 Off-street car parking with parking bay sizes 2.4 m x 5.4 m and aisle widths of 5.8 metres. Therefore, the on-site car parking is considered suitable for the construction phase of the development ensuring all vehicle movements to and from the site will be undertaken in a forward direction.

5.3 Stormwater, Soil and Erosion Control

The proposed stormwater management system has been designed to reduce post-development flows to align with the pre-development conditions on the site. To achieve this, a detention basin is proposed at the north-eastern corner of the development area. This basin provides a holding volume of 142m³ and is supported with a low flow pipe and overflow weir. The stormwater management system proposed has been designed in accordance with Council requirements and with the proposed mitigation measures achieves compliance with the pre-development stormwater flows.

The stormwater drainage strategy for the development can be summarised as:

> *(i) All impervious runoff from the proposed photovoltaic arrays will discharge to the existing ground surface where the natural flow regime will be maintained.*
>
> *(ii) Runoff from the proposed gravel/hardstand area catchment will be conveyed via sheet flow to the proposed above ground onsite stormwater detention basin.*
>
> *(iii) Discharge from the above ground onsite stormwater detention basing will be limited to the pre-development flow rates*

In accordance with the stormwater drainage philosophy proposed for the site, the Narrabri Solar Farm will limit the Post-Development peak flows to Pre-Development flow rates for the 1 EY, 10% AEP and 1% AEP events.

Detailed Stormwater Plans and Report including DRAINS modelling have been prepared DRB Consulting Engineers provided at **Appendix G**.

5.4 Flora and Fauna

Kleinfelder have undertaken a Flora and Fauna Assessment of the proposed development (refer **Appendix C**). This assessment has been undertaken with reference to the EP&A Act 1979 as well as the BC Act 2016 and the EPBC Act 1999.

As noted within the Flora and Fauna Assessment Report, the proposed development will require the removal of native vegetation within the development area, including six trees (White Cypress Pine) and three dead stags, two of which contain hallows. A negligible amount of native groundcover vegetation is required to be removed due to the predominance of exotic grasslands. The proposed site is not within or in close proximity to any mapped Areas of Outstanding Biodiversity Value. Impacts on biodiversity values have been addressed through an iterative design process to avoid areas of higher biodiversity value within the site.

Field surveys undertaken by qualified ecologist(s) recorded no threatened flora or fauna species on the site with the proposed development unlikely to cause a significant impact to any threatened species, populations or ecological communities listed under the NSW BC Act. Entry into the NSW BOS is not triggered by the proposed development.

No EPBC listed species, ecological communities, migratory species or important habitat for such entities were identified within the Development Area. The Flora and Fauna Assessment determined that impacts to Matters of National Environmental Significance are unlikely; therefore, an EPBC referral to the Commonwealth Minister for the Environment is not recommended.

Inclusion of the avoidance and mitigation measures made within the Flora and Fauna Report in relation to vegetation clearing, erosion control, dust control, chemical spills and weed management, will be followed to reduce potential impacts to biodiversity values within the subject site and the environment.

5.5 Noise

A Noise Assessment (NA) undertaken by Muller Acoustic Consultants measured and modelled the potential noise generation for the operation (both during construction and once operational) including sleep disturbance noise emissions (refer to **Appendix J**). The NA concludes the following in relation to construction and operational noise.

Construction Noise

Modelled noise emissions from all project construction activities identify that relevant noise management levels are expected to exceed the NMLs at 15 receivers when works are at their nearest proximity during standard construction hours. Exceedances at this receiver are expected from all construction activities (piling, trenching & assembly), however, would be of a temporary nature and of short duration. Noise management measures as provided in the enclosed Noise Assessment (refer to **Appendix J**) are to be implemented to reduce potential impacts on surrounding receivers during construction activities. Road noise emissions are predicted to satisfy the relevant Road Noise Policy (RNP) criteria at all receivers along the proposed transportation route. Vibration impacts from the proposed works are considered to be negligible.

Construction noise mitigation measures to be implemented include:

- *A construction noise management protocol to minimise noise emissions, manage out of hours (minor) works to be inaudible, and to respond to potential concerns from the community;*
- *Where possible use localised mobile screens or construction hoarding around piling rig/plant to act as barriers between construction works and receivers, particularly where equipment is near the site boundary and/or a residential receiver including areas in constant or regular use (e.g. unloading and laydown areas);*
- *Operating plant in a conservative manner (no over-revving), shutdown when not in use, and be parked/started at farthest point from relevant assessment locations;*
- *Selection of the quietest suitable machinery available for each activity;*
- *Minimise noisy plant/machinery working simultaneously where practicable;*
- *Minimise impact noise wherever possible;*
- *Utilise a broadband reverse alarm in lieu of the traditional high frequency type reverse alarm;*
- *Provide toolbox meetings, training and education to drivers and contractors visiting the site during construction so they are aware of the location of noise sensitive receivers and to be cognisant of any noise generating activities;*

- *Signage is to be placed at the front entrance advising truck drivers of their requirement to minimise noise both on and off-site; and*

- *Utilise project related community consultation forums to notify residences within proximity of the site with project progress, proposed/upcoming potentially noise generating works, its duration and nature and complaint procedure.*

Operational Noise

The results of the NA demonstrate that emissions from the project is able to satisfy the relevant Project Noise Trigger Levels (PNTL) at all assessed receivers for all assessment periods once the noise controls are implemented. Furthermore, sleep disturbance is not anticipated, as emissions from impact noise are predicted to remain below the EPA screening criterion for sleep disturbance and awakenings.

Notwithstanding, it is recommended that the proponent actively minimise potential noise emissions from the project. To assist in noise management for the project it is recommended that a one-off noise validation monitoring assessment be completed to quantify operational noise emissions from site and to confirm emissions meet relevant criteria. The monitoring assessment would consist of operator attended noise measurements during normal operation to determine the noise contribution from the project.

5.6 Landscape and Visual Impact

It is relevant to consider the visual impact of the proposal given the existing rural landscape character of the area and location of a number of neighbouring properties within 1km radius of the site. SLR Consulting has undertaken a Visual Analysis and Landscape Concept to assess the potential visual amenity changes which may occur as a result of the proposed development, see **Appendix E**.

Based on the appraisal and findings of the Visual Analysis and Landscape Concept, it can be considered the proposed solar farm would have a 'minor' visual impact rating on the existing landscape character and values of the site and its local context. Although the subject site is a relatively short distance from Narrabri, views of the existing site from public viewpoints are very limited due to the presence of obstructions such as topographic features, vegetation and built elements.

The views of the site from public viewpoints were from Airport Road and Kaputar Road. This is due to the low flat areas adjoining the site and obstructions between the viewpoints and the site such as residential structures and vegetation along verges and property boundaries. Although the site is visible from adjoining roads, from certain locations it's distance from viewpoints along the roads combined with the presence of existing vegetation reduces its overall visibility within the landscape.

The height and visual permeability of the array will mean that the relative visual impacts of the Solar Farm are generally low, especially given the distance from the most notable public vantage points.

Given the relatively low height of the Solar Farm, the informal planting of native shrubs to complement the existing rural landscape character along the southern and south eastern side of the lease area, outside of the fence line would assist in minimising visual impacts of the development on the surrounding rural landscapes and the adjoining residential properties.

The planting of trees directly adjoining the solar farm would not be encouraged due to the potential for shadows to be cast over the array during certain times of the day.

5.7 Glare Analysis

A Reflective Glare Assessment (RGA) has been undertaken by SLR Consulting to assess the potential for reflected light induced impacts on aviation, road operations, rail operations, industrial and heavy machinery operations, and residential amenity (refer **Appendix D**).

The proposed solar PV panels include solar trackers which results in minimal potential for horizontal reflectivity to occur as light is generally reflected upwards. The RGA found no impact would be made in regard to Motorist 'Traffic Disability' Glare or Rail Traffic 'Disability' Glare. Reflections from the proposed solar farm may be visible from surrounding residences, although the impacts are calculated are minimal. It is recommended that if modules are required to be near horizontal for extended periods, then they should be positioned at a slightly eastwards tilt angle of at least 10°.

Quantitative analysis using the FAA-SGHAT software tool has shown that there will be nil glare from the project at Narrabri Airport with the solar array in normal tracking mode, i.e. panels tilting ±60°. The SGHAT results show potential for glare involving the panels being left at a fixed tilt angle of between 30° (westwards) to 40° (eastwards). Accordingly, such a situation should be avoided, e.g. during construction, during maintenance periods, etc.

Glare resulting from onsite lighting will be mitigated in accordance with AS4282-1997 Control of the Obtrusive Effect of Outdoor Lighting effectively controlling potential for light spill and glare generated by the proposed development.

Due to the use of high-quality solar tracking systems and site buffer distances to surrounding receivers and transport networks, potential for glare impacts on the surrounding area is considered to be negligible. For further detail and discussion see **Appendix D**.

5.8 Heritage

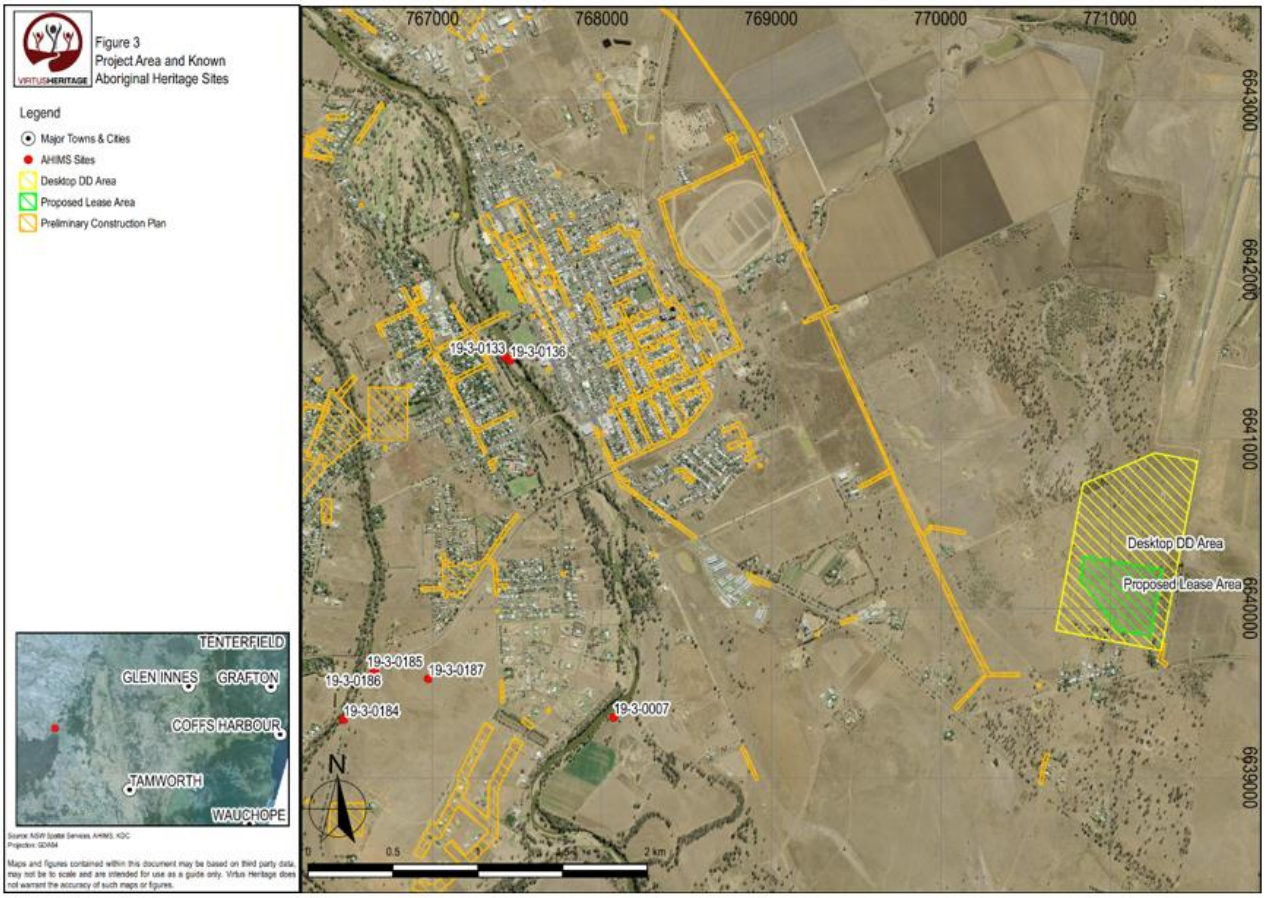
5.8.1 Aboriginal Heritage

Virtus Heritage undertook preliminary Aboriginal archaeological advice (**Appendix H**) for the proposed development area in accordance with the Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (2010) and where applicable, the requirements of the Code of Practice for Archaeological Investigation of Aboriginal Objects, NSW (2010). See **Appendix H** for further discussion and **Figure 6** below.

A site inspection was undertaken on 13 January 2021 within the Narrabri Local Aboriginal Lands Council (LALC) area. The site inspection was undertaken by Elaine Lin, Senior Archaeologist (Virtus Heritage) and two site officers from Narrabri LALC, Kristie Toomey and Kenneth Mason.

There are no previously recorded sites within the project area based on heritage searches and background research of previous archaeological investigations to date. No Aboriginal objects or sites were observed in the project area and given the disturbance and lack of any undisturbed soils or sensitive landforms identified during survey, the project area is deemed to have a very low potential for archaeological deposits. Comments from Narrabri LALC Site Officers, Kristie Toomey and Kenneth Mason supported the assessment of low archaeological potential on site during fieldwork. No other comments were received from Narrabri LALC to date. Should further comment be received from the Narrabri LALC, it shall be considered where possible in the future by PAG.

Figure 6 Indigenous Heritage Map (Source: Virtus Heritage)



The following recommendations have been made by Virtus Heritage:

- *No Aboriginal objects were identified during the site inspection. No Aboriginal places are registered within the project area. No areas of archaeological potential are identified within the project area requiring archaeological testing, salvage or mitigation.*

- *All site workers and personnel involved in site impact works associated with the proposal should be inducted and briefed on the possible identification of Aboriginal sites and objects during construction and their responsibilities according to the provisions of the NPW Act 1974, in case any additional unknown objects or items are uncovered during proposed works.*

- *As part of this induction, the contact phone numbers of the Heritage NSW regional archaeologist and EnviroLine 131 555, the relevant Environmental Officer responsible for this project should also be given to all site workers and personnel, in case unknown objects or items are uncovered during excavation.*

- *Site workers should be made aware of the location of any Aboriginal sites that may at any stage occur within the proposal site and their scientific significance and their legal obligations in relation to the protection and management of these Aboriginal sites under the NPW Act 1974, and 2010 ancillary provisions and amendments.*

- *As part of this induction, workers should be made aware that in the event that any unexpected human remains are uncovered on site, the area of the suspected remains must be secured and cordoned off and the NSW Police notified. No further works can be undertaken until the NSW Police provide written advice. If these remains are deemed to require archaeological investigation by the NSW Police or NSW Coroner, then Heritage NSW and the relevant Aboriginal parties must be notified. A plan of management for the preservation of any identified Aboriginal human remains or for their salvage must be put in place or conducted under an AHIP methodology and variation developed in consultation with all relevant Aboriginal parties and the Heritage NSW.*

- *Providence Asset Group or delegated authority may wish to consider the input and engagement of interested Aboriginal stakeholder groups and Narrabri LALC in the development of inductions and toolbox talks for this project.*

5.8.2 European Heritage

The site does not contain any listed heritage items under Schedule 5 of LEP 2010, nor is it located within a heritage conservation area. No other heritage items are located in proximity to the site.

5.9 Social and Economic Impacts

The proposed establishment of a solar farm on the site is anticipated to have an ongoing positive social and economic impact on the local Narrabri area and the broader community.

A review of existing renewable projects along with NSW State Government research reveals support for renewable energy projects is generally favourable within the North West Region (including the broader Narrabri region). This research revealed:

- 94 per cent of respondents supported using renewables to generate electricity in NSW;

- 81 per cent believed NSW should increase the use of renewables over the next five years; and

- 95 per cent supported the use of solar farms in NSW, 92 per cent in their local region, and 84 per cent within 1–2 kilometres of where they lived.

The most common perceived advantages of renewables included environmental benefits and lower cost of electricity. The most common perceived disadvantages included higher cost and concerns about efficiency and reliability. In the North West, 74 per cent were prepared to use renewables 'provided I don't have to pay more for my electricity' and 22 per cent were prepared to pay more to support them.

The proposed solar farm is predicted to improve intergenerational equity through its beneficial contribution to Australia's Climate Change and greenhouse gas minimisation efforts, specifically:

- Directly contribute to helping Australia in meeting the Renewable Energy Target;

- Reduce greenhouse gas emissions required to meet Australia's international climate conditions; and

- Assist in the transition towards cleaner electricity generation.

This is achieved by the potential to generate up to 5MW of electricity potentially powering 2,000 homes during daylight hours whilst reducing CO2 emissions by around 200,000 tonnes over the lifespan of the project.

Ongoing communication with the community has been highlighted as an imperative to maximise social benefits of the proposed development. Further recommendations include the following:

- Liaison with local industry representatives to maximise the use of local contractors, manufacturing facilities, materials;
- Establish visual screening early to minimise the visual impact on the solar farm. Visual screening should be done in consultation with closest property holders in accordance with Visual Analysis and Landscape Concept;
- Establish good relations with people living in the vicinity of the proposal site at the beginning of the proposal and maintain; and
- Implement a community consultation plan to manage impacts to community stakeholders, including but not limited to:
    - mitigation measures to reduce potential construction impacts
    - protocols to keep the community updated about the progress of the Proposal and proposal benefits
    - protocols to inform relevant stakeholders of potential impacts (haulage, noise, air quality etc.)
    - protocols to respond to any complaints received
    - information on how potential customers can access the renewable energy source
    - a process to monitor the predicted social impacts and amend mitigation and management measures as required.

In summary, the proposed establishment of a Solar PV Farm on the site is anticipated to have an ongoing positive social and economic impact on the local area and the broader Narrabri community. Overall, it is considered that the development:

- Is consistent with the regulatory and business development framework, including state government legislation and the Narrabri Shire Council strategic plans;
- Will have positive impacts intergenerational equity, with the provision of cleaner energy in the future;
- Supports Commonwealth and NSW climate change commitments;
- Will generate enough clean, renewable energy for about 2,000 homes;
- Is an appropriate development in relation to the projected changes to population and demographics in the region;
- Is unlikely to have significant negative social impacts to the locality and region; and
- Would be a benefit contributing to the overall community sustainability of the Narrabri community.

6 Conclusion

The proposed solar PV electrical generation operation located at 115 Airport Road, Narrabri will provide electrical power to support the needs of Narrabri and the surrounding agricultural operations, along with rural towns and villages.

With the growth in demand for renewable energy source in both the Narrabri area and New England regional as a whole, the new electrical generator proposed under this DA will greatly assist in meeting the growing electrical demands.

The site has been chosen for its suitability in terms of land use zoning, relatively flat topography, limited trees and vegetation and access to high capacity transmission lines.

The proposed solar PV electrical generation plant is consistent with the objectives of the RU1 Primary Production zone as it will provide a compatible land use which minimises land use conflict in the area whilst contributing to the land use diversity of the area. The proposal will not increase demand for public services or facilities and will have minimal impact on native vegetation and wildlife corridors or on waterways, wetlands or riparian zones. The development is compliant with the relevant LEP clauses, presenting no variations to any development standard. The proposal is generally compliant with the requirements of Narrabri DCP 1993.

The design of the development incorporates appropriate stormwater management, respects the natural environment, and minimises potential amenity impacts on neighbouring properties.

Due to the use of high-quality solar tracking systems and site buffer distances to surrounding receivers and transport networks, potential for glare impacts on the surrounding area is considered to be negligible.

This SEE has addressed the potential impacts arising from the proposal on surrounding properties including traffic, access and parking, noise, visual amenity, ecological, and waste and water management. Where necessary, mitigation measures are proposed to minimise these potential impacts and reduce potential risk associated with the development.

Given the merit of the design and the absence of any significant adverse environmental impacts or planning issues, the DA is considered to be in the public's interest and worthy of Council's support.

APPENDIX A

Development Plans

Balance Power and Energy Pty Ltd

APPENDIX B

Traffic Impact Assessment

Intersect Traffic Pty Ltd

APPENDIX C

Flora and Fauna Assessment Report

Kleinfelder

APPENDIX D

Reflectivity Glare Assessment

SLR Consulting Pty Ltd

APPENDIX E

Visual Analysis and Landscape Concept

SLR Consulting Pty Ltd

APPENDIX F

Flood Impact Assessment

Torrent Consulting

APPENDIX G

Stormwater Management Plan

DRB Consulting Engineers Pty Ltd

APPENDIX H

Due Diligence Aboriginal Archaeological Assessment

Virtus Heritage

APPENDIX I

Compliance Tables

Table 1 Narrabri DCP 1993 – Industrial Development

CONTROL	REQUIREMENT	COMMENT	COMPLIANCE
INDUSTRIAL DEVELOPMENT CODE			
4.3 OPEN STORAGE AND WORK AREAS	*(a) Where any work or storage of materials is proposed to be undertaken outside the confines of a building, full details of hose parts of the site to be used, and of the materials to be* *stored, are to be provided with the application.*	No open work or storage areas are proposed.	N/A
	(b) Approved open work and storage areas are to be located at the rear of industrial developments and screened from view by the use of landscaping and screen fencing. Such fencing is to be constructed of masonry materials or pre-coloured metal cladding, having a minimum height of 2.0 metres.	No open work or storage areas are proposed.	N/A
4.4 SECURITY FENCING	*Security fencing should be visually unobtrusive and, wherever practicable, should be located behind the landscape setback area.*	A 2.3m high security fence will be located around the site area. It will be visually unobtrusive in design.	Y
4.6.1 SETBACKS	*A front building setback of eight (8) metres from the property boundary should be provided. This eight (8) metre front setback is to be intensively landscaped.*	A 10m front setback area is proposed from the existing fence onsite to the proposed security fence.	Y
	Side and rear setbacks will be determined by the requirements of Ordinance 70 under the Local Government Act, 1919.	A 10m rear setback is proposed and appropriate side setbacks are proposed, with no development in proximity to the sides of the site.	Y
4.7 LANDSCAPED TREATMENT	*(a) To improve the visual quality and amenity of industrial development though the effective landscape treatment of industrial sites;*	Informal planting of native shrubs along the southern and south eastern side of the lease area, outside of the fence line is proposed to complement the existing rural landscape character , refer to Appendix E..	Y
	(b) To provide a natural buffer between industrial development and adjoining or adjacent non-industrial land uses whilst enhancing the general streetscape and amenity of Narrabri's industrial areas.		Y
4.7.1 AREAS	*(a) The front building setback;*		Y

REQUIRED TO BE LANDSCAPED	*(b) Side and rear setbacks where visible from a public place or an adjoining residential area;*	Informal planting of native shrubs along the southern and south eastern side of the lease area, outside of the fence line is proposed to complement the existing rural landscape character, refer to Appendix E.	
	(c) Areas adjacent to building entrances and pedestrian access points;		
	(d) The perimeter of all approved open storage areas and staff/visitor parking areas. (See also Section 4.3 of this Code). Large car parking areas should be interspersed with internal planting bays to reduce the visual impact of larges areas of paved surfaces.		
4.7.2 LANDSCAPE GUIDELINES	*(a) Landscaped areas are to be an integral part of the site, and may, due to the size and scale of development proposed, require the incorporation of mounding to add visual relief to the development.*	Refer to Appendix E for details.	Y
	(b) Landscaped areas should be planted and maintained with suitable trees, shrubs and ground cover in accordance with a landscape plan, which must be submitted for approval prior to the release of building plans.	Informal planting of native shrubs along the southern and south eastern side of the lease area, outside of the fence line is proposed to complement the existing rural landscape character, refer to Appendix E.	Y
	(c) Landscaping should be completed in accordance with the approved landscape plan prior to the occupation of the development and shall be suitably maintained throughout the life of the development.	Informal planting of native shrubs along the southern and south eastern side of the lease area, outside of the fence line is proposed to complement the existing rural landscape character, refer to Appendix E. All landscaping will be completed in accordance with the Visual Analysis and Landscape Concept.	Y
	(d) Every effort should be made to preserve existing trees on proposed development sites. All existing trees should be shown on the plan submitted with the application, and those which are required to be removed should be clearly highlighted.	The proposed development will require the removal of native vegetation within the development area, including six trees (White Cypress Pine) and three dead stags, two of which contain hallows. A negligible amount of native groundcover vegetation is required to be removed due to the	N-Justified

		predominance of exotic grasslands.	
	(e) Trees shall be planted on the Council footpath, 900mm in from the kerb, along the entire frontage of the property, at intervals of approximately 10 metres (making allowance for the location of the driveways). The tree types that can be used are included in Annexure 1 and shall be approved by the Shire Engineer.	No tree planting on Council footpath is required.	N/A
F.4.8.1 ACCESS, PARKING AND OFF - STREET LOADING/ UNLOADING FACILITIES – GENERAL REQUIREMENTS	*(a) The design, layout and construction of access, parking and service areas for all industrial development shall be in accordance with the requirements of the Narrabri Shire Parking Code.*	Due to the nature of the development, no prescribed parking rate is applicable. However, the DCP allows for merit-based assessment of parking needs. A Traffic Impact Assessment is provided at Appendix B detailing site access.	Y
	(b) Council is required to consult the NSW Traffic Authority to obtain advice on traffic and safety aspects for major traffic generating developments. This consultation is a statutory requirement prescribed by State Environmental Planning Policy No. 11. Additional information about the consultation procedure can be obtained by contacting Council's Environmental Services Section.	The proposed development is not considered a traffic generating development.	Y
	c) Industrial development should be designed to ensure that all vehicles can enter and leave the site in a forward direction. Details of vehicle size and manoeuvring areas should be submitted with the development application to enable an adequate assessment of these aspects.	The proposed access and turning circle proposed for the site will allow all vehicles to enter and exit the site in a forward direction.	Y
	(d) Individual parking bays should be clearly delineated and have minimum dimensions of 2.6 metres x 5.5 metres, except where it is adjacent to a solid obstruction when a 3.0 metre width should be provided.	The proposed parking bay for the site will be constructed according to parking requirements.	Y

4.8.2 ACCESS AND ROAD CONSTRUCTION REQUIREMENTS	*(a) The following road works are generally required in conjunction with industrial development:* *- Industrial type vehicular gutter crossings;* *- Construction of kerb, gutter and road shoulder between the lip of the gutter and the edge of the existing bitumen seal, footway formation and paving and associated road drainage for the fill frontage of the site.*	Required road works are proposed with this development, including a vehicle access road via Airport Road which is suitable for B-Double access and a turnaround. The proposed access driveway width at the combined entry/ exit gate is proposed to be 5 metres wide. It is considered this is an adequate width for the proposed development type. The proposed development is not considered as 'traffic generating development.' A new access road is proposed off Airport Road No access driveway proposed across a footpath.	N-Justified
	(b) Access drives to have a minimum width of six (6) metres; Note – major traffic generating developments may require a greater access width divided at the property line.		N-Justified
	(c) The location of access driveways at intersections shall be in accordance with the Traffic Authority of NSW 'Policy, Guidelines and Procedures for Traffic Generating Developments', however the minimum distance shall be 6.0 metres from the intersecting boundaries;		Y
	(d) Access driveways across the footpath should hard sealed, consisting of either concrete, two coat bitumen seal, asphaltic concrete, paving blocks or other approved material.		Y
	(e) All driveways, parking areas, loading bays and vehicular turning areas are to be constructed with a base course of adequate depth to suite design traffic, and are to be sealed with either bitumen asphaltic concrete, concrete or interlocking pavers. Full details should be indicated on the plans submitted with the Development Application.		Y
4.8.3 PARKING REQUIREMENTS	*On-site car parking should be provided in accordance with Council's adopted Car Parking Code, copies of which are available from Council.*	As above, due to the nature of the development, no prescribed parking rate is applicable. However, the DCP allows for merit-based assessment of parking needs.	Y
4.10 SERVICES AND DRAINAGE	*(a) To ensure that services provided are adequate for the scale of the development proposed.*	A Stormwater Management Plan has been provided at Appendix G detailing the	Y

	(b) To ensure adequate drainage facilities are provided within the site to collect and carry stormwater to external drainage systems.	stormwater drainage strategy during both pre-development and post-development.	
	(c) To reduce the hazard of flooding and the diversion or concentration of water onto adjoining properties.		
4.10.3 TRADE WASTE	*A Trade Waste Application will be required where liquid wastes other than sewerage are to be discharged to Council's sewerage system. Council levees a charge for the disposal of the Trade Waste to the sewer based on the volume and strength of the discharge.*	No liquid waste is expected to be produced.	N/A
4.10.4 DRAINAGE	*(a) Stormwater runoff from roofs and paved areas is to be collected and disposed of to the street drainage or direct to Council's underground system.*	A Stormwater Management Plan has been provided at Appendix G detailing the stormwater drainage strategy during both pre-development and post-development.	Y
	(b) The Council will not permit the erection of buildings over drainage easements under its control.		
	(c) A contribution towards Downstream Drainage may be required based on the increased run-off generated by the development.		
PARKING CODE NO.1 1993			
CONSTRUCTION	*1. All parking areas are to be paved, and the manoeuvring and parking spaces are to be clearly delineated. The parking area is to be drained to Council's stormwater network.*	The provided parking and manoeuvring area will be paved. Further details are provided in the Traffic Impact assessment located at Appendix B.	Y
	2. Upon an application being lodged, the paving required may be waived, if the applicant can demonstrate that the parking turnover will not adversely effect the proposed pavement.		
LANDSCAPING	*It is suggested that carparking areas be landscaped, especially with shade trees.*	Due to the nature of the development, and the lack of requirement for car parking spaces, the proposed car parking landscaping control is not considered necessary.	N-Justified
PARKING REQUIREMENTS	*Parking Rates:* *Factories:* *- 1.3 spaces per 100m² GFA*	As above, due to the nature of the development, no prescribed parking rate is applicable. However, the DCP allows for merit-based assessment of parking needs.	Y

		As there is no building proposed for the development, no on-site parking is required to be provided under DCP requirements. However, as indicated in the Traffic Impact Assessment located at Appendix B, sufficient on-site parking will be provided for construction staff during construction, and the one maintenance vehicle during operation.	

APPENDIX J

Noise Assessment

Muller Acoustic Consulting

APPENDIX K

Waste Management Plan

SLR Consulting Pty Ltd

APPENDIX L

Capital Investment Value & Detailed Cost Report

RPS Australia East Pty Ltd

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

NEWCASTLE CBD
Suite 2B, 125 Bull Street
Newcastle West NSW 2302
Australia
T: +61 2 4940 0442

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND
Level 4, 12 O'Connell Street
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

NARRABRI SOLAR FARM

Visual Analysis and Landscape Concept

Prepared for:

Providence Asset Group

704/99 Bathurst Street, SYDNEY NSW 2000

SLR Ref: 620.30220 Version No: -v1.0 FEBRUARY 2021

PROJECT NAME

Location	Lot 489, DP 754944 115 Airport Road, Narrabri, NSW 2390
Project Number	620.30220.00000
Client	Providence Asset Group

PREPARED BY

SLR Consulting (Pty Ltd)

ABN 29 001 584 612

Level 2, 15 Astor Terrace, Spring Hill QLD 4000

PO Box 26, Spring Hill QLD 4004 Australia

Phone +61 7 3858 4815

www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Providence Asset Group (the Client).
Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the client. No warranties or guarantees are expressed or should be inferred by any third parties.
This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

This report has been designed to be reproduced at A3 size.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
620.30220.00000-v0.1	February 2021	Dallas Ellis	Dean Butcher	Dean Butcher
	February 2021	Dallas Ellis	Dean Butcher	Dean Butcher

CONTENTS

1. INTRODUCTION

1.1 Background

This Visual Analysis and Landscape Concept has been prepared for the proposed Solar Farm near Narrabri, NSW.

This visual analysis assessment has been prepared to provide an effective and objective assessment of the anticipated high level impacts of the project on the surrounding visual environment.

SLR has worked closely with other members of the project team in determining and rating visual impacts of the proposed solar farm project works on its immediate surrounds as well as suggesting mitigation measures to further reduce any impacts that may occur.

There are 2 parts to this report.

- Visual Analysis, and
- Landscape Concept.

1.2 Site Location

The land on which the Solar Farm is located (the subject site) for the proposed Solar Farm (the project) is situated approximately 3km south east of Narrabri Township.

The site is located at Airport Road,and the proposed development will consist of solar panels mounted on single-axis trackers connected to a power conversion station with an access and hardstand area from Airport Road. The development will be confined to Lot 489 DP754944 (**Figure 1**).

Figure 1. Locality Plan

2. BASELINE VISUAL ENVIRONMENT

2.1 Subject Site and Surrounding Context

The subject site is located on the western side of Airport Road, Narrabri and is a typically open grassed rural site, similar to those rural properties surrounding it. The site is approximately 3km south east of Narrabri Township. The site falls generally from south east to north west from approximately AHD 217m to AHD 215m.

2.1.2 Roads and Access

The subject site is accessed by one road, Airport Road which is a sealed local road that is adjacent to the east of the subject site and is aligned in a north south direction, connecting to the Narrabri Airport.

Kaputar Road is a local road that is south of the subject site and joins to Old Gunnedah Road which connects to the town of Narrabri in a north west direction.

2.1.3 Vegetation

The subject site has been cleared of vegetation except for a few scattered shrubs and specimen trees remaining which are scattered around the proposed Solar Farm. The local area in general is very sparsely vegetated, with some established vegetation along Airport Road verge to the east and the adjoining site to the north of the subject site being the most visible in the local area.

Generally vegetation to the east of the site, in the middle ground of viewshed is relatively dense. This forms a visual edge to the local catchment especially with the openness of the rural landscape. Further east the vegetated, elevated hills of Mount Kaputar National Park are visible which give further context to the site.

2.1.4 Structures

There are no structures on the subject site. There are a number of rural residential dwellings and industrial businesses around the subject site immediately to the south.

Higher density residential development (subdivisions) is located further toward Narrabri to the west.

2.1.5 Infrastructure

The subject site has power poles and lines running through it generally from east to west.

Apart from the roads mentioned above, the site is located to the south of the Narrabri Airport.

3. LANDSCAPE CHARACTER ANALYSIS

3.1 Regional Context

The landscape character of the region surrounding the site is flat to gently undulating, open rural lands used with a mix of pastoral and agricultural uses. Regionally, the site sits within the context of both rural, urban and natural areas.

3.2 Baseline Visual Character of Subject Site and Surrounds

The subject site is typical of the rural landscape character of the region in that it is open, gently undulating and typically grassed (minimal tree coverage). As the size of the site is small in the context of its surrounds, it utilises the ‘borrowed landscape’ of the adjoining rolling hills to define its visual context and define local views.

Although the overarching character of the landscape is rural, the urban areas of Narrabri and Narrabri West sit within the overall rural context rather than dominate it. To the east the landscape becomes more natural and less rural in character with the vegetated hills which are visible from the site.

4. PROPOSAL

4.1 Project Description

A full description of the proposal is provided within the main Statement of Environmental Effects and site plans, but a brief description is as follows. Section 4.1.1 identifies key elements of the proposal that are of particular relevance to an assessment of impacts on the visual analysis.

4.1.1 Indicative project Layout

The solar electricity generating facility will consist of the following elements:

- Solar array area of approximately 9 hectares within a total fenced area of approximately 13.3 hectares
- Solar array mounted on trackers (142 sets)
- Rectangular photovoltaic module
- Trackers area horizontal single-axis type
- Solar array up to 2.6m high with +/-60° rotation angle
- - Trackers orientated north - south
- Associated infrastructure
- Power Conversion Station (PCS)
- Entry to the site via improved access from Airport Road
- Security fencing
- Car park area
- Offload and hardstand area

During construction, temporary facilities located within the site may include:

- Construction office

4.1.2 Solar panel dimensions and arrangement

The proposed solar array module dimensions are approximately 1.1 m wide x 2.3m high. They are mounted on a tracking system that will maximise the electricity production. The tracking system rotates about a north-south axis to follow the sun with the aim of orienting each panel to be as close to perpendicular as possible to the incoming sun.

The tracking systems will be arranged in rows running in a north-south direction as indicated in **Figure 2**.

The diagram in **Figure 2.1** illustrates the dimensions and rotation of the panels. The panels only rotate from east to west and are not tilted toward the north.

Figure 2.1 Solar panel / tracking system

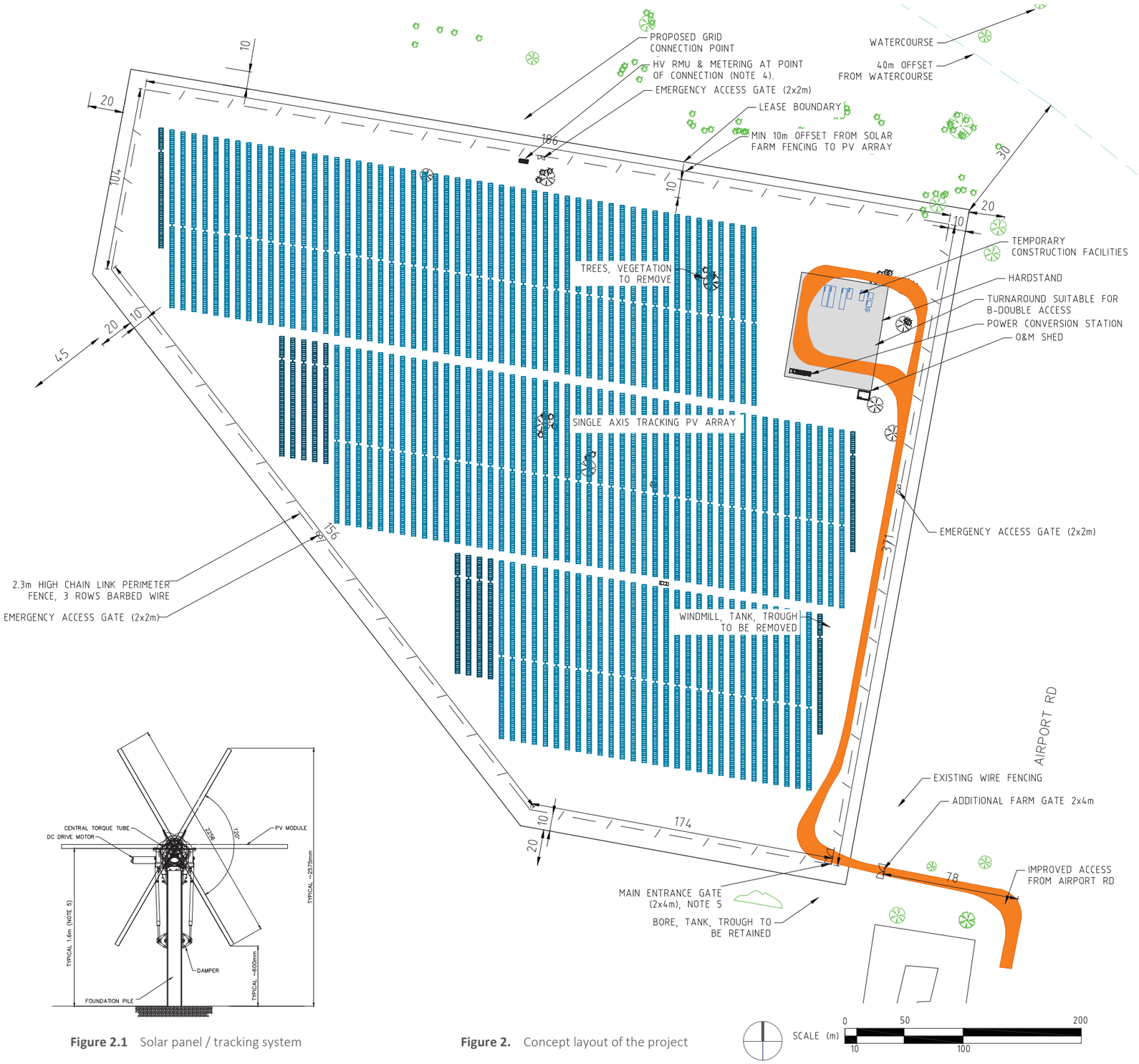


Figure 2. Concept layout of the project

5. VISUAL IMPACT ASSESSMENT

5.1 Process

The Visual Impact Analysis generally applies the assessment techniques set out in the 'Guidelines for Landscape and Visual Impact Assessment, Third Edition' (2013) prepared by The Landscape Institute and the Institute for Environmental Management and Assessment (UK).

The analysis includes the following:

- Review of the proposal (scale, bulk, height, technical specifications and landscape);
- Analysis of the subject site (visual exposure, visual qualities and landscape values);
- Identification of potential impacts on key receptors including the rating of magnitude for each receptor group;
- Rating of impact significance for each receptor group.
- The significance is evaluated as a product of the sensitivity or value of the receptor, and the magnitude of impacts on the receptor;
- Potential mitigation measures to meet the necessary planning requirements and any community expectations;
- The report included a desktop analysis and a visual site investigation in November 2020. The desktop review included the review of aerial photography, site topography and vegetation cover;

Photo-montages were also prepared to inform the analysis.

5.2 Assessment of Visual Impacts for Key Receptors

Photographic imagery was taken of the site to assist in the assessment of visual impacts. Photos were taken with a Canon EOS 6D Mark II digital single-lens reflex (DLSR) camera with a 50 mm lens.

Three photomontage images were prepared to assist in the Visual Analysis process; all from public receptor points.

The five receptors used in the photomontage were selected to investigate a range of visual solutions and illustrating views from areas of perceived sensitivity. During the site investigation, local areas around the site were observed to determine the potential visibility of the proposed Solar Farm.

For the purposes of this Visual Analysis a Photomontage image was produced from each of the three viewpoints chosen. The approximate extent of the proposed Solar Farm has been identified to give a general impression of the location on site and the approximate height.

The Photo montage Images are represented in Section 5.8 and show the following overlays of information.

- Existing visual baseline (existing landform);
- Overlay of the final solar farm proposed development.

5.3 Receptor Sensitivity

The receptor sensitivity is derived from a combination of factors including:

- Receptors interest in the visual environment (high, medium or low interest in their everyday visual environment and the duration of the effect);
- Receptors viewing opportunity (prolonged, regular viewing opportunities); and
- Number of viewers and their distance/ angle of view from the source of the effect, extent of screening/ filtering of view.

Whilst the assessment of visual values and effects is largely measured on a qualitative basis, assessment against scale enables a more objective evaluation and comparison of sensitivity of receptors and magnitude of effects. The Receptor Sensitivity Rating is described as being High, Medium, Low or Negligible as described in **Table 1.**

5.4 Magnitude of Landscape Change

The Magnitude of Change to the landscape character depends on the nature, scale, intensity, extent and duration of the impacts/ change due to proposal. The magnitude of change also depends on the loss, change or addition of any feature to the existing landscape and is based on the character type that is most likely to be impacted by the project prior to the addition of any mitigation measures.

The Magnitude of Change is described as being High, Medium, Low or Negligible as described in **Table 2**.

Descriptions of Magnitude and Sensitivity are illustrative only and there is no defined boundary between levels of impacts.

Table 1. Receptor Sensitivity Rating

Receptor Sensitivity	Description
High	• Visitors to heritage sites, regionally important locations, scenic routes, lookouts within 2.5km with quality views, important views of the site and surrounding areas where landscape is the specific focus. • High numbers of visitors • Views to landscape that are rare and or unique and are possibly vulnerable to change • Views from residences within 1km of the site or are representative of high quality views
Medium	• Travellers/visitors along roads or rail routes that are not scenic routes but offer quality views within 2.5km of the site • Medium numbers of visitors/ residents (rural communities or townships) • Views that are representative of local character or sense of place but are not rare or unique • Views from residences beyond immediate vicinity (1km-5km) of the site or are representative of moderate quality views • Recreational users/ viewers beyond 2.5km from the site with moderate interest in their surrounds
Low	• Travellers/visitors along roads or rail routes that are not scenic routes but offer reasonable views within 4km of the site • People at place of work where setting or views not important to quality of working environment • Recreational users not dependent on views or scenic quality of landscape • View experience takes in broad context with which site is visible but not an important element. • Small numbers of visitors with passing interest in their surroundings (those travelling along mid-level roads) • Viewers whose interest is not specifically focused on landscape or scenic qualities (commuters, workers)
Negligible	• Very occasional or low level of users with passing interest in their surrounds (those travelling along minor roads or views from the air) • Travellers/visitors along unsealed roads offering views greater than 4km of the site

5.5 Impact of Significance on Landscape Character

The Impact Significance is evaluated according to 2 key criteria as noted above and is reflected in **Table 3.**

The rating is a means of comparing impacts on different receptors. Professional judgement and experience have been applied in order to identify the level of significance for each character type which has been assessed on its own merits.

- The sensitivity of the receptor or existing landscape; and
- The magnitude of the change or impact that is likely to occur.

The process of assessment and the use of the ratings tables reflect typical outcomes for visual impacts.

- Impacts on receptors that are particularly sensitive to change in views and visual amenity are more likely to be significant.
- Impacts that constitute a substantial change to the visual environment are likely to be more significant than the impacts that do not cause substantial change.

5.6 Summary of Potential Landscape Character Impacts

The following sheets summarise the assessment of impacts on each of the identified visual receptor groups.

Three representative viewpoints were identified where the site could be seen preferably from public locations. Due to the distances from the site, presence of topographic and vegetated features, surrounding structures and the limited views from publicly accessible areas, the choice of viable views was limited. The following sheets describe and rate the sensitivity of each viewpoint, the nature and magnitude of impacts likely to occur and the resultant significance of impacts for each receptor.

Typically views to the site from local roads and other public locations in the area were very limited. Photos from each receptor are provided and photomontages prepared to show how the proposed Solar Farm will be perceived from that particular viewpoint. Mitigation measures have been included where appropriate.

Table 2. Magnitude of Change

Magnitude of Change	Description
High	Dominant Change • Major change in view at close distances, affecting substantial part of the view continuously visible for a long duration or obstructing a substantial part or important elements of the view • Overwhelming loss or additional features in the view such as the nature of view or character of landscape fundamentally changed • Views to key landscape features affected • Visual amenity of local residents or road users substantially diminished • Substantial change to the landscape due to loss of and or change to elements, features or characteristics of the landscape creating an overall worsening of landscape quality
Medium	Considerable Change • Clearly perceptible changes in views at intermediate distances resulting in either distinct new element in a significant part of the view or a more widely ranging, less concentrated change across a wider area • Significant loss or addition of features in the view, such that nature of view or character of landscape is altered • Noticeable contrast of any new features in the view such that the nature of the view or landscape character is changed • Noticeable contrast of any new features or changes compared to existing landscape • Views to key landscapes partially obstructed but views remain intact
Low	Noticeable Change • Minor memorable change to the landscape or views • Temporary or reversible impact • Landscape dominant element and built form/ development well integrated within it • Little permanent change or no fundamental change to local landscape character
Negligible	Barely Perceptible Change • No memorable or rarely perceptible change to landscape character or key views

Table 3. Effect Significance Rating

Receptor Sensitivity	Magnitude of Change in Landscape				
	High (Dominant Change)	Medium (Considerable Change)	Low (Noticeable Change)	Negligible (Barely Perceptible Change)
High	High	Moderate-High	Moderate	Minor-Moderate
Medium	Moderate-High	High	Minor-Moderate	Minor
Low	Moderate	Minor-Moderate	Minor	Minor-Negligible
Negligible	Minor-Moderate	Minor	Minor-Negligible	Negligible

5.6.1 Selected Viewports

Figure 3. Selected Visual Receptors and Direction of View

5.6.2 Viewpoint 1 - Existing

Receptor - VP1	Airport Road, Narrabri
Coordinate Location	30°20’35.586” S 149°49’20.94” E
View Description	View from Airport Road looking north west toward the proposed solar farm site.
Distance from Site	Approximate 80m
Comments • Open rural landscape, with minimal canopy vegetation on site but existing vegetation to the east along Airport Road • No hills or local topographic changes visible from this view	

5.6.3 Viewpoint 1 - Proposed

Receptor - VP1 Summary of Impact Assessment	
Receptor Sensitivity	Low
View Magnitude of Landscape Change	Low
Impact Significance	Minor
Mitigation Measures	• Informal shrub planting (to a maximum height of 3m) adjoining lease boundary could integrate the solar array appearance into the landscape. This would be on the southern and south eastern sides of the solar farm to provide screening from residential properties and part of Airport Road. • No tree planting or formal shrub planting.

5.6.4 Viewpoint 2 - Existing

Receptor - VP2	Airport Road, Narrabri
Coordinate Location	30°20'3.528" S 149°49'26.958" E
View Description	View from Airport Road, looking south west towards the solar farm site
Distance from Site	Approximate 620 m
Comments • Open and gently undulating rural landscape character in the foreground with vegetated rural landscape in the background of the view. Prominent vegetation along Airport Road in the middle ground adjoining the site is visible. • Roads and rail lines are visible in the foreground although not prominent.	

5.6.5 Viewpoint 2 - Proposed

Receptor - VP2 Summary of Impact Assessment	
Receptor Sensitivity	Low
View Magnitude of Landscape Change	Low
Impact Significance	Minor
Mitigation Measures	• No mitigation required

5.6.4 Viewpoint 3 - Existing

Receptor - VP3	Airport Road, Narrabri
Coordinate Location	30°19’58.242” S 149°49’22.986” E
View Description	View from unnamed track which joins Airport Drive, looking south towards the solar farm site
Distance from Site	Approximate 700m to the edge of the site
Comments • Open rural landscape, with minimal canopy vegetation in the foreground with a sparsely vegetated rural landscape behind the site in the background that terminates most of the views.	

5.6.5 Viewpoint 3 - Proposed

Receptor - VP3 Summary of Impact Assessment	
Receptor Sensitivity	Low
View Magnitude of Landscape Change	Low
Impact Significance	Minor
Mitigation Measures	• No mitigation required

5.6.6 Viewpoint 4 - Existing

Receptor - VP4	Private access track, Narrabri
Coordinate Location	30°20’49.5” S 149°48’39.636” E
View Description	View from Kaputar Road, looking north east towards the solar farm site
Distance from Site	Approximate 1km
Comments • Open, flat rural landscape character with sparse vegetation coverage and rural residential dwellings to the south. • Elevated vegetated hills in the background are elements of low prominence within the visible landscape.	

5.6.6 Viewpoint 4 - Proposed

Receptor - VP4 Summary of Impact Assessment	
Receptor Sensitivity	Negligible
View Magnitude of Landscape Change	Negligible
Impact Significance	Negligible
Mitigation Measures	• No mitigation required

6. SUMMARY OF ASSESSMENT

6.1 Summary of Assessment

The visual environment for the subject site and surrounding area is characterised by open, typically flat rural land.

Whilst the subject has been cleared of vegetation, established specimens and groups of trees on adjoining properties reinforce the local rural character of the area.

Although the subject site is located within 3km of Narrabri township, views of the site from public viewpoints are only generally visible along Airport Road and Kaputar Road. This is due to the low flat areas adjoining the site and obstructions between the viewpoints and the site such as residential structures and vegetation along verges and property boundaries.

Although the site is visible from adjoining roads, from certain locations it's distance from viewpoints along the roads combined with the presence of existing vegetation reduces its overall visibility within the landscape.

The height and visual permeability of the array will mean that the relative visual impacts of the Solar Farm are generally low, especially given the distance from the most notable public vantage points.

As the landscape view shed from the 4 nominated viewpoints are considered to be wide, the proposed solar farm would not be a prominent element in the landscape nor would it change the existing rural character.

Overall the Solar Farm is considered to have an Effect Significance rating of **Minor**.

6.2 Mitigation Measures

As described in the summary for each of the 4 viewpoints, the height and nature of the solar farm along with the distances from the site will mean that it will not be a highly visible element within the landscape. However as it represents a minor visual change to the rural landscape some mitigation would be recommended on those sides that are visible from the main public viewpoints and the adjoining private receptors of the residential properties.

Given the relatively low height of the Solar Farm, the informal planting of native shrubs to compliment the existing rural landscape character along the southern and south eastern side of the lease area, outside of the fence line would assist in minimising visual impacts of the development on the surrounding rural landscapes and the adjoining residential properties.

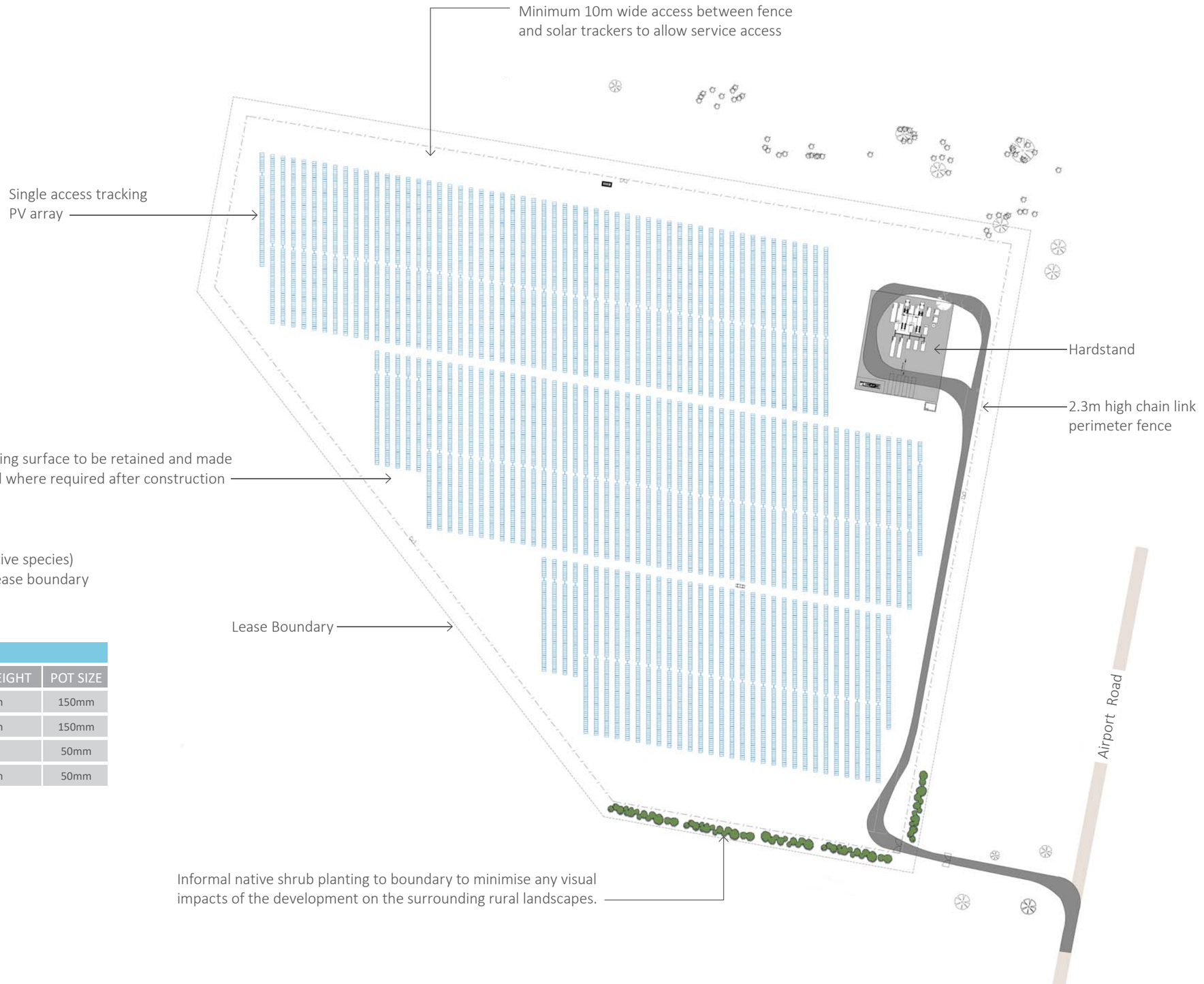
The planting of trees directly adjoining the solar farm would not be encouraged due to the potential for shadows to be cast over the array during certain times of the day.

Table 4. Summary of Visual Impact Ratings for each Receptor

Receptor	Receptor Sensitivity	Magnitude of Change	Effect Significance
VP1	Low	Low	Minor
VP2	Low	Low	Minor
VP3	Low	Low	Minor
VP4	Negligible	Negligible	Negligible

8. LANDSCAPE CONCEPT

8.1 Landscape Plan



LEGEND

Existing trees

3-4m wide buffer with shrub planting (native species) outside of security fence and within the lease boundary

PLANTING SCHEDULE

SHRUBS			
SPECIES	COMMON NAME	APPROX. HEIGHT	POT SIZE
Acacia decora	Western Silver Wattle	Up to 4m	150mm
Dodeonaea viscosa	Stocky Hop Bush	Up to 4m	150mm
Lomandra longifolia	Mat Rush	1m	50mm
Notelaea microcarpa	Velvet mock olive	Up to 2m	50mm

0 10 20 30 50 100m

SCALE 1:2500 @ A3

ASIA PACIFIC OFFICES

BRISBANE

Level 2, 15 Astor Terrace

Spring Hill QLD 4000

Australia

T: +61 7 3858 4800

F: +61 7 3858 4801

CANBERRA

GPO 410

Canberra ACT 2600

Australia

T: +61 2 6287 0800

F: +61 2 9427 8200

DARWIN

Unit 5, 21 Parap Road

Parap NT 0820

Australia

T: +61 8 8998 0100

F: +61 8 9370 0101

GOLD COAST

Level 2, 194 Varsity Parade

Varsity Lakes QLD 4227

Australia

M: +61 438 763 516

MACKAY

21 River Street

Mackay QLD 4740

Australia

T: +61 7 3181 3300

MELBOURNE

Level 11, 176 Wellington Parade

East Melbourne VIC 3002

Australia

T: +61 3 9249 9400

F: +61 3 9249 9499

NEWCASTLE

10 Kings Road

New Lambton NSW 2305

Australia

T: +61 2 4037 3200

F: +61 2 4037 3201

PERTH

Ground Floor, 503 Murray Street

Perth WA 6000

Australia

T: +61 8 9422 5900

F: +61 8 9422 5901

TOWNSVILLE SOUTH

12 Cannan Street

South Townsville QLD 4810

Australia

T: +61 7 4722 8000

F: +61 7 4722 8001

WOLLONGONG

Level 1, The Central Building

UoW Innovation Campus

North Wollongong NSW 2500

Australia

T: +61 2 4249 1000

AUCKLAND

Level 4, 12 O'Connell Street

Auckland 1010

New Zealand

T: 0800 757 695

NELSON

6/A Cambridge Street

Richmond, Nelson 7020

New Zealand

T: +64 274 898 628

www.slrconsulting.com

NARRABRI SOLAR FARM

Reflective Glare Assessment

Prepared for:

Providence Asset Group
704/99 Bathurst Street
SYDNEY NSW 2000

SLR Ref: 610.30220-R01
Version No: -v1.1
February 2021

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Tenancy 202 Submarine School, Sub Base Platypus, 120 High Street
North Sydney NSW 2060 Australia

T: +61 2 9427 8100
E: sydney@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Providence Asset Group (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.30220-R01-v1.1	25 February 2021	Peter Hayman	Dr Peter Georgiou	Dr Neihad Al-Khalidy
610.30220-R01-v1.0	25 February 2021	Peter Hayman	Dr Peter Georgiou	Dr Neihad Al-Khalidy

EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Providence Asset Group to carry out a Reflective Glare assessment of the proposed Narrabri Solar Farm (the "Project") under development by Providence Asset Group. The Project is located close to Narrabri and in particular Narrabri Airport, whose Runway 36 southern threshold lies approximately 1.1 km from the nearest perimeter of the Project.

The proposed (up to) 5 MWac facility (refer Section 2) will comprise 11,592 solar PV panels within a 15 ha project site area. The 540 W panels, measuring approximately 2.26 m by 1.13 m, will be positioned as currently understood on single-axis trackers oriented north-south with a spacing of 6.25 m.

The following potential glare conditions have been considered:

- Daytime Reflective glare (and glint) arising from the solar PV panels within the facility:
  - . Aviation Sector Reflective Glare;
  - . Motorist "Disability" Reflective Glare and Pedestrian "Discomfort" Reflective Glare;
  - . Rail Operator Reflective Glare;
  - . Industrial critical machinery operators (heavy vehicles, etc) Reflective Glare; and
  - . Residential "Nuisance" Glare
- Night-time Illumination glare if any 24/7 operational security lighting is incorporate into the Project in the future

Quantitative analysis using the FAA-SGHAT software tool has shown that there will be nil glare from the Project at Narrabri Airport with the solar array in normal tracking mode, ie panels tilting ±60°. The SGHAT results show potential for glare involving the panels being left at a fixed tilt angle of between 30° (westwards) to 40° (eastwards).

The months when this occurs are April to August (over winter). Accordingly, such a situation should be avoided, eg during construction, during maintenance periods, etc, during these months. This situation should also be considered in the application of sophisticated "back-tracking" operational modes for the proposed facility.

Primarily due to the selection of the single-axis tracking system for the mounting of the ground-based array panels, there will be nil glare from the Project in relation to traffic disability glare in normal ±60° tracking mode. Similarly, the potential for rail traffic disability glare from the Project is nil.

The potential for nuisance glare from the Project to surrounding residential or other receivers is nil.

Night-time lighting is not currently incorporated into the Project. If 24/7 lighting is required in the future for operational purposes, there should be negligible impact, assuming the lighting design is in accordance with AS 4282-1997 Control of the Obtrusive Effect of Outdoor Lighting. This would also address any potential adverse eco-lighting issues in relation to nocturnal fauna within and surrounding the site, although, as far as is known, no biodiversity issues have been identified in relation to the Project. Any future lighting design should also be checked against CASA's NASF Guidelines (E & F).

When key Project decisions are finalised during detailed design (eg final panel selection, mounting details, etc), the present analysis should be re-visited to confirm the conclusions set out above if key assumptions made in the analysis change significantly.

CONTENTS

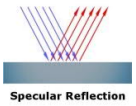
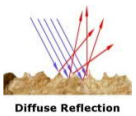
CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

Abbreviations and Definitions

Terms relevant to Daytime Reflective Glare	
PV Panel	Photovoltaic (PV) panels are designed to absorb solar energy and retain as much of the solar spectrum as possible in order to produce electricity.
Glare	Glare refers to the reflections of the sun off any reflective surface, experienced as a source of excessive brightness relative to the surrounding diffused lighting. Glare covers reflections: . Which can be experienced by both stationary and moving observers (the latter referred to as "glint"). . Which are either specular or diffuse.
Specular	A reflection which is essentially mirror-like – there is virtually no loss of intensity or angle dispersion between the incoming solar ray and outgoing reflection. 
Diffuse	A reflection in which the outgoing reflected rays are dispersed over a wide ("diffuse") range of angle compared to the incoming (parallel) solar rays, typical of "rougher" surfaces. 
KVP	Key View Points (KVPs) are offsite locations where receivers of interest have the potential to experience adverse reflective glare.

Terms relevant to Night-Time Illumination	
Luminous intensity	The concentration of luminous flux emitted in a specific direction. Unit: candela (Cd).
Luminance AS 1158.2:2005	This is the physical quantity corresponding to the brightness of a surface (e.g. a lamp, luminaire or reflecting material such as façade glazing) when viewed from a specified direction. Unit: Cd/m^2
Illuminance AS 1158.2:2005	This is the physical measure of illumination. It is the luminous flux arriving at a surface divided by the area of the illuminated surface – the unit is lux (lx) … 1 lx = 1 lm/m^2 The term covers both "Horizontal Illuminance" (the value of illuminance on a designated horizontal plane at ground level) and "Vertical Illuminance" (the value of illuminance on a designated vertical plane at a height of 1.5m above ground level).
Glare AS 1158.2:2005	Condition of vision in which there is a discomfort or a reduction in the ability to see, or both, caused by an unsuitable distribution or range of luminance, or to extreme contrast in the field of vision. Glare can include: (a) Disability Glare – glare that impairs the visibility of objects without necessarily causing discomfort. (b) Discomfort Glare – glare that causes discomfort without necessarily impairing the visibility of objects.
Threshold Increment (TI) AS 4282:2019	TI is the measure of disability glare expressed as the percentage increase in contrast required between an object and its background for it to be seen equally well with a source of glare present. Higher TI values correspond to greater disability glare.

1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Providence Asset Group to carry out a Reflective Glare assessment of the proposed Narrabri Solar Farm (the "Project") under development by Providence Asset Group. The Project is located close to Narrabri, NSW, approximately 2.5 km southwest of Narrabri town centre and 1.5 km from the nearest Narrabri suburbs.

The following potential glare conditions have been considered:

- Daytime Reflective glare (and glint) arising from the solar PV panels within the facility
- Night-time Illumination glare from 24/7 operational security lighting within the facility

1.1 Structure of Report

The remainder of this report is structured as follows:

- Section 2 describes the Project and surrounding environment;
- Section 3 describes the range of receptors surrounding the site with the potential to experience adverse reflective glare (or glint);
- Section 4 presents the acceptability criteria used for the study;
- Section 5 addresses the assumptions made in the glare impact analysis;
- Section 6 presents the results of the glare impact analysis of the Project;
- Section 7 presents the conclusions of the study.

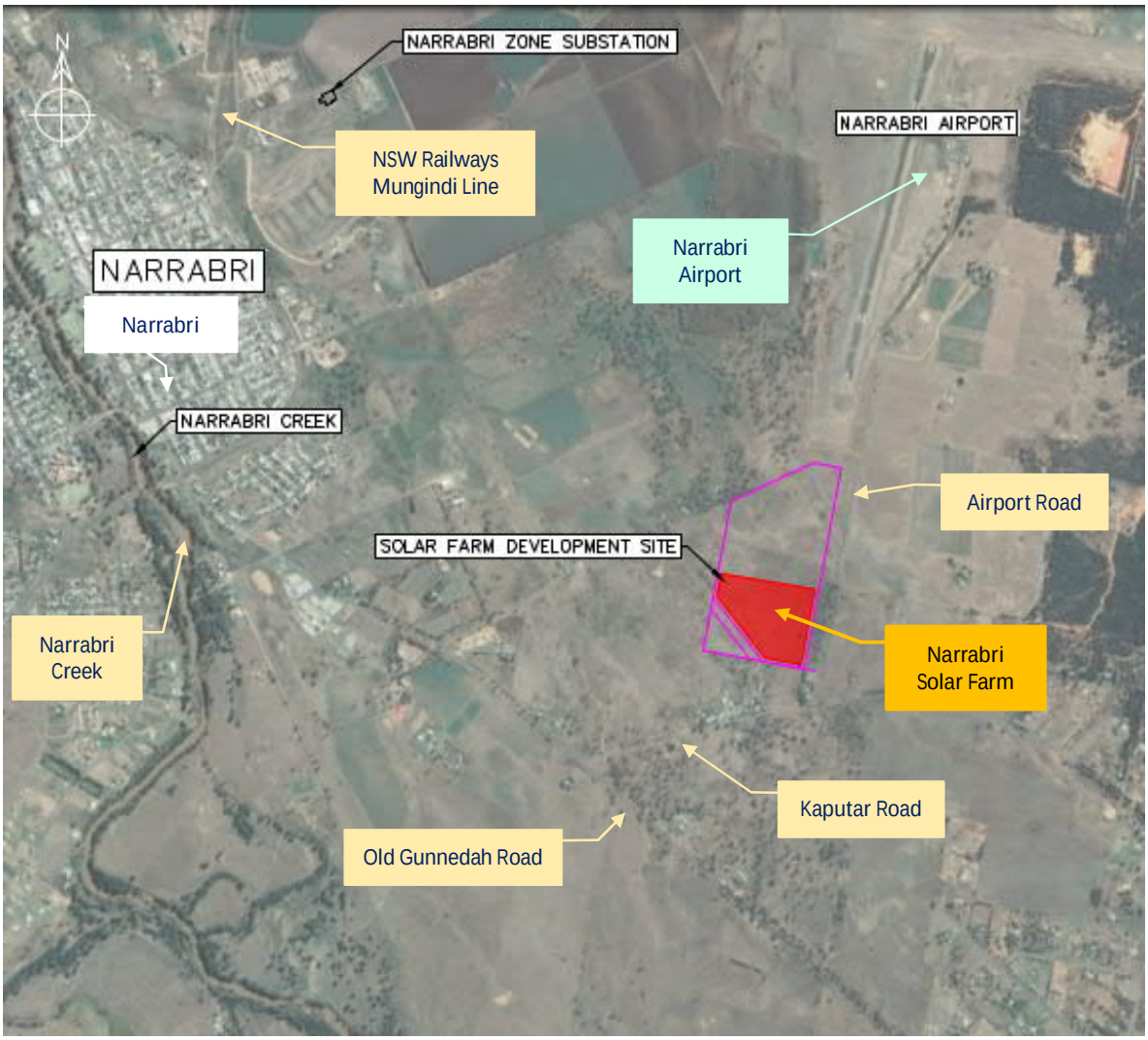
2 PROPOSED NARRABRI SOLAR FARM PROJECT

2.1 Site Location

The Project is seeking approval for an (up to) 5 MWac photovoltaic (PV) solar plant occupying a 15 ha area as shown in Figure 1. The Project is located approximately 3.5 km east-southeast of Narrabri town centre. The northern perimeter of the development site is approximately 1.1 km south of the southern end of Narrabri Airport's main Runway 18/36.

The land required for the Project has been subject to constraints identified by site investigation, i.e. native vegetation, and areas of cultural or heritage significance. The plan of the Project has been developed following completion of these site investigations and the assessment of any constraints and their impact.

Figure 1 Narrabri Solar Farm - Location Map



2.2 Site Description and Key Project Components

From a Reflective Glare point of view, the key components of the Project are:

- the photovoltaic (PV) modules in relation to their daytime reflective glare potential; and
- the facility's security/emergency lighting design in relation to potential night-time illumination glare issues (if such 24/7 lighting is incorporated into the Project).

Solar Panel Mounted Array – refer Figure 2

The proposed ground-mounted array (refer Figure 2(a)) would consist of 142 trackers oriented in a north-south direction, each supporting 84 x 540W solar panels (11,592 panels in total);

- The trackers are "single-axis" capable of rotating solar panels to a maximum of ±60° - refer Figure 2(b);
- The trackers are oriented north-south and spaced 6.25 m apart;
- Individual panels (2.26 m x 1.13 m) reach a maximum height above ground of 2.58 m at their full 60° tilt angle; and
- The eastern perimeter of the Project lies approximately 80 m from Airport Road with the southern perimeter just over 200m from Kaputar Road at its closest point. The northern perimeter of the solar farm site lies approximately 1,100 m from the southern threshold of Narrabri Airport's main Runway 18/36.

Figure 2 Narrabri Solar Farm Site Layout (to be updated with site layout drawing)

(a)
Site Layout

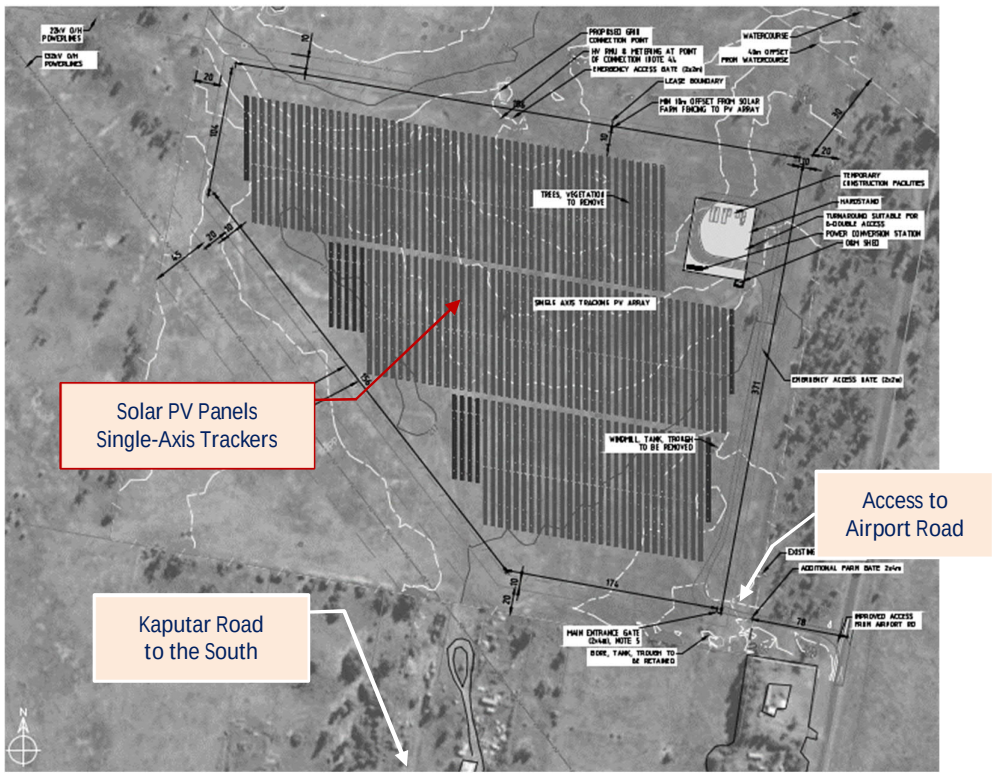
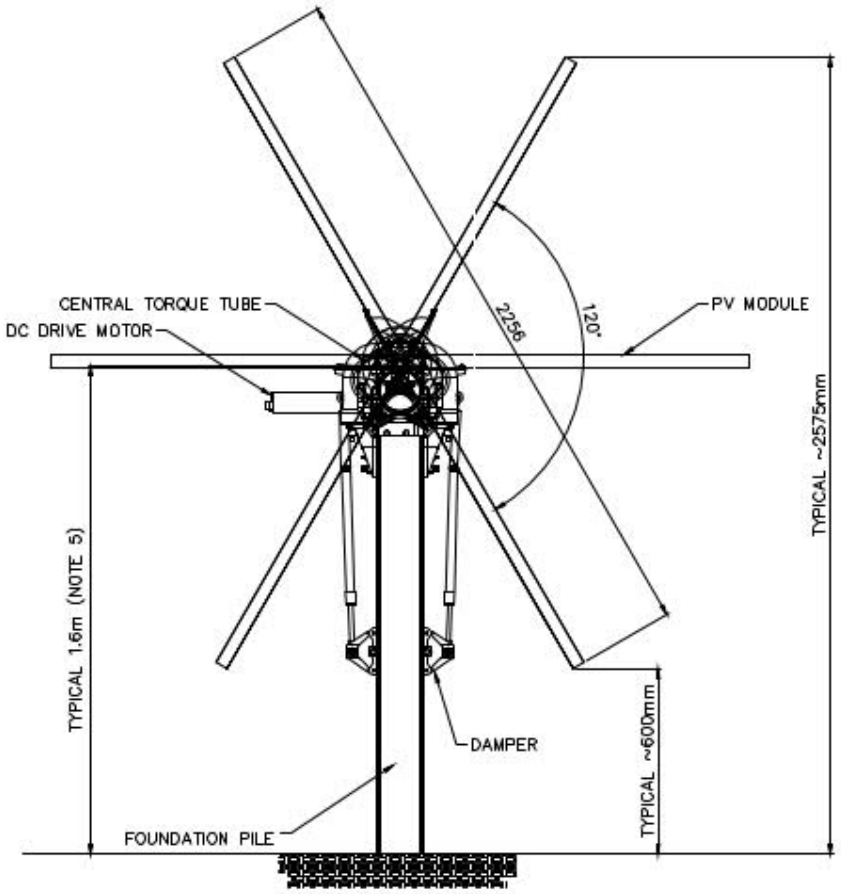


Fig.2 (cont'd)

(b)
Single-Axis
Tracker Profile
(±60° **Tilt**)



3 RECEIVERS AND ASSOCIATED IMPACTS

3.1 Receiver Impacts

The issues of concern in relation to daytime reflective glare and night-time illumination glare and the associated receivers of interest are detailed below.

Aviation-Related Glint & Glare (Aircraft, Helicopters, Airport Control Towers)

There have been several documented cases globally, none in Australia, of solar panel installations at airports interfering with Airport Control Tower operations. There is the added potential for reflective glare to impact pilots especially during the latter approach stages of landing, when the line of sight of the pilot is directed downwards.

Motorist Traffic Disability Glare on the surrounding road network

The issue of concern here is the potential occurrence of Traffic Disability Glare, which most often arises from incoming solar rays striking a reflective surface at a moderately high ("glancing") incident angle (typically greater than 70˚) and altitude angle less than 25˚ (altitude angles greater than this would be intersected and obstructed by a typical windscreen roof-line).

Train Driver Disability Glare on the surrounding rail network

The issue of concern here is the potential impact of reflective glare interfering with or distracting a train operator's activities or the potential for reflections to obscure railway signals.

Industrial Critical Machinery Operators (draglines, heavy trucks, etc)

The issue of concern here is the potential impact of reflective glare interfering with or distracting the operators of critical industrial machinery.

Residential Nuisance Glare on surrounding receivers

The issue of concern here is the potential "nuisance" caused by extended periods of reflective glare.

Nearest neighbours may also be impacted by light spill from night-time illumination.

3.2 Nearest Receiver Locations

Receivers of interest relevant to the Project are shown in:

Figure 3 Nearest aerodrome;

Figure 4 Surrounding road network;

Figure 5 Surrounding rail network; and

Figure 6 Nearest representative residential receivers.

Figure 3 Nearest Aerodrome to Project Site

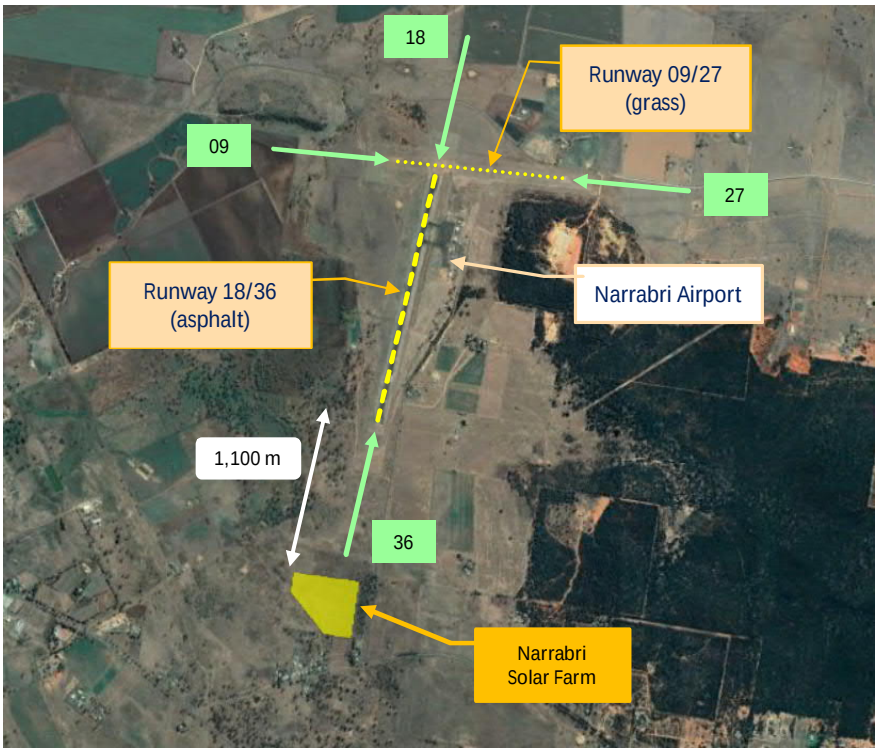


Figure 4 Surrounding Road Network

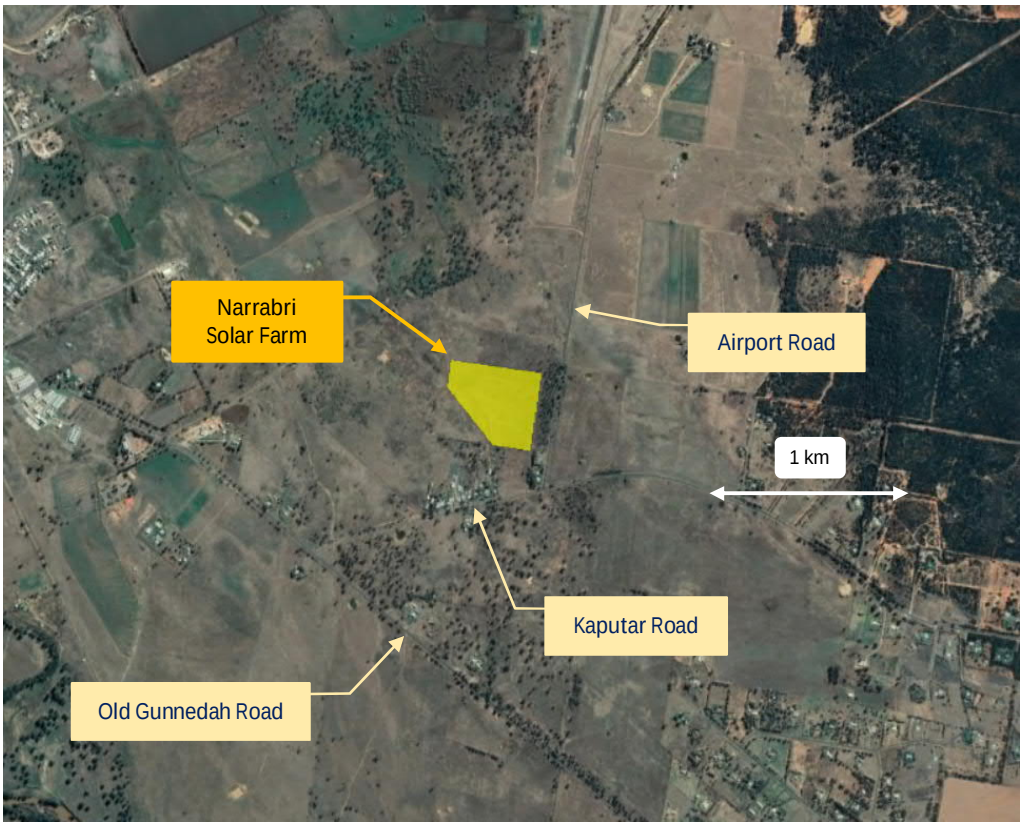


Figure 5 Surrounding Rail Network and NSW Rail Map

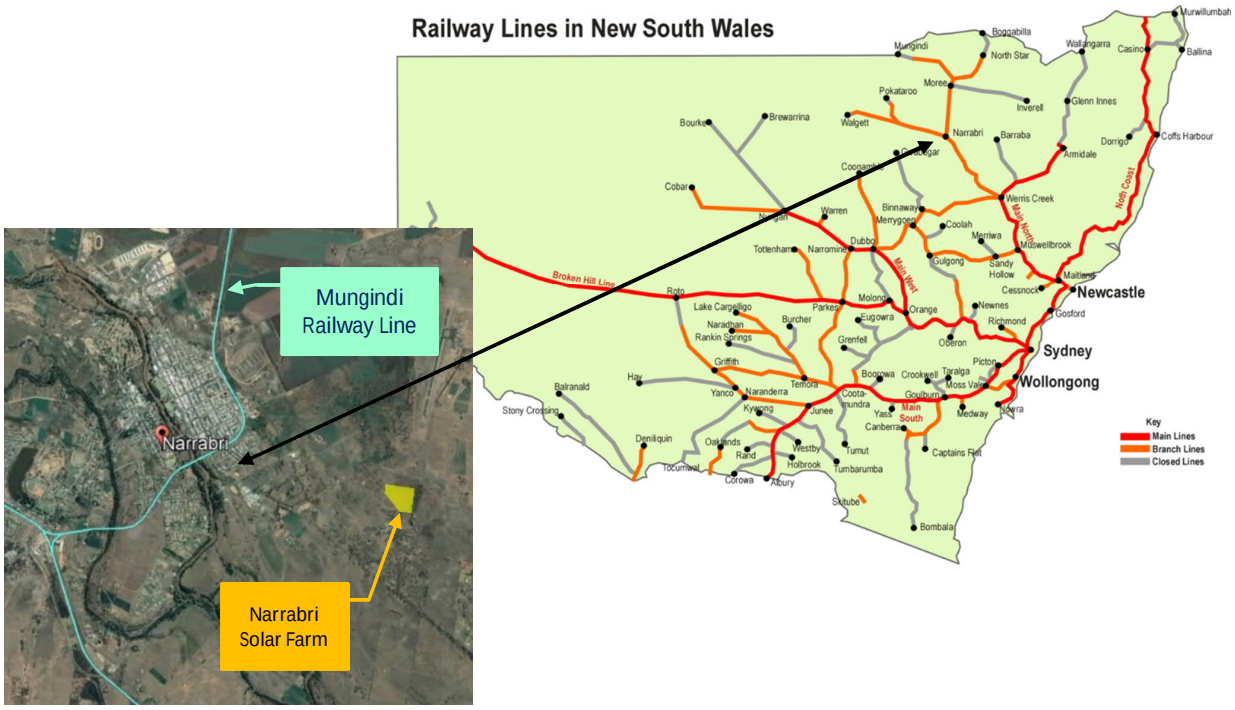
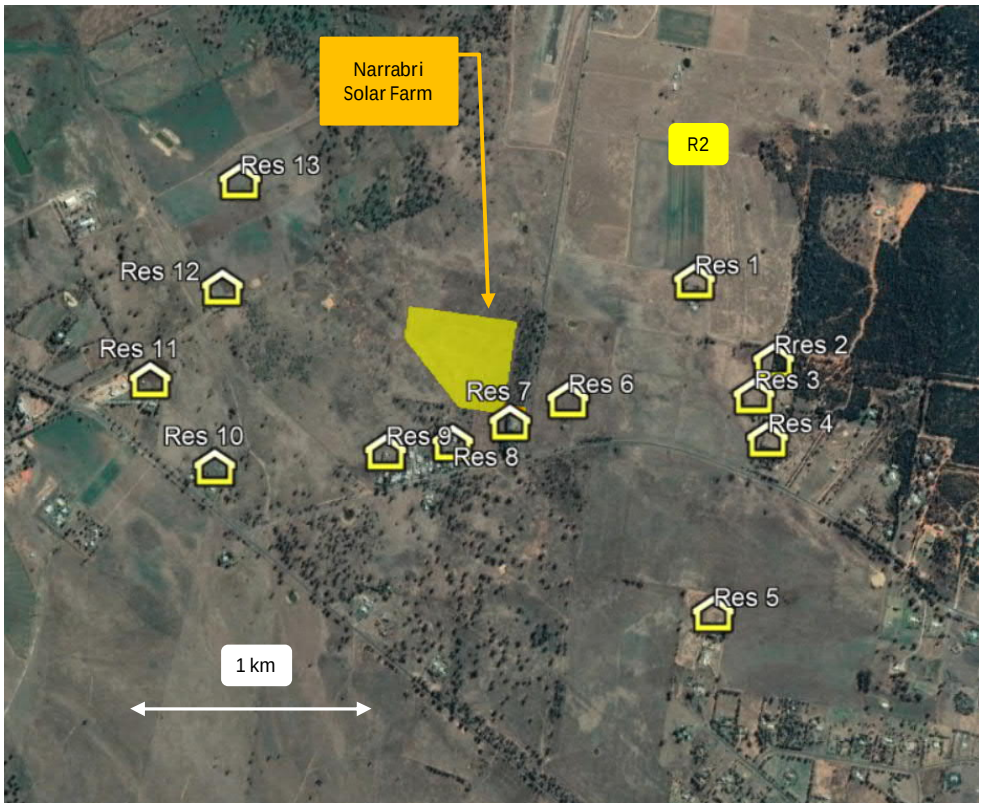


Figure 6 Nearest Representative Residential Receivers



4 GLARE ACCEPTABILITY CRITERIA

In relation to daytime reflective glare impact, the Project contains the following elements of interest:

- PV modules using solar panels on the Project ground array;

In relation to night-time illumination glare impact, the Project may, in the future, include the following elements of interest:

- 24/7 lighting for access roads to enable site maintenance, fire and other emergency events, and 24/7 lighting for the on-site Operations & Maintenance building and power conversion unit which provide connection to the local distribution network.

Night-time illumination is not presently incorporated in the current Project design.

4.1 Aviation Sector Reflective Glare

The impact of solar PV systems on aviation activity is something that solar developers today are addressing more and more often, given the (global) proliferation of solar projects, in particular those located either within or around airport precincts.

US FAA

In relation to the potential impact of solar PV systems on aviation activity, guidance is available from the US FAA which regulates and oversees all aspects of American civil aviation. On the basis of the above and other technical R&D references, the FAA issued a Technical Guidance Policy in 2010 and a subsequent (and over-riding) Interim Policy in 2013. The Technical Guidance Policy was updated in 2018.

- FAA, "Technical Guidance for Evaluating Selected Solar Technologies on Airports", Federal Aviation Administration, Washington, D.C., November 2010.
- FAA, "Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports", Federal Register, Oct. 23, 2013.
- FAA, "Technical Guidance for Evaluating Selected Solar Technologies on Airports", Federal Aviation Administration, Washington, D.C., Version 1.1, April 2018.

In support of the above, the FAA contracted Sandia Labs to develop their Solar Glare Hazard Analysis Tool (SGHAT) software as the standard tool for measuring the potential ocular impact of any proposed solar facility on a federally obligated airport. SGHAT utilises the Solar Glare Ocular Hazard Plot to determine and assess the potential for glare.

SGHAT is described in the following references:

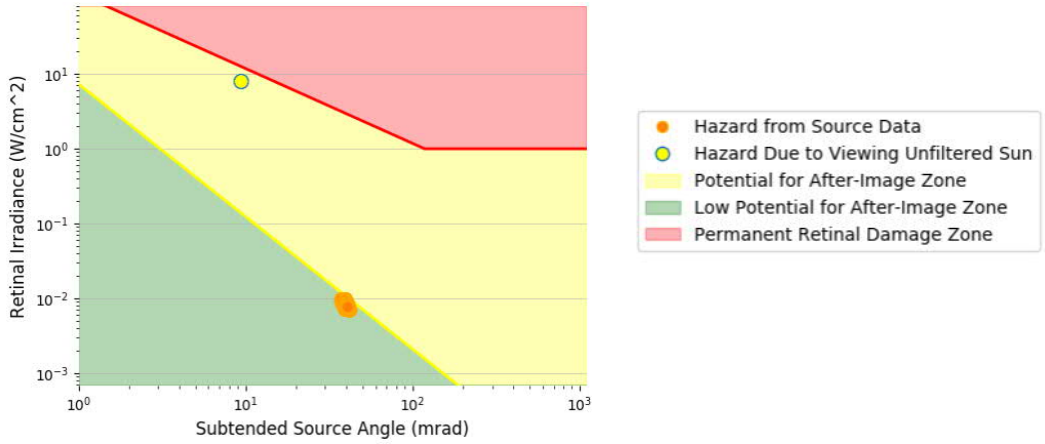
- Ho, C.K., Ghanbari, C.M. and Diver, R.B., "Methodology to Assess Potential Glint and Glare Hazards from Concentrating Solar Power Plants: Analytical Models and Experimental Validation", J. Solar Engineering, August 2011, Vol.133, 031021-1 to 031021-9.
- Ho, C.K. & Sims, C., "Solar Glare Hazard Analysis Tool (SGHAT) User's Manual v2.0", Sandia National Laboratories, Albuquerque, NM. August 2013.

A sample Solar Glare Ocular Hazard Plot is shown in Figure 7. The analysis contained in this plot is derived from solar simulations that extend over the ENTIRE CALENDAR YEAR in 1-MINUTE intervals, sunrise to sunset.

The SGHAT criteria state that a proposed solar facility should satisfy the following:

- Airport Traffic Control Tower (ATCT) cab: NO Glare
- Final approach paths for landing aircraft: Glare to NOT exceed "Low Potential for After-Image"

Figure 7 Example Solar Glare Ocular Hazard Plot (SGHAT Software Output)



In Figure 7, the following is noted:

- SGHAT ocular impact is a function of both the "retinal irradiance" (ie the light seen by the eye) and "subtended source angle" (ie how wide an arc of view the light appears to be arriving from).
- SGHAT ocular impact falls into three categories:
  . GREEN: low potential to cause "after-image"
  . YELLOW: potential to cause temporary "after-image"
  . RED: potential to cause retinal burn (permanent eye damage)
- "After Image" is the term applied to a common retinal phenomenon that most people have experienced at some point or other, such as the effect that occurs when a photo with flash is taken in front of a person who then sees spots in front of their eyes for a few seconds. A more extreme example of "after-image" occurs when staring at the sun. "After-image" (also known as "photo bleaching") occurs because of the de-activation of the cells at the back of the eye's retina when subjected to a very bright light.
- The SGHAT plot provides an indication of the relative intensity of both the incoming reflection and the sources of light itself (ie the sun).
  . The occurrence of glare is shown in the plot as a series of orange circles, one circle for each minute that a reflection is visible.
  . A reference point is also shown in each SGHAT plot, the green circle, representing the hazard level of viewing the sun without filtering, ie staring at the sun.
- In Figure 8, it can be seen that the reflection visible by the receiver is roughly 1,000 times less intense than the light from the sun.

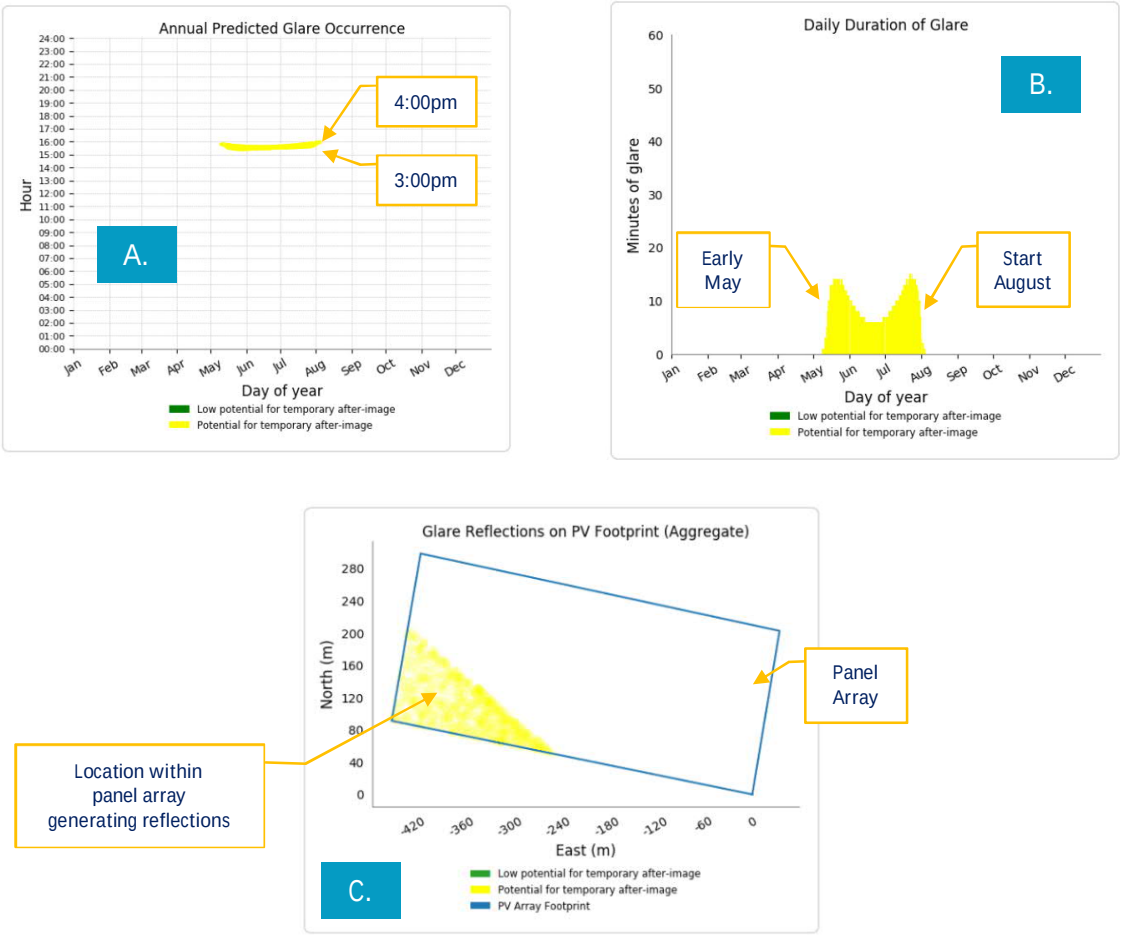
- Finally, in relation to PV Solar facilities, it is important to note that the third SGHAT Ocular Plot "RED" category is not possible, since PV modules DO NOT FOCUS reflected sunlight.

Additional Information Available with the SGHAT Analysis Tool

In addition to the above "assessment" output, the SGHAT software package also produces information which reveals the extent of visibility of reflections at any chosen receiver position, regardless of whether the reflections constitute a glare condition or not – an example is shown in Figure 8.

- Figure 8-A: shows the am/pm time periods when reflections occur at a specific position throughout the year, in this case typically between around 3:30pm and 4:00pm.
- Figure 8-B: shows the months during the year and the minutes per day when reflections occur at a specific position, in this case from early-May to the start of August.
- As noted above, this information is made possible because the SGHAT analysis covers the entire solar annual cycle in 1-minute intervals to ascertain any potential impacts on surrounding receivers.
- Finally, Figure 8-C shows WHERE within the solar farm panel array the reflection rays of interest are emanating from, in this case from panels near the southeast corner.

Figure 8 Example Solar Glare Output Plots (SGHAT Software Output)



4.2 Motorist "Disability" Glare and Pedestrian "Discomfort" Glare

The criteria commonly used by Australian Local Government Authorities to assess the acceptability or otherwise of potential adverse reflections from glazed façade systems onto surrounding roadways and pedestrian crossings utilise the so-called Threshold Increment (TI) Value of the reflection condition.

TI Value Definition

AS/NZS 4282:2019 defines Threshold Increment (TI) as:

> "the measure of disability glare expressed as the percentage increase in contrast required between an object and its background for it to be seen equally well with a source of glare present. Note: Higher values of TI correspond to greater disability glare."

The TI Value is calculated as the ratio of "veiling" luminance (eg from a reflection) to the overall average background ("adaptation") luminance, with the necessary constant and exponent parameters provided in AS 1158.2:2005.

The formula for calculating the TI Value is ... $TI = 65 L_v / L_{tb}^{0.8}$, where:

- L_v = veiling luminance from a source of interest (eg reflection) – Cd/m^2
- L_{tb} = so-called "adaptation" luminance (total background) – Cd/m^2

TI Value Acceptability Criteria

The acceptability criteria adopted by Australian Local Government Authorities to assess the acceptability or otherwise of potential adverse reflections from glazed façade systems onto surrounding roadways and pedestrian crossings utilise the so-called Threshold Increment (TI) Value of the reflection condition (refer above for definition and calculation equations).

For (Motorist) Traffic Disability Glare, the TI Value should remain:

- Below 10 for major roads
- Below 20 for minor roads

For Pedestrian Discomfort Glare, the TI Value should remain:

- Below 2 at critical locations such as pedestrian crossings
- Below 3 for other locations

For the present study, Pedestrian Discomfort Glare is relevant to the potential for residential nuisance glare from surrounding receivers.

It should be noted that while Pedestrian Discomfort Glare can occur over a wide range of solar altitude angles, in most such instances, a pedestrian has the ability to adjust their line of sight to a more horizontal view away from the glare source, thereby rendering TI values essentially negligible.

4.3 Rail Operators Reflective Glare

Almost all Australian Rail Authorities have guidelines covering glare in general (ie not specific to solar PV panel glare) aimed at avoiding discomfort/distraction to train operators and obscuring train signals. Most guidelines refer either to Table 2.10 of AS 1158.3.1 for the TI Value criterion and/or Table 3.2 of AS 1158.4 for the Cd (Candela) criterion associated with the control of glare.

- For Rail Traffic Disability Glare, the relevant AS1158 criteria are:
  - The TI Value should remain below 20%
  - The Cd Value at 70° incidence should remain below 6,000.

4.4 Residential "Nuisance" Glare

Instances of documented nuisance glare associated with solar PV panels (grid-scale, industrial or residential) and nearby residential receivers have been relatively infrequent globally, especially given the widespread and rapid increase in the take-up of residential solar panels in Australia and elsewhere.

There are currently no national or state guidelines in Australia
governing the acceptability or otherwise of residential nuisance glare specific to solar PV.

Existing guidance that exists in relation to solar panels from state governments typically covers installation audits and compliance checks. Additional guidance in relation to compliance with Australia Standards is provided by:

Clean Energy Council
Website: https://www.cleanenergycouncil.org.au/industry/products/modules

Accordingly, to assist in addressing residential nuisance glare, reference has been made of the concepts used for glare acceptability criteria outlined in the preceding sections.

4.5 Industrial Critical Machinery Operations

There are currently no (Australian) national or state guidelines governing the acceptability or otherwise of reflective glare for industrial site critical operations. Instead, the concepts used for acceptability criteria in the preceding sections, in particular Traffic Disability Glare, can assist when dealing with this issue.

The issue most commonly arises in relation to mining operations where machinery operators can be located in elevated locations, eg dragline operations, where a line of sight may be possible to a solar facility located in close proximity. Ports with their observation towers are another potential source of elevated receivers of interest if located adjacent to a solar facility.

No such industrial operations exist in the present case.

4.6 Night-Time Illumination Glare

The effect of light spill from outdoor lighting impacting on residents, transport users, transport signalling systems and astronomical observations is governed by AS 4282-2019.

The adverse effects of light spill from outdoor lighting are influenced by a number of factors:

- The topology of the area. Light spill is more likely to be perceived as obtrusive if the lighting installation is located higher up than the observer. Lighting installations are usually directed towards the ground and an observer could hence have a direct view of the luminaire.
- The surrounding area. Hills, trees, buildings, fences and general vegetation have a positive effect by shielding the observer from the light installation.
- Pre-existing lighting in the area. Light from a particular light source is seen as less obtrusive if it is located in an area where the lighting levels are already high, eg in cities. The same lighting installation would be seen as far more bothersome in a less well-lit residential area.
- The zoning of the area. A residential area is seen as more sensitive compared to commercial areas where high lighting levels are seen as more acceptable.

Typical illuminance levels for a variety of circumstances are given in Table 1 for comparison.

Table 1 Typical Illuminance Levels for Various Scenarios

Lighting Scenario	Horizontal Illuminance (lux)
Moonless overcast night	0.0001
Quarter Moon	0.01
Full Moon	0.1
Twilight	10
Indoor office	300
Overcast day	1,000
Indirect sunlight clear day	10,000-20,000
Direct sunlight	100,000-130,000

Recommended criteria of light technical parameters for the control of obtrusive lighting are given in Table 2. The vertical illuminance limits for curfew hours apply in the plane of the windows of habitable rooms or dwellings on nearby residential properties. The vertical illuminance criteria for pre-curfew hours apply at the boundary of nearby residential properties in a vertical plane parallel to the boundary.

Values given are for the direct component of illuminance, i.e. no reflected light is taken into account.

- Limits for luminous intensity for curfew hours apply in directions where views of bright surfaces of luminaires are likely to be troublesome to residents, from positions where such views are likely to be maintained.
- Limits for luminous intensity for pre-curfew hours apply to each luminaire in the principal plane, for all angles at and above the control direction.

Table 2 Recommended Maximum Values of Light Technical Parameters (AS4282-1997)

Light Technical Parameter	Time of Operation	Commercial Areas	Residential Areas	
			Light Surrounds	Dark Surrounds
Illuminance in vertical plane (E_v)	Pre-curfew hours	25 lx	10 lx	10 lx
	Curfew hours	4 lx	2 lx	1 lx
Luminous Intensity emitted by luminaires (I)	Pre-curfew hours	7,500 Cd (for a medium to large area with Level 1 control)	100,000 Cd (for a large area with Level 1 control)	100,000 Cd (for a large area with Level 1 control)
	Curfew hours	2,500 Cd	1,000 Cd	500 Cd

The Project is located outside the Narrabri town area and has the potential to impact on surrounding residential properties – refer Figure 6. As these properties are not located within township environs proper, they would therefore be classed as being in a residential area with "Dark Surrounds" - refer Table 2.

The applicable limits for adverse spill light will depend on the time of operation for the lighting installation.

For the Project, it is possible that internal access roads and any equipment buildings in particular, will be operational 24/7, suggesting the application of the more restrictive limit relevant to curfew hours.

Accordingly:

- Light spill from the Project onto the facades of the surrounding residential dwellings should be kept below 1 lux during curfew hours

Finally, it has been known for some time that night-time artificial lighting has the potential to disrupt the natural behaviour of nocturnal fauna species such as arboreal mammals, large forest owls and microbats. The standards mentioned above do not contain limiting lux levels in relation to the mitigation of such eco-lighting impacts.

Mitigation recommendations in relation to adverse eco-lighting therefore centre on feasible night-time lighting minimisation, bearing in mind the provision of appropriate health and safety and security conditions given the nature of the site. Biodiversity associated with the Project is discussed in the Flora and Fauna Assessment Report prepared for the Project. As far as is known, no adverse eco-lighting issues are apparent.

5 GLARE IMPACT ASSESSMENT - ASSUMPTIONS

The following potential glare conditions have been considered:

- Daytime Reflective glare (and glint) arising from the solar PV panels
- Night-time Illumination glare if any 24/7 operational security lighting is located within the site

5.1 Assumptions – Solar Panel Geometry

The glare assessment discussed in detail in following sections is based on the following assumptions:

- The solar panel array trackers are "single-axis" capable of rotating solar panels to a maximum of ±60°.
- The trackers are oriented north-south and spaced 6.25 m apart;
- Individual panels (2.26 m x 1.13 m) reach a maximum height above ground of 2.58 m at their full 60° tilt angle;
- The eastern perimeter of the Project lies approximately 80 m from Airport Road with the southern perimeter just over 200 m from Kaputar Road at its closest point. The northern perimeter of the solar farm site lies approximately 1,100 m from the southern threshold of Narrabri Airport's main Runway 18/36.

5.2 Project Site Solar Angles – Annual Variations

One of the challenging issues encountered with daytime solar panel glare is the varying nature of the reflections, whose duration will vary with time of day and day of the year as the sun's rays follow variable incoming angles between the two extremes of:

- summer solstice - sunrise incoming rays from just south of east, maximum angle altitude rays at midday, sunset incoming rays from just south of west
- winter solstice - sunrise incoming rays from the northeast, minimum angle altitude rays at midday, sunset incoming rays from the northwest

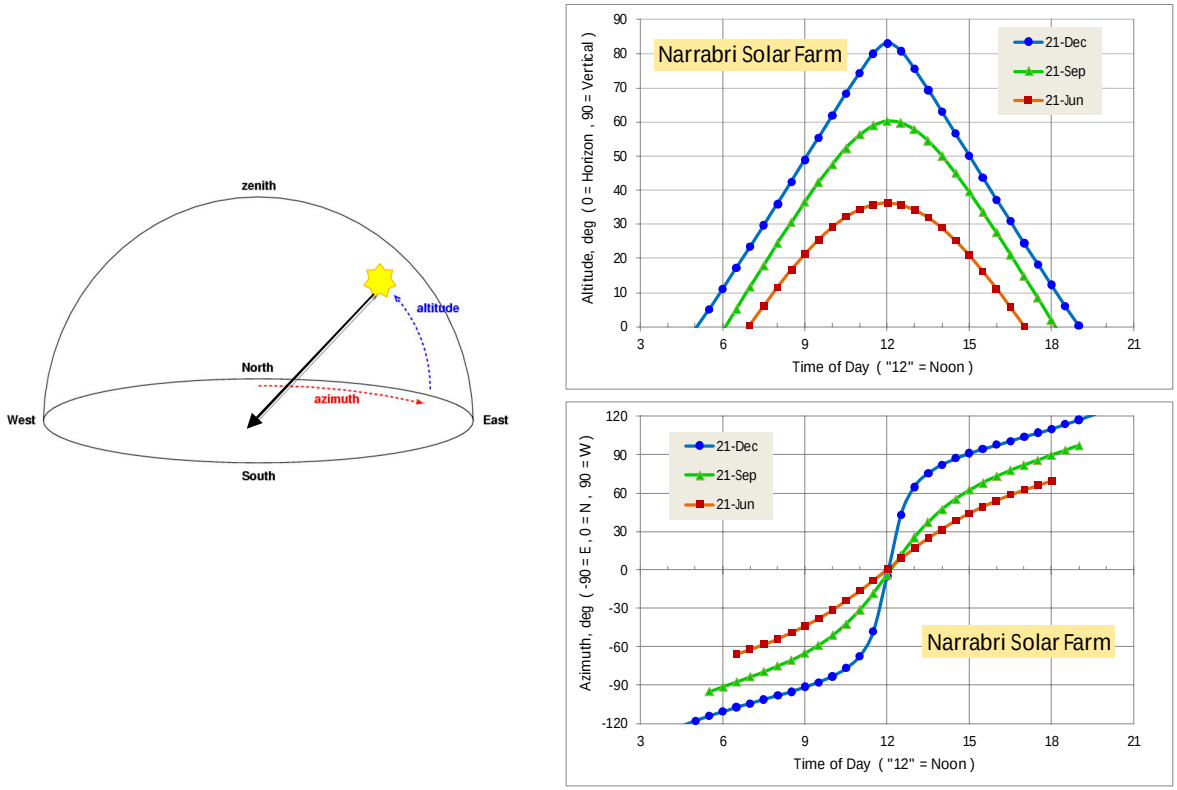
Any solar glare analysis must take into account the complete cycle of annual reflection variations noted above.

The potential range of incoming solar angles at the Project site relevant to daytime glare is shown in Figure 9 with relevant critical angles summarised in Table 3.

Table 3 Key Annual Solar Angle Characteristics for Project Site

Day of Year	Sunrise	Sunset	Azimuth Range (sunrise-sunset)	Max Altitude
Summer Solstice	5:04 am	7:02 pm	117° E of North to 117° W of North	83.0°
Equinox	6:06 am	6:09 pm	91° E of North to 91° W of North	60.2°
Winter Solstice	6:58 am	5:00 pm	63° E of North to 63° W of North	36.2°

Figure 9 Project Site Incoming Solar Angle Variations

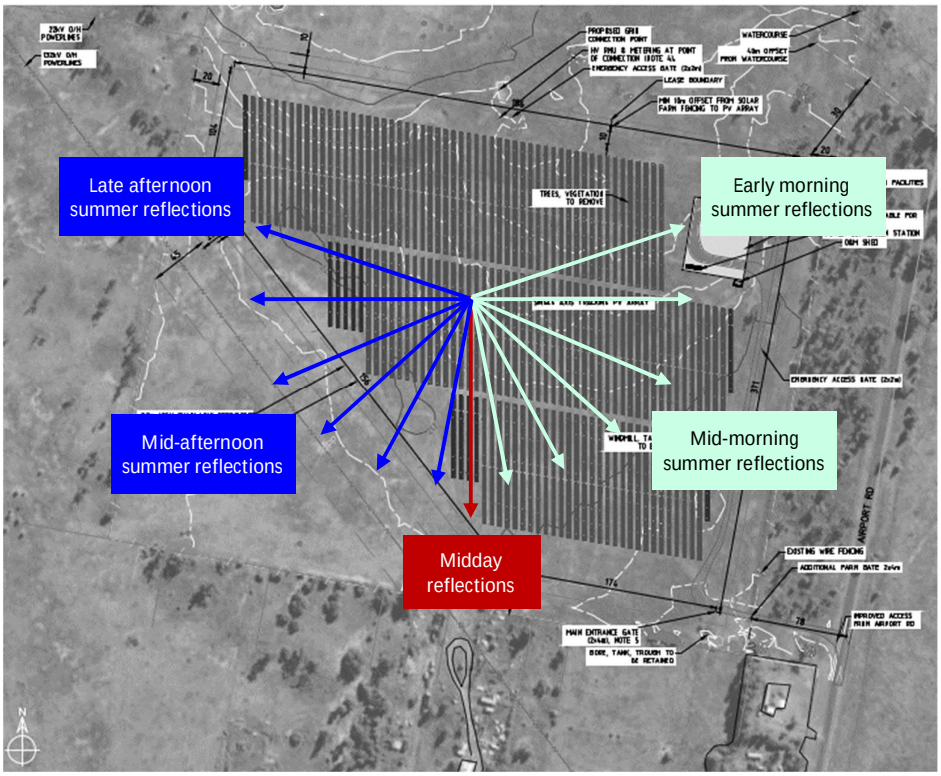


5.3 Project Solar Reflections

The project will use single-axis tracking panels (with the axis of rotation oriented north-south) as described in Section 2.2. In "plan" view, reflections from the project's panels will be directed as shown in Figure 10 for a representative area of panels, with the direction of reflected rays shown for typical mid-summer days.

As a result of the tracking motion of the solar panels throughout the day, reflections will generally be directed upwards and hence not visible by ground-based receivers at roughly the same elevation as the facility. Where such reflections can be observed by surrounding elevated receivers they would typically be seen as "low incidence" reflections with corresponding low reflectivity. This is the inevitable outcome of the objective of maximising the solar gain of each panel (where the reflectivity would ideally be minimal) and justifying the additional cost of using a tracking system for the panels which follows the sun, rather than a fixed panel system.

Figure 10 Potential Solar PV Panel Reflection Angles from the Project (typical mid-summer)



5.4 Solar Panel Reflectivity

Solar PV panels are designed to capture (absorb) the maximum possible amount of light within the layers below the front (external) surface. Consequently, solar PV panels are designed to minimise reflections off the surface of each panel. Reflections are a function of:

- the angle at which the light is incident onto the panel (which will vary depending on the specific location, time of day and day of the year), and
- the index of refraction of the front surface of the panel and associated degree of diffuse (non-directional) versus specular (directional or mirror-like) reflection which is a function of surface texture of the front module (reflecting) surface.

Some typical reflectivity values (given in terms of the "n" refractive index value) are:

- Snow (fresh, flaky) n = 1.98
- Standard Window Glass n = 1.52
- Plexiglass, Perspex n = 1.50
- Solar Glass n = 1.33
- Solar Glass with AR Coating n = 1.25

Standard PV Solar Panels

Representative reflectivity curves are shown in Figure 11.

Figure 11 Typical Reflectivity Curves as a Function of Incidence Angle

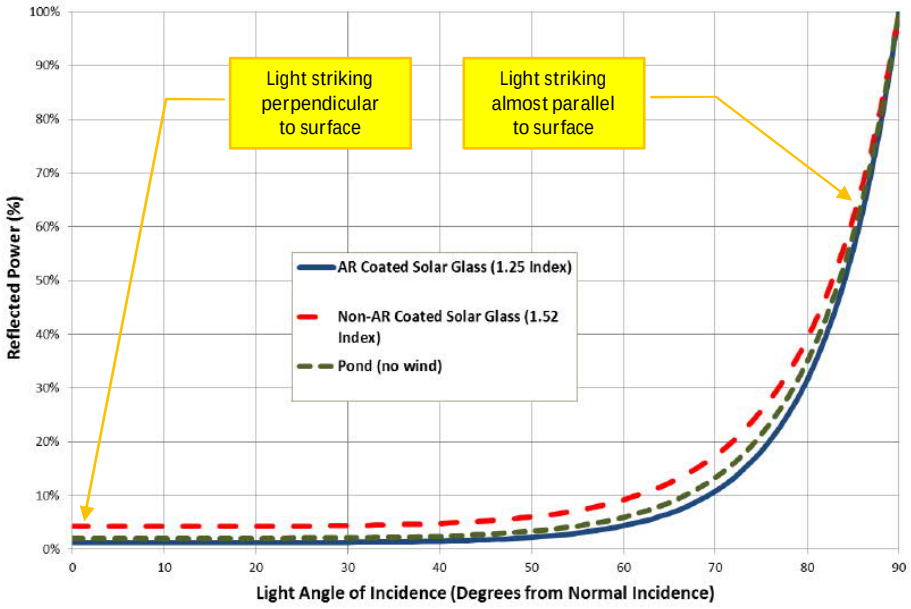


Figure 11 shows that:

- When an oncoming solar ray strikes the surface of a solar PV panel close to perpendicular to the panel surface (i.e. low "incident" angle), the reflectivity percentage is minimal (less than 5% for all solar panel surface types).
- It is only when an incoming solar ray strikes the panel at a large "incidence" angle, i.e. almost parallel to the panel, that reflectivity values increase. When this happens, reflections become noticeable and potentially at "glare" level for all solar panel surface types.
- However, for very high incidence angle, it would almost always be the case that the observer (motorist, train driver, pedestrian, etc) would perceive reflections coming from virtually the same direction as the incoming solar rays themselves. Such a condition would not constitute a glare situation as the intensity of the incoming solar ray itself would dominate the field of vision perceived by the observer.

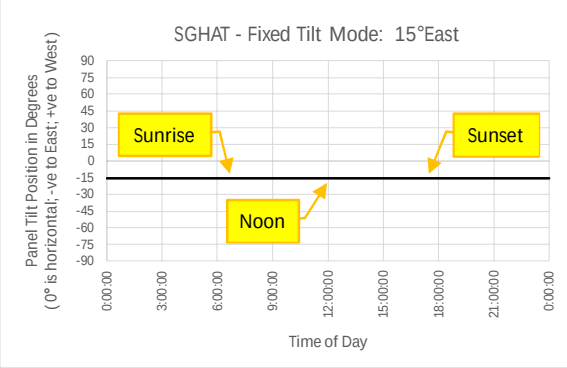
5.5 Modelling Real-World Tracking Axis Operational Modes

The SGHAT software tool is capable of modelling solar farm panel positions in one of three modes – as shown in Figure 12.

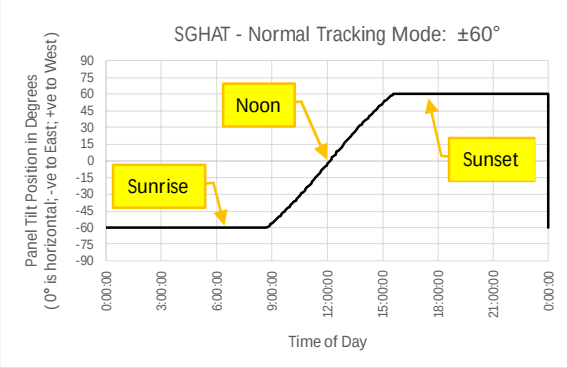
- Fixed Tilt Mode: in this mode, all panels are assumed to remain at a user-defined fixed angle all day long, eg horizontal, 15°East, 10°West, etc – refer Figure 12-A.
- Normal Tracking Mode: in this mode, panels move between maximum tilt angles once the sun is above the relevant altitude angle (eg an altitude angle of 30° for ±60° single-axis trackers). They remain at the maximum tilt angles at all other times, switching over during the night – refer Figure 12-B.
- Normal Tracking Mode / Fixed Tilt Stowed: in this mode, panels move during the day in "normal tracking": mode, but can then move (instantaneously) to any user-defined fixed tilt angle at all other times – refer Figure 12-C where the panels move to a horizontal position (ie 0°) outside of "normal tracking" hours.

Figure 12 SGHAT Panel Mode Simulation Options

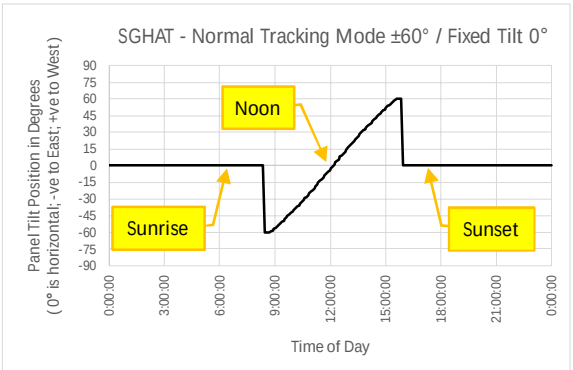
A



B



C



"Backtracking" Mode

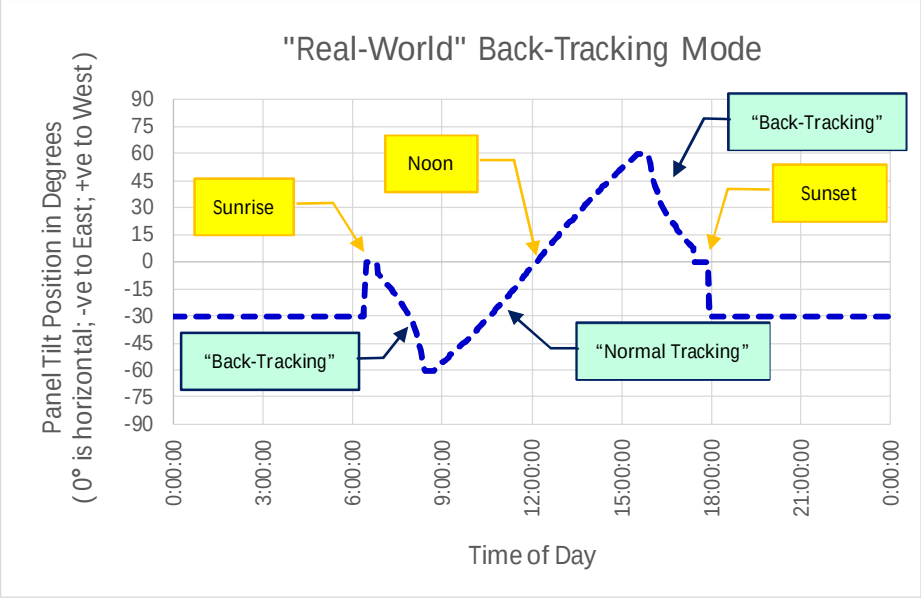
Most recently, sophisticated "back-tracking" operational modes have been developed, typically by the manufacturers of the tracking systems that support solar panels.

- Algorithms are developed (usually fine-tuned during the commissioning stage of a solar facility) aimed at minimising inter-row shading in the early morning and late afternoon. These algorithms are based on the location of a solar facility (ie its latitude), topography, panel row spacing, etc.
- They typically involve constantly re-positioning panels in the early morning and late afternoon starting and ending in a more horizontal position, that "just" avoids inter-row shading.
- During these early morning and late afternoon periods, panel motion is referred to as being in "back-tracking" mode.
- During the remaining hours in the middle of the day, solar panels follow the simplified "normal tracking" mode, ie moving between their maximum (±60°) tilt positions.
- There is typically a transition period between the two tracking modes (say ~15 minutes), calculated according to the local site tracking system algorithms.

A real-world example of a "back-tracking" mode is shown in Figure 13.

- The sun reaches an altitude angle of 30° in the morning at around 8:30am and again in the afternoon at around 3:45pm. During these hours (ie between around 8:30am and 3:45pm), the panels operate in "normal tracking" mode, ie from -60° facing East to +60° facing West.
- From sunrise till 8:30am and from 3:45pm to sunset, the panels operate in "back-tracking" mode, starting at sunrise and ending at sunset in a horizontal position.
- Overnight, the panels are "stowed" in a fixed (in this case, -30°) position to minimise wind loading and ensure any moisture (dew or rain) does not pool on the panel overnight and cause increased soiling.

Figure 13 Example 24-Hour "Back-Tracking" Operational Mode (around equinox)



SGHAT has not evolved yet to deal with sophisticated "back-tracking" operational modes of the type shown in Figure 13. They can only simulate solar farm panel positions in the three simplified modes shown in Figure 12.

It will be appreciated therefore that care must be taken when comparing the glare predictions of simplified SGHAT-type simulation modes, such as those shown in Figure 12, with possible real-world reflectivity behaviour of operational panel modes as shown in Figure 13.

6 GLARE IMPACT ASSESSMENT - RESULTS

6.1 Aviation Sector Reflective Glare

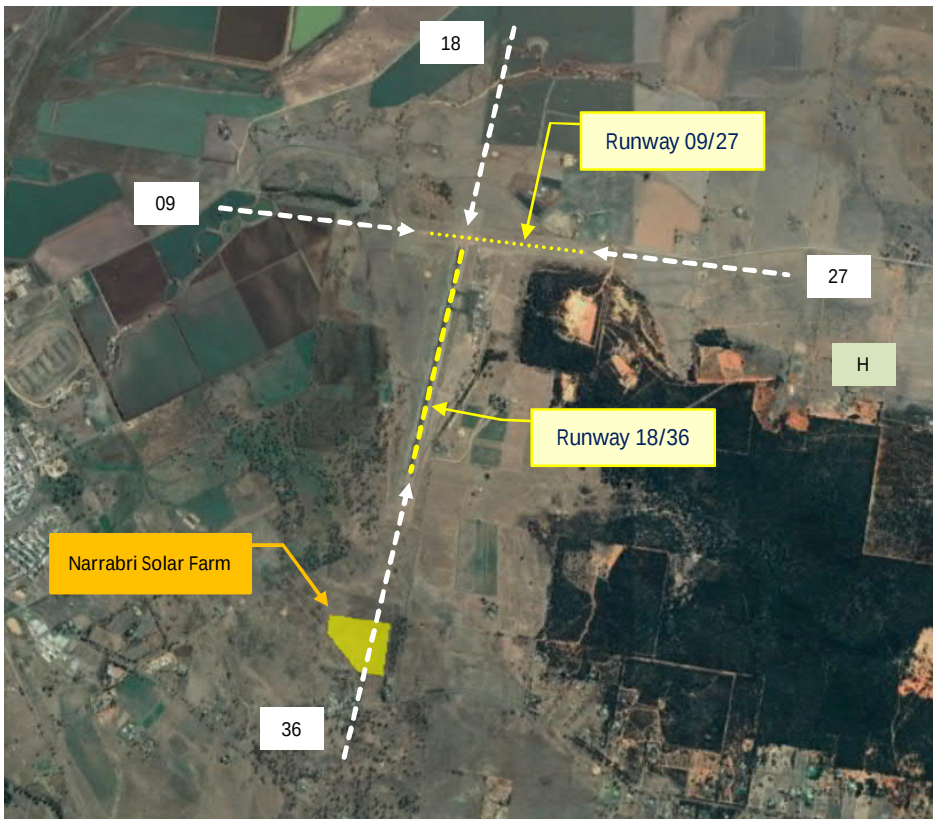
Narrabri Airport (IATA: NAA, ICAO: YNBR) is the nearest aerodrome to the site. It is located immediately to the north with the southern threshold of its main Runway 18/36 approximately 1.1 km from the northern perimeter of the Project. The airport is serviced by Link Airways (which operate a fleet of SAAB 340B Plus and Fairchild Metro 23 turboprop aircraft), general aviation aircraft and helicopters.

- The airport's main runway is 1,524 m asphalt Runway 18/36, oriented roughly north-south.
- The airport's secondary runway is 1,213 m grass Runway 09/27, oriented roughly east-west.
- The airport does not have a control tower (and as far as is known to SLR, none is planned).

Figure 14 shows (landing) flight paths of interest:

- The approach path to Runway 36 would have a direct line of sight towards the Project and its reflections at the commencement of final approach (taken to be approximately 2 miles (3.2 km) from the runway threshold); no reflections exist for final approach on Runway 18;
- Runway 09/27 approach paths are essentially perpendicular to the site.
- Helicopter flight paths can be highly variable and landing approach paths in the direct line of sight of the Project are possible, although there is greater flexibility in adjusting helicopter flight paths if required.

Figure 14 Flight Path Geometry for SGHAT Analysis



Accordingly, a quantitative analysis was carried out using the Sandia Labs Solar Glare Hazard Analysis Tool (SGHAT) software tool to examine potential worst-case scenario flight path approaches and take-offs and their ability to create adverse and unacceptable glare (and glint) conditions.

- The aircraft flight paths are all for landing scenarios (worst-case with the pilot looking downwards).

The flights paths assessed for the Project are shown in Figure 14.

SGHAT Modelling Assumptions:

- All runway approaches shown in Figure 13 were examined.
- A range of worst-case flight path scenarios has been assessed, named after their respective runway designations.
- For all Runways, landing flight paths are aligned with their respective runways.
- All aircraft landing flight paths are 2 miles in length, on a 3° glide angle (standard SGHAT protocol).
- The SGHAT analysis examines ALL possible solar angles throughout the year – in 1-minute intervals.
- The reflectivity of the PV panels was assumed to be the same as that shown in the standard solar glass shown in Figure 11.

In terms of the relative heights of flight paths and the solar farm for the critical Runway 36 approach paths of interest:

- Ground elevations (ASL) of Narrabri Solar Farm range from 217 m to 220 m;
- Ground elevations below Runway 36 flight paths are in the range 216 m to 224 m.

From the above, it can be seen that the terrain in the Narrabri area is reasonably flat, with only some surrounding receivers (residences, vehicles) just slightly elevated compared to the solar farm.

A number of panel scenarios were assessed:

- "Normal Tracking": panels tilt ±60° about a north-south horizontal axis – this would be the normal operational mode for the solar farm;
- "Fixed Tilt": panels remain fixed at angles of 0° (horizontal) and ±10° – this is a scenario theoretically possible under a situation involving: shutdown, maintenance, pre-commissioning, etc
- "Tracking + Stowed": panels tilt ±60° about a north-south horizontal axis and then rest for the remainder of the time at a fixed angle of 0°

SGHAT Results – "NORMAL TRACKING ±60°"

The SGHAT Ocular Plots results for this scenario for all flight paths shown in Figure 14 are presented in Table 4, which shows the total number of minutes in a year that solar panel reflections would be potentially visible within any relevant SGHAT "zone" (refer Figure 7).

It will be recalled that solar panel reflections (glint and glare) are acceptable according to the FAA-SGHAT protocol if there are no "Yellow" zone or "Red" zone results for aircraft flight paths.

Table 4 SGHAT Analysis Results (No of Minutes Reflections are in SGHAT Zones)

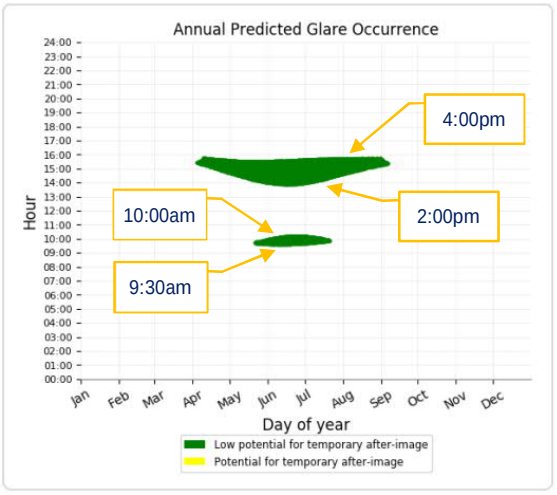
Flight Path	SGHAR Results for "NORMAL TRACKING" ±60° Scenario		
	"Green" Zone	"Yellow" Zone	"Red" Zone
09	0	0	0
18	0	0	0
27	0	0	0
36	11,792	0	0

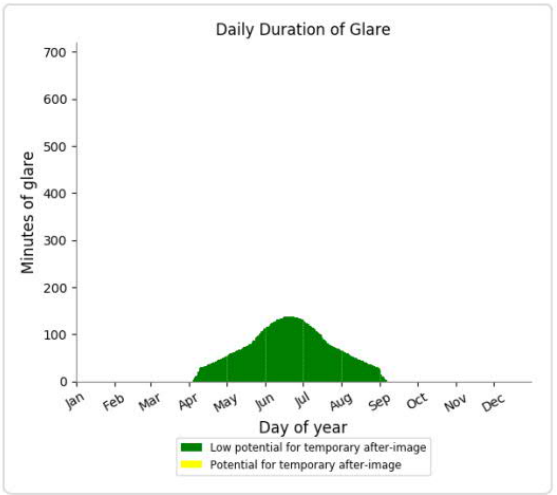
Representative Results

Figure 15 shows representative reflection conditions occurring at different times of the year for Runway 36:

- Reflections are visible during the winter months (low altitude solar rays) both in the morning and afternoon; during this period, reflections are visible for periods ranging from several minutes to almost two hours each day

Figure 15 Selected SGHAT Results: Standard "Normal Tracking" Mode (Runway 36)





SGHAT Results – FIXED TILT Scenarios

The SGHAT Ocular Plots results for these scenarios for all flight paths shown in Figure 14 are presented in Table 5, which shows the total number of minutes in a year that solar panel reflections would be potentially visible within any relevant SGHAT "zone" (refer Figure 7).

It will be recalled that solar panel reflections (glint and glare) are acceptable according to the FAA-SGHAT protocol if there are no "Yellow" zone or "Red" zone results for aircraft flight paths.

Table 5 SGHAT Analysis Results (No of Minutes Reflections are in SGHAT Zones)

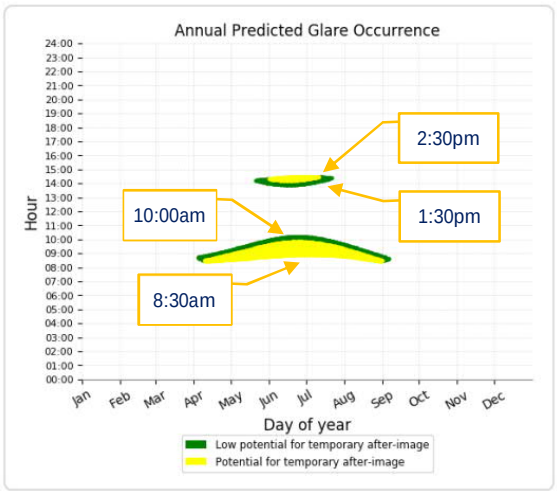
Flight Path	SGHAT Results for "FIXED TILT" Scenarios								
	15° East Tilt			0° (Horizontal)			15° West Tilt		
	"Green" Zone	"Yellow" Zone	"Red" Zone	"Green" Zone	"Yellow" Zone	"Red" Zone	"Green" Zone	"Yellow" Zone	"Red" Zone
09	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-
27	-	-	-	54	-	-	-	-	-
36	4,946	2,655	-	3,942	5,624	-	9,950	1,461	-

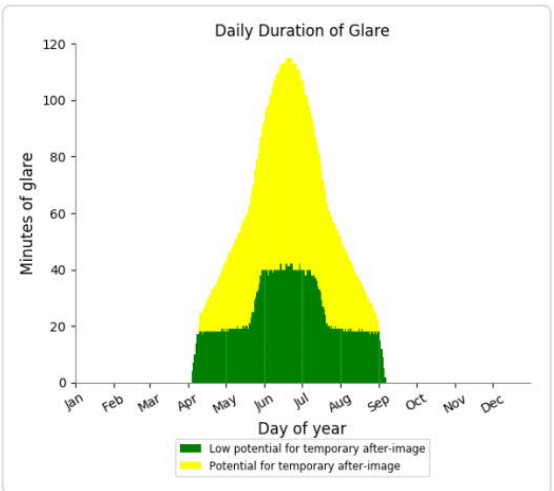
Representative Results

Figure 16 shows representative reflection conditions occurring at different times of the year for Runway 36:

- Reflections are visible during the winter months (low altitude solar rays) both in the morning and afternoon; during this period, reflections are visible for periods ranging from several minutes to almost two hours each day.

Figure 16 Selected SGHAT Results: FIXED TILT 0° Mode (Runway 36)





SGHAT Results – TRACKING + FIXED TILT Scenarios

The SGHAT Ocular Plots results for these scenarios for all flight paths shown in Figure 14 are presented in Table 6, which shows the total number of minutes in a year that solar panel reflections would be potentially visible within any relevant SGHAT "zone" (refer Figure 7).

It will be recalled that solar panel reflections (glint and glare) are acceptable according to the FAA-SGHAT protocol if there are no "Yellow" zone or "Red" zone results for aircraft flight paths.

Table 6 SGHAT Analysis Results (No of Minutes Reflections are in SGHAT Zones)

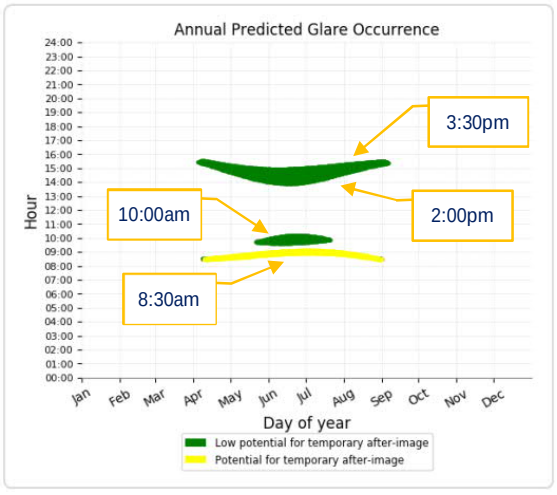
Flight Path	SGHAT Results for "±60° TRACKING + 0° FIXED TILT" Scenario		
	"Green" Zone	"Yellow" Zone	"Red" Zone
09	-	-	-
18	-	-	-
27	54	-	-
36	7,86	1,706	-

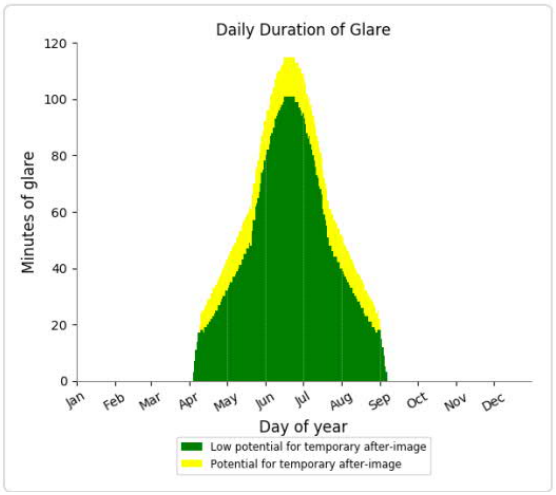
Representative Results

Figure 17 shows representative reflection conditions occurring at different times of the year for Runway 36:

- Reflections are visible during the winter months (low altitude solar rays) both in the morning and afternoon; during this period, reflections are visible for periods ranging from several minutes to almost two hours each day

Figure 17 Selected SGHAT Results: "±60°TRACKING + 0°FIXED TILT" Mode (Runway 36)





Summary of SGHAT Results:

"±60° Normal Tracking"

- In "±60° Normal Tracking" mode, the SGHAT results indicate reflections in the so-called "GREEN ZONE" for all runways - this COMPLIES with the FAA criteria.

"FIXED TILT at -15°, 0° and +15°"

- In ALL of the "Fixed Tilt" modes, the SGHAT results indicate reflections in both the called "GREEN" and "YELLOW" ZONES for Runway 36 – this does NOT COMPLY with the FAA criteria.

"±60° Tracking + FIXED TILT 0°"

- The SGHAT results for Runway 36 indicate reflections in both the called "GREEN" and "YELLOW" ZONES – this does NOT COMPLY with the FAA criteria.

Other "FIXED TILT Scenarios: ±20°, ±25°, ±30°, ±35°, ±40°"

Additional runs were undertaken to establish what fixed tilt angles (either east or west) would result in NIL "YELLOW" zone SGHAT glare:

- NIL "YELLOW" zone SGHAT results are achieved all-year-round for an EASTwards tilt of 40°; and
- NIL "YELLOW" zone SGHAT results are achieved all-year-round for a WESTwards tilt of 30°.

Recommendation:

- The proposed solar farm will comply with SGHAT requirements under standard "±60° Normal Tracking" mode, where the panels are at 60° eastwards from sunrise until the solar altitude angle reaches 30° above the horizon, at which time that commence tracking the sun until the solar angle reaches 30° above the horizon (to the west), where they then remain until sunset.
- The potential for "Yellow Zone" SGHAT occurrences on Runway 36 for scenarios involving the panels being left at a FIXED tilt angle is NIL for an eastwards tilt of 40° (or more), and for a westwards tilt of 30° (or more) on an all-year-round basis.
- The months leading to the "Yellow Zone" exceedances are the winter months of April to August. Accordingly, if the more sophisticated "back-tracking" mode is being considered for the facility, the tracking system manufacturer should be made aware of the horizontal tilt issue and the months of concern, so that the facility's algorithms can be adjusted to ensure nil occurrence of "Yellow Zone" exceedances.

6.2 Motorist "Disability" Glare and Pedestrian 'Discomfort" Glare

The "major" and "minor" thoroughfares in the immediate vicinity of the Project are shown in Figure 5, including:

- Old Gunnedah Road – eastbound and westbound "major"
- Kaputar Road - eastbound and westbound "minor"
  Airport Road - northbound and southbound "minor"

The relevant TI criteria for the above roads would be:

- For (Motorist) Traffic Disability Glare, the TI Value should remain below 20 for "minor" roads and below 10 for "major" roads; and

- For Pedestrian Discomfort Glare, the TI Value should remain below 2 at pedestrian crossings and below 3 for other locations.

Important factors influencing the potential for traffic disability glare include:

- Any difference in elevation between the motorist and the solar panel array;
- The potential for solar reflections of concern to be obstructed by intervening terrain and topography as well as dense vegetation;
- The difference between the line of sight of a driver (i.e. in the direction of the road) and the line of sight relative to incoming reflections. Significant TI values can only occur when this difference is small. In some cases, eg when traffic is moving away from the line of incoming reflections, such reflections become essentially invisible to the motorist – this would apply for example to traffic on Aircraft Road moving northwards after passing the site.

Figure 18 shows that some of the potential road glare scenarios for the Project site. In most cases, the difference in line of sight of a driver and the Project (and hence potential reflections) is reasonable, ie not small. Note also the presence of vegetation providing line of sight interruption to the site from some roadway locations, in particular the trees along the west side of Airport Road in the vicinity of the Project.

SLR has undertaken TI Value calculations for the roadways discussed above. Calculation locations were varied along the relevant carriageways, focussed on positions where the line of sight of drivers was close to the angle of potential incoming solar reflected rays.

Table 7 shows the results for the standard "±60° Normal Tracking" mode.

Table 7 TI Value Results – Combined Results from ALL PROJECT SOLAR PANELS

Location		Classification	TI Value	Occurrence	
				Time of Year / Day	Duration
Old Gunnedah Road	eastbound westbound	Major	nil	all-year-round all-year-round	na na
Kaputar Road	eastbound westbound	Minor	nil	all-year-round all-year-round	na na
Airport Road	northbound southbound	Minor	nil	all-year-round all-year-round	na na

The TI calculation results shown in Table 7 indicate the following:

- TI Values registered for all carriageways were zero at all times of the year.

In all cases, the relevant Motorist Traffic Disability Glare criteria and Pedestrian Discomfort Glare criteria are satisfied. The reasons for this result are:

- Essentially the same elevation for motorists and the solar array panels, with some intervening vegetation and trees in between in the case of Airport Road; and
- The single axis trackers which support the panels – these cause outgoing reflections for all incoming solar angles to be redirected upwards away from the ground.

Figure 18 View of the Project from Surrounding Roads

Driving east along Old Gunnedah Road

Driving along Kaputar Road (looking north)

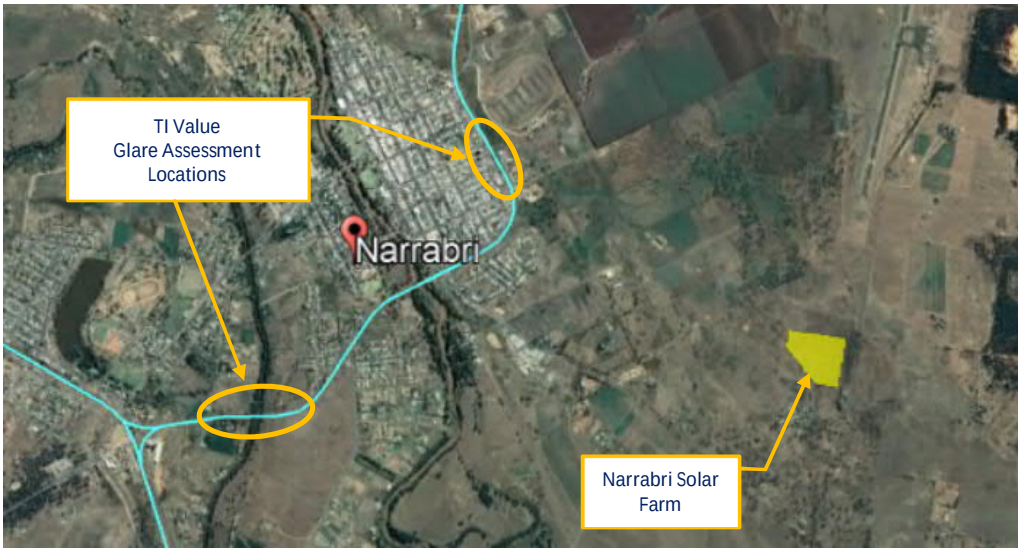
Driving north along Airport Road (looking west)

6.3 Rail Operator Reflective Glare

Figure 5 shows the Mungindi Railway Line approaching Narrabri from the south-southeast and then branching towards the north and west. At its closest approach, the rail line is just over 2.3 km from the nearest perimeter of the Project.

SLR has undertaken TI Value calculations for two sections of rail line shown in Figure 19, focussed on positions where the line of sight of train drivers was closest to the angle of potential incoming solar reflected rays.

Figure 19 Mungindi Railway Line – Glare Assessment Areas



In all cases, the TI Values for Disability Glare were NIL due to:

- Essentially the same elevation for train drivers and the solar array panels, along with intervening buildings and vegetation; and
- The single axis trackers which support the panels – these cause outgoing reflections for all incoming solar angles to be redirected upwards away from the ground.

6.4 Industrial Critical Machinery Operators

There are no industrial operations in the vicinity of the Project (e.g. mining operations) and none planned (mining or otherwise), with the kind of machinery where the relevant operators have the potential to experience reflective glare from the Project, eg elevated cabins in draglines, etc.

6.5 Residential "Nuisance" Glare

The nearest residential receivers to the Project are identified in Figure 6.

- They surround the site at varying distances from the nearest respective site boundary.
- Their ground elevations are similar to the Project, with only selected receivers slightly higher.

There are no formal TI Value (or alternative) criteria governing reflective glare from solar facilities.

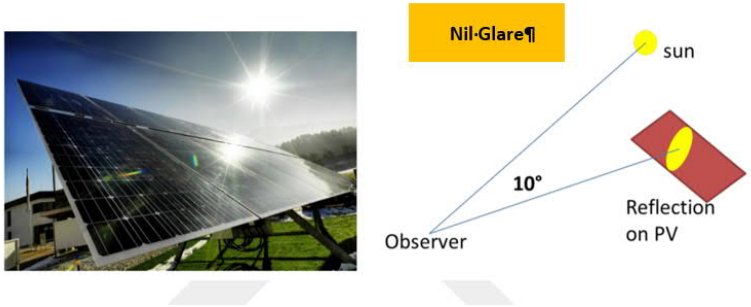
Accordingly, SLR has carried out TI Value calculations for the receivers discussed above, to gain an understanding of the potential for nuisance glare conditions from the project. The results are shown in Table 8.

Table 8 TI Value Results – Residential Receivers

Scenario	Receivers (refer Figure 6)	TI Value	Occurrence	
			Time of Year / Day	Duration
±60° Normal Tracking	R1 to R13	nil	all-year-round	na
Fixed Tilt 0°	R5, R7-R11	nil	all-year-round	na
	R1-R4, R6	Up to TI ~ 5	very early morning	0-8 min /day
	R12-R13	up to TI ~ 5	very late afternoon	0-3 min / day

The results indicate the following:

- For the "±60° Normal Tracking" mode, there will be NIL impact on surrounding residential receivers; and
- For the "0° Fixed Tilt" mode there is potential for reflections to be noticeable. However, for these occurrences, the angle of the incoming reflections will almost be coincident with the incoming solar rays themselves. When this angle difference is no greater than 10, see graphic below, reflections are considered to constitute a glare condition.



6.6 Night-Time Illumination Glare

Although presently not fully defined, it is assumed that an area within the Narrabri Solar Farm Project site will be set aside for an Operation and Maintenance buildings, power conversion unit, fire access routes and egress, etc, and that some of these may need to be operational 24/7.

Although night-time illumination is not presently planned for the Project, it may be required in the future for some of the above relevant areas and, as such, is addressed in principle in this assessment.

The only potential for any future night-time illumination glare would be associated with the nearest thoroughfares and residential and other sensitive receivers to the Project. Consideration has also been given to the potential for adverse eco-lighting impacts on nocturnal fauna habitats in close proximity to the Project site, especially within any close-by native vegetation areas. On the basis of the Flora and Fauna Assessment Report carried out for the Project, there are no such habitats close to the Project site.

The recommendations set out below are therefore made in the event that future 24/7 lighting is incorporated into the Project, to achieve the best lighting performance (taking into account safety considerations) while having a minimal impact on the surrounding properties, carriageways and nocturnal fauna.

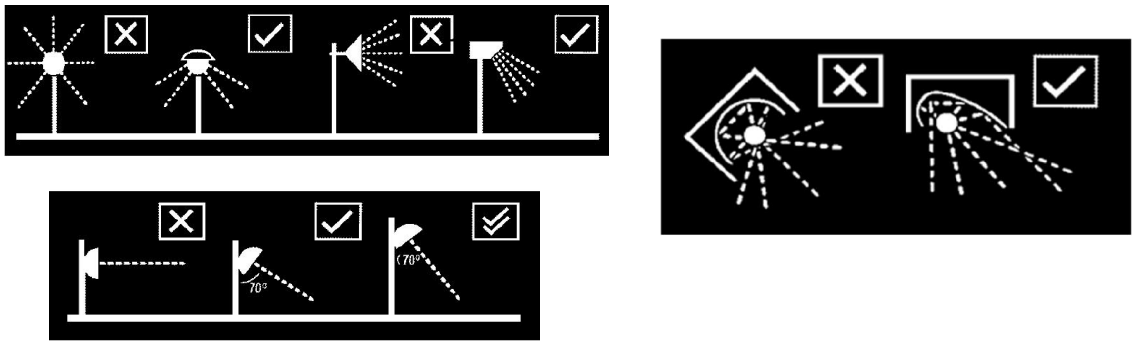
In terms of any future potential night-time lighting, the adopted goal of limiting night-time light spill to no more than 1 lux falling on the nearby residential facades during curfew hours will be easily achieved given the distances to the nearest residential and other receivers.

Accordingly, the potential for any future nuisance glare will be non-existent.

AS4282-1997 Control of the Obtrusive Effect of Outdoor Lighting sets out general principles that should be applied when designing outdoor light to minimise any adverse effect of the light installation.

- Direct lights downward as much as possible and use luminaires that are designed to minimise light spill, e.g. full cut-off luminaires where no light is emitted above the horizontal plane, ideally keeping the main beam angle less than 70°. Less spill-light means that more of the light output can be used to illuminate the area and a lower power output can be used, with corresponding energy consumption benefits, but without reducing the illuminance of the area - refer Figure 20.
- Do not waste energy and increase light pollution by over-lighting.
- Wherever possible use floodlights with asymmetric beams that permit the front glazing to be kept at or near parallel to the surface being lit.

Figure 20 Luminaire Design Features that Minimise Light Spill



7 CONCLUSION

SLR Consulting Australia Pty Ltd (SLR) has been engaged to carry out a Reflective Glare assessment of the proposed Narrabri Solar Farm (the "Project") under development by Providence Asset Group.

The following potential glare conditions have been considered:

- Daytime Reflective glare (and glint) arising from the solar PV panels within the facility:
  - . Aviation Sector Reflective Glare;
  - . Motorist "Disability" Reflective Glare and Pedestrian "Discomfort" Reflective Glare;
  - . Rail Operator Reflective Glare;
  - . Industrial critical machinery operators (heavy vehicles, etc) Reflective Glare; and
  - . Residential "Nuisance" Glare
- Night-time Illumination glare if any 24/7 operational security lighting is incorporate into the Project in the future

The Project is located close to Narrabri and in particular Narrabri Airport, whose Runway 36 southern threshold lies approximately 1.1 km from the nearest perimeter of the Project. The proposed (up to) 5 MWac facility will comprise 11,592 solar PV panels within a 15 ha project site area. The 540 W panels, measuring approximately 2.26 m by 1.13 m, will be positioned as currently understood on single-axis trackers oriented north-south with a spacing of 6.25 m.

Aviation-Related Potential Glare

Quantitative analysis using the FAA-SGHAT software tool has shown that there will be nil glare from the Project at Narrabri Airport with the solar array in normal tracking mode, ie panels tilting ±60°. The SGHAT results show potential for glare involving the panels being left at a fixed tilt angle of between 30° (westwards) to 40° (eastwards).

The months when this occurs are April to August (during winter). Accordingly, such a situation should be avoided, eg during construction, during maintenance periods, etc, during these months. This situation should also be considered in the application of sophisticated "back-tracking" operational modes for the proposed facility.

Motorist and Rail Traffic "Traffic Disability" Glare and Residential Nuisance Glare

Primarily due to the selection of the single-axis tracking system for the mounting of the ground-based array panels, there will be nil glare from the Project in relation to traffic disability glare in normal ±60° tracking mode. Similarly, the potential for rail traffic disability glare from the Project is nil.

The potential for nuisance glare from the Project to surrounding residential or other receivers is nil.

Night-Time Illumination Glare

Although presently not incorporated into the Project, consideration has been given to the future potential for night-time lighting related to equipment and/or buildings, fire access routes and egress, etc. Recommendations have been made to ensure that the potential for any future possible night-time illumination glare will be non-existent. Any future lighting design should also be checked against the requirements of CASA's NASF Guidelines.

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
5 Foelsche Street
Darwin NT 0800
Australia
T: +61 8 8998 0100
F: +61 2 9427 8200

GOLD COAST
Ground Floor, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

ROCKHAMPTON
rockhampton@slrconsulting.com
M: +61 407 810 417

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TAMWORTH
PO Box 11034
Toowoomba NSW 2340
Australia
M: +61 408 474 248
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
5 Duncan Street
Port Nelson 7010
New Zealand
T: +64 274 898 628

NEW PLYMOUTH
Level 2, 10 Devon Street East
New Plymouth 4310
New Zealand
T: +64 0800 757 695

www.slrconsulting.com

03/02/2021

Project Number: 200650

STORMWATER MANAGEMENT REPORT

at

NARRABRI SOLAR FARM | 115 AIRPORT ROAD NARRABRI

for

PROVIDENCE ASSET GROUP

Project No. 200650

Revision: B – Reissued for DA

TABLE OF CONTENTS

1. Introduction

DRB Consulting Engineers (DRB) were engaged by Providence Asset Group Pty Ltd to undertake a Stormwater Management Plan for the proposed Narrabri Solar Farm, located within LOT 489 DP 754944 Airport Road, Narrabri NSW.

This report will provide commentary on the impact the proposed development will have on the existing site with regard to stormwater quantity.

It should be noted that, this report has been prepared to a level suitable for Development Application only.

This report should be read in conjunction with the Concept Stormwater Management plans 200650/CIV01-03.

2. Site Description & Proposed Development

The site is located at Airport Road, Narrabri. The site is located on the eastern side of Airport Road and is identified as Lot 489 DP 754944.

The proposed Narrabri Solar Farm will be located in the southern portion of the site, known as the Investigation Area (IA).

At the time of this investigation, the IA was a vacant rural parcel of land approximately 14.8 Ha in area. The IA had a good grass coverage and sloped from the southeast to the northwest at slopes of approximately 0.3%.

115 Airport Road Narrabri had an existing watercourse running through the central portion of the lot. During rainfall events, surface runoff from the IA would sheet flow towards the existing watercourse.

Figure 1 below shows the existing site and investigation area.

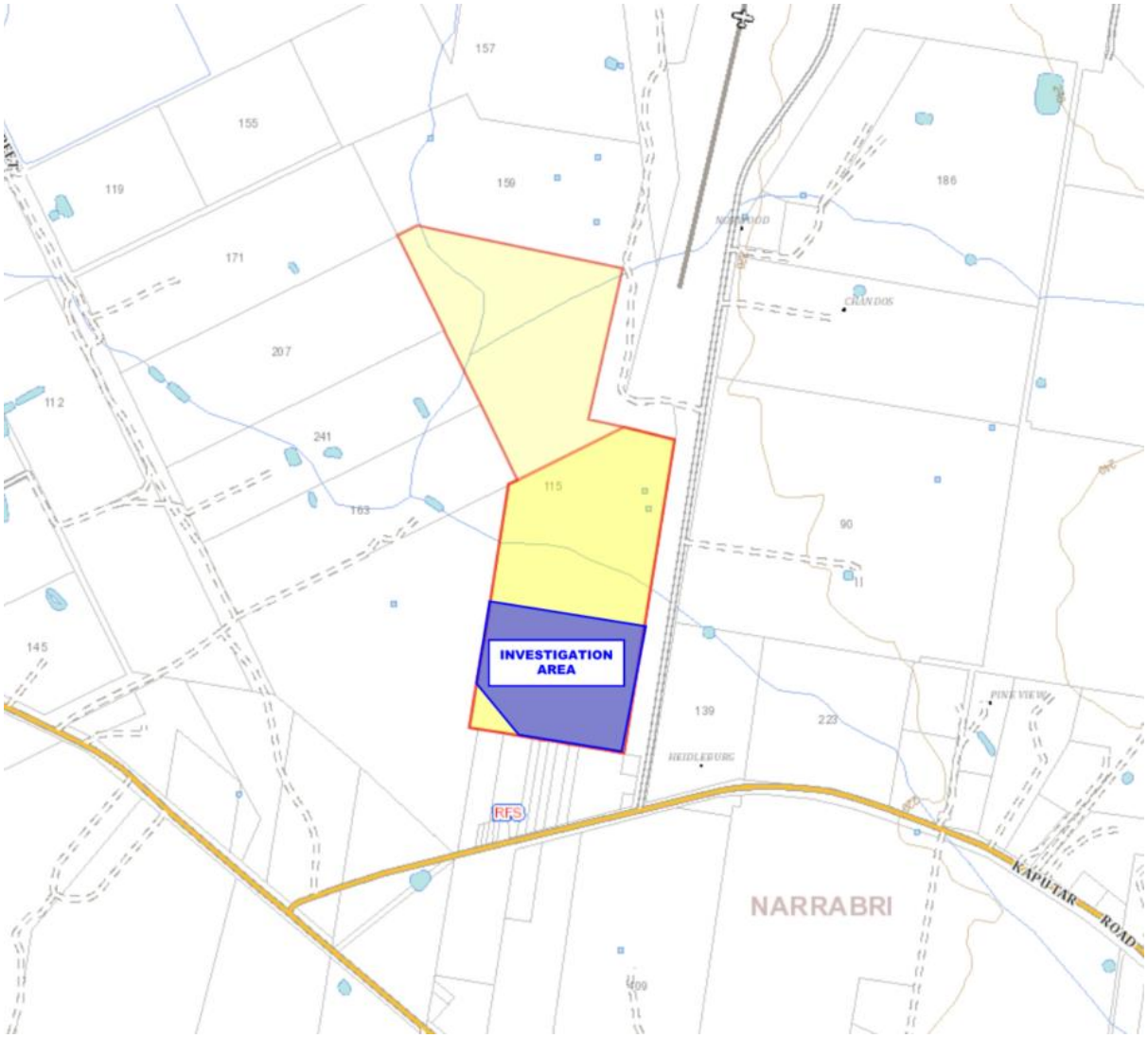


Figure 1 – Existing Site Boundaries

The proposed Solar Farm layout can be seen in Figure 2 below.

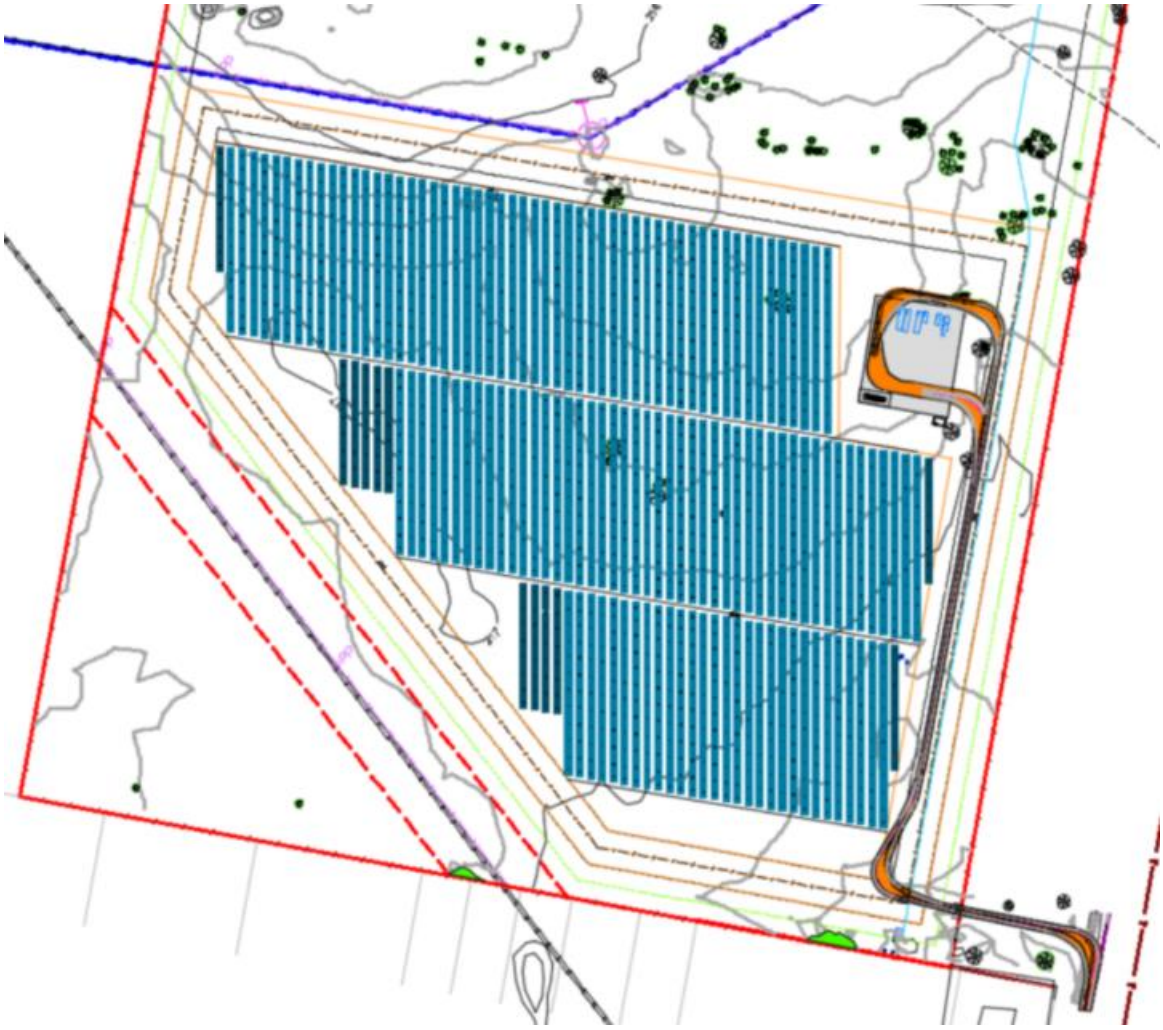


Figure 2 – Proposed Solar Farm

3. Council Requirements

A review of Narrabri Shire Council's Development Plan did not provide guidance on developments of this nature. As such, based on previous experience of design of solar farms, we propose to:

- *Limit the Post-Development flow rates from the proposed development to the Pre-Development flow rates for all storm events up to and including the 1 in 100 year storm event.*

Furthermore, the site must discharge legally without causing nuisance flows onto neighbouring properties.

4. Water Quantity Analysis (Onsite Stormwater Detention)

4.1. Overview

The proposed development area has been split into two separate catchments for the assessment of Stormwater Quantity; the Photovoltaic Array stage and the Gravel / Hardstand catchments. Figure 3 below shows the proposed catchment boundaries.

Figure 3 – Proposed Catchment Boundaries

4.2. *Photovoltaic Array*

The Photovoltaic Array will consist of 142 x Ground Mounted Single Axis Trackers. The array structure will be steel pile supported and will have approximately 600mm clearance above the existing ground surface.

4.2.1. *Pre-Development Peak Flows*

The catchment characteristics for the Pre-Development catchment area can be seen in Table 1 below:

Construction Stage	***Parameter***	
Photovoltaic Array Catchment Pre-Development	Sub-Catchment Area	88,887.80 m^2
	Percentage Impervious	0 %
	Flowpath Length	464 m
	Flowpath Slope	0.3 %
	Retardance Coefficient 'n'	0.075

Table 1 – Existing Catchment Parameters

A DRAINs model was developed to determine the pre-development peak flow rates. The DRAINs model used the *ARR 2019 Initial loss - Continuing loss (IL-CL) hydrological model* and 2016 IFD data. The Hydrological model parameters were determined using the ARR data hub and can be seen in Figure 4 below.

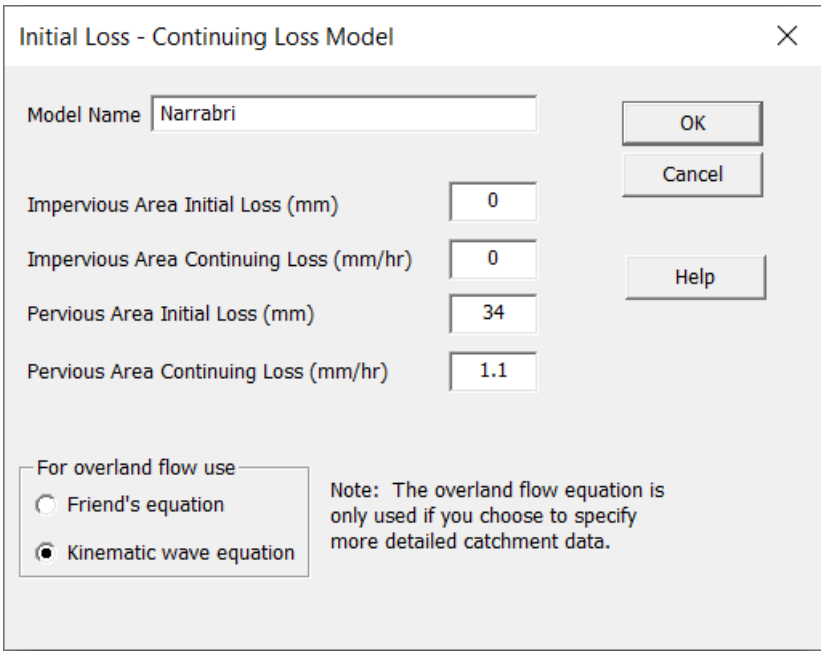


Figure 4 – Hydrological Model Parameters

The model was developed for the 1 EY (Exceedances per year), 10% AEP (Annual Exceedance Probability) and 1% AEP events and analysed the following storm durations.

5 minutes	45 minutes	9 hours
10 minutes	1 hour	12 hours
15 minutes	2 hours	18 hours
20 minutes	3 hours	24 hours
25 minutes	4.5 hours	
30 minutes	6 hours	

The Results of the DRAINs model can be seen below in Table 2.

Construction Stage	***Storm Event (Exceedance Probability / Annual Exceedance Probability)***	***Peak Flow***
Photovoltaic Array Catchment Pre-Development	1EY	0.122 m^3/s
	10% AEP	0.577 m^3/s
	1% AEP	1.260 m^3/s

Table 2 – Pre-Development Peak Flow

4.2.2. Post-Development Peak Flows

The Post-Development site conditions can be summarised below:

(i) The proposed arrays will be at varying angles, however, in a worst-case runoff scenario, it is assumed the arrays are horizontal to the existing ground surface level.

(ii) Runoff from the proposed arrays will fall immediately on to the untouched natural ground surface.

(iii) The pervious area under the arrays will not receive direct rainfall, however, it will be available for both initial and continuing loss for the runoff of the array immediately upslope.

The catchment characteristics for the Post-Development catchment area can be seen in Table 3 below:

Construction Stage	***Parameter***	
Photovoltaic Array Catchment Post-Development	Sub-Catchment Area	88,887.80 m^2
	Percentage Impervious	36.1 %
	Flowpath Length	464 m
	Flowpath Slope	0.3 %
	Retardance Coefficient ‘n’	0.075

Table 3 – Proposed Development Catchment Parameters

To replicate the proposed site conditions and consider the available pervious areas located underneath the proposed arrays, the Pervious Area Initial and Continuing Loss was factored up by 1.565. This allowed the total pervious area to be included in the assessment.

The Hydrological model parameters used in the Post-Development model can be seen in Figure 5 below.

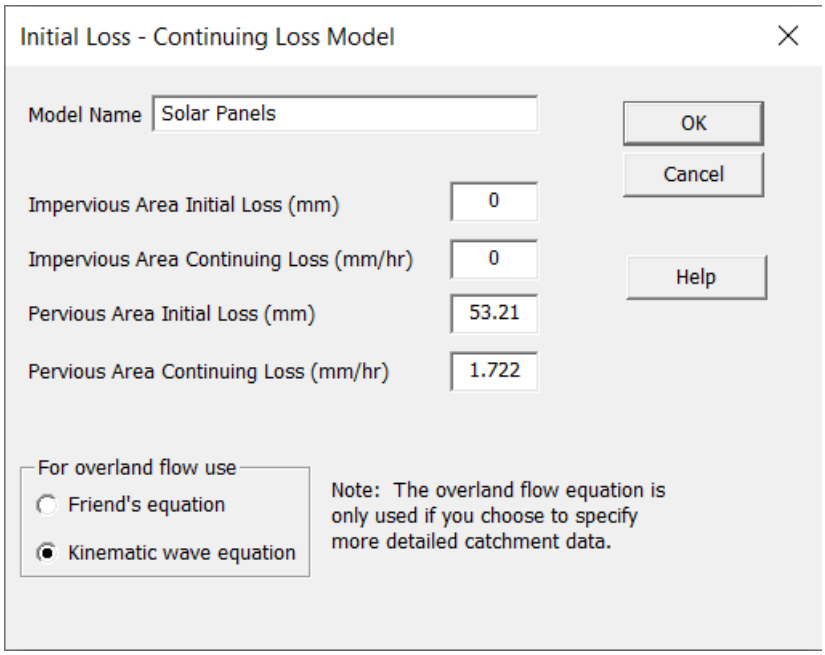


Figure 5 – Hydrological Model Parameters

The Results of the DRAINs model can be seen below in Table 4.

Construction Stage	***Storm Event (Exceedance Probability / Annual Exceedance Probability)***	***Pre-Development Peak Flow***	***Post-Development Peak Flow***	***Difference***
Photovoltaic Array Catchment 1 Post-Development	1EY	0.122 m^3/s	0.101 m^3/s	- 0.021 m^3/s
	10% AEP	0.577 m^3/s	0.437 m^3/s	- 0.140 m^3/s
	1% AEP	1.260 m^3/s	1.010 m^3/s	- 0.250 m^3/s

Table 4 – Post-Development Peak Flow

4.2.3. Conclusion

By discharging the runoff from proposed Photovoltaic Array's directly to the existing ground surface and maintaining the existing natural surface levels and travel paths the proposed development area catchment limited the increase to peak runoff to negligible values, and reduced the peak runoff during the 1% AEP.

4.3. Gravel / Hardstand Area

The Gravel / Hardstand Area includes the proposed roads, gravel laydown area and temporary buildings located within the Investigation Area.

It is proposed that runoff from this area will captured within a roadside swale used to convey these flows to a new above ground onsite stormwater detention basin. The basin will then reduce flows to the pre-development levels.

4.3.1. Pre-Development Peak Flows

The catchment characteristics for the Pre-Development catchment area can be seen in Table 5 below:

Catchment	***Parameter***	
Pre-Developed	Sub-Catchment Area	6,225.40 m^2
	Percentage Impervious	0.0 %
	Flowpath Length	97 m
	Flowpath Slope	0.6 %
	Retardance Coefficient 'n'	0.013

Table 5 – Existing Catchment Parameters

A DRAINs model was developed to determine the pre-development peak flow rates. The DRAINs model used the *ARR 2019 Initial loss - Continuing loss (IL-CL) hydrological model* and 2016 IFD data. The Hydrological model parameters were determined using the ARR data hub (see Figure 4 above) and was developed for the 1 EY (Exceedances per year), 10% AEP (Annual Exceedance Probability) and 1% AEP events.

The Results of the DRAINs model can be seen below in Table 6.

Catchment	***Storm Event (Exceedance Probability / Annual Exceedance Probability)***	***Combined Peak Flow***
Pre-Developed	1EY	0.014 m^3/s
	10% AEP	0.101 m^3/s
	1% AEP	0.212 m^3/s

Table 6 – Pre-Development Peak Flow

4.3.2. Post-Development Peak Flows

The Post-Development site conditions can be summarised below:

(i) The proposed gravel roads and hardstand areas will be assumed to be impervious.
(ii) A retardance coefficient of 0.013 was adopted for both the proposed gravel road and hardstand area.
(iii) The runoff from the impervious area was treated as sheet flow along the proposed levels before being captured within a new roadside swale and conveyed to the proposed above ground onsite detention basin.

The catchment characteristics for the Post-Development catchment area can be seen in Table 7 below:

Catchment	***Parameter***	
Hardstand / Remaining Gravel Road	Sub-Catchment Area	6,225.40 m^2
	Percentage Impervious	87.2 %
	Flowpath Length	97 m
	Flowpath Slope	0.6 %
	Retardance Coefficient 'n'	0.013

Table 7 – Proposed Development Catchment Parameters

The Gravel / Hardstand Catchment drained directly into an above ground Onsite Stormwater Detention Basin. The Basin characteristics can be seen in Table 8 below.

OSD Basin	
Basin Invert	216.38m AHD
Basin – Top of Bank	216.68m AHD
Low flow pipe diameter	225mm
Low flow pipe invert	216.38m AHD
Orifice Diameter	130mm
Base of Weir Width	3.50 m
Base of Weir Level	216.60m AHD
Top of Weir Width	7.5 m
Top of Weir Level	216.68m AHD
Basin Volume	142 m^3

Table 8 – Proposed OSD Basin Characteristics

The Results of the DRAINs model can be seen below in Table 9.

Storm Event	***Pre-Dev. Peak Flow***	***Post-Dev. Peak Flow***	***Post-Dev. Peak Flow - Mitigated***	***Difference***	***Top Water Level***
1EY	0.014 m^3/s	0.098 m^3/s	0.014 m^3/s	0.000 m^3/s	216.60m AHD
10% AEP	0.101 m^3/s	0.230 m^3/s	0.099 m^3/s	- 0.002 m^3/s	216.65m AHD
1% AEP	0.212 m^3/s	0.364 m^3/s	0.207 m^3/s	- 0.005 m^3/s	216.68m AHD

Table 9 – Post-Development Peak Flow

It is noted that the existing dam and volume will be maintained with the proposed OSD low flow located at the existing dam water level/overflow.

4.3.3. Conclusion

By discharging the runoff from proposed Gravel / Hardstand Area through the proposed OSD basin, the Post-development peak flows for the entire Investigation Area are reduced back to the Pre-development peak flow values.

5. Conclusion

The stormwater drainage strategy for the proposed Narrabri Solar Farm at Airport Road, Narrabri can be summarised as:

(i) All impervious runoff from the proposed Photovoltaic Arrays will discharge to the existing ground surface where the natural flow regime will be maintained.

(ii) Runoff from the proposed gravel/hardstand area catchment will be conveyed via sheet flow and the proposed roadside swale to the proposed above ground onsite stormwater detention basin.

(iii) Discharge from the above ground onsite stormwater detention basin will be limited to the pre-development flow rates.

Provided the above stormwater drainage philosophy is adopted for the site, the proposed Narrabri Solar Farm will limit the Post-Development peak flows to Pre-Development flow rates for the 1 EY, 10% AEP and 1% AEP events.

Should you require any further advice or clarification of any of the above, please do not hesitate to contact us.

Yours faithfully
DRB CONSULTING ENGINEERS PTY LIMITED

Mathew McNamara
BEng (Civil) Hons MIE Aust

Flora and Fauna Assessment Report

KDC Pty Ltd

Narrabri Solar Farm

Lot 489 DP 754944, 115 Airport Road, Narrabri NSW

19 January 2021

Flora and Fauna Assessment Report

Narrabri Solar Farm

Lot 489 DP 754944, 115 Airport Road, Narrabri NSW

Kleinfelder Document Number: NCA21R120643
File Name: NCA21R120643_NarrabriFFAR_20210115_V1
Project No: 20212718

Prepared for:

KDC PTY LTD

Document Control:

Version	Description	Date	Author	Peer Reviewer
1.0	Draft for Client Review	19 January 2021	C. Whyte	G. Whyte

Contents

Tables

Figures

Plates

Appendices

1. INTRODUCTION

1.1 PROJECT BACKGROUND

Kleinfelder has been engaged by KDC Pty Ltd (KDC) on behalf of Providence Asset Group to prepare a Flora and Fauna Assessment Report for a proposed solar farm located at Lot 489 DP 754944, 115 Airport Road, Narrabri NSW 2390 (**Figure 1**). The project will be assessed under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) with Narrabri Shire Council as the determining authority.

The following terms are used throughout this report to describe geographical areas (**Figure 2**):

- Study area – Lot 489 DP 754944 (30.1 ha).
- Subject site (development footprint) – area of the study area proposed for development (15 ha).
- Locality – land within a 5 km radius of the study area.

This report identifies flora, fauna and threatened species present, or likely to occur within the study area based on species and/or habitats detected during field surveys and threatened flora and fauna records from the locality. An assessment of the likely impacts on identified threatened species, habitat features, wildlife corridors and vegetation communities as a result of the proposed development has also been undertaken.

1.2 SITE DESCRIPTION

The study area is located on the eastern boundary of the township of Narrabri within the Narrabri Shire Local Government Area (LGA). The study area is zoned 'RU1 – Primary Production under the *Narrabri Local Environmental Plan 2012* (LEP). The study area is approximately 30.1 ha in area, with the southern portion (approximately 15 ha) proposed as the subject site (development footprint).

The eastern boundary of the study area lies adjacent to Airport Road, immediately south of the Narrabri Airport (NAA). The southern boundary borders a number of residential lots that lie to the north of Kaputar Road. The western and northern boundaries of the study area border vacant land lying within Lots 490, 503 and 506 DP 754944 and Lot 7038 DP 1024282.

The vegetation within the study area is dominated by exotic grasslands with scattered trees and has been used for agricultural purposes (i.e. horses were grazing the site at the time of field survey). Two constructed dams are located in the north-east of the study area and an unnamed watercourse runs east west through the northern portion of the study area. The topography within the study area and surrounding lands is relatively flat. Site photographs are provided in **Appendix 1.**

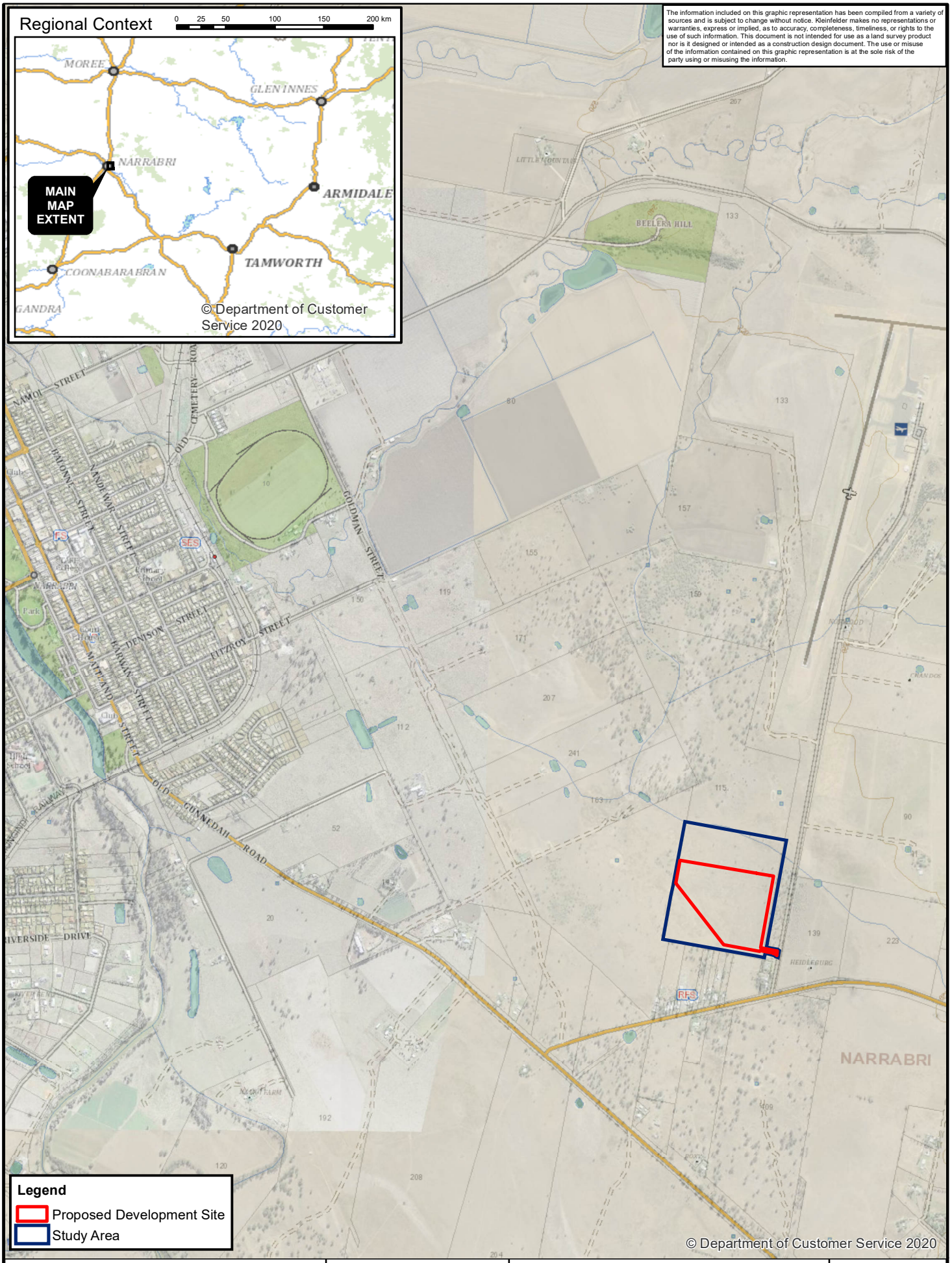
1.3 PROPOSED DEVELOPMENT

The Narrabri Solar Farm project will include a 5 MW grid-connected solar PV installation. The proposed project layout is approximately 15 ha in area and is provided in **Figure 3**. The location of the proposed solar farm is situated in the south of the study area. Proposed site access is from the south-eastern boundary off of Airport Road. Construction of a powerline is needed to facilitate the solar farm development and is proposed to extend from the south-western corner of the subject site through to neighbouring land.

1.4 REPORT OBJECTIVES

The objectives of the Flora and Fauna Assessment Report include:

- Describe the flora and fauna (and their habitats) present on, or likely to occur on the subject site.
- Assess the relevance and value of the subject site for threatened species and ecological communities (and their habitats) listed under the NSW *Biodiversity Conservation Act 2016* (BC Act).
- Assess the potential impacts of the proposed development on threatened species and ecological communities, pursuant to Section 7.3 of the BC Act (5-part test).
- Comment on the likely occurrence and relevance of matters of national environmental significance listed under the Commonwealth *Environment Planning and Biodiversity Conservation Act 1999* (EPBC Act).
- Describe steps to avoid and mitigate any identified impacts on flora and fauna and to protect the natural environment of the subject site.



km
0 0.1 0.2 0.4 0.6 0.8 1

N

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT REFERENCE: 20213329

DATE DRAWN: 2021/01/15 14:59 Version 2

DRAWN BY: GJoyce

DATA SOURCE:
NSW DFSI - 2020
NSW OEH - 2019

Locality

KDC Pty Ltd
Flora & Fauna Assessment
Narrabri Solar Farm

FIGURE:

1

L:\GIS FOLDER\00 CLIENT FILES\130060_KDC_PtyLtd\20213329_FFAR_NarrabriSolarFarm\Mapping\20213329_FFAR_Fig1_Locality.mxd

Metres
0 25 50 100 150 200
N

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

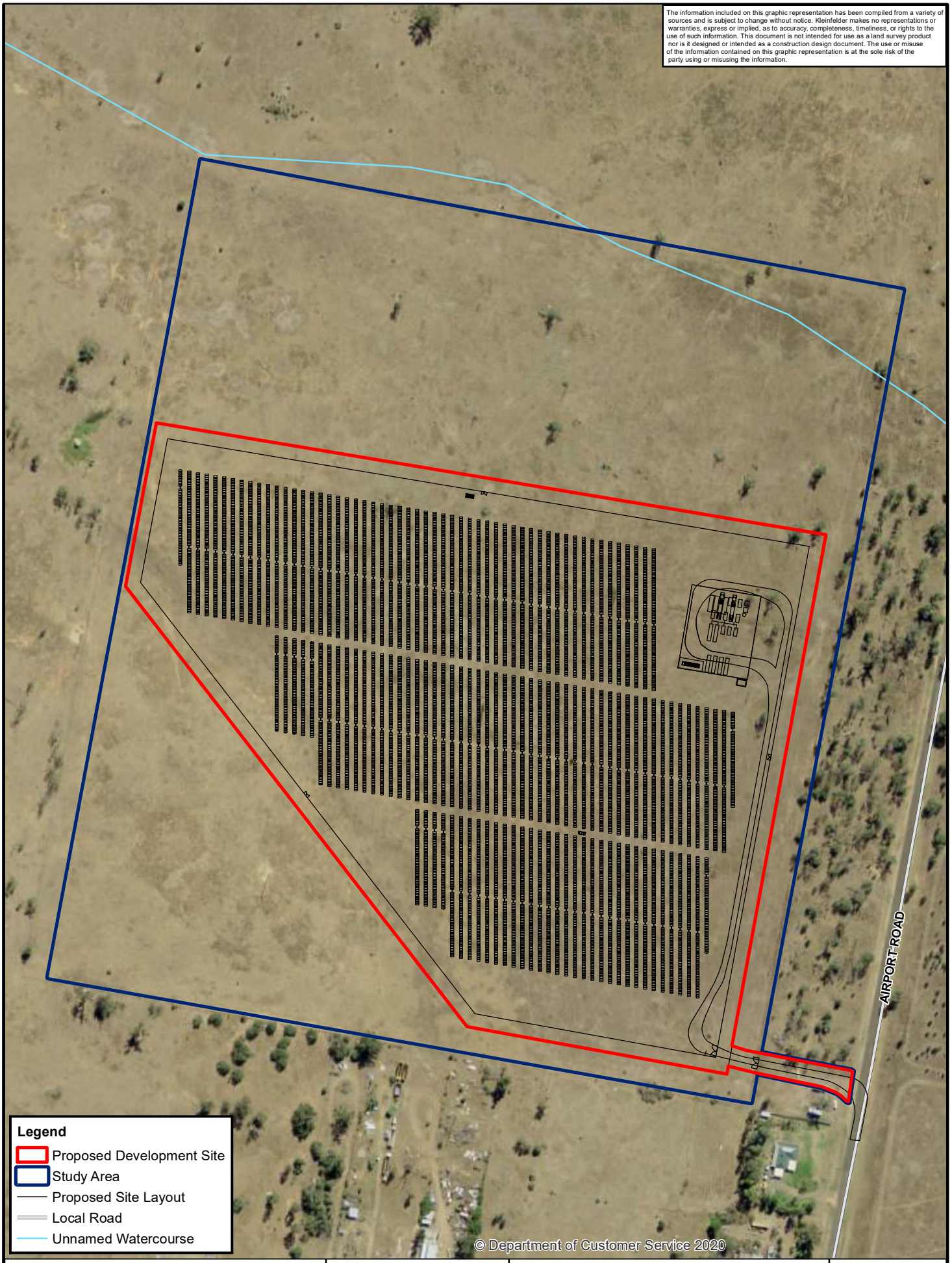
PROJECT REFERENCE: 20213329
DATE DRAWN: 2021/01/15 15:08 Version 1
DRAWN BY: GJoyce
DATA SOURCE:
NSW DFSI - 2020
NSW OEH - 2019

Study Area and Subject Site

KDC Pty Ltd
Flora & Fauna Assessment
Narrabri Solar Farm

FIGURE:
2

L:\GIS FOLDER\00 CLIENT FILES\130060_KDC_PtyLtd\20213329_FFAR_NarrabriSolarFarm\Mapping\20213329_FFAR_Fig2_StudyArea_SubjectArea.mxd



Metres
0 25 50 100 150 200
N

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT REFERENCE: 20213329
DATE DRAWN: 2021/01/15 15:09 Version 1
DRAWN BY: GJoyce
DATA SOURCE:
KDC - 2021
NSW DFSI - 2020
NSW OEH - 2019

Proposed Site Layout

KDC Pty Ltd
Flora & Fauna Assessment
Narrabri Solar Farm

FIGURE:
3

L:\GIS FOLDER\00 CLIENT FILES\130060_KDC_PtyLtd\20213329_FFAR_NarrabriSolarFarm\Mapping\20213329_FFAR_Fig3_ProposedSiteLayout.mxd

2. LEGISLATIVE CONTEXT

2.1 COMMONWEALTH LEGISLATION

2.1.1 Environment Protection & Biodiversity Conservation Act 1999

The purpose of the EPBC Act is to ensure that actions likely to cause a significant impact on 'matters of national environmental significance' undergo an assessment and approval process. Under the EPBC Act, an action includes a proposal, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things. An action that 'has, will have or is likely to have a significant impact on a Matter of National Environmental Significance (MNES) is deemed to be a 'controlled action' and may not be undertaken without prior approval from the Australian Minister for the Environment.

The EPBC Act identifies nine MNES:

- World heritage properties.
- National heritage places.
- Wetlands of international importance (Ramsar Wetlands).
- Threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.
- The Great Barrier Reef Marine Park.
- Nuclear actions (including uranium mining).
- A water resource, in relation to coal seam gas development and large coal mining development.

As part of the current assessment, MNES that are predicted to occur within the locality (applying a 5 km buffer) were obtained from the on-line Protected Matters Search Tool (DAWE, 2020a). These records are discussed in **Section 4**. The EPBC Act has been further addressed in this assessment through:

- Field surveys for EPBC Act listed threatened biota and migratory species.
- Assessment of potential impacts on EPBC Act listed threatened species and migratory biota.

- Identification of suitable impact mitigation and environmental management measures for EPBC Act listed threatened species and migratory biota.

2.2 STATE LEGISLATION

2.2.1 Environmental Planning and Assessment Act 1979

The EP&A Act forms the legal and policy platform for proposal assessment and approval in NSW and aims to '*encourage the proper management, development and conservation of natural and artificial resources'*. All development in NSW is assessed in accordance with the provisions of the EP&A Act and the EP&A Regulation 2000.

Development activities that require consent are assessed and determined in accordance with Part 4 of the EP&A Act. The determining authority for the project is Narrabri Shire Council.

2.2.2 Biodiversity Conservation Act 2016

The NSW BC Act, the NSW *Biodiversity Conservation Regulation 2017* (NSW BC Regulation) and amendments to the NSW *Local Land Services Act 2013* (LLS Act) commenced on 25 August 2017. The legislation aims to deliver "a strategic approach to conservation in NSW while supporting improved farm productivity and sustainable development". The NSW BC Act repeals several pre-existing Acts, most notably the NSW *Threatened Species Conservation Act 1995,* the NSW *Nature Conservation Trust Act 2001* and the *NSW Native Vegetation Act 2003*.

In accordance with the NSW BC Act, entry into the Biodiversity Offsets Scheme (BOS) is not required for the proposed development due to the following:

- The proposed development is not deemed to be 'State Significant' under the NSW EP&A Act.
- The proposed development will not impact an Area of Outstanding Biodiversity Value (AOBV) as listed under Part 3 of the NSW BC Act.
- The proposed development is unlikely to cause a significant impact on a threatened species, population or ecological community, as listed under Schedules 1 and 2 of the NSW BC Act, as determined by application of a five-part-test of significance under Section 7.3 of the NSW BC Act.

- The proposed development will not impact areas mapped as having 'high biodiversity value' as indicated by the NSW Biodiversity Values Map (BV Map).
- The proposed development will occupy an areas approximately 15 ha; however, due to the prevalence of exotic vegetation (grasslands) it is estimated via GIS that the project will directly remove small areas of exotic groundcover vegetation, six trees and three stags, two of which contain hollows (further discussed in **Section 5.1.1**). Therefore, the project will not exceed the BOS threshold for the site (1 ha threshold for a minimum lot size of 100 ha) as determined by the NSW *Biodiversity Conservation Regulation 2017*.

In consideration of the criteria listed above, a Biodiversity Development Assessment Report (BDAR) is not required for the proposed development. As part of the current assessment, threatened species and ecological communities as listed under the NSW BC Act that have previously been recorded within the locality (applying a 5 km buffer) were obtained from the on-line BioNet Atlas of NSW Wildlife (DPIE, 2020a). These records are discussed in **Section 4** of this report.

The NSW BC Act has been further addressed in this assessment through:

- Field surveys to assess the presence of threatened species, populations and ecological communities, as listed under Schedules 1 and 2 of the NSW BC Act, within the subject site.
- Assessment of potential impacts threatened species, populations and ecological communities, as listed under Schedules 1 and 2 of the NSW BC Act, as determined by application of a five-part-test of significance under Section 7.3 of the NSW BC Act.
- Identification of suitable impact mitigation and environmental management measures.

2.2.3 Biosecurity Act 2015

The *NSW Biosecurity Act 2015* provides a streamlined statutory framework to protect the NSW economy, environment and community from the negative impact of pests, diseases and weeds. The primary objective of the Act is to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers.

In NSW, all plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows

(or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.

Weed species recorded within the subject site during the current investigation are discussed in **Section 4**.

2.2.4 National Parks and Wildlife Act 1974

The NSW *National Parks and Wildlife Act 1979* (NPWS Act) aims to conserve nature, objects, places or features (including biological diversity) of cultural value within the landscape. The Act also aims to foster public appreciation, understanding and enjoyment of nature and cultural heritage, and provides for the preservation and management of national parks, historic sites and certain other areas identified under the Act.

No areas of National Park estate occur within or adjacent to the subject site.

2.2.5 Water Management Act 2000

Controlled activities carried out in, on or under waterfront land are regulated by the NSW WM Act. The NSW Natural Resource Asset Regulator (NRAR) administers the WM Act and is required to assess the impact of any proposed controlled activity to ensure that no more than minimal harm will be done to 'waterfront land' as a consequence of carrying out the controlled activity. Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 m of the highest bank of the river, lake or estuary (NRAR, 2018). This means that a controlled activity approval must be obtained from the NRAR before commencing the activity.

A mapped waterway runs through the northern portion of the study area in an east west direction. The proposed site layout has been designed to avoid the mapped waterway. No vegetation clearing or disruption to the creek is likely to occur as a result of the construction of the solar array or the grid connection.

Notwithstanding, the application of the WM Act and an assessment of indirect impacts of the proposed development on aquatic habitat and downstream aquatic habitats is provided in **Section 5.1**.

2.2.6 State Environmental Planning Policy (Koala Habitat Protection) 2020

State Environmental Planning Policy (Koala Habitat Protection) aims to encourage the conservation and management of areas of natural vegetation that provide habitat for Koalas to support a permanent free-living population over their present range and reverse the current trend of Koala population decline.

A Koala Plan of Management (KPoM) has not been prepared for the study area; therefore, provisions of Clause 9 of the SEPP (Koala Habitat Protection) is applicable to the proposed development. As such, Council must take into account the requirements of the Koala Habitat Assessment Guideline (DPIE, 2020b), or information prepared by a suitably qualified and experienced person in accordance with the guideline to determine if the land is classified as Highly Suitable Koala Habitat or Core Koala Habitat.

See **Section 4.9** for a summary of the Koala habitat assessment.

2.3 LOCAL PLANNING INSTRUMENTS

2.3.1 Narrabri Local Environmental Plan 2012

The study area is located within the Narrabri Shire Council LGA. The *Narrabri Shire LEP 2012* (LEP) is the principal legal document for controlling development at a Local Government level. The zoning provisions establish acceptability of uses and standards regulate the degree of development. Under the LEP, the study area is located within the designated flood planning area which permits development on land that is compatible with the land's flood hazard.

2.3.2 Narrabri Shire Council Development Control Plans

The Narrabri Shire Development Control Plans (DCP's) provide a clear guideline regarding the types of development that may occur on specific sites. DCP's are prepared and adopted by Council after consultation with the community. DCP's are supporting documents to Council's LEP.

3. MATERIALS AND METHODS

3.1 DESKTOP ASSESSMENT

Existing information on the flora and fauna of the subject site and the locality, including relevant threatened biota was obtained from:

- Regional vegetation mapping: *Border Rivers Gwydir / Namoi Regional Native Vegetation Map Version 2.0. VIS_ID 4467* (DPIE 2020d).
- The BioNet Atlas of NSW Wildlife (DPIE, 2020a) for previous records of threatened species, populations and ecological communities (as listed under the BC Act) within a 5 km radius of the study area (data retrieved 12/01/2021).
- The Department of Agriculture, Water and the Environment (DAWE, 2020a) Protected Matters Search Tool, which involved a search for matters of national environmental significance within a 5 km radius of the study area (conducted on 12/01/2021).
- Relevant published literature on threatened biota (see References).

The results of the database searches were used to compile a list of threatened species, populations and communities, as listed under the BC Act and EPBC Act that could potentially occur on the subject site, and their likelihood of occurrence.

3.2 FIELD SURVEY

3.2.1 Vegetation Assessment

A diurnal inspection of the subject site and surrounds was undertaken on 03 January 2021 to provide specific observations for this report.

Native vegetation types were identified based on dominant flora species present within each structural layer (i.e. canopy, shrub and ground layers). Exotic or highly modified native vegetation was defined based on structure and species composition. Boundaries of vegetation types and communities were marked with a hand-held GPS and mapped using geographical information system (GIS) software.

Vegetation types were assessed against identification criteria for State and Commonwealth listed threatened ecological communities (DAWE, 2020b; DPIE, 2020c). Vegetation and habitats were compared with descriptions provided in the BioNet Vegetation Classification to identify Plant Community Types (PCTs).

Two 400 m² floristic plot/transects were sampled in accordance with Section 5.3.4 of the NSW Biodiversity Assessment Method (BAM) (OEH, 2017). Percentage cover and relative abundance was recorded for all plant species within each plot/transect. Plot/ transects were positioned to sample areas that were most representative of the floristic characteristics of each PCT.

Plant identification and nomenclature were based on species descriptions presented within The Flora of New South Wales Volumes 1 to 4 (Harden, 1993) and with reference to taxonomic updates in PlantNET - The Plant Information Network System of Botanic Gardens Trust, Sydney, Australia (Botanic Gardens Trust, 2020). The locations of all floristic plot/ transects are presented in **Figure 4**.

3.2.2 Fauna Habitat Assessment

The locations of any important habitat features, such as microbat roosting habitat, hollow-bearing trees, terrestrial refugia and nests/burrows were captured with a handheld GPS device and photographed where appropriate.

Searches for potential habitat for threatened fauna species included but were not limited to:

- Koala feed trees.
- Foraging trees for threatened birds.
- Hollow-bearing trees.
- Potential roosts for microbats.
- Vegetated ponds, riparian vegetation and drainage lines for frogs and waterbirds.
- Woody debris, leaf litter and bush rock.

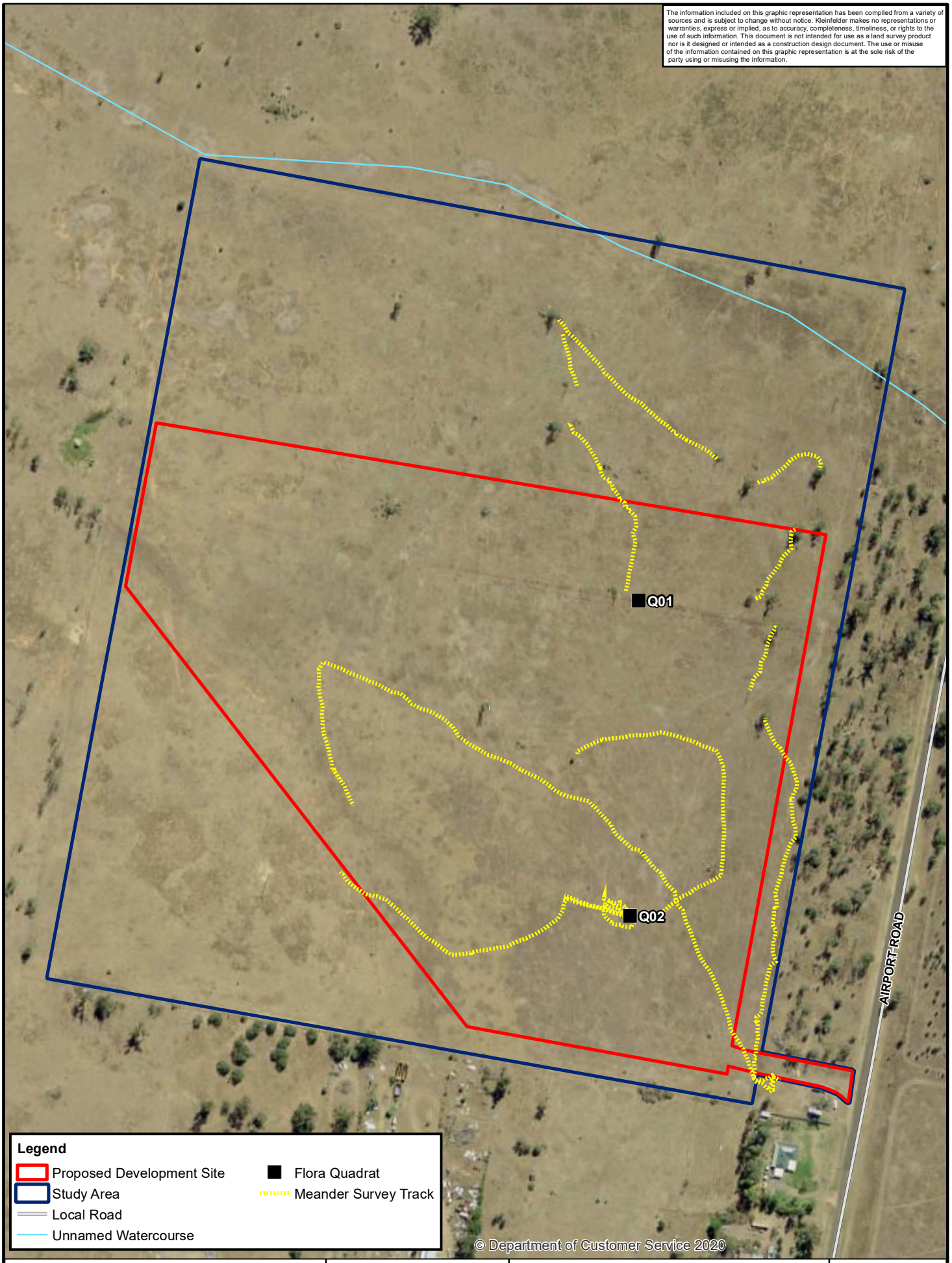
Diurnal opportunistic observations of fauna species and fauna activity such as scats, tracks, burrows or other traces were recorded during survey.

3.3 SURVEY LIMITATIONS

The survey techniques and survey effort applied for this study were commensurate with the nature and condition of the subject site. Due to these limitations, priority was given to habitat assessment for relevant threatened biota. A 'likelihood of occurrence' assessment was applied to all species previously recorded or predicted to occur within the locality based on State and Commonwealth information sources.

The field survey was undertaken during an eight-hour survey period by one ecologist. While a low diversity of native and a high exotic flora species was recorded, a longer survey duration or multiple seasonal surveys would likely result in the detection of a greater diversity of species. The majority of the subject site is considered to be degraded and unsuitable for most threatened plant species known to occur in the locality; therefore, the survey effort that is recommended in *The NSW Guide to Surveying Threatened Plants* (OEH, 2016) is not considered to be applicable.

No targeted fauna surveys, microchiropteran bat surveys (i.e. Anabat), fauna trapping or targeted surveys for cryptic fauna species was undertaken, as the proposed development will avoid the watercourses and will not clear significant habitat features. No 'call playback' for arboreal fauna, large forest owl species were conducted. Given the historical use of the site for agricultural purposes and the limited amount of clearing required for the proposed development, the survey effort was considered adequate to assess the biodiversity values present.



Metres
0 25 50 100 150 200
N

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT REFERENCE: 20213329
DATE DRAWN: 2021/01/18 13:41 Version 1
DRAWN BY: GJoyce
DATA SOURCE:
KDC - 2020
NSW DFSI - 2020
NSW OEH - 2019

Survey Effort

KDC Pty Ltd
Flora & Fauna Assessment
Narrabri Solar Farm

FIGURE:
4

L:\GIS FOLDER\00 CLIENT FILES\130060_KDC_PtyLtd\20213329_FFAR_NarrabriSolarFarm\Mapping\20213329_FFAR_Fig4_SurveyEffort.mxd

4. RESULTS

4.1 PLANT DIVERSITY

A total of 57 plant species were identified during the assessment. These were comprised of 20 exotics and 37 natives. A complete list of flora species is presented in **Appendix 2**. The majority of the exotic plant species were comprised of annual herbs and grasses associated with the grasslands. Native plant species were comprised mainly of grasses and herbs. Isolated native tree and shrub species are scattered throughout the north east of the subject site, with the majority located in the woodland area east of the development footprint.

4.2 WEEDS

Four High Threat Exotics (HTE) (DPIE 2020), two listed priority weeds (DPI 2020) and one listed Weed of National Significance (WoNS) (DAWE 2020d) were identified during the assessment:

- *Carthamus lanatus* Saffron Thistle (HTE and listed priority weed).
- *Opuntia stricta* Prickly Pear (HTE, listed priority weed and WoNS).
- *Paspalum dilatatum* Paspalum (HTE).
- *Urochloa muticus* Para Grass (HTE).

Mitigation measures to prevent the spread of weeds are presented in **Section 5.2.**

4.3 PLANT COMMUNITY TYPES

The regional vegetation mapping for the locality maps the grassland areas of the subject site as *Candidate Native Grasslands* and the south eastern boundary of the subject site is identified as *Brigalow Clay Plain Woodlands, PTC 35: Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Piliga Scrub to Goondiwindi, Brigalow Belt South Bioregion*. This community is dominated by Brigalow *Acacia harpophylla*, Belah *Casuarina cristata* and Bimble Box *Eucalyptus populnea* ssp. *Bimbil.*

The assessment determined that the regional vegetation mapping for the subject site is incorrect, with the majority of the subject site being comprised of exotic grassland vegetation with scattered *Callitris glaucophylla* White Cypress Pine (**Figure 5**). This vegetation is in a low condition state and is not commensurate with any native Plant Community Types (NSW Bionet Vegetation Classification - DPIE 2021).

The grasslands are dominated by *Cynodon dactylon* Couch. Although this species is a native species, it is also a very common pasture species in grazing paddocks. Other dominant exotic pasture species included *Paspalum dilatatum* Paspalum, *Urochloa panicoides* Liverseed Grass, *Panicum capillare* Witch Grass and *Vulpia myuros* (Rat's tail Fescue). Native grass species that occurred to a lesser extent included *Austrostipa verticillata* Slender Bamboo Grass*, Aristida ramosa* Purple Wire Grass*, Bothriochloa macra* Red-legged Grass*, Chloris truncata* Windmill Grass and *Chloris ventricosa.* Occasional native herb species included *Portulaca oleracea* Pigweed, *Boerhavia dominii* Tarvine, *Dysphania pumilio* Crumb Weed and *Tribulus terrestris* Caltrop*.* Common introduced herbs included *Sida spinosa*, *Sida rhombifolia* Paddy's Lucerne and *Lepidium africanum* Common Peppercress.

The shrub layer was largely absent, although infestations of *Lycium ferocissimum* African Box Thorn occurred around the base of some isolated trees. Three native chenopod species occurred occasionally in some areas: *Einadia hastata*, *Sclerolaena muricata* Black Roly-poly and *Sclerolaena birchii* Galvanised Burr.

The grasslands contain low densities of leaf litter and woody debris. In addition to the high coverage of exotic flora, this suggested that the site has a long history of agricultural use (i.e. grazing).

The woodland vegetation adjacent to the study area was dominated by *Callitris glaucophylla* White Cypress Pine with occasional *Acacia salicina* Sally Wattle and *Geijera parviflora* Wilga.

4.4 THREATENED ECOLOGICAL COMMUNITIES

The grasslands within the subject site are dominated by exotic species with scattered trees and do not contain the floristic structure or composition of any TEC's listed under the BC Act or the EPBC Act.

4.5 THREATENED FLORA SPECIES

No threatened flora species were identified within the subject site during the assessment.

A search of the BioNet Atlas of NSW Wildlife (DPIE, 2020a) returned three records of threatened plant species within a 5 km radius of the study area: *Dichanthium setosum* Bluegrass, *Swainsona murrayana* Slender Darling Pea and *Lepidium aschersonii* Spiny Peppercress. A "likelihood of occurrence" assessment determined that the study area is likely to be too degraded to support any populations of threatened species. It was concluded that habitat for threatened plant species does occur within the subject site (**Appendix 3**).

An EPBC Protected Matters Search returned a list of five threatened plant species predicted to occur within a 5 km radius of the study area (**Appendix 3** and **Appendix 4**). A "likelihood of occurrence' assessment determined that habitat is not present within the subject site for the predicted matters.

4.6 FAUNA HABITAT

The assessment revealed that the vegetation within the subject site is comprised mainly of exotic grassland with isolated scattered trees. At the time of the assessment, leaf-litter and woody debris was generally absent. A total of six dead stags were identified within the study area, three of which occur within the subject site, two of which contain hollows.

The subject site was found to lack vegetation with a complex structure, shrubs and midstorey species were generally absent. The habitat is likely to support a low diversity of native fauna, including birds and mammal species common within agricultural landscapes. In summary, the fauna habitat assessment determined the following:

- The isolated trees within the subject site may provide marginal foraging and nesting habitat for several common native bird species.
- The grasslands may provide foraging habitat for a range of native birds and terrestrial mammals such as macropods (Kangaroos and Wallabies).
- The grasslands may provide hunting habitat for native predatory birds, such as Falcons, Kestrels and Large Forest Owls.
- No nests, fallen logs or rocky outcrops were identified within the subject site.
- Three dead stags occur within the subject site, two of which contain hollows and potential roosting habitat for microchiropteran bats.

4.7 FAUNA SPECIES

Opportunistic fauna observations included sightings of common bird species such as:

- *Corvus coronoides* Australian Raven.
- *Eolophus roseicapilla* Galah.
- *Grallina cyanoleuca* Magpie Lark.
- *Rhipidura leucophrys* Willie Wagtail.
- *Coracina novaehollandiae* Black-faced Cuckoo Shrike.
- *Cacatua galerita* Sulphur Crested Cockatoo.
- *Manorina melanocephala* Noisy Miner.
- *Psephotus haematonotus* Red-rumped Parrot.
- *Struthidea cinerea* Apostle Bird.

No reptile or amphibian species were opportunistically identified during survey.

4.8 THREATENED FAUNA SPECIES

One BC Act listed vulnerable fauna species, *Haliaeetus leucogaster* White Bellied Sea Eagle was observed flying over the subject site. No nest trees or areas of large open water were identified within the subject site. Therefore, the subject site is not considered to provide nesting or foraging habitat for this species.

A search of the BioNet Atlas of NSW Wildlife (DPIE, 2020a) returned a list of 19 threatened fauna species that have previously been recorded within 5 km radius of the subject site. A "likelihood of occurrence" assessment determined that the subject site provides minimal roosting and foraging habitat for the *Saccolaimus flaviventris* Yellow-bellied Sheathtail-bat, a listed vulnerable species under the BC Act. Mitigation measures are presented in **Section 5.2** to reduce the potential for impacts to this species during the construction phase of the project.

The habitat is considered to be too degraded to support habitat for any other threatened fauna species. Justifications for this determination are presented in **Appendix 3** where the habitat requirements of threatened species are discussed individually.

4.9 KOALA HABITAT

One preferred Koala feed tree species listed for the Western Slopes and Plains Koala Management Area (DPIE 2020d) was identified during survey. White Cypress Pine occurs in scattered occurrences.

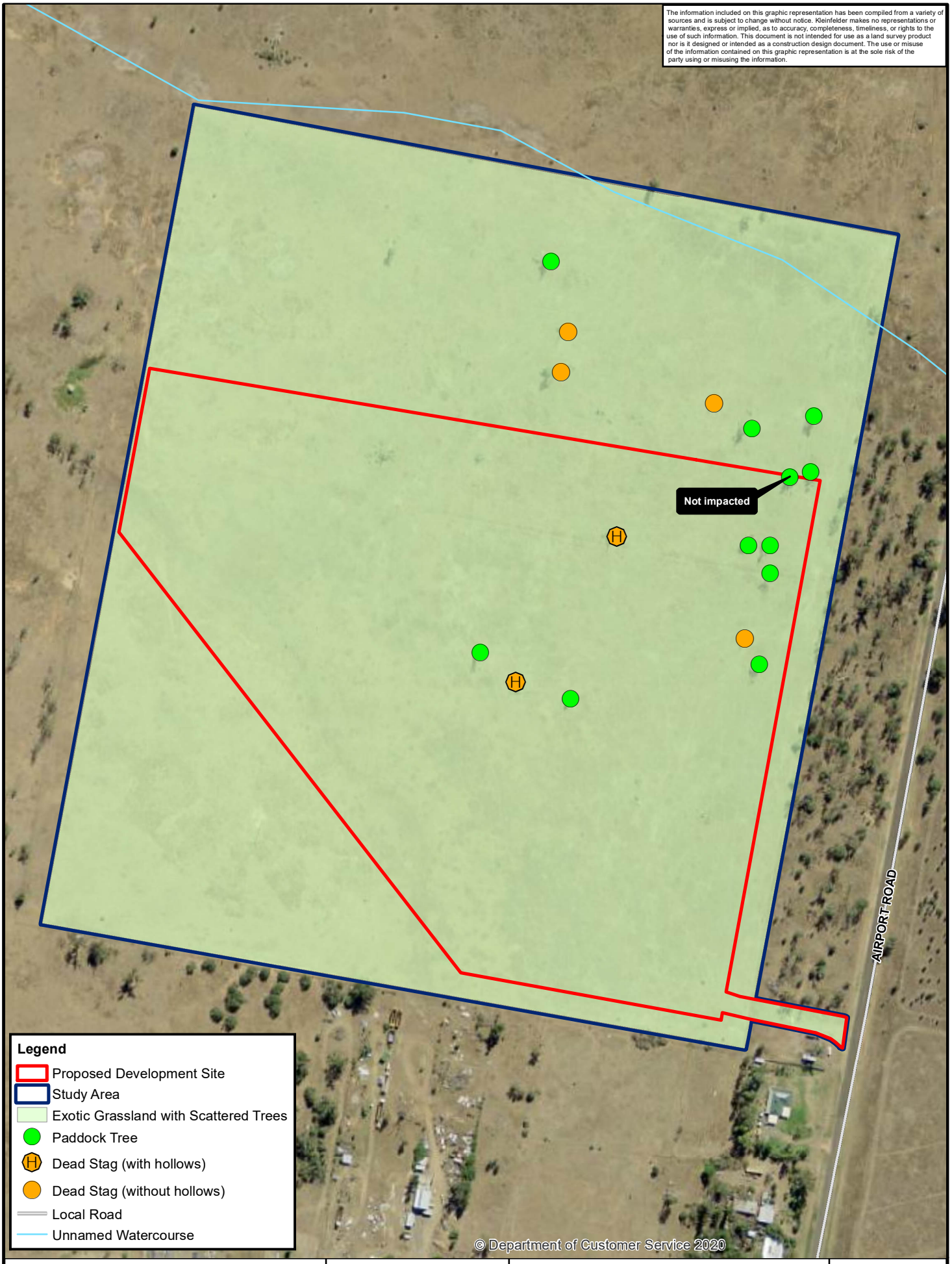
An assessment of Koala habitat within the subject site determined that no Highly Suitable Koala Habitat, or Core Koala Habitat is present. This is based on the following:

- No evidence of a resident population of Koalas was detected during the assessment (i.e. No Koala individuals, scats or scratch marks were identified).
- Few and scattered occurrences of only one Koala feed tree was identified within the subject site.
- Die to the isolated locations of the trees, better quality habitat for Koalas occurs outside the subject site.
- The trees within the subject site do not form part of an important habitat corridor that is likely to be utilised by Koalas.

4.10 EPBC ACT PROTECTED MATTERS

A 'likelihood of occurrence' assessment was conducted for all threatened species and migratory species returned by the EPBC Protected Matters Search (**Appendix 3** and **Appendix 4**). The habitats present within the subject site were considered to be too degraded for all species, with the exception of the Fork-tailed Swift *Apus pacificus* and the White-throated Needletail *Hirundapus caudacutus.*

Both of these bird species may forage aerially over a very wide range of habitats including vegetated and non-vegetated areas. The proposed development will not remove habitat features considered to be important to these species. The extent of foraging habitat is likely to be unaffected.



Metres
0 25 50 100 150 200
N

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT REFERENCE: 20213329
DATE DRAWN: 2021/01/15 15:43 Version 1
DRAWN BY: GJoyce

DATA SOURCE:
KDC - 2021
NSW DFSI - 2020
NSW OEH - 2019

Vegetation and Habitat Features

KDC Pty Ltd
Flora & Fauna Assessment
Narrabri Solar Farm

FIGURE:
5

L:\GIS FOLDER\00 CLIENT FILES\130060_KDC_PtyLtd\20213329_FFAR_NarrabriSolarFarm\Mapping\20213329_FFAR_Fig5_VegetationCommunities_Habitat.mxd

5. DISCUSSION

5.1 IMPACT ASSESSMENT

5.1.1 Removal of Native Vegetation

Removal of native vegetation within the subject site will be limited to the removal of six trees (i.e. White Cypress Pine) and three dead stags, two of which contain hollows. A negligible amount of groundcover vegetation is required to be removed to accommodate the proposed development (**Figure 5**).

5.1.2 Impacts to Fauna

Potential impacts of the proposed development on resident fauna populations include the following:

- Removal of three stags within the subject site, two of which contain hollows.
- Removal of six isolated trees within the subject site, the trees may provide marginal foraging and nesting habitat for common native bird species.
- Noise and lighting during the construction phase may cause minor disturbance to resident fauna within the locality and disrupt their natural behaviour.
- Pollution such as chemical spills from construction machinery may have adverse effects on the water quality and biota within the constructed dam and aquatic habitat.
- Ground disturbance by machinery during the construction phase may create dust and facilitate the movement of sediment. Sedimentation could adversely affect the water quality within the aquatic habitat.

Management measures are presented in **Section 5.2** to reduce the potential for these impacts.

5.1.3 Impacts to Threatened Species

One threatened species was identified during the assessment. The White Bellied Sea Eagle was overserved flying over the subject site. The subject site is not considered to provide foraging or nesting habitat for this species.

A “likelihood of occurrence” assessment determined that potential habitat occurs within the subject site for Yellow-bellied Sheathtail-bat. In accordance with Section 7.3 of the BC Act, an ‘assessment of significance’ determined that the proposed development is unlikely to have a significant impact on this species.

5.1.4 Impacts to Threatened Ecological Communities

No TEC’s listed under the BC Act and the EPBC Act were identified within the subject site.

5.1.5 Impacts to Aquatic Habitat

The proposed development has been designed to avoid directly impacting the mapped waterway within the study area. Potential indirect impacts include the following:

- The excavation of soil within the subject site during the construction phase has the potential to facilitate erosion and sediment movement. Runoff from the subject site has the potential to introduce nutrients and other toxins to aquatic habitats.
- The introduction of chemicals such as fuels for vehicles and machinery during the construction phase has the potential to cause pollution to downstream aquatic habitat.

Recommendations to reduce the potential for adverse environmental impacts to aquatic habitat are presented in **Section 5.2.**

5.1.6 Cumulative Impacts

Cumulative impacts arise from the interaction of individual elements associated with the proposed development and the additive effects of other external projects. No other known projects within the locality are known to have relevance to this project that could exacerbate cumulative impacts.

5.2 IMPACT AMELIORATION

5.2.1 Avoidance Measures

Impacts on biodiversity values have been addressed through an iterative design process to avoid areas of higher biodiversity value within the subject site. The design of the solar panel

array will ensure that minimal trees and native vegetation will be removed within the subject site.

5.2.2 Vegetation Clearing Control

Prior to any vegetation clearing, a survey of the stags should be conducted in the development footprint by suitably qualified ecologist. If either of the stags contain fauna (including threatened species) they must be left standing for two nights after the surrounding vegetation has been cleared to encourage any native fauna species utilising the habitat hollows to self-relocate.

The felling of all habitat trees will be attended by a suitably qualified and experienced ecologist in order to ensure the safety of any fauna found to be in the hollows. Hollow bearing stags (i.e. trees) will be 'soft felled' by an experienced machine operator. The recommended soft felling procedure is as follows:

- The hollow-bearing tree is given several moderate nudges with an excavator to give a warning to any occupying native fauna.
- The hollow-bearing tree is then carefully watched, and any native fauna present is given an opportunity to self-relocate before the tree is felled.
- Once felled, all hollows will be inspected for native fauna species and if any are found, the animal will be relocated at an appropriate time of day (i.e. dusk for nocturnal species).
- If the animal is injured, it will be taken to a local veterinarian.
- The fauna should be removed and released at night into suitable habitat.

5.2.3 Erosion Control

Mitigation measures to reduce soil erosion and pollutant run-off during construction activities should include:

- Installation of erosion and sediment control structures within 40 m of any water features prior to any construction works.
- Regular inspection of erosion and sediment control measures, particularly following rainfall events to ensure their ongoing functionality.
- The immediate removal offsite of any excavated materials.
- Avoid stockpiling of materials adjacent to native vegetation, but instead use areas that are already cleared/ disturbed.
- Undertake maintenance of silt fences and other mitigation measures to isolate runoff.

5.2.4 Dust Control

Specific measures to minimise the generation of dust and associated impacts on adjacent natural environments should include:

- Setting maximum speed limits for all traffic within the subject site to limit dust generation.
- Use of a water tanker to spray unpaved access tracks during the construction phase where required.
- Application of dust suppressants or covers on soil stockpiles.

5.2.5 Chemical Spills

Specific measures to minimise the potential for chemical spills and associated impacts on adjacent natural environments should include the following:

- All chemicals must be kept in clearly marked bunded areas.
- Regularly inspect vehicles and mechanical plant for leakage of fuel or oil.
- No re-fuelling of vehicles, washing of vehicles or maintenance of vehicles and plant to be undertaken within 20 m of natural drainage lines and / or water features.

5.2.6 Weed Management

The following recommendations are to be implemented during construction and operation to minimise the impact of weeds within the subject site:

- All vehicles should be cleaned prior to entering the site to prevent the introduction of new weed species.
- The site should be monitored during and after construction to ensure that THE, priority weeds for the region and WoNS are not introduced.

5.2.7 Offset Provisions

As described previously in **Section 2.2.2**, entry into the Biodiversity Offsets Scheme (BOS) is not required for the proposed development.

5.3 CONCLUSION

The proposed development will mainly affect areas of exotic grassland (agricultural land). The habitat is considered to be generally unsuitable habitat for threatened species; therefore, the proposed development is unlikely to cause a significant impact to any threatened species, populations or ecological communities listed under the NSW BC Act. Entry into the NSW BOS is not triggered by the proposed development.

No EPBC listed species, ecological communities, migratory species or important habitat for such entities was identified within the subject site. The assessment determined that impacts to MNES are unlikely; therefore, an EPBC referral to the Commonwealth Minister for the Environment is not recommended.

Avoidance and mitigation measures have been presented to reduce potential impacts to biodiversity values within the subject site and the environment.

REFERENCES

Botanic Gardens Trust. (2020). New South Wales Flora online - PlantNET. Retrieved from http://plantnet.rbgsyd.nsw.gov.au/.

DAWE. (2020a). *EPBC Protected Matters Search Tool*. Commonwealth of Australia

DAWE. (2020b). *Species Profile and Threats Database (SPRAT)*. Commonwealth of Australia

DAWE. (2020c). *Weeds of National Significance*. Retrieved from http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html

DPI. (2020). *NSW WeedWise*. Retrieved from http://weeds.dpi.nsw.gov.au/

DPIE. (2020a). *Bionet Atlas of NSW Wildlife*. Retrieved from https://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx

DPIE. (2020b). *Koala Habitat Protection Guideline*.

DPIE. (2020c). *Threatened Species Profile Database*. Retrieved from https://www.environment.nsw.gov.au/threatenedSpeciesApp/

DPIE. (2020d) Revegetating Koala Habitat - Western Slopes and Plains Koala Management Area | NSW Environment, Energy and Science

DPIE. (2020e) State Vegetation Type Map: Border Rivers Gwydir/Namoi Version 2.0. VIS_ID 4467 Retrieved from: https://datasets.seed.nsw.gov.au/dataset/border-rivers-gwydir-namoi-regional-native-vegetation-map-version-2-0-vis_id-420443dc7

Harden, G. (1993). *Flora of New South Wales Volumes 1–4*.

NRAR. (2018). *Guidelines for controlled activities on waterfront land. Riparian corridors.* Sydney

OEH. (2016). *NSW Guide to Surveying Threatened Plants*. 59 Goulbourn Street Sydney NSW 2000

OEH. (2017). *Biodiversity Assessment Method*. NSW Office of Environment and Heritage Retrieved from https://www.environment.nsw.gov.au/biodiversity/assessmentmethod.htm

LEP (2012) Narrabri Local Environmental Plan 2012 - NSW Legislation. Retrieved 25 November 2020.

APPENDIX 1: SITE PHOTOGRAPHS

Plate 1: **Exotic grassland within the central portion of the study area**

Plate 2: **Isolated trees in the study area**

APPENDIX 2: FLORA SPECIES LIST

Table 1: Flora list

	Growth Form	*Species*	Q1		Q2		Random Meander
			Cov.	Abun.	Cov.	Abun.	
Exotic species							
1.	Exotic Cactus	*Opuntia stricta*					x
3.	Exotic Grass	*Paspalum dilatatum*					x
4.	Exotic Grass	*Panicum capillare*			0.1	20	
5.	Exotic Grass	*Urochloa panicoides*	10	1,000	20	10,000	x
6.	Exotic Grass	*Vulpia myuros*					x
7.	Exotic Herb	*Argemone ocroleuca*					x
8.	Exotic Herb	*Rapistrum rugosum*					
9.	Exotic Herb	*Carthamus lanatus*	0.1	10	1	5	
10.	Exotic Herb	*Cirsium vulgare*					x
11.	Exotic Herb	*Conyza bonariensis*	0.1	20			x
12.	Exotic Herb	*Gomphrena celisoides*			0.1	5	x
13.	Exotic Herb	*Lepidium africanum*			1	50	x
14.	Exotic Herb	*Polygonum aviculare*	0.1	20			x
15.	Exotic Herb	*Rapistrum rugosum*			0.1	2	
16.	Exotic Herb	*Sida rhombifolia*					x
17.	Exotic Herb	*Verbena bonariensis*					x
18.	Native Herb	*Sida trichopoda*	0.5	50	2	1,000	x
19.	Exotic Herb	*Solanum nigrum*					x
20.	Exotic Herb	*Tribulus terrestris*	0.5	200	2	1,000	x
21.	Exotic Shrub	*Lycium ferocissimum*					x
Native species							
1.	Native Chenopod	*Einadia hastata*					x
2.	Native Chenopod	*Sclerolaena birchii*	10	1,000			x
3.	Native Chenopod	*Sclerolaena muricata*	0.5	50	40	500	
4.	Native Grass	*Austrostipa verticillata*	1	50	2	1,000	x
5.	Native Grass	*Aristida ramosa*			5	100	x
6.	Native Grass	*Bothriochloa macra*			1	100	x
7.	Native Grass	*Chloris truncata*			5	1,000	
8.	Native Grass	*Chloris ventricosa*	0.1	50			x
9.	Native Grass	*Cynodon dactylon*	60	10,000	50	10,000	x
10.	Native Grass	*Dichelachne micrantha*					x
11.	Native Grass	*Dichanthium sericeum*	0.1	50			

	Growth Form	*Species*	Q1		Q2		Random Meander
			Cov.	Abun.	Cov.	Abun.	
12.	Native Grass	*Digitaria parviflora*			0.1	10	
13.	Native Grass	*Echinochloa colona*	2	1,000			x
14.	Native Grass	*Eragrostis sp.*			0.1	10	
15.	Native Grass	*Poa sp.*					x
16.	Native Grass	*Sporobolus creber*	0.5	100	0.1	10	x
18.	Native Herb	*Alternanthera denticulata*					x
19.	Native Herb	*Boerhavia dominii*			1	500	x
20.	Native Herb	*Calotis lappulacea*			1	100	x
21.	Native Herb	*Dysphania pumilio*	5	1,000	2	500	x
22.	Native Herb	*Einadia trigonos*					x
23.	Native Herb	*Oxalis perrenans*	1	500	1	500	x
24.	Native Herb	*Portulaca oleracea*			0.1	20	x
26.	Native Herb	*Solanum esuriale*	0.1	100			x
27.	Native Herb	*Sclerolaena birchii*			0.5	50	
28.	Native Herb	*Tetragonia tetragonioides*					x
29.	Native Herb	*Vittadinia cuneata*			0.1	5	
30.	Native Herb	*Wahlenbergia communis*			1	200	
31.	Native Herb	*Wahlenbergia gracilis*	0.1	50	0.5	100	x
32.	Native Herb	*Xerochrysum bracteatum*	0.1	5	0.1	5	
33.	Native Shrub	*Atriplex sp.*					x
34.	Native Shrub	*Abutilon oxycarpum*			0.1	20	
35.	Native Tree	*Acacia salicina*					x
36.	Native Tree	*Callitris glaucophylla*					x
37.	Native Tree	*Geijera parviflora*					x

*Notes: High Threat exotics (HTE) are classified in accordance with the DPIE HTE List and are in **bold**. Growth forms were classified in accordance with the DPIE growth forms data.*

APPENDIX 3: THREATENED SPECIES 'LIKELIHOOD OF OCCURRENCE'

Table 2: Likelihood of occurrence

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
Flora								
1.	*Androcalva procumbens*	V	V	-	PMST	Endemic to NSW, mainly confined to the Dubbo-Mendooran-Gilgandra region, but also in the Pilliga and Nymagee areas. Recent collections made from the Upper Hunter region. Grows in sandy sites, often along roadsides. Recorded in *Eucalyptus dealbata* and *Eucalyptus sideroxylon* communities, *Melaleuca uncinata* scrub, under mallee eucalypts with a *Calytrix tetragona* understorey, and in a recently burnt Ironbark and Callitris area. Other associated species include *Acacia triptera, Callitris endlicheri, Eucalyptus melliodora, Allocasuarina diminuta, Philotheca salsolifolia, Xanthorrhoea species, Exocarpos cupressiformis, Leptospermum parvifolium* and *Kunzea parvifolia.* **A readily identifiable species that is detectible at all times of year. The subject site lacks most of the species commonly associated with its occurrence. The species was not detected within the subject site during the assessment.**	Low	Low

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
2.	*Cadellia pentastylis*	V	V	-	PMST	Occurs along the western edge of the North West Slopes from north of Gunnedah to west of Tenterfield. The natural range of Ooline is from 24ºS to 30ºS in the 500 to 750 mm per annum rainfall belt. Forms a closed or open canopy mixing with eucalypt and cypress pine species. There appears to be a strong correlation between the presence of Ooline and low- to medium-nutrient soils of sandy clay or clayey consistencies, with a typical soil profile having a sandy loam surface layer, grading from a light clay to a medium clay with depth. **A readily identifiable species that is detectible at all times of year. The species was not detected within the subject site during the assessment.**	Low	Low
3.	*Dichanthium setosum* Bluegrass	V	V	2	BioNet, PMST	Bluegrass occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, extending to northern Queensland. It is associated with heavy basaltic black soils and red-brown loams with clay subsoil. It is often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture. (Often collected from disturbed open grassy woodlands on the northern tablelands, where the habitat has been variously grazed, nutrient-enriched and water-enriched). **A readily identifiable species that is detectible at all times of year. The species was not detected within the subject site during the assessment.**	Low	Low

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
4.	*Lepidium aschersonii* Spiny Peppercress	V	V	2	BioNet, PMST	Species grows within open to dense forest, and sometimes within grasslands. Plants within the Narrabri regions are known to produce abundant of seed. Populations may disappear following a flood event but then reappear several seasons later. **The subject site has been grazed. The species was not detected within the site during the assessment. The site is considered to be too degraded to support a population of this species.**	Nil	Nil
5.	*Prasophyllum sp. Wybong* Leek Orchid	-	CE	-	PMST	Endemic to NSW, it is known from near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell, Tenterfield, Currabubula and the Pilliga area. A perennial orchid, appearing as a single leaf over winter and spring. Flowers in spring and dies back to a dormant tuber over summer and autumn. Known to occur in open eucalypt woodland and grassland. **The subject site has been grazed. The species was not detected within the site during the assessment. The site is considered to be too degraded to support a population of this species.**	Low	Low
6.	*Swainsona murrayana* Slender Darling Pea	V	V	2	BioNet, PMST	Found throughout NSW, it has been recorded in the southern riverine plain, the Hay plain as far north as Willandra National Park and in various localities between Dubbo and Moree. Grows in a variety of vegetation types including bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with *Maireana* species. Plants have been found in remnant native grasslands or grassy woodlands that have been intermittently grazed or cultivated. **A readily identifiable species that was detectable during the time of survey. The species was not detected within the subject site during survey.**	Low	Low

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
7.	*Tylophora linearis*	V	E	-	PMST	Grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa, Eucalyptus sideroxylon, Eucalyptus albens, Callitris endlicheri, Callitris glaucophylla* and *Allocasuarina luehmannii.* **The subject site has been grazed. The species was not detected within the site during the assessment. The site is considered to be too degraded to support a population of this species.**	Low	Low
Threatened Ecological Communities								
1.	*Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions*	E	E	-	PMST	The structure of the community may vary from tall riparian woodlands to very open 'savanna like' grassy woodlands with a sparse midstorey of shrubs and saplings. Typically, these woodlands form mosaics with grasslands and wetlands, and are characterised by Coolibah (*Eucalyptus coolabah*) and, in some areas, Black Box (*E. largiflorens*). Other tree species may be present including River Cooba (*Acacia stenophylla*), Cooba (*A. salicina*), Belah (*Casuarina cristata*) and Eurah (*Eremophila bignoniiflora*). **This community was not detected within the subject site during the assessment.**	Nil	Nil

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
2.	*Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia*	E	E	-	PMST	Inland Grey Box Woodland includes those woodlands in which the most characteristic tree species, *Eucalyptus microcarpa* (Inland Grey Box), is often found in association with *E. populnea subsp. bimbil* (Bimble or Poplar Box), *Callitris glaucophylla* (White Cypress Pine), *Brachychiton populneus* (Kurrajong), *Allocasuarina luehmannii* (Bulloak) or *E. melliodora* (Yellow Box), and sometimes with *E. albens* (White Box). Shrubs are typically sparse or absent, although this component can be diverse and may be locally common, especially in drier western portions of the community. A variable ground layer of grass and herbaceous species is present at most sites. At severely disturbed sites the ground layer may be absent. **This community was not detected within the study area during the assessment.**	Nil	Nil
3.	*Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland*	-	CE	-	PMST	is strongly reliant on soil type as it is associated with fine textured, often cracking clays* derived from either basalt or quaternary* alluvium. The ecological community generally occurs on flat to low slopes, of no more than 5% (or less than 1 degree) inclination. As slope increases, grassy woodlands dominated by trees such as *Acacia pendula* (weeping myall), *Eucalyptus coolabah* (coolibah), *E. populnea* (poplar box) or *E. melliodora* (yellow box) occur. **This community was not detected within the subject site during the assessment.**	Nil	Nil

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
4.	*Poplar Box Grassy Woodland on Alluvial Plains*	-	E	-	PMST	Temperate to semi-arid grassy eucalypt woodland that is sparsely scattered inland of the Great Dividing Range from around Cowra in NSW to near Collinsville in Queensland. This eucalypt woodland is mainly associated with alluvial plains including back plains, higher terraces and levees along rivers, ephemeral watercourses and depressions. The ecological community varies from a grassy woodland to grassy open woodland with an overstorey dominated by *Eucalyptus populnea* (poplar/bimble box) and an understorey mostly composed of native perennial forbs and grasses but may include some shrubs and sedges, depending on the season, rainfall and location in the landscape. Patches of the ecological community generally lack a substantial mid (tall shrub) layer. **This community was not detected within the subject site during the assessment.**	Nil	Nil
5.	*Weeping Myall Woodlands*	-	E	-	PMST	Occurs on the inland alluvial plains west of the Great Dividing Range in NSW and QLD**, g**enerally on flat areas, shallow depressions or Gilgai's on raised alluvial plains. The Weeping Myall Woodlands range from open woodlands to woodlands, generally, 4 to 12m high. The overstorey is dominated by Weeping Myall (*Acacia pendula*) trees and in some cases this species may be the only tree canopy species. **This community was not detected within the subject site during the assessment.**	Nil	Nil

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
6.	*White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland*	CE	CE	-	PMST	An open woodland community (sometimes occurring as a forest formation), in which the most obvious species are one or more of the following: White Box *Eucalyptus albens*, Yellow Box *E. melliodora* and Blakely's Red Gum *E. blakelyi*. Intact sites contain a high diversity of plant species, including the main tree species, additional tree species, some shrub species, several climbing plant species, many grasses and a very high diversity of herbs. **This community was not detected within the subject site during the assessment.**	Nil	Nil
Birds								
1.	*Anseranas semipalmata* Magpie Goose	V	-	1	BioNet	Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges.Equally at home in aquatic or terrestrial habitats; often seen walking and grazing on land; feeds on grasses, bulbs and rhizomes. Activities are centred on wetlands, mainly those on floodplains of rivers and large shallow wetlands formed by run-off; breeding can occur in both summer and winter dominated rainfall areas and is strongly influenced by water level; most breeding now occurs in monsoonal areas; nests are formed in trees over deep water; breeding is unlikely in south-eastern NSW. **No wetland or nesting habitat within the subject site. More suitable habitat is available in surrounding lands.**	Low	Low
2.	*Artamus cyanopterus cyanopterus* Dusky Woodswallow	V	-	1	BioNet	Primarily inhabit dry, open eucalypt forests and woodlands with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and groundcover of grasses or sedges and fallen woody debris. Also found in farmland, usually at the edges of forest or woodland. **May aerially forage over the subject site. More suitable habitat is available in the study area and surrounding lands.**	Low	Low

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
3.	*Burhinus grallarius* Bush Stone-curlew	E	-	1	BioNet	Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights. Feed on insects and small vertebrates, such as frogs, lizards and snakes.Nest on the ground in a scrape or small bare patch. **The subject site does not contain suitable habitat for this species.**	Nil	Nil
4.	*Chthonicola sagittate* Speckled Warbler	V	-	14	BioNet	The Speckled Warbler lives in a wide range of *Eucalyptus* dominated communities that have a grassy understory, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. **The subject site does not contain suitable habitat for this species.**	Low	Low
5.	*Circus assimilis* Spotted Harrier	V	-	2	BioNet	Occurs in grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. **The subject site does not contain suitable habitat for this species.**		
6.	*Calyptorhynchus lathami* Glossy Black-Cockatoo	V	-	2	BioNet	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (*Allocasuarina littoralis*) and Forest Sheoak (*A. torulosa*) are important foods. **The subject site does not contain suitable habitat for this species.**		

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
7.	*Daphoenositta chrysoptera* Varied Sittella	V	-	5	BioNet	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy. **The subject site is comprised of agricultural lands that contain few native trees. The habitat in the subject site is unsuitable for this species.**	Low	Low
8.	*Glossopsitta pusilla* Little Lorikeet	V	-	2	BioNet	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species. **The subject site is comprised of agricultural lands that contain few native trees. The habitat in the subject site is unsuitable for this species.**	Low	Low
9.	*Lophoictinia isura* Square-tailed Kite	V	-	2	BioNet	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland. **The subject site is comprised of agricultural lands that contain few native trees. The habitat in the subject site is unsuitable for this species.**	Low	Low

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
10.	*Polytelis swainsonii* Superb Parrot	V	-	2	BioNet PMST	Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. In the Riverina the birds nest in the hollows of large trees (dead or alive) mainly in tall riparian River Red Gum Forest or Woodland. On the South West Slopes nest trees can be in open Box-Gum Woodland or isolated paddock trees. Species known to be used are Blakely's Red Gum, Yellow Box, Apple Box and Red Box. Nest in small colonies, often with more than one nest in a single tree. **The subject site is comprised of agricultural lands that contain few native trees. The habitat in the subject site is unsuitable for this species.**	Low	Low
11.	*Grantiella picta* Painted Honeyeater	V	V	1	BioNet PMST	Inhabits Boree/ Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) and Box-Gum Woodlands and Box-Ironbark Forests. This species is a specialist feeder on the fruits of mistletoes growing on woodland Eucalypts and Acacias. Prefers mistletoes of the genus Amyema. **The subject site is comprised of agricultural lands that contain few native trees. No mistletoe was identified. The habitat is considered to be too degraded to support this species.**	Low	Low
12.	*Pomatostomus temporalis temporalis* Grey-crowned Babbler (eastern subspecies)	V	-	9	BioNet	Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Woodlands on fertile soils in coastal regions. **May use the subject site for aerial foraging.**	Low	Low

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
13.	*Tyto longimembris* Eastern Grass Owl	V	-	2	BioNet	Eastern Grass Owls are found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. They rest by day in a 'form' - a trampled platform in a large tussock or other heavy vegetative growth. If disturbed they burst out of cover, flying low and slowly, before dropping straight down again into cover. Always breeds on the ground. Nests are found in trodden grass, and often accessed by tunnels through vegetation. **The subject site is comprised of agricultural lands that contain few native trees and has been heavily grazed. The habitat is considered to be too degraded to support this species.**	Low	Low
14.	*Anthochaera phrygia* Regent Honeyeater	CE	CE	-	PMST	Inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. **The subject site is comprised of agricultural lands that contain few native trees. The habitat is considered to be too degraded to support this species.**	Low	Low
15.	*Botaurus poiciloptilus* Australasian Bittern	E	E	-	PMST	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha spp*.) and spikerushes (*Eleocharis spp*.). **No suitable aquatic habitat is present within the subject site.**	Low	Low

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
16.	*Calidris ferruginea* Curlew Sandpiper	E	CE	-	PMST	It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes inland. **No suitable estuarine habitat is present within the subject site.**	Low	Low
17.	*Falco hypoleucos* Grey Falcon	E	-	-	PMST	The Grey Falcon is sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range. Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey. **No suitable habitat is present within the subject site. May aerially forage over the subject site.**	Low	Low
18.	*Rostratula australis* Australian Painted Snipe	E	E		PMST	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. **No suitable aquatic habitat is present within the subject site.**	Low	Low
19.	*Stictonetta naevosa* Freckled Duck	V	-	1	BioNet	Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. Generally, rest in dense cover during the day, usually in deep water. Feed at dawn and dusk and at night on algae, seeds and vegetative parts of aquatic grasses and sedges and small invertebrates. **No suitable aquatic habitat is present within the subject site.**	Low	Low

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
Mammals								
1.	*Chalinolobus dwyeri* Large-eared Pied Bat	V	V	-	PMST	Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. **No cave habitat is present within the subject site.**	Nil	Nil
2.	*Dasyurus maculatus (SE mainland population)* Spot-tailed Quoll	V	E		PMST	This species has been recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites. **The subject site is comprised of agricultural lands that contain few native trees. The habitat is considered to be too degraded to support this species.**	Low	Low
3.	*Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)* Koala	V	V	2	BioNet PMST	In NSW, Koalas occur along the coast, extending west to the Darling Riverine Plains and Mulga Lands bioregions in the north of the state; to the Cobar Peneplain bioregion in the centre of the state; and to the Riverina and eastern most parts of the Murray-Darling Depression bioregions in the south. The koala is found in a variety of forest types. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. **No Koalas or evidence of Koalas were identified during assessment within the subject site.**	Low	Low

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
4.	*Saccolaimus flaviventris* Yellow-bellied Sheathtail-bat	V	-	4	BioNet	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. **The subject site provides potential roosting and foraging habitat for this species.**	Moderate	Low
5.	*Nyctophilus corbeni* Corben's Long-eared Bat	V	V		PMST	Inhabits a variety of vegetation types, including Mallee, Bulloke *Allocasuarina leuhmanni* and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. **The subject site is comprised of agricultural lands that contain few native trees. The habitat is considered to be too degraded to support this species.**	Low	Low
6.	*Pteropus poliocephalus* Grey-headed Flying-fox	V	V	1	BioNet PMST	Occurs across a wide range of habitat types along the eastern seaboard of Australia, depending on food availability. Fruit from myrtaceous trees and rainforest trees form the major components of their diet. **Potential marginal foraging habitat is present; however, no camps were detected. The habitat is not considered to be important to this species.**	Low	Low
Reptiles								

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
1.	*Anomalopus mackayi* Five-clawed Worm-skink	E	V	1	BioNet	Patchy distribution on the North West Slopes and Plains of north-east NSW and south-east Queensland, from the Ashford area west to Mungindi and Walgett in NSW and north to Dalby in Queensland. Close to or on the lower slopes of slight rises in grassy White Box woodland on moist black soils, and River Red Gum-Coolibah-Bimble Box woodland on deep cracking loose clay soils. May also occur in grassland areas and open paddocks with scattered trees. Live in permanent deep tunnel-like burrows and deep soil cracks, coming close to the surface under fallen timber and litter, especially partially buried logs. **No logs or fallen timber and no soil cracks or deep tunnels were identified during the assessment within the subject site. The subject site does not contain suitable habitat for this species.**	Low	Low
2.	*Hoplocephalus bitorquatus* Pale-headed Snake	V	-	1	BioNet	In NSW it has historically been recorded from as far west as Mungindi and Quambone on the Darling Riverine Plains, across the north west slopes, and from the north coast from Queensland to Sydney. A small number of historical records are known for the New England Tablelands from Glenn Innes and Tenterfield; however, the majority of records appear to be from sites of relatively lower elevation. Found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest. In drier environments, it appears to favor habitats close to riparian areas. Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees. **The subject site does not contain suitable habitat for this species.**	Low	Low
Migratory Species								

No.	Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
		BC Act	EPBC Act					
1.	*Apus pacificus* Fork-tailed Swift	-	M	-	PMST	Forages aerially over a very wide range of habitats includes both vegetated and non- vegetated areas. **Potential aerial foraging habitat above the subject site.**	Moderate	Low
2.	*Hirundapus caudacutus* White-throated Needletail	-	M	-	PMST	Forages in high open spaces over varied habitat types. **Potential aerial foraging habitat above subject site.**	Moderate	Low
3.	*Motacilla flava* Yellow Wagtail	-	M	-	PMST	Typically inhabits inundated fields, saltmarsh and wetlands and occasionally coastal areas. **No suitable habitat within the subject site.**	Low	Low
4.	*Myiagra cyanoleuca* Satin Flycatcher	-	M	-	PMST	Found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests. **No suitable habitat within the subject site.**	Low	Low
5.	*Rhipidura rufifrons* Rufous Fantail	-	M	-	PMST	Found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. **No suitable habitat within the subject site.**	Low	Low

APPENDIX 4: EPBC ACT PROTECTED MATTERS SEARCH REPORT

Australian Government

Department of Agriculture, Water and the Environment

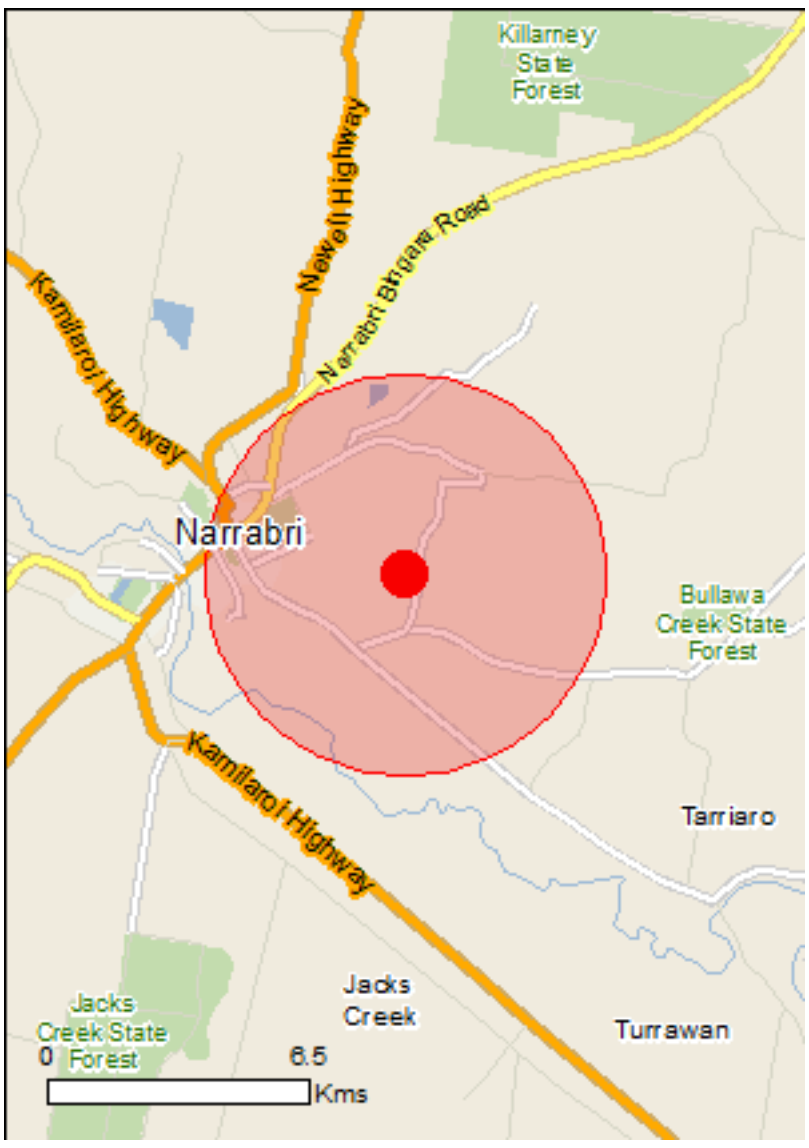
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

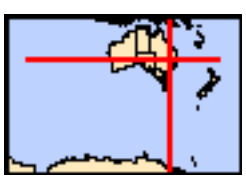
Report created: 12/01/21 12:04:47



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates

Buffer: 5.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	3
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	23
Listed Migratory Species:	10

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	5
Commonwealth Heritage Places:	1
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	25
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Banrock station wetland complex	900 - 1000km upstream
Riverland	900 - 1000km upstream
The coorong, and lakes alexandrina and albert wetland	1100 - 1200km

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community likely to occur within area
Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered	Community may occur within area
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	Critically Endangered	Community likely to occur within area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community may occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Fish		
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pseudomys pilligaensis Pilliga Mouse, Poolkoo [99]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Plants		
Androcalva procumbens [87153]	Vulnerable	Species or species habitat likely to occur within area
Cadellia pentastylis Ooline [9828]	Vulnerable	Species or species habitat likely to occur within area
Dichanthium setosum bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area
Prasophyllum sp. Wybong (C.Phelps ORG 5269) a leek-orchid [81964]	Critically Endangered	Species or species habitat may occur within area
Tylophora linearis [55231]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Anomalopus mackayi Five-clawed Worm-skink, Long-legged Worm-skink [25934]	Vulnerable	Species or species habitat may occur within area
Aprasia parapulchella Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus		
White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land - Australian Postal Commission
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Commonwealth Scientific & Industrial Research Organisation
Commonwealth Land - Commonwealth Trading Bank of Australia
Commonwealth Land - Telstra Corporation Limited

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Narrabri Post Office and former Telegraph Office	NSW	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-30.33329 149.82248

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

APPENDIX 5: ASSESSMENT OF SIGNIFICANCE (PURSUANT TO SECTION 7.3 OF THE BC ACT)

Factors of Assessment - *Biodiversity Conservation Act 2016*

The five factors considered in the test of significance under s.7.3 of BC Act are shown in the table below. The tests of significance for all threatened species, populations and ecological communities considered likely to occur within the subject site are provided in the proceeding sub-sections.

Table 3: Factors addressed in the assessment of significance

Factor	Species	Population	Ecological Community
in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.	X		
in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction			X
in relation to the habitat of a threatened species, population or ecological community: the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality	X		X
whether the proposed development or activity is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).	NA	NA	NA
whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of, a key threatening process.	X	X	X

Threatened Fauna

Table 4: *Saccolaimus flaviventris* Yellow-bellied Sheathtail-bat

Factors	Assessment of Significance
(a) Effect on life cycle	The subject site provides potential roosting and foraging habitat for the Yellow-bellied Sheatail-bat. The species was not detected within the subject site during the assessment; however, records of the species occur in the locality and suitable potential habitat has been identified within the two stags to be removed within the subject site. With the implementation of mitigation measures provided in **Section 5.2.2**, it is unlikely that the proposed development will adversely affect the lifecycle of the species, such that a local population would be at risk of extinction.
(c) (i) Habitat Removal	Large areas of suitable habitat for the species occur in the surrounding lands and the study area, which will be retained following the proposed development.
(c) (ii) Habitat Fragmentation	The two stags to be removed provide potential habitat only. With the implementation of mitigation measures provided in **Section 5.2.2, t**he proposed development will not cause further habitat fragmentation for the species within the locality.
(c) (iii) Habitat importance	The habitat to be is not considered important to the species within the locality. With the implementation of mitigation measures provided in **Section 5.2.2,** th**e r**emoval of two stags containing hollows is unlikely to put a local population at risk of extinction.
(d) Effect on biodiversity value	The proposed development does not occur within an Area of Outstanding Biodiversity Value (AOBV).
(e) KTP	The following KTPs are listed in order of their relevance to the species and the proposed development: • Removal of dead wood and dead trees. • Removal of native vegetation. Given that the subject site is already a highly modified environment the proposed development is likely to facilitate the above listed KTPs to a minor extent. Impacts are likely to be negligible.
Conclusion	As the proposed development will not impact an area containing a known occurrence of the Yellow-bellied Sheathtail-bat and with the implementation of mitigation measures provided in **Section 5.2.2, t**he proposed development is considered unlikely to have a significant impact on this species in the locality.

APPENDIX 6: LICENSES AND PERMITS

Kleinfelder employees involved in the current study are licensed or approved under the *National Parks and Wildlife Act 1974* (License Number: SL100730, Expiry: 31 March 2021) and the *Animal Research Act 1985* to harm/trap/release protected native fauna and to pick for identification purposes native flora and to undertake fauna surveys.

Noise Assessment

Narrabri Solar Farm
Narrabri, NSW

Prepared for: Providence Asset Group
February 2021
MAC201186-04RP1

Muller Acoustic Consulting

Document Information

Noise Assessment

Narrabri Solar Farm

Narrabri, NSW

Prepared for: Providence Asset Group

704/99 Bathurst Street

Sydney NSW 2000

Prepared by: Muller Acoustic Consulting Pty Ltd

PO Box 262, Newcastle NSW 2300

ABN: 36 602 225 132

P: +61 2 4920 1833

www.mulleracoustic.com

DOCUMENT ID	STATUS	DATE	PREPARED	SIGNED	REVIEWED	SIGNED
MAC201186-04RP1	Final	1 February 2021	Rod Linnett		Oliver Muller	

CONTENTS

1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Providence Asset Group (PAG) to prepare a Noise Assessment (NA) for the proposed Narrabri Solar Farm near Narrabri, NSW (the 'project'). This report presents the methodology and findings of the NA for the construction and operation of the project.

1.1 Purpose and Objectives

A NA is required as part of the environmental assessment to be submitted to Narrabri Shire Council as part of the Development Application (DA). The purpose of the NA is to quantify potential environmental noise emissions associated with the construction and operation of the project. Where impacts are identified, the assessment includes recommendations for potential noise mitigation and management measures.

1.2 Scope of the Assessment

The NA includes the following key tasks:

- review construction and operating activities to identify key noise generating plant, equipment, machinery or activities proposed to be undertaken as part of the project;
- identify the closest and/or potentially most affected receivers situated within the area of influence to the project;
- determine project-specific construction Noise Management Levels (NMLs), and operational noise criteria;
- undertake 3D noise modelling to predict levels that may occur as a result of the construction and operation of the project at the closest and/or potentially most affected receivers;
- provide a comparison of predicted noise levels against relevant construction and operational criteria;
- assess the potential noise impacts associated with construction and operational aspects of the project;
- assess the potential noise impacts associated with road traffic noise during construction; and
- provide feasible and reasonable noise mitigation and management measures, and monitoring options, where criteria may be exceeded.

The assessment has been undertaken in accordance with the following documents:

- NSW Department of Environment and Climate Change (DECCW) – NSW Interim Construction Noise Guideline (ICNG), July 2009;
- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- NSW Department of Environment, Climate Change and Water (DECCW) – NSW Road Noise Policy (RNP), March 2011;
- Australian Standard AS 1055:2018 - Acoustics - Description and measurement of environmental noise - General Procedures; and
- International Standard ISO 9613:1996 - Acoustics - Attenuation of sound during propagation outdoors.

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

2 Project Description

2.1 Background

PAG propose to construct and operate a 5 Megawatt (MW) solar farm using photovoltaic (PV) technology at 115 Airport Road, Narrabri NSW, NSW approximately 3km south east of Narrabri, NSW.

2.2 Description of Proposed Construction Works

The project includes installation of groups of north aligned PV modules on mounting structures of 1.5m to 1.8m in height. Approximately 11,600 PV panels will be installed using a single axis tracking system, tilting along the north-south axis. The PV mounting structure would comprise steel posts driven into the ground using a small pile driver. Additional support structures would be attached to the piles, which would then support the PV panels.

Where cabling of each PV array/module to inverters is required to be underground, earthworks will primarily involve trenching. Other minor earthworks would be completed for the preparation of the site and in most cases a concrete slab would be required to support the ancillary infrastructure. Most of the infrastructure would be pre-fabricated off-site, delivered and assembled on-site.

It is anticipated that the solar farm would be constructed in stages, with construction of two to three stages occurring at any one time over a six month period during standard construction hours.

All vehicles would access the project site from the Newell Highway via Tibbereena Street, Fitzroy Street, Maitland Street, Old Gunnedah Road Kaputar Road and Airport Road during construction and operational phases.

During construction, traffic generated by the project would include employee and delivery vehicles. During the peak construction period, the daily traffic volume is expected to be up to four heavy vehicles (semi-trailers or B-doubles) per hour and 20 light commercial vehicles or equivalent for worker transport during the morning and afternoon peaks.

2.3 Description of Proposed Operation

PV infrastructure on site will comprise of groups of PV panels installed in rows running north to south. The PV modules will be on a single axis tracker system which will follow the sun and move in an east to west direction. Electrical cabling would be attached beneath the modules and would connect the individual PV modules to each other. Inverters will be located centrally and connected by underground cables. The project will be contained solely within the site as shown in **Figure 1**. Project layout drawings are presented in **Appendix B**.

The project would operate 24 hours a day, 7 days a week, with no permanent staff on site. During operation, the PV panels would generate electricity which would be fed into the power grid via the adjacent existing powerline. Key noise emissions from the operation of the project are associated with the inverter and transformer(s). It is noted that emissions from these sources are anticipated to be acoustically insignificant compared to ambient background noise levels at assessed receivers.

When required, maintenance activities will occur during standard working hours (except for emergencies) and are expected to include:

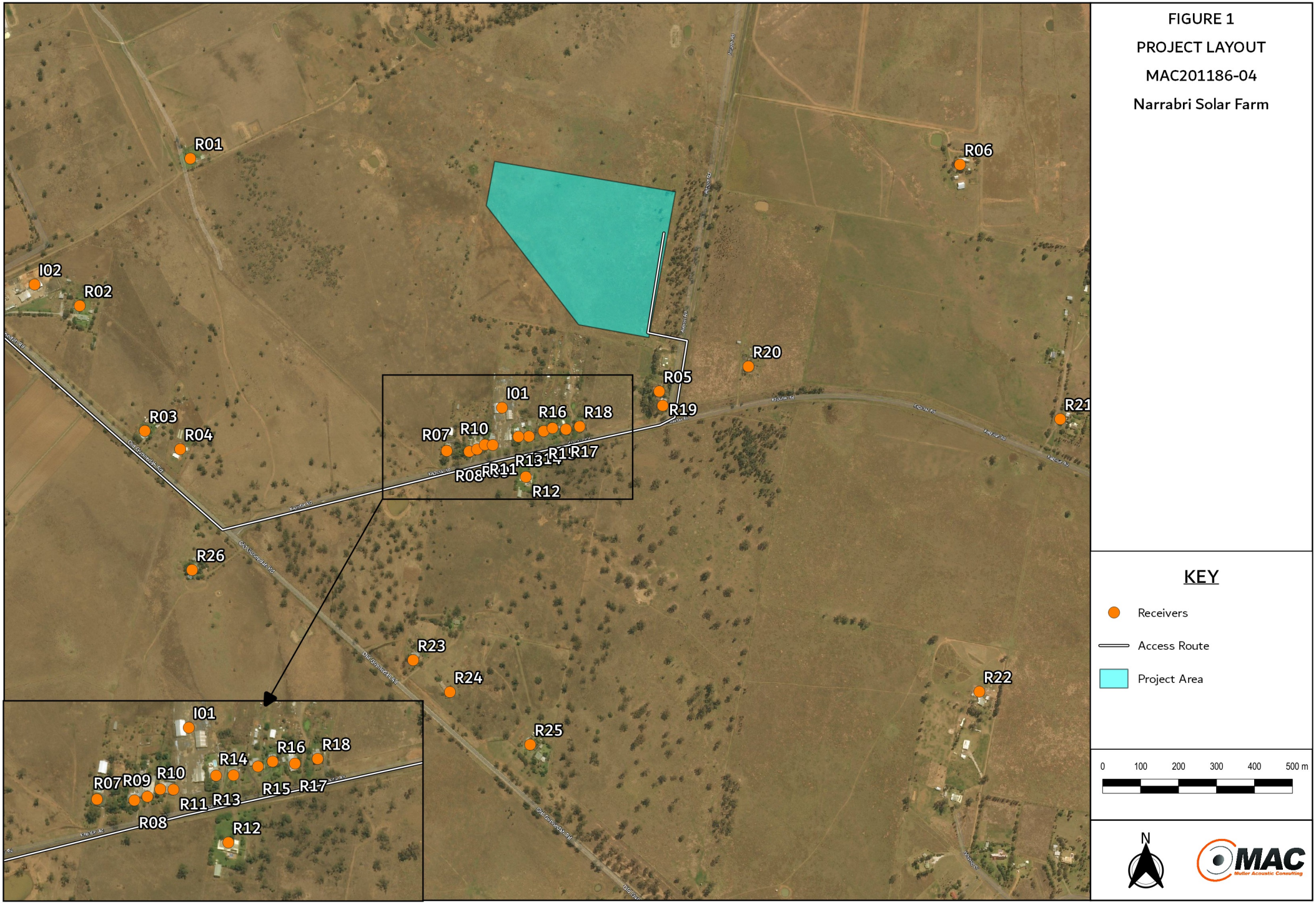
- panel cleaning;
- repairs or replacement of infrastructure, as required; and
- land management including mowing to control vegetation as required.

Typical noise sources associated with maintenance activities would include light vehicle movements on site and maintenance of equipment.

2.4 Receiver Review

Using aerial photography, geospatial information and other project design information, MAC has identified the following potentially sensitive receivers that may be affected by noise from operation or construction activities and project related road traffic. **Table 1** presents a summary of receiver identification, type, address and coordinates. These are reproduced visually in **Figure 1**.

Table 1 Receiver Locations				
Receiver	Description	Receiver Type	Coordinates (GDA94/MGA55)	
			Easting	Northing
R01	163 Old Gunnedah Road	Residential	770033	6640330
R02	175 Old Gunnedah Road	Residential	769742	6639942
R03	225 Old Gunnedah Road	Residential	769913	6639612
R04	237 Old Gunnedah Road	Residential	770006	6639564
R05	7 Airport Road	Residential	771269	6639717
R06	90 Airport Road	Residential	772061	6640314
R07	59 Kaputar Road	Residential	770709	6639560
R08	65 Kaputar Road	Residential	770768	6639558
R09	67 Kaputar Road	Residential	770789	6639564
R10	69 Kaputar Road	Residential	770809	6639576
R11	71 Kaputar Road	Residential	770830	6639575
R12	80 Kaputar Road	Residential	770917	6639491
R13	79 Kaputar Road	Residential	770898	6639597
R14	83 Kaputar Road	Residential	770925	6639598
R15	85 Kaputar Road	Residential	770964	6639612
R16	87 Kaputar Road	Residential	770988	6639620
R17	91 Kaputar Road	Residential	771023	6639617
R18	97 Kaputar Road	Residential	771059	6639624
R19	117 Kaputar Road	Residential	771278	6639679
R20	139 Kaputar Road	Residential	771504	6639782
R21	225 Kaputar Road	Residential	772326	6639643
R22	106 Whiting Drive	Residential	772112	6638925
R23	305 Old Gunnedah Road	Residential	770620	6639008
R24	369 Old Gunnedah Road	Residential	770717	6638924
R25	363 Old Gunnedah Road	Residential	770929	6638785
R26	264 Old Gunnedah Road	Residential	770038	6639246
I01	73 Kaputar Road Palmer Steel Frame & Truss	Commercial	770855	6639674
I02	173 Old Gunnedah Rd Johnstone Concrete & Landscaping	Commercial	769623	6639998



3 Noise Policy and Guidelines

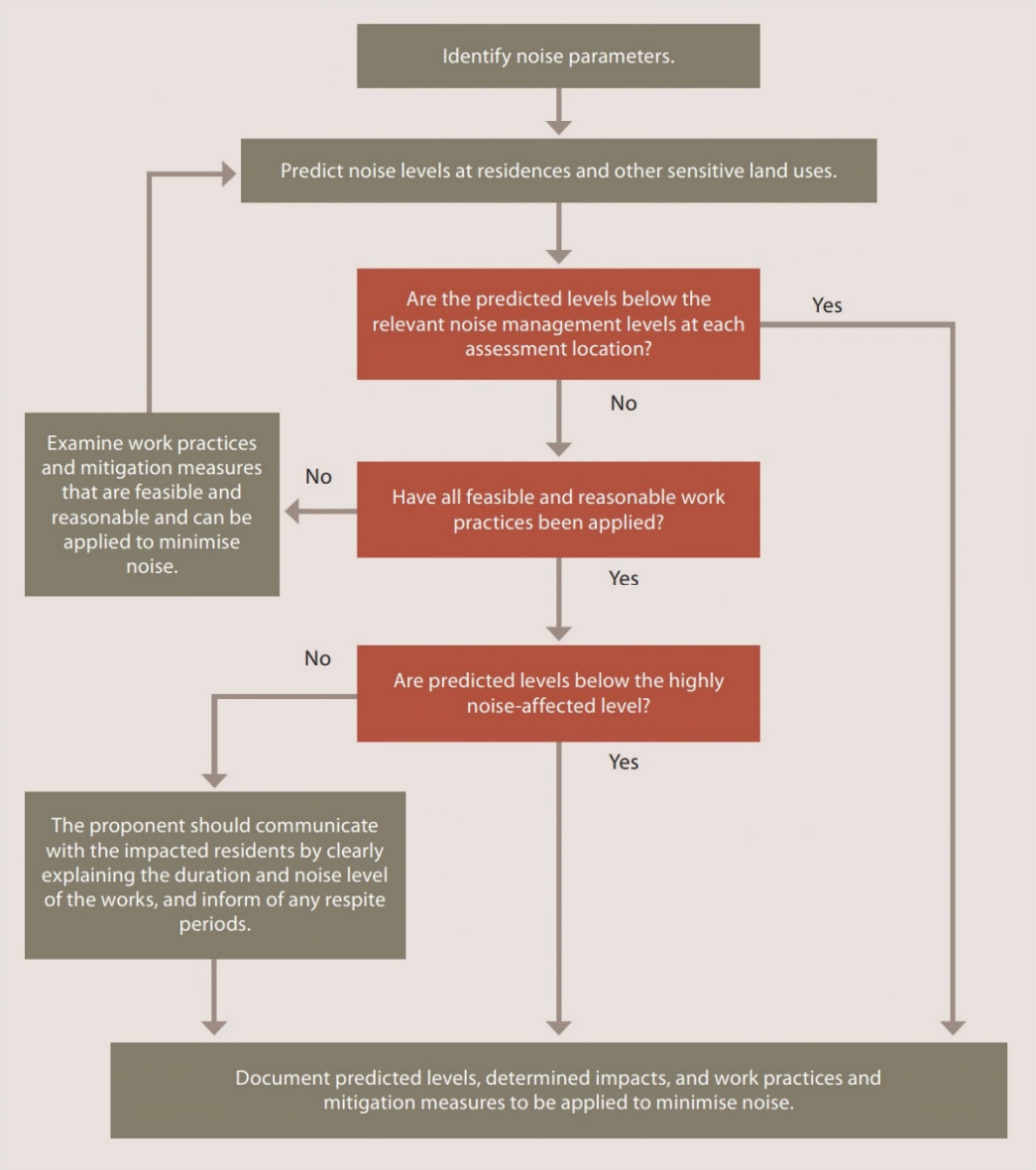
3.1 Interim Construction Noise Guideline

The ICNG sets out procedures to identify and address the impacts of construction noise on residences and other sensitive land uses. This section provides a summary of noise objectives that are applicable to the assessment. The ICNG provides two methodologies for the assessment of construction noise emissions:

- Quantitative, which is suited to major construction projects with typical durations of more than three weeks; and
- Qualitative, which is suited to short term infrastructure maintenance (< three weeks).

The qualitative assessment methodology is a more simplified approach that relies on noise management strategies. This study has adopted a quantitative assessment approach which is summarised in **Figure 2.** The quantitative approach includes identification of potentially affected receivers, derivation of the construction noise management levels, quantification of potential noise impact at receivers via predictive modelling and, provides management and mitigation recommendations.

Figure 2 Quantitative Assessment Processes for Assessing and Managing Construction Noise



Source: Department of Environment and Climate Change, 2009.

3.1.1 Standard Hours for Construction

Table 2 summaries the ICNG recommended standard hours for construction works.

Table 2 Recommended Standard Hours for Construction

Daytime	Construction Hours
Monday to Friday	7am to 6pm
Saturdays	8am to 1pm
Sundays or Public Holidays	No construction

These recommended hours do not apply in the event of direction from police, or other relevant authorities, for safety reasons or where required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.

Construction activities are anticipated to be undertaken during standard construction hours.

3.1.2 Out of Hours Construction

Works conducted outside of recommended standard hours are considered out of hours work (OOH). The ICNG suggests that any request to vary the hours of construction activities as identified above shall be:

- considered on a case by case basis or activity-specific basis;
- accompanied by details of the nature and need for activities to be undertaken during the varied construction hours; and
- accompanied by written evidence that activities undertaken during the varied construction hours are strongly justified; appropriate consultation with potentially affected receivers and notification of the relevant regulatory authorities has occurred; and all practicable and reasonable mitigation measures will be put in place.

3.1.3 Construction Noise Management Levels

Section 4 of the ICNG (DECC, 2009) details the quantitative assessment method involving predicting noise levels and comparing them with the Noise Management Level (NML) and are important indicators of the potential level of construction noise impact. **Table 3** reproduces the ICNG Noise Management Level (NML) for residential receivers. The NML is determined by adding 10dB (standard hours) or 5dB (OOH) to the Rating Background Level (RBL) for each specific assessment period.

Table 3 Noise Management Levels

Time of Day	Management Level LAeq(15min)[1]	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays.	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq(15min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of work to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account times identified by the community when they are less sensitive to noise such as before and after school for work near schools, or mid-morning or mid-afternoon for work near residences; and if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours.	Noise affected RBL + 5dB	A strong justification would typically be required for work outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

Note 1: The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the construction noise management levels for noise assessment purposes and is the median of the ABL's.

3.1.4 Construction Sleep Disturbance

Section 4.3 of the ICNG (DECC, 2009) states that a sleep disturbance assessment is required where construction activities are planned to occur for more than two consecutive nights. Given that construction activities are anticipated to occur during standard construction hours, sleep disturbance has not been considered in this assessment.

3.2 Noise Policy for Industry

The EPA released the Noise Policy for Industry (NPI) in October 2017 which provides a process for establishing noise criteria for consents and licenses enabling the EPA to regulate noise emissions from scheduled premises under the Protection of the Environment Operations Act 1997.

The objectives of the NPI are to:

- provide noise criteria that is used to assess the change in both short term and long-term noise levels;
- provide a clear and consistent framework for assessing environmental noise impacts from industrial premises and industrial development proposals;
- promote the use of best-practice noise mitigation measures that are feasible and reasonable where potential impacts have been identified; and
- support a process to guide the determination of achievable noise limits for planning approvals and/or licences, considering the matters that must be considered under the relevant legislation (such as the economic and social benefits and impacts of industrial development).

The policy sets out a process for industrial noise management involving the following key steps:

1. Determine the Project Noise Trigger Levels (PNTLs) (ie criteria) for a development. These are the levels (criteria), above which noise management measures are required to be considered. They are derived by considering two factors: shorter-term intrusiveness due to changes in the noise environment; and maintaining the noise amenity of an area.
2. Predict or measure the noise levels produced by the development with regard to the presence of annoying noise characteristics and meteorological effects such as temperature inversions and wind.
3. Compare the predicted or measured noise level with the PNTL, assessing impacts and the need for noise mitigation and management measures.

4. Consider residual noise impacts - that is, where noise levels exceed the PNTLs after the application of feasible and reasonable noise mitigation measures. This may involve balancing economic, social and environmental costs and benefits from the proposed development against the noise impacts, including consultation with the affected community where impacts are expected to be significant.

5. Set statutory compliance levels that reflect the best achievable and agreed noise limits for the development.

6. Monitor and report environmental noise levels from the development.

3.2.1 Project Noise Trigger Levels (PNTL)

The policy sets out the procedure to determine the PNTLs relevant to an industrial development. The PNTL is the lower (ie, the more stringent) of the **Project Intrusiveness Noise Level** (PINL) and **Project Amenity Noise Level** (PANL) determined in accordance with Section 2.3 and Section 2.4 of the NPI.

3.2.2 Rating Background Level (RBL)

The Rating Background Level (RBL) is a determined parameter from noise monitoring and is used for assessment purposes. As per the NPI, the RBL is an overall single figure background level representing each assessment period (day, evening and night) over the noise monitoring period.

3.2.3 Project Intrusiveness Noise Level (PINL)

The PINL ($LA_{eq(15min)}$) is the RBL + 5dB and seeks to limit the degree of change a new noise source introduces to an existing environment. Hence, when assessing intrusiveness, background noise levels need to be measured.

3.2.4 Project Amenity Noise Level (PANL)

The PANL is relevant to a specific land use or locality. To limit continuing increases in intrusiveness levels, the ambient noise level within an area from all combined industrial sources should remain below the recommended amenity noise levels specified in Table 2.2 (of the NPI). The NPI defines two categories of amenity noise levels:

- **Amenity Noise Levels (ANL)** – are determined considering all current and future industrial noise within a receiver area; and
- **Project Amenity Noise Level (PANL)** – is the recommended level for a receiver area, specifically focusing the project being assessed.

Additionally, Section 2.4 of the NPI states: “to ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise as follows”:

PANL for new industrial developments = recommended **ANL** minus 5dBA.

The following exceptions apply when deriving the PANL:

- areas with high traffic noise levels;
- proposed developments in major industrial clusters;
- existing industrial noise and cumulative industrial noise effects; and
- greenfield sites.

Where relevant this assessment has considered influences of traffic with respect to amenity noise levels (ie areas where existing traffic noise levels are 10dB greater than the recommended amenity noise level).

The recommended amenity noise levels as per Table 2.2 of the NPI are reproduced in **Table 4**.

Table 4 Amenity Criteria			
Receiver Type	Noise Amenity Area	Time of day	Recommended amenity noise level dB LAeq(period)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks.	See column 4	See column 4	5dB above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School Classroom	All	Noisiest 1-hour period when in use	35 (internal) 45 (external)
Hospital ward			
- internal	All	Noisiest 1-hour	35
- external	All	Noisiest 1-hour	50
Place of worship - internal	All	When in use	40
Passive Recreation	All	When in use	50
Active Recreation	All	When in use	55
Commercial premises	All	When in use	65
Industrial	All	When in use	70

Notes: The recommended amenity noise levels refer only to noise from industrial noise sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Types of receivers are defined as rural residential; suburban residential; urban residential; industrial interface; commercial; industrial – see Table 2.3 and Section 2.7 of the NPI.

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

3.2.5 Maximum Noise Assessment Trigger Levels

The potential for sleep disturbance from maximum noise level events from a project during the night-time period needs to be considered. The NPI considers sleep disturbance to be both awakenings and disturbance to sleep stages.

Where night-time noise levels from a development/premises at a residential location exceed the following criteria, a detailed maximum noise level event assessment should be undertaken:

- $L_{Aeq(15min)}$ 40dB or the prevailing RBL plus 5dBA, whichever is the greater, and/or
- L_{Amax} 52dB or the prevailing RBL plus 15dBA, whichever is the greater.

A detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Other factors that may be important in assessing the impacts on sleep disturbance include:

- how often the events would occur;
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the development;
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods); and
- current understanding of effects of maximum noise level events at night.

3.3 Road Noise Policy

The road traffic noise criteria are provided in the Department of Environment, Climate Change and Water NSW (DECCW), Road Noise Policy (RNP), 2011. The policy sets out noise criteria applicable to different road classifications for the purpose of quantifying traffic noise impacts. Road noise criteria relevant to this assessment are presented in detail in Section 4.5.

This page has been intentionally left blank

4 Noise Assessment Criteria

Background noise monitoring has not been conducted for this project and hence, the minimum applicable Rating Background Levels (RBL) of 35dBA for the daytime period and 30dBA for the evening and night time periods have been adopted in accordance with NPI methodology.

4.1 Construction Noise Criteria

The relevant Noise Management Levels (NMLs) for standard construction hours are presented in Table 5.

Table 5 Construction Noise Management Levels

Receiver Type	Assessment Period	Adopted RBL dB LA_{90}	NML dB $LA_{eq(15min)}$
Urban Residential	Standard Hours	35	45 (RBL+10dBA)
Suburban Residential	Standard Hours	35	45 (RBL+10dBA)
Rural Residential	Standard Hours	35	45 (RBL+10dBA)
Educational	When in use	N/A	45 (internal) 60 (external)[1]
Hospital Wards	When in use	N/A	45 (internal) 60 (external)[1]
Place of Worship	When in use	N/A	45 (internal) 60 (external)[1]
Active Recreation Areas	When in use	N/A	65 (external)
Passive Recreation Areas	When in use	N/A	60 (external)
Industrial Premises	When in use	N/A	75 (external)
Community Centres	When in use	N/A	Refer to AS2107 for maximum internal levels and specific use
Commercial Premises	When in use	N/A	70 (external)

Note 1: External level based on 15dB loss through partially open window.

4.2 Construction Vibration

Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: A Technical Guideline* (the 'Guideline') provides guidance on determining effects of vibration on buildings occupants. The guideline does not address vibration induced damage to structures, blast induced vibration effects or structure borne noise effects.

The Construction Noise & Vibration Strategy (CNVS, V4.1 Transport for NSW, 2019) sets out safe working distances to achieve the human response criteria for vibration. The key vibration generating source proposed to be used is small pile driver used to drive the piles into the ground on which the PV mounting structures are mounted and vibratory roller for road construction. The CNVS sets a safe working distance of 50m for a hammer piling rig and 100m for a large vibratory roller to achieve the residential human response criteria for continuous vibration. Therefore, as the nearest non project related receivers to the project are greater than 100m from the project boundary, human exposure to vibration is anticipated to be minimal. Furthermore, where the human response criteria are satisfied, the structural or cosmetic criteria for sensitive receivers will be achieved. Therefore, vibration impacts are not considered to be a significant issue and have not been considered further in this assessment.

4.3 Operational Noise Criteria

4.3.1 Project Intrusiveness Noise Levels

The PINLs for the project are presented in **Table 6** and have been determined based on the RBLs +5dBA.

Table 6 Project Intrusiveness Noise Levels

Receiver	Period[1]	Adopted RBL dB LA90(period)	PINL dB LAeq(15min)
All Residential Receivers	Day	35	40
	Evening	30	35
	Night	30	35

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.3.2 Project Amenity Noise Levels

The PANL for residential receivers and other receiver types (ie non-residential) potentially affected by the project are presented in **Table 7.**

Table 7 Amenity Noise Levels and Project Amenity Noise Levels

Receiver Type	Noise Amenity Area	Assessment Period[1]	Recommended ANL dB $LA_{eq(period)}$	ANL dB $LA_{eq(period)}$[2]	PANL dB $LA_{eq(15min)}$[3]
Residential	Rural	Day	50	45	48
		Evening	45	40	43
		Night	40	35	38
Residential	Suburban	Day	55	50	53
		Evening	45	40	43
		Night	40	35	38
Residential	Urban	Day	60	55	58
		Evening	50	45	48
		Night	45	40	43
Hotels Motels	Rural/Urban/ Suburban	Day	ANL +5dB	ANL +5dB	ANL +5dB
		Evening	ANL +5dB	ANL +5dB	ANL +5dB
		Night	ANL +5dB	ANL +5dB	ANL +5dB
Educational		When in use	35 (internal 1 hr)	30 (internal 1 hr)	33 (internal 1 hr) 48 (external 1 hr)[4]
Hospital Wards		When in use	35 (internal 1 hr) 50 (external 1 hr)	30 (internal 1 hr) 45 (external 1 hr)	33 (internal 1 hr) 48 (external 1 hr)
Place of worship		When in use	40 (internal)	35 (internal 1 hr)	38 (internal 1 hr) 53 (external 1 hr)[4]
Passive Recreation		When in use	50	45	48
Active Recreation		When in use	55	50	53
Commercial		When in use	65	60	63
Industrial		When in use	70	65	68
Industrial Interface		When in use	ANL +5dB	ANL +5dB	ANL +5dB

Note 1: Monday – Saturday, Day 7am to 6pm; Evening 6pm to 10pm; Night 10pm to 7am. On Sundays and Public Holidays, Day 8am to 6pm; Evening 6pm to 10pm; Night 10pm to 8am.
Note 2: Project Amenity Noise Level equals the Amenity Noise Level as there is no other industry in the area.
Note 3: Includes a +3dB adjustment to the amenity period level to convert to a 15-minute assessment period as per Section 2.2 of the NPI.
Note 4: External level based on 15dB loss through partially open window.

4.3.3 Project Noise Trigger Levels

The PNTLs are the lower of either the PINLs or the PANLs. **Table 8** presents the derivation of the PNTLs in accordance with the methodologies outlined in the NPI. For this assessment the night time PNTL of 35dB $L_{Aeq(15min)}$ is the limiting criteria for residential receivers.

Table 8 Project Noise Trigger Levels

Catchment	Assessment Period[1]	PINL dB $L_{Aeq(15min)}$	PANL dB $L_{Aeq(15min)}$	PNTL dB $L_{Aeq(15min)}$
Residential Receivers (Rural)	Day	40	53	40
	Evening	35	48	35
	Night	35	43	35
Industrial	When in use	--	68	68

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.4 Maximum Noise Assessment Trigger Levels

The maximum noise trigger levels shown in **Table 9** are based on night time RBLs and trigger levels as per Section 2.5 of the NPI. The trigger levels will be applied to transient noise events that have the potential to cause sleep disturbance.

Table 9 Maximum Noise Trigger Level

Rural Residential Receivers	
52dB L_{Amax} or RBL + 15dB	
Trigger	52
RBL 30+15dB	45
Highest	**52**

Note: Monday to Saturday; Night 10pm to 7am. On Sundays and Public Holidays Night 10pm to 8am.
Note: NPI identifies that maximum of the two values is to be adopted which is shown in bold font.

4.5 Road Traffic Noise Criteria

It is acknowledged that the functional classification of roads connecting to arterial roads such as major highways are 'Collector Roads' in accordance with the Roads and Maritime Noise Criteria Guideline (April 2015). However, the Road Noise Policy does not provide separate noise criteria for Collector Roads but applies the sub-arterial category to all roads that are not classified as local roads and hence, the 'sub arterial road' category has been adopted for collector roads. The relevant road traffic noise criteria are provided in the RNP and are presented in **Table 10** for residential receivers.

Table 10 Road Traffic Noise Assessment Criteria			
Road category	Type of project/development	Assessment Criteria – dBA	
		Day (7am to 10pm)	Night (10pm to 7am)
Freeways/arterial/ sub-arterial Roads	Existing residences affected by additional traffic on freeways/arterial/sub-arterial roads generated by land use developments	60dB LAeq(15hr)	55dB LAeq(9hr)
Local roads	Existing residences affected by additional traffic on local roads generated by land use developments	55dB LAeq(1hr)	50dB LAeq(1hr)
School Classrooms	Proposed road projects and traffic generating developments	40dB LAeq(1hr) (internal) when in use	N/A
Hospital Wards		35dB LAeq(1hr) (internal)	35dB LAeq(1hr) (internal)
Places of Worship		40dB LAeq(1hr) (internal)	40dB LAeq(1hr) (internal)
Open Space (active use)		60dB LAeq(1hr)	N/A
Open Space (passive use)		55dB LAeq(1hr)	N/A
Isolated residences in commercial or industrial zones		Refer to AS2107 for internal levels	
Mixed Use development		Each component to be considered separately	
Childcare Facilities		Sleeping rooms 35dB LAeq(1hr) (internal) Indoor play areas 40dB LAeq(1hr) (internal) Outdoor play areas 55dB LAeq(1hr) (external)	

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2dBA, which is generally accepted as the threshold of perceptibility to a change in noise level.

This page has been intentionally left blank

5 Modelling Methodology

A computer model using DGMR (iNoise, Version 2020.0) noise modelling software was used to quantify noise emissions from the project. iNoise is a new intuitive and quality assured software for industrial noise calculations in the environment. 3D noise modelling is considered industry best practice for assessing noise emissions from projects.

The model incorporated a three-dimensional digital terrain map giving all relevant topographic information used in the modelling process. Additionally, the model uses relevant noise source data, ground type, attenuation from barrier or buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers. Where relevant, modifying factors in accordance with Fact Sheet C of the NPI have been applied to calculations.

The model calculation method used to predict noise levels was in accordance with ISO 9613-1 'Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere' and ISO 9613-2 'Acoustics - Attenuation of sound during propagation outdoors. Part 2: General method of calculation' including corrections for meteorological conditions using CONCAWE[1]. The ISO 9613 standard from 1996 is the most used noise prediction method worldwide. Many countries refer to ISO 9613 in their noise legislation. However, the ISO 9613 standard does not contain guidelines for quality assured software implementation, which leads to differences between applications in calculated results. In 2015 this changed with the release of ISO/TR 17534-3. This quality standard gives clear recommendations for interpreting the ISO 9613 method. iNoise fully supports these recommendations. The models and results for the 19 test cases are included in the software.

5.1 Construction Assessment Methodology

Construction activities are proposed to be progressive (trenching, piling and assembly) and will occur at several locations simultaneously. Noise emissions were modelled for the following four scenarios:

- earthworks for internal roads and compound construction including the stripping of topsoil and unsuitable soil and the placement and compaction of road base for internal roads;
- earthworks involving trenching for cabling;
- piling of panel supports; and
- assembly of the panels.

[1] Report no. 4/18, "the propagation of noise from petroleum and petrochemical complexes to neighbouring communities", Prepared by C.J. Manning, M.Sc., M.I.O.A. Acoustic Technology Limited (Ref.AT 931), CONCAWE, Den Haag May 1981

It is envisaged that all four construction scenarios have the potential to occur simultaneously at up to two key locations across the site. Noise emission data and assumptions used in this assessment are summarised in **Table 11**. All significant noise generating construction activities will be limited to standard construction hours. Where low intensity construction activities are required to be undertaken outside standard construction hours, such as cabling, minor assembly, use of hand tools etc, they will be managed such that they are not audible at any residential receivers.

Table 11 Construction Equipment Sound Power Levels, Lw dBA (re 10^{-12} Watts)

Noise Source/Item	Utilisation %	Quantity	Lw/Item	Total Lw
Trenching & Earthworks				
Backhoe	80	1	104	103
Light vehicle	25	2	76	73
Total – Trenching & Earthworks				**105**
Piling				
Piling Rig (hydraulic)	80	1	113	112
Tele-handler	75	1	106	105
Light vehicle	25	2	76	73
Total – Piling				**113**
Assembly				
Mobile Crane/HIAB	75	1	104	103
Tele-handler	75	1	106	105
Light vehicle	25	2	76	73
Hand tools/Power tools	50	1	102	99
Welder	50	1	105	102
Total – Assembly				**109**
Transport (on site)				
Heavy vehicle	40	1	104	101
Tele-handler	50	1	106	103
Total – Transport				**105**

5.2 Operational Assessment Methodology

For this assessment, noise predictions were modelled for a typical worst-case operational scenario over a 15-minute assessment period based on the assumptions and sound power levels in **Table 12.** Plant noise emission data used in modelling for this assessment were obtained from manufacturers data or the MAC database. Where relevant, modifying factors in accordance with Section 3.3 and Fact Sheet D of the NPI have been applied to calculations.

Table 12 Operational Equipment Sound Power Levels, Lw dBA (re 10^{-12} Watts)

Noise Source/Item	Activity	Quantity	Lw/Item	Total Lw
PV Panel Tracking Motor[1, 2]	All tracking motors in operation 1 minute per 15-minute period	142	78	83
2.5MW Inverter[2]	Constant	2	81	84
5MVA Transformer[2]	Constant	1	77	77

Note 1: Tracking motor is situated underneath the PV panel, -5dB attenuation applied to account for shielding provided by the panel.

Note 2: Modifying factor penalty of +5dB added for low frequency and +5dB added for tonality.

5.2.1 Meteorological Analysis

Noise emissions can be influenced by prevailing weather conditions. Light stable winds (<3m/s) and temperature inversions have the potential to increase noise at a receiver.

Fact Sheet D of the NPI provides two options when considering meteorological effects:

- adopt the noise enhancing conditions for all assessment periods without an assessment of how often the conditions occur – a conservative approach that considers a source to receiver winds for all receivers and F class temperature inversions with wind speeds up to 2m/s at night; or
- determine the significance of noise enhancing conditions. This requires assessing the significance of temperature inversions (F and G Class stability categories) for the night time period and the significance of light winds up to 3m/s for all assessment periods during stability categories other than E, F or G.

Standard meteorological conditions and noise-enhancing meteorological conditions as defined in Table D1of the NPI are reproduced in **Table 13**.

Table 13 Standard and Noise-Enhancing Meteorological Conditions	
Meteorological Conditions	Meteorological Parameters
Standard Meteorological Conditions	Day/evening/night: stability categories A–D with wind speed up to 0.5m/s at 10m AGL.
Noise Enhancing Meteorological Conditions	Daytime/evening: stability categories A–D with light winds (up to 3 m/s at 10m AGL). Night-time: stability categories A–D with light winds (up to 3m/s at 10m AGL) and/or stability category F with winds up to 2m/s at 10 m AGL.

A detailed analysis of the significance of noise enhancing conditions has not been undertaken and hence, the (worst case) NPI noise enhancing meteorological conditions have been applied to the noise modelling assessment are presented in **Table 14**.

Table 14 Modelled Meteorological Parameters				
Assessment Condition[1]	Temperature	Wind Speed[2]/ Direction	Relative Humidity	Stability Class[2]
Day	20°C	3m/s all directions	50%	D
Evening	10°C	3m/s all directions	50%	D
Night	10°C	2m/s all directions	50%	F

Note 1: Day 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening 6pm to 10pm; Night - the remaining periods.

Note 2: Implemented using CONCAWE meteorological corrections.

5.3 Road Traffic Noise Assessment Methodology

Due to the low traffic volume generated by the project over a typical day during the construction phase, road traffic noise calculation methods such as Calculation of Road Traffic Noise (CRTN - ISBN 0 11 550847 3) by Department of Transport (UK) 1988 or Traffic Noise Model (TNM) by the United States Department of Transport, Federal Highway Administration are not considered appropriate as they are primarily intended to calculate noise emissions from motorways and highways. Whilst each method has a low volume correction, the project traffic volume is out of the scope of these methods. Therefore, road traffic noise has been modelled using iNoise modelling software using ISO 9613-1 and ISO 9613-2 calculation methods, representing the road traffic as “moving sources” along the transport route using the parameters presented in **Table 15.**

Table 15 Road Traffic Noise Modelling Parameters				
Noise Source/Item	Lw dBA re 10^{-12} W	Movements/hr	Speed, km/h	Source Height, m[1]
Heavy vehicle (rigid, semi trailer or b-double)	104	8	50	1.5
Light Vehicle	96	20	50	0.75

Note 1: Height above ground level.

6 Noise Assessment Results

6.1 Construction Noise Assessment

Noise levels were predicted all identified receivers at 1.5m above ground level for typical construction activities for standard construction hours. **Table 16** summarises the predicted noise level range and maximum predicted noise level for each of the construction scenarios (trenching, piling and assembly) at identified receivers.

Table 16 Predicted Construction Noise Levels

Receiver	Description/Address	Predicted Noise Level Range dB $LA_{eq(15min)}$[1]	Highest Predicted Noise Level dB $LA_{eq(15min)}$	NML Standard Hours dB $LA_{eq(15min)}$	Compliance Achieved
R01	163 Old Gunnedah Road	<30-42	42	45	✓
R02	175 Old Gunnedah Road	30-38	38	45	✓
R03	225 Old Gunnedah Road	31-42	42	45	✓
R04	237 Old Gunnedah Road	32-40	40	45	✓
R05	7 Airport Road	44-54	**54**	45	✗
R06	90 Airport Road	<30-43	43	45	✓
R07	59 Kaputar Road	39-47	**47**	45	✗
R08	65 Kaputar Road	39-48	**48**	45	✗
R09	67 Kaputar Road	40-48	**48**	45	✗
R10	69 Kaputar Road	40-49	**49**	45	✗
R11	71 Kaputar Road	40-49	**49**	45	✗
R12	80 Kaputar Road	39-48	**48**	45	✗
R13	79 Kaputar Road	41-50	**50**	45	✗
R14	83 Kaputar Road	41-50	**50**	45	✗
R15	85 Kaputar Road	42-51	**51**	45	✗
R16	87 Kaputar Road	42-51	**51**	45	✗
R17	91 Kaputar Road	42-51	**51**	45	✗
R18	97 Kaputar Road	43-51	**51**	45	✗
R19	117 Kaputar Road	44-53	**53**	45	✗
R20	139 Kaputar Road	37-51	**51**	45	✗
R21	225 Kaputar Road	<30-39	39	45	✓
R22	106 Whiting Drive	<30-36	36	45	✓
R23	305 Old Gunnedah Road	30-40	40	45	✓
R24	369 Old Gunnedah Road	<30-39	39	45	✓
R25	363 Old Gunnedah Road	<30-38	38	45	✓
R26	264 Old Gunnedah Road	30-38	38	45	✓

Table 16 Predicted Construction Noise Levels					
Receiver	Description/Address	Predicted Noise Level Range dB $LA_{eq(15min)}$[1]	Highest Predicted Noise Level dB $LA_{eq(15min)}$	NML Standard Hours dB $LA_{eq(15min)}$	Compliance Achieved
I01	73 Kaputar Road Palmer Steel Frame & Truss	39-51	51	75	✓
I02	173 Old Gunnedah Rd Johnstone Concrete & Landscaping	<30-37	37	75	✓

Note 1: Noise levels from construction activities vary due to their position across the project site with respect to surrounding receivers.

Noise levels are expected to exceed the NMLs by up to 10dB at 15 receivers when works are at their nearest proximity during standard construction hours. Exceedances at this receiver are expected from all construction activities (piling, trenching & assembly), however, would be of a temporary nature and of short duration.

6.2 Operational Noise Assessment

Noise levels were predicted all identified receivers at 1.5m above ground level for all operational sources and are presented in **Table 17**. Noise levels are expected to satisfy the PNTLs at all receivers.

Table 17 Predicted Operational Noise Levels				
Receiver	Description/Address	Predicted Noise Level dB $LA_{eq(15min)}$	PNTL dB $LA_{eq(15min)}$ Day/Eve/Night[1]	Compliance Achieved
R01	163 Old Gunnedah Road	<30	40/35/35	✓
R02	175 Old Gunnedah Road	<30	40/35/35	✓
R03	225 Old Gunnedah Road	<30	40/35/35	✓
R04	237 Old Gunnedah Road	<30	40/35/35	✓
R05	7 Airport Road	<30	40/35/35	✓
R06	90 Airport Road	<30	40/35/35	✓
R07	59 Kaputar Road	<30	40/35/35	✓
R08	65 Kaputar Road	<30	40/35/35	✓
R09	67 Kaputar Road	<30	40/35/35	✓
R10	69 Kaputar Road	<30	40/35/35	✓
R11	71 Kaputar Road	<30	40/35/35	✓
R12	80 Kaputar Road	<30	40/35/35	✓
R13	79 Kaputar Road	<30	40/35/35	✓
R14	83 Kaputar Road	<30	40/35/35	✓
R15	85 Kaputar Road	<30	40/35/35	✓
R16	87 Kaputar Road	<30	40/35/35	✓

Table 17 Predicted Operational Noise Levels				
Receiver	Description/Address	Predicted Noise Level dB LAeq(15min)	PNTL dB LAeq(15min) Day/Eve/Night[1]	Compliance Achieved
R17	91 Kaputar Road	<30	40/35/35	✓
R18	97 Kaputar Road	<30	40/35/35	✓
R19	117 Kaputar Road	<30	40/35/35	✓
R20	139 Kaputar Road	<30	40/35/35	✓
R21	225 Kaputar Road	<30	40/35/35	✓
R22	106 Whiting Drive	<30	40/35/35	✓
R23	305 Old Gunnedah Road	<30	40/35/35	✓
R24	369 Old Gunnedah Road	<30	40/35/35	✓
R25	363 Old Gunnedah Road	<30	40/35/35	✓
R26	264 Old Gunnedah Road	<30	40/35/35	✓
I01	73 Kaputar Road Palmer Steel Frame & Truss	<30	40/35/35	✓
I02	173 Old Gunnedah Road Johnstone Concrete & Landscaping	<30	40/35/35	✓

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

6.3 Maximum Noise Level Assessment

A detailed maximum noise level assessment is not required as predicted noise levels for night time operations do not exceed the maximum noise level screening criterion of 40dB LAeq(15min) and there are no operational noise sources that generate significant maximum noise events.

6.4 Road Traffic Noise Assessment

During construction, traffic generated by the project include employee/subcontractor and delivery vehicles. The traffic volume over a typical day for standard construction hours is expected to be up to four heavy vehicles (semi-trailers or B-doubles) per hour and 20 light commercial vehicles or equivalent mini buses for worker transport during the morning and afternoon peak hour periods.

The transport route for all vehicles to the access the project site from the Newell Highway is yet to be determined. Therefore, it has been assumed that the closest residential receivers along the transport route are 15m from the road to represent a potential worst case assessment scenario.

Predicted noise levels from project related construction traffic has been calculated using the methodology described in Section 5.3 and the parameters presented in Table 15. The results presented in Table 18 show the calculated noise levels as $LA_{eq(1hr)}$ for local roads and $LA_{eq(15hr)}$ for arterial/sub arterial roads to align with RNP categories and assessment periods.

Table 18 Predicted Construction Road Traffic Noise Levels

Road Type/Name	Offset Distance to Receiver	Predicted Noise Level	RTN Criteria	Compliance Achieved
Arterial, Sub Arterial and Collector Roads	15m	45dB LAeq(15hr)	60dB LAeq(15hr)	✓
Local Roads	15m	48dB LAeq(1hr)	55dB LAeq(1hr)	✓

Results demonstrate that project construction traffic noise levels would comply with the relevant RNP criteria.

Existing road traffic flows on the Newell Highway are not available. The project proposes to add an additional 20 light vehicles per day and 100 heavy vehicles over a six month construction period, which would be considered a negligible increase to existing traffic flows resulting in a negligible increase in road traffic noise.

Therefore, it is concluded that project related road traffic noise levels would satisfy the relevant RNP criteria at any residential receiver along the proposed transport routes and not increase existing noise levels by more than 2dB.

7 Recommendations

7.1 Construction Noise Recommendations

It is noted that construction noise emissions are anticipated to exceed the relevant NMLs depending on the type of construction and proximity of activities to receivers. The following noise mitigation measures should be considered during the construction phase to reduce emissions to the surrounding community:

- a construction noise management protocol to minimise noise emissions, manage out of hours (minor) works to be inaudible, and to respond to potential concerns from the community;
- where possible use localised mobile screens or construction hoarding around piling rig/plant to act as barriers between construction works and receivers, particularly where equipment is near the site boundary and/or a residential receiver including areas in constant or regular use (eg unloading and laydown areas);
- operating plant in a conservative manner (no over-revving), shutdown when not in use, and be parked/started at farthest point from relevant assessment locations;
- selection of the quietest suitable machinery available for each activity;
- minimise noisy plant/machinery working simultaneously where practicable;
- minimise impact noise wherever possible;
- utilise a broadband reverse alarm in lieu of the traditional high frequency type reverse alarm;
- provide toolbox meetings, training and education to drivers and contractors visiting the site during construction so they are aware of the location of noise sensitive receivers and to be cognisant of any noise generating activities;
- signage is to be placed at the front entrance advising truck drivers of their requirement to minimise noise both on and off-site; and
- utilise project related community consultation forums to notify residences within proximity of the site with project progress, proposed/upcoming potentially noise generating works, its duration and nature and complaint procedure.

The reduction achieved from the mitigation measures will depend on the specific measures implemented. Monitoring with and without the measures in place will provide an indication of the reduction achieved.

7.2 Operational Noise Recommendations

Operational noise predictions identify that relevant noise criteria would be satisfied at all receivers. Notwithstanding, it is recommended that the proponent actively minimise potential noise emissions from the project. To assist in noise management for the project it is recommended that a one-off noise validation monitoring assessment be completed to quantify operational noise emissions from site and to confirm emissions meet relevant criteria. The monitoring assessment would consist of operator attended noise measurements during normal operation to determine the noise contribution from the project.

8 Discussion and Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Assessment for a proposed Solar Farm near Narrabri , NSW.

The results of the Noise Assessment demonstrate that construction noise levels have potential to exceed relevant construction NMLs at several receiver locations. Recommendations have been provided to minimise the potential noise impacts from construction, albeit of a temporary nature during the daytime over a six month construction period.

The results of the Noise Assessment demonstrate that emissions from the project would satisfy the operational PNTLs at all identified receivers.

Furthermore, sleep disturbance is not anticipated, as there are no operational noise sources that generate significant maximum noise events and noise emissions from the project are predicted to satisfy the EPA maximum noise level criteria.

Road noise emissions associated with the project are anticipated to satisfy the relevant RNP criteria at all receivers along the proposed transportation route.

A qualitative assessment of potential vibration impacts has been completed. Due to the nature of the works proposed and distances to potential vibration sensitive receivers, vibration impacts from the project would be negligible.

Based on the Noise Assessment results, there are no noise related issues which would prevent approval of the proposed project.

This page has been intentionally left blank

Appendix A – Glossary of Terms

A number of technical terms have been used in this report and are explained in **Table A1**.

Table A1 Glossary of Acoustical Terms

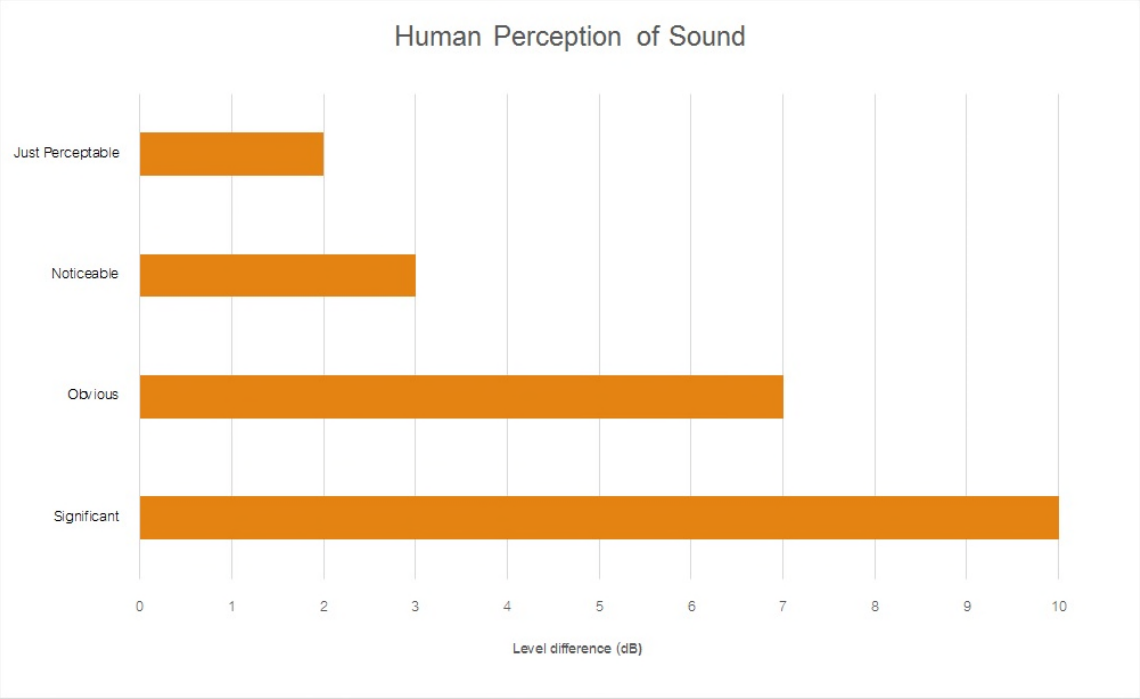
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Ambient Noise	The total noise associated with a given environment. Typically, a composite of sounds from all sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to sound.
Background Noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is usually represented by the LA90 descriptor
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Z-weighted or decibels Linear (unweighted).
Extraneous Noise	Sound resulting from activities that are not typical of the area.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A sound level which is exceeded 10% of the time.
LA90	Commonly referred to as the background noise, this is the level exceeded 90% of the time.
LAeq	Represents the average noise energy or equivalent sound pressure level over a given period.
LAmax	The maximum sound pressure level received at the microphone during a measuring interval.
Masking	The phenomenon of one sound interfering with the perception of another sound. For example, the interference of traffic noise with use of a public telephone on a busy street.
RBL	The Rating Background Level (RBL) as defined in the NPI, is an overall single figure representing the background level for each assessment period over the whole monitoring period. The RBL, as defined is the median of ABL values over the whole monitoring period.
Sound power level (Lw or SWL)	This is a measure of the total power radiated by a source in the form of sound and is given by 10.log10 (W/Wo). Where W is the sound power in watts to the reference level of 10^{-12} watts.
Sound pressure level (Lp or SPL)	the level of sound pressure; as measured at a distance by a standard sound level meter. This differs from Lw in that it is the sound level at a receiver position as opposed to the sound 'intensity' of the source.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA

Source	Typical Sound Pressure Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



This page has been intentionally left blank

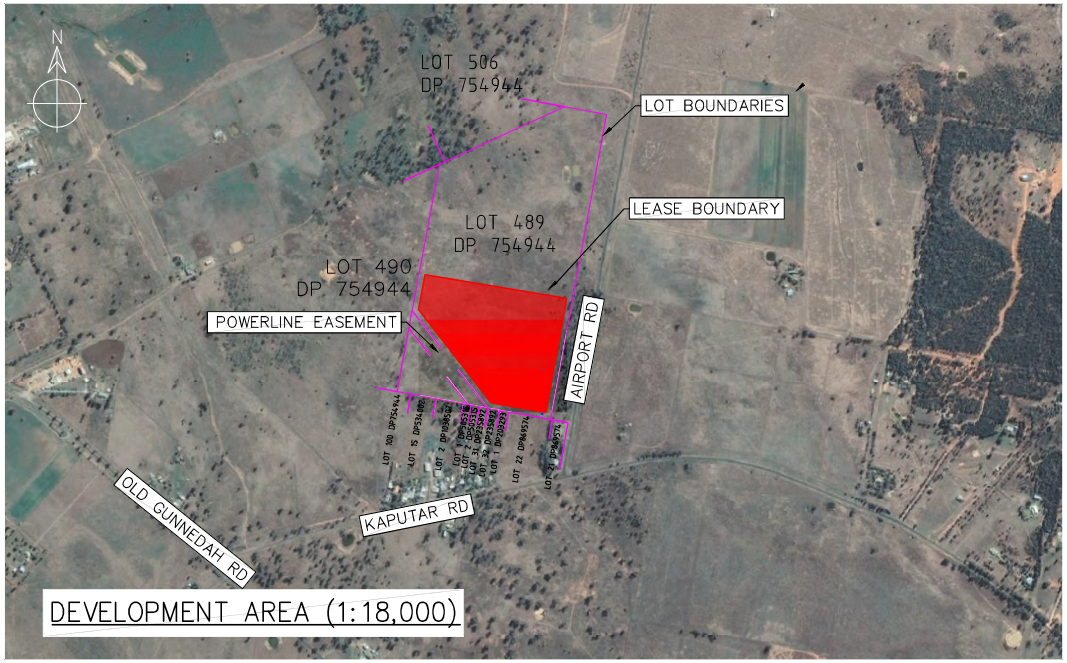
Appendix B – Project Layout

NARRABRI AREA (1:30,000)

ADDRESS
LOT 489, DP 754944
115 AIRPORT ROAD,
NARRABRI,
NSW 2390

COORDINATES
-30.340021°, 149.819839°

NSW STATE MAP



DEVELOPMENT AREA (1:18,000)

PROVIDENCE ASSET GROUP

REFERENCES

REVISIONS						
REV.	DATE	DESCRIPTION	DRWN.	DESIGNED	CHKD.	APPR.
B	2021.01.14	MINOR REVISIONS	JM	JM	SS	JM
A	2021.01.14	FIRST ISSUE	JM	JM	SS	JM

TITLE
PROVIDENCE ASSET GROUP
NARRABRI SOLAR FARM
LOCATION DETAIL

DWG No. 10100-G-GAD-01-1

SCALE
AS SHOWN

REVISION
A

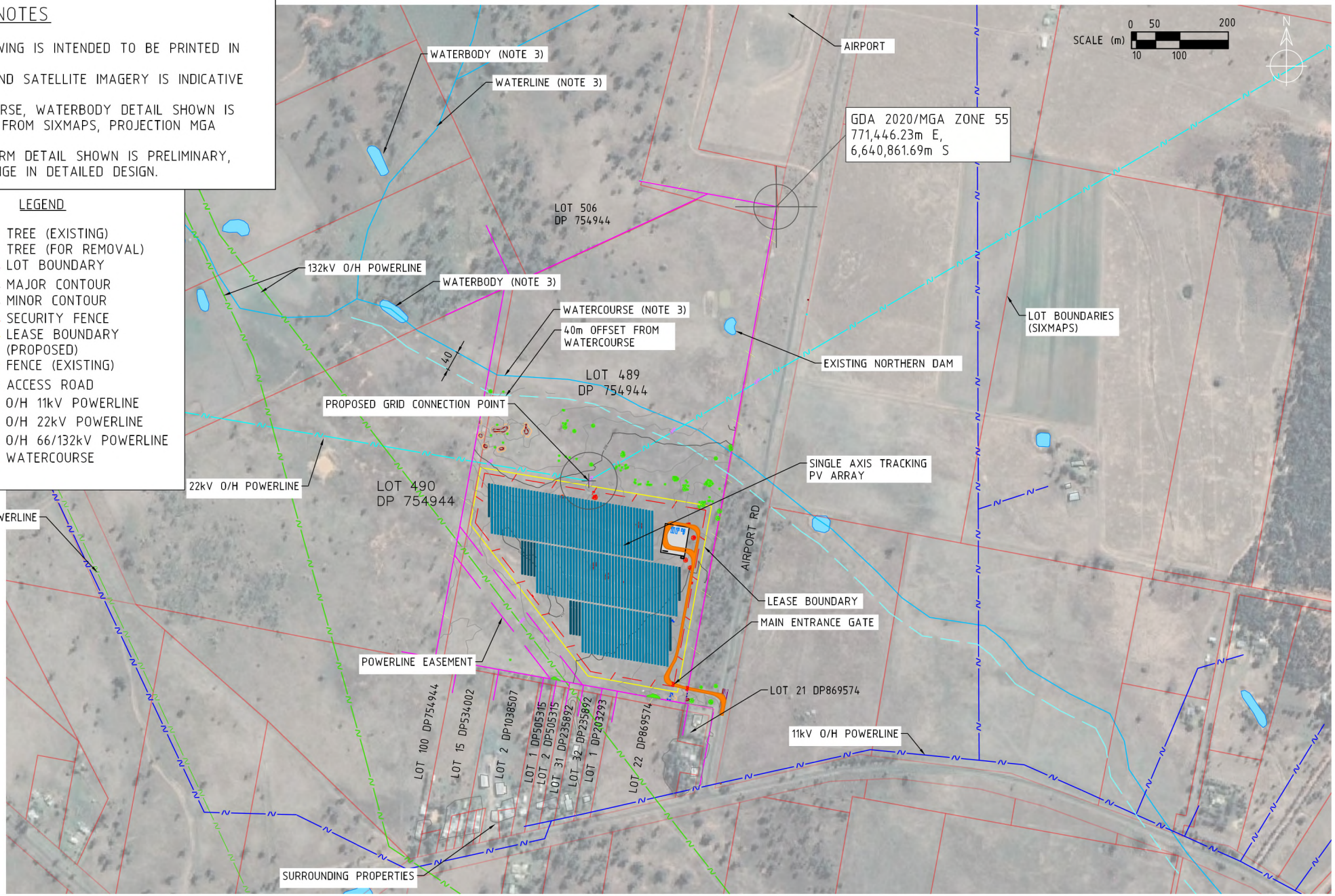
PAPER SIZE
A3

GENERAL NOTES

1. THIS DRAWING IS INTENDED TO BE PRINTED IN COLOUR.
2. BACKGROUND SATELLITE IMAGERY IS INDICATIVE ONLY.
3. WATERCOURSE, WATERBODY DETAIL SHOWN IS OBTAINED FROM SIXMAPS, PROJECTION MGA ZONE 55.
4. SOLAR FARM DETAIL SHOWN IS PRELIMINARY, MAY CHANGE IN DETAILED DESIGN.

LEGEND

- TREE (EXISTING)
- TREE (FOR REMOVAL)
- LOT BOUNDARY
- 400 MAJOR CONTOUR
- MINOR CONTOUR
- SECURITY FENCE
- LEASE BOUNDARY (PROPOSED)
- FENCE (EXISTING)
- ACCESS ROAD
- O/H 11kV POWERLINE
- O/H 22kV POWERLINE
- O/H 66/132kV POWERLINE
- WATERCOURSE



PROVIDENCE ASSET GROUP

REFERENCES

REV.	DATE	DESCRIPTION	DRWN.	DESIGNED	CHKD.	APPR.
B	2021.01.14	MINOR REVISIONS	JM	JM	SS	JM
A	2021.01.14	FIRST ISSUE	JM	JM	SS	JM

TITLE
PROVIDENCE ASSET GROUP
NARRABRI SOLAR FARM
GENERAL ARRANGEMENT
OVERVIEW

DWG No. 10100-G-GAD-02-1

SCALE 1:7,500
REVISION A
PAPER SIZE A3

LEGEND

- TREE (EXISTING)
- TREE (FOR REMOVAL)
- LOT BOUNDARY
- 400 — MAJOR CONTOUR
- MINOR CONTOUR
- SECURITY FENCE
- FENCE (EXISTING)
- LEASE BOUNDARY (PROPOSED)
- PV TABLE
- O/H 22kV POWERLINE
- O/H 132kV POWERLINE
- WATERCOURSE

SYSTEM SUMMARY

ELECTRICAL CONFIGURATION:
- TOTAL PV PLANT CAPACITY (DC): 6.260 MWp
- TOTAL INVERTER CAPACITY (AC): 4.95MVA
- PV PLANT MAXIMUM EXPORT CAPACITY (AC): 4.95MW
- DC:AC RATIO: 1.265
- STRINGS OF 28 PV MODULES.
- 207 PV STRINGS PER INVERTER.
- 414 PV STRINGS TOTAL.

PV MODULES:
- MFR: LONGI SOLAR
- MODEL: LR5-72HPH-540M
- NAMEPLATE: 540Wp
- QUANTITY: 11,592 MODULES

INVERTERS:
- MFR: SUNGROW
- MODEL: SG2475HV-MV
- NAMEPLATE: 2475kVA
- QUANTITY: 2

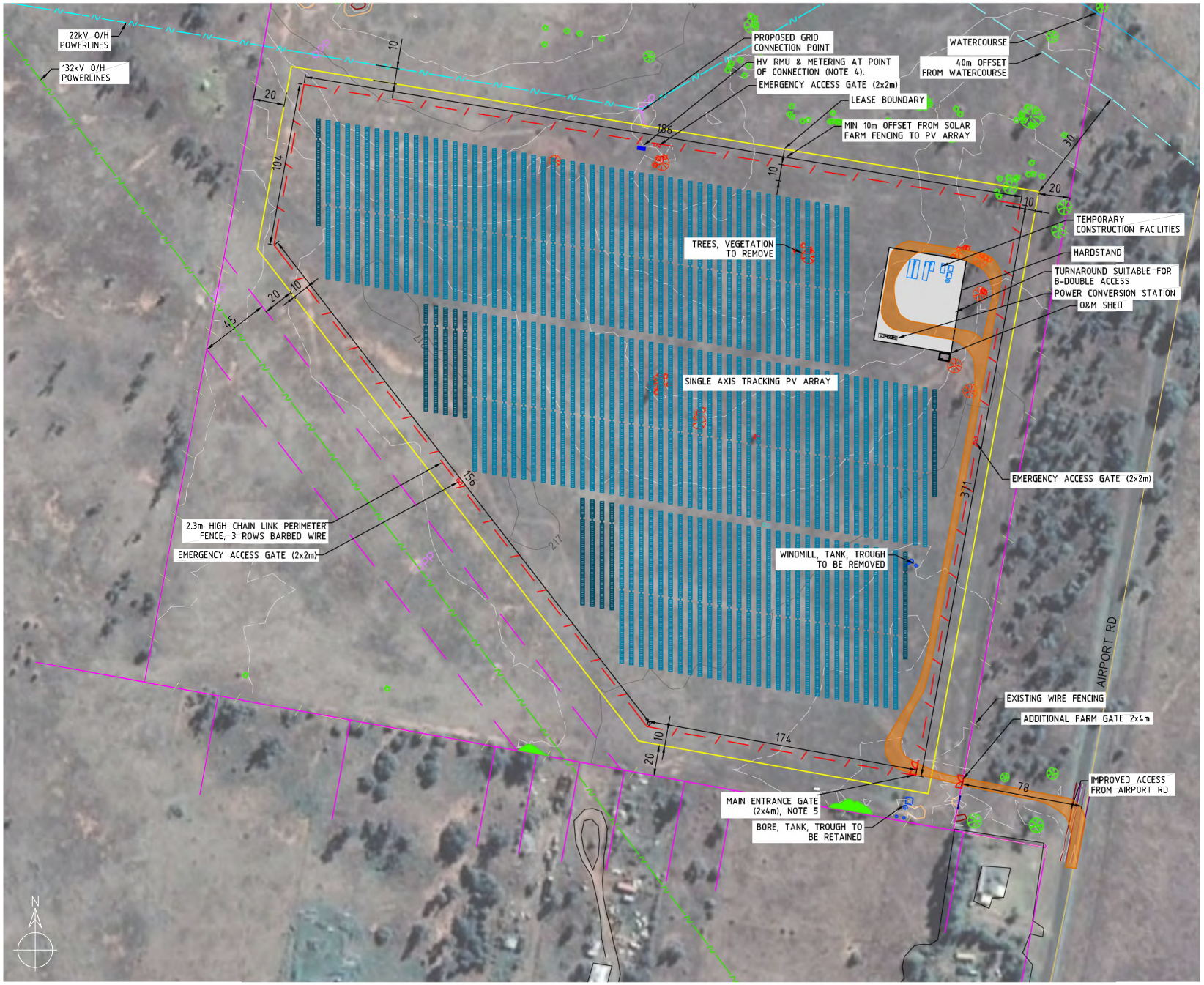
MV POWER STATION:
- MFR: SUNGROW
- MODEL: SG4950HV-MV
- QUANTITY: 1

TRACKER ARRAY:
- TYPE: GROUND MOUNT SINGLE AXIS TRACKING
- CONFIGURATION: INDEPENDENT TYPE
- RANGE OF MOTION: ±60°
- PITCH: 6.25m
- GCR: 36.096%
- QUANTITY: 142 TABLES

FENCED AREA: 132,821 m^2
LEASE AREA: 148,223 m^2

GENERAL NOTES:

1. DETAIL SHOWN IS PRELIMINARY, MAY CHANGE IN DETAILED DESIGN.
2. ENTRY FROM AIRPORT ROAD.
3. CLEARANCE BETWEEN SOLAR TRACKER ARRAY & SITE SECURITY FENCE TYPICALLY 10m
4. HV RMU & METERING (LOCATION AND TYPE TO BE DETERMINED, IS SUBJECT TO ESSENTIAL ENERGY FEEDBACK).
5. FOR SECURITY GATE DETAILS REFER TO DRAWING 10100-C-DET-02-1.
6. WATERCOURSE, WATERBODY DETAIL FROM SIXMAPS, MGA ZONE 55 PROJECTION
7. FOR ON SITE STORMWATER DETENTION DETAIL REFER TO DRAWING 10100-C-DET-01-1 (TBC).



PROVIDENCE ASSET GROUP

REFERENCES

REVISIONS						
REV.	DATE	DESCRIPTION	DRWN.	DESIGNED	CHKD.	APPR.
A	2021.01.14	FIRST ISSUE	JM	JM	SS	JM

TITLE
PROVIDENCE ASSET GROUP
NARRABRI SOLAR FARM
GENERAL ARRANGEMENT
SYSTEM DETAIL

DWG No. 10100-G-GAD-02-2

SCALE 1:2,500
REVISION A
PAPER SIZE A3

Muller Acoustic Consulting Pty Ltd
PO Box 262, Newcastle NSW 2300
ABN: 36 602 225 132
P: +61 2 4920 1833
www.mulleracoustic.com

MAC
Muller Acoustic Consulting

TRAFFIC IMPACT ASSESSMENT

SOLAR PHOTOVOLTAIC (PV) POWER GENERATING FARM & ASSOCIATED SUPPORTIVE INFRASTRUCTURE

LOT 489 DP 754944
115 AIRPORT ROAD, NARRABRI

PREPARED FOR: PROVIDENCE ASSET GROUP

JANUARY 2021

20/193

TRAFFIC IMPACT ASSESSMENT
PROVIDENCE ASSET GROUP

SOLAR PHOTVOLTAIC (PV) POWER FARM
LOT 489 DP754944
115 AIRPORT ROAD, NARRABRI

Intersect Traffic Pty Ltd (ABN: 43 112 606 952)

Address:
16 Mount Harris Drive
Maitland Vale NSW 2320
PO Box 268
East Maitland NSW 2323

Contact:
(Mob) 0423 324 188
Email: jeff@intersecttraffic.com.au

QUALITY ASSURANCE

This document has been prepared, checked and released in accordance with the Quality Control Standards established by Intersect Traffic Pty Ltd.

Issue	Date	Description	By
A	29/12/20	Draft	JG
B	30/12/20	Edit	JG
C	29/01/21	Final Proof	JG
D	29/01/21	Approved	JG

This document has been authorised by

Date 29th January 2021

Disclaimer

This report has been prepared based on the information supplied by the client and investigation undertaken by Intersect Traffic Pty Ltd & other consultants. Recommendations are based on Intersect Traffic's professional judgement only and whilst every effort has been taken to provide accurate advice, Council and any other regulatory authorities may not concur with the recommendations expressed within this report. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that for which it was supplied by Intersect Traffic Pty Ltd. Intersect Traffic makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information.

Confidentiality Statement

All information, concepts, ideas, strategies, commercial data and all other information whatsoever contained within this document as well as any and all ideas and concepts described during the presentation are provided on a commercial in confidence basis and remain the intellectual property and Copyright of Intersect Traffic Pty Ltd and affiliated entities.

CONTENTS

ATTACHMENTS

FIGURES

PHOTOGRAPHS

TABLES

1.0 INTRODUCTION

Intersect Traffic Pty Ltd (Intersect Traffic) has been engaged by Providence Asset Group to prepare a traffic impact assessment report for a proposed Solar Photovoltaic (PV) Power Farm (up to 5MW) on Lot 489 DP 754944 115 Airport Road, Narrabri.

The proposed development involves installation of solar panel banks, off-load area, inverter and AC combiner area, HV switchboard area, MV power station area, direct connection to a suitable existing power line near the site, on-site car parking and temporary construction office. Vehicular access to the site will be via a new access road with turnaround area off Airport Road approximately 220 metres north of Kaputar Road near an existing access gate to the property. The development concept plans are shown in ***Attachment A.***

This report is required to support a development application to Narrabri Shire Council and allow the Council to assess the proposal in respect of its impact on the local and state road network.

This report presents the findings of the traffic and parking assessment and includes the following:

1. An outline of the existing situation near the site.
2. Assessment of the additional traffic generated by the proposal, identifies a preferred delivery route and the additional traffic's impact on the local road network.
3. Review of the adequacy of the proposed vehicular access to the site.
4. Review of the suitability and provision of on-site car parking through assessment against Council and Australian Standards requirements.
5. Presentation of conclusions and recommendations.

2.0 SITE DESCRIPTION

The subject site is shown in ***Figure 1*** below. It is located on the western side of Airport Road, Narrabri approximately 200 metres north of Kaputar Road and approximately 4 kilometres south-east of the Narrabri CBD. The site currently contains vacant rural pasture used for agricultural purpose.

The property has the formal title of Lot 489 DP754944, 115 Airport Road, Narrabri with road frontage access directly off Airport Road. The development area for the proposal is approximately 15 hectares. The site is currently zoned RU1 – Primary Production pursuant to the Narrabri LEP (2012).

The proposed vehicular access to the site will be provided off Airport Road approximately 220 metres north of Kaputar Road near an existing access gate to the property. Deliveries to the site will use the identified delivery road shown on ***Figure 1*** being via the Kamilaroi Highway from the south from Sydney and Newcastle or from the north from Brisbane. Noting that whilst Old Gunnedah Road is a designated B-Double route, both Kaputar Road and Airport Road are not designated B-Double routes. Therefore Council will need to provide special permission for B-Doubles to deliver materials to the site. It is considered that the short length of Kaputar Road and Airport Road to be used by B-Double delivery vehicles is suitable for the short construction period. ***Photograph 1*** below shows the existing development site from Airport Road and the existing access gate to the site while, ***Photograph 2*** shows the existing Old Gunnedah Road / Kaputar Road T-intersection near the site, which lies on the proposed construction vehicle delivery route.

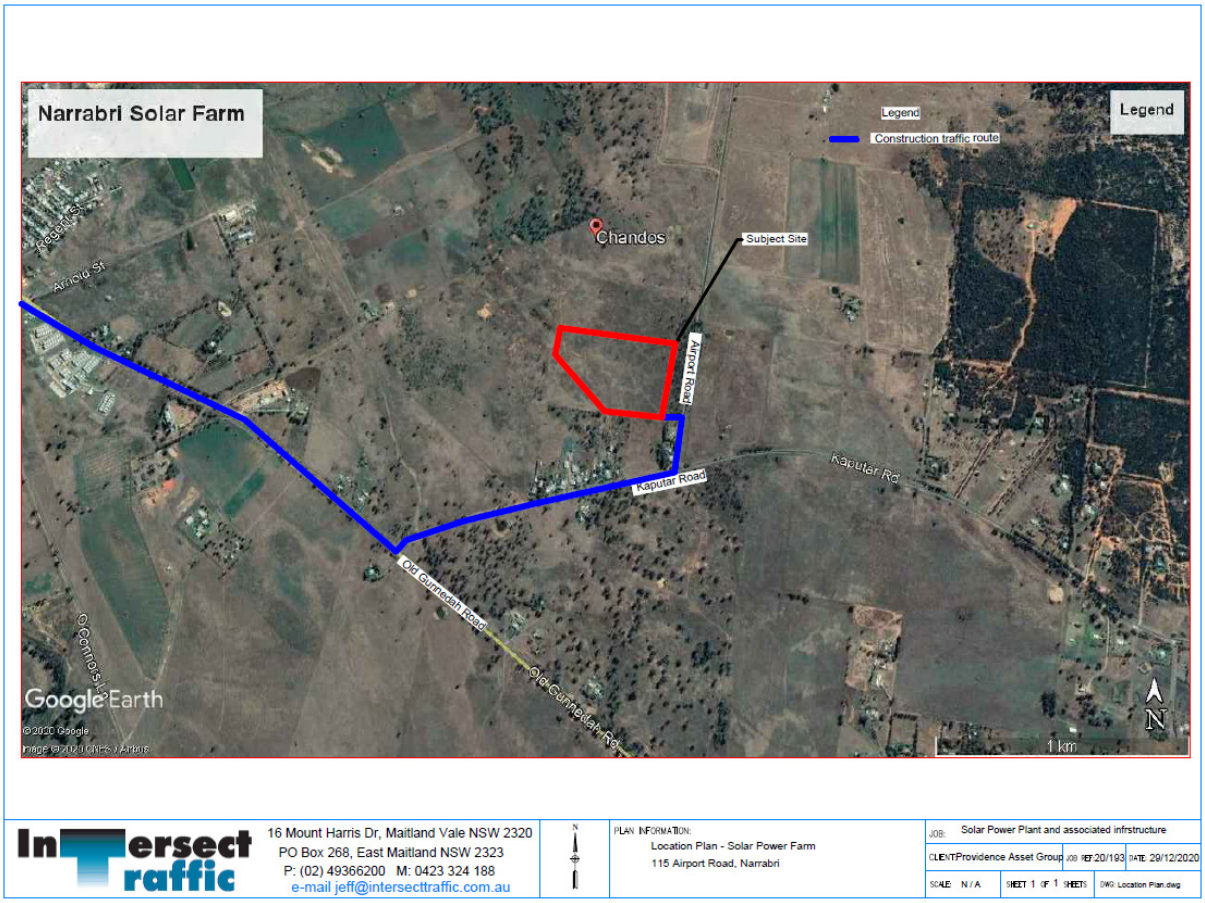


Figure 1 – Site Location

Photograph 1 – Development site from Airport Road near existing access gate

Photograph 2 – Old Gunnedah Road / Kaputar Road stop sign controlled intersection.

3.0 EXISTING ROAD NETWORK

3.1 Kamilaroi Highway

The Kamilaroi Highway is a classified state highway (SH29) with its primary function to connect the New England Highway at Willow Tree to the Mitchell Highway at Bourke through Gunnedah, Boggabri, Narrabri, Wee Waa, Walgett and Brewarrina. As such, it is an arterial road and major NSW transport route from inland NSW to the NSW coastal area. As a sealed rural arterial road, the Kamilaroi Highway is under the care and control of Transport for NSW (TfNSW).

Near Narrabri the Kamilaroi Highway is a two-lane two-way sealed rural road with a 9-metre wide sealed carriageway consisting of 3.5 metre wide travel lanes and 1 metre wide sealed shoulders. Additional turning lanes are provided at major intersections along its length. North and south of Narrabri, the speed zoning is 100 km/h north while a 60 km/h speed zoning exists through Narrabri. At the time of inspection, the Kamilaroi Highway was observed to be in good condition as shown in ***Photograph 3*** below. It is considered suitable for use by heavy vehicle traffic.

Photograph 3 – Kamilaroi Highway, near site.

3.2 Old Gunnedah Road

Old Gunnedah Road is a local sealed rural collector road with its primary function to collect and distribute traffic from the south-eastern area of Narrabri to the arterial road network at Narrabri, as well as provide vehicular access to properties along its length. As a local rural sealed road, it is under the care and control of Narrabri Shire Council and 80 km/h and 100 km/h speed zoning apply to the road from Narrabri through to Kaputar Road. Old Gunnedah Road is a designated B-Double route.

Old Gunnedah Road is a two-lane two-way sealed rural road. It has a 7 metre wide sealed pavement and gravel / grass shoulders and verge that comfortably allows two lanes of traffic flow,

one in each direction, with parking or pull over areas along its length. At the time of inspection, Old Gunnedah Road near Kaputar Road was found to be in good condition as shown in ***Photograph 4*** below.

Photograph 4 – Old Gunnedah Road near Kaputar Road.

3.3 Kaputar Road

Kaputar Road is a local sealed rural road with its primary function to provide vehicular access to properties along its length. As a local rural road, it is under the care and control of Narrabri Shire Council and a 100 km/h speed zoning would apply to Kaputar Road. Kaputar Road is not a designated B-Double route.

Near the site, Kaputar Road is a two-lane two-way sealed rural road with a 7-metre wide sealed carriageway which comfortably allows two-way traffic flow. It currently services a number of rural residential and rural properties along its length. At the time of inspection, Kaputar Road near Airport Road was found to be in good condition as shown in ***Photograph 5*** below.

3.4 Airport Road

Airport Road is a local sealed rural road with its primary function to provide vehicular access to properties along its length, including Narrabri airport. As a local rural road it is under the care and control of Narrabri Shire Council and a 100 km/h speed zoning would apply to Airport Road. Note Airport Road is not a designated B-Double route.

Near the site, Airport Road is a two-lane two-way sealed rural road with a 7-metre wide sealed carriageway which comfortably allows two-way traffic flow. It currently services a couple of rural properties along its length, as well as Narrabri Airport. At the time of inspection, Airport Road near the site was found to be in good condition as shown in ***Photograph 6*** below.

Photograph 5 – Kaputar Road near Airport Road.

Photograph 6 – Airport Road near the site.

4.0 ALTERNATE TRANSPORT MODES

Forest Coach Lines provide regular public transport (bus) services within Narrabri with their route map shown below in ***Figure 2***. It is noted however that the nearest service to the site Route 457C (Narrabri Town Loop) is still some 3.5 km by road to the site and therefore not considered appropriate for the development.

As a rural area, there are no pedestrian footpaths or on / off road cycleways within the local road network. Near the site, pedestrians are generally required to utilise the grass verges and road shoulders / pavement, while cyclists are required to utilise the road shoulders or share the travel lanes with other vehicles.

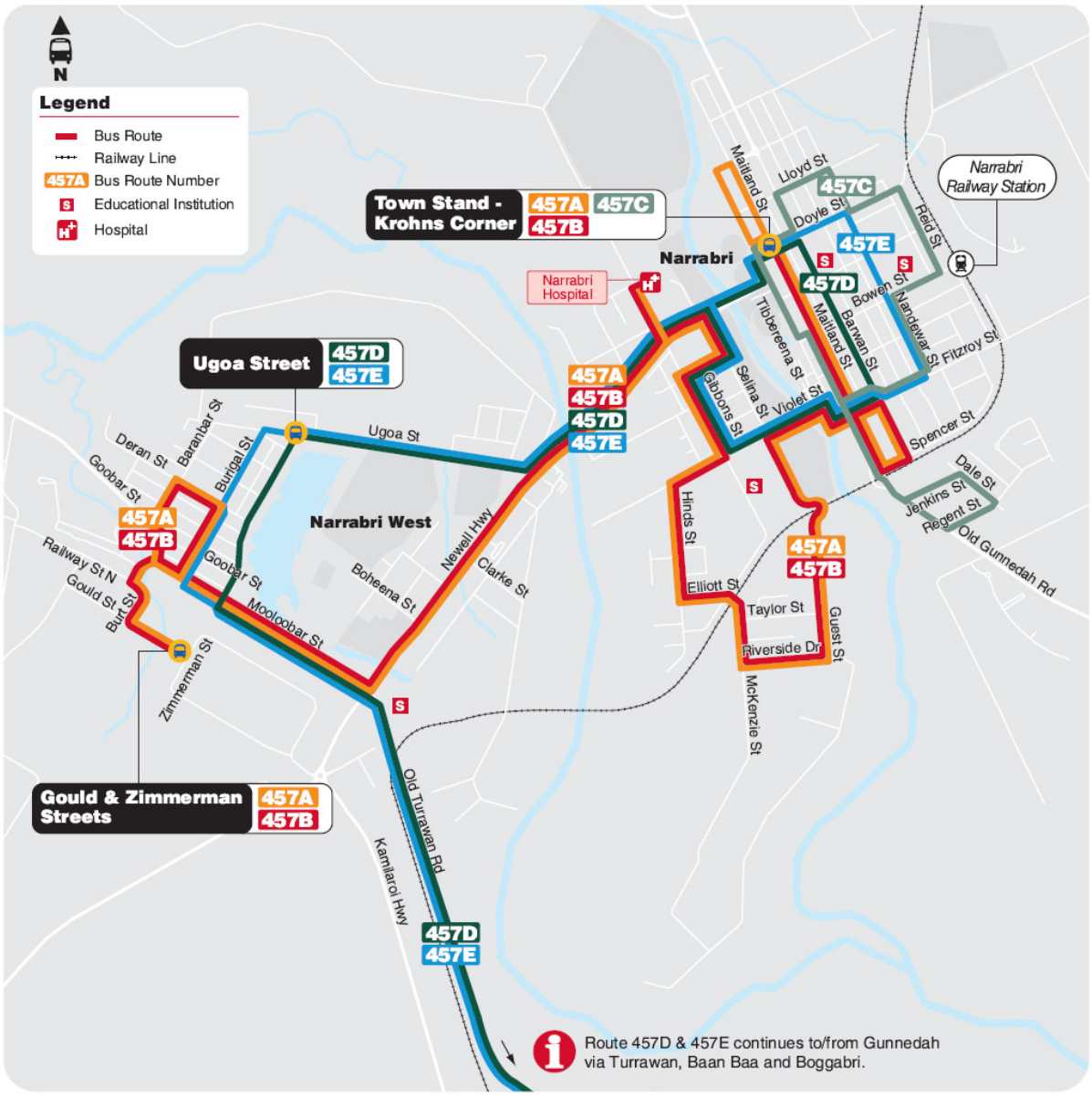


Figure 2 – Forest Coach Lines – Narrabri bus routes

5.0 DEVELOPMENT PROPOSAL

The proposed development involves the construction of a Solar Photovoltaic (PV) Power Farm on the site. The development concept plans are shown in ***Attachment A*** with the specific works involved in the expansion listed below:

- Installation of temporary construction office and amenities.
- Installation of Solar Panel arrays.
- Earthworks for construction lay-down area, hardstand areas and internal roads.
- Installation of inverters, transformers and switchgear.
- Construction of unsealed access road from Airport Road to the construction site.
- Construction of security fence and entrance gate; and
- Drainage and landscaping to Narrabri Shire Council requirements.

The development will require a team of 30 construction employees for a period of up to 6 months working 7 am to 5 pm Monday to Friday and 8 am – 1 pm on Saturdays. The majority of traffic movements associated with the development will occur during the construction of the solar power farm. Traffic movements generated by the operation of the development would include a single staff light vehicle movement associated with maintenance inspections as required and specific maintenance work which would be short term and infrequent. Deliveries during construction works would be expected to be within rigid and articulated vehicles. More detail on construction traffic is provided later in this report.

6.0 TRAFFIC IMPACTS

6.1 – Traffic Generation and Trip Distribution

The TfNSW publication "*RTA's Guide to Traffic Generating Developments (2002)*" provides advice on the traffic generating potential of different land uses. However this document does not cover Solar Farms therefore determining traffic generation is reliant on advice from the applicant regarding construction and operation of the development.

From an operational perspective traffic generation is expected to be minimal with only regular daily maintenance inspections carried out when necessary. Therefore based on 1 visit per day per week a peak hour traffic generation of 2 vehicle trips per hour (vtph) has been assumed for this assessment. There may be times when specific maintenance tasks have to be undertaken but these will be infrequent, short-term and undertaken under a construction traffic management plan for the work. Construction traffic estimates for the development are as follows based on the information provided in ***Attachment C***.

- Construction employees on-site – Maximum 30 transported in up to 10 light vehicles per day arriving between 6 am and 7 am and departing between 5 pm and 6 pm.
- Deliveries – Mainly heavy rigid vehicles and articulated vehicles (AV). Maximum – 8 per day but average of 5 per day between 10 am and 4 pm. Whilst these are likely to mostly arrive outside the peak hour traffic generation periods associated with the arrival and departure of employees, logistically there could be occurrences when due to circumstances out of the control of the contractor, a delivery arrives during the peak hour periods.
- Other vehicles – Some earthworks plant may be required on-site as well as concrete agitators and road base material deliveries during construction of the access. It would be expected a maximum frequency of 3 deliveries within a peak hour is assumed.
- Construction period – up to 6 months

Based on this advice, the likely peak hour traffic generation, which will occur in the AM peak coinciding with employees arriving on site and in the PM peak coinciding with employees leaving the site, is calculated below. It is also noted deliveries involve 2 trips with an inbound trip and an outbound trip.

AM peak = 10 inbound employees + 3 x 2 roadworks and other plant + 1 x 2 deliveries = 18 vtph (14 inbound and 4 outbound).
PM peak = 10 outbound employees + 3 x 2 roadworks and other plant + 1 x 2 deliveries = 18 vtph (14 outbound and 4 inbound).

It is expected that the distribution of trips will be all north-west towards or from Narrabri, with deliveries being via the New England Highway and Kamilaroi Highway from the south or via Newell Highway and Kamilaroi Highway from the north, originating from either Newcastle or Sydney or Brisbane. In accessing the site, the likely transportation route as envisaged is shown on the location plan (***Figure 1***) in this report.

Existing traffic volumes in the area were recorded by Intersect Traffic at the Old Gunnedah Road / Kaputar Road and Kaputar Road / Airport Road intersections during the likely peak AM and PM traffic periods (road network) i.e. 3 pm – 4 pm and 8 am – 9 am on Thursday 3rd December 2020 and Friday 4th December 2020 respectively. These periods were chosen following interrogation of Transport for NSW (TfNSW) data in the area on its Traffic Volume Viewer application. The data sheets for these counts are provided in ***Attachment B***.

These traffic counts determined that the relevant peak hour two-way mid-block traffic volumes on the state and local road network in the AM and PM periods during this period were.

- Old Gunnedah Road west of Kaputar Road - 213 vtph in the AM peak and 198 vtph in the PM peak.
- Old Gunnedah Road east of Kaputar Road – 106 vtph in the AM peak and 136 vtph in the PM peak.
- Kaputar Road north of Old Gunnedah Road and west of Airport Road – 100 vtph in the AM peak and 72 vtph in the PM peak.
- Kaputar Road east of Airport Road – 97 vtph in the AM peak and 62 vtph in the PM peak; and
- Airport Road north of Kaputar Road – 3 vtph in the AM peak and 6 vtph in the PM peak.

Northern Transport Planning and Engineering (NTPE) also installed a traffic classifier on Old Gunnedah Road approximately 80 metres west of Kaputar Road from Friday 27th November 2020 until Thursday 3rd December 2020, a period of 1 week. This count recorded a peak two-way AM traffic volume of 276 vtph on Tuesday 1st December 2020 and a peak two-way PM traffic volume of 306 vtph on Tuesday 1st December 2020. It is noted the traffic classifier counts are higher than the intersection counts and have therefore been used in this assessment. The classifier counts also determined a heavy vehicle percentage of approximately 5%. The traffic classifier summary spreadsheets are also provided in ***Attachment B***.

Given the construction will be completed within a 6 month period and the peak operational traffic volume from the site is only 2 vtph, there is no need to undertake a 2030 (10 year horizon period) assessment of this development.

6.2 – Road Capacity

Table 4.5 of the TfNSW publication "*RTA's Guide to Traffic Generating Developments"* provides some guidance on likely mid-block capacity of two-lane two-way rural roads. This table is reproduced below as ***Table 1***:

Table 1 – Rural Road Mid-Block Capacity Table

Table 4.5
peak hour flow on two-lane rural roads (veh/hr)
(Design speed of 100km/hr)

Terrain	Level of Service	Percent of Heavy Vehicles			
		0	5	10	15
Level	B	630	590	560	530
	C	1030	970	920	870
	D	1630	1550	1480	1410
	E	2630	2500	2390	2290
Rolling	B	500	420	360	310
	C	920	760	650	570
	D	1370	1140	970	700
	E	2420	2000	1720	1510
Mountainous	B	340	230	180	150
	C	600	410	320	260
	D	1050	680	500	400
	E	2160	1400	1040	820

The data for Table 4.5 assumes the following criteria:

- *terrain level* with 20% no overtaking.
- *rolling* with 40% no overtaking.
- *mountainous* with 60% no overtaking.
- 3.7 m traffic lane width with side clearances of at least 2m.
- 60/40 directional split of traffic.

Source: - RTA's Guide to Traffic Generating Developments (2002)

It is assumed that the appropriate terrain levels for Old Gunnedah Road, Kaputar Road and Airport Road are Level and that a satisfactory level of service (LoS) on the road network is a LoS C. Therefore, after adopting a 5% heavy vehicle percentage on traffic volumes, the above table suggests the relevant two-way mid-block road capacities for a LoS C are as follows:

- All roads – 970 vtph.

Therefore the two-way mid-block road capacity thresholds adopted in this assessment are:

- Old Gunnedah Road, Kaputar Road and Airport Road – 970 vtph.

As the combination of the two-way mid-block peak hour traffic data and traffic generation figures reported in ***Section 6.1*** in the AM and PM peak hour traffic volumes on the local and state road network during construction will be well below the existing capacity thresholds determined above, then the local road network has sufficient spare two-way mid-block capacity to cater for the construction and operation of the Solar Farm. The addition of up to 18 vtph will not cause the capacity thresholds determined above to be reached. Therefore it can be concluded that the proposed development will not adversely impact on the local road network mid-block efficiency.

6.3 – Intersection Capacity

The main intersections impacted by the construction of the development is the Old Gunnedah Road / Kaputar Road priority controlled stop sign T-intersection and the Kaputar Road / Airport Road priority controlled give way T-intersection. However traffic volumes at this intersection are well below the thresholds sourced from Austroads *Guide to Traffic Management Part 6 – Intersections, Interchanges and Crossings (2010),* reproduced below in ***Table 2*** of this report**.** The Guide states that if traffic volumes are not above these thresholds, then uninterrupted flow

conditions can be assumed and little or no delay will be experienced by motorists at these intersections. No further intersection analysis is then required.

Table 2 – Uninterrupted flow condition thresholds at an intersection

Major road type[1]	Major road flow (vph)[2]	Minor road flow (vph)[3]
Two-lane	400	250
	500	200
	650	100
Four-lane	1000	100
	1500	50
	2000	25

Source: - Austroads Guide to Traffic Management – Part 6: Intersections, Interchanges and Crossings (2010)

With traffic flows on Old Gunnedah Road being less than 306 vtph and traffic flows on Kaputar Road and Airport Road being less than 100 vtph and 6 vtph respectively, it is clearly seen that these intersections are currently operating with uninterrupted flow conditions, confirmed by observation on site during the traffic counts. The additional 18 vtph generated by the construction of the Solar Farm will not result in the thresholds within the above table being reached. Therefore it can be concluded that during construction and post development, the Old Gunnedah Road / Kaputar Road priority controlled stop sign T-intersection and the Kaputar Road / Airport Road priority controlled give way T-intersection will continue to operate with uninterrupted flow conditions. Therefore it is reasonable to conclude that the development does not adversely impact on the operation of this intersection or any other intersection on the local and state road network.

6.4 Access Assessment

In terms of width, the access to the development providing access to a user class 1 (long term) car parking facility with less than 25 car spaces fronting a local road is required to be a category 1 access (Table 3.1 of the Standard). Table 3.2 of the Standard then specifies a category 1 access facility as a combined entry / exit between 3.0 to 5.5 metres wide. However the proposed entrance width at the combined entry / exit access at Airport Road will need to be a minimum 12.5 metres wide to cater for the swept turning paths for delivery vehicles during the construction stage and satisfy the requirements of Australian Standard *AS2890.1-2004 Parking Facilities – Part 1 Off-street car parking* and Australian Standard *AS2890.2-2002 Parking Facilities – Part 2 Off-street commercial vehicle facilities.*

Sight distance at the proposed access off Airport Road was observed to be in excess of 250 metres in each direction which therefore complies with the requirements of Figure 3.2 of Australian Standard *AS2890.1-2004 Parking Facilities – Part 1 Off-street car parking (160 metres minimum SSD for 100 km/h*) as well as Austroads *Guide to Road Design – Part 4A – Unsignalised and signalised intersections - Table 3.2 (248 metres for 100 km/h)* for safe intersection sight distance.

It is therefore concluded that the proposed site access is suitably located and satisfactory for use for the Solar Farm as it complies with the requirements of Australian Standard *AS2890.1-2004 Parking Facilities – Part 1 Off-street car parking* and Australian Standard *AS2890.2-2002 Parking Facilities – Part 2 Off-street commercial vehicle facilities.*

The main issue with access for construction vehicles to the site, is the suitability of the local road network to safely cater for heavy vehicle deliveries. In this regard it is noted that Airport Road has sealed pavement approximately 7 metres wide and therefore complies with Austroads Standards for Rural Roads with more than 500 vtph. It would therefore allow two heavy vehicles to pass each other at normal speed. Therefore it is considered the proposed transportation route to the site is suitable to carry heavy vehicles and thus is suitable to cater for the construction traffic from the Solar Farm construction. However, the additional heavy vehicle loading from the construction may

accelerate the deterioration in the sealed pavement along the transportation route. It is therefore recommended that a dilapidation report be prepared for the project in regard to Kaputar Road and Airport Road caused by the construction of the Solar Farm and ensure the road network is repaired to Council's satisfaction post the construction stage of the development. This will require pre and post construction stage inspections of the road pavement along the proposed transport routes.

Overall, with a suitable condition of consent included for the preparation of a dilapidation report covering Kaputar Road and Airport Road and the satisfactory repair of the local road network post construction, it is considered the local road network would be suitable to cater for the expected construction traffic associated with the development.

7.0 ON-SITE CAR PARKING

On-site car parking for the proposal is required to comply with the Industrial Development controls of the Narrabri Shire Council's Development Control Plan – Parking Code No. 1. Adopting the factory rates for this project the relevant on-site car parking provision during the operation of the Solar Farm is.

- *1.3 spaces per 100m² GFA .*

With no building proposed for the Solar Farm, the development is theoretically not required to provide any on-site car parking space under the DCP requirements. However, with a single maintenance vehicle visit to the site likely to occur at most once a week, it would be prudent to provide at least 1 on-site vehicle car park within the development. However, it is also the responsibility of the applicant to provide sufficient on-site car parking for construction employees during the construction of the development to comply with the car parking objectives of the DCP. Construction employee car parking will be provided on the hard stand area identified as the construction lay down area and is large enough to cater for the expected storage requirements during construction as well as the provision of at least 10 on-site car parks for construction employees, which is the expected traffic generation from employees to the site. This is in excess of the Industrial land use requirements of the Narrabri Shire Council Development Control Plan – Parking Code No. 1. With significant overflow parking areas also on site, it is reasonable to conclude the development provides sufficient on-site car parking that complies with the objectives and controls related to car parking required within Narrabri Shire Council's Development Control Plan – Parking Code No. 1.

The employee car parking area would need to comply with the requirements of Australian Standard *AS2890.1-2004 Parking Facilities – Part 1 Off-street car parking* with parking bay sizes 2.4 m x 5.4 m and aisle widths of 5.8 metres. There is sufficient room on-site to ensure compliance with this requirement, which could be covered by a suitable condition of consent. Overall, it is considered suitable on-site car parking can be provided for the development ensuring all vehicle movements to and from the site off Airport Road will be undertaken in a forward direction.

8.0 ALTERNATE TRANSPORT MODES

The proposed development will not generate any increase in public transport demand during both the construction and operational phases of the development particularly given the site is not currently serviced by convenient public transport. Therefore there is no nexus for the provision of new services or improved infrastructure resulting from the development. Similarly, the development will not generate any additional pedestrian or cycle traffic during both the construction and operation phases of the development therefore no nexus exists for the provision of additional pedestrian paths or cycle ways near the site.

9.0 CONCLUSIONS

This traffic and parking assessment for the proposed Solar Photovoltaic (PV) Power Farm (up to 5MW) on Lot 489 DP 754944 115 Airport Road, Narrabri has determined the following:

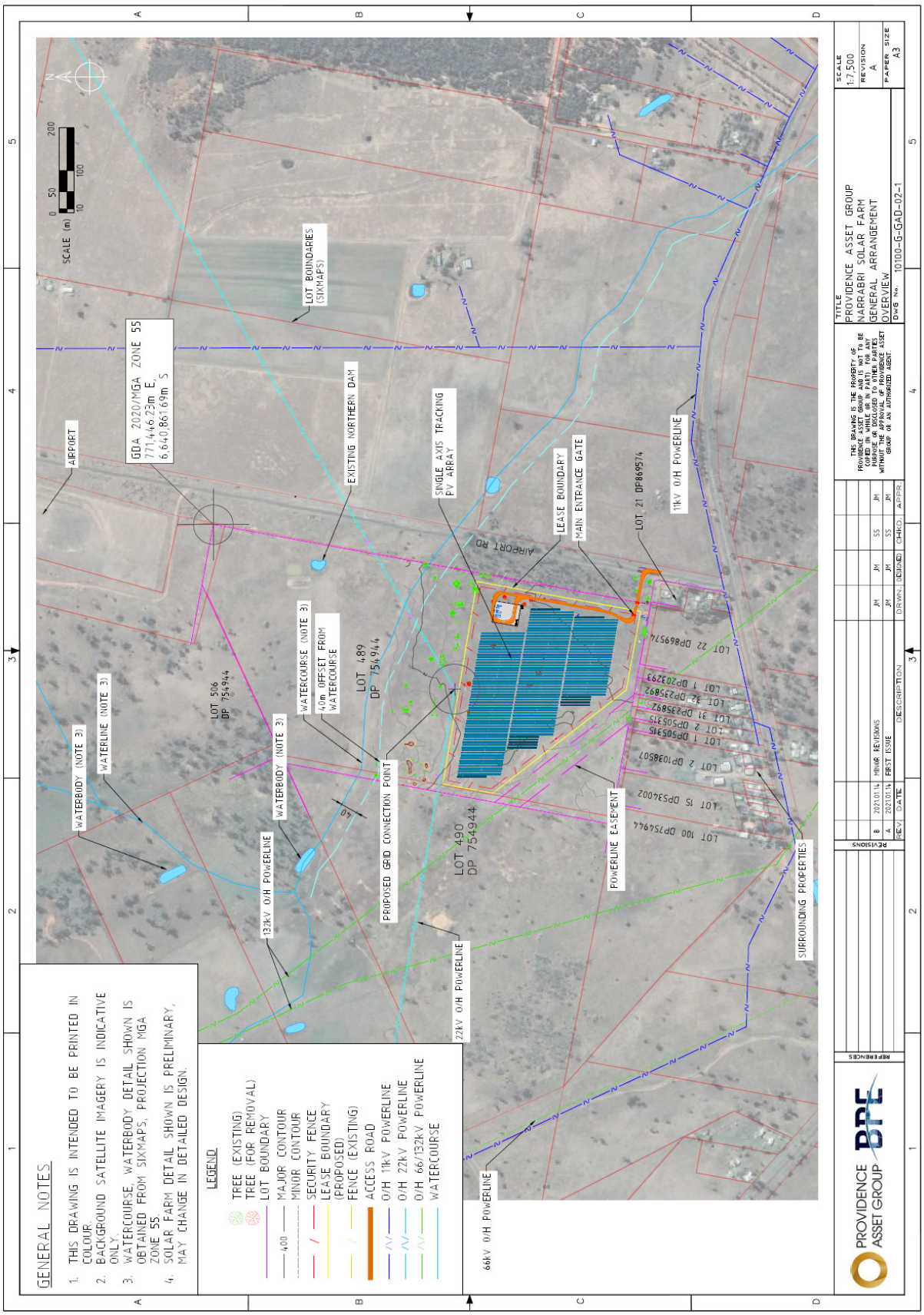
- The development during construction will generate up to an additional 18 vehicle movements to and from the site during the weekday AM and PM peak periods but only 2 vtph during the operation of the Solar Farm.
- The existing peak traffic volumes on the local road network are well below the two-way mid-block capacity threshold of 970 vtph for the local road network (LoS C). Traffic volumes will remain below this threshold during the construction and operation of the development.
- The Old Gunnedah Road / Kaputar Road priority controlled stop sign T-intersection and the Kaputar Road / Airport Road priority controlled give way T-intersection will continue to operate with uninterrupted flow conditions during and post construction of the Solar Farm with little if any impact on the operation of the intersection resulting from the development.
- It is also reasonable to conclude the development will not adversely impact on the intersections on the wider local and state road network given the high levels of intersection control on the major intersections and the relatively low traffic generation from the development.
- Therefore, the additional construction and operational traffic generated by this development will not adversely impact on the efficiency or effectiveness of the local and state road network.
- The proposed site access is suitable for use for construction and operation of the development being compliant with Australian Standard and Austroads requirements.
- With a suitable condition of consent included for the preparation of a dilapidation report covering Kaputar Road and Airport Road and the satisfactory repair of the local road network post construction, it is considered the local and state road network would be suitable to cater for the expected construction traffic associated with the development.
- There is sufficient area on-site to accommodate the expected peak parking demand generated by the development during both construction and operation with the provision of an AS2890.1-2004 compliant car park within the construction laydown area for a minimum 10 spaces as well as the provision of numerous overflow parking areas on the site.
- The proposed development will not generate any increase in public transport demand; therefore no nexus exists for the provision of new services or improved infrastructure resulting from the development. Similarly, the development will not generate any additional pedestrian or cycle traffic, therefore no nexus exists for the provision of additional pedestrian paths or cycle ways near the site.

10.0 RECOMMENDATION

Having carried out this traffic and parking assessment for the proposed Solar Photovoltaic (PV) Power Farm (up to 5MW) on Lot 489 DP 754944 115 Airport Road, Narrabri, it is recommended that the proposal can be supported from a traffic perspective as the development will not adversely impact on the local and state road network and complies with all relevant requirements of Narrabri Shire Council, Austroads, Australian Standards and TfNSW.

JR Garry BE (Civil), Masters of Traffic
Director
Intersect Traffic Pty Ltd

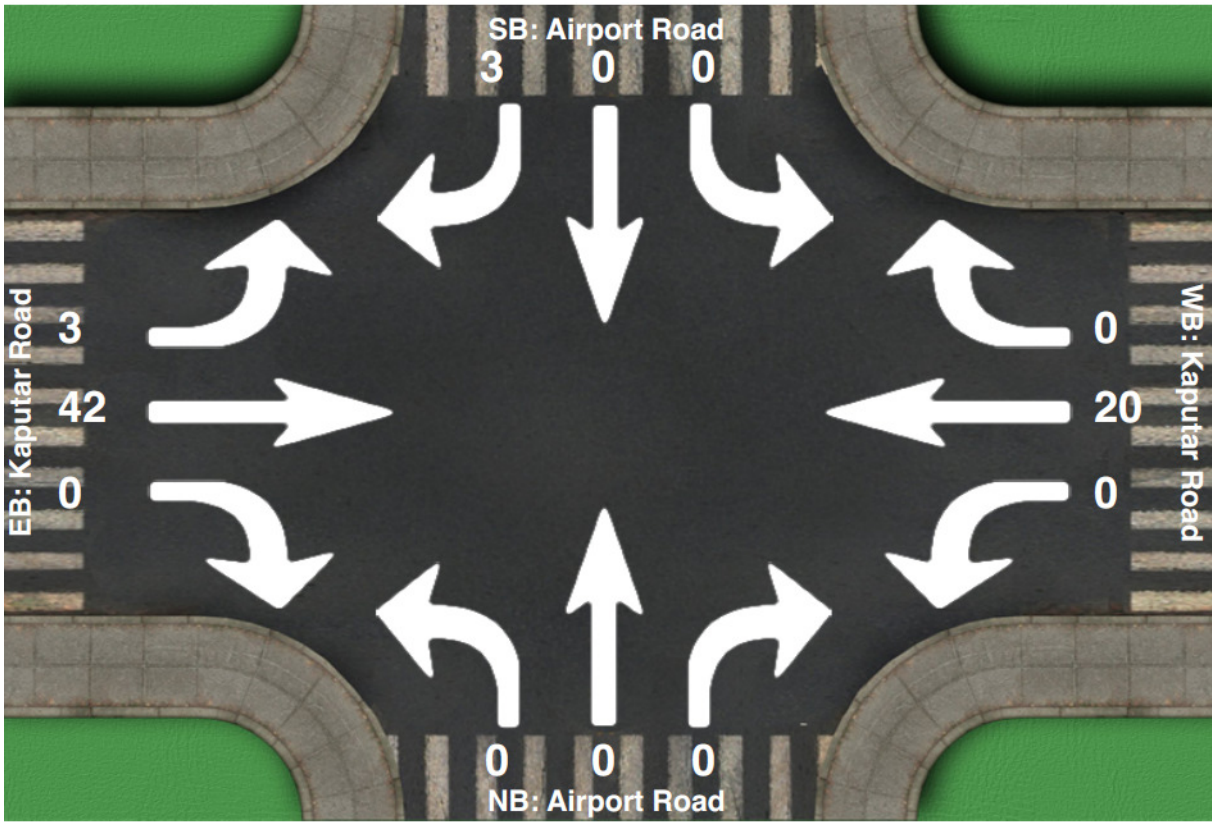
ATTACHMENT A
DEVELOPMENT PLANS



ATTACHMENT B
TRAFFIC COUNT DATA

Intersection Peak Hour

Location: Airport Road at Kaputar Road, Narrabri
GPS Coordinates: Lat=-30.319506, Lon=149.781525
Date: 2020-12-03
Day of week: Thursday
Weather:
Analyst: Lezette



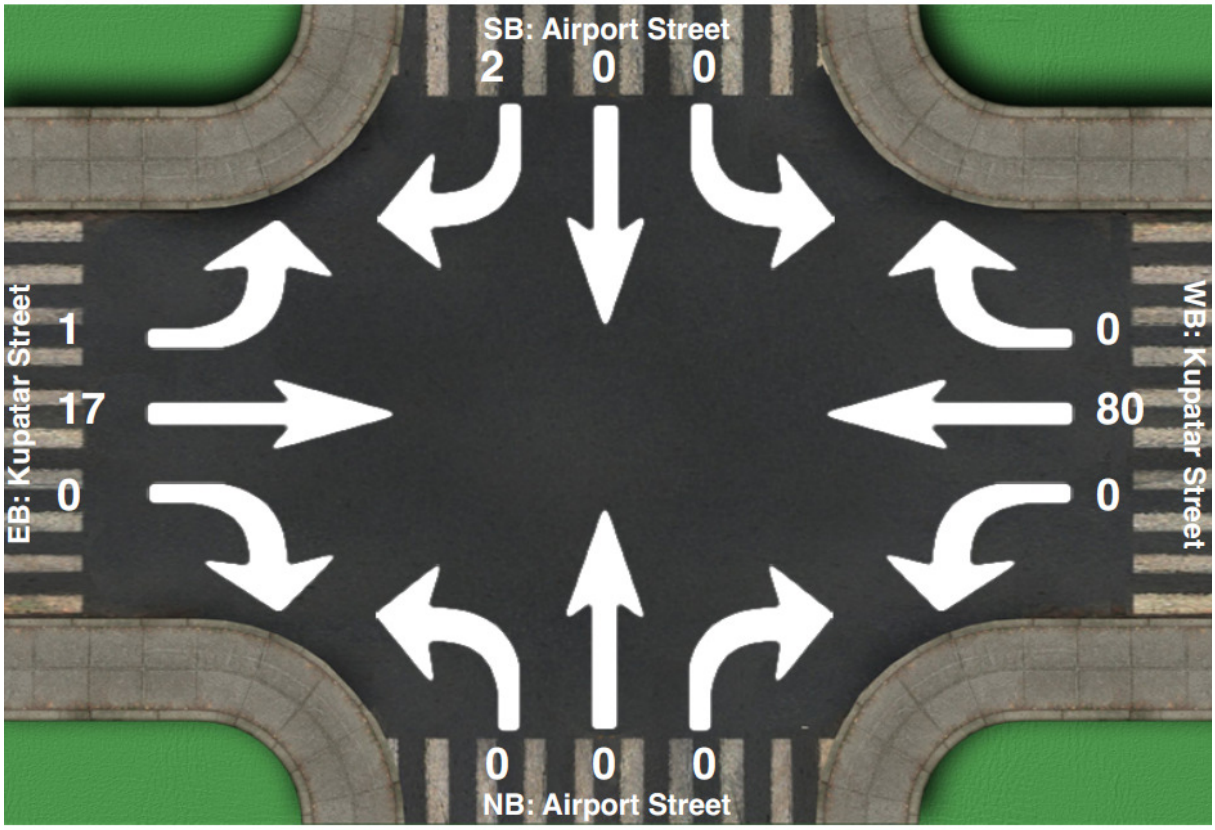
Intersection Peak Hour

15:00 - 16:00

	SouthBound			Westbound			Northbound			Eastbound			Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
Vehicle Total	0	0	3	0	20	0	0	0	0	3	42	0	68
Factor	0.00	0.00	0.38	0.00	0.71	0.00	0.00	0.00	0.00	0.75	0.95	0.00	0.89
Approach Factor	0.38			0.71			0.00			0.94			

Intersection Peak Hour

Location: Airport Street at Kupatar Street, Narrabri
GPS Coordinates: Lat=-30.347930, Lon=149.809599
Date: 2020-12-04
Day of week: Friday
Weather:
Analyst: Lezette



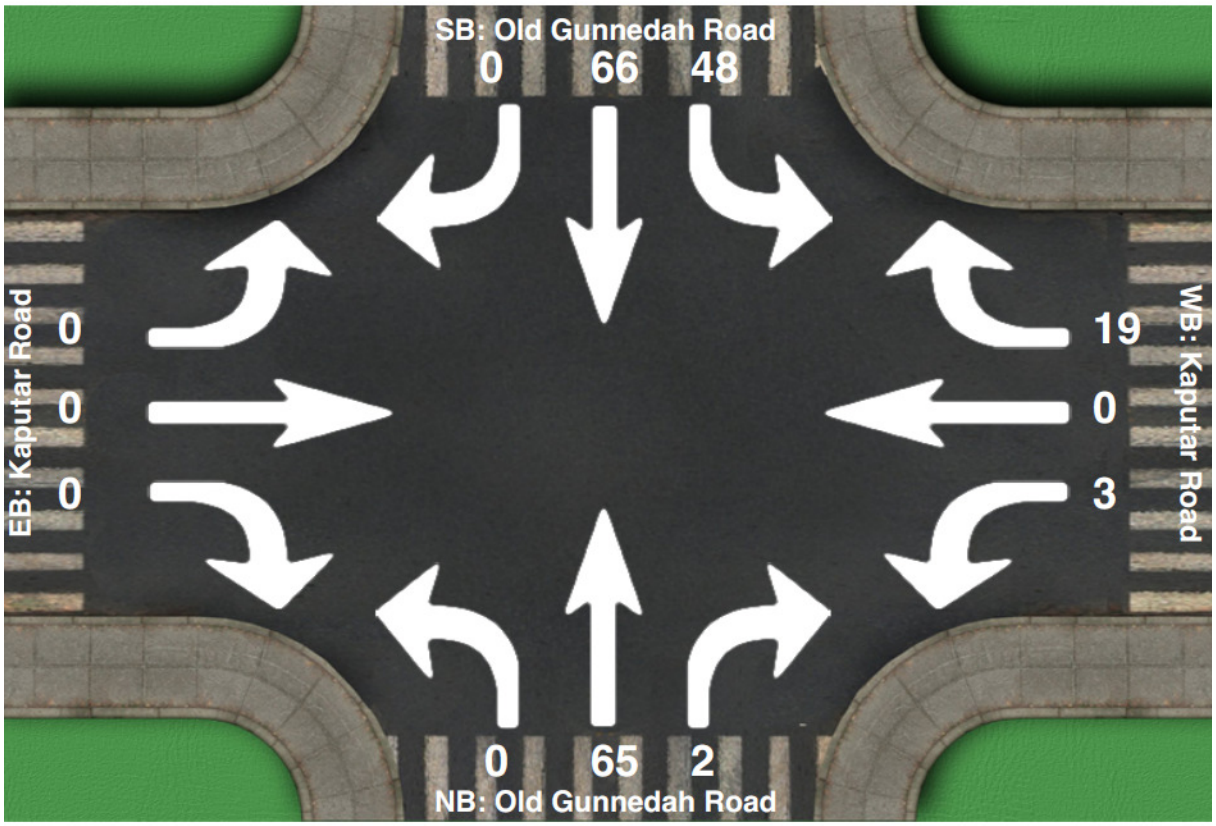
Intersection Peak Hour

08:00 - 09:00

	SouthBound			Westbound			Northbound			Eastbound			Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
Vehicle Total	0	0	2	0	80	0	0	0	0	1	17	0	100
Factor	0.00	0.00	0.50	0.00	0.74	0.00	0.00	0.00	0.00	0.25	0.71	0.00	0.78
Approach Factor	0.50			0.74			0.00			0.75			

Intersection Peak Hour

Location: Old Gunnedah Road at Kaputar Road, Narrabri
GPS Coordinates: Lat=-30.324583, Lon=149.782975
Date: 2020-12-03
Day of week: Thursday
Weather:
Analyst: Jeff



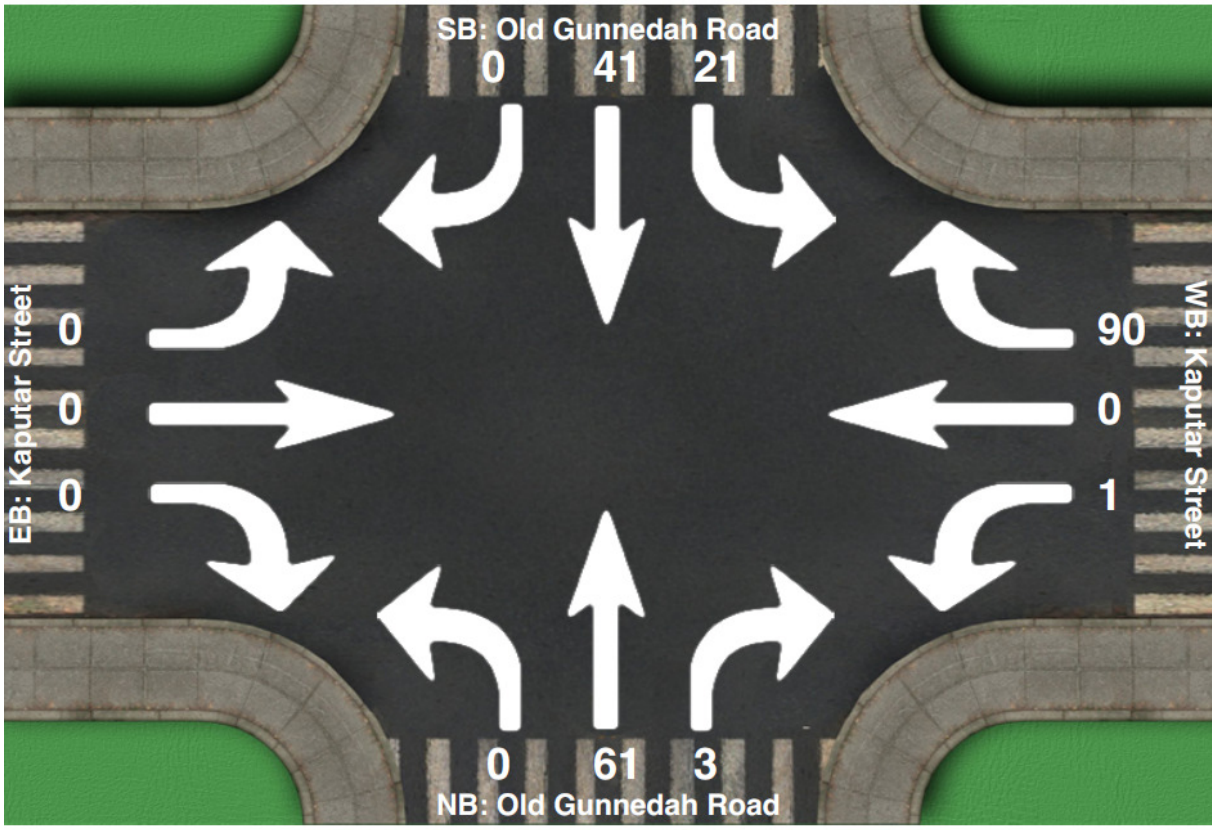
Intersection Peak Hour

15:00 - 16:00

	SouthBound			Westbound			Northbound			Eastbound			Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
Vehicle Total	48	66	0	3	0	19	0	65	2	0	0	0	203
Factor	0.80	0.87	0.00	0.75	0.00	0.59	0.00	0.74	0.25	0.00	0.00	0.00	0.78
Approach Factor	0.84			0.61			0.76			0.00			

Intersection Peak Hour

Location: Old Gunnedah Road at Kaputar Street, Narrabri
GPS Coordinates:
Date: 2020-12-04
Day of week: Friday
Weather:
Analyst: Jeff



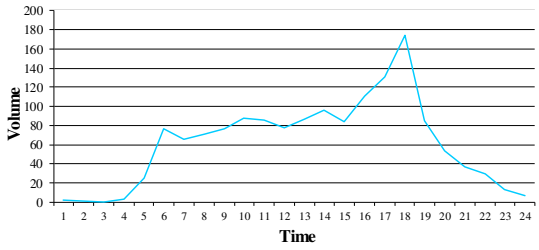
Intersection Peak Hour

08:00 - 09:00

	SouthBound			Westbound			Northbound			Eastbound			Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
Vehicle Total	21	41	0	1	0	90	0	61	3	0	0	0	217
Factor	0.66	0.64	0.00	0.25	0.00	0.68	0.00	0.80	0.38	0.00	0.00	0.00	0.82
Approach Factor	0.70			0.69			0.84			0.00			

Site 1 Old Gunnedah Rd N of Kaputa Rd [80] **Eastbound**

Day	*Fri*	*Sat*	*Sun*	*Mon*	*Tue*	*Wed*	*Thu*	*W/Day*	*W/End*	*7 Day*
Time	27/11/2020	28/11/2020	29/11/2020	30/11/2020	1/12/2020	2/12/2020	3/12/2020	*Ave.*	*Ave.*	*Ave*
0:00	1	4	9	3	1	2	2	2	7	3
1:00	0	2	4	0	4	3	0	1	3	2
2:00	2	5	2	0	1	1	0	1	4	2
3:00	5	1	1	2	1	3	6	3	1	3
4:00	23	20	14	22	26	24	30	25	17	23
5:00	57	36	30	76	89	83	78	77	33	64
6:00	66	24	18	62	74	70	57	66	21	53
7:00	71	50	45	68	75	80	61	71	48	64
8:00	66	59	45	66	86	76	88	76	52	69
9:00	93	87	78	93	84	95	76	88	83	87
10:00	81	105	84	81	85	82	100	86	95	88
11:00	87	96	83	77	82	66	74	77	90	81
12:00	90	104	99	71	95	85	93	87	102	91
13:00	112	85	74	90	99	86	91	96	80	91
14:00	101	62	53	80	88	79	74	84	58	77
15:00	139	64	55	104	100	97	115	111	60	96
16:00	122	66	92	127	132	128	145	131	79	116
17:00	164	75	78	172	183	183	167	174	77	146
18:00	84	82	60	87	91	79	84	85	71	81
19:00	63	46	48	51	57	57	40	54	47	52
20:00	41	40	27	27	31	53	32	37	34	36
21:00	31	28	15	26	31	33	29	30	22	28
22:00	30	19	6	4	12	9	11	13	13	13
23:00	17	18	4	5	3	5	4	7	11	8
Total	**1546**	**1178**	**1024**	**1394**	**1530**	**1479**	**1457**	**1481**	**1101**	**1373**

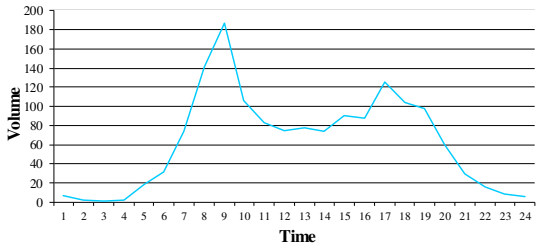


Summary

	from	to	
AM Peak	10:00 AM	11:00 AM	**100**
PM Peak	5:00 PM	6:00 PM	**183**
		Week Day Average	**1481**
		Weekend Day Average	**1101**
		7 Day Average	**1373**

Site 1 Old Gunnedah Rd N of Kaputa Rd [80] **Westbound**

Day	*Fri*	*Sat*	*Sun*	*Mon*	*Tue*	*Wed*	*Thu*	*W/Day*	*W/End*	*7 Day*
Time	27/11/2020	28/11/2020	29/11/2020	30/11/2020	1/12/2020	2/12/2020	3/12/2020	*Ave.*	*Ave.*	*Ave*
0:00	4	6	6	2	9	8	9	6	6	6
1:00	5	2	4	0	5	1	0	2	3	2
2:00	1	3	2	1	2	2	1	1	3	2
3:00	2	5	2	2	3	1	3	2	4	3
4:00	17	9	3	16	22	19	20	19	6	15
5:00	28	11	8	30	35	33	33	32	10	25
6:00	57	47	40	73	88	83	68	74	44	65
7:00	121	74	57	149	127	150	159	141	66	120
8:00	185	94	58	185	190	195	181	187	76	155
9:00	107	104	101	107	112	104	102	106	103	105
10:00	91	99	93	91	74	70	88	83	96	87
11:00	80	88	63	73	72	76	74	75	76	75
12:00	82	74	71	79	78	76	74	78	73	76
13:00	85	78	56	68	82	65	72	74	67	72
14:00	112	53	69	79	101	70	92	91	61	82
15:00	109	62	59	74	86	87	84	88	61	80
16:00	106	81	73	121	151	134	114	125	77	111
17:00	88	77	66	97	123	108	105	104	72	95
18:00	104	101	82	105	101	98	80	98	92	96
19:00	62	75	57	54	58	73	52	60	66	62
20:00	39	20	25	26	30	25	27	29	23	27
21:00	17	27	20	12	17	15	20	16	24	18
22:00	11	13	2	4	9	8	11	9	8	8
23:00	9	8	6	6	2	8	5	6	7	6
Total	**1522**	**1211**	**1023**	**1454**	**1577**	**1509**	**1474**	**1507**	**1117**	**1396**



Summary

	from	to	
AM Peak	8:00 AM	9:00 AM	**195**
PM Peak	4:00 PM	5:00 PM	**151**
		Week Day Average	**1507**
		Weekend Day Average	**1117**
		7 Day Average	**1396**

ATTACHMENT C
TRAFFIC GENERATION INFORMATION

PROVIDENCE ASSET GROUP

Preliminary Solar Farm Vehicle Movement Guidance

27/03/2020

1 Traffic Generated by Construction Works

During the construction of the solar farm, it is estimated that approximately 50 x 40 ft containers will be transported to site. Added to these containers are waste traffic, equipment, temporary installations and workforce transport to and from site. A logistics agent will be engaged to manage the freight from the delivery port [TBC] to the solar farm site.

An estimation of the traffic created by the worksite is provided in Figure 1, below.

The vehicular traffic for the transport vehicles is based on a 3-axle rigid truck. The General Mass Limit (GML) for a 3-axle load is assumed to be 20 tonnes based on The Australian Trucking Association's 'Technical Advisory Procedure for Truck Configurations' [24]. Depending on the availability of vehicles it may be possible that a conventional B-doubles will transport equipment to site. The GML for this vehicle is 40 tonnes. In this case the vehicular traffic for the container loads will reduce by a factor of 2 for each B-double transporting equipment to site.

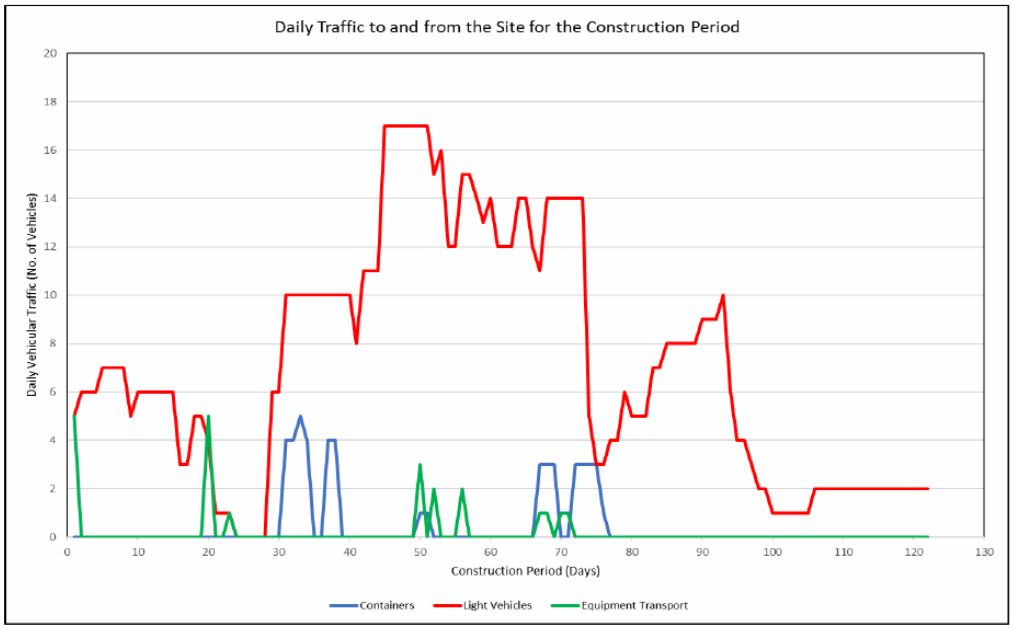


Figure 1 - Daily Traffic to and from Site for the Construction Period

At the peak of the equipment supply, the number of transport vehicles entering and leaving the solar farm site will be 4 to 5 daily for a period of just over a month into the construction period. There will be another busy week midway through the construction period where there will be approximately 3 transport vehicles entering and leaving the site daily.

All heavy transport to and from the site will predominantly be on standard working days between 8am and 4pm.

It is anticipated that there will be up to 30 personnel working on the site during the construction period that will generate the anticipated light vehicle traffic.

The light traffic will be concentrated at the beginning and the end of the day around 6-7am and 4-5pm. The container transport will be concentrated between 10am and 3pm.

2 Impact on Existing Traffic

With a maximum of eight to ten light vehicles and six to eight heavy vehicles travelling to and from the site daily, it is not anticipated that the increased traffic due to construction works will have any significant impact on the existing traffic.

3 Additional Road Signage of Existing Road

It is suggested that road signage is provided for the proposed site entrance on Manilla Road. The recommended locations of the warning signs be placed at distances of 200 metres approaching the intersection to the north and south. The warning signs will indicate that it is a construction site entrance. The entrance to the site on Mannum Road will be designed for the anticipated heavy transport loads volumes during the construction period that are detailed in Section 1. A Traffic Control Plan will be submitted to the DPTI Traffic Management Centre for approval, with all signage to be placed and maintained to the satisfaction of the Commissioner of Highways.

4 Parking

All parking for site personnel will be on site. This will be sign posted at the site entrance. Balance will not permit parking on Mannum Road and will incorporate this in the site induction.

5 O&M Traffic

Once the solar farm has been constructed and has entered the “operations and maintenance” stage the traffic onto site will consist of light vehicles, with few exceptions, at a frequency of 1 to 5 visits per fortnight.

5MW Solar Farm - Typical Vehicle Movements			
Construction - Major Equipment	Load	Quantity	Comments
Piling & Tracker Components	40' Container / Trailer	24	Doubles if permitted / practical
PV Modules	40' Container / Trailer	26	Doubles if permitted / practical
Switchgear	20' Container / Trailer	1	
Inverters	20' Container / Trailer	2	
Cranes	~50T	3	
Cables	40' Container / Trailer	2	Doubles if permitted / practical
Balance of Plant (BOP)	40' Container / Trailer	3	
Civil Plant	Float or Drop Deck	8	4ea at mob / demob
Piling Plant	Float or Drop Deck	4	2ea at mob / demob
Site Facilities	Float/Drop Deck/40' Trailer	8	4ea at mob / demob
Light trucks - 6 wheelers	local deliveries - sand, gen fteight etc	10	
Light trucks - 4 wheelers	local deliveries - sand, gen fteight etc	10	
		101	
Construction - Light Vehicles / Other	Load	Quantity	Comments
Light Vehicle - 4WD ute or similar	Personell / tools	384	Average 4 per day
Light Vehicle - ?	Workforce private vehicles	576	Average 6 per day - depends on engagement of workforce
		960	
O&M	Load	Quantity	Comments
Light Vehicle - 4WD ute or similar	fortnightly inspection	30	1 per fortnight, plus additional
Light Vehicle - 4WD ute or similar	3 monthly Inspections	8	2 visits, 4 times per year
Light Vehicle - 4WD ute or similar	Faults	4	
Light trucks - 4 wheelers	PV Module cleaning	2	Once per Year
		44	

Torrent Consulting Pty Ltd
86 Blanch Street
Shortland NSW 2307

ABN 11 636 418 089

www.torrentconsulting.com.au

Our Ref: DJW: L.T2104.003.docx

3 February
Providence Asset Group
Suite 704, 97-99 Bathurst Street
Sydney NSW 2000
Attention: Jeremy Every

Dear Jeremy

RE: FLOOD IMPACT ASSESSMENT FOR PROPOSED NARRABRI SOLAR FARM AT LOT 489 DP754944, AIRPORT ROAD, NARRABRI NSW

Background

Torrent Consulting was engaged to undertake a Flood Impact Assessment to assist in the DA process for the proposed Narrabri Solar Farm at Airport Road (Lot 489 DP754944), Narrabri, NSW (the Site). It is understood that Council has identified the site as being potentially at risk of flooding, with existing flood information available in the Narrabri Flood Study (WRM, 2016) and the Narrabri Floodplain Risk Management Study and Plan (WRM, 2019).

The Site is located at the edge of the right floodplain of Namoi River (as presented in Figure 1), the catchment area of which totals over 25 000 km^2 at Narrabri. The Site is also affected by breakout flows from Horsearm Creek, some 3 km to the north. Local catchment drainage also traverses the northern end of the Site, conveying runoff from the hillslopes to the east through to Horsearm Creek. The local catchment is over 3 km^2 upstream of the Site.

There are no existing design flood conditions for the local catchment at the Site. The assessment therefore includes the development of a TUFLOW model. This model will provide a platform to assess the potential flood impacts associated with the proposed development. It will also enable a more detailed understanding of the local flood depths, velocities and hazards.

Model Development

For this assessment, a TUFLOW hydraulic model was developed covering the site and the local contributing catchment area, which is around 3 km^2. The model utilised the NSW Spatial Services LiDAR data product, downloaded via the ELVIS Foundation Spatial Data portal to define the local topography, as presented in Figure 2.

As the Site is potentially impacted by flooding from the Namoi River, the model extent also includes the right floodplain of the Namoi, as presented in Figure 3. The model was constructed using a 5 m grid cell resolution, sampling elevations from the LiDAR data.

Land use coverage in the catchment was digitised using aerial imagery, to distinguish between cleared land and areas of remnant vegetation. The cleared land was assigned a Manning's 'n' roughness coefficient of 0.06, with areas of remnant vegetation being assigned an 'n' value of 0.12.

The boundaries of the model were configured to reproduce flooding from the Namoi River as presented in the Narrabri Floodplain Risk Management Study and Plan. An upstream inflow boundary was applied to represent floodplain flows within the modelled area, with a downstream boundary to represent tailwater

levels. The flows and levels were estimated using information contained in the Narrabri Floodplain Risk Management Study and Plan. Following initial model simulations these flows and levels were adjusted until the modelled flood extents and levels matched those in the Narrabri Floodplain Risk Management Study and Plan mapping. Direct rainfall input was applied to the upstream hillslopes to the east to simulate catchment runoff and any resultant local flooding.

Design Flood Hydrology

The TUFLOW model was simulated (using the HPC solver) for the 5% AEP, 1% AEP and 0.5% AEP design rainfall events for storm durations ranging from two hours to nine hours. The design rainfall depths were sourced from the BoM IFD (Intensity Frequency Duration) portal. An Areal Reduction Factor (ARF) was applied to the design point rainfall using the contributing catchment area of 3 km^2 upstream of the Site. ARFs calculated in accordance with ARR 2019 for the Central NSW ARF region range from around 0.96 at the 2-hour duration to 1.0 at the 9-hour duration.

Design rainfall losses considered the recent NSW-specific guidance and initial losses of 8-15 mm and 16-18 mm (for the 1% AEP and 5% AEP respectively) and a continuing loss of 0.4 mm/h were adopted accordingly.

The ARR 2019 guidelines ensemble method to design flood hydrology involves the simulation of ten rainfall temporal patterns for each design event magnitude and duration, with the average condition of the ten being adopted for design purposes. The point rainfall temporal patterns provided for the Central Slopes temporal rainfall region were adopted for the ensemble method accordingly.

The TUFLOW model simulations were analysed at the point of discharge next the Site to identify the critical duration, i.e. that which produces the peak flood flows for each design event magnitude. This is undertaken by calculating the average peak flood flow and the peak flood flow variance of the ten simulated hydrographs for each design event duration and magnitude. The 4.5-hour duration was identified as being critical for the 5% AEP event, with the 3-hour being critical for the 1% AEP and 0.5% AEP events. The design temporal pattern IDs 2339 and 2282 were selected for the 5% AEP and 1% AEP events respectively, as producing hydrographs most representative of the mean design condition from the results of the ensemble method.

For the simulation of the PMF (Probable Maximum Flood) condition the Generalised Short Duration Method (GSDM) published by the BoM was adopted. Events for the 15-minute to 2-hour durations were simulated to determine the critical conditions. This found the Probable Maximum Precipitation (PMP) for the 1.5-hour duration to be critical, with a rainfall depth of 480 mm (320 mm/h intensity). The simulated peak design flows discharging from the Site are summarised in Table 1.

Table 1 – Modelled Peak Design Flows (m^3/s)

Design Event	Site Outlet
5% AEP 4.5-hour (2339)	8.0
1% AEP 3-hour (2282)	13.7
0.5% AEP 3-hour (2282)	20.5
PMF 1.5-hour (GSDM)	234

Note: contents of parentheses denote the adopted design temporal pattern ID

Baseline Design Flood Conditions

The TUFLOW hydraulic model was simulated (using the HPC solver) for the adopted design flood hydrology. Figure 4 presents the modelled peak flood extents at the Site for the 5% AEP, 1% AEP and PMF events. Figure 5, Figure 6, Figure 7 and Figure 8 are presented for additional context and show the modelled peak flood depths and peak flood level contours for the 5% AEP, 1% AEP, 0.5% AEP and PMF (Extreme Flood Event for the Namoi River floodplain) events respectively.

Figure 9, Figure 10, Figure 11 and Figure 12 present the flood hazard classification at the Site for the 5% AEP, 1% AEP, 0.5% AEP and PMF (Extreme Flood Event for the Namoi River floodplain) events respectively. The flood hazards have been determined in accordance with Guideline 7-3 of the Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia (AIDR, 2017). This produces a six-tier hazard classification, based on modelled flood depths, velocities and velocity-depth product. The hazard classes relate directly to the potential risk posed to people, vehicles and buildings, as presented in Chart 1.

The flood hazard mapping is useful for providing context to the nature of the modelled flood risk and to identify potential constraints for development of the Site with regards to floodplain risk management. The principal consideration of good practice floodplain risk management is to ensure compatibility of the proposed development with the flood hazard of the land, including the risk to life and risk to property.

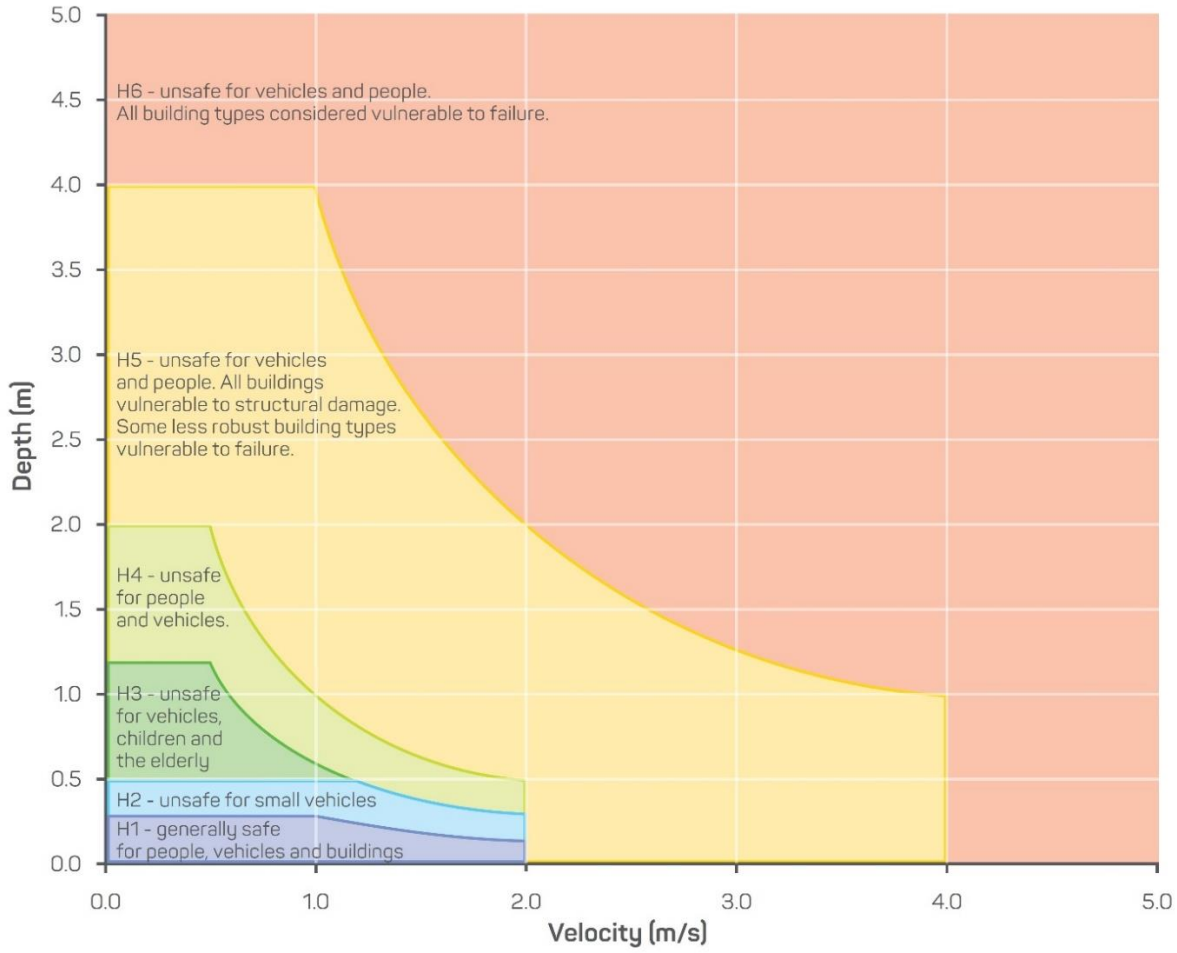


Chart 1 – General Flood Hazard Vulnerability Curves (AIDR, 2017)

The modelled flood conditions show that the Site is unaffected by local catchment flooding. Whilst the northern area of the Lot is flood-prone, the southern area in which the Solar Farm is to be located is flood-free at the 1% AEP and 0.5% AEP events. The Site is not totally free from flood risk, however, as it can potentially become inundated by a local catchment PMF event or an Extreme Flood event of the Namoi River. For an Extreme Flood of the Namoi River the modelled flood hazards would be expected to damage infrastructure. However, for a local catchment PMF event the resultant flood hazard within the proposed Solar Farm footprint is only low (H1 or H2), as presented in Figure 13.

Flood Impact Assessment

The principal consideration of good practice floodplain risk management is to ensure compatibility of the proposed development with the flood hazard of the land, including the risk to life and risk to property. Requirements within a Council's LEP (Local Environment Plan) and DCP (Development Control Plan) typically consider the management of flood risk, with the application of an FPL (Flood Planning Level) being the principal control measure. The standard FPL for residential development in NSW is the 1% AEP flood level plus a 0.5 m freeboard. However, requirements for non-residential development can vary significantly.

The objective of the management of risk to property is to minimise the damages that would be incurred in the event of a flood. This includes potential damage to future building structures and their contents, and critical infrastructure and services. Risk to property is typically managed to the 1% AEP design flood event.

The flood modelling results show that at the 1% AEP event (and the 0.5% AEP event) the proposed solar farm infrastructure is unaffected by flooding.

The objective of the management of risk to life is to minimise the likelihood of deaths in the event of a flood and is typically considered for rarer flood events than the 1% AEP, up to the PMF. Ample flood-free refuge is available on-site if people are present during a local catchment flood PMF event. For an Extreme Flood of the Namoi River the entire Site would be inundated. It is advised that the Solar Farm be closed to site visitors in the event of a Major Flood Warning being issued by the BoM for the Namoi River to manage this minimal risk. This course of action is advisable regardless of risk to the Site, as local and regional roads could be flood-affected, preventing Site access.

In addition to the management of flood risk exposure of the proposed development, the potential for off-site flood impacts to the existing baseline flood conditions also need to be considered to avoid adverse impacts to neighbouring property and infrastructure. However, as the proposed Solar Farm is only inundated in an extreme flood event, the potential for adverse off-site flood impacts is negligible and therefore further consideration of flood impacts is not required.

Conclusion

Torrent Consulting was engaged to undertake a Flood Impact Assessment to assist in the DA process for the proposed Narrabri Solar Farm.

This assessment has included development of a TUFLOW model for the local catchment runoff and has simulated design flood conditions in accordance with the ARR 2019 guidelines, specifically the ensemble method for design flood hydrology. The main river flood conditions of the Namoi River have also been reproduced, using information contained in the Narrabri Floodplain Risk Management Study and Plan.

Flood hazard mapping has been produced that shows that the Site is of a low flood risk and is suitable for the proposed solar farm.

The flood modelling results show that at the 1% AEP event (and the 0.5% AEP event) the proposed solar farm infrastructure is unaffected by flooding, with the Solar Farm area being flood-free.

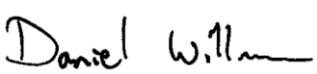
Ample flood-free refuge is available on-site if people are present during a local catchment flood event and all but an Extreme Flood event of the Namoi River, during which the entire Site would be inundated. It is advised that the Solar Farm be closed to site visitors in the event of a Major Flood Warning being issued by the BoM for the Namoi River to manage this minimal risk. This course of action is advisable regardless of risk to the Site, as local and regional roads could be flood-affected, preventing Site access.

As the proposed Solar Farm is only inundated in an extreme flood event, the potential for adverse off-site flood impacts is negligible and therefore further consideration of flood impacts is not required.

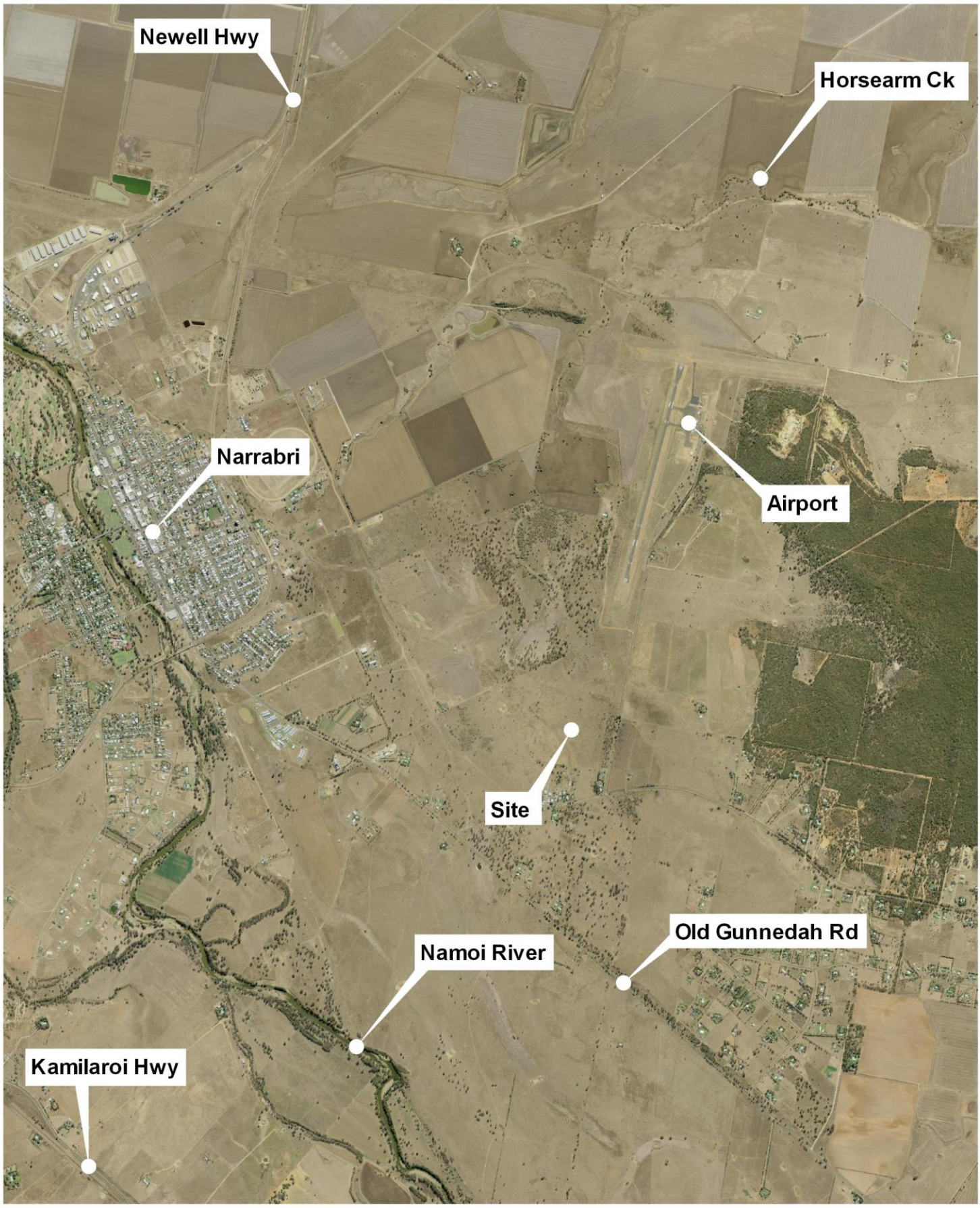
We trust that this report meets your requirements. For further information or clarification please contact the undersigned.

Yours faithfully

Torrent Consulting



Dan Williams
Director



Title:

Study Locality

0 1 2 km

approx. scale

Figure: 1

Revision: A

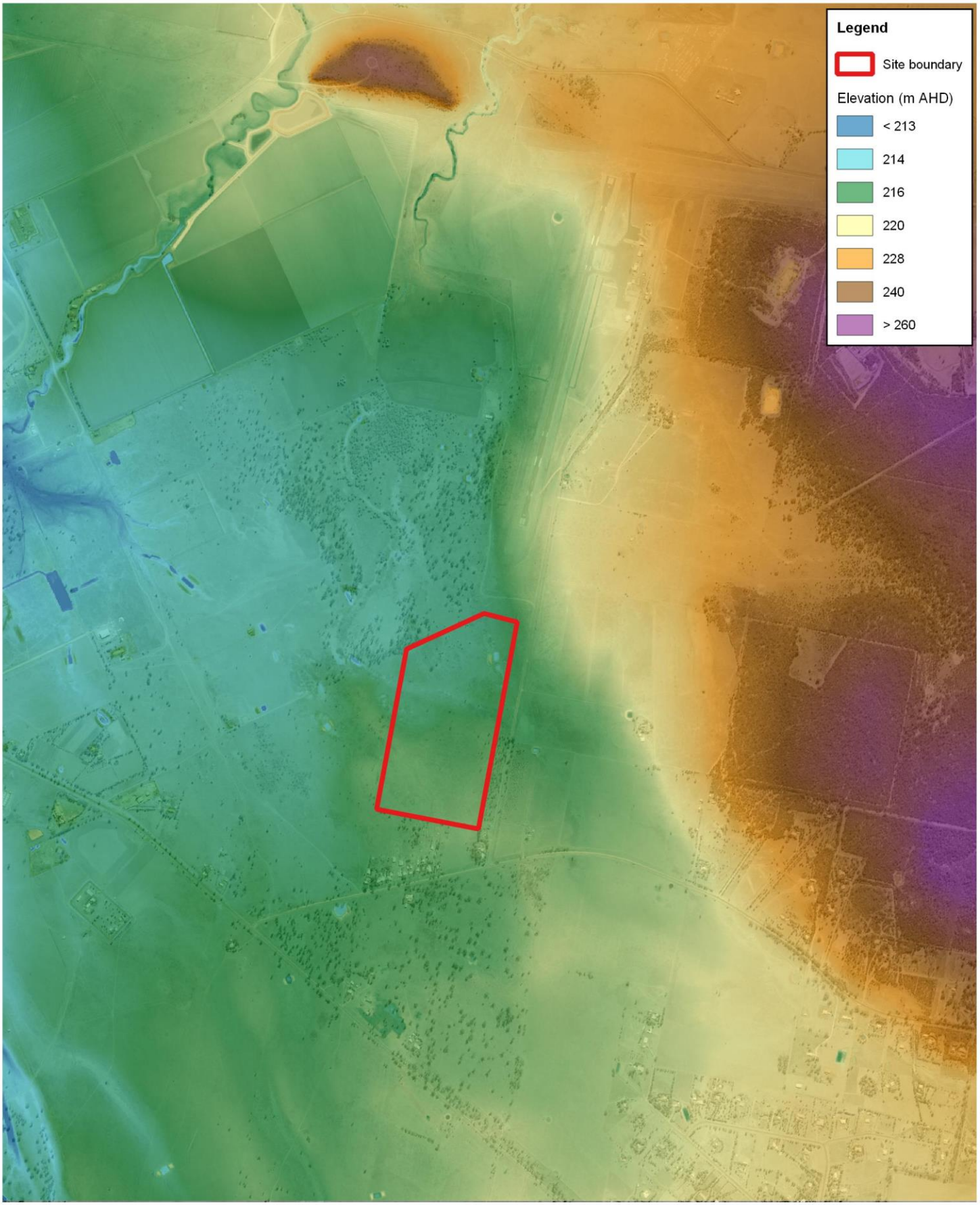
Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING

www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_005_210202_Locality.qgz



Title:

Local Topography

0 0.6 1.2 km

approx. scale

Figure: 2

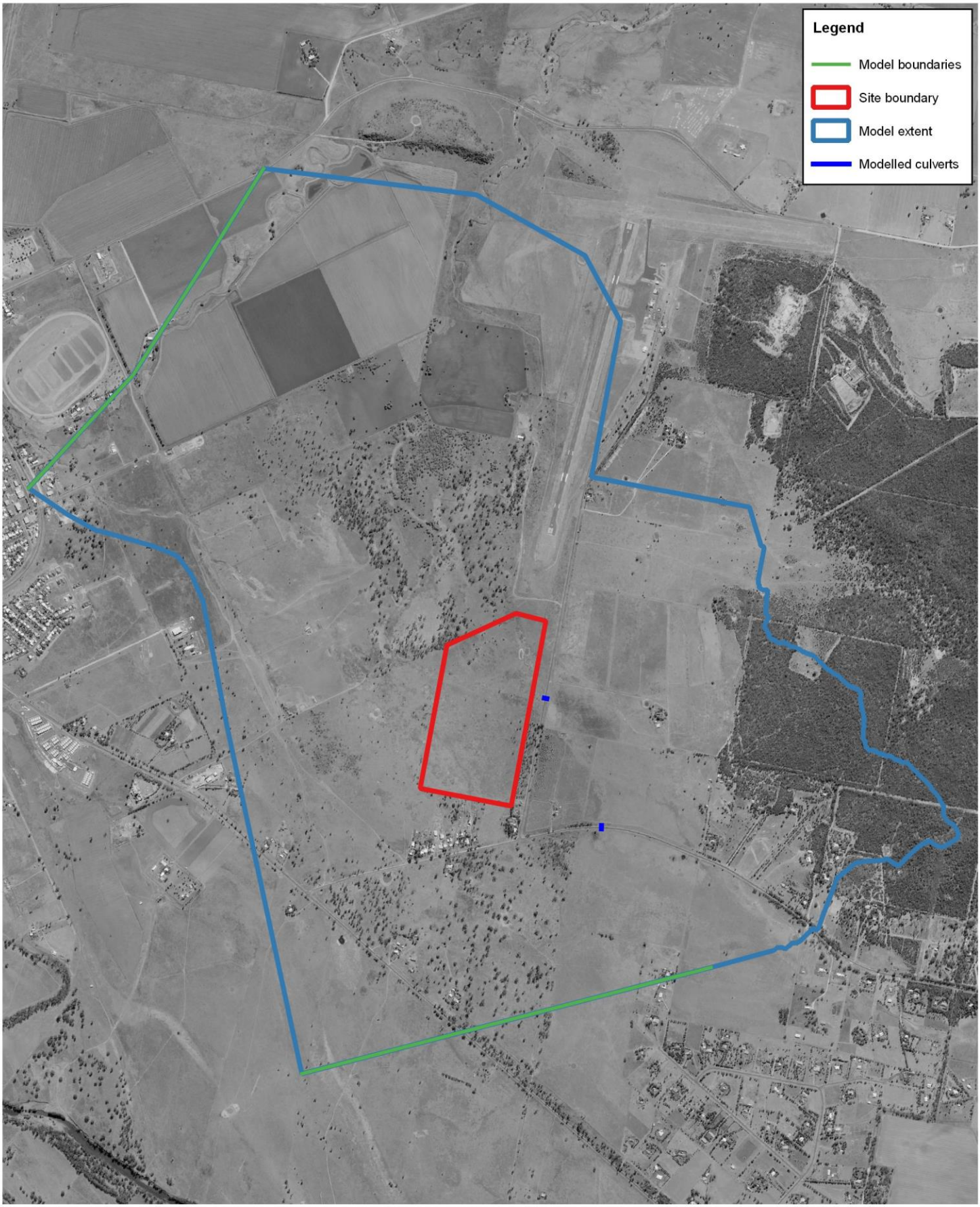
Revision: A

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_006_210202_Topography.qgz



Title:

TUFLOW Model Components

0 0.7 1.4 km

approx. scale

Figure: 3

Revision: A

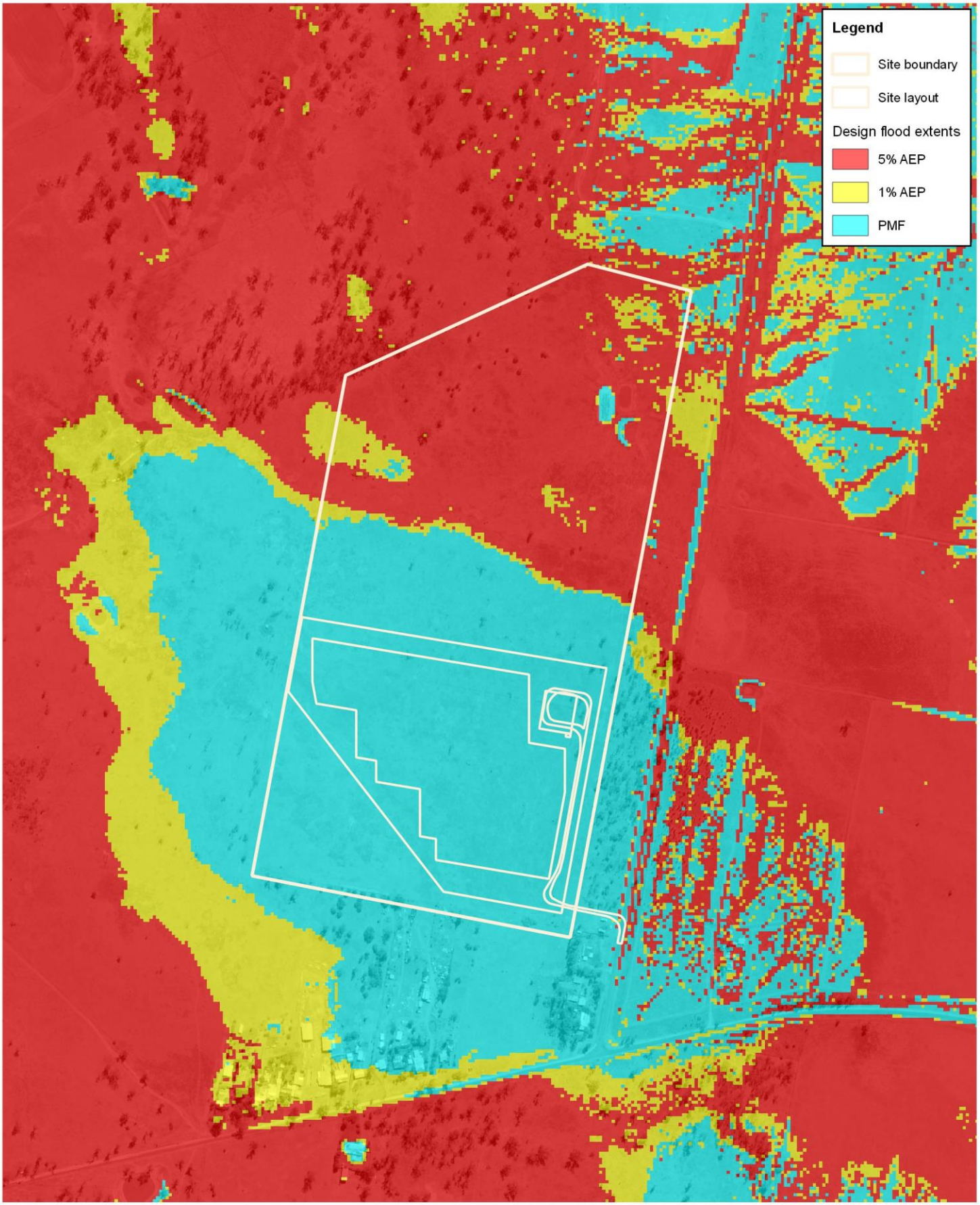
Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING

www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_007_210202_TUFLOW.qgz



Title:

Modelled Flood Extents and Site Layout

0 200 400 m

approx. scale

Figure: 4

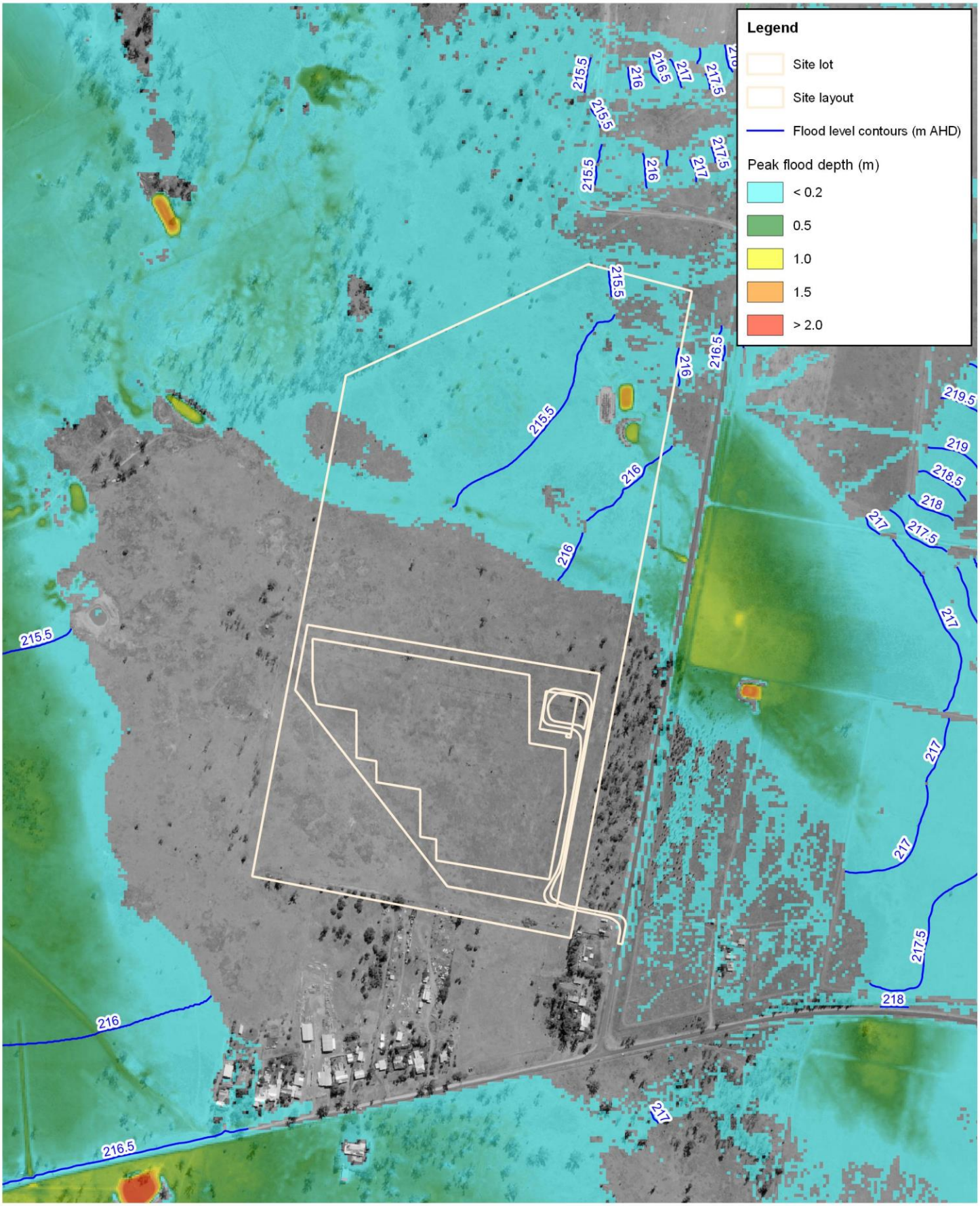
Revision: A

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_008_210202_Extents.qgz



Title:

Modelled 5% AEP Flood Depths and Levels

0 200 400 m

approx. scale

Figure: 5

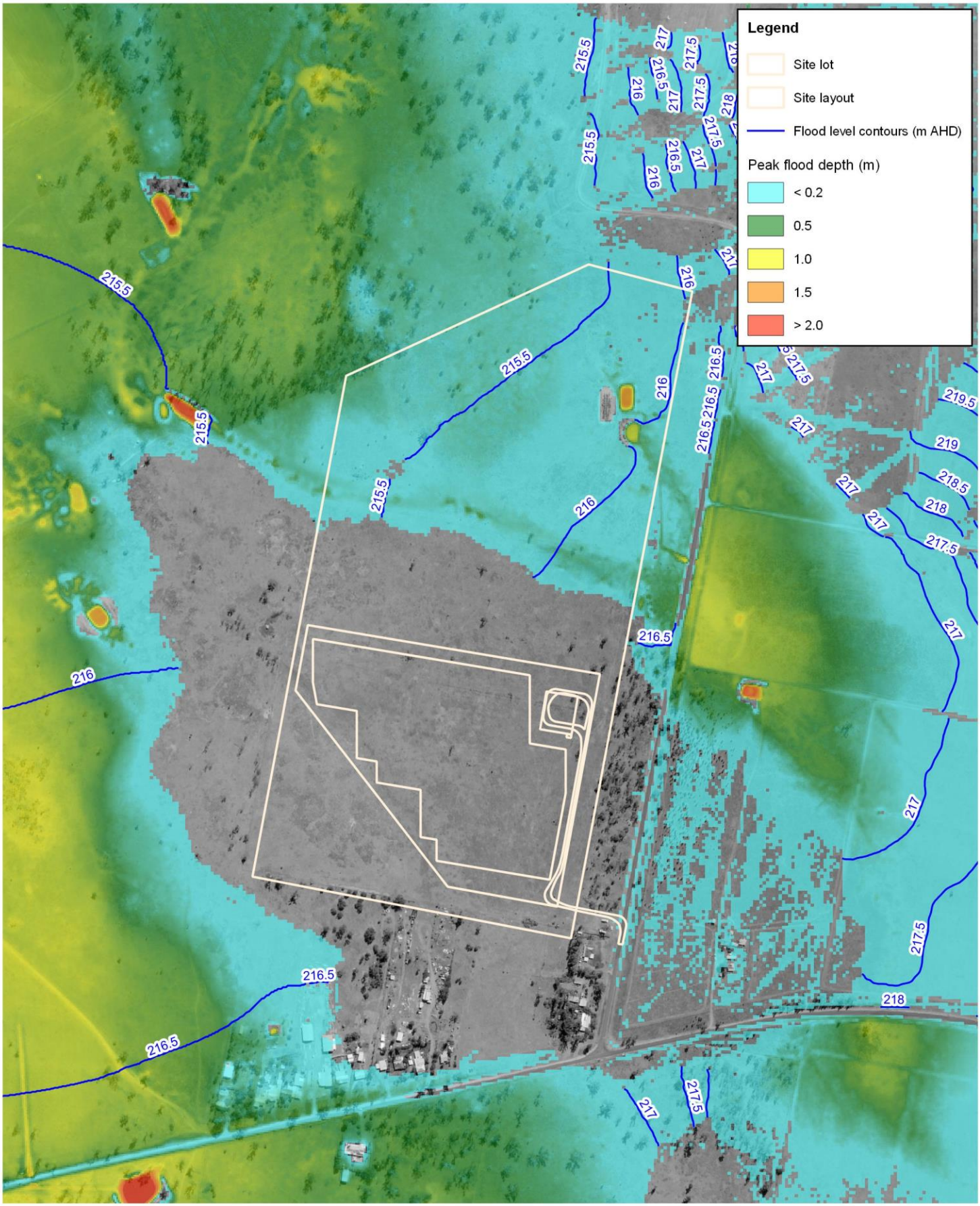
Revision: A

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_009_210202_20y_levels.qgz



Title:

Modelled 1% AEP Flood Depths and Levels

0 200 400 m

approx. scale

Figure: 6

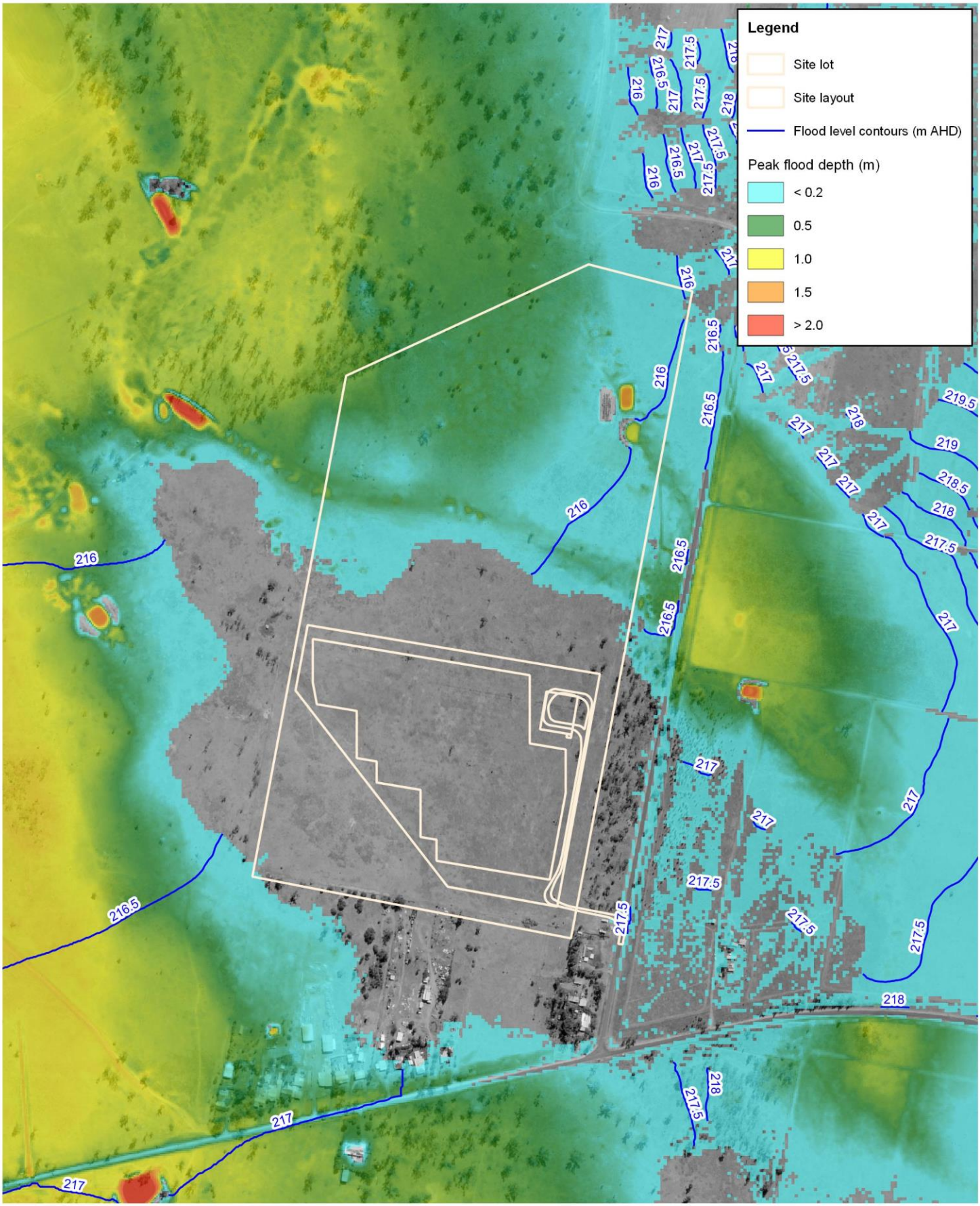
Revision: A

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_001_210121_100y_levels.qgz



Title:

Modelled 0.5% AEP Flood Depths and Levels

0 200 400 m

approx. scale

Figure: 7

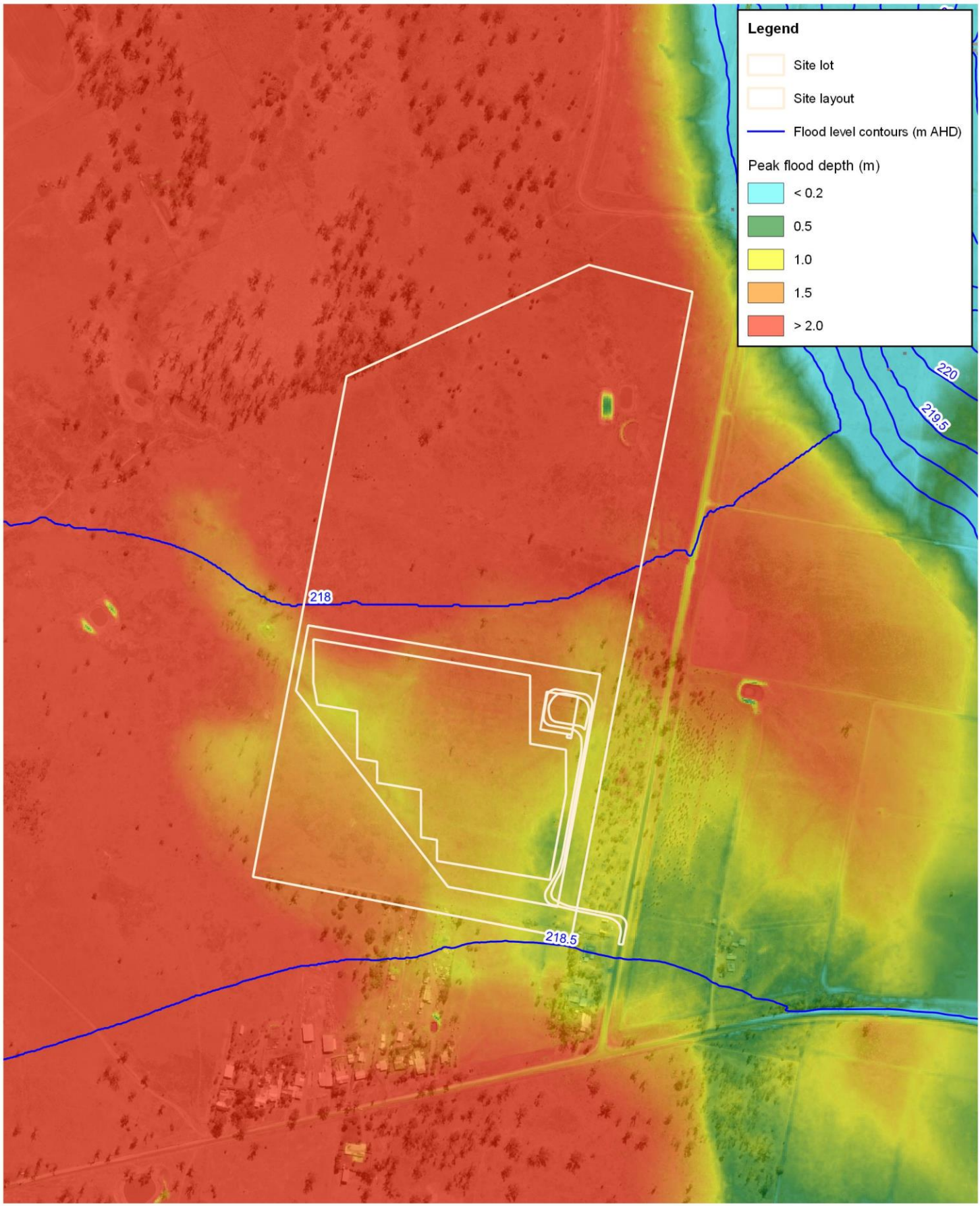
Revision: A

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_003_210121_200y_levels.qgz



Title:

Modelled PMF/Extreme Flood Depths and Levels

0 200 400 m

approx. scale

Figure: 8

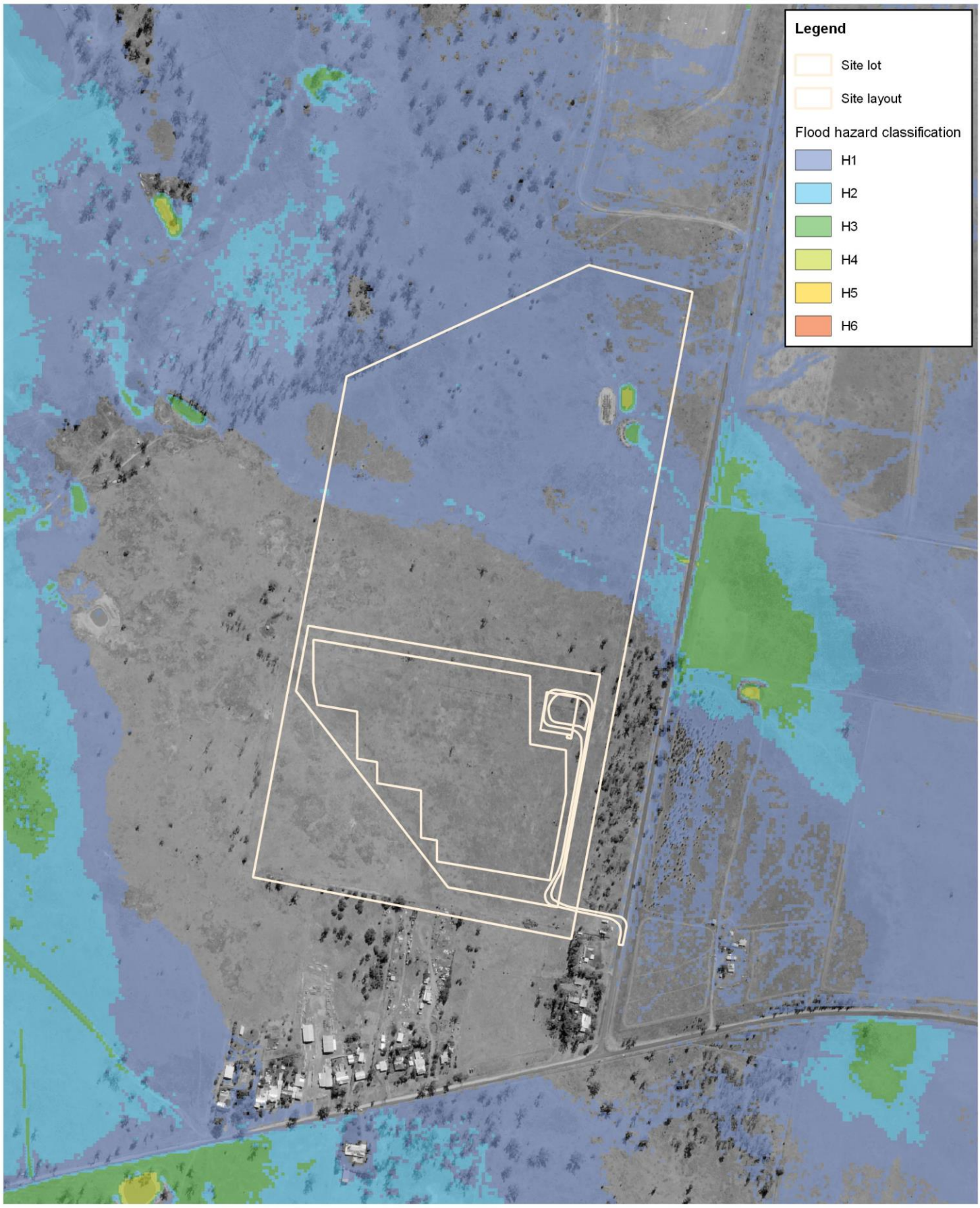
Revision: A

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_010_210202_pmf_levels.qgz



Title:

5% AEP Flood Hazard Classification

0 200 400 m

approx. scale

Figure: 9

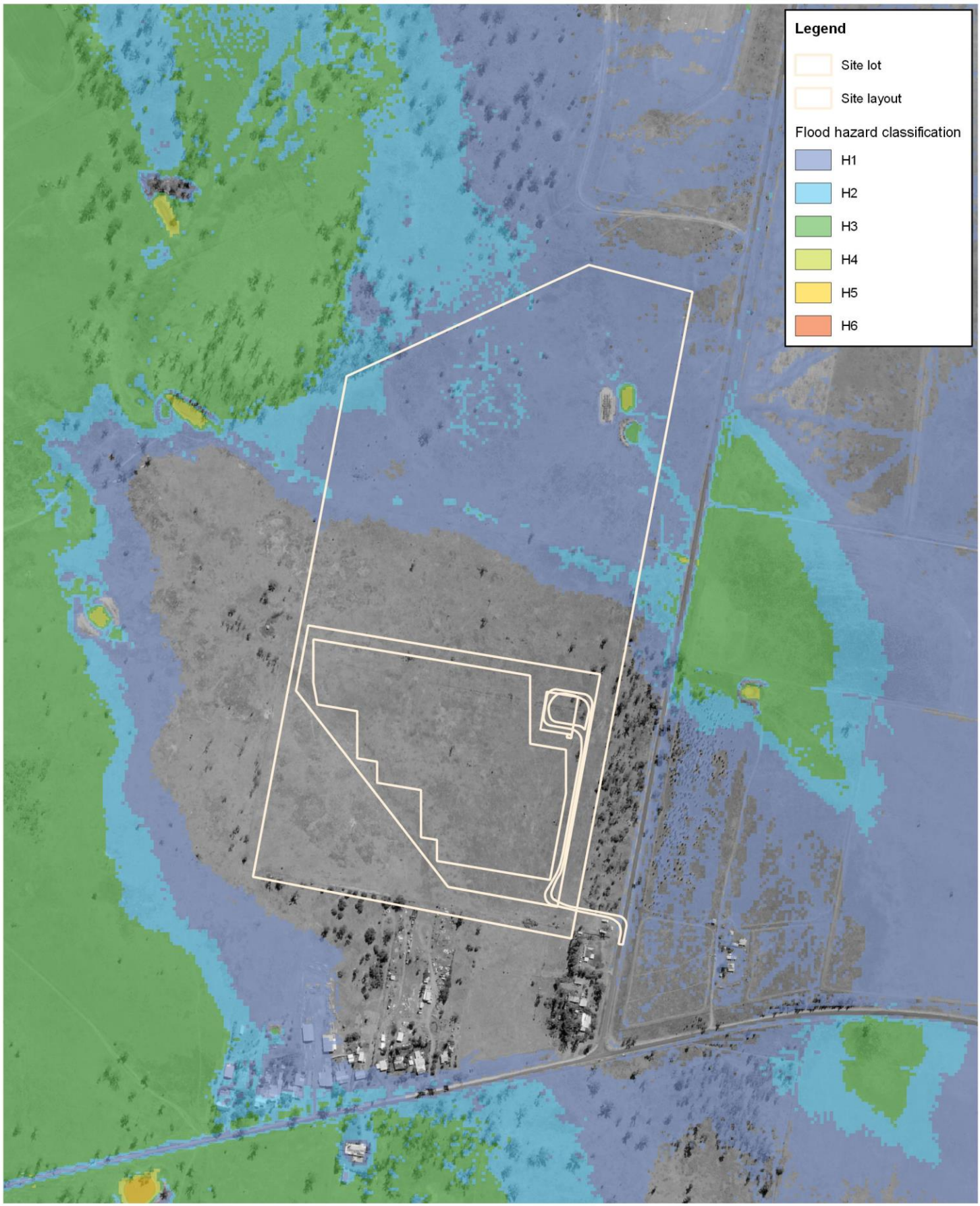
Revision: A

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_011_210202_20y_hazard.qgz



Title:

1% AEP Flood Hazard Classification

0 200 400 m

approx. scale

Figure: 10

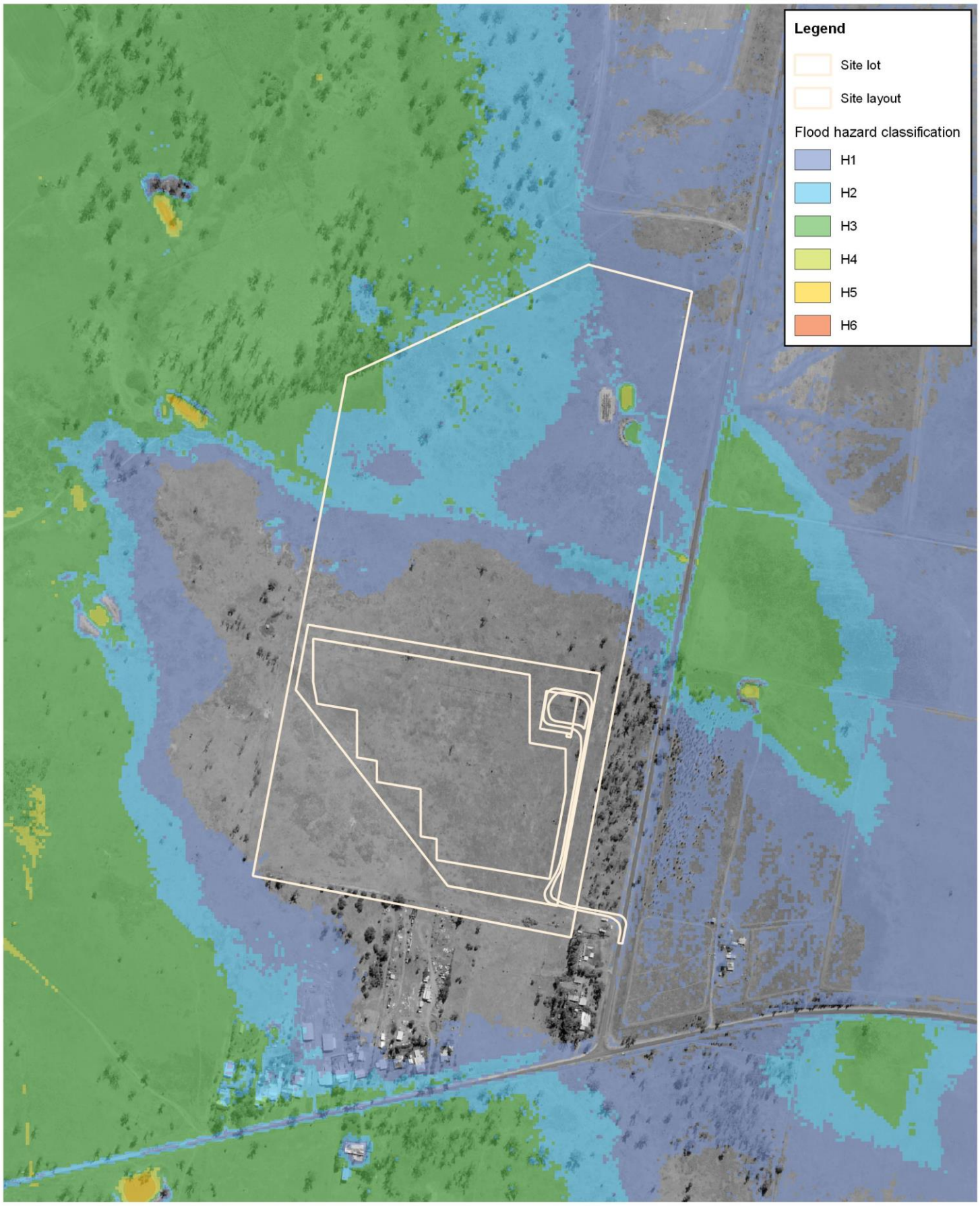
Revision: A

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_012_210202_100y_hazard.qgz



Title:

0.5% AEP Flood Hazard Classification

0 200 400 m

approx. scale

Figure: 11

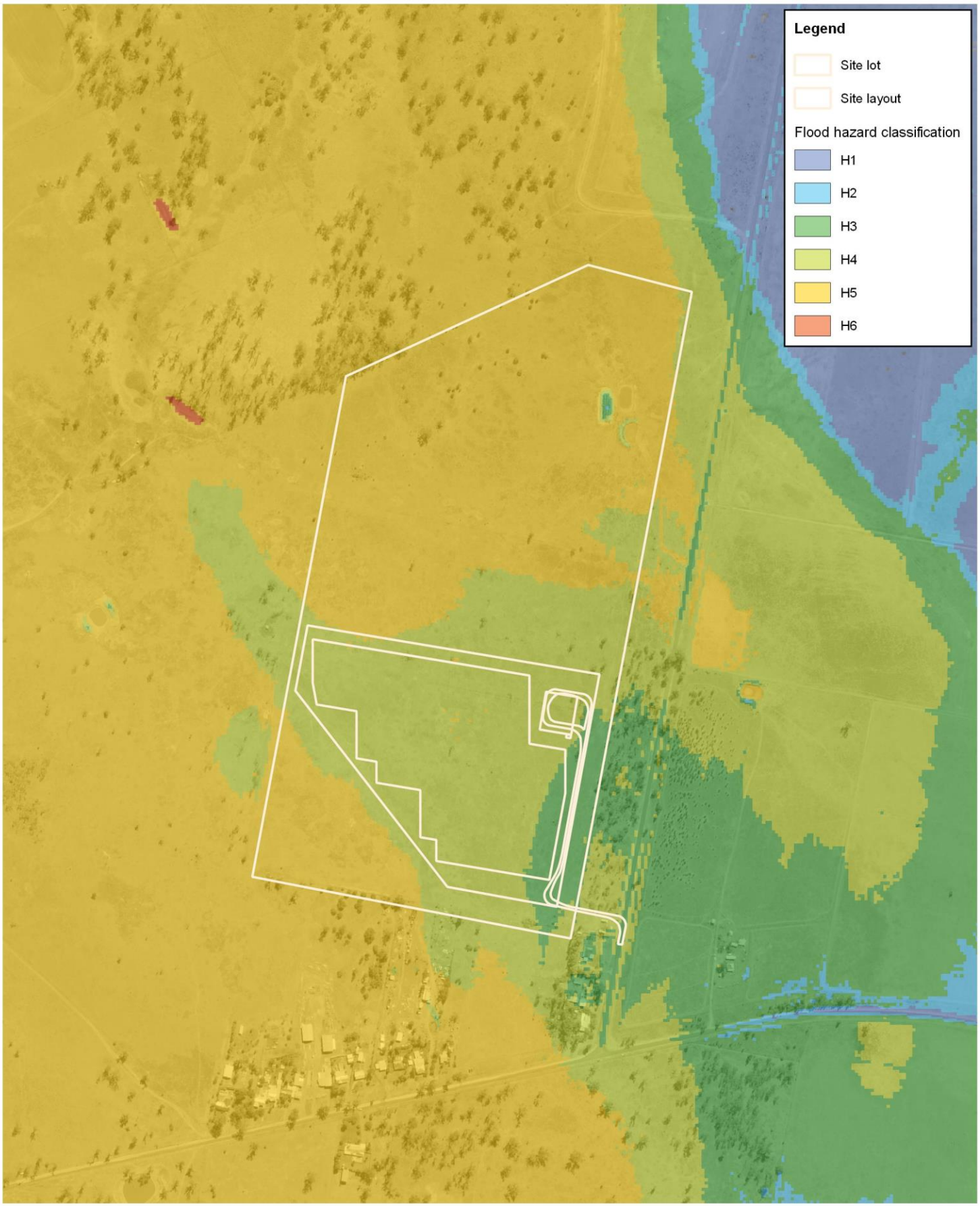
Revision: A

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_004_210202_200y_hazard.qgz



Title:

PMF/Extreme Flood Hazard Classification

0 200 400 m

approx. scale

Figure: 12

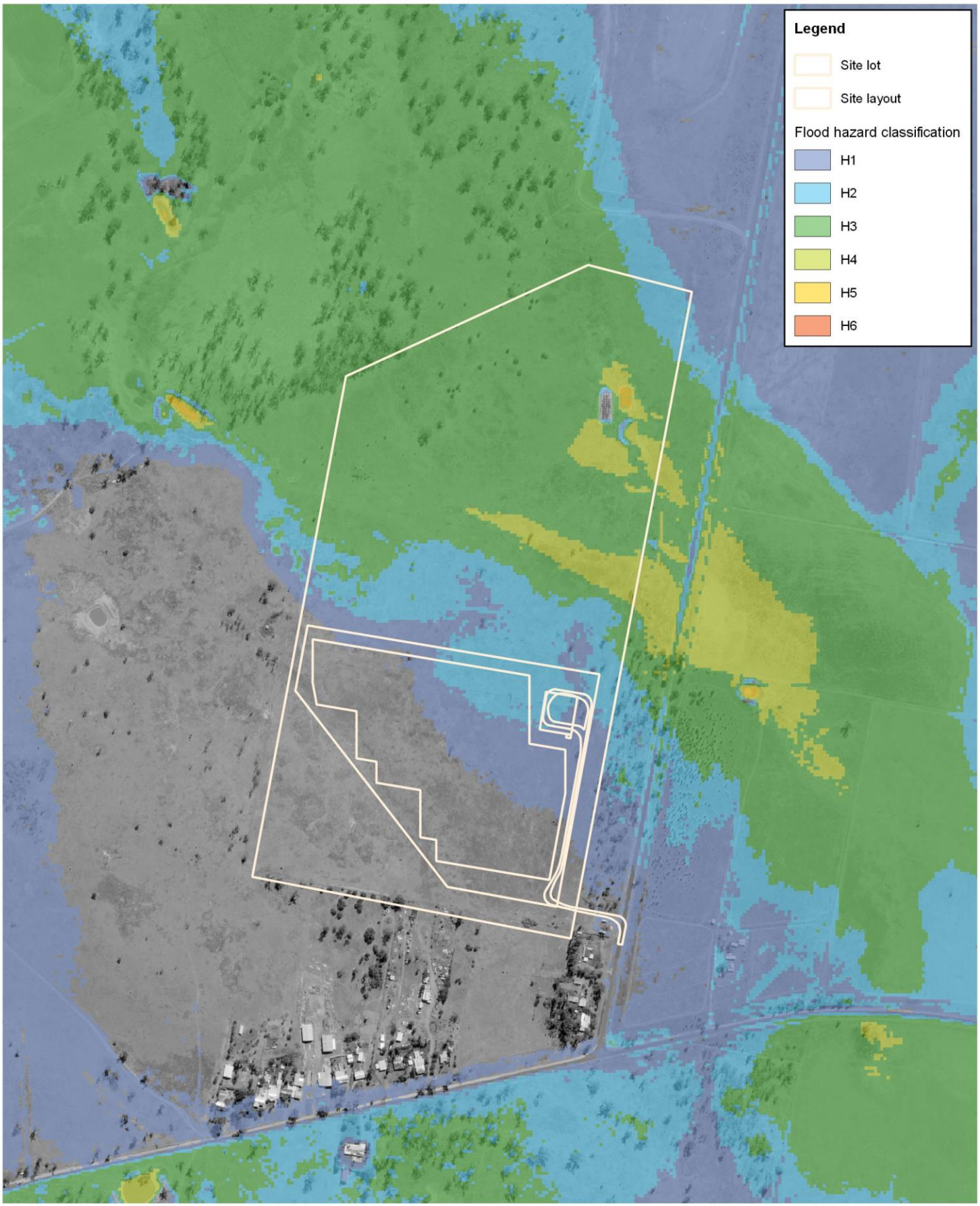
Revision: A

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_013_210202_pmf_hazard.qgz



Title:

PMF Local Catchment Flood Hazard Classification

0 200 400 m

approx. scale

Figure: 13

Revision: A

Information shown on this figure is compiled from numerous sources and may not be complete or accurate. Torrent Consulting cannot be held responsible for the misuse or misinterpretation of any information and offers no warranty guarentees or representations of any kind in connection to its accuracy or completeness. Torrent Consulting accepts no liability for any loss, damage or inconvenience caused as a result of reliance on the information.

N

Torrent CONSULTING
www.torrentconsulting.com.au

Filepath: \Projects\T2104_Narrabri_FIA\GIS\T2104_013_210202_pmf_hazard.qgz

25 February 2021

Providence Asset Group
704/99 Bathurst Street
SYDNEY NSW 2000

Narrabri Solar Farm
Waste Management Plan

Address: 115 Airport Road, Narrabri NSW 2309

Proposal: Establishment of Solar PV Power Generation Plant

1 OBJECTIVES FOR THE WASTE MANAGEMENT ON THIS SITE

- To minimise resource requirements and construction waste through reuse and recycling; and the efficient selection and ordering of resources.
- To ensure the waste management systems are compatible with the relevant waste collection services.

The management of waste is addressed in this WMP in the following sections, according to the stages of the development:

- Site preparation and construction; and
- Ongoing operation.

2 SITE PREPARATION AND CONSTRUCTION STAGE

Construction waste will be separated on site by builder's contractors and builder's laborers during the construction stage.

The site manager will erect a sign on site for waste areas and will inform the builders staff where material is to be collected for recycling, and will set aside on site an area to store the recyclable materials for transportation to local recycling plants. The site manager and/or builder will impose the execution of the waste separation policy on a regular basis and to have on-going checks.

Stockpiles shall be located and managed appropriately to prevent sediment runoff and ensure minimal environmental impact from the building site.

A suitable all-weather vehicular access points shall be provided for the construction phase, and all sediment and erosion control devices implemented on site prior to commencement of construction works.

TYPE OF WASTE GENERATED	ESTIMATES VOLUME IN M^3 OR AREA M^2 OR WIGHT IN TONNE (T)	REUSE AND RECYCLING		DISPOSAL
		ON SITE	*OFF SITE*	
Green Waste	<8t		Directed for green waste reuse by local recycler.	
Excavated Material	<10m3	Possible reuse of soil onsite.	Un-recyclable excavated material to be disposed at local waste facility.	
Metal (Ferrous) Eg. Steel	2.7t		Sent to local metal recycler by contractor.	
Metal (Non-ferrous) Eg. Aluminium	<1t		Sent to local metal recycler by contractor.	
Packaging (Wood) Eg. Pallets, dunnage	35t		Reuse by logistics contactor. Broken directed to recycler.	
Packaging (Other) (Plastic, cardboard etc)	4.3t		Cardboard/paper sent to recycler by contractor.	Disposed of at local waste facility by contractor
Other waste e.g. pvc plastics, paint, paper / cardboard	<2t	-		Disposed of at local waste facility by contractor

3 OPERATION STAGE

Staff will separate general waste and recyclables within the waste storage / management area. A minimum of two separate bins (general and recycle bins) will be located within the waste area. Waste and recycling bins will be clearly labelled and identifiable. The bins and waste storages areas will be cleaned by staff with protective gloves as required.

TYPE OF WASTE GENERATED	ESTIMATED VOLUME PER WEEK	REUSE AND RECYCLING		DISPOSAL
		ON SITE	*OFF SITE*	
Food and General Waste	20L			Disposed of at local landfill by waste contractor on an as needs basis
Recyclable Waste	20L			Disposed of at local recycle plant by waste contractor on an as needs basis
Green Waste	20L			Disposed of at local recycle plant by waste contractor on an as needs basis

Yours sincerely

MEGAN CROWHURST

Checked/
Authorised by: CB

VIRTUSHERITAGE

Narrabri Solar Farm
115 Airport Road
Narrabri, NSW

DUE DILIGENCE ABORIGINAL ARCHAEOLOGICAL ASSESSMENT
FINAL ♦ February 2021

Prepared for SLR Consulting on behalf of Providence Asset Group

ABN 86 889 757 693
PO Box 101 Pottsville NSW 2489 ♦ Ph: 02 6676 4354 ♦ Mob: 0439 703 886
Email: mj.sutton@virtusheritage.com.au
Website: www.virtusheritage.com.au

Version	Date	Prepared by	Approved by	Comments
1	22.01.2021	E. Lin Virtus Heritage Pty Ltd	M.Sutton Virtus Heritage Pty Ltd	Draft
1b	22.01.2021	E. Lin Virtus Heritage Pty Ltd	M. Sutton Virtus Heritage Pty Ltd	Draft
2	02.02.2021	E. Lin Virtus Heritage Pty Ltd	M. Sutton Virtus Heritage Pty Ltd	Final

Disclaimer

This Report (including any enclosures and attachments) has been prepared by Virtus Heritage for the exclusive use and benefit of SLR Consulting (SLR) and Providence Asset Group (PAG) for their use regarding the Narrabri Solar Project and solely for the purpose for which it is provided. Unless we provide express prior written consent, no part of this report should be reproduced, distributed or communicated to any third party. We do not accept any liability if this report is used for an alternative purpose from which it is intended, nor to any third party in respect of this report.

Information contained in the Report is current as at the date of the Report, and may not reflect any event or circumstances which occur after the date of the Report.

All queries related to the content, or to any use of this report must be addressed to Dr Mary-Jean Sutton.

FIGURES

TABLES

APPENDICES

EXECUTIVE SUMMARY

Virtus Heritage was engaged by SLR on behalf of Providence Asset Group to prepare an Aboriginal archaeological due diligence assessment for the Narrabri Solar Farm. The project is located at 115 Airport Road (Lot 489 DP754944), Narrabri within the Narrabri Shire local government area (LGA). Proposed works include the development of a grid-connected 4.95 MVA solar PV farm with a 4-metre wide access gate and road connecting the proposed solar farm to Airport Road in the southeastern corner of the development. The proposed solar farm will include 11,592 panels, 142 single axis solar trackers, two 2475kVA inverters, and a medium voltage power station unit.

Consultation

The project area lies within the boundaries of the Narrabri Local Aboriginal Land Council (LALC). Kristie Toomey and Kenneth Mason (Site Officers, Narrabri LALC) attended the site survey to assist with identifying Aboriginal sites and objects and to provide cultural information about the project area. Comments made during fieldwork were recorded (refer to **Section 5**). A copy of this draft report was provided to Narrabri LALC for review and comment and a detailed consultation log for the project is included (refer to **Appendix A**). No comments have been received to date, and any comments or reviews of the due diligence assessment report in the future will be appended to the consultation log and addressed where possible by PAG.

Environmental Context

The landscape of Narrabri around the project area has been largely cleared for agriculture. Prior to European settlement, however, the open mixed woodland and grassland landscape would have provided Aboriginal people with a rich and diverse range of terrestrial resources. Eucalyptus species would have been abundant in these woodlands, with a thick understorey of varying grass types. The subhumid climate would have been warm and habitable all year round. The current mean annual temperature in the region is between 10 – 19°C, with a mean annual rainfall between 449 – 1,015mm.

In terms of major waterways, the project area is situated approximately 3 km northeast of the confluence between the Namoi River and Narrabri Creek. Smaller permanent and ephemeral creeklines would have stemmed from these two major waterways, likely traversing the alluvial plains landscape around the site, giving access to aquatic resources such as fish, turtles, sea birds, eels, rays and shellfish. The topography is characterised by coalescing systems of alluvial fans on long pediment footslopes below Permian and Triassic sandstone hills, which would have additionally been easy to traverse on foot through the open wooded landscape.

The project area is situated within Quaternary alluvial plains with outwash fans derived from Tertiary basalts. It is part of the Mitchell (2002) Liverpool Alluvial Plains landscape, characterised by undulating hills and sloping plains with channels and associated floodplains. The landscape around the project area is dominated by grey, brown and red clays, with potential for deep vertosols and cracking clays. The surface geology and associated soils of the region would have supported a dense and diverse ecosystem with vegetation such as plains grass, panic grass, windmill grass and blue grass. In terms of biodiversity, extant communities in the Brigalow Belt South Bioregion include both terrestrial and wetland species such as amphibians, reptiles, birds, mammals, and riverine species such as fish, turtles and rays.

In normal circumstances, this combination of environmental factors would have resulted in high potential for the area to contain cultural materials. While high biodiversity and ease of access to resources in the landscape may have allowed for dense occupation and land use by Aboriginal people in the past, heavy clearance of the wooded areas and intensive agricultural use of the alluvial plains and footslopes since

European settlement has greatly impacted on the potential for preservation of cultural remains. The land immediately around the project area has been completely cleared for cropping and animal grazing and continues to function as a farmed rural plot.

Archaeological Context

The results of the background archaeological research, including heritage searches and a review of previous assessments in the region indicate that the most common site type are low density artefact scatters. The potential for scarred trees, though common in the region, is very low due to heavy deforestation and land clearance around the project area for cultivation and grazing. The archaeological context of the project area indicates that evidence of Aboriginal occupation is most likely to occur on the alluvial plains and in low catchments in close proximity to permanent water sources outside of the project area. Survival of evidence of Aboriginal occupation is, however, dependent on the impacts of previous land use history.

Site Inspection Results

The site inspection was undertaken on the 13 January 2021 on lands within the Narrabri LALC area. The site inspection was undertaken by Elaine Lin, Senior Archaeologist (Virtus Heritage) and two site officers from Narrabri LALC, Kristie Toomey and Kenneth Mason. The field survey was completed over one field day. The proposal area was inspected via pedestrian survey in four transects, targeting all areas of exposure. The survey included an inspection of all mature trees within the project area, and no drainage lines were identified during the inspection (refer to **Appendix D** for photographs of the site inspection).

There are no previously recorded sites within the project area based on heritage searches and background research of previous archaeological investigations to date. No Aboriginal objects or sites were observed in the project area and given the disturbance and lack of any undisturbed soils or sensitive landforms identified during survey, the project area is deemed to have a very low potential for archaeological deposits. Comments from Narrabri LALC Site Officers, Kristie Toomey and Kenneth Mason support the assessment of low archaeological potential.

Recommendations

The following recommendations have been made based on the information provided on project impacts, consultation to date, relevant archaeological and environmental background research, and the results of the site inspection.

1. No Aboriginal objects were identified during the site inspection. No Aboriginal places are registered within the project area. No areas of archaeological potential are identified within the project area requiring archaeological testing, salvage or mitigation.
2. All site workers and personnel involved in site impact works associated with the proposal should be inducted and briefed on the possible identification of Aboriginal sites and objects during construction and their responsibilities according to the provisions of the *NPW Act 1974*, in case any additional unknown objects or items are uncovered during proposed works.
    a. As part of this induction, the contact phone numbers of the Heritage NSW regional archaeologist and EnviroLine 131 555, the relevant Environmental Officer responsible for this project should also be given to all site workers and personnel, in case unknown objects or items are uncovered during excavation.
    b. Site workers should be made aware of the location of any Aboriginal sites that may at any stage occur within the proposal site and their scientific significance and their legal obligations in relation to the protection and management of these Aboriginal sites under the *NPW Act 1974*, and 2010 ancillary provisions and amendments.

c. As part of this induction, workers should be made aware that in the event that any unexpected human remains are uncovered on site, the area of the suspected remains must be secured and cordoned off and the NSW Police notified. No further works can be undertaken until the NSW Police provide written advice. If these remains are deemed to require archaeological investigation by the NSW Police or NSW Coroner, then Heritage NSW and the relevant Aboriginal parties must be notified. A plan of management for the preservation of any identified Aboriginal human remains or for their salvage must be put in place or conducted under an AHIP methodology and variation developed in consultation with all relevant Aboriginal parties and Heritage NSW.

d. Providence Asset Group or delegated authority may wish to consider the input and engagement of interested Aboriginal stakeholder groups and Narrabri LALC in the development of inductions and toolbox talks for this project.

3. A copy of the final report has been made available to Narrabri LALC for comment and review. Any additional comments by the LALC will be considered where possible in the future by PAG.

1. INTRODUCTION

Virtus Heritage was engaged by SLR on behalf of Providence Asset Group to prepare an Aboriginal archaeological due diligence assessment for the Narrabri Solar Farm Project. The project is located at 115 Airport Road, Narrabri, within the Narrabri Shire local government area (LGA) (refer to **Figure 1**).

1.1 Project Description

This project proposes the development of a solar PV farm at Narrabri, including a grid-connected solar PV installation with a total PV plant capacity (DC) of 6.26 MWp. It is proposed to connect into the electrical transmission grid via the existing transmission lines which run along the northern boundary of the site. The solar PV farm will include the following components:

- 11,592 x 540w solar PV panels;
- 142 x single axis solar trackers;
- 2 x 2475kVA inverters; and
- 1 x medium voltage power station unit.

A 4m wide gate and access road is proposed to connect the solar farm to Airport Road at the south eastern corner of the lease area. The solar farm will be fully fenced with emergency access gates and temporary construction office. The proposal is indicatively located on the Development Plan (refer to **Figure 2**).

1.2 Report Aims and Statutory Requirements

This report was compiled with reference to the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (DECCW 2010a) and where applicable, the requirements of the *Code of Practice for Archaeological Investigation of Aboriginal Objects, NSW* (hereafter referred to as the 'Code of Practice') (DECCW 2010b). The purpose of this report is to provide advice on Aboriginal archaeological (scientific) values of the project area in relation to the proposed works to guide the client in its decision-making process.

In general, the aims of a due diligence assessment are to:

- identify whether or not Aboriginal objects are, or are likely to be, present in the area;
- if objects are present or likely to be present, determine whether the proposed development activities are likely to harm Aboriginal objects; and
- determine whether further assessment or an Aboriginal Heritage Impact Permit (AHIP) is required.

The *National Parks and Wildlife Act 1974* (NPW Act), the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Heritage Act, 1977* are the relevant statutory controls protecting Aboriginal heritage within New South Wales.

1.2.1 National Parks and Wildlife Act 1974

Under the provisions of the NPW Act, all Aboriginal objects are protected regardless of their significance or land tenure. Aboriginal objects are defined as '*any deposit, object or material evidence (not being a handicraft made for sale) relating to Aboriginal habitation of the area that comprises NSW, being habitation before or concurrent with the occupation of that area by persons of non-Aboriginal extraction and includes Aboriginal remains'*.

Aboriginal objects are therefore limited to physical evidence and may also be referred to as 'Aboriginal sites', 'relics' or 'cultural material'. Aboriginal objects can include pre-contact features such as scarred trees, middens and artefact scatters, as well as physical evidence of post-contact use of the area such as Aboriginal built fencing or stockyards and missions.

The NPW Act also protects Aboriginal Places, which are defined as *'a place that is or was of special significance to Aboriginal culture. It may or may not contain Aboriginal objects'*. Aboriginal Places can only be declared by the Minister administering the NPW Act. The NPW Act protects Aboriginal objects and Aboriginal places in NSW. Under the *National Parks and Wildlife Act 1974* (NPW Act), including the 2010 amendments, it is an offence to harm an Aboriginal object:

- Which the person knows is an Aboriginal object (a 'knowing offence'); and
- Whether or not a person knows it is an Aboriginal object (a 'strict liability offence').

The maximum penalty for a knowing offence is $550,000 for an individual or $1.1 million for a corporation and a 2 year gaol term. The maximum penalty for a strict liability offence is $110,000 for an individual or $220,000 for a corporation (DECCW 2010b: 5). A person or organisation who exercises due diligence in determining that their actions would not harm Aboriginal objects has a defence against prosecution for the strict liability offence if they later unknowingly harm an object without an AHIP (DECCW 2010b, 2010:5). The due diligence defence is not available for activities which harm Aboriginal places. The Code of Practice sets out a procedure which, when followed, will satisfy the due diligence requirement. If a person or company can demonstrate that they exercised due diligence and determined that it was unlikely that Aboriginal objects would be harmed, then they have a defence to prosecution under the strict liability offence under Section 86(2) of the NPW Act (DECCW 2010b 2010: 5).

Harm includes activities that destroy, deface or damage an Aboriginal object or Aboriginal place, and in relation to an object; move the object from the land on which it has been situated. Under Section 91 of the Act, Heritage NSW must be informed upon the identification of all Aboriginal objects. Failure to do this within reasonable time is an offence under the Act. Under Section 90 of the Act, it is an offence for a person to destroy, deface, damage or desecrate an Aboriginal Object or Aboriginal Place without the prior issue of AHIP. AHIPs may only be obtained from Heritage NSW. Part 6 of the NPW Act provides specific protection for Aboriginal objects and places by making it an offence to harm them. If harm to Aboriginal objects and places is anticipated an Aboriginal Heritage Impact Permit (AHIP) is required.

The Act also provides for stop-work orders under Section 91A if an action is likely to significantly affect an Aboriginal object or Aboriginal Place. The order may require that an action is to cease or that no action is carried out in the vicinity of the Aboriginal object or Aboriginal Place for a period of up to 40 days.

1.2.2 Heritage Act, 1977

The *Heritage Act, 1977* (as amended in 2009) protects and aims to conserve the environmental heritage of New South Wales. *Environmental heritage* is broadly defined under Section 4 of the *Heritage Act* as consisting of "those places, buildings, works, relics, moveable objects, and precincts, of State or local heritage significance" (Heritage Branch, DoP 2009: 4). Aboriginal places or objects that are recognized as having high cultural value (potentially of local and State significance) can be listed on the State Heritage Register and protected under the provisions of the *Heritage Act*.

Amendments to the *Heritage Act* made in 2009 have changed the definition of an archaeological *'relic'* under the Act, so that it is no longer based on age. A relic is now an archaeological deposit, resource or feature that has *heritage significance* at a local or State level. This significance-based approach to identifying 'relics' is consistent with the way other heritage items such as buildings, works, precincts or landscapes are identified and managed in NSW (Heritage Branch, DoP 2009: 1). Section 4(1) of the *Heritage Act* (as amended 2009) defines 'relic' as follows:

> ***Relic*** *means any deposit, artefact, object or material evidence that:*
> *(a) relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and*
> *(b) is of State or local heritage significance* (Heritage Branch, DoP, 2009: 6).

Other relevant State and Commonwealth legislation are discussed below.

1.2.3 Environmental Planning and Assessment Act 1979

The EP&A Act requires that consideration be given to environmental impacts as part of the land use planning process. In NSW, environmental impacts include cultural heritage impacts. Part 3 of the Act relates to planning instruments including those at local and regional levels, Part 4 of the Act controls development assessment processes and Part 5 of the Act refers to approvals by determining authorities.

1.2.4 Native Title legislation

The Native Title Act 1993 (NTA) provides the legislative framework to:

- recognise and protect native title;
- establish ways in which future dealings affecting native title may proceed and to set standards for those dealings, including providing certain procedural rights for registered native title claimants and native title holders in relation to acts which affect native title;
- establish a mechanism for determining claims to native title; and
- provide for, or permit, the validation of past acts invalidated because of the existence of native title.

The *NSW Native Title Act 1994* was introduced to make sure the laws of NSW are consistent with the Commonwealth's NTA on future dealings. It validates past and intermediate acts that may have been invalidated because of the existence of native title.

The National Native Title Tribunal has a number of functions under the NTA, including maintaining the Register of Native Title Claims, the National Native Title Register and the Register of Indigenous Land Use Agreements and mediating native title claims.

1.2.5 Other Acts

The Australian Government *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* may be relevant if any item of Aboriginal heritage significance to an Aboriginal community or historical heritage is under threat of injury or desecration and state-based processes are unable to protect it. The *Environment Protection and Biodiversity Conservation Act 1999* is relevant to projects where there are heritage values of national significance present.

1.3 Consultation

Aboriginal people are the primary determinants of their culture and heritage, and cultural values can only be assessed and advised by the relevant Aboriginal parties for the locality. It should be noted that Aboriginal heritage refers both to Aboriginal archaeological sites and sites/places of cultural value to Aboriginal people, protected under the *National Parks and Wildlife Act, 1974* (NPW Act, 1974) as "Aboriginal objects" and "Aboriginal places". Sites and places of Aboriginal cultural significance can only be identified by the relevant local Aboriginal people and are likely in many cases (for example, song lines and story places) to not contain any archaeological evidence.

This assessment was conducted by an archaeologist providing advice on the archaeological (scientific) values of the project area. The cultural values of the project area were assessed by the Narrabri Local Aboriginal Land Council (LALC). Kristie Toomey and Kenneth Mason from Narrabri LALC did not know of any sites within the vicinity relating to the project area and did not think the area bore any cultural significance during the site inspection. No other comments have been provided to date.

Further comment may be received by the LALC and will be considered where possible in the future by PAG.

A consultation log for the project is included (**Appendix A**), which will be appended with comments if any are received in the future from Narrabri LALC.

1.4 Limitations

This report is limited to the assessment of project impacts described in information provided by SLR on behalf of Providence Asset Group and mapped in this report. Virtus Heritage takes no responsibility for errors within the Department of Premier and Cabinet, Heritage NSW (Heritage NSW) Aboriginal Heritage Information Management Systems (AHIMS) data, and the Heritage NSW listings. Virtus Heritage has assumed information provided by Heritage NSW is accurate.

The site inspections undertaken were confined to the area of proposed works illustrated in **Figure 1**. Visibility on site was generally very poor. Nevertheless, access on foot to the entire project area was unhindered.

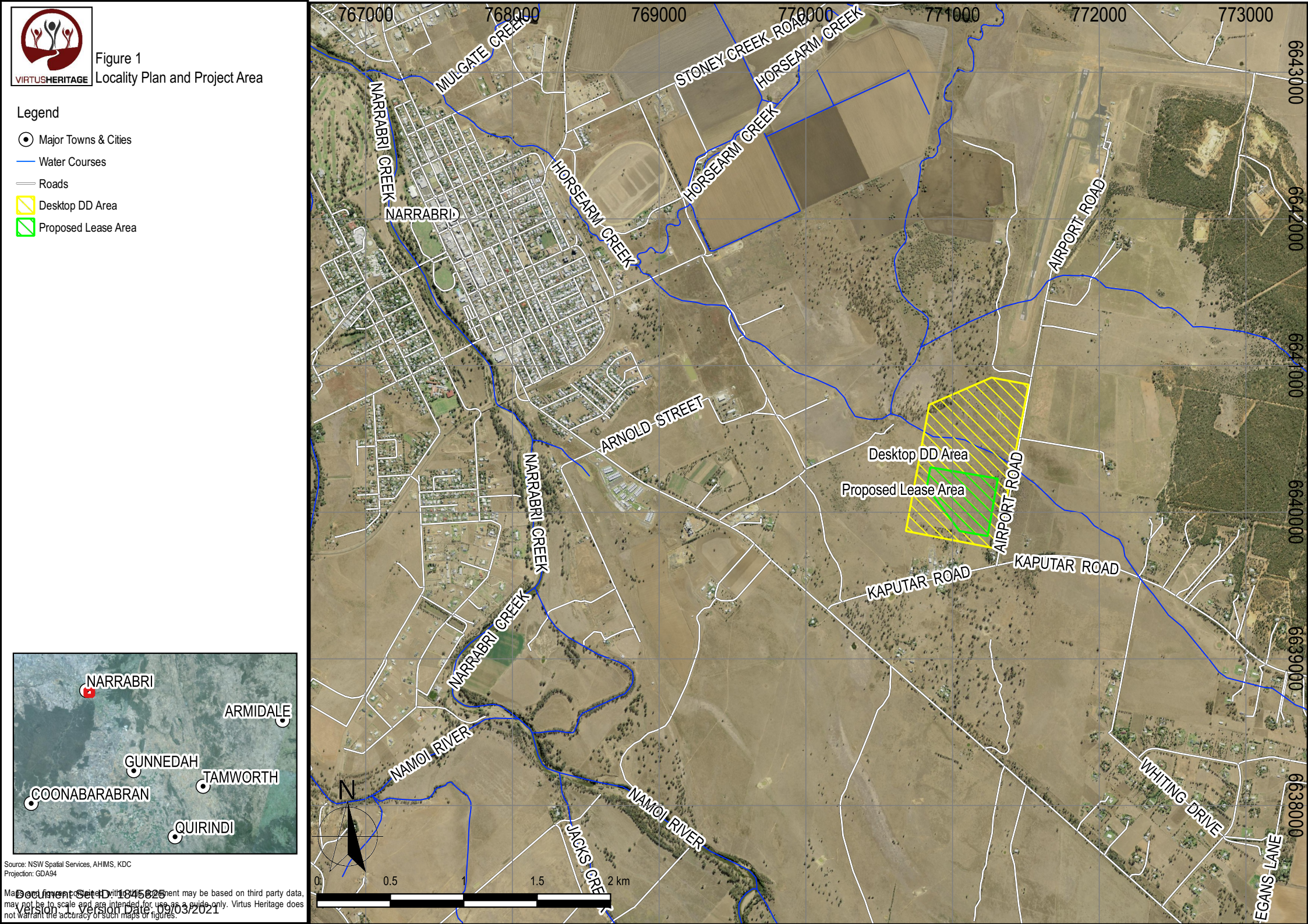
1.5 Project Team and Qualifications

This report was compiled by Elaine Lin, Senior Archaeologist (M.Arch.Sci. (Adv) Hons., Australian National University; B.Arts (Hons.) Archaeology, University of Sydney), with quality review undertaken by Dr Mary-Jean Sutton, Principal Archaeologist and Director (PhD, Archaeology, University of Queensland; B.Arts, Hons. Prehistoric and Historical Archaeology, University of Sydney). Project information and description of works was provided by SLR.

1.6 Acknowledgements

We would like to acknowledge the assistance of the following individuals for the completion of this report:

- Kristie Toomey, Narrabri LALC
- Kenneth Mason, Narrabri LALC
- Rachel Pettitt, SLR



LEGEND

- TREE (EXISTING)
- TREE (FOR REMOVAL)
- LOT BOUNDARY
- 400 MAJOR CONTOUR
- MINOR CONTOUR
- SECURITY FENCE
- FENCE (EXISTING)
- LEASE BOUNDARY (PROPOSED)
- PV TABLE
- O/H 22kV POWERLINE
- O/H 132kV POWERLINE
- WATERCOURSE

SYSTEM SUMMARY

ELECTRICAL CONFIGURATION:
- TOTAL PV PLANT CAPACITY (DC): 6.260 MWp
- TOTAL INVERTER CAPACITY (AC): 4.95MVA
- PV PLANT MAXIMUM EXPORT CAPACITY (AC): 4.95MW
- DC:AC RATIO: 1.265
- STRINGS OF 28 PV MODULES.
- 207 PV STRINGS PER INVERTER.
- 414 PV STRINGS TOTAL.

PV MODULES:
- MFR: LONGI SOLAR
- MODEL: LR5-72HPH-540M
- NAMEPLATE: 540Wp
- QUANTITY: 11,592 MODULES

INVERTERS:
- MFR: SUNGROW
- MODEL: SG2475HV-MV
- NAMEPLATE: 2475kVA
- QUANTITY: 2

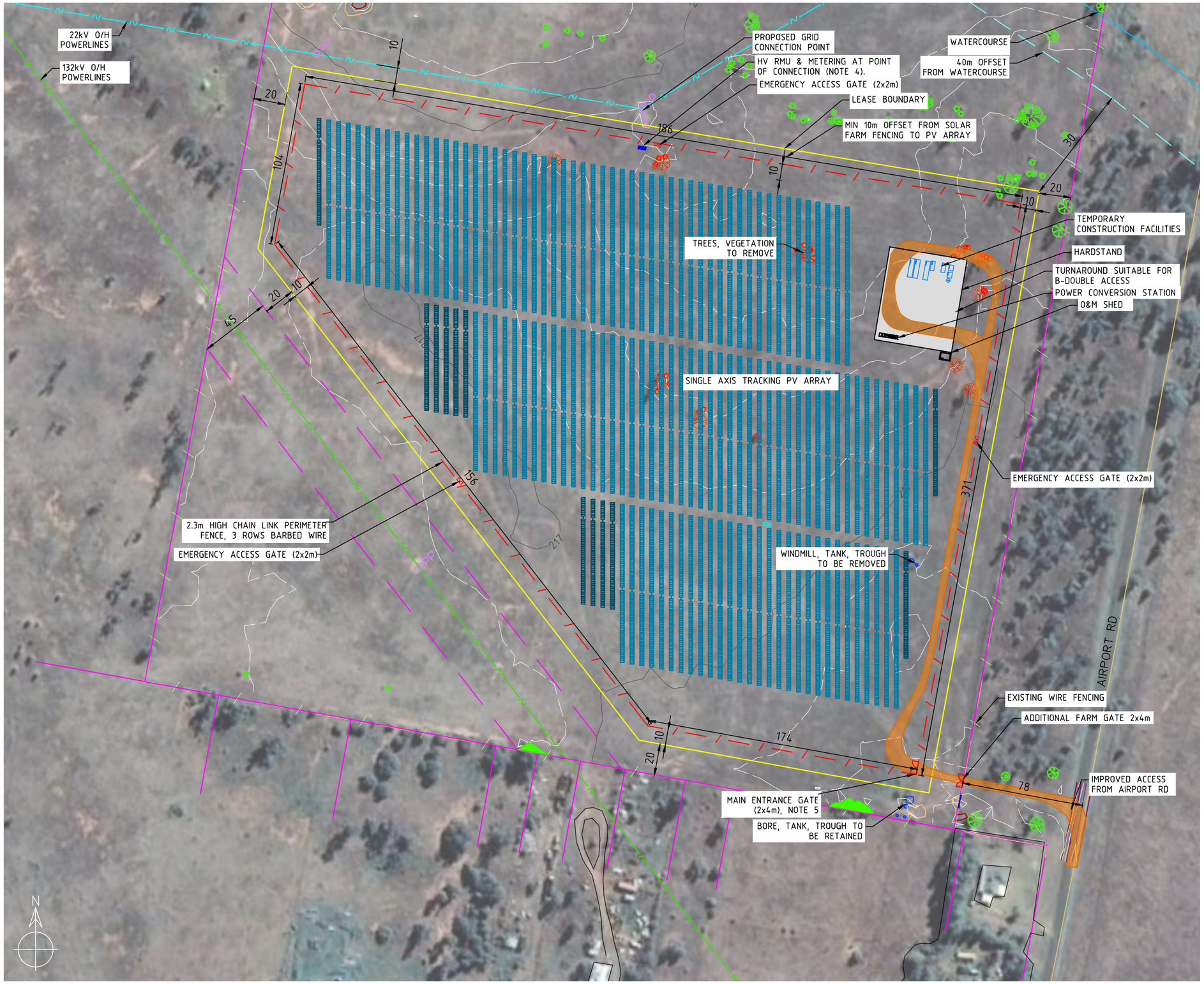
MV POWER STATION:
- MFR: SUNGROW
- MODEL: SG4950HV-MV
- QUANTITY: 1

TRACKER ARRAY:
- TYPE: GROUND MOUNT SINGLE AXIS TRACKING
- CONFIGURATION: INDEPENDENT TYPE
- RANGE OF MOTION: ±60°
- PITCH: 6.25m
- GCR: 36.096%
- QUANTITY: 142 TABLES

FENCED AREA: 132,821 m²
LEASE AREA: 148,223 m²

GENERAL NOTES:

1. DETAIL SHOWN IS PRELIMINARY, MAY CHANGE IN DETAILED DESIGN.
2. ENTRY FROM AIRPORT ROAD.
3. CLEARANCE BETWEEN SOLAR TRACKER ARRAY & SITE SECURITY FENCE TYPICALLY 10m
4. HV RMU & METERING (LOCATION AND TYPE TO BE DETERMINED, IS SUBJECT TO ESSENTIAL ENERGY FEEDBACK).
5. FOR SECURITY GATE DETAILS REFER TO DRAWING 10100-C-DET-02-1.
6. WATERCOURSE, WATERBODY DETAIL FROM SIXMAPS, MGA ZONE 55 PROJECTION
7. FOR ON SITE STORMWATER DETENTION DETAIL REFER TO DRAWING 10100-C-DET-01-1 (TBC).



N

SCALE (m) 0 50 200 (10 100)

PROVIDENCE ASSET GROUP

REFERENCES

REV.	DATE	DESCRIPTION	DRWN.	DESIGNED	CHKD.	APPR.
A	2021.01.14	FIRST ISSUE	JM	JM	SS	JM

TITLE
PROVIDENCE ASSET GROUP
NARRABRI SOLAR FARM
GENERAL ARRANGEMENT
SYSTEM DETAIL

DWG No. 10100-G-GAD-02-2

SCALE 1:2,500
REVISION A
PAPER SIZE A3

2. ENVIRONMENTAL CONTEXT

This section of the report describes the environmental context of the project area spanning previous land-use history, topography and landforms, soils and geology, and fauna and flora. These factors are integral influences of Aboriginal land use, the resultant patterning of archaeological sites, and the survival of sites in the modern landscape.

2.1 Previous Land Use History

The township of Narrabri developed on the banks of Narrabri Creek, directly northeast from the Namoi River and immediately north of the confluence between the river and the creek. The town was first settled by explorer John Oxley in 1832, with settlers in the first squatting run 'Nurrabry' soon to follow in 1834 (DPIE Website, accessed 21st January 2021). It has historically been a province of the pastoral industry, later associated with large scale forestry and agriculture. Between the 1830s and the 1880s, the region was largely settled for sheep and cattle grazing (Hunt 1980). Narrabri also has a long history of coal mining, with a more recent intensification of gas interests (Askland *et al.* 2016: 20). Intensive European settlement due to intensifying agriculture and pastoralism in the Narrabri region by the mid-19th Century had drastically changed the landscape, impacting the movement of people, culture and subsistence practices of the local Kamilaroi people (OzArk Environment & Heritage 2020: 22 – 23).

While the Narrabri region near the Namoi River was extensively cleared and was used for cultivation and cattle farming, the nearby Pilliga Forest was the focus of large-scale forestry. By the late 1870s, a fully fledged timber industry was thriving in the region, with gazetted timber reserves following soon after (AECOM Australia Pty Ltd 2016: 15). Rail infrastructure was introduced to accommodate the booming agricultural and forestry industries, with the railway line reaching Narrabri in 1882 (Rolls 1981: 11, 187). Most of the landscape around the township of Narrabri had historically been cleared for cultivation. The land around the project area has been cleared for cropping, where it remains a rural plot that is intensively farmed and cultivated.

2.2 Topography, Hydrology and Climate

The proposed area of works is situated within the Brigalow Belt South Bioregion (BBSB). It is part of the Namoi subregion. Geologically, the BBSB comprises of horizontally bedded Jurassic and Triassic quartz with limited areas of conglomerate or basalts. The town of Narrabri is part of the southern extremity of the Queensland Brigalow Belt, though is not covered in brigalow as the name suggests. The landscapes of this region derive from a combination of extensive basalt lava flows and quartz sandstones, with variable vegetation, geology and soils (NSW NPWS 2003: 131). It is situated within the subhumid eastern zone of Australia (NSW NPWS 2003: 131). The mean annual temperature is 10 – 19°C, with a mean annual rainfall between 449 – 1015mm (NSW DPIE website, accessed 22 January 2021).

The project area is situated within Quaternary alluvial plains with outwash fans derived from Tertiary basalts. It is part of the Mitchell (2002) Liverpool Alluvial Plains landscape, characterised by undulating hills and sloping plains with channels and associated floodplains. The general elevation is 300 – 350 metres, with local relief less than 10 metres (Mitchell 2002: 11).

The Namoi River and Narrabri Creek are the nearest major permanent water sources to the project area, which is situated approximately 3 kilometres northeast of their confluence. The palaeo channels of the river remain distinguishable over the surface of the alluvial plain landscape and tell the story of a dynamic and continually changing river system (Jakovljevic 2018: 11). These smaller permanent and ephemeral creeklines stemming from these two major waterways would have likely traversed the plains landscape around the

project area. As such, it can be inferred that access to ephemeral and permanent waterways across the entire floodplain would have provided ample resources to Aboriginal people living in the area.

2.3 Geology and Soils

The project area is within the Gunnedah Basin and is characterised by horizontally bedded Jurassic and Triassic quartz, sandstone and shale with minor volcanic basalt caps (Totterdell 2009). The basin has Permian Triassic stratigraphic units which are overlain by Tertiary volcanic and laval units from intrusive shield volcanoes (Jakovljevic 2018: 11). The landscape today is dominated by alluviums in the form of large fans and outwash slopes that provide evidence of larger stream courses of Quaternary age which occurred in the long, sand-filled channels and clay plains between ridges (NSW NPWS 2003: 132).

Soils vary greatly across the Brigalow Belt South Bioregion. In areas with underlying sandstone, texture contrast soils are most common downslope. Increasing clay content with depth is common; as such, these soils are often found with harsh clay sub-soils. Valley floor sediments, however, tend to be sorted into deep sands with yellow earthy profiles, harsh grey clays, or more texture contrast soils with a greater concentration of soluble salts (NSW NPWS 2003: 132). The project area contains grey, brown and red clays (Stace *et al.* 1968) and/or vertosols (DPIE 2020) in a quaternary alluvial landscape (NSW NPWS 2003: 132; Mitchell 2002: 11).

Table 1. Soil Landscape Group

AUSTRALIAN SOIL CLASSIFICATION	AUSTRALIAN GREAT SOIL GROUP	PROVINCE	GEOLOGY
Vertosols	GC_BC_RC: Grey, Brown and Red Clays	Gunnedah Basin (Totterdell *et al.* 2009)	Permo-Triassic Basin (Colquhuon *et al.* 2019) with Quaternary Alluviums (NSW NPWS 2003)

2.4 Flora and Fauna

The landscape around the project area, including the nearby township of Narrabri, has largely been cleared for agriculture. Where native vegetation is extant in basaltic areas, however, remnant species may include brigalow, belah, whitewood, wilga, budda and poplar box on the hills, with river red gum, belah, Acacia pendula and poplar box on the flats. In alluvial clay landscapes such as that of the project area, white box, silver-leaved ironbark, white wood, bull oak and brigalow are supported where there is extant native vegetation. River red gum occurs on streams in this bioregion (NSW DPIE Website, accessed 22nd January 2021). Diverse grasslands dominate the Liverpool Alluvial Plains, within which the project area is situated. Common species include plains grass (Stipa sp.), panic grass (Panicum sp.), windmill grass (Chloris sp.) and blue grass (Dicanthium sp.) on black earths (Mitchell 2002: 11).

The Brigalow Belt South Bioregion has a high biodiversity in terms of terrestrial and wetland species of animals. This landscape currently supports 18 amphibian species, 68 reptiles, 281 birds and 82 mammal species (NSW DPIE Website, accessed 22nd January 2021). These may have included forest canopy, grassland and wetland birds, lizards, snakes, and small terrestrial mammals. Additionally, the proximity of the site to the Namoi rivers and major permanent creeks would have provided easy access across the alluvial plains and valleys to aquatic species of animals such as fish, turtles, and rays. While the area has been heavily cleared and stripped of soil and vegetation since European settlement, it would have, in the past, been an abundant source of floral and faunal resources to local Aboriginal people.

2.5 Summary

The alluvial plains landscape and long footslopes in the vicinity of the project area would have provided an easily traversable region of high biodiversity, with abundant woodland nearby in the Pilliga, diverse grasslands, and numerous aquatic species associated with the Namoi River and Narrabri Creek. The landscape would have provided many nearby permanent water sources as well as ephemeral creeks and drainage channels over the surrounding alluvial plains. The situation of the project area in a landscape on deep Quaternary alluviums would have in the past provided catchments of deposits and cultural remains.

Due to heavy disturbance since European settlement, however, preservation of evidence for Aboriginal cultural occupation and land use is unlikely. Extensive land clearance around Narrabri and the proposed area of works has largely stripped the area of all topsoil, as demonstrated in the field survey for this project. The potential for scarred trees is also very low due to heavy deforestation for cultivation and grazing beginning from the earliest European pastoral settlement of the site. The maintenance of this degraded rural landscape continues to the present day.

3. ARCHAEOLOGICAL CONTEXT AND ETHNOHISTORY

This section presents the ethnohistorical and archaeological context for the evaluation of the project area, specifically known archaeological sites identified by previous archaeological investigations, and the understanding of Aboriginal heritage developed by previous archaeological and heritage studies.

3.1 Ethnohistorical Context

This ethno-historical context is drawn from review of accessible sources including:

- *Australian Dictionary of Biography*,
- a review of primary sources including parish maps and newspaper articles,
- sources identified on the National Library of Australia's *Trove* database,
- consultation with Aboriginal community organisations in the locality,

The Narrabri area has a long-documented history of Aboriginal settlement by Kamilaroi people, who occupied large parts of the now Brigalow Belt South Bioregion and the nearby Nandewar Bioregion, which includes towns such as Tamworth and Barraba. For most of the year, small groups divided up to hunt and gather, focusing on the Namoi and Mooki Rivers. In the mid-1700's however, a large flood along the Namoi and Mooki is believed to have significantly reduced the Aboriginal population. Their arrival additionally brought disease and conflict, resulting in the death or displacement of many of the local Aboriginal people in the area at the time (Berry 2018: 91).

While accounts of the broader Kamilaroi group are abundant in the early historical literature, the focus was largely around later larger population centres such as Tamworth. Little else is known specifically about the the Kamilaroi in the Narrabri area, and much of our inferences about Aboriginal settlement and culture rely on the archaeological record for the area. Through these investigations of sites around the Liverpool Plain and the nearby Pilliga area, however, a rich history of settlement and land use has been revealed (Jakovljevic 2018: 15). Previous archaeological investigations in this region will be addressed later in this section.

3.2 Heritage Register and Database Searches

The following heritage registers and database searches were undertaken as part of this preliminary assessment:

- National Native Title Tribunal (NNTT);
- Aboriginal Heritage Information Management System (AHIMS);
- The Australian Heritage Database (AHD);
- State Heritage Register (SHR) and Inventory (SHI); and
- Narrabri Local Environmental Plan (2012).

3.2.1 National Native Title Tribunal

A search was undertaken of the National Native Title Register maintained by the National Native Title Tribunal (NNTT) on 3 November 2020 of the project area to identify if Native Title exist over the project area. The searches identified that no Native Title issues exist for the site. The project area is, however, within an Active Native Title Application claim area by the Gomeroi People (refer to **Appendix B**).

3.2.2 Aboriginal Heritage Information Management System (AHIMS search)

Searches were conducted of the AHIMS register on 3 November and 7 December 2020 for any Aboriginal heritage sites recorded within and adjacent to the project area. The search covered the area datum: GDA, Zone: 55, Eastings: 766080 – 776080, Northings: 6635078 – 6645078 (approximate 5km radius around project area). A total of 7 Aboriginal sites and 0 Aboriginal places were listed (refer to **Appendix C**, **Table 2** and **Figure 3)**.

Table 2. AHIMS Search Results

AHIMS Site ID	Site Name	Site Type	Features	Number of Sites	Sites Within Project Area
19-3-0184	Namoi River Scar Tree	Modified Tree	Open site with one modified tree	1	0
19-3-0185	Namoi River IF	Artefact	Open site with isolated artefact	1	0
19-3-0186	Namoi River IF2	Artefact	Open site with isolated artefact	1	0
19-3-0187	Namoi River Artefact with Pattern	Artefact	Open site with isolated artefact	1	0
19-3-0007	Narrabri Junction; Namoi Farm	Artefact	Open campsite – surface scatter of artefacts eroding out of a terrace adjacent to a billabong – flakes of various kinds, some cores, a broken ground edge tool, a blade, and some broken pieces of European artefacts dumped nearby	1	0
19-3-0133	Collins Park site 2 artefacts	Artefact and Modified Tree	Open site with five artefacts and one modified tree	1	0
19-3-0136	Collins Park site 1 artefact	Artefact	Open site with isolated artefact	1	0

Seven sites were identified within 5km of the project area. Of these, five sites were artefact scatters or isolated artefacts, with one modified tree site and one site with both a modified trees and numerous artefacts (refer to **Table 2**). None of these sites occur within or adjacent to the proposed project area (refer to **Figure 3**).

3.2.3 Australian Heritage Database

The Australian Heritage Database (AHD) is a Commonwealth administered heritage database that includes entries from the former Register of the National Estate and the current Commonwealth and National Heritage Lists. This database was searched on the 3 November 2020 for all Indigenous heritage items within the Narrabri Local Government Area. The AHD search listed 12 results within the Narrabri Shire LGA for heritage places, including three Indigenous Places. None of these are within or adjacent to the project area. No other items on the AHD are within the project area.

3.2.4 NSW State Heritage Register and NSW State Heritage Inventory

The State Heritage Register is a heritage database administered by the NSW Heritage Branch of the Office of Environment and Heritage. This database includes heritage listings for State significant heritage items. This database was searched on the 3 November 2020 for all heritage items within the Narrabri Local Government Area.

The results indicate 1 item listed on the register, and no Aboriginal places in the LGA nor within the project area. The Narrabri Gaol and Residence is not within or adjacent to the project area.

The State Heritage Inventory is a heritage database administered by the NSW Heritage Branch of the Office of Environment and Heritage. This database includes heritage listings from local and regional planning instruments and heritage studies and state significant heritage items. This database was searched on the 3 November 2020 for all Indigenous heritage items within the Narrabri Shire Local Government Area.

The results of the search identified 75 historical items, of which 39 are in Narrabri. However, none of these items are within or adjacent to the project area.

3.2.5 Narrabri Local Environmental Plan (2012)

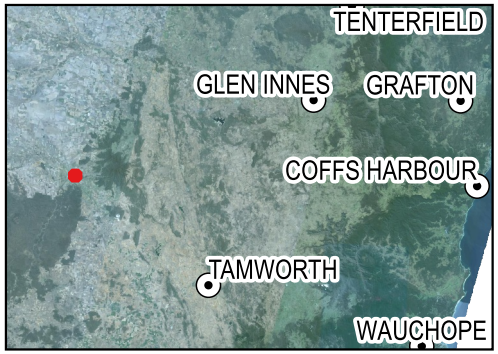
The Narrabri Local Environmental Plan (LEP) is a planning instrument administered by Narrabri Shire Council, which contains provisions and listings of items of environmental heritage including heritage, conservation areas and archaeological sites within Schedule 5. The LEP was searched on 3 November 2020. There were 40 items listed within the Narrabri LGA, of which 21 were listed in the town of Narrabri.

The results of the search identified no registered Indigenous heritage items within the project area.

Figure 3
Project Area and Known Aboriginal Heritage Sites

Legend

- Major Towns & Cities
- AHIMS Sites
- Desktop DD Area
- Proposed Lease Area
- Preliminary Construction Plan



Source: NSW Spatial Services, AHIMS, KDC
Projection: GDA94

Maps and figures produced within this assessment may be based on third party data, may not be to scale and are intended for use as a guide only. Virtus Heritage does not warrant the accuracy of such maps or figures.

767000 768000 769000 770000 771000

6643000 6642000 6641000 6640000 6639000

19-3-0133 19-3-0136 19-3-0185 19-3-0187 19-3-0186 19-3-0184 19-3-0007

Desktop DD Area
Proposed Lease Area

N

0 0.5 1 1.5 2 km

3.3 Previous Archaeological Research

A review of the AHIMS library and online searches were undertaken to obtain copies of previous Aboriginal heritage studies and archaeological investigations within the locality of the project area. No investigations have been published from the immediate surrounds of the proposed site (5km radius). As such, other sources for archaeological reports were consulted to gain a better understanding of the archaeological research near Narrabri and the project area (refer to **Table 3**). This section outlines the studies in the locality that can assist in building up a picture of the potential archaeology of the region. This in turn can help to predict the types of sites that may be expected to be present within the project area.

Table 3. Previous Archaeological Surveys within the Locality

AUTHOR/ DATE	LOCALITY	INVESTIGATION AND DISTANCE TO PROJECT AREA	NO. RECORDED SITES	SITE TYPES	SITES WITHIN PROJECT AREA
OzArk Environment & Heritage 2020	Narrabri LGA	LGA Wide Aboriginal Cultural Heritage Study with oral history survey and regional consultation to recommend sites for future inclusion in the Narrabri LEP.	N/A	N/A	N/A
Trindall 2007	Narrabri	Aboriginal Cultural Heritage Assessment and field survey for Narrabri Coal Seam Gas Development (approx. 15km WSW of project area)	1	One scarred tree in a slightly wooded section of the northern Pilliga East State Forest	0
CQCHM 2015	Narrabri	Aboriginal Cultural Heritage Assessment and field survey for Narrabri Gas Project (approx. 12km west and 11km south of project area).	4	Two living scarred trees with single scars, and two isolated artefacts (both unmodified quartz flakes)	0
AECOM 2011	Narrabri	Archaeological constraints analysis with field survey for Eastern Star Gas	20	11 scarred trees, five artefact scatters and four isolated artefacts	0
NSW NPWS 2002	Brigalow Belt South Bioregion	Entire bioregion; survey focusing on Pilliga Forest (northern boundary approx. 6km south of project area).	1110	Shelter sites with rock art, rock engraving, ochre quarry, stone arrangements, stone quarry. Full results excluded from report at the request of Aboriginal communities.	0

A major Aboriginal cultural heritage assessment was conducted by NSW National Parks and Wildlife Service (2002) of the broader Brigalow Belt South Bioregion. Field survey, oral history collection, landform mapping, and cultural plant recording was undertaken over an area of 52,409 km^2 including regions near

Narrabri such as the Pilliga forest. While no sites in the immediate vicinity of the project area was found, results indicated intensive Aboriginal settlement of the area, particularly around sources of water. A total of 1,110 sites were recorded, of which 50% were within 200 metres of water. The most common site types were surface artefact scatters, with culturally modified trees also well represented in areas where communities of native mature vegetation survive (NSW NPWS 2002). Of particular interest to this study are the results from the alluvial floodplains and landforms, which indicated that in these areas, a variety of Aboriginal site types existed up to 4km away from water, and on average, a distance of 410m from water (Jakovljevic *et al.* 2018).

3.4 Regional Character

The Kamilaroi people had a prior presence in the New England area for many thousands of years. They formed part of a wider indigenous nation which extended from around Singleton in the Hunter Valley to the Warrumbungle Mountains in the west and up through Narrabri, Walgett, Moree and Mungindi in NSW to Nindigully in south-western Queensland (TRC 2006: 5). A large variety of sites containing physical evidence of past Aboriginal land use remain within the wider region. Site types include bora grounds/ceremonial grounds, campsites, rock art and engravings, rock shelters, artefact scatters, stone quarries, ochre quarries, isolated finds, and scarred or carved trees.

The earliest dates for human occupation in the Brigalow Belt South Bioregion (BBSB) are 4,950 BP from Bendemeer rock shelter on Glendon Station and 3,600 BP from Moore Creek 4 rock shelter. In their *Tamworth Aboriginal and Archaeological Study*, Wilson and McAdam (2000) suggest that in light of the dates for the wider region, it is likely that the Kamilaroi have occupied their country for at least 20,000 years, and these dates may be extended with further excavations in the area (Boileau 2007: 8).

Within the surrounds of Narrabri and the project area, archaeological sites generally occur as open camp sites, surface artefact scatters and modified tree sites in alluvial plains and forested slopes, or as rock shelters and grinding grooves around the margins of the plain where underlying sandstone or sandstone cliffs are dominant such as in the Pilliga (NSW NPWS 2002). Within the plains, elevated platforms along the margins of creeks and rivers offering abundant water and aquatic resources, would have been favourable for Aboriginal occupation. This is reflected in the archaeological record, with higher artefact and site densities recorded near alluvial margins such as the Namoi River and Narrabri Creek (refer to AHIMS site types on **Figure 3**).

The region's vicinity to sources of wood and lithic material, such as in the Pilliga forest south of the project area, would have additionally been favourable to the Kamilaroi people (NSW NPWS 2002). Materials such as fine-grained claystone, basalt, quartz, siltstone, tuff and other volcanic materials would have been available in the Liverpool Plains landscape within which the project area is situated (Mitchell 2002; Bioregional Assessments Website, accessed 22nd January 2021).

3.5 Summary

The results of the background archaeological research, including heritage searches and a review of previous assessments in the region indicate that the most common site type is low density artefact scatters. The potential for scarred trees, though common in the region, is very low due to heavy deforestation and land clearance around the project area for cultivation and grazing. The archaeological context of the project area indicates that evidence of Aboriginal occupation is most likely to occur on the alluvial plains and in low catchments in close proximity to permanent water sources outside of the project area. Survival of evidence of Aboriginal occupation is, however, dependent on the impacts of previous land use history.

4. PREDICTIVE MODEL AND ARCHAEOLOGICAL POTENTIAL

Based on the known archaeological, environmental and landscape context of the locality, a predictive model for evidence of Aboriginal occupation for the project area is presented below:

Scarred trees and **carved trees** contain evidence of scars and carved patterns which can be attributed as having Aboriginal cultural origin. Scarred trees are typically created by the removal of bark from the trunk of the tree (usually with a stone axe) to make shields, canoes, implements and other types of items which leave a wound on the tree trunk. Carved trees contain carved patterns on the tree trunk and are often found in association with ceremonial grounds, burials or cultural sites. Carved trees are a moderately common site type in the Narrabri region as indicated by the AHIMS search results. They may be found where areas of mature trees are extant within the project area. Due to the previous land use history of the area, however, potential is low in the proposed area of works.

Isolated artefacts and **open campsites (artefact scatters)** are the locations of discarded stone artefacts, often material that has been discarded as part of making stone tools or over frequent episodes of occupation/visitation in an area. The objects are most likely to be found within 100 metres of a major water course, well drained alluvial flats, lower slope adjacent water courses, crests, and areas near the lake foreshore where the landscape has not been heavily modified. The potential for artefact scatters and isolated artefacts is low to moderate. They are the most common site type in the region, though potential has been limited due to heavy impacts to the landscape associated with intensive agriculture.

Middens are the accumulation of debris from fish, crustaceans and shell fish (shells, fish bones) consumed as part of Aboriginal people's diet. Middens also often contain charcoal, stone artefacts, bone and other types of material used by Aboriginal people. Middens often occur within close proximity to freshwater and saltwater sources which have potential to contain mussels, oysters and other types of edible shellfish. The potential is low due to the absence of permanent or major water sources within the project area.

There are no known **burial sites, bora grounds** or **stone arrangements** within the project area based on Aboriginal consultation to date and preliminary previous archaeological and historical research for this assessment. Burial sites, which are a very rare site type, are also unlikely to be found within the project area in areas of high modification. While burials are more likely within shell middens, no known middens have been recorded within the vicinity.

Petroglyphs (also referred to as Rock Engravings) are art sites where marks have been made in stone by Aboriginal people (for example, spirit figures, animals, implements and footprints). **Rock shelter sites with art** consist of rock overhangs used for shelter by Aboriginal people and where smooth surfaces on the walls of the shelter (sandstone surfaces) are painted with ochres and pigments). **Rock shelter sites with occupation deposits** include sediment deposits that potentially retain archaeological material. No known landforms supportive of rock shelters have been recorded in the vicinity of the project area.

Aboriginal axe grinding grooves are grooves most often found in sandstone where Aboriginal people have sharpened or manufactured stone axes and other implements, and in some cases, ground seed and grains in the sandstone forming 'bowls'. This site type may occur if suitable geology is present such as outcropping sandstone or suitable sandstone shelves in creek beds. The potential for this site type within the project area is low due to a lack of suitable geology. No outcroppings of stone nor grinding groove sites were identified during site survey.

Potential Archaeological Deposits refer to soil profiles within landforms which are predicted to contain buried evidence of Aboriginal occupation. This buried evidence is most often stone artefact scatters which survive frequently in the archaeological record and may occur in both primary and secondary depositional environments. Nearly all soil landscapes and landform types in Australia are connected to Aboriginal occupation and have potential to contain evidence of such.

Artefacts are most commonly recorded in A unit soils (topsoils) and at great depth in B unit alluvial deposits. They occur also in other types of B unit subsoils and deposited between the cracks of C unit cracking clays, where artefacts have moved down the soil profile. Evidence of Aboriginal occupation occurs commonly in both natural secondary deposits as well as in many types of disturbed contexts. Due to the large number of environments and soils where artefacts can occur, deposits are considered to have archaeological potential unless the absence of artefacts is anticipated as a result of post-depositional factors. How archaeological potential is defined and to be assessed in this report is provided in **Table 4.**

Table 4. Definitions of Archaeological Potential

ARCHAEOLOGICAL POTENTIAL	DEFINITION
Low to Zero	Landforms that have been totally modified and have low to zero potential for any remaining original soil profile or intact archaeological deposits. This is infrequent as usually disturbed sites remain redeposited or partially redistributed in the landscape. In order to designate areas as having low to zero potential, complete stripping of original soil profiles down to or through bedrock must be evident. Sites of that description are rare and are usually deep quarries or open cut mines.
Low	Landforms that may have been utilised by Aboriginal people in the past, but at a lower intensity relative to all surrounding landforms, resulting in a lower artefact density than all surrounding landforms. This category also includes landscape areas of low terrain integrity, where geomorphic processes or human action may have redistributed artefacts from their deposited locations, such as stripping of soil or excavation to create culverts or dams, resulting in site disturbance or destruction.
Moderate	Landforms that are predicted to have been utilised by Aboriginal people in the past, but not intensively or repeatedly. There is therefore potential for artefactual deposition, but at a lower frequency and density than in areas of high archaeological potential. This category may also refer to landforms known to be sensitive for higher levels of Aboriginal occupation but where prior ground surface disturbances has decreased the archaeological integrity and potential of finding evidence of Aboriginal occupation (for example, creek confluences, alluvial terraces and riverbanks, where stratigraphic integrity may have decreased due to previous land use).
High	Landscape areas predicted to have been intensively or repeatedly utilised by Aboriginal people in the past, such as creek confluences, Pleistocene terraces, floodplains or elevated landforms above major watercourses (high stream order tributaries) or floodplains. In these areas, site and artefact density are expected to be higher than the surrounding landscape, and sites in these areas may

	possibly be more complex. Though terrain integrity in these areas may be variable, the high archaeological potential of these areas give the associated deposits research potential, or the capacity to provide valuable information on past Aboriginal land use.

No Potential Archaeological Deposits were recorded during the survey. The area has been identified as having low potential for intact archaeological deposits and low sensitivity in terms of landform. Intensive clearing and farming appears to have stripped the majority of topsoil from the property, which in conjunction with the lack of mature trees and the high visibility over the site's entirety, revealed no archaeological materials during the site inspection to indicate potential for preserved cultural materials.

4.1. Summary

The project area is in a heavily disturbed landscape, whereby remnant A1 topsoils may have been re-distributed or almost entirely removed, limiting the potential for intact Aboriginal objects and sites to occur. During the site inspection no outcroppings of stone and no evidence of grinding grooves were identified. Mature trees were also uncommon in the landscape due to heavy land clearance and deforestation for intensive agriculture. As such, the potential for axe grinding grooves and scarred or modified trees is low.

The landforms in the area may be suitable for artefact scatters or isolated artefacts to occur dependent on the level of disturbance and modification, though the potential is low due to previous land use history and the lack of vegetation required for topsoil retention. While the potential is low, these site types have been demonstrated to occasionally occur within cracks in clayey subsoil horizons, or in remnant pockets of topsoil within undulating parts of otherwise disturbed landscapes. Other site types such as stone arrangements, art sites, burials and ceremonial sites such as bora rings are unlikely to occur in the project area.

5. SITE INSPECTION AND RESULTS

The site inspection was undertaken on the 13 January 2021 on lands within the Narrabri LALC area. The site inspection was undertaken by Elaine Lin, Senior Archaeologist (Virtus Heritage) and two site officers from Narrabri LALC, Kristie Toomey and Kenneth Mason. The field survey was completed over one field day. The proposal area was inspected via pedestrian survey in four transects, targeting all areas of exposure. The survey included an inspection of all mature trees within the project area, and no drainage lines were identified during the inspection (refer to **Appendix D** for photographs of the site inspection).

5.1 Site Inspection Results

General visibility was low over the project area as the entire paddock was overgrown with thick, tall grass and numerous exotic pasture grass, small shrub and weed species. The general exposure ranged between 0 – 20%, with rare areas of exposure with visibility ranging between 80 – 95%. The project area has been heavily disturbed by European farming activities for plant cultivation and animal grazing, such as ploughing and tree clearing. The soil across the project area, where visible, was a red loamy to fine sandy clay with an occasional fine layer of dark brown to black silty loam topsoil. These soils accounted for less than 20% of exposed areas with visible soil. No outcroppings of stone nor drainage lines were identified during the site inspection.

Trees located on the property were scarce, and no scarring was identified on any potential mature or native tree species within the project area. No cultural material was observed during the survey. The study area has been identified as having very low potential for intact archaeological deposits to occur. Intensive clearing and farming appears to have stripped the majority of topsoil from the area, which in conjunction with the lack of mature trees and the lack of materials in the occasional large areas of exposure, has produced no archaeological materials to indicate any potential for preserved cultural materials.

5.1.1 Cultural Comments and Potential for Archaeological Deposits

During the site inspection, Narrabri LALC Site Officers, Kristie Toomey and Kenneth Mason supported the assessment of the proposed works area as having low potential for evidence of Aboriginal occupation due to heavy disturbance of the site. The Site Officers also noted a lack of sensitive landforms in the vicinity. Neither Kristie nor Kenneth knew of any sites within the immediate area and were unaware of any areas of cultural significance near the proposed development. *We note these comments must be reviewed and finalised in consultation with Narrabri LALC during the review of this final report, as all comments have been verbal to date.*

5.2 Summary of Site Inspection

There are no previously recorded sites within the project area based on heritage searches and background research of previous archaeological investigations to date. No Aboriginal objects or sites were observed in the project area and given the disturbance and lack of any undisturbed soils or sensitive landforms identified during survey, the project area is deemed to have a very low potential for archaeological deposits. Comments from Narrabri LALC Site Officers, Kristie Toomey and Kenneth Mason supported the assessment of low archaeological potential on site during fieldwork.

6. RECOMMENDATIONS

The following recommendations have been made based on the information provided on project impacts, consultation to date, relevant archaeological and environmental background research, and the results of the site inspection.

4. No Aboriginal objects were identified during the site inspection. No Aboriginal places are registered within the project area. No areas of archaeological potential are identified within the project area requiring archaeological testing, salvage or mitigation.
5. All site workers and personnel involved in site impact works associated with the proposal should be inducted and briefed on the possible identification of Aboriginal sites and objects during construction and their responsibilities according to the provisions of the *NPW Act 1974*, in case any additional unknown objects or items are uncovered during proposed works.
    a. As part of this induction, the contact phone numbers of the Heritage NSW regional archaeologist and EnviroLine 131 555, the relevant Environmental Officer responsible for this project should also be given to all site workers and personnel, in case unknown objects or items are uncovered during excavation.
    b. Site workers should be made aware of the location of any Aboriginal sites that may at any stage occur within the proposal site and their scientific significance and their legal obligations in relation to the protection and management of these Aboriginal sites under the *NPW Act 1974*, and 2010 ancillary provisions and amendments.
    c. As part of this induction, workers should be made aware that in the event that any unexpected human remains are uncovered on site, the area of the suspected remains must be secured and cordoned off and the NSW Police notified. No further works can be undertaken until the NSW Police provide written advice. If these remains are deemed to require archaeological investigation by the NSW Police or NSW Coroner, then Heritage NSW and the relevant Aboriginal parties must be notified. A plan of management for the preservation of any identified Aboriginal human remains or for their salvage must be put in place or conducted under an AHIP methodology and variation developed in consultation with all relevant Aboriginal parties and the Heritage NSW.
    d. Providence Asset Group or delegated authority may wish to consider the input and engagement of interested Aboriginal stakeholder groups and Narrabri LALC in the development of inductions and tool box talks for this project.
6. A copy of the final report has been made available to Narrabri LALC for comment and review. Any additional comments by the LALC will be considered where possible in the future by PAG.

7. REFERENCES

AECOM Australia Pty Ltd 2011. *Archaeological Constraints*. Report prepared for Eastern Star Gas.

AECOM Australia Pty Ltd 2016. *Historic Heritage Impact Assessment: Narrabri Gas Project*. Report prepared for GHD Pty Ltd.

Askland, M. *et al.* 2016. *Local Attitudes to Changing Land Use – Narrabri Shire*. Report prepared for NSW

Department of Primary Industries (NSW DPI) and The University of Newcastle (UON).

Berry 2018. *Gunnedah Solar Farm Environmental Impact Statement.* Report prepared by Pitt & Sherry for KMH Environmental.

Bioregional Assessments Website, Namoi Subregion: https://www.bioregionalassessments.gov.au/assessments/namoi-subregion [accessed 22nd January 2021].

Boileau, J. 2007. *Thematic History of Nundle, Manilla and Barraba. Tamworth Regional Council Community Based Heritage Study*. Report prepared for Tamworth Regional Council.

Colquhuon, G. *et al.* 2019. New South Wales Seamless Geology dataset, version 1.1 [Digital Dataset]. Geological Survey of New South Wales. NSW Department of Planning and Environment: Maitland.

CQCHM 2015. *Aboriginal Cultural Heritage Assessment Report, Narrabri Gas Project*. Report prepared for the Narrabri Gas Project.

DECCW. 2010a. *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW and Archaeological Investigation of Aboriginal Objects Code of Practice*.

DECCW. 2010b. *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW*.

DECCW. 2010c. *Aboriginal heritage consultation requirements for proponents 2010*.

Department of Planning, Industry and Environment (DPIE) 2020. *Australian Soil Classification (ASC) Soil Type map of NSW, Version 4*. Department of Planning, Industry and Environment: Sydney.

Hunt, G. 1980. *When Narrabri was young: a history of Narrabri 1818 – 1900*. Narrabri Municipal Council: Narrabri NSW.

ICOMOS Burra Charter 2013. The Burra Charter.

Jakovljevic, A. *et al.* 2018. *Gunnedah Solar Farm Aboriginal Heritage Assessment*. Report prepared by Kelleher Nightingale Consulting Pty Ltd for Photon Energy.

Mitchell, P. 2002. *Descriptions for NSW (Mitchell) Landscapes: Version 2*. Report prepared for Department of Environment & Climate Change NSW.

NSW Department of Planning, Industry and Environment Website (DPIE Website). Brigalow Belt South Bioregion: https://www.environment.nsw.gov.au/bioregions/BrigalowBeltSouthBioregion.htm [accessed

22nd January 2021].

NSW Department of Planning, Industry and Environment Website (DPIE Website). Narrabri Railway Station, SHR Listing: https://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=4801198 [accessed 21st January 2021].

NSW National Parks and Wildlife Service (NPWS) 2002. *Aboriginal Cultural Heritage Assessment, Brigalow Belt South, Stage 2*. Final report prepared for Resource and Conservation Assessment Council: NSW Western Regional Assessments.

NSW National Parks and Wildlife Service (NPWS) 2003. The Bioregions of NSW: their biodiversity, conservation and history. NSW National Parks and Wildlife Service: Hurstville.

OzArk Environment & Heritage 2020. *Aboriginal Cultural Heritage Study: Narrabri LGA Study*. Report prepared for Narrabri Shire Council.

Rolls, E. 1981. *A Million Wild Acres*. Penguin Books: Ringwood, Victoria.

Stace, H. *et al.* 1968. *A Handbook of Australian Soils*. Rellim Technical Publishing: Glenside.

Tamworth Regional Council (TRC) 2006. *Tamworth and Districts Early History*. Tamworth Regional Council: Tamworth.

Totterdell, J. *et al.* 2009. Sequence stratigraphy of the Bowen-Gunnedah and Surat Basins in New South Wales, in *Australian Journal of Earth Sciences* 56(3).

Trindall, E. 2007. *Narrabri Coal Seam Gas Utilisation Project: Aboriginal Heritage Assessment*. Report prepared for Eastern Star Gas Limited.

Wilson, J. & McAdam, L. 2000. *The Tamworth Aboriginal Archaeological Site Study*. Report for the Tamworth Regional Council.

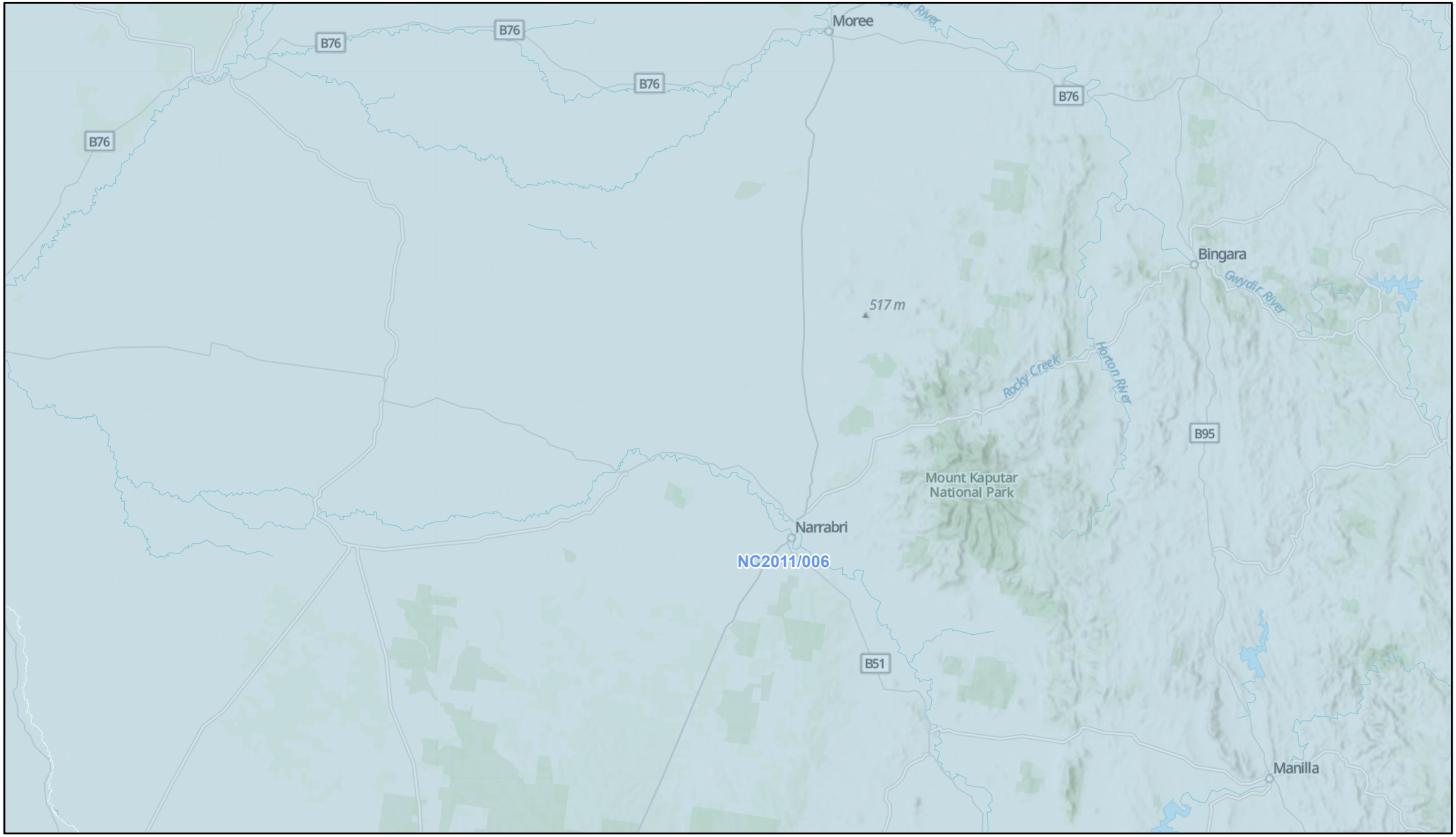
APPENDIX A

CONSULTATION LOG

APPENDIX B

NATIONAL NATIVE TITLE TRIBUNAL SEARCH

Native TitleVision Web Map



11/3/2020, 2:08:25 PM

Applications (Schedule)

1:1,155,581

0 5 10 20 mi

0 12.5 25 50 km

Esri, HERE, Garmin, FAO, METI/NASA, USGS, Esri, CGIAR

Document Set ID: 1845825
Version: 1, Version Date: 09/03/2021

Native TitleVision

Esri, USGS | Esri, HERE, Garmin, FAO, NOAA, USGS | National Native Title Tribunal,

NATIVE TITLE DETERMINATION APPLICATION

Gomeroi People

Gomeroi People

Register Attachment:
NSD37/2019 (NC2011/006)
Map of the area covered by the application
Attachment C of the Application
Page 1 of 1, A4, 20/01/2012

National Native Title Tribunal

NORTH

0 25

KILOMETRES

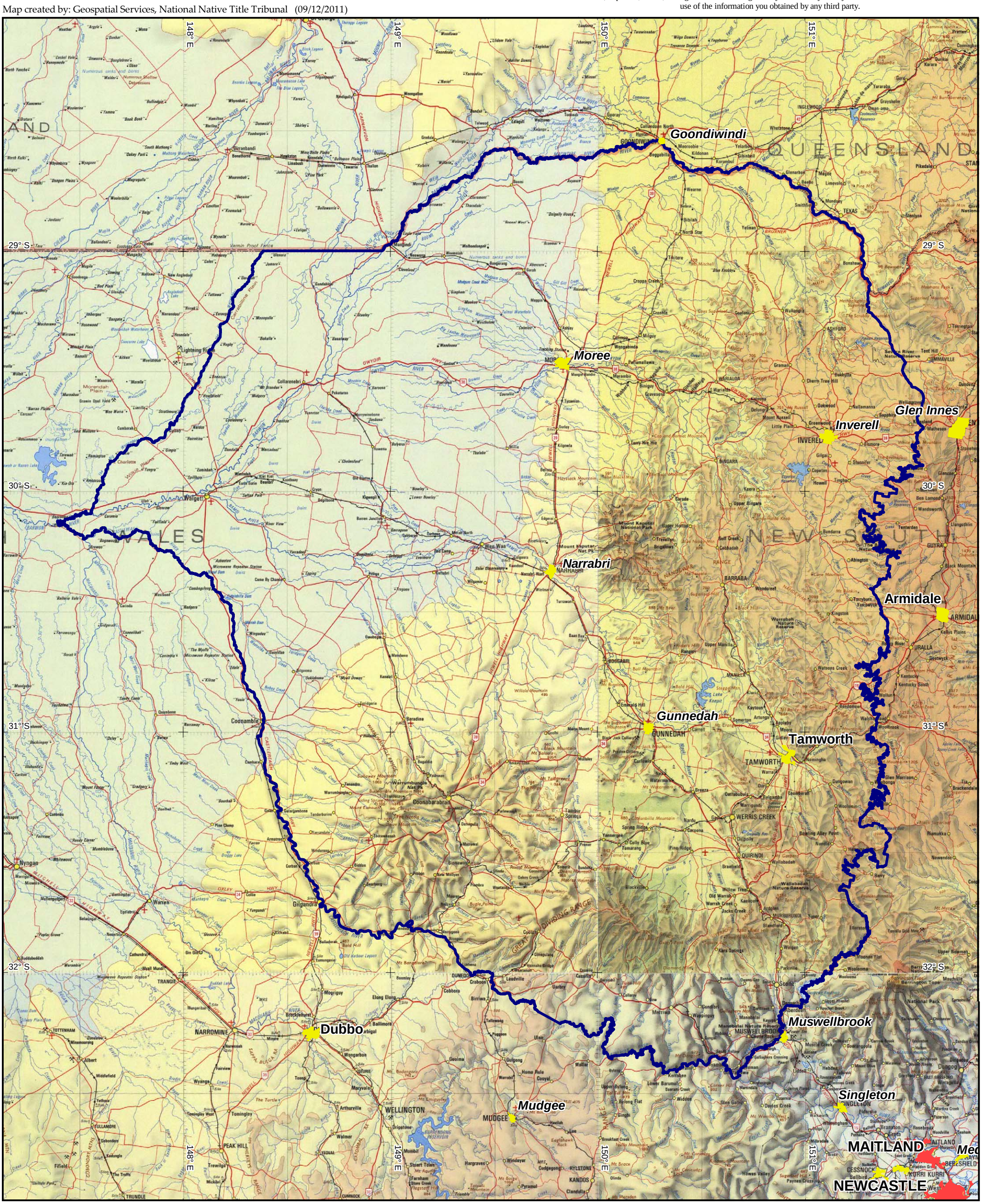
Latitude and Longitude based on Geocentric Datum of Australia 1994
Non Projection

NOTE: To determine areas subject to claim within the external boundary, reference to the application description is necessary.

Application boundary data compiled by the NNTT from data sourced from DOL (NSW).

NOTE: Topographic images should be used as a guide only.

Map created by: Geospatial Services, National Native Title Tribunal (09/12/2011)



Filepath: P:\GEO_INFO\Products\NSW\NTDA\Proposed\Gomeroi\Mapping\GT2011_1789\20111209_Gomeroi_topo_A3P.wor Map Ref: 20111209_Gomeroi_Topo_A3P.pdf

APPENDIX C

AHIMS SEARCH

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : 221 - Narrabri Solar

Client Service ID : 555629

Elaine Lin

17/469-475 Parramatta Road
Leichhardt New South Wales 2040

Attention: Elaine Lin

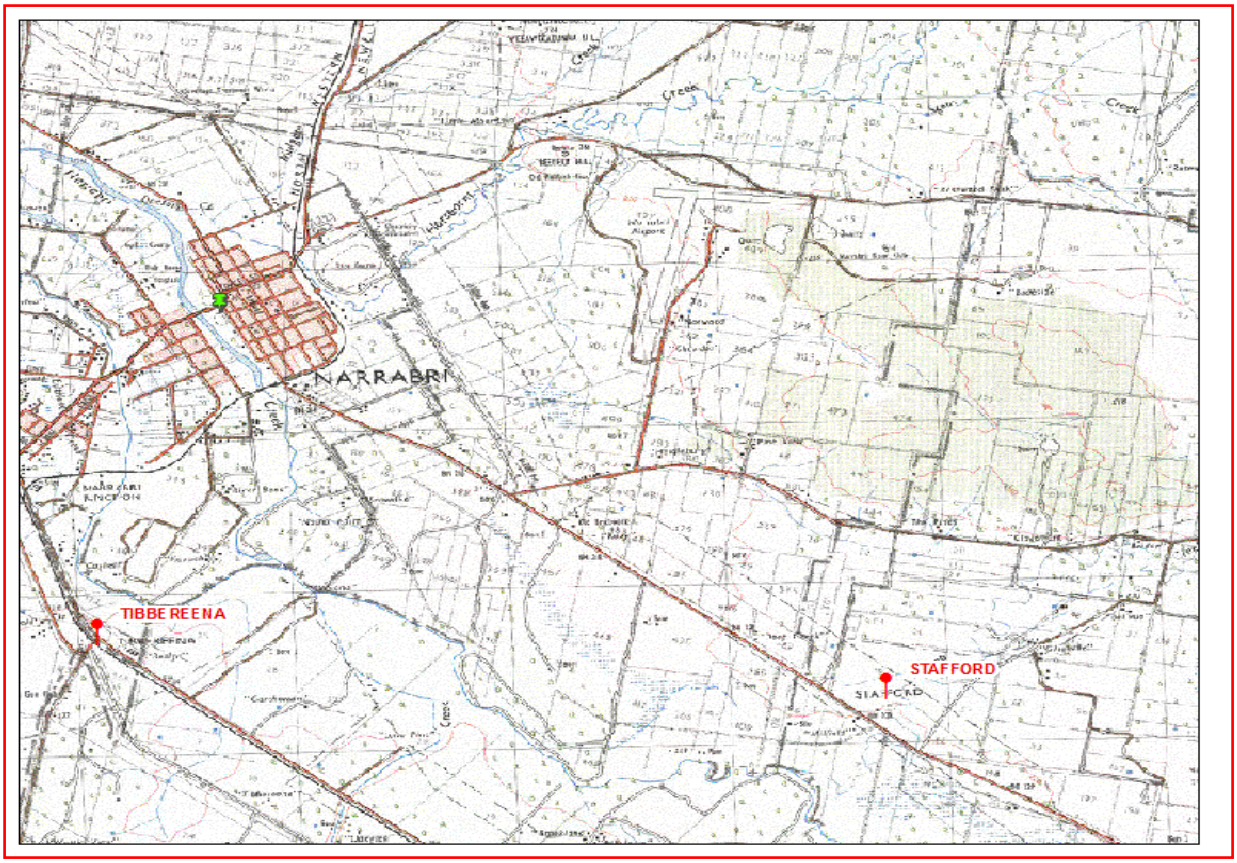
Email: e.lin@virtusheritage.com.au

Date: 07 December 2020

Dear Sir or Madam:

AHIMS Web Service search for the following area at Datum :GDA, Zone : 55, Eastings : 766080 - 776080, Northings : 6635078 - 6645078 with a Buffer of 0 meters. Additional Info : Redoing search as per advice from Eva due to mapping issue with AHIMS system - fee to be waived, conducted by Elaine Lin on 07 December 2020.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

7	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the NSW Government Gazette (http://www.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

3 Marist Place, Parramatta NSW 2150
Locked Bag 5020 Parramatta NSW 2220
Tel: (02) 9585 6380 Fax: (02) 9873 8599

ABN 30 841 387 271
Email: ahims@environment.nsw.gov.au
Web: www.environment.nsw.gov.au

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 221 - Narrabri Solar

Client Service ID : 555629

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
19-3-0184	Namoi River Scar tree	GDA	55	766474	6639342	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact	**Recorders**	Paul Houston,Mr.Steven Booby					**Permits**		
19-3-0185	Namoi River IF	GDA	55	766653	6639633	Open site	Valid	Artefact : 1		
	Contact	**Recorders**	Paul Houston,Mr.Steven Booby					**Permits**		
19-3-0186	Namoi River IF 2	GDA	55	766653	6639625	Open site	Valid	Artefact : 1		
	Contact	**Recorders**	Paul Houston,Mr.Steven Booby					**Permits**		
19-3-0187	Namoi River Artefact with Pattern	GDA	55	766975	6639584	Open site	Valid	Artefact : 1		
	Contact	**Recorders**	Paul Houston,Mr.Steven Booby					**Permits**		
19-3-0007	Narrabri Junction;Namoi Farm;	AGD	55	767955	6639171	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	**Recorders**	Brown					**Permits**		
19-3-0133	Collins Park site 2 artefacts	GDA	55	767429	6641486	Open site	Valid	Artefact : 5, Modified Tree (Carved or Scarred) : 1		
	Contact	**Recorders**	Mr.Allison Stewart					**Permits**		
19-3-0136	Collins Park site 1 artefact	GDA	55	767458	6641465	Open site	Valid	Artefact : 1		
	Contact	**Recorders**	Mr.Allison Stewart					**Permits**		

Report generated by AHIMS Web Service on 07/12/2020 for Elaine Lin for the following area at Datum :GDA, Zone : 55, Eastings : 766080 - 776080, Northings : 6635078 - 6645078 with a Buffer of 0 meters. Additional Info : Redoing search as per advice from Eva due to mapping issue with AHIMS system - fee to be waived. Number of Aboriginal sites and Aboriginal objects found is 7

APPENDIX D

PLATES

Plate 1. Access to proposed solar farm lease area from 115 Airport Road, Narrabri, NSW.

Plate 2. Entrance gate into lease area for proposed solar development and start of transect one; facing west.

Plate 3. Start of transect two showing completely overgrown paddock with exotic pasture species; facing south.

Plate 4. End of transect three showing completely overgrown paddock with exotic grass and weed pasture species and horses in paddock; facing north.

Plate 5. Start of transect four showing one of two major areas of exposure with approximately 80% visibility; facing west.

Plate 6. Example of rare large area of exposure with approximately 80% visibility; facing northwest.