

WEE WAA SOLAR FARM

Prepared for:

Providence Asset Group
704/99 Bathurst Street
SYDNEY NSW 2000

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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

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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 3843 Yarrie Lake Road, Wee Waa NSW 2388 (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 4-5m wide access road from the north boundary of the site;
- Construction of unsealed access road from existing gravel access off Yarrie Lake Road to the development area;
- Earthworks for construction lay-down area, hardstand areas and internal roads;
- High chain link security fencing 2.3m high; and
- Other associated site improvements as shown on the Plans at **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 1979). 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 a 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 advice email and provides comments on each of the matters raised.

Table 1 Consultation with Narrabri Shire Council

Matters Raised	Comments
Land Affected by the DA (a) All land affected by the proposed development is to be included in the DA. This includes any land required for access (excluding public roads). (b) Provide landowners consent for all land affected by the development. (c) The impact assessment provided should consider the impacts of the development on all land affected by the development. (d) The development will require access to be constructed over a crown road. Please refer to https://www.industry.nsw.gov.au/lands/access/roads to determine requirements for works on crown roads.	This Statement of Environmental Effects provides and 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 with this DA lodgement. Upgrades required for the access road are detailed in the Traffic Impact Assessment and are able to comply with the Road Act 1993.
DA Plans The following plans are to be submitted with the DA: - An existing site plan; - A proposed site plan; - A floor plan (of any buildings and structures); - Elevation Plans (of any buildings and structures); and - Plans showing the road works within the Crown road reserve.	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; - 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 the grid connection	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
• Consideration of the applicable Environmental Planning Instruments, DCPs and other applicable legislation. In partial: • SEPP 55; • Koala Habitat Protection SEPP; • Infrastructure SEPP; • Narrabri LEP, including Earthworks (clause 6.1), Flood Planning Area (clause 6.2) and Essential Services (clause 6.5) • Identification of the environmental impacts • Measures taken to protect the environment or to lessen the expected harm.	
Traffic A Traffic Impact Assessment (TIA) should be included with any DA, prepared by a suitably qualified consultant in accordance with Austroads Guide to Traffic Management Part 12 Integrated Transport Assessments for Developments. • 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	A Traffic Impact Assessment (TIA) has been prepared for the proposal and is located at Appendix D. Within the TIA is an assessment of existing conditions of the roads, traffic generation, vehicle access points, manoeuvring and identification of any road upgrade work required.

Matters Raised	Comments
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); • 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.	Refer to Section 5.4 of this SEE.
Koala SEPP 2019 The following 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—	The site is not identified as an area for site investigation for Koala Plans of Management.

Matters Raised	Comments
• 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 airstrips, residential receptors, road users, rail users, and any airstrips. Noting the DA will likely be referred to CASA.	A Reflectivity Glare Assessment has been conducted for the application and is located at Appendix E.
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 Impact Assessment has been prepared for the proposal and is located at Appendix F.
Agricultural Land Impacts An assessment on the impact of the development on productive agricultural land.	The solar array is designed to minimise impacts on existing cropping activities adjacent to the development area. The development site was chosen as it features, in the experience of the owner, less productive soils compared to other lots within the owner's landholdings. The site has also been located on the extremity of the landholdings, maximising access to adjacent lots and minimising impact on planting and harvesting activities. Opportunities for livestock grazing (sheep) is currently being explored with the landowner, which can be easily accommodated through the design proposed.
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.

2 The Site and Surrounds

2.1 Site Description

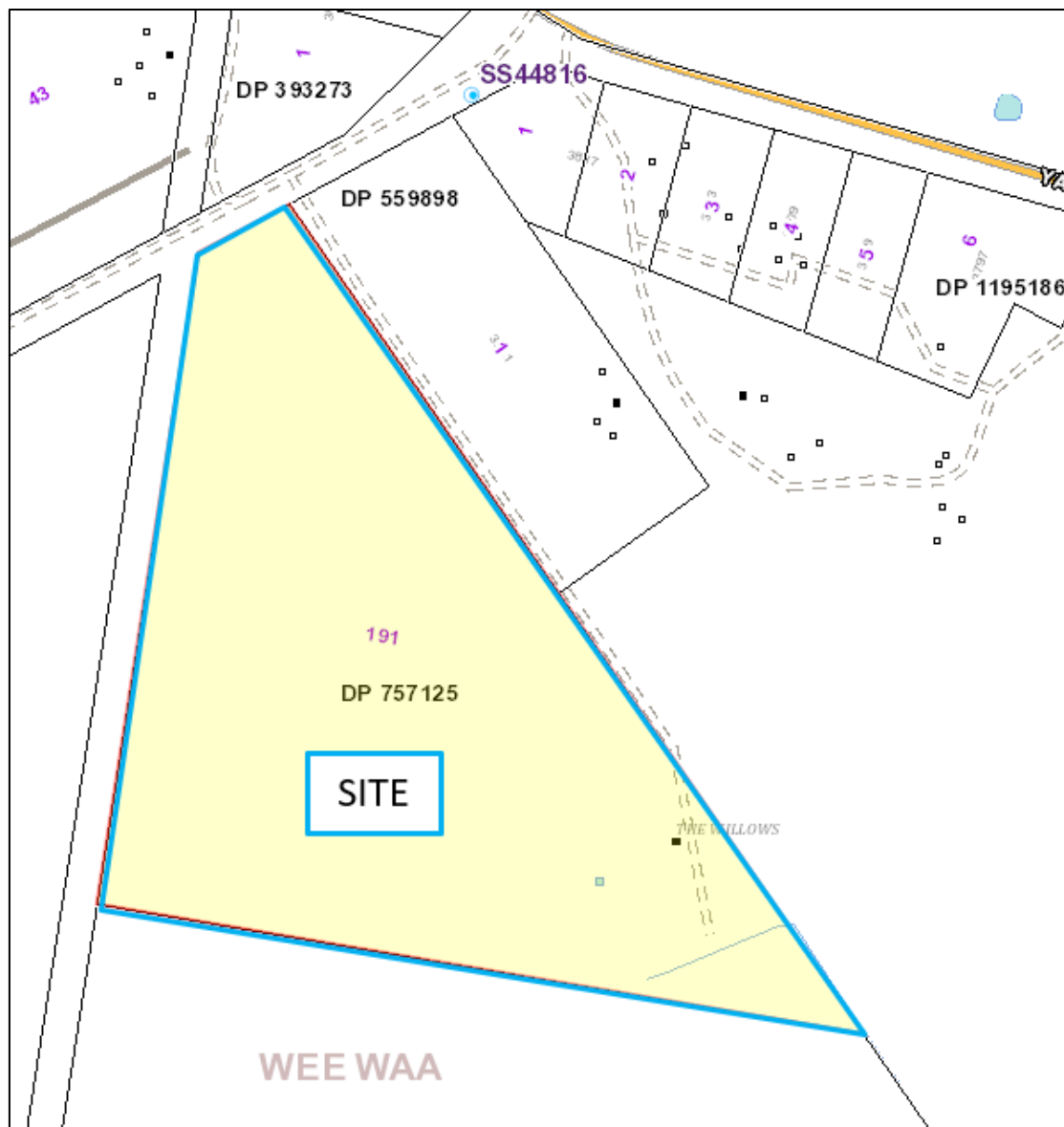
The land is legally known as part Lot 191 DP757125 and is generally referred to as 3843 Yarrie Lake Road, Wee Waa NSW 2388 (refer to Figure 1). The land is currently used for agricultural purposes primarily intensive cultivation activities including sorghum and cotton. In terms of topography, the site is relatively flat with a gradual slope from south-east to north-west.

The proposed lot boundary site is irregular in shape and comprises approximately 41.5 hectares. The site is heavily cropped and has a lack of trees or vegetation in the area.

The proposed development/lease site is a 4-sided polygon shape which is generally flat and comprises approximately 15 hectares. The development site is located in the northern section of Lot 191 DP757125, holding a frontage access off an unnamed gravel access road off Yarrie Lake Road. Vehicular access to the site is proposed via the existing gravel access to the site off Yarrie Lake Road approximately 1.4 km south of Culgoora Road.

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 3.3km south-east of Wee Waa town centre, within the Narrabri Shire Council Local Government Area (LGA). The unnamed access road for the site is single lane in each direction, unsealed, unmarked and with no kerb or guttering on either side. The road connects to Yarrie Lake Road.

Surrounding lands are similar to the investigation area consisting of agricultural and primary production land with rural dwellings, sheds, dams, and scattered remnant vegetation. The site is approximately 167m south-west from the nearest dwelling external to the site.

The site is also 1.60km south-west from Cotton Seed Distributors Ltd located on Culgoora Road. The site is located 150m south-east of a nearby private airstrip and 3.8km east of the Wee Waa Aerodrome. Aviation has been considered as part of the reflectivity report completed for the project (refer to **Appendix E**).

3 Project Description

The Wee Waa 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 Country Energy Substation at 23348 Kamlaroi Highway, Wee Waa 8 Stoney which is approximately 1.4km north-east of the proposed development site.

The proposed development aims to erect an estimated 12,572 solar PV panels with a nameplate rating of 540W. Other electrical generation infrastructure is proposed on the site including a power conversion station (PCS) consisting of inverters, transformer switchgear and auxiliary plant. Due to the capacity of the inverter system, the proposed development will produce less than 5MW. Most of the infrastructure would be pre-fabricated off-site, delivered and assembled on-site.

The PV arrangement will consist of 154 ground mounted single axis trackers, refer to Figure 3. The solar PV panels measuring approximately 2.26m by 1.13m with 600mm clearance above the existing ground surface. The panels will be positioned on single axis-trackers oriented north-south with a spacing of 6.3m. The PV mounting structure will comprise steel posts driven to approximately 1.5m below ground using a small pile driver. Additional support structures will be attached to the piles, which would then support the PV panels.

The proposed development will not require the entire removal of vegetation within the development area, it is noted that the site has had extensive land clearing for agricultural purposes (cropping) and remnant native ground cover on the site is negligible. The proposal will not involve clearing of native vegetation that exceeds the Biodiversity Offset Scheme (BOS) threshold for the site. The proposed solar farm, once operational, is expected to re-establish grasslands on site whilst managing dust generation and encouraging continued agricultural activities through livestock grazing. Weed management and control will be included as part of the standard operation procedures of the facility.

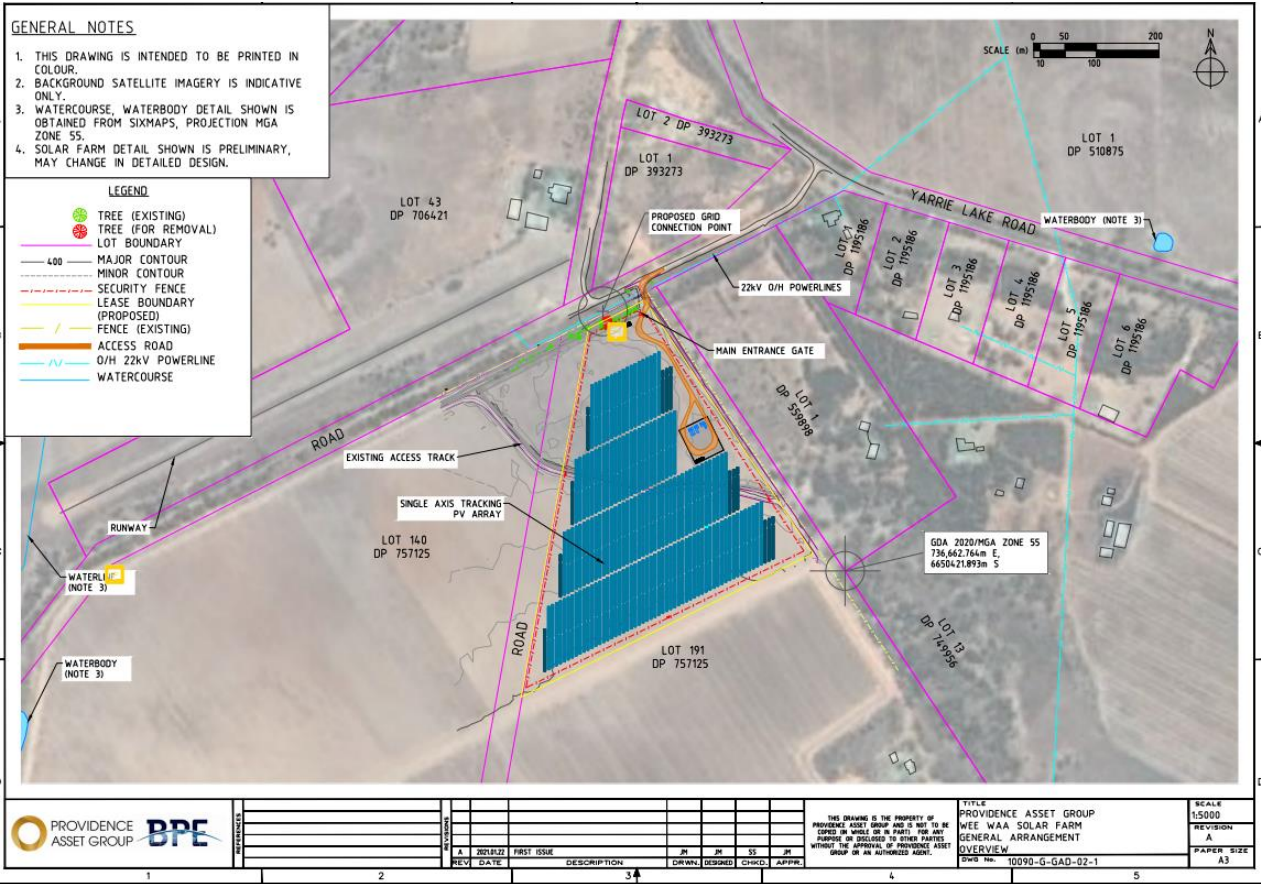
Vehicular access to the site will be via the existing access road off Yarrie Lake Road approximately 3 km south-east of Wee Waa, with the site entrance located in the north-east corner of the site. The solar farm will be fully fenced with a 2.3m security fencing including barbed wire at the top. Gate access is provided on the northern border of the site with emergency access gates on each boundary of the lease area. A temporary construction office area is indicatively shown on the General Arrangement Plan, with expectations that temporary car parking and off load areas are located within the hardstand area, also identified within the general arrangement plan (refer to Figure 3). Motion activated security lighting will be installed at the site.

A stormwater management system is proposed including an onsite detention basin holding a total volume of 154m³ supported with a low flow outlet. Refer to the Stormwater Management Plans at **Appendix B**. Earthworks for the project are generally limited to the establishment of the access road, drainage swales and batters, laydown area, and detention basin.

The solar PV farm would 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.

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

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;*
- *Biodiversity Conservation Act 2016;*
- *Local Land Services Act 2013.*
- *State Environmental Planning Policy (State and Regional Development) 2011;*
- *State Environmental Planning Policy (Infrastructure) 2007;*
- *State Environmental Planning Policy 55 – Remediation of Land;*
- *State Environmental Planning Policy (Koala Habitat Protection) 2019;*
- *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 Environmental 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.

Due to a general lack of natural landscape or habitat features, it is unlikely that the site contains important habitat for any EPBC listed biota. It is unlikely that any future development would require referral to the Commonwealth Department of the Environment and Energy for consideration pursuant to the EPBC Act.

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.

It is noted, pursuant to Section 4.46 of the EP&A Act 1979, the proposed development does not trigger integrated development.

4.3 Biodiversity Conservation Act

The Biodiversity Conservation Act 2016 (BC Act 2016) 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 2016 governs endangered species and communities and provides a framework for a Biodiversity Offset Scheme.

Desktop research was undertaken by SLR in accordance with Section 7.3 of the BC Act 2016 to determine the 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 of the SLR desktop research is provided in Section 5.4 of this Report.

4.4 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 191 of DP757125 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.

4.5 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 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 CIV greater than \$5 million (refer to Appendix H) 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.

4.6 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, the proposed solar PV project is therefore 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 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 as such does not trigger traffic generating development under the SEPP. Referral under this clause to Transport for NSW is therefore not required.

4.7 State Environmental Planning Policy No 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 4 licenses have been issued under the Protection of the Environment Operations Act in Wee Waa, however, none are noted within proximity to the site. Environmental protection licenses issued within Wee Waa include:

- Licence 11684 – Cotton Seed Distributors Ltd – CSD Delinting Plant “Shenstone”, Culgoora Road, Wee Waa NSW 2388 – No longer in force;
- Licence 10858 – Naomi Cotton Limited – Myall Vale Cotton Gin Spring Plains Road, Wee Waa NSW 2388 – Surrendered;
- Licence 7192 – Hunter and New England Area Health Service – Alma Street, Wee Waa, NSW 2388 – Application Approved; and
- Licence 10862 – Naomi Cotton Limited – Yarraman Cotton Gin Burren Junction Road, Wee Waa NSW 2388 – Issued.

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 SEPP55.

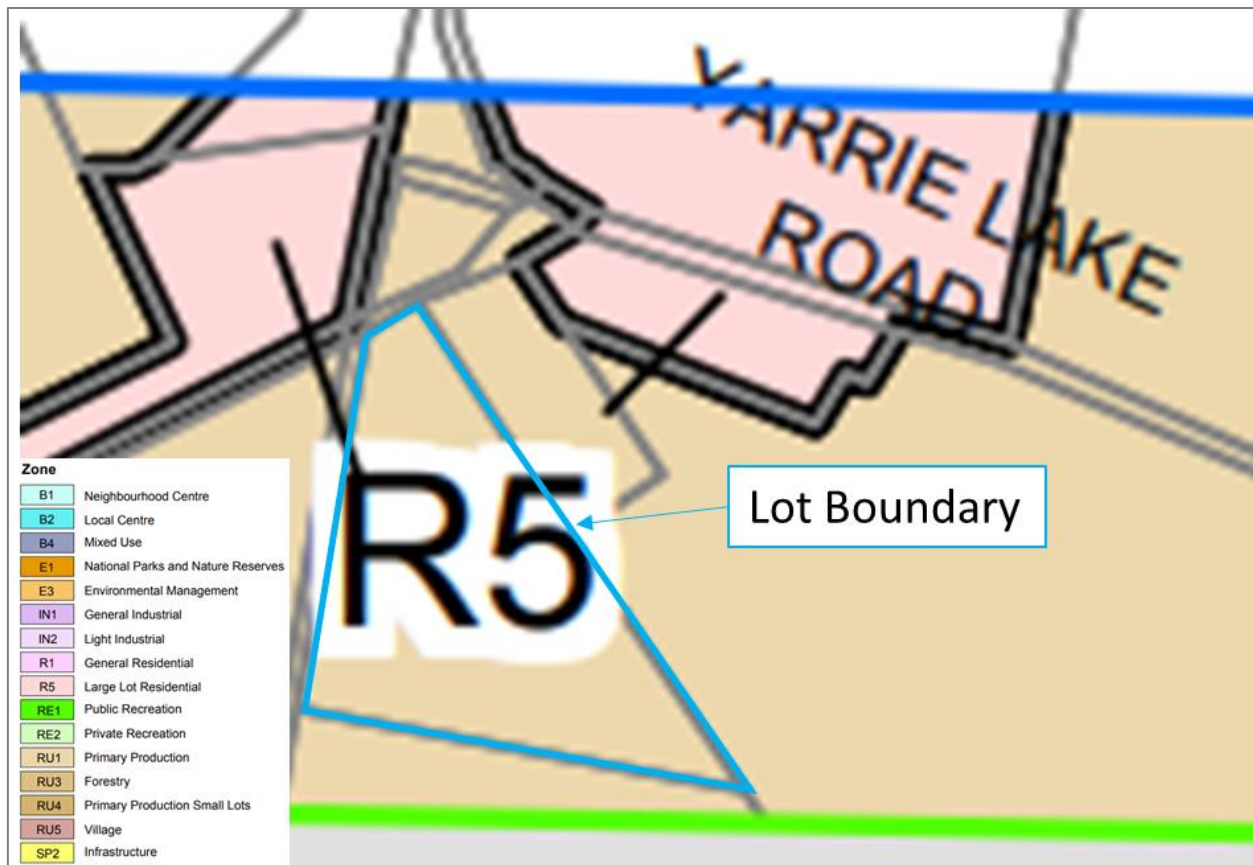
4.8 State Environmental Planning Policy (Koala Habitat Protection) 2020

This Policy aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas through the identification of core koala habitat and by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat. The SEPP is relevant to the proposal noting that Narrabri is a listed LGA in Schedule 1 and the proposal involves an area more than 1 hectare in size.

Noting that the site is devoid of trees and woody vegetation, it is considered unlikely that the site contains potential koala habitat or core koala habitat. This is discussed further at Section 5.4 within this report.

4.9 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 Extract Narrabri LEP 2012 (LZN_001)

The objectives and land use table of the RU1 Primary Production are as follows:

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

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.

The proposed land use, defined as electricity generating works, is prohibited within the RU1 as *any other development not specified in item 2 or 3*. As a result, permissibility of the project will require an alternative approval pathway, noting the proposal is permissible under Clause 34 of SEPP (Infrastructure) 2007 as discussed in Section 4.6.

Clause 4.1 Minimum Subdivision Lot Size

The minimum lot size for subdivision across the investigation area is 100 hectares. Subdivision does not form part of the scope of works for the solar PV farm.

Clause 4.3 Height of Buildings

This clause has not been adopted under LEP 2012.

Clause 4.4 Floor Space Ratio

This clause has not been adopted under LEP 2012.

Clause 5.10 Heritage Conservation

The investigation area 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 investigation area is not mapped within a flood prone land area under the LEP 2012. The Planning Certificate for the site does not conclude definitively if the site is flood prone. Notwithstanding, the nature of the will not increase the flood risk or alter any potential flood behaviour.

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. The site is located 150m south-east of a nearby private airstrip and 3.8km east of the Wee Waa Aerodrome. This clause has been duly considered, however, the site is not listed within the Obstacle Limitation Surface Map as per Clause 6.3 of the Narrabri LEP 2012. Aviation has been considered as part of the reflectivity report completed for the project (refer to **Appendix E**).

Clause 6.5 Essential Services

Provision of services relevant to the proposal, such as: water supply, stormwater drainage, and vehicular access suitable for the proposed development will be provided for the site.

In summary, the solar PV farm project is compliant with the relevant clauses and controls contained within NLEP 2012 with the exception of permissibility, which is overridden by SEPP Infrastructure.

4.10 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 C**.

4.11 New England North West Regional Plan

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 Wee Waa and the larger Narrabri LGA and New England Region.

4.12 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 1979 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 to no impact on flora or fauna under the BC Act 2016;
- 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 C**.

5.2 Traffic, Access, and Parking

Traffic

A Traffic Impact Assessment (TIA) has been undertaken by Intersect Traffic and is attached at **Appendix D**. 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 would include a single, staff light vehicle movement associated with maintenance inspections and specific maintenance work (on an as needs basis) which would be short term and infrequent. 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.

Peak hour construction traffic has been calculated with a predicted peak of 18 vehicle trips per hour consisting of 10 light vehicles, 3 roadwork vehicles, and 2 delivery vehicles. 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. It is noted that construction traffic is temporary in nature and will be managed through a future Construction Management Plan.

The TIA notes the existing condition of the surrounding road network in particular Kamilaroi Highway and Yarrie Lake Road. At the time of assessment, the aforementioned road networks are considered suitable to cater for the short-term heavy vehicle increase as required during the construction phase. It is considered the local and state road network would be suitable to cater for the expected construction traffic associated with the development.

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 (both now and in 10 years) is capable of accommodating the expected additional traffic from the proposal.

Access and Internal Circulation

The proposed vehicular access to the site will be provided via the existing gravel access to the site off Yarrie Lake Road approximately 1.4 km south of Culgoora Road. Deliveries to the site will use the identified delivery road shown on Figure 1 of the TIA, being via Yarrie Lake Road to Narrabri and then the Kamilaroi Highway from the south from Sydney and Newcastle or from the north from Brisbane.

During the construction phase of the development the proposed site access road has an unsealed pavement width in excess of 7 metres wide which allows two heavy vehicles to pass each other at normal speed. The TIA demonstrates that Yarrie Lake Road has a sealed pavement at a minimum of 7 metres wide and therefore complies with Austroads Standards for Rural Roads with more than 500 vtp. Therefore, it is widely considered the proposed transportation route to the site is suitable to carry heavy vehicles and is suitable to cater for the construction traffic from the Solar Farm construction.

Parking

The Narrabri Shire DCP 1993 sets out the relevant on-site car parking rates for land uses within the Wee Waa 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.

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 south-east corner of the development area. This basin provides a holding volume of 154m³ and is supported with a low flow pipe and overflow weir. The stormwater management system proposed has been designed in accordance with best practice as Narrabri Shire Council's Development Plan does not provide specific guidance on developments of this nature. Therefore, DRB Consulting Engineers proposed 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*'.

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 and the proposed roadside swale used as an 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 Wee Waa 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 B**.

5.4 Flora and Fauna

SLR undertook a desktop research with reference to the EP&A Act 1979 as well as the BC Act 2016 and the EPBC Act 1999.

As noted throughout this report, the site is mainly cleared of vegetation due to previous agricultural development. Due to the extensive land clearing for agricultural purposes (cropping), remnant native ground cover on the site is negligible. Following the establishment of the proposed solar farm, grasslands are expected to be re-established on site, managing dust generation and encouraging continued agricultural activities through livestock grazing. Weed management and control will be included as part of the standard operation procedures of the facility.

The proposed site is not within or in close proximity to any mapped Areas of Outstanding Biodiversity Value and it is therefore, not expected that any EPBC listed species, ecological communities, migratory species or important habitat for such entities would be identified within the Development Area.

The following historical aerial images reflect clearing of native vegetation consistent with a land management activity lawfully undertaken both before and after the commencement of the Act (1 January 1990). The images reflect regular furrows resulting in a concentric square pattern emphasizing ploughing and cropping has been undertaken.

It is considered this evidence supports Clause 52 of the Land Management (Native Vegetation) Code 2018 therefore the proposed development falls under the designation of category 1– Exempt (Local Land Services Act 2013) thus excluding the need for a Biodiversity Development Assessment Report (BDAR) for this proposed development.

There is the capability to review historic images from 1985, however, the quality does not demonstrate evidence of what is on site. It is assumed due to the history that the proposed development area in the subject site of Lot 191 of DP757125 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.

Photo 1 **Historic Aerial Photo: 2012 (Source: Google Earth)**



Photo 2 Historic Aerial Photo: 2013 (Source: Google Earth)



Photo 3 Historic Aerial Photo: 2015 (Source: Google Earth)



Photo 4 Historic Aerial Photo: 2018 (Source: Google Earth)



Photo 5 Historic Aerial Photo: 2020 (Source: Google Earth)



Photo 6 Current Site Photo (Source: SLR)



As seen in the historic images above, the site is mainly cleared of vegetation due to previous agricultural development. Due to the extensive land clearing for agricultural purposes (cropping), remnant native ground cover on the site is negligible. The images reflect regular furrows emphasizing ploughing and cropping has been undertaken. Therefore, it is considered that there is no need for a Flora and Fauna assessment or a Biodiversity Development Assessment Report (BDAR) for this proposed development.

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 G**). The report concludes that based on the Noise Assessment results, there are no noise related issues which would prevent approval of the proposed project.

Operational Noise

The results of the NA demonstrate that emissions from the project would 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.

Based on the NA results, there are no noise related issues which would prevent the approval of the project. The results of the assessment shows compliance with the relevant operational and road noise criteria. Accordingly, no additional ameliorative measures will be required.

Construction Noise

Modelled noise emissions from all four project construction activities identify that relevant noise management levels may be exceeded at a number of receiver locations adjacent to the site. Hence, noise management measures as provided in the enclosed Noise Assessment (refer to **Appendix G**) are to be considered for implementation 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 recommended for consideration 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.*

5.6 Landscape and Visual Impact

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 (VA) to assess the potential visual amenity changes which may occur as a result of the proposed development, see **Appendix F**.

Based on the appraisal and findings of the Visual Analysis, 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 Yarrie Lake Road and Wee Waa town centre, 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 the adjacent unsealed access road, Yarrie Lake Road and Culgoora Road. Due to the scale of the solar farm in relation to the overall landscape surrounding the site, the degree of change is considered to be relatively low.

Given the distance of the site from notable public vantage points, the visual impacts are relatively low. The existing vegetation along the site boundaries particularly to the north and east, currently screen the site from almost all views from surrounding roads and public locations and thus it is considered that no additional landscaping is required to be implemented on the site. The Visual Analysis advises that given the limited number of users and infrequent number of access areas, the site location, surrounding vegetation and proposed development would suggest that the solar farm would not require any mitigation measures to lessen these already minimal impacts.

5.7 Glare Analysis

SLR Consulting have prepared a Reflective Glare Assessment, refer to **Appendix E** and conclusion of findings below.

Aviation-Related Potential Glare

Quantitative analysis using the FAA-SGHAT software tool has shown that there will be nil glare from the Project at Wee Waa Aerodrome and the nearby Private Airstrip with the solar array in normal tracking mode, i.e., panels tilting $\pm 60^\circ$.

There is potential for glare on Private Airstrip Runway 06 if panels need to be left at a near horizontal or slightly westwards fixed tilt angle, e.g., during construction, back-tracking mode, etc. Leaving the solar array with a slight eastwards fixed tilt angle (say 15°) for the 6-month period September to March or instituting an Airstrip Management Agreement with the Private Airstrip Landowner would eliminate this occurrence.

Motorist, Rail Traffic and Residential Glare

There will be nil glare from the Project in relation to road traffic and rail traffic disability glare.

Similarly, there will be minimal risk for nuisance glare from the Project to surrounding residential receivers, even when panels are left horizontal or tilted slightly east or west, given the significant vegetation and trees surrounding the site, which effectively would screen the facility from surrounding ground level receivers.

5.8 Heritage

5.8.1 Indigenous Cultural Heritage

SLR undertook an AHIMS basic search for the site to identify aboriginal heritage at the site and found that no known Aboriginal sites or Aboriginal Places are recorded on AHIMS in the project area. There are no landscape features located on site that would indicate the presence of Aboriginal objects. Further, the lack of features relating to Aboriginal occupation in the proposed project area, makes it unlikely Aboriginal objects would be present.

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 Wee Waa 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 Wee Waa 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;
 - 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; and
 - 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 Wee Waa 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 Wee Waa community.

6 Conclusion

The proposed solar PV electrical generation operation located at 3843 Yarrie Lake Road, Wee Waa NSW 2388 will provide electrical power to support the needs of Wee Waa and the surrounding agricultural operations, along with rural towns and villages. With the growth of the Wee Waa area, the new electrical generator proposed under this DA will greatly assist in meeting the growing electrical demands required to support that growth.

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

STORMWATER MANAGEMENT PLAN

DRB Consulting Engineers Pty Ltd

APPENDIX C

COMPLIANCE TABLE

SLR Consulting Australia Pty Ltd

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.	N/A, 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.	N/A, 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 greater than 8m 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;	The site is vacant of vegetation, existing vegetation screens the site from the viewpoints selected in the Visual Analysis at Appendix F . Due to the proposed	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.	development, limited landscaping is proposed. The proposed development is void of natural vegetation. The VIA at Appendix F state that the surrounding area is characterised by open, flat, rural land and views of the site are unavailable from Yarrie Lake Road.	Y
4.7.1 AREAS REQUIRED TO BE LANDSCAPED	(a) The front building setback; (b) Side and rear setbacks where visible from a public place or an adjoining residential area; (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 large areas of paved surfaces	N/A – As above.	Y
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. (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.	No landscaping is proposed. The VIA states that analysis from each of the 2 viewpoints, the height and nature of the solar farm along with the distances from the site will mean that it will have limited visibility within the landscape and from public vantage points. Given the minor visual change to the rural landscape especially from public viewpoints, no mitigation measures are considered necessary.	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. (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. (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.		
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. (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.	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. A Traffic Impact Assessment is provided at Appendix D detailing site access. The proposed development is not considered a traffic generating development.	Y Y

	Additional information about the consultation procedure can be obtained by contacting Council's Environmental Services Section. 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. (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 access and turning circle proposed for the site will allow all vehicles to enter and exit the site in a forward direction. The proposed parking bay for the site will be constructed according to parking requirements.	Y 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. (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.	Vehicular access to the site will be via the existing access road off Yarrie Lake Road approximately 3 km south-east of Wee Waa. The proposed access driveway width at the combined entry/ exit gate is proposed to be 12.5 metres wide to accommodate swept turning paths during the construction stage. It is considered this is an adequate width for the proposed development type.	Y Y

	(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; (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. (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.	The proposed development is not considered as 'traffic generating development.' Vehicular access to the site will be via the existing access road off Yarrie Lake Road. No access driveway proposed across a footpath.	Y 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. (b) To ensure adequate drainage facilities are provided within the site to collect and carry stormwater to external drainage systems; (c) To reduce the hazard of flooding and the diversion or concentration of water onto adjoining properties.	A Stormwater Management Plan has been provided at Appendix B detailing the stormwater drainage strategy during both pre-development and post-development.	Y

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 levies 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. A Waste Management Plan is provided at Appendix I .	Y
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. (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.	A Stormwater Management Plan has been provided at Appendix B detailing the stormwater drainage strategy during both pre-development and post-development.	Y
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. 2. Upon an application being lodged, the paving required may be waived, if the applicant can demonstrate that the parking turnover will not adversely affect the proposed pavement.	The provided parking and manoeuvring area will be paved. Further details are provided in the Traffic Impact assessment located at Appendix D .	Y
LANDSCAPING	It is suggested that carparking areas be landscaped, especially with shade trees.	N/A - 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.	Y

PARKING REQUIREMENTS	Parking Rates: Factories: - 1.3 spaces per 100m2 GFA	N/A - 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. 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 D, sufficient on-site parking will be provided for construction staff during construction, and the one maintenance vehicle during operation.	Y
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APPENDIX D

TRAFFIC IMPACT ASSESSMENT

Intersect Traffic Pty Ltd

APPENDIX E

REFLECTIVE GLARE ASSESSMENT

SLR Consulting Australia Pty Ltd

APPENDIX F

VISUAL ANALYSIS

SLR Consulting Australia Pty Ltd

APPENDIX G

NOISE ASSESSMENT

Muller Acoustic Consulting Pty Ltd

APPENDIX H

QUANTITY SURVEYOR REPORT

RPS Australia East Pty Ltd

APPENDIX I

WASTE MANAGEMENT PLAN

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WEE WAA SOLAR FARM

Visual Analysis

Prepared for:

Providence Asset Group

704/99 Bathurst Street, SYDNEY NSW 2000

SLR Ref: 620.30235 Version No: -v2.0 FEBRUARY 2021





PROJECT NAME

Location	Lot 191, DP 757125 3843 Yarrie Road, Wee Waa, NSW 2388
Project Number	620.30235.00000
Client	Providence Asset Group

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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.
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Reference	Date	Prepared	Checked	Authorised
620.30235.00000-v0.1	February 2021	Dallas Ellis	Dean Butcher	Dean Butcher
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1. INTRODUCTION

1.1 Background

This Visual Analysis has been prepared for the proposed Solar Farm near Wee Waa, 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.

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 2.9 km south east of the Wee Waa Township.

The site is located along an unnamed, private access track which connects to Yarrie Lake Road.

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 the existing unnamed access road.

The development will be confined to Lot 191, DP757125 (**Figure 1**).

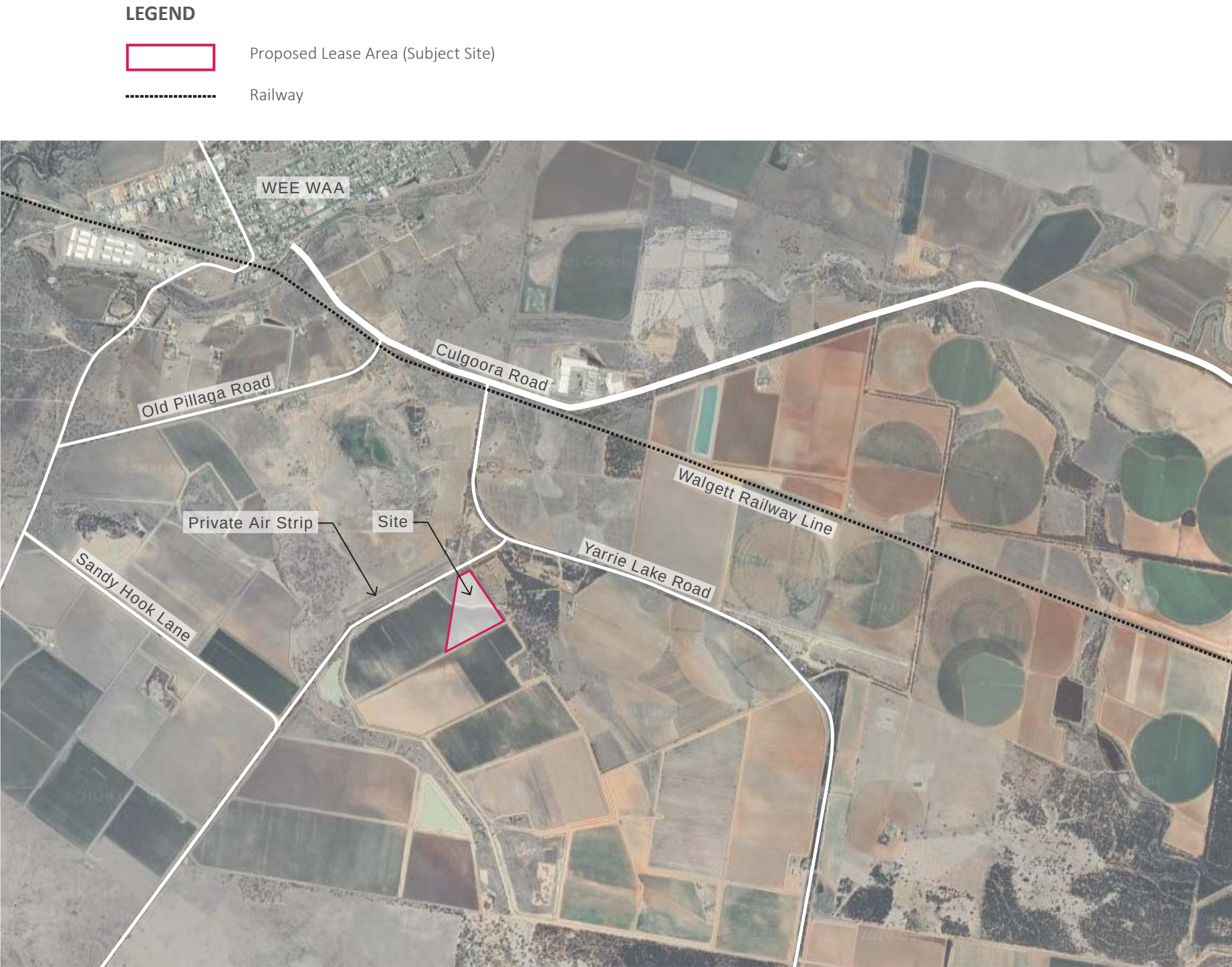


Figure 1. Locality Plan

Scale (m)
0 500 1000 2000 5000

2. BASELINE VISUAL ENVIRONMENT

2.1 Subject Site and Surrounding Context

The subject site is located on the southern and northern sides of Yarrie Lake Road, Wee Waa and is a typically open cropped and grassed rural site, similar to those rural properties surrounding it. The site is approximately 2.9km south east of Wee Waa township. The site, like its surrounding context is typically flat with no major land form features visible from the site.

2.1.2 Roads and Access

Yarrie Lake Road is a local road north of the subject site, which joins Culgoora Road further north. There are a number of local unsealed roads around the site such as Sandy Hook Lane, but the majority of vehicular access in the area are private tracks between rural areas for rural-based activities.

2.1.3 Vegetation

The subject site has been cleared of vegetation except for a few scattered specimens remaining which are located on the northern edge of the proposed Solar Farm.

The local area in general is very sparsely vegetated, with some established vegetation along the Yarrie Lake Road, other local roads and property boundaries. Vegetation along the sites northern and eastern boundaries terminate views outside of the site whilst also limiting views into the site external to it.

2.1.4 Structures

There are no structures on the subject site. There are a number of rural residential dwellings in the surrounding area to the north and east of the site and higher density detached residential dwellings in the township of Wee Waa to the north.

2.1.5 Infrastructure

The subject site has power poles and lines running past it on the southern and northern sides and a private air strip adjacent to the site on the northern side.

3. LANDSCAPE CHARACTER ANALYSIS

3.1 Regional Context

The landscape character of the region surrounding the site is flat, open rural lands used with a mix of pastoral and agricultural uses. Whilst the vegetation is sparse on the agricultural lands, it is typically concentrated around the local waterways. This however is generally not within the local visual context of the site.

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 and typically devoid of tree and vegetation cover except for along boundaries and roads.

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.

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 9.9 hectares within a total fenced area of approximately 13.6 hectares
- Solar array mounted on trackers (154 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 the unnamed, private access track which connects to Yarrie Lake 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 enclosure for the solar panel arrays and associated equipment will cover approximately 13.6Ha.

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.

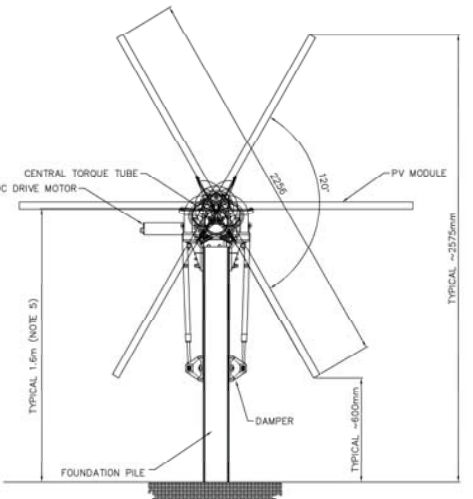


Figure 2.1 Solar panel / tracking system

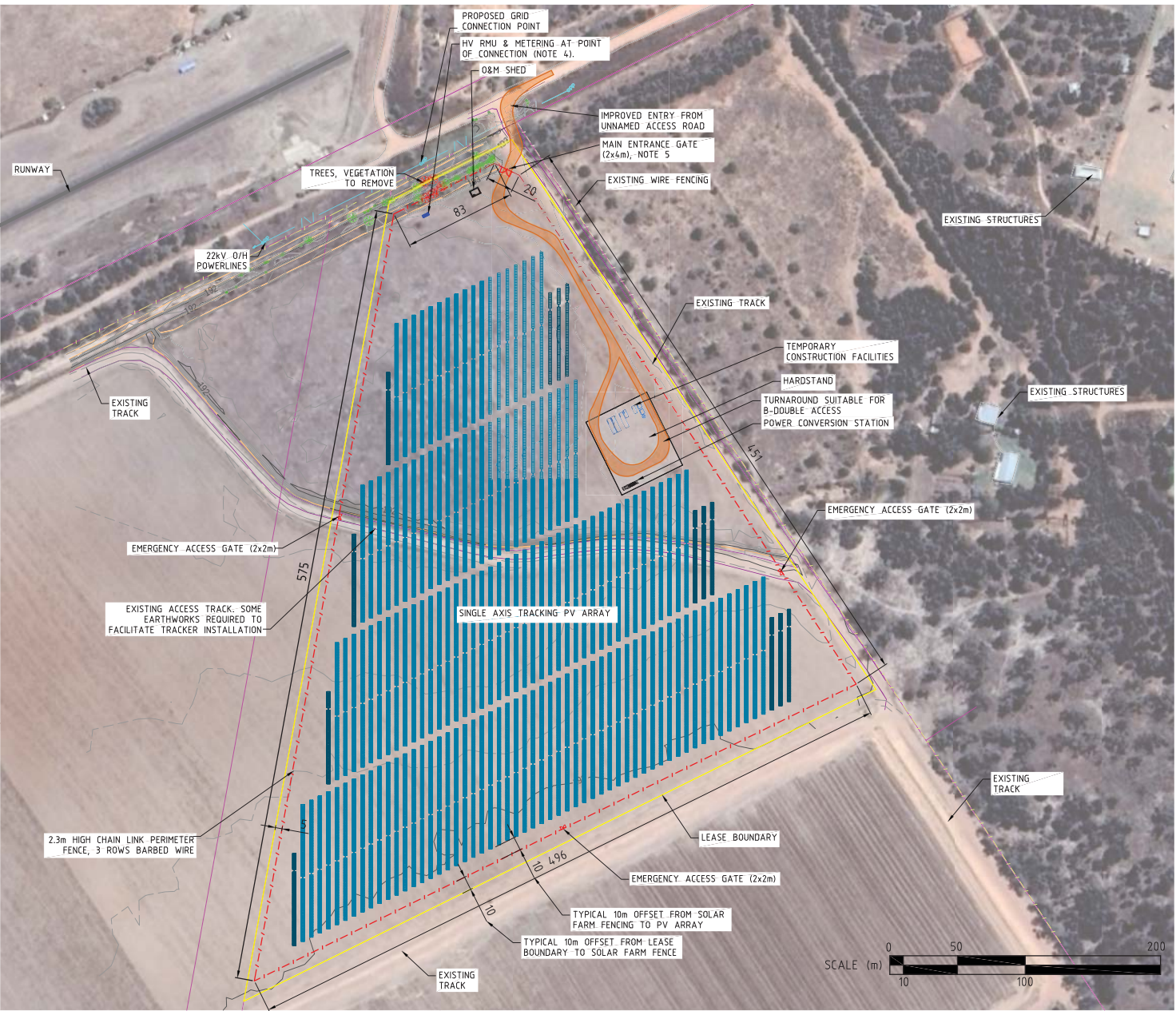


Figure 2. Concept layout of the project

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; and
- 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.

Photomontages 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 (DSLR) 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 5.6 and show the following overlays of information.

- Existing visual baseline (existing landform); and
- 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

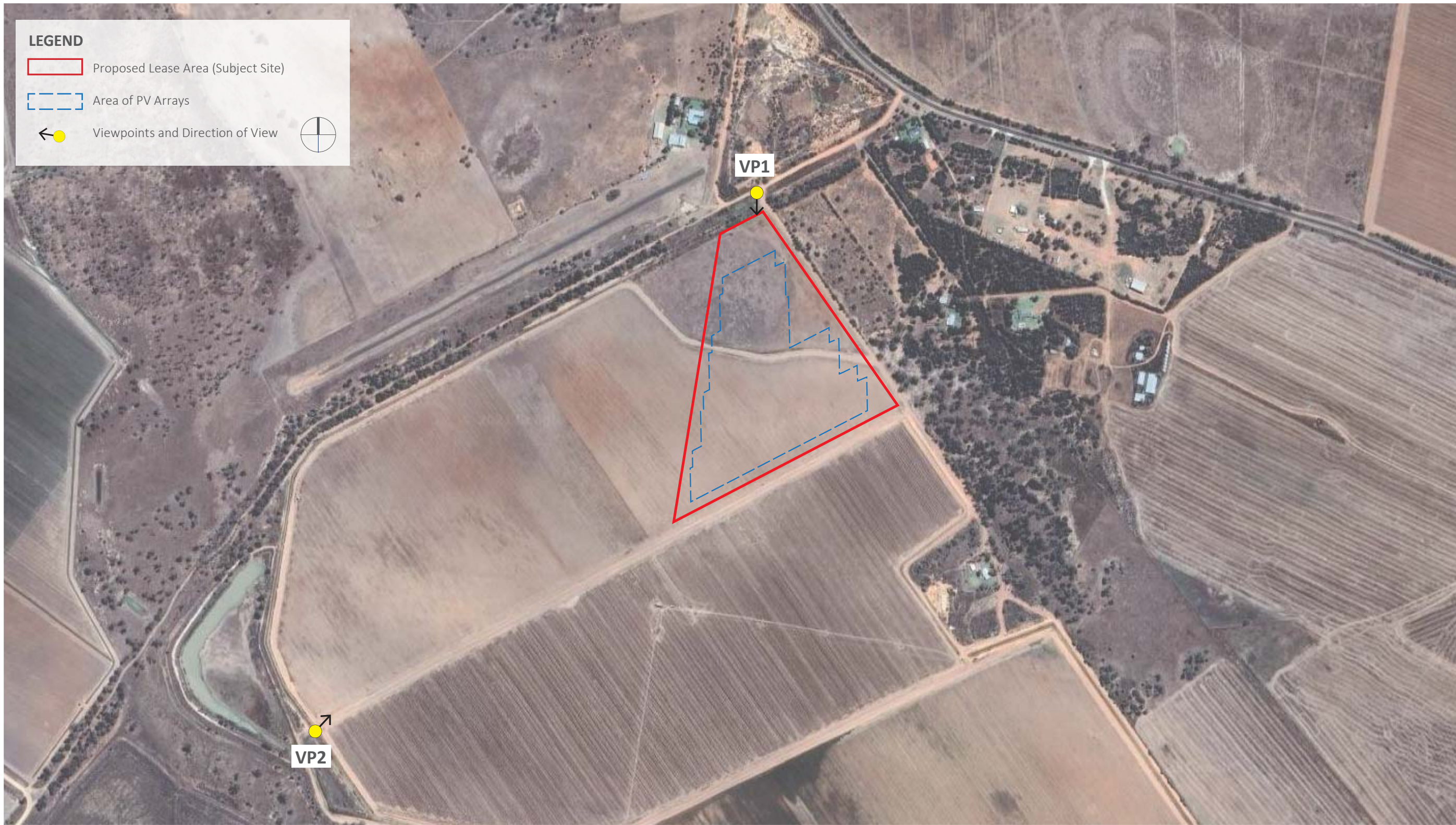


Figure 3. Selected Visual Receptors and Direction of View

5.6.2 Viewpoint 1 - Existing



Receptor - VP1	Private access track which connects to Yarrie Lake Road, Wee Waa
Coordinate Location	30°15'2.112" S 149°27'23.082" E
View Description	View from the private access track, looking south east toward the proposed solar farm site.
Distance from Site	Approximate 30m
Comments - Open rural (agricultural) landscape, with minimal canopy vegetation in the background except along the boundary lines to the south and west. Established vegetation visible in the foreground of the view within the verge areas. - Generally flat landscape with no prominent topographical landform visible from this viewpoint	

5.6.3 Viewpoint 1 - Proposed



Receptor - VP1 Summary of Impact Assessment	
Receptor Sensitivity	Negligible
View Magnitude of Landscape Change	Medium
Impact Significance	Minor
Mitigation Measures	No mitigation necessary

5.6.4 Viewpoint 2 - Existing



Receptor - VP2	Private access track which connects to Yarrie Lake Road, Wee Waa
Coordinate Location	30°15'36.45" S 149°26'49.716" E
View Description	View from the private access track, looking north east
Distance from Site	Approximate 835m
Comments - Open rural (agricultural) landscape, with minimal canopy vegetation in the background except along the boundary lines to the north east. Established vegetation visible in the foreground of the view. - Generally flat landscape with no prominent topographical landform visible from this viewpoint	

5.6.5 Viewpoint 2 - Proposed



Receptor - VP2 Summary of Impact Assessment	
Receptor Sensitivity	Negligible
View Magnitude of Landscape Change	Low
Impact Significance	Minor - Negligible
Mitigation Measures	No mitigation measures recommended

6. SUMMARY OF ASSESSMENT

6.1 Summary of Assessment

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

Whilst the subject has been cleared of vegetation, the local rural character of the area is evident and reinforced by the surrounding land uses and vegetation.

Although the site location is relatively close to the Yarrie Lake Road, views of the site are unavailable due to the presence of vegetation and minor topographic landform changes.

Visibility from the Culgoora Road into the site is very limited due to the obstruction of views by the elevated railway lines as well as existing established vegetation along boundary lines and on adjoining properties.

Most of these views however will be limited due to the distances from the site and existing elements that will obscure views. As the surrounding topography is very flat, this will exacerbate the limited visibility of the solar farm elements especially given the level of prominence in the landscape will be very low. This will result typically in the solar farm having limited visual impacts on the surrounding visual environment.

The Solar Farm is considered to have an overall Effect Significance of **Minor**.

6.2 Mitigation Measures

As described in the summary for each of the 2 viewpoints, the height and nature of the solar farm along with the distances from the site will mean that it will have limited visibility within the landscape and from public vantage points. Given the minor visual change to the rural landscape especially from public viewpoints, no mitigation measures are considered necessary.

The existing vegetation along the site boundaries particularly to the north and east, currently screen the site from almost all views from surrounding roads and public locations.

It would be reasonably expected that given the limited number of users and infrequent number of access areas would suggest that the solar farm would not require any mitigation measures to lessen these already minimal impacts.

Table 4. Summary of Visual Impact Ratings for each Receptor

Receptor	Receptor Sensitivity	Magnitude of Change	Effect Significance
VP1	Negligible	Medium	Minor
VP2	Negligible	Low	Minor - Negligible

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WEE WAA SOLAR FARM

Reflective Glare Assessment

Prepared for:
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SLR Ref: 610.30235-R01
Version No: -v2.0
March 2021



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BASIS OF REPORT

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610.30235-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 Wee Waa Solar Farm (the "Project"). The Project is located just over 3 km south-southeast of the township of Wee Waa and is close to two nearby airfields, being just under 4 km east of the nearest runway threshold of Wee Waa Aerodrome and 150 m from the eastern runway end of a private airstrip located just to the northwest of the site.

The proposed (up to) 5 MWac facility (refer Section 2) will comprise 12,572 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 6.3 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 incorporated into the Project in the future; none is currently planned.

Quantitative analysis using the FAA-SGHAT software tool has shown that there will be nil glare from the Project at Wee Waa Aerodrome and the nearby Private Airstrip with the solar array in normal tracking mode, ie panels tilting $\pm 60^\circ$.

There is potential for glare on Private Airstrip Runway 06 if panels need to be left at a near horizontal or slightly westwards fixed tilt angle, eg during construction, back-tracking mode, etc. Leaving the solar array with a slight eastwards fixed tilt angle (say 15°) for the 6-month period September to March or instituting an Airstrip Management Agreement with the Private Airstrip Landowner would eliminate this occurrence.

There will be nil glare from the Project in relation to road traffic and rail traffic disability glare.

Similarly, there will be minimal risk for nuisance glare from the Project to surrounding residential receivers, even when panels are left horizontal or tilted slightly east or west, given the significant vegetation and trees surrounding the site, which effectively would screen the facility from surrounding ground level receivers.

It is noted that night-time lighting is not currently incorporated into the Project. If 24/7 lighting is required in the future at the site 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.

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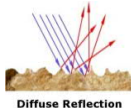
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Abbreviations and Definitions

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 Wee Waa Solar Farm (the “Project”). The Project is located just over 3 km south-southeast of the township of Wee Waa and is close to two nearby airfields, being just under 4 km east of the nearest runway threshold of Wee Waa Aerodrome and 150 m from the eastern runway end of a private airstrip located just to the northwest of the site.

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 WEE WAA 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 just over 3 km south-southeast of the township of Wee Waa and is close to two nearby airfields, being just under 4 km east of the nearest runway threshold of Wee Waa Aerodrome and 150 m from the eastern runway end of a private airstrip located just to the northwest of the site.

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 Wee Waa 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 – note: none is currently planned.

Solar Panel Mounted Array – refer Figure 2

The proposed ground-mounted array (refer Figure 2(a)) would consist of 154 trackers oriented in a north-south direction, each supporting 56-84 x 540W solar panels (12,572 panels in total);

- The trackers are “single-axis” capable of rotating solar panels to a maximum of $\pm 60^\circ$ - refer Figure 2(b);
- The trackers are oriented north-south and spaced 6.3 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 northern perimeter of the Project lies approximately 380 m from Yarrie Lake Road at its closest point. The western perimeter of the site lies approximately 3.7 km from the eastern threshold of Wee Waa Airfield's only Runway 05/23; the northern perimeter of the site lies just over 150 m from the eastern threshold of a Private Airstrip's Runway 06/24.

Figure 2 Wee Waa Solar Farm Site Layout

(a)
Site Layout

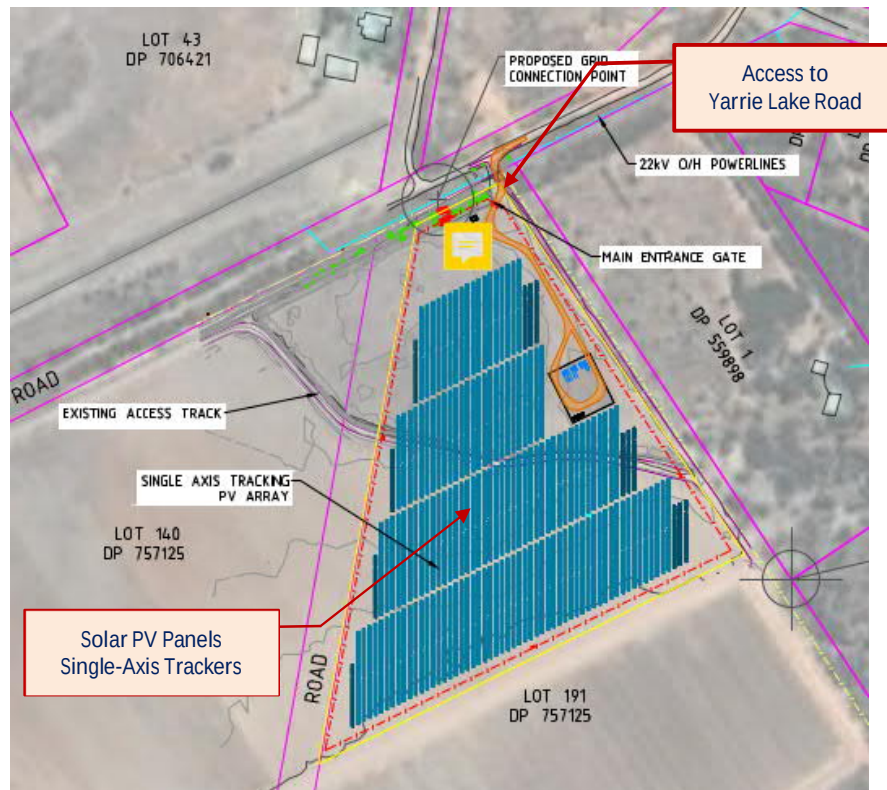
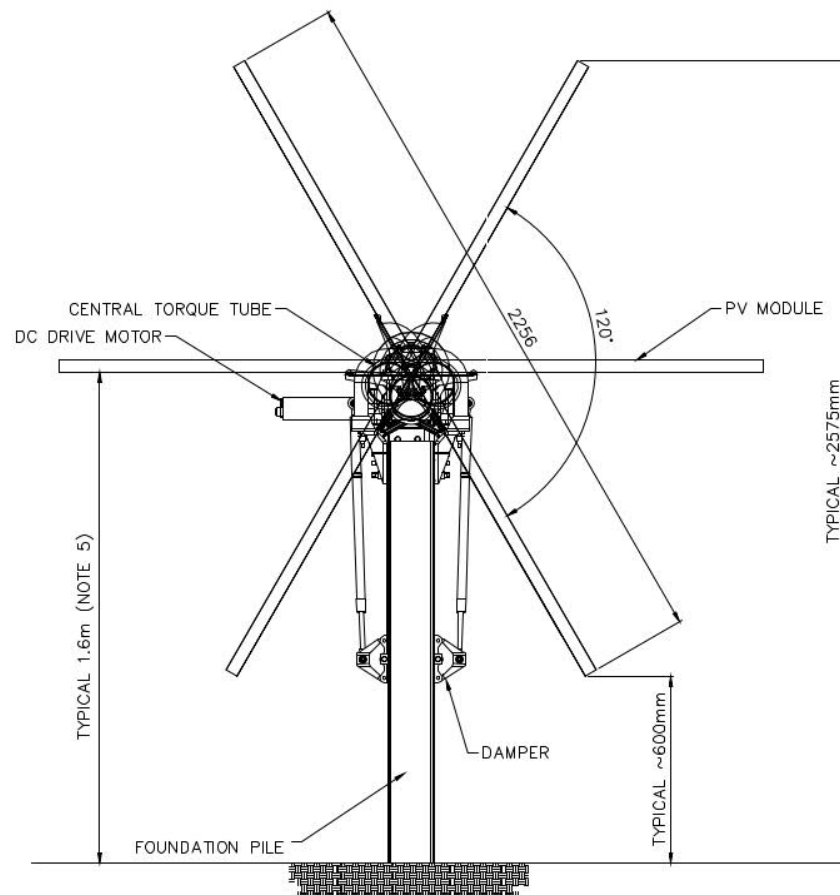


Fig.2 (cont'd)

(b)
Single-Axis
Tracker Profile
($\pm 60^\circ$ 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, although it is noted that none is currently planned for the Project.

3.2 Nearest Receiver Locations

Receivers of interest relevant to the Project are shown in:

- Figure 3 Nearest aerodromes, airfields;
- Figure 4 Surrounding road network;
- Figure 5 Surrounding rail network; and
- Figure 6 Nearest representative residential receivers.

Figure 3 Nearest Aerodromes to Project Site

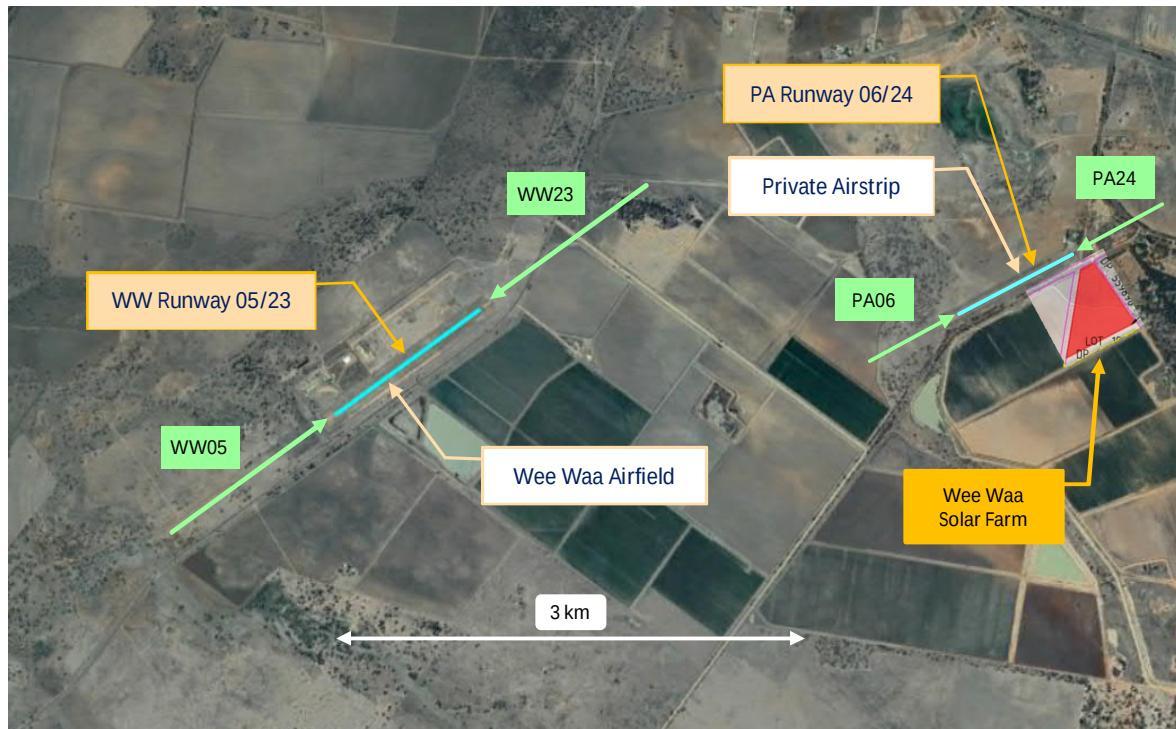


Figure 4 Surrounding Road Network

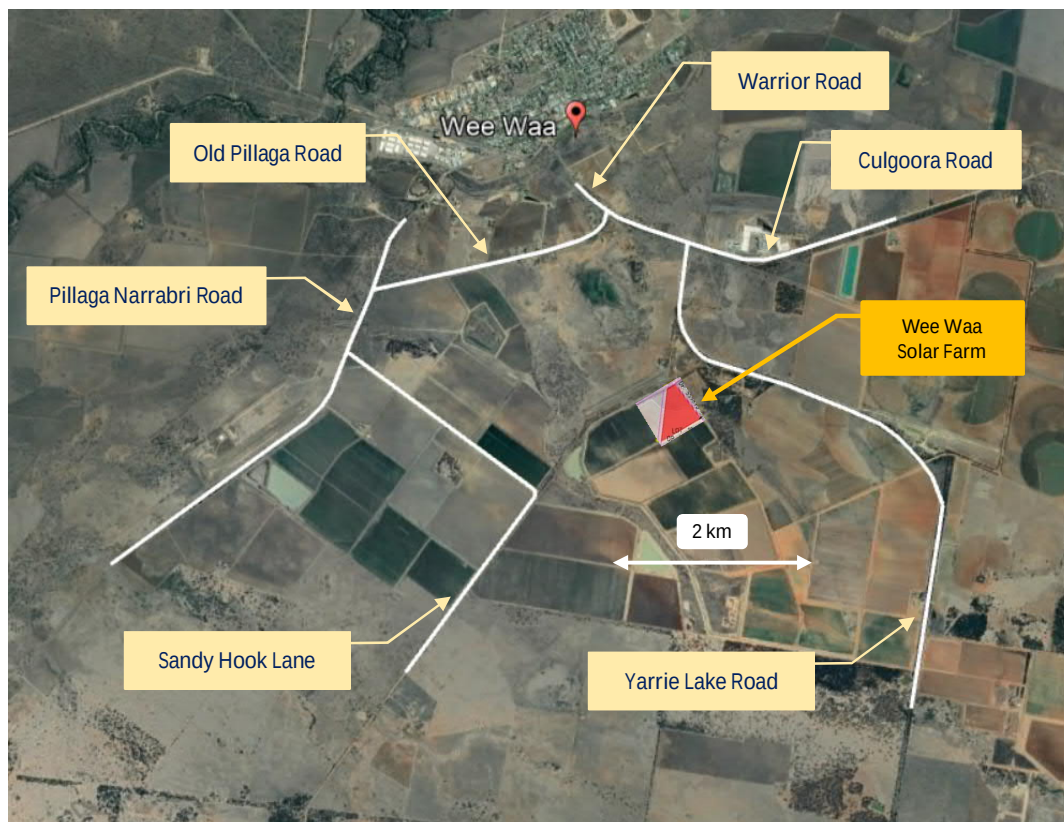


Figure 5 Surrounding Rail Network and NSW Rail Map

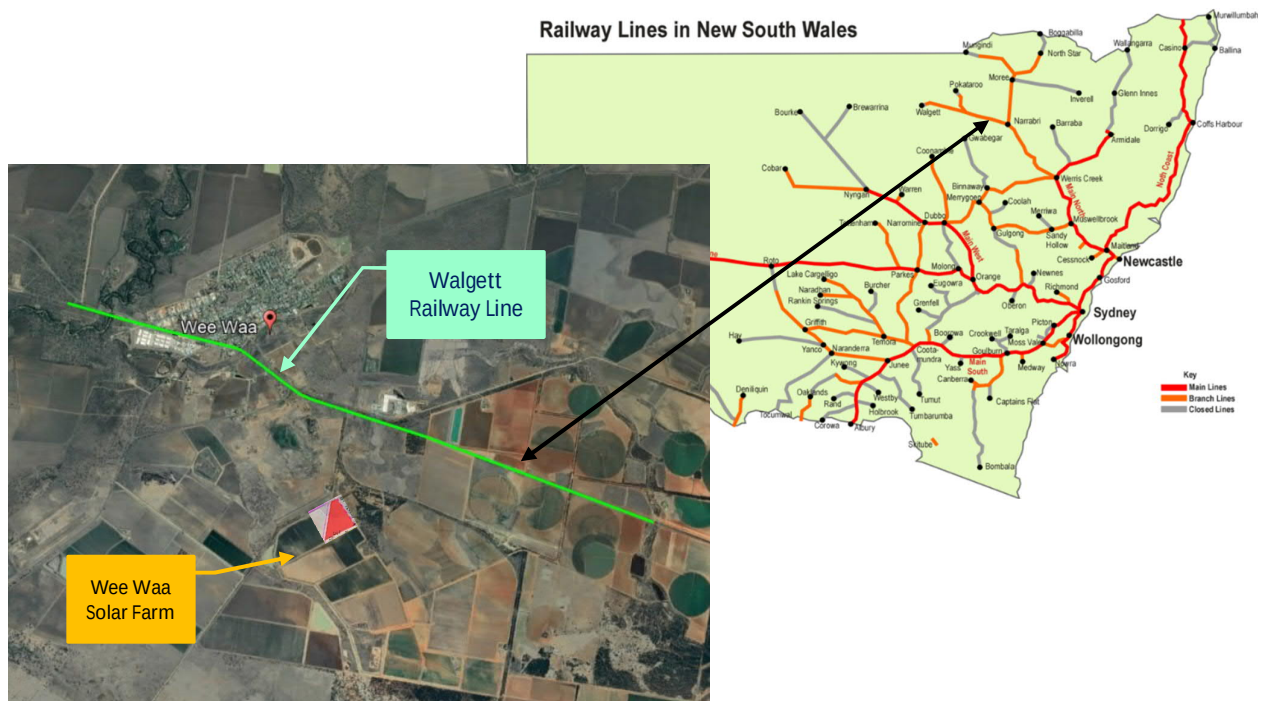


Figure 6 Nearest Representative Residential Receivers



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:

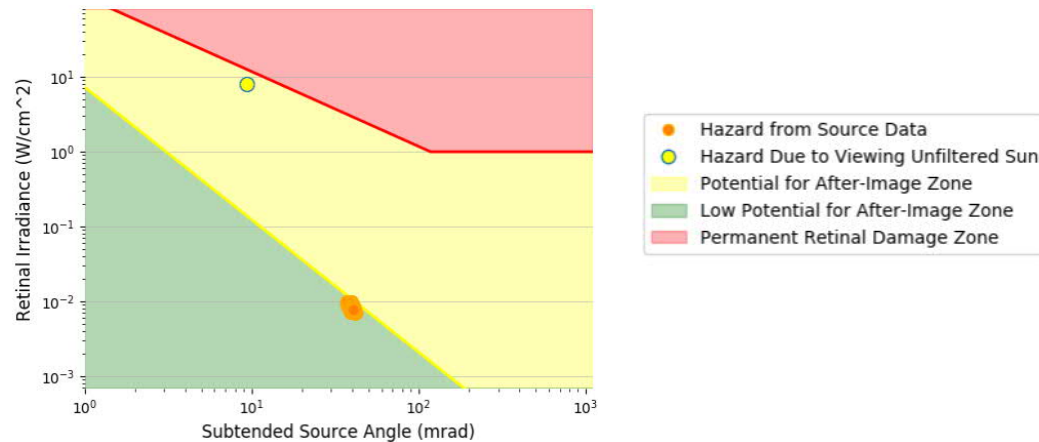
- Ho, C.K., Ghanbari, C.M. and Diver, R.B., "Methodology to Assess Potential Glint and Glare Hazards from Concentrating Solar Power Plants: Analytical Models and Experimental Validation", J. Solar Engineering, August 2011, Vol.133, 031021-1 to 031021-9.
- Ho, C.K. & Sims, C., "Solar Glare Hazard Analysis 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 7, it can be seen that the reflection visible by the receiver is roughly 1,000 times less intense than the light from the sun.

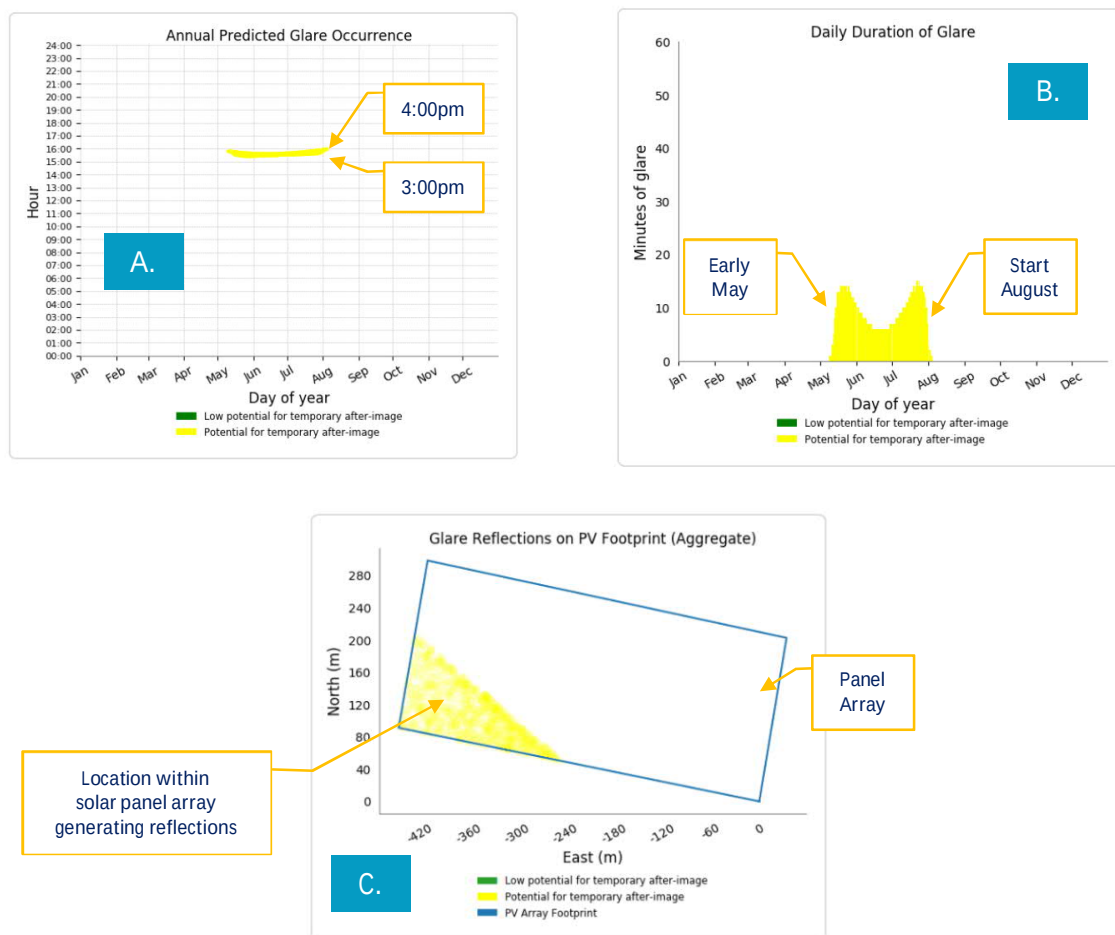
- Finally, in relation to PV Solar facilities, it is important to note that the third SGHAT Ocular Plot “RED” category is **not possible**, since PV modules DO NOT FOCUS reflected sunlight.

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 southwest 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/m²
- L_{tb} = so-called “adaptation” luminance (total background) – Cd/m²

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 Wee Waa township 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

It is noted that night-time lighting is not currently incorporated into the Project.

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 $\pm 60^\circ$.
- The trackers are oriented north-south and spaced 6.3 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 northern perimeter of the Project lies approximately 380 m from Yarrie Lake Road at its closest point. The western perimeter of the site lies approximately 3.7 km from the eastern threshold of Wee Waa Airfield’s only Runway 05/23. The northern perimeter of the site lies just over 150 m from the eastern threshold of a Private Airstrip’s Runway 06/24.

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

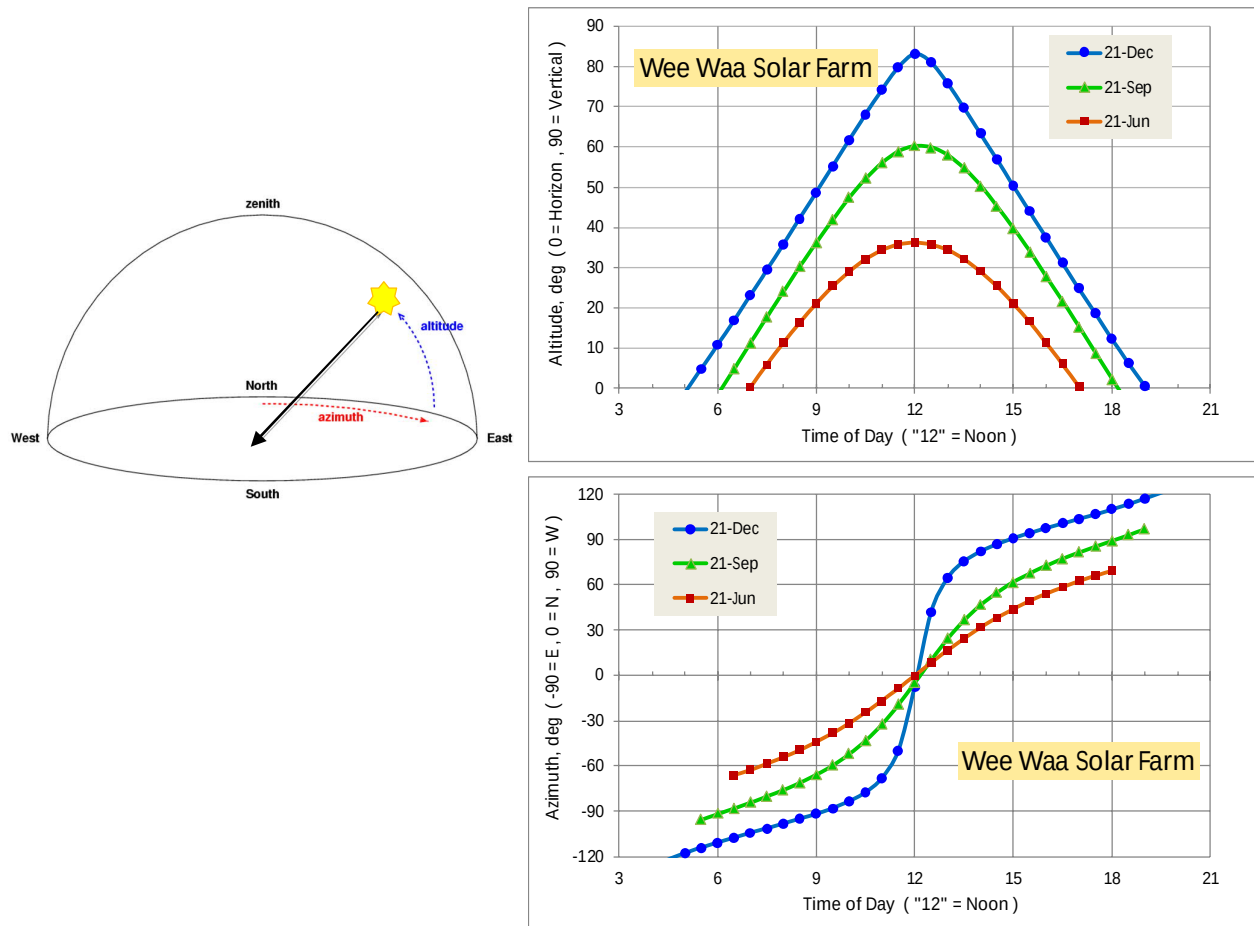
Any solar glare analysis must take into account the complete cycle of annual reflection variations noted above.

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	5:06 am	7:03 pm	117.4° E of North to 117.4° W of North	83.1°
Equinox	6:08 am	6:10 pm	90.7° E of North to 90.7° W of North	60.2°
Winter Solstice	6:59 am	5:02 pm	62.6° E of North to 62.6° W of North	36.3°

Figure 9 Project Site Incoming Solar Angle Variations

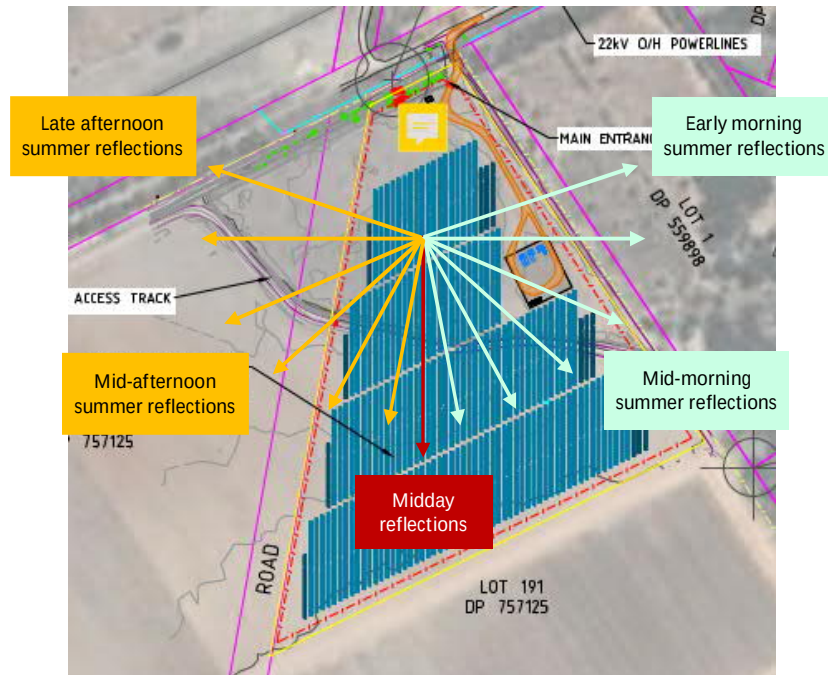


5.3 Project Solar Reflections

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 PV Solar Panels
• Standard Window Glass	n = 1.52	
• Plexiglass, Perspex	n = 1.50	
• Solar Glass	n = 1.33	
• Solar Glass with AR Coating	n = 1.25	

Representative reflectivity curves are shown in Figure 11.

Figure 11 Typical Reflectivity Curves as a Function of Incidence Angle

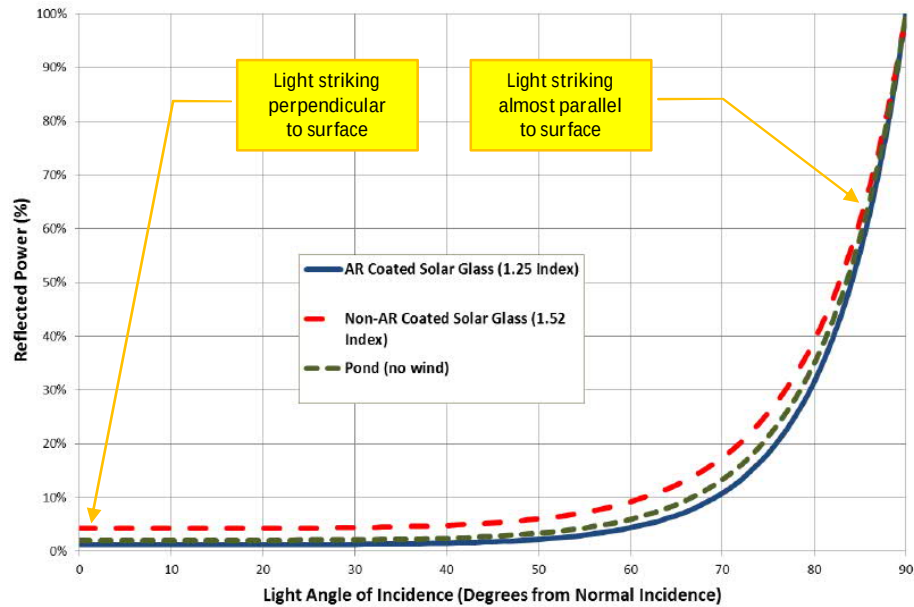


Figure 11 shows that:

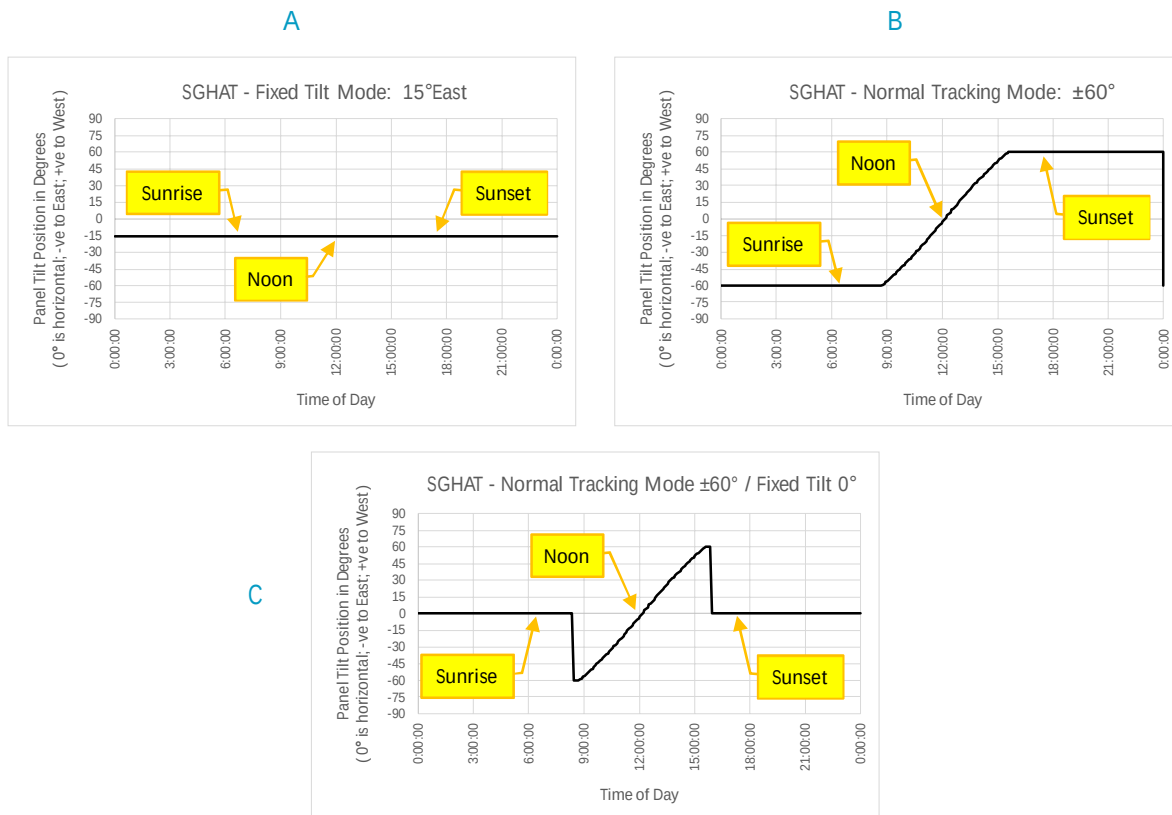
- When an oncoming solar ray strikes the surface of a solar PV panel close to perpendicular to the panel surface (i.e. low “incident” angle), the reflectivity percentage is minimal (less than 5% for all solar panel surface types).
- It is only when an incoming solar ray strikes the panel at a large “incidence” 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



“Backtracking” Mode

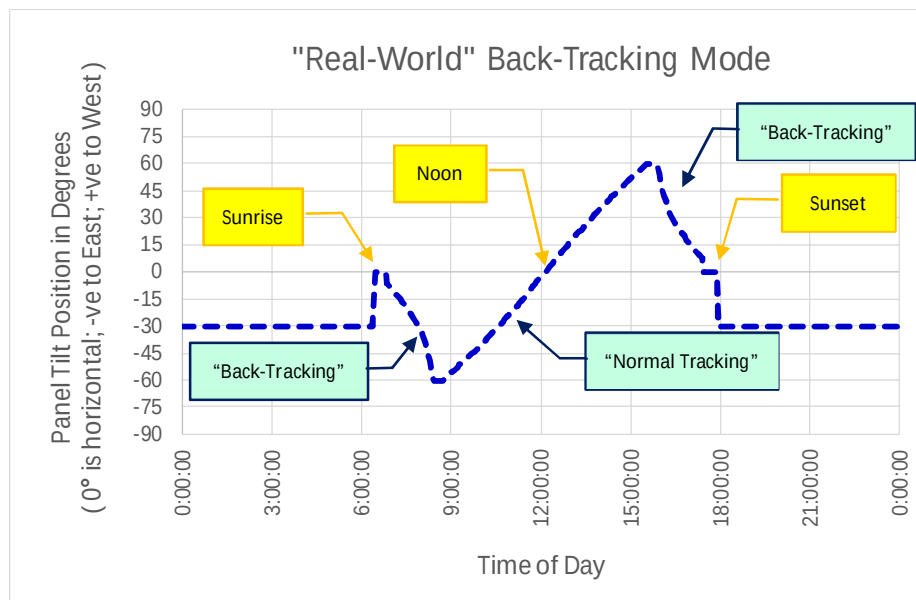
Most recently, sophisticated “back-tracking” operational modes have been developed, typically by the manufacturers of the tracking systems that support solar panels.

- 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 ($\pm 60^\circ$) 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 $+60^\circ$ 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

Wee Waa Aerodrome (ICAO: YWWA) is located to the west of the Project, with the eastern threshold of its single WW Runway 05/23 just under 4 km from the western perimeter of the Project. The aerodrome is serviced by general aviation aircraft and helicopters.

- The aerodrome's only 1,100 m runway is WW Runway 05/23, oriented roughly northeast-southwest.
- The aerodrome does not have a control tower (and as far as is known to SLR, none is planned).

There is a private airstrip, classified by CASA as an "Aircraft Landing Area", to the immediate northwest of the Project, with the eastern threshold of its single PA Runway 06/24 just over 150 m from the northern perimeter of the Project. The airstrip is presumably serviced by the landowner's GA aircraft and other contracted services, eg crop dusting aircraft.

- The airstrip's unmarked runway, PA Runway 06/24, is just over 800 m long, and is also oriented roughly northeast-southwest.

Figure 3 shows (landing) flight paths of interest:

- Aircraft using WW Runway 05 and PA Runway 06 (both approaching from the southwest) would have a line of sight towards the Project and potential associated reflections.
- Aircraft using WW Runway 23 (approaching Wee Waa Aerodrome from the northeast) would not have a line of sight towards the Project once the aircraft has passed a point perpendicular to the Project which is approximately 2 miles from the runway threshold – the limit of analysis required in the SGHAT software.
- Aircraft using PA Runway 24 (approaching the Private Airstrip from the northeast) would have a line of sight towards the Project. However, reference to Figure 9 shows that reflections from the proposed facility would not be visible at this approach angle (reflections cannot occur from the southwest).
- 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.

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 3.

SGHAT Modelling Assumptions:

- All runway approaches shown in Figure 3 were examined.
- 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:

- Ground elevations (ASL) of Wee Waa Solar Farm range from 190 m to 194 m;
- Ground elevations below the various flight paths are in the range 188 m to 192 m.

From the above, it can be seen that the terrain in the Wee Waa area is reasonably flat, with all surrounding receivers (residences, vehicles) at similar elevations compared to the solar farm.

A number of panel scenarios were assessed:

- “Normal Tracking”: panels tilt $\pm 60^\circ$ 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 $\pm 15^\circ$
– this is a scenario theoretically possible under a situation involving: shutdown, maintenance, pre-commissioning, etc
- “Tracking + Stowed”: panels tilt $\pm 60^\circ$ 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 $\pm 60^\circ$ ”

The SGHAT Ocular Plots results for this scenario for all flight paths shown in Figure 3 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 landing paths.

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

Flight Landing Path (refer Fig.3)	SGHAT Results for “NORMAL TRACKING” $\pm 60^\circ$ Scenario		
	“Green” Zone	“Yellow” Zone	“Red” Zone
Wee Waa Aerodrome 05	0	0	0
Wee Waa Aerodrome 23	0	0	0
Private Airstrip 06	0	0	0
Private Airstrip 24	0	0	0

SGHAT Results – FIXED TILT Scenarios (15° West, 0° and 15° East)

The SGHAT Ocular Plots results for these scenarios for all flight paths shown in Figure 3 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)

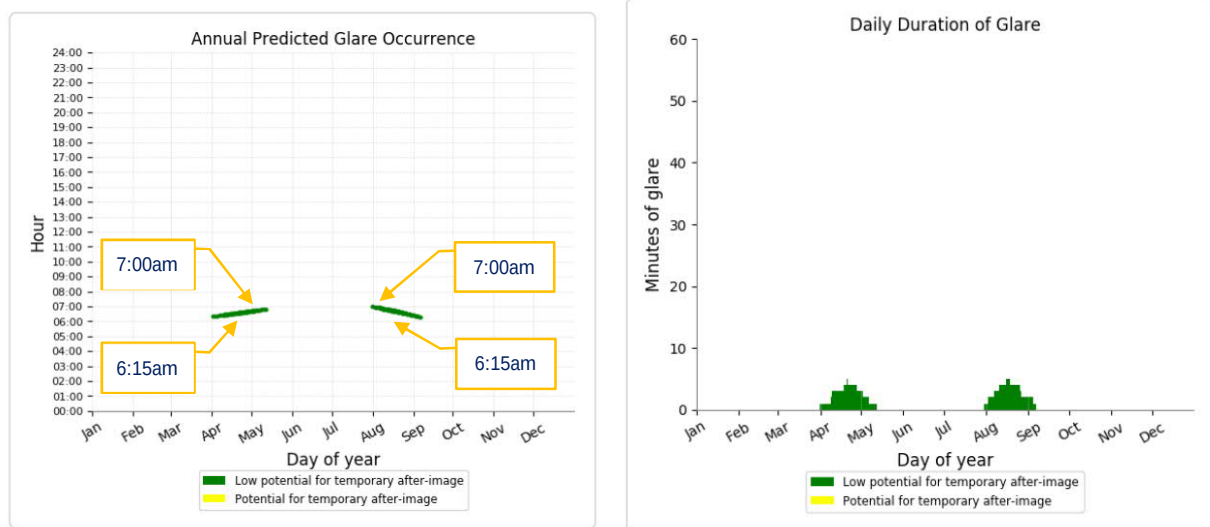
Flight Landing Path (Fig.3)	SGHAT Results for "FIXED TILT" Scenarios								
	15° East Tilt			0° (Horizontal)			15° West Tilt		
	"Green" Zone	"Yellow" Zone	"Red" Zone	"Green" Zone	"Yellow" Zone	"Red" Zone	"Green" Zone	"Yellow" Zone	"Red" Zone
WW 05	0	0	0	212	0	0	282	0	0
WW 23	0	0	0	0	0	0	0	0	0
PA 06	0	0	0	198	2029	0	131	1926	0
PA 24	0	0	0	0	0	0	0	0	0

Representative Results – Wee Waa Aerodrome

Figure 14 shows representative reflection conditions occurring at different times of the year for Wee Waa Aerodrome Runway 05:

- SGHAT "GREEN" zone reflections are visible in April and August in the very early morning (very low altitude solar rays); during this period; these are visible for periods ranging from less than one minute to a maximum of four minutes each day.

Figure 14 Selected SGHAT Results: WEE WAA AERODROME - FIXED TILT 0° Mode (WW Runway 05)

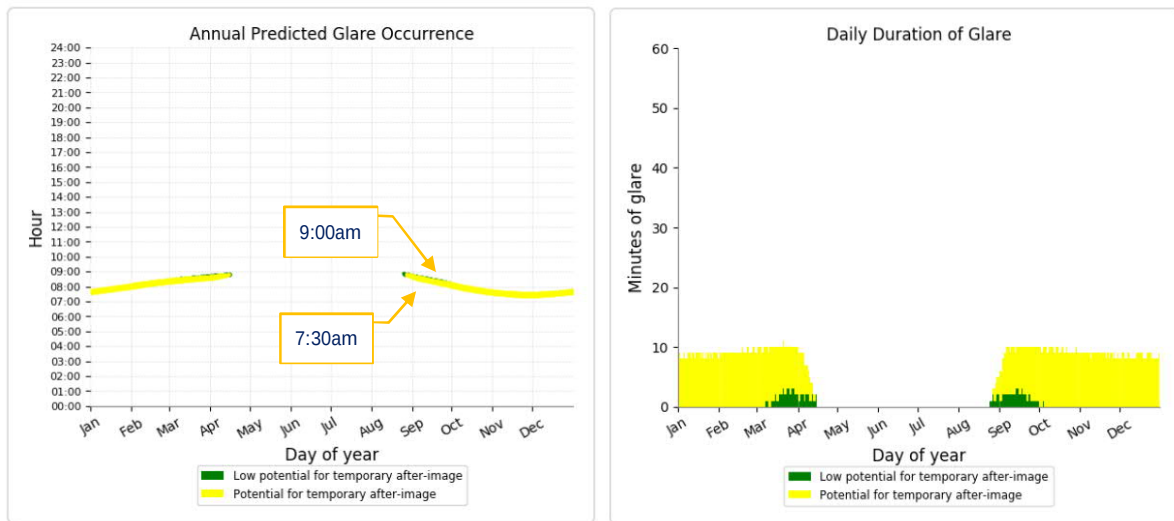


Representative Results – Private Airstrip

Figure 15 shows representative reflection conditions occurring at different times of the year for Private Airstrip Runway 06:

- Reflections mainly in the SGHAT “YELLOW” zone are visible from the end of August through to the beginning of April (relatively low altitude solar rays) in the morning; during this period, reflections are visible for periods typically around 10 minutes each day.

Figure 15 Selected SGHAT Results: PRIVATE AIRSTRIP - FIXED TILT 0° Mode (PA Runway 06)



SGHAT Results – TRACKING + FIXED TILT 0° Scenario

The SGHAT Ocular Plot results for this scenario for all flight paths shown in Figure 3 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 Landing Path (ref Fig.3)	SGHAT Results for “±60° TRACKING + 0° FIXED TILT” Scenario		
	“Green” Zone	“Yellow” Zone	“Red” Zone
Wee Waa Aerodrome 05	212	0	0
Wee Waa Aerodrome 23	0	0	0
Private Airstrip 06	198	2029	0
Private Airstrip 24	0	0	0

Representative Results

The representative reflection conditions occur at exactly the same times of the year and for the same durations as shown in Table 4. In both cases, the solar panels are horizontal at sunrise enabling the visibility of reflections essentially from the same direction as the incoming (direct) solar rays.

Summary of SGHAT Results:

The various reflection conditions are summarised in Table 7 for the “ $\pm 60^\circ$ Normal Tracking” mode scenarios and the three “Fixed Tilt” modes: 15° West, 0° (horizontal) and 15° East. The combined “ $\pm 60^\circ$ Tracking + FIXED TILT 0° ” mode results are not shown as they are identical to the “Fixed Tilt” 0° (horizontal) results.

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 7 SGHAT Analysis Summary Results - SGHAT Compliance

Panel Mode Scenario	Wee Waa Aerodrome	Private Airstrip
“ $\pm 60^\circ$ Normal Tracking”	Complies	Complies
“Fixed Tilt” mode: 15° West	Complies	Does Not Comply
“Fixed Tilt” mode: 0° (horizontal)	Complies	Does Not Comply
“Fixed Tilt” mode: 15° East	Complies	Complies

Recommendations:

Normal Tracking Mode:

- The proposed solar farm will comply with SGHAT requirements under standard “ $\pm 60^\circ$ 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.

Non-Normal Operational Modes:

There may be situations where solar panels need to be left at or near horizontal tilt angles, eg for maintenance purposes, during construction, during “back-tracking”, etc. In this instance, two options are available:

- Solar panels could be left with a slight eastwards tilt, say at least 10° eastwards, during a 6-month period from September through to March.

OR

- Institute an “Airstrip Management Agreement” with the Private Airstrip landowner, providing a notification to aircraft using the airstrip that reflections are possible during very short (maximum 10-minute) periods in the morning hours and hence flight landing approach paths from the southwest should either be avoided (eg choose the PA Runway 24 for landing) during these times or, when landing on PA Runway 06, approach the airstrip with a more southerly flight path and straighten up with PA Runway 06 at the last stage of landing.

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 4, including:

- | | |
|--|---------|
| • Pillaga Narrabri Road – northeast-bound | “major” |
| • Old Pillaga Road – eastbound | “major” |
| • Warrior-Culgoora Roads – eastbound and westbound | “major” |
| • Sandy Hook Lane - eastbound and northbound | “minor” |
| • Yarrie Lake Road - eastbound and northbound | “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.

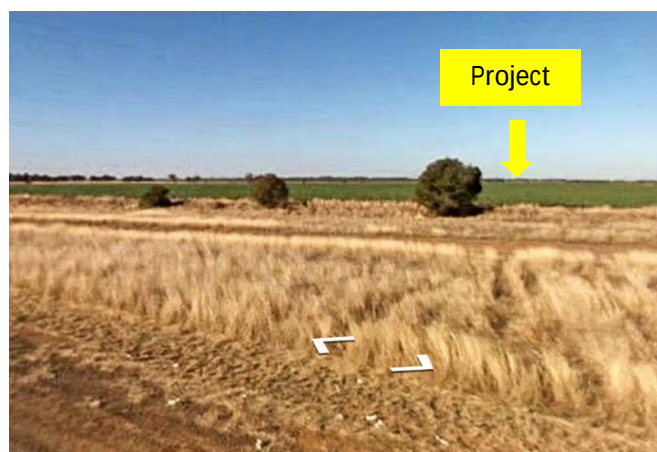
Important factors influencing the potential for traffic disability glare include:

- 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 Pillaga Narrabri Road travelling westwards away from Wee Waa.

Figure 16 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.

Figure 16 View of the Project from Surrounding Roads

Driving northeast along
Pillaga Narrabri Road



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 “ $\pm 60^\circ$ Normal Tracking” mode.

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.

Table 8 TI Value Results – Combined Results from ALL PROJECT SOLAR PANELS

Location		Classification	TI Value	Occurrence	
				Time of Year / Day	Duration
Pillaga Narrabri Road	eastbound	Major	nil	all-year-round	na
Old Pillaga Road	eastbound	Major	nil	all-year-round	na
Warrior Culgoora Road	eastbound	Major	nil	all-year-round	na
	westbound			all-year-round	na
Sandy Hook Lane	eastbound	Minor	nil	all-year-round	na
	northbound			all-year-round	na
Yarrie Lake Road	westbound	Minor	nil	all-year-round	na
	northbound			all-year-round	na

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; 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.

Of equal significance, it is noted that the TI Value computations were undertaken without the benefit of any of the vegetation, trees, etc, that exist around the site. For example, the site is actually not visible from Yarrie Lake Road, the nearest carriageway to the site.

- Indeed, for most surrounding carriageways, the vegetation surrounding the site essentially would screen the facility and its reflections, even under horizontal panel mode scenarios.

Example of the extent of vegetation surrounding the site are shown in Figure 17.

Figure 17 Vegetation and Trees Surrounding the Site



6.3 Rail Operator Reflective Glare

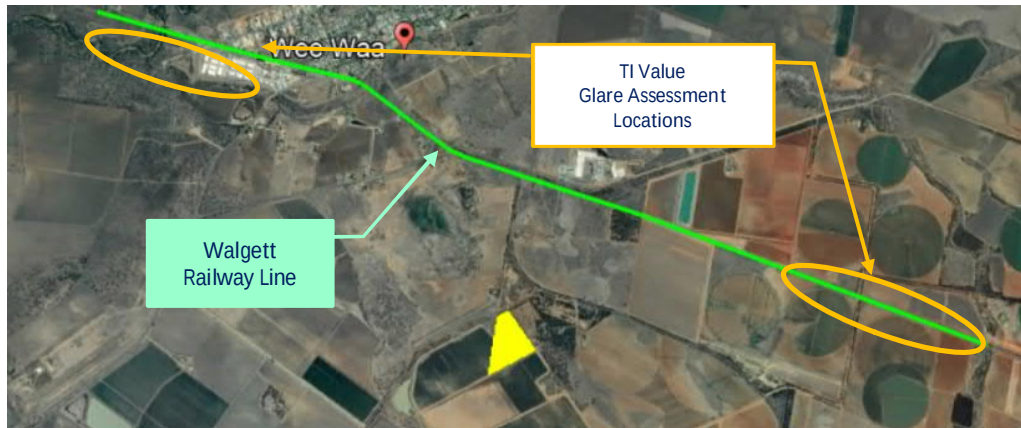
Figure 5 shows the Walgett Railway Line approaching Wee Waa from the east-southeast and then moving towards the west-northwest. At its closest approach, the rail line is just over 1.3 km from the nearest perimeter of the Project.

SLR has undertaken TI Value calculations for two sections of rail line shown in Figure 18, focussed on positions where the line of sight of train drivers was closest to the angle of potential incoming solar reflected rays.

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.

Figure 18 Walgett Railway Line – Glare Assessment Areas



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 minimally 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 6.

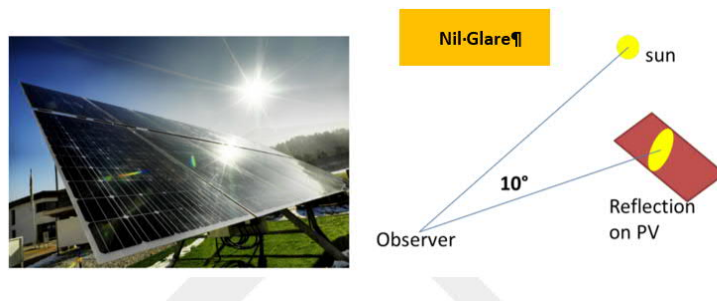
Table 9 TI Value Results – Residential Receivers

Scenario	Receivers (refer Figure 6)	TI Value	Occurrence	
			Time of Year / Day	Duration
±60° Normal Tracking	R1 to R8	nil	all-year-round	na
Fixed Tilt 0°	R1, R8	nil	all-year-round	na
	R3-R7	Up to TI ~ 3	very late afternoon	0-5 min /day
Fixed Tilt 15° EAST	R1 to R8	Up to TI ~ 3	very late afternoon	0-5 min /day
Fixed Tilt 15° WEST	R1 to R8	nil	all-year-round	na

The results indicate the following:

- For the “ $\pm 60^\circ$ Normal Tracking” mode, there will be NIL impact on surrounding residential receivers; and
- For the “ 0° and 15° EAST Fixed Tilt” modes 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, refer Figure 17, reflections are generally NOT considered to constitute a glare condition.
- For the “ 15° WEST Fixed Tilt” mode there is NO potential for reflections to be noticeable.

Figure 19 Nil Glare Condition for Residential Nuisance Glare



Again, it is noted that the above computations were undertaken without the benefit of any of the vegetation, trees, etc, that exist around the site – refer Figure 17.

- Indeed, for virtually all surrounding residential receivers, the vegetation surrounding the site would essentially screen the facility and its reflections, even under horizontal panel mode scenarios.

6.6 Night-Time Illumination Glare

Although presently not fully defined, it is assumed that an area within the Wee Waa 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.

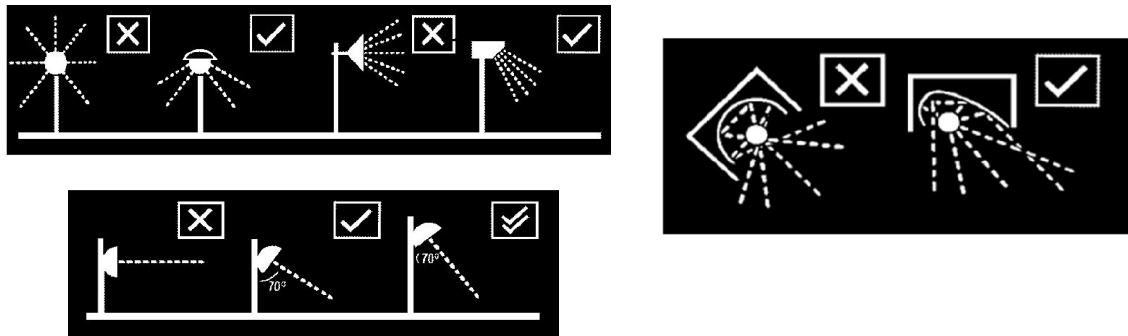
In terms of any future potential night-time lighting, the adopted goal of limiting night-time light spill to no more than 1 lux falling on the nearby residential facades during curfew hours will be easily achieved given the distances to the nearest residential and other receivers.

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 Wee Waa 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 (noting that lighting is not currently planned)

The Project is located close to the township of Wee Waa and Wee Waa Airfield, whose Runway 05/23 eastern threshold lies approximately 3.7 km from the nearest perimeter of the Project. The proposed (up to) 5 MWac facility will comprise 12,572 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 6.3 m. A Private Airstrip is located immediately to the north-northwest of the site.

Aviation-Related Potential Glare

Quantitative analysis using the FAA-SGHAT software tool has shown that there will be nil glare from the Project at Wee Waa Aerodrome and the nearby Private Airstrip with the solar array in normal tracking mode, ie panels tilting $\pm 60^\circ$.

There is potential for glare on Private Airstrip Runway 06 if panels need to be left at a near horizontal or slightly westwards fixed tilt angle. Leaving the solar array with a slight eastwards fixed tilt angle (say 15°) for the 6-month period September to March or instituting an Airstrip Management Agreement with the Private Airstrip Landowner would eliminate this occurrence .

Motorist and Rail Traffic “Disability” Glare, residential Nuisance Glare

There will be nil glare from the Project in relation to road traffic and rail traffic disability glare.

There is minimal risk for nuisance glare from the Project to surrounding residential receivers, even when panels are left horizontal or tilted slightly east or west, given the significant vegetation and trees surrounding the site, which effectively would screen the facility from surrounding ground level receivers.

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.

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11/02/2021

Project Number: 210679

STORMWATER MANAGEMENT REPORT

at

WEE WAA SOLAR FARM | 3843 YARRIE LAKE ROAD WEE WAA

for

PROVIDENCE ASSET GROUP

Project No. 210679

Revision: B – Reissued for DA

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1. Introduction

DRB Consulting Engineers (DRB) were engaged by Providence Asset Group Pty Ltd to undertake a Stormwater Management Plan for the proposed Wee Waa Solar Farm, located within LOT 191 DP 757125 Yarrie Lake Road, Wee Waa 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 210679/CIV01-04.

2. Site Description & Proposed Development

The site is located at Yarrie Lake Road, Wee Waa. The site is located on the southwest of Yarrie Lake Road and is identified as Lot 191 DP 757125.

The proposed Wee Waa Solar Farm will be located in the northern 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 15 Ha in area. The IA had a good grass coverage and had a berm running through the central portion. The IA sloped from the southeast to the north before reaching the berm conveying any sheet flow to the northeast.

On the northern side of the existing berm, the runoff from the IA sheet flows to a low point where water will pond before infiltrating and/or evaporating. Should the pond fill up it overflows to the north into an irrigation channel located adjacent to the northern boundary.

Figure 1 below shows the existing site and investigation area.

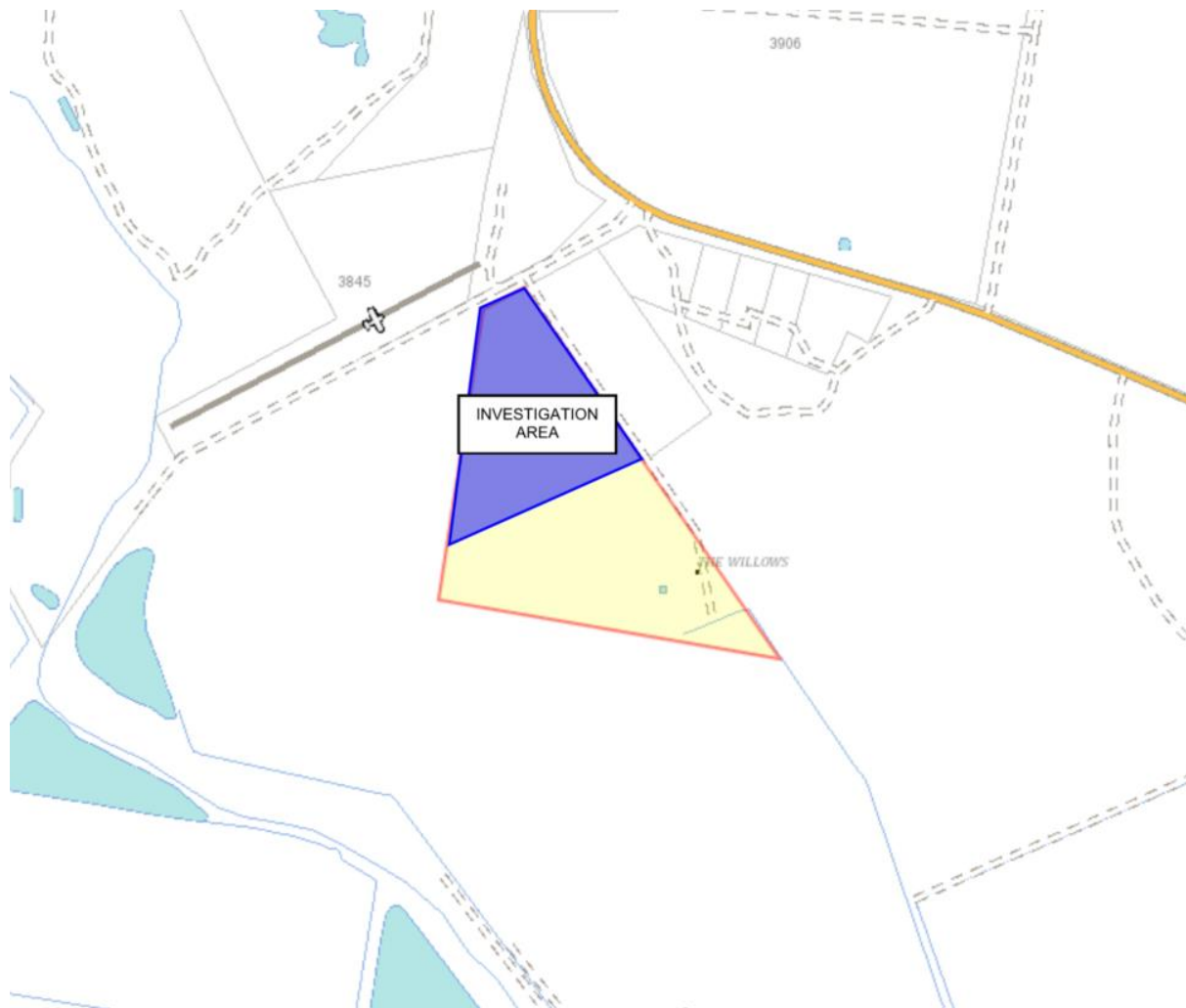


Figure 1 – Existing Site Boundaries

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

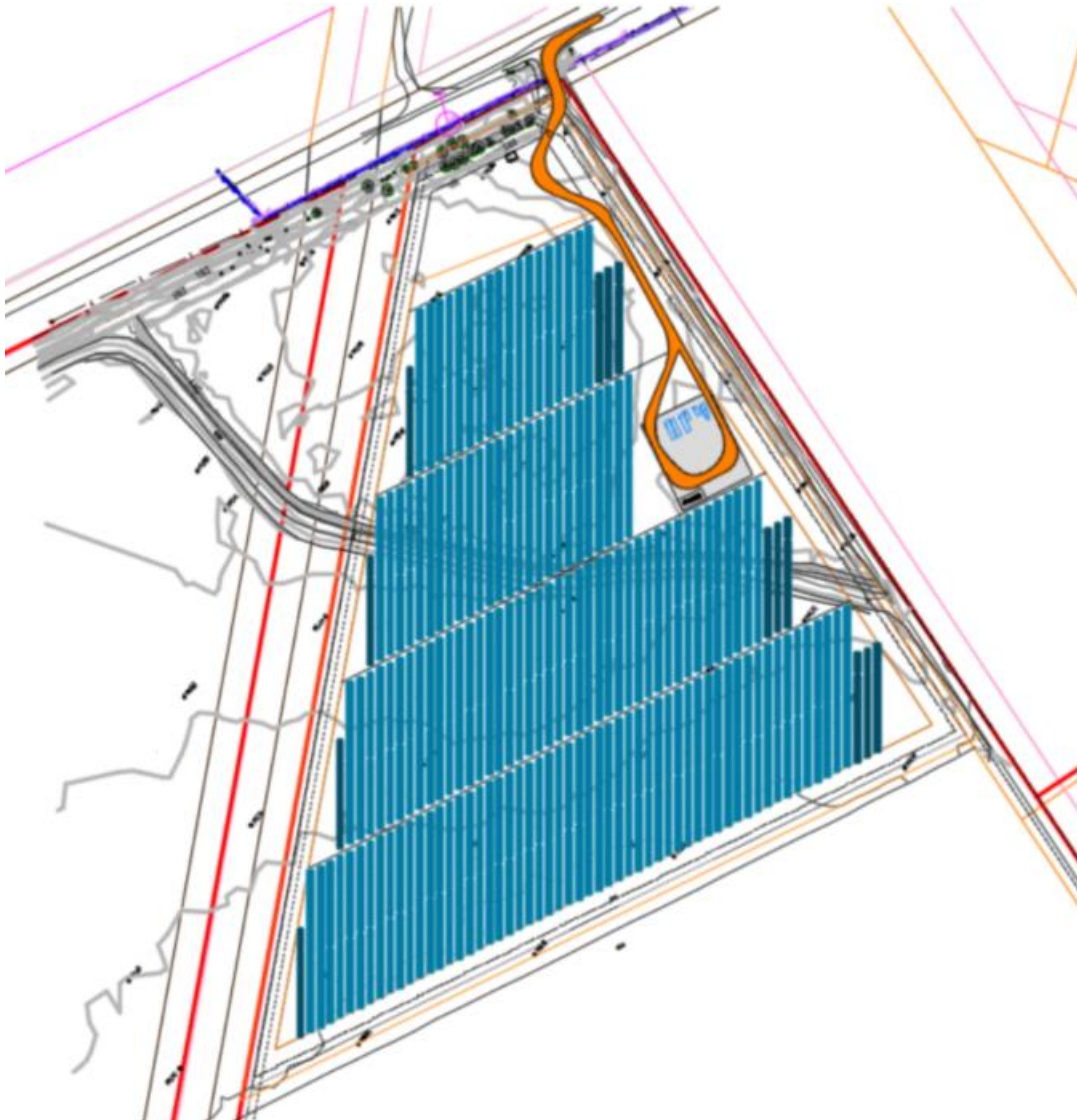


Figure 2 – Proposed Solar Farm

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.

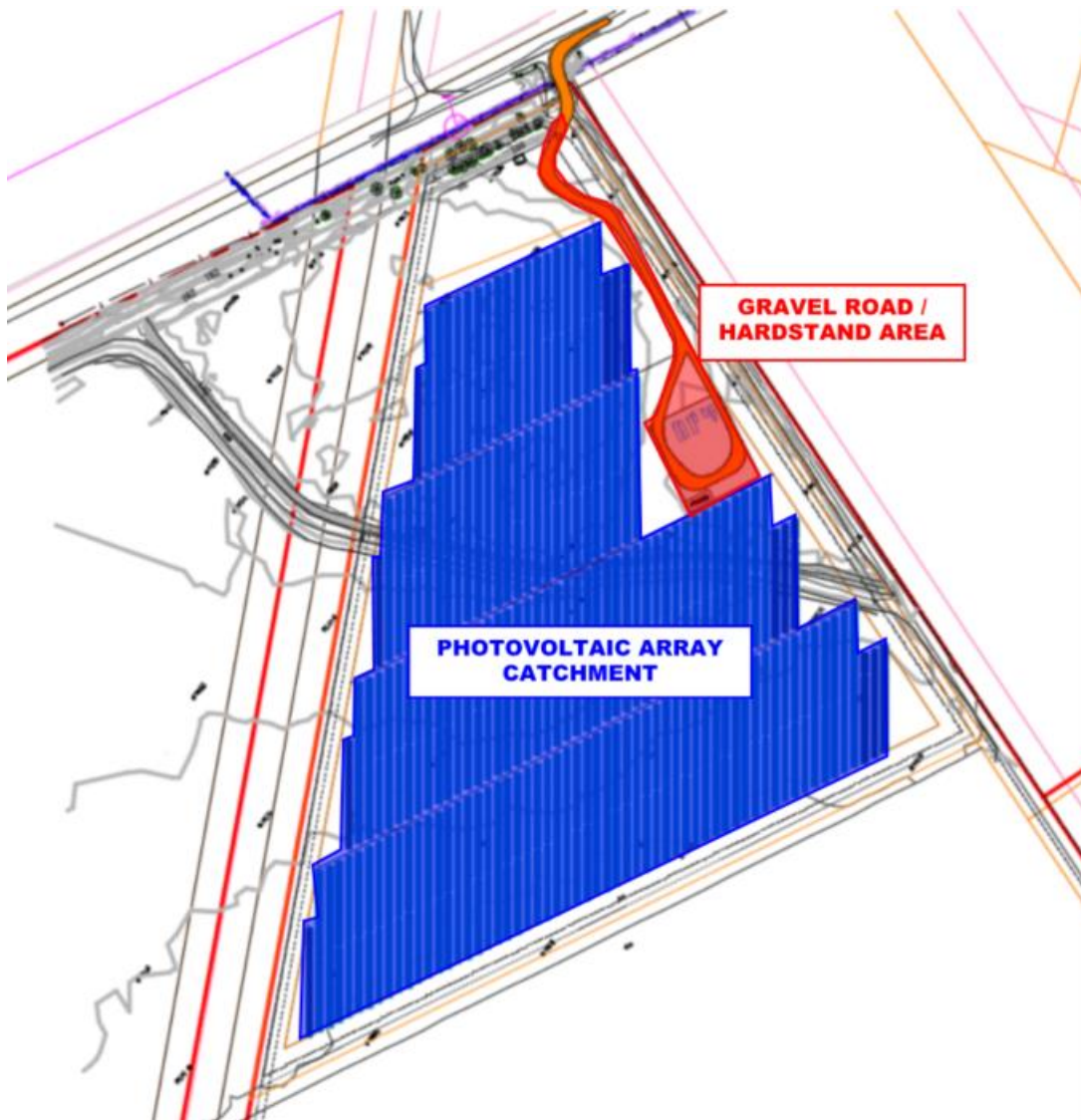


Figure 3 – Proposed Catchment Boundaries

4.2. Photovoltaic Array

The Photovoltaic Array will consist of 154 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.

The Photovoltaic Array Catchment was split into two separate catchments for the assessment of Stormwater Quantity. Figure 4 below shows the proposed catchment boundaries.



Figure 4 – Proposed Photovoltaic Catchment Boundaries

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 1 Pre-Development	Sub-Catchment Area	28,874 m ²
	Percentage Impervious	0 %
	Flowpath Length	83 m
	Flowpath Slope	0.2 %
	Retardance Coefficient 'n'	0.075
Photovoltaic Array Catchment 2 Pre-Development	Sub-Catchment Area	68,586 m ²
	Percentage Impervious	0 %
	Flowpath Length	235 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 5 below.

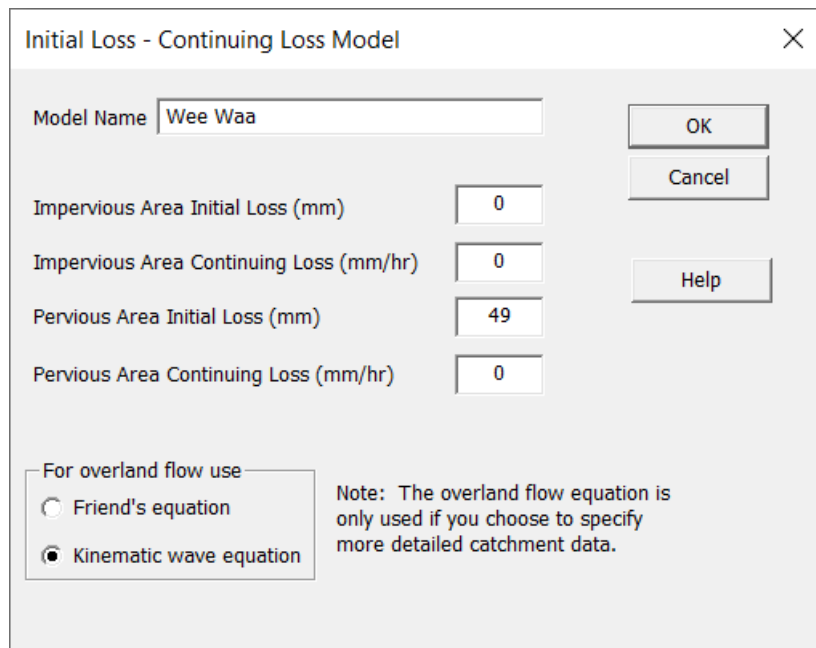


Figure 5 – Hydrological Model Parameters

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 1 Pre-Development	1EY	0.052 m ³ /s
	10% AEP	0.347 m ³ /s
	1% AEP	0.741 m ³ /s
Photovoltaic Array Catchment 2 Pre-Development	1EY	0.090 m ³ /s
	10% AEP	0.579 m ³ /s
	1% AEP	1.250 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 1 Post-Development	Sub-Catchment Area	28,874 m ²
	Percentage Impervious	35.81 %
	Flowpath Length	83 m
	Flowpath Slope	0.2 %
	Retardance Coefficient 'n'	0.075
Photovoltaic Array Catchment 2 Post-Development	Sub-Catchment Area	68,586 m ²
	Percentage Impervious	35.81 %
	Flowpath Length	235 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 1.56. 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 6 below.

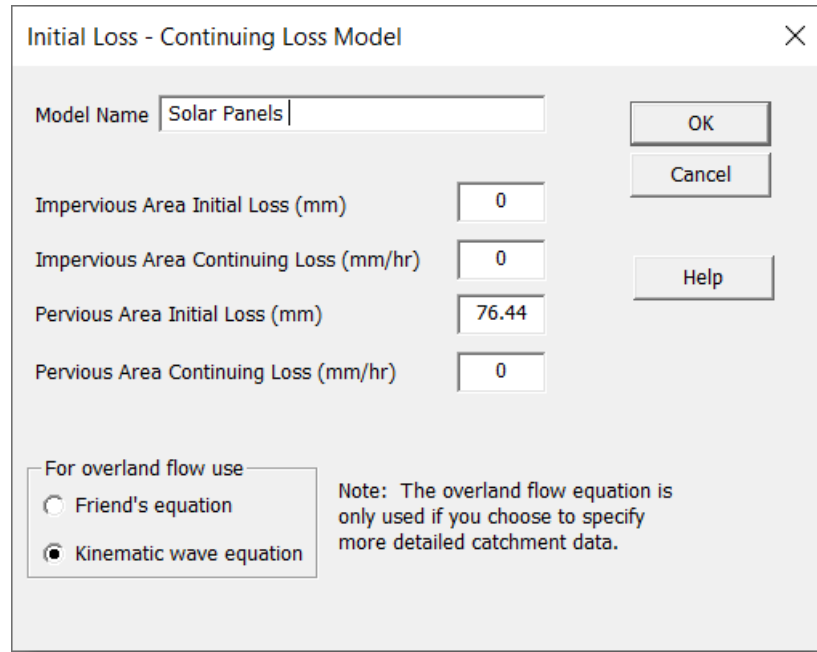


Figure 6 – Hydrological Model Parameters

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	1EY	0.052 m ³ /s	0.042 m ³ /s	- 0.010 m ³ /s
Catchment 1	10% AEP	0.347 m ³ /s	0.228 m ³ /s	- 0.122 m ³ /s
Post-Development	1% AEP	0.741 m ³ /s	0.563 m ³ /s	- 0.178 m ³ /s
Photovoltaic Array	1EY	0.090 m ³ /s	0.077 m ³ /s	- 0.013 m ³ /s
Catchment 2	10% AEP	0.579 m ³ /s	0.371 m ³ /s	- 0.208 m ³ /s
Post-Development	1% AEP	1.250 m ³ /s	0.955 m ³ /s	- 0.295 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 be captured within a roadside swale used as 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	5,114 m ²
	Percentage Impervious	0 %
	Flowpath Length	78 m
	Flowpath Slope	0.25 %
	Retardance Coefficient 'n'	0.075

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	0.010 m ³ /s
	10% AEP	0.068 m ³ /s
	1% AEP	0.146 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 used as a 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	5,114 m ²
	Percentage Impervious	89 %
	Flowpath Length	78 m
	Flowpath Slope	0.5 %
	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	192.43m AHD
Basin – Top of Bank	192.73m AHD
Low flow pipe diameter	150mm
Low flow pipe invert	192.43m AHD
Orifice Diameter	110mm
Base of Weir Width	2.0 m
Base of Weir Level	192.65m AHD
Top of Weir Width	6.0 m
Top of Weir Level	192.73m AHD
Basin Volume	154 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	0.010 m ³ /s	0.089 m ³ /s	0.009 m ³ /s	- 0.001 m ³ /s	192.64m AHD
10% AEP	0.068 m ³ /s	0.193 m ³ /s	0.067 m ³ /s	- 0.001 m ³ /s	192.69m AHD
1% AEP	0.146 m ³ /s	0.298 m ³ /s	0.141 m ³ /s	- 0.005 m ³ /s	192.73m AHD

Table 9 – Post-Development Peak Flow

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 Wee Waa Solar Farm at Yarrie Lake Road, Wee Waa 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 used as an 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 Wee Waa 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

A handwritten signature in blue ink, appearing to read 'Mathew McNamara', with a long horizontal stroke extending to the right.

Mathew McNamara
BEng (Civil) Hons MIE Aust



Ecological Due Diligence - Desktop Assessment



Wee Waa Solar Farm

Lot 191 DP 757125, Wee Waa, NSW 2388

05 November 2021

Ecological Due Diligence - Desktop Assessment

Wee Waa Solar Farm
Lot 191 DP 757125, Wee Waa, NSW 2388

Kleinfelder Document Number: NCA21P132742

Project No: 20212718
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Prepared for:

KDC/ PROVIDENCE ASSET GROUP

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Document Control:

Version	Description	Date	Author	Peer Reviewer
2.0	Final Report	05 November 2021	G. Whyte	G. Whyte

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Appendix 1:	Site photographs
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Appendix 3:	Threatened Species 'Likelihood of occurrence'
Appendix 4:	Licenses and Permits

1. INTRODUCTION

1.1 PROJECT BACKGROUND

Kleinfelder was engaged by Providence Asset Group to prepare an Ecological Due Diligence Desktop Assessment for a proposed solar farm located at Wee Waa NSW 2388 (Lot 191 DP757125). 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:

- Study Area – Lot 191 DP 757125
- Locality – land within a 5 km radius of the Study Area

This report identifies flora, fauna and threatened species likely to occur within the Study Area based on a desktop assessment. 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 undertaken.

1.2 SITE DESCRIPTION

The Study Area is located 2.7 kilometres (Km) south-east of Wee Waa within the Narrabri Shire Local Government Area (LGA). The Study Area is zoned 'RU1 – Primary Production under the *Narrabri Local Environmental Plan 2012* (LEP).

Access to the Study Area is achieved via an unnamed access road from Yarrie Lake Road to the east. The surrounding lands are predominantly used for agricultural purposes. The Study Area has a somewhat even topography. Aerial imagery and site photographs indicate that native vegetation has previously been cleared within the site (**Appendix 1** and **Appendix 2**). Remaining native vegetation consists of low regrowth vegetation.

No major wetlands or streams are mapped within the Study Area. The nearest waterway is Illaroo Creek, which occurs to the west.

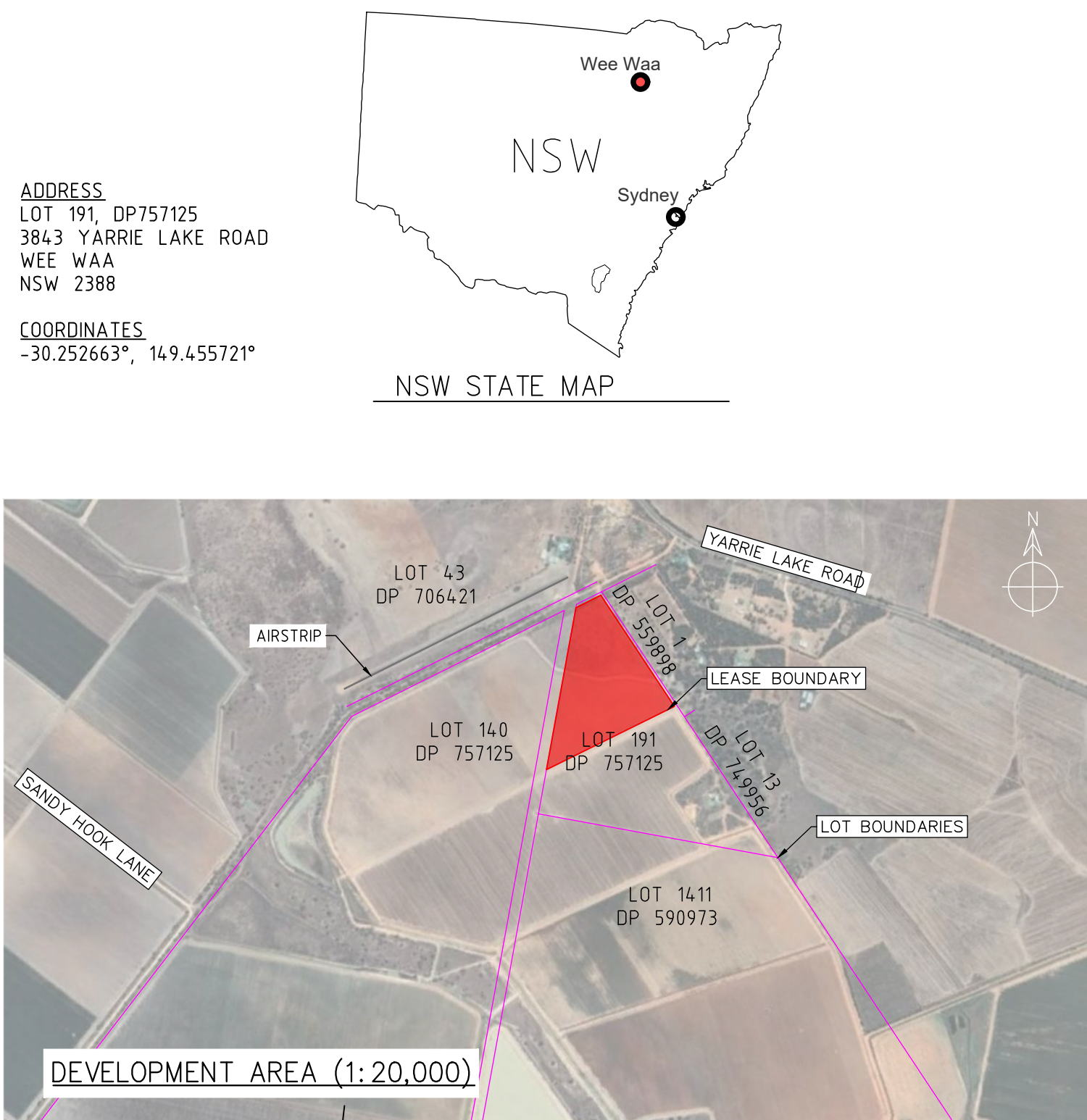
1.3 PROPOSED DEVELOPMENT

The Wee Waa Solar Farm project will include a 5 MW grid-connected solar PV installation. The proposed project layout is shown in the development drawings from page 2 of this report..

1.4 REPORT OBJECTIVES

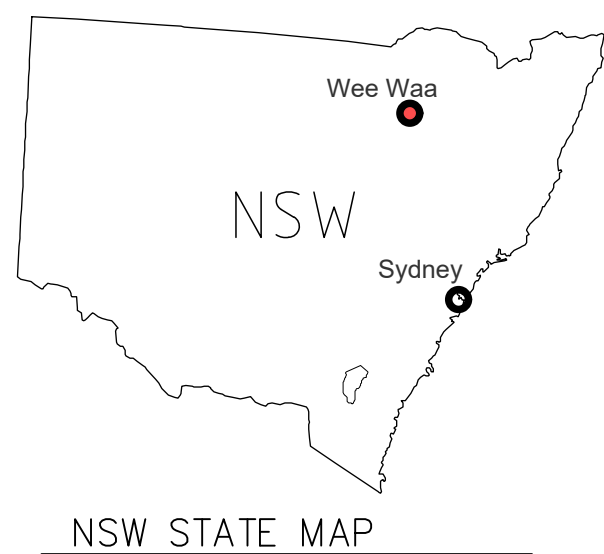
The objectives of the assessment include:

- Conduct a desktop assessment using various information sources (see **Section 2.1**).
- Discuss the flora and fauna (and their habitats) likely to be present within the Study Area.
- Assess the relevance and value of the Study Area for threatened species and ecological communities (and their habitats) listed under the NSW *Biodiversity Conservation Act 2016* (BC Act).
- 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 Study Area.



ADDRESS
LOT 191, DP757125
3843 YARRIE LAKE ROAD
WEE WAA
NSW 2388

COORDINATES
-30.252663°, 149.455721°



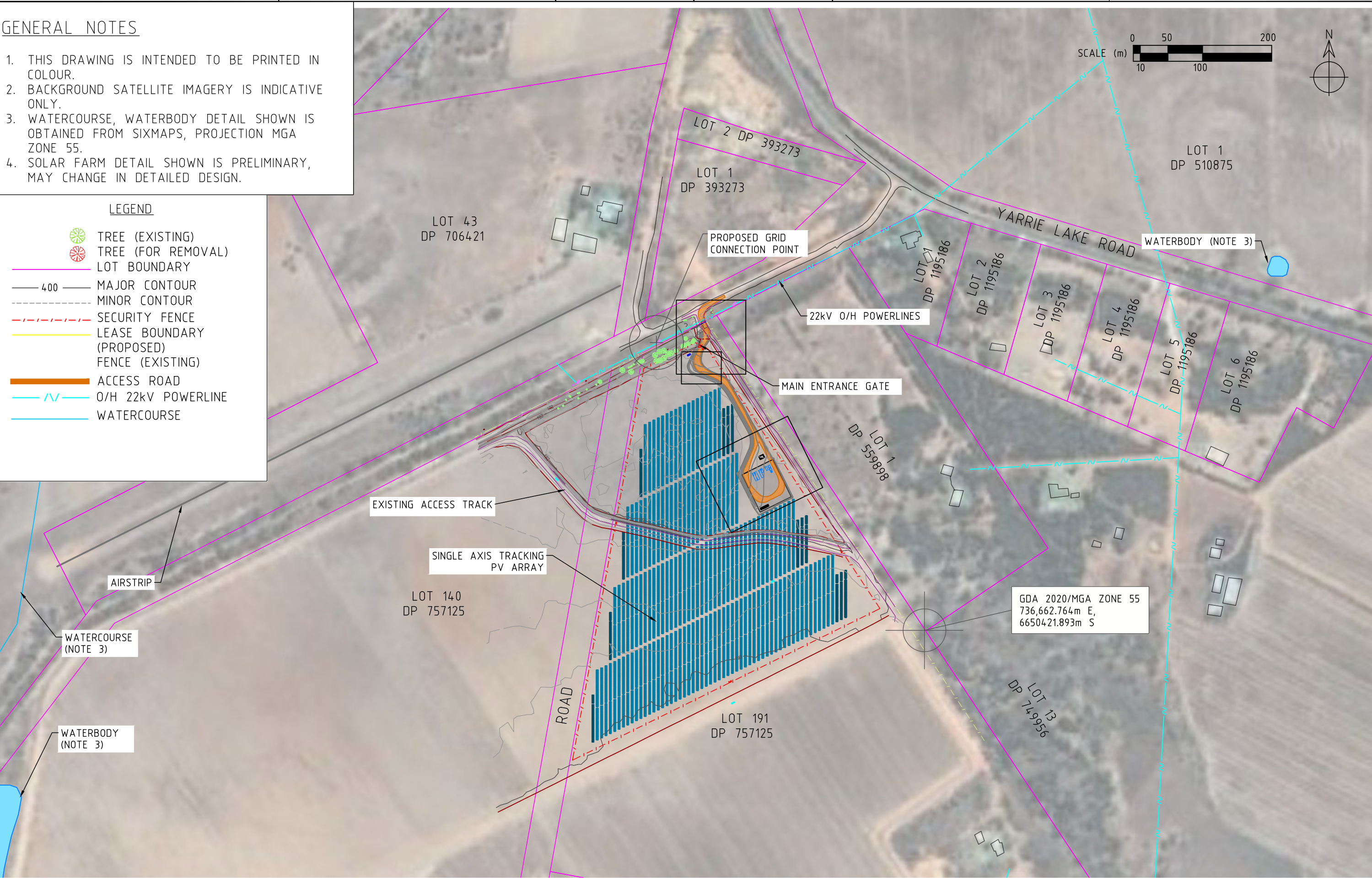
 	REFERENCES							THIS DRAWING IS THE PROPERTY OF PROVIDENCE ASSET GROUP AND IS NOT TO BE COPIED (IN WHOLE OR IN PART) FOR ANY PURPOSE OR DISCLOSED TO OTHER PARTIES WITHOUT THE APPROVAL OF PROVIDENCE ASSET GROUP OR AN AUTHORIZED AGENT.	TITLE PROVIDENCE ASSET GROUP WEE WAA SOLAR FARM LOCATION DETAIL	SCALE AS SHOWN	
										REVISION B	
		B	2021.02.05	MINOR REVISIONS	JM	JM	SS			JM	PAPER SIZE A3
		A	2021.01.21	FIRST ISSUE	JM	JM	SS			JM	
		REV.	DATE	DESCRIPTION	DRWN.	DESIGNED	CHKD.			APPR.	
											DWG No. 10090-G-GAD-01-1

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
- MAJOR CONTOUR
- MINOR CONTOUR
- SECURITY FENCE
- LEASE BOUNDARY (PROPOSED)
- FENCE (EXISTING)
- ACCESS ROAD
- O/H 22kV POWERLINE
- WATERCOURSE



REFERENCES		REVISED		DATE		DESCRIPTION		DRWN.	DESIGNED	CHKD.	APPR.
B		2021.02.19		CIVIL STORMWATER DETAIL ADDED		JM		JM	SS	JM	
A		2021.01.22		FIRST ISSUE		JM		JM	SS	JM	

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TITLE		SCALE
PROVIDENCE ASSET GROUP		1:5000
WEE WAA SOLAR FARM		REVISION
GENERAL ARRANGEMENT		B
OVERVIEW		PAPER SIZE
DWG No. 10090-G-GAD-02-1		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
- WATERCOURSE

SYSTEM SUMMARY

ELECTRICAL CONFIGURATION:

TOTAL PV PLANT CAPACITY (DC): 6.789 MWp
TOTAL INVERTER CAPACITY (AC): 4.95MVA
PV PLANT MAXIMUM EXPORT CAPACITY (AC): 4.95MW
DC:AC RATIO: 1.371
STRINGS OF 28 PV MODULES.
424/425 PV STRINGS PER INVERTER.
449 PV STRINGS TOTAL.

PV MODULES:

MFR: LONGI SOLAR
MODEL: LR5-72HPH-540M
NAMEPLATE: 540Wp
QUANTITY: 12,572 MODULES

INVERTERS:

MFR: SUNGROW
MODEL: SG2475HV-MV
NAMEPLATE: 2475kVA
QUANTITY: 2

MV POWER STATION:

MFR: SUNGROW
MODEL: SG4950HV-MV
QUANTITY: 1

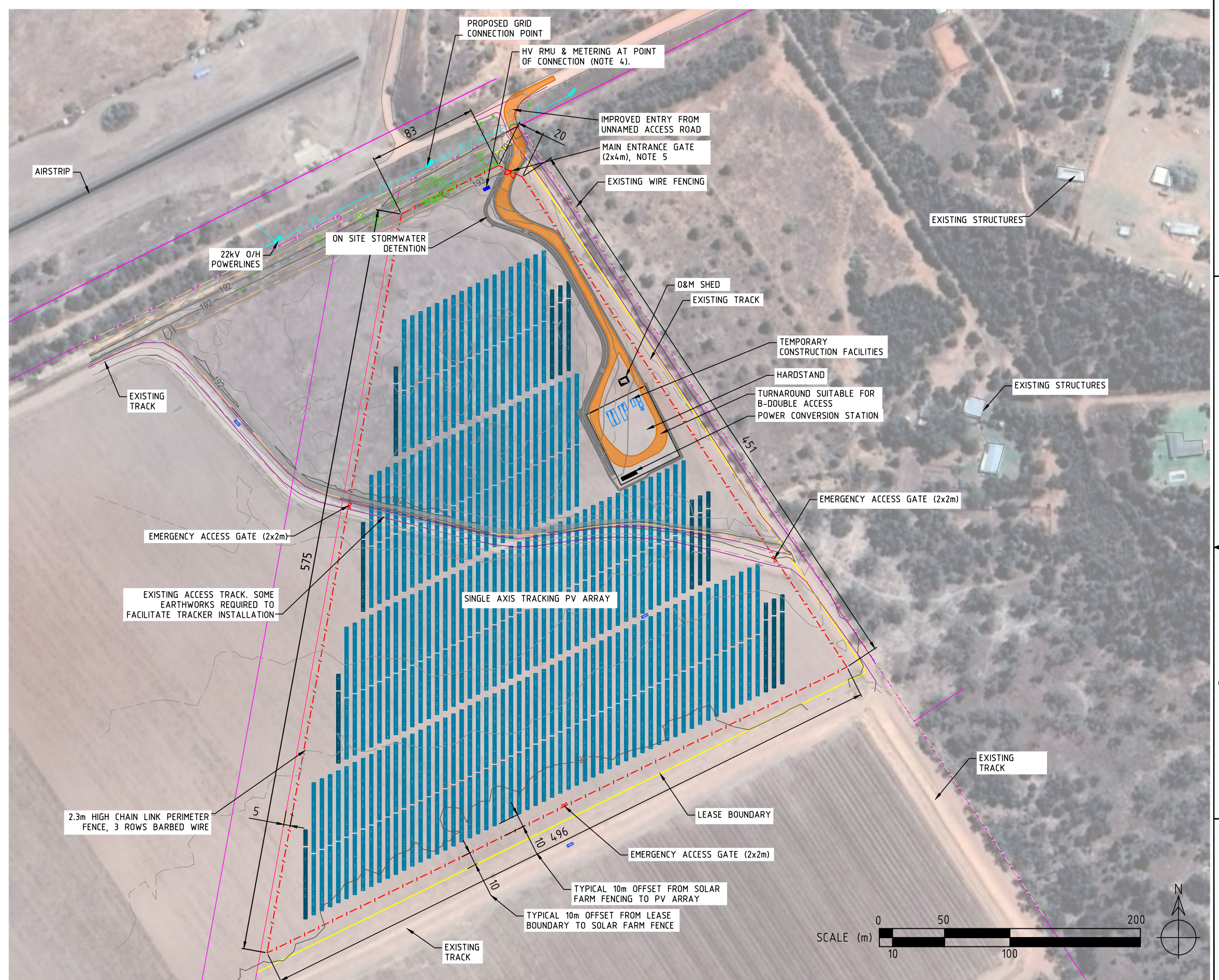
TRACKER ARRAY:

TYPE: GROUND MOUNT SINGLE AXIS TRACKING
CONFIGURATION: INDEPENDENT TYPE
RANGE OF MOTION: $\pm 60^\circ$
PITCH: 6.30m
GCR: 35.81%
QUANTITY: 154 TABLES (13 SHORT, 141 FULL)

FENCED AREA: 136,146 m²
LEASE AREA: 149,989 m²

GENERAL NOTES:

- SITE ACCESS VIA UNNAMED ROAD CONNECTING TO YARRIE LAKE ROAD.
- DETAIL SHOWN IS PRELIMINARY, MAY CHANGE IN DETAILED DESIGN.
- CLEARANCE BETWEEN SOLAR TRACKER ARRAY & SITE SECURITY FENCE TYPICALLY 10m
- HV RMU & METERING (LOCATION AND TYPE TO BE DETERMINED, IS SUBJECT TO ESSENTIAL ENERGY FEEDBACK).
- FOR SECURITY GATE DETAILS REFER TO DRAWING 10090-C-DET-02-1.
- WATERCOURSE, WATERBODY DETAIL FROM SIXMAPS, MGA ZONE 55 PROJECTION.
- REFER TO CIVIL DETAIL DRAWING 10090-C-DET-01-1.



REVISED

REVISIONS

REV	DATE	DESCRIPTION	DRWN.	DESIGNED	CHKD.	APPR.
B	2021.02.19	CIVIL STORMWATER DETAIL ADDED	JM	JM	SS	JM
A	2021.01.22	FIRST ISSUE	JM	JM	SS	JM

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TITLE
PROVIDENCE ASSET GROUP
WEE WAA SOLAR FARM
GENERAL ARRANGEMENT
SYSTEM DETAIL
DWG No. 10090-G-GAD-02-2

SCALE
1:3000
REVISION
B
PAPER SIZE
A3

2. DESKTOP ASSESSMENT

2.1 ASSESSMENT METHODS

Existing information on the flora and fauna of the Study Area 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 4204* (OEH 2015).
- The BioNet Atlas of NSW Wildlife (DPIE, 2020) 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 05/11/2021).
- 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 Study Area, and their likelihood of occurrence.

2.2 VEGETATION ASSESSMENT

Regional Mapping

The regional vegetation mapping for the Study Area, based on the *Border Rivers Gwydir / Namoi Regional Native Vegetation Map Version 2.0. VIS_ID 4204* (OEH 2015) is shown in **Figure 1**. This mapping indicates the following:

- The majority of the southern portion of the Study Area is mapped as non-native vegetation (shown in green in **Figure 1**).
- The northern portion of the site is mapped as: PCT 53 *Shallow freshwater wetland sedgland in depressions and floodplains on inland alluvial plains and floodplains* (shown in red on **Figure 1**).
- Vegetation directly to the east of the Study Area is mapped as:
 - PCT 1: *Candidate Native Grasslands* (shown in purple on **Figure 1**)
 - PCT 397: *Pilliga Outwash Dry Sclerophyll Forests* (shown in blue on **Figure 1**)
 - PCT 35: *Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion* (shown in bright green on **Figure 1**).

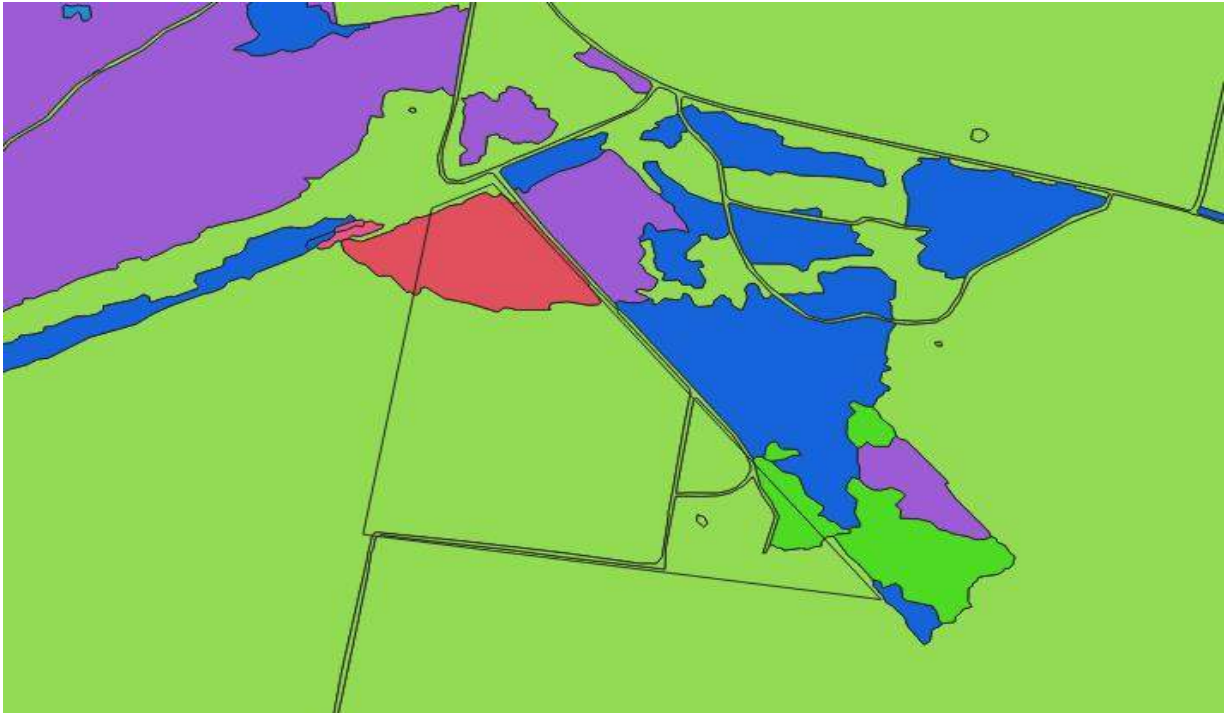


Figure 1 Regional vegetation mapping (VIS_ID4204). The Shallow freshwater Wetland mapping within the Study Area is shown in red.

Site Photographs

Photographs of the Study Area indicate that the vegetation is predominantly cleared and comprised of exotic groundcover species (see **Appendix 1**). The dominant grass species appears to be *Avena fatua* (Oats Grass). Other dominant exotic grass species also appear to occur.

Dominant exotic herbs appear to include *Echium plantagineum* (Patterson's Cure), *Conyza bonariensis* (Flax-leaf Fleabane), *Verbena rigida* (Veiny Verbena), *Hirschfeldia incana* (Twiggy Turnip) and *Capsella bursa-pastoralis* (Shepherd Purse).

Native species appear to be limited to occasional occurrences of *Dichondra repens* (Kidney Weed), *Solanum esuriale* (Quena) and regrowth of *Alectryon oleifolius* (Western Rosewood). The coverage of these species appears to be less than 5%.

Aerial Imagery

A review of aerial imagery (**Appendix 2**) shows that the site has a long history of agricultural use. This is consistent with the lack of native plant diversity within the site.

Plant Community Type Determination

Based on the lack of native plant species within the Study Area, the vegetation is not commensurate with any native Plant Community Types (PCTs) according to the NSW Bionet Vegetation Classification.

2.3 THREATENED BIOTA

Threatened Ecological Communities

Based on the lack of native plant species within the Study Area, the vegetation is not commensurate with any Threatened Ecological Communities (TECs) listed under the NSW BC Act or the Commonwealth EPBC Act.

Threatened Species (BC Act)

A database search using the BioNet Atlas of NSW Wildlife (DPIE, 2020) returned a list of ten threatened fauna species that have previously been recorded within a 5 km radius of the Study Area. The Atlas returned no records of threatened plant species. A “likelihood of occurrence” assessment determined that the habitat is considerably degraded due to previous land management practises and does not contain suitable habitat to support populations of any threatened fauna species (**Appendix 3**).

Threatened Species (EPBC Act)

The habitats present within the Study Area are also considered to be too degraded to support populations of EPBC listed threatened species, with the exception of the Fork-tailed Swift *Apus pacificus* and the White-throated Needletail *Hirundapus caudacutus*, which utilise the aerial space above the Study Area as foraging habitat. 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.

Koala Habitat

The Study Area is highly unlikely to support Koala habitat based on the following:

- The BioNet Atlas of NSW Wildlife (DPIE, 2020) returned no records of Koalas within the locality.
- Site photographs and aerial imagery indicate that preferred Koala feed tree species are unlikely to occur within the Study Area.

2.4 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 Study Area. The assessment determined that impacts to MNES are unlikely; therefore, an EPBC referral to the Commonwealth Minister for the Environment is not recommended.

2.5 MITIGATION MEASURES

Avoidance Measures

Impacts on biodiversity values appear to be minimal. The design of the solar panel array indicates that no native vegetation will be removed within the Study Area. Further avoidance measures are not considered applicable to the project.

Erosion Control

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

- Installation of erosion and sediment control structures along the boundaries of the site adjacent to areas of native vegetation prior to 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.

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.

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.

Weed Management

The Study Area contains a high coverage of exotic groundcover species. The following recommendations are to be implemented during construction and operation to minimise the spread of weeds:

- 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 Priority Weeds for the region and Weeds of National Significance are not introduced.

APPENDIX 1: SITE PHOTOGRAPHS



Plate 1: Grassland (degraded) within the Study Area



Plate 2: Grassland (degraded) within the Study Area

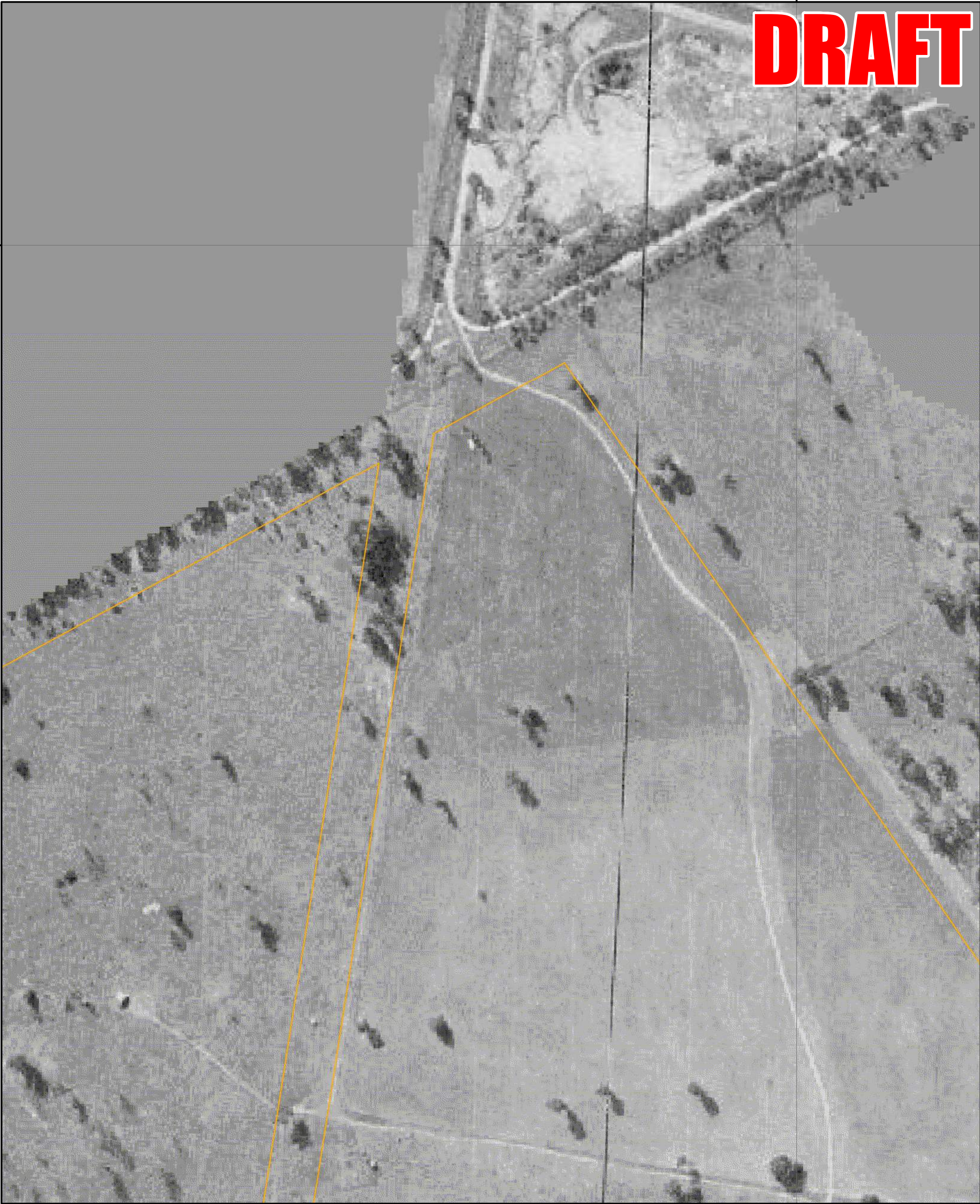


Plate 3: Groundcover (Exotic) within the Study Area



Plate 4: Groundcover (Exotic) within the Study Area

APPENDIX 2: SITE IMAGERY

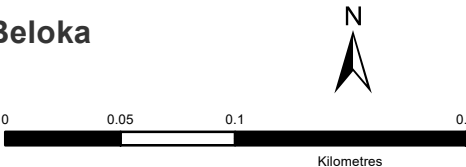


Legend

- Landholding Boundary
- Excluded Land
- Sensitive Regulated Land
- Vulnerable Regulated Land
- Treatment Area
- Set Aside Area
- Riparian Buffer
- Drainage Line

Landholding Reference: Beloka
Image Date: 1964

Map 1 of 1



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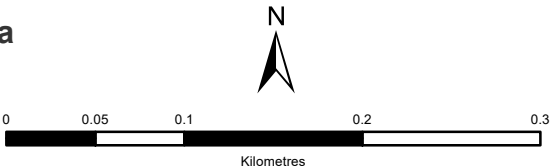


Legend

- | | | | |
|--|---------------------------|---|-----------------|
|  | Landholding Boundary |  | Treatment Area |
|  | Excluded Land |  | Set Aside Area |
|  | Sensitive Regulated Land |  | Riparian Buffer |
|  | Vulnerable Regulated Land |  | Drainage Line |

Landholding Reference: Beloka
Image Date: 1983

Map 1 of 1



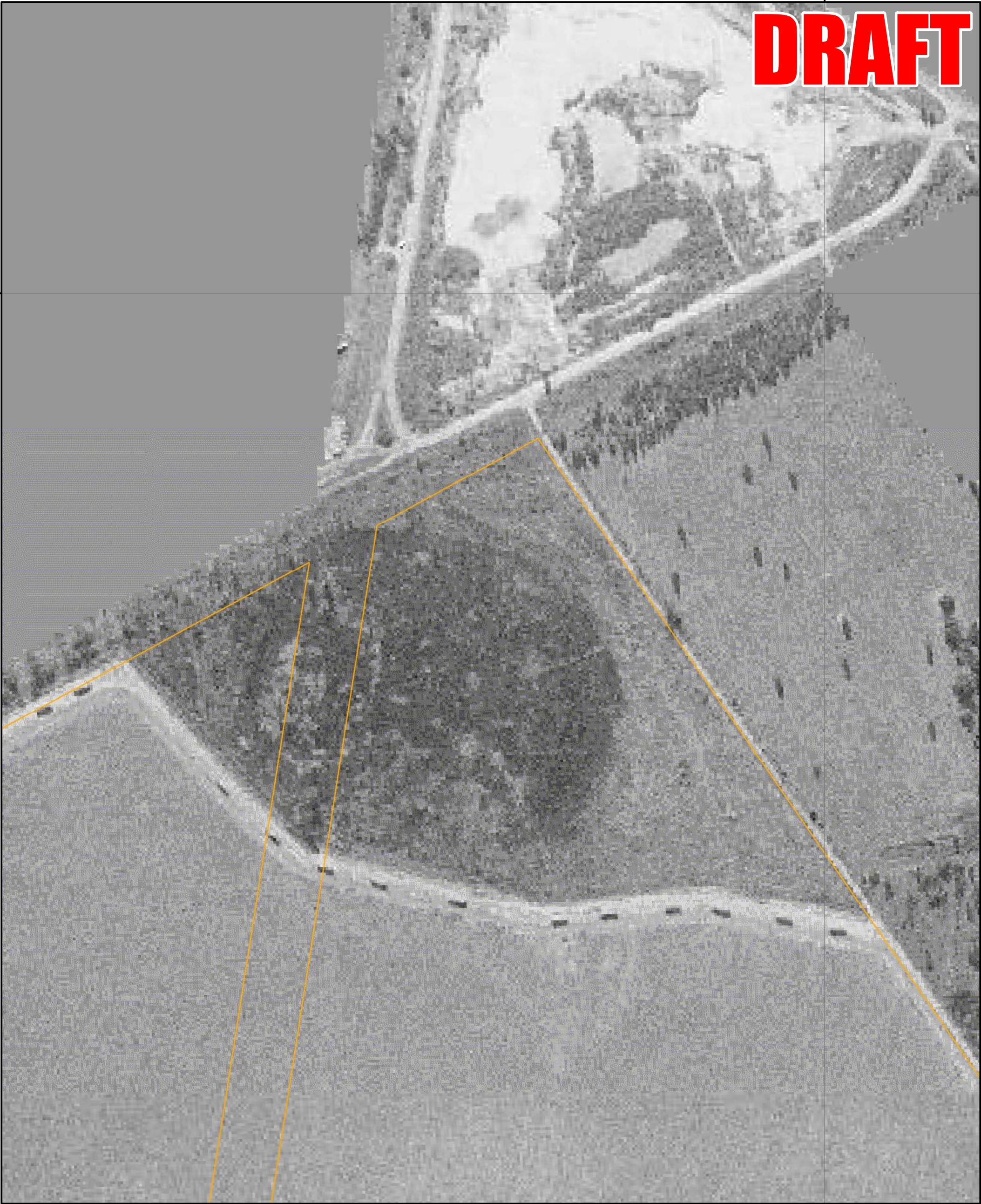
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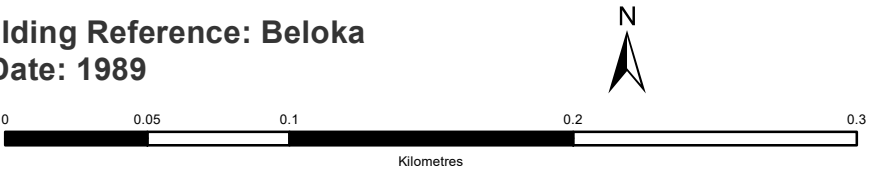




Legend

- Landholding Boundary
- Excluded Land
- Sensitive Regulated Land
- Vulnerable Regulated Land
- Treatment Area
- Set Aside Area
- Riparian Buffer
- Drainage Line

Landholding Reference: Beloka
Image Date: 1989



Map 1 of 1

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Legend

- Landholding Boundary
- Excluded Land
- Sensitive Regulated Land
- Vulnerable Regulated Land
- Treatment Area
- Set Aside Area
- Riparian Buffer
- Drainage Line

Landholding Reference: Beloka
Image Date: 1994



Map 1 of 1

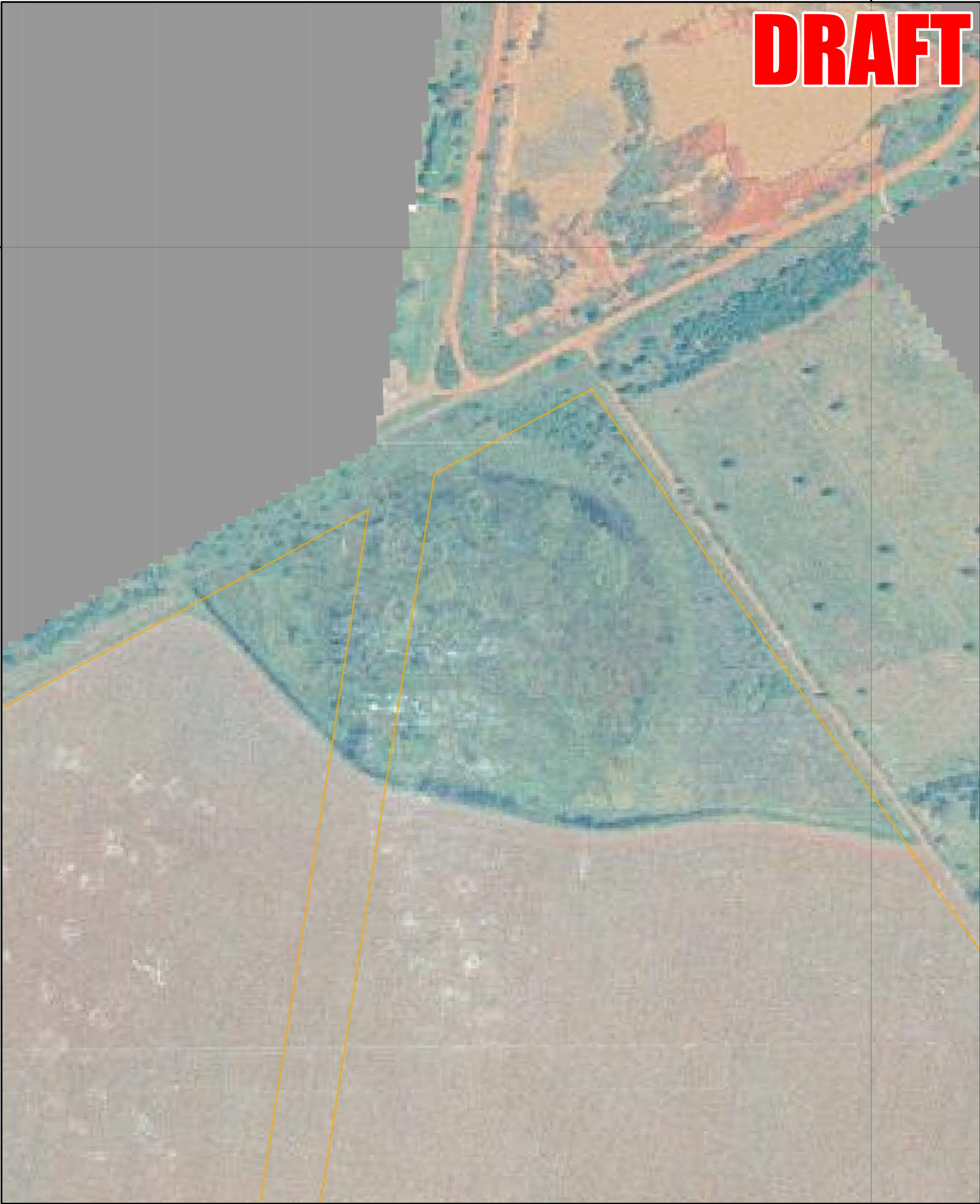
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Legend

- Landholding Boundary
- Excluded Land
- Sensitive Regulated Land
- Vulnerable Regulated Land
- Treatment Area
- Set Aside Area
- Riparian Buffer
- Drainage Line

Landholding Reference: Beloka
Image Date: 1998



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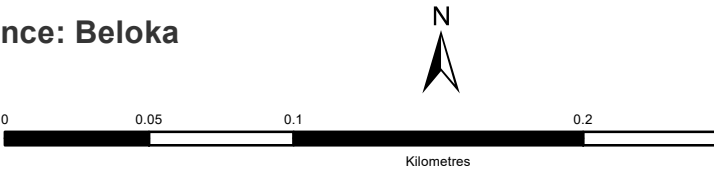


Legend

- Landholding Boundary
- Excluded Land
- Sensitive Regulated Land
- Vulnerable Regulated Land
- Treatment Area
- Set Aside Area
- Riparian Buffer
- Drainage Line

Landholding Reference: Beloka
Image Date: 2010

Map 1 of 1



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APPENDIX 3: THREATENED SPECIES 'LIKELIHOOD OF OCCURRENCE'

Table 1: Likelihood of occurrence

Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
	BC Act	EPBC Act					
<i>Androcalva procumbens</i>	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 <i>Eucalyptus dealbata</i> and <i>Eucalyptus sideroxylon</i> communities, <i>Melaleuca uncinata</i> scrub, under mallee eucalypts with a <i>Calytrix tetragona</i> understorey, and in a recently burnt Ironbark and Callitris area. Other associated species include <i>Acacia triptera</i>, <i>Callitris endlicheri</i>, <i>Eucalyptus melliodora</i>, <i>Allocasuarina diminuta</i>, <i>Philotheca salsolifolia</i>, <i>Xanthorrhoea species</i>, <i>Exocarpos cupressiformis</i>, <i>Leptospermum parvifolium</i> and <i>Kunzea parvifolia</i>.	Low	Low
<i>Cadellia pentastylis</i>	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 24°S to 30°S 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.	Low	Low

Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
	BC Act	EPBC Act					
<i>Dichanthium setosum</i> Bluegrass	V	V	-	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).	Low	Low
<i>Swainsona murrayana</i> Slender Darling Pea	V	V	-	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 <i>Maireana</i> species. Plants have been found in remnant native grasslands or grassy woodlands that have been intermittently grazed or cultivated.	Low	Low
<i>Tylophora linearis</i>	V	E	-	PMST	Grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of <i>Eucalyptus fibrosa</i> , <i>Eucalyptus sideroxylon</i> , <i>Eucalyptus albens</i> , <i>Callitris endlicheri</i> , <i>Callitris glaucophylla</i> and <i>Allocasuarina luehmannii</i> .	Low	Low
<i>Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions</i>	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 (<i>Eucalyptus coolabah</i>) and, in some areas, Black Box (<i>E. largiflorens</i>). Other tree species may be present including River Cooba (<i>Acacia stenophylla</i>), Cooba (<i>A. salicina</i>), Belah (<i>Casuarina cristata</i>) and Eurah (<i>Eremophila bignoniiflora</i>).	Nil	Nil

Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
	BC Act	EPBC Act					
<i>Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia</i>	E	E	-	PMST	Inland Grey Box Woodland includes those woodlands in which the most characteristic tree species, <i>Eucalyptus microcarpa</i> (Inland Grey Box), is often found in association with <i>E. populnea subsp. bimbil</i> (Bimble or Poplar Box), <i>Callitris glaucophylla</i> (White Cypress Pine), <i>Brachychiton populneus</i> (Kurrajong), <i>Allocasuarina luehmannii</i> (Bulloak) or <i>E. melliodora</i> (Yellow Box), and sometimes with <i>E. albens</i> (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.	Low	Low
<i>Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland</i>	-	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 <i>Acacia pendula</i> (weeping myall), <i>Eucalyptus coolabah</i> (coolibah), <i>E. populnea</i> (poplar box) or <i>E. melliodora</i> (yellow box) occur.	Nil	Nil

Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
	BC Act	EPBC Act					
<i>Poplar Box Grassy Woodland on Alluvial Plains</i>	-	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 <i>Eucalyptus populnea</i> (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.	Nil	Nil
<i>Weeping Myall Woodlands</i>	-	E	-	PMST	Occurs on the inland alluvial plains west of the Great Dividing Range in NSW and QLD, generally 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 (<i>Acacia pendula</i>) trees and in some cases this species may be the only tree canopy species.	Nil	Nil
<i>White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland</i>	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 <i>Eucalyptus albens</i> , Yellow Box <i>E. melliodora</i> and Blakely's Red Gum <i>E. blakelyi</i> . 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.	Nil	Nil

Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
	BC Act	EPBC Act					
<i>Artamus cyanopterus cyanopterus</i> 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.	Low	Low
<i>Glossopsitta pusilla</i> Little Lorikeet	V	-	6	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.	Low	Low
<i>Pomatostomus temporalis temporalis</i> Grey-crowned Babbler (eastern subspecies)	V	-	2	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.	Low	Low
<i>Anthochaera phrygia</i> 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.	Low	Low
<i>Botaurus poiciloptilus</i> Australasian Bittern	E	E	-	PMST	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (<i>Typha spp.</i>) and spikerushes (<i>Eleocharis spp.</i>).	Nil	Nil
<i>Calidris ferruginea</i> 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.	Nil	Nil

Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
	BC Act	EPBC Act					
<i>Falco subniger</i> Black Falcon	V	-	1	Bionet PMST	The Black Falcon is widely, but sparsely, distributed in New South Wales, mostly occurring in inland regions. Some reports of 'Black Falcons' on the tablelands and coast of New South Wales are likely to be preferable to the Brown Falcon. In New South Wales there is assumed to be a single population that is continuous with a broader continental population, given that falcons are highly mobile, commonly travelling hundreds of kilometres (Marchant & Higgins 1993). The Black Falcon occurs as solitary individuals, in pairs, or in family groups of parents and offspring.	Low	Low
<i>Rostratula australis</i> 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.	Nil	Nil
<i>Chalinolobus dwyeri</i> 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 (<i>Petrochelidon ariel</i>), frequenting low to mid-elevation dry open forest and woodland close to these features.	Nil	Nil
<i>Dasyurus maculatus</i> (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.	Nil	Nil
<i>Phascolarctos cinereus</i> (combined populations of Qld, NSW and the ACT) Koala	V	V	-	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.	Low	Low

Species	Legal Status*		No. of Records	Source#	Habitat Preferences	Likelihood of occurrence	Potential Impact
	BC Act	EPBC Act					
<i>Nyctophilus corbeni</i> Corben's Long-eared Bat	V	V	-	PMST	Inhabits a variety of vegetation types, including Mallee, Bulloke <i>Allocasuarina leuhmanni</i> 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.	Low	Low
<i>Pteropus poliocephalus</i> Grey-headed Flying-fox	V	V	-	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.	Low	Low
<i>Aprasia parapulchella</i> Pink-tailed Worm Lizard	V	V	-	PMST	Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by Kangaroo Grass (<i>Themeda australis</i>). Sites are typically well-drained, with rocky outcrops or scattered, partially buried rocks.	Nil	Nil
<i>Apus pacificus</i> Fork-tailed Swift	-	M	-	PMST	Forages aerially over a very wide range of habitats includes both vegetated and non- vegetated areas.	Moderate	Low
<i>Hirundapus caudacutus</i> White-throated Needletail	-	M	-	PMST	Forages in high open spaces over varied habitat types.	Moderate	Low
<i>Motacilla flava</i> Yellow Wagtail	-	M	-	PMST	Typically inhabits inundated fields, saltmarsh and wetlands and occasionally coastal areas.	Nil	Low
<i>Myiagra cyanoleuca</i> Satin Flycatcher	-	M	-	PMST	Found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	Nil	Low

APPENDIX 4: 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 2022) 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

Wee Waa Solar Farm
Wee Waa, NSW



Document Information

Noise Assessment

Wee Waa Solar Farm

Wee Waa, NSW

Prepared for: Providence Asset Group

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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 Wee Waa Solar Farm near Wee Waa, 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 3843 Yarrie Lake Road, Wee Waa NSW, approximately 3km south east of Wee Waa, 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 12,600 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.

The designated transport route from the Newell Highway at Narrabri via Mooloobar Street, Baranbar Street, Goobar Street onto Yarrie Lake 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
PR1 ¹	3843 Yarrie Lake Road	Residential	736765	6650113
R01	3759 Yarrie Lake Road	Residential	736869	6650634
R02	3797 Yarrie Lake Road	Residential	737109	6650698
R03	3799 Yarrie Lake Road	Residential	736996	6650750
R04	3809 Yarrie Lake Road	Residential	736928	6650787
R05	3833 Yarrie Lake Road	Residential	736857	6650809
R06	3837 Yarrie Lake Road	Residential	736696	6650921
R07	3841 Yarrie Lake Road	Residential	736716	6650638
R08	3845 Yarrie Lake Road	Residential	736216	6651019
R09	3906 Yarrie Lake Road	Residential	736533	6651636
R10	3935 Yarrie Lake Road	Residential	736027	6651827

Note 1: Project related receiver.



FIGURE 1
PROJECT LAYOUT
MAC201186-05
Wee Waa Solar Farm

KEY

- Receivers
 - Site Access Route
 - PV Panel Array
 - Project Boundary
- 0 100 200 300 400 500 600 m



3 Noise Policy and Guidelines

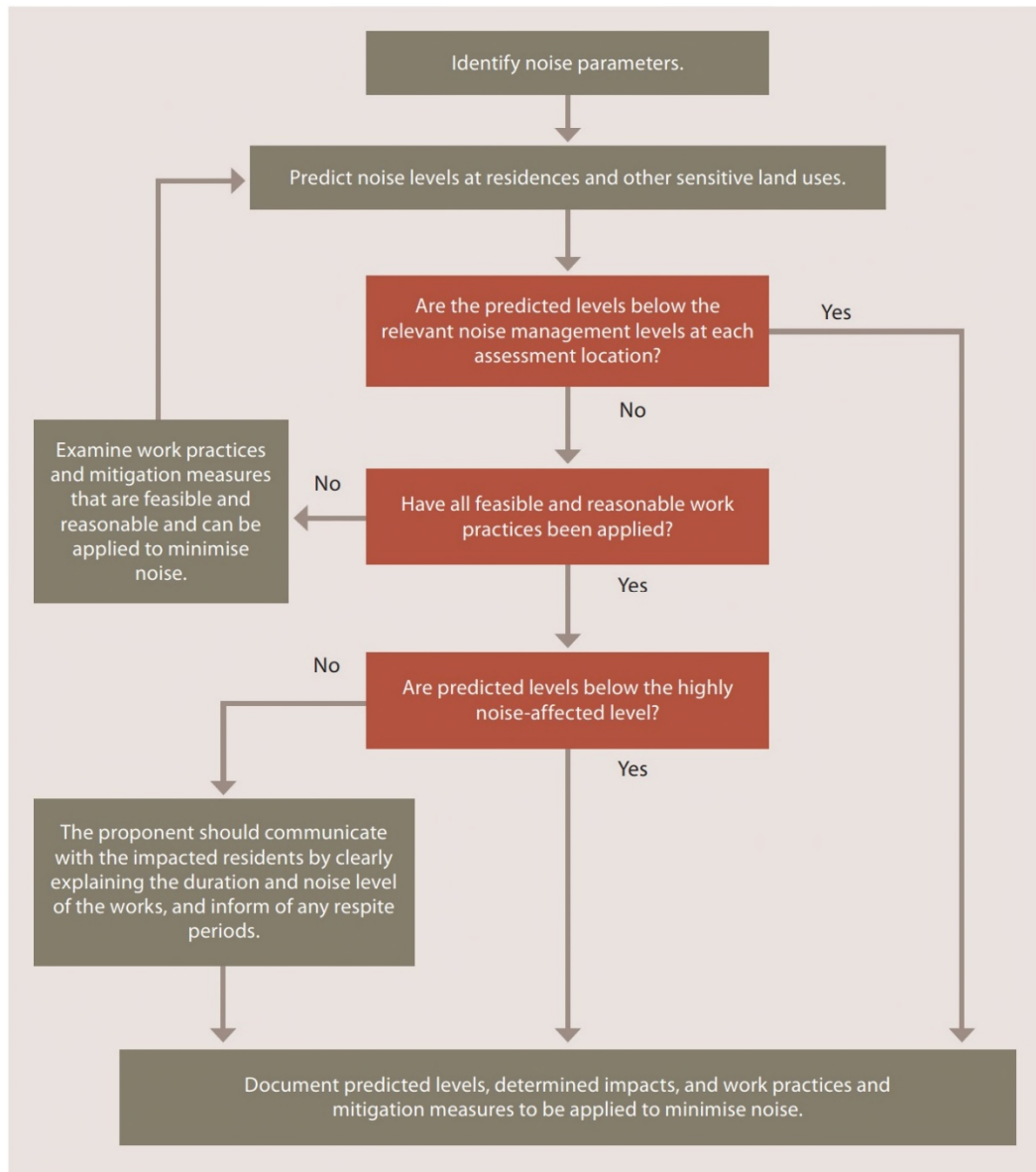
3.1 Interim Construction Noise Guideline

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		How to Apply
	LAeq(15min) ¹		
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 ($L_{Aeq}(15min)$) 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:

- LAeq(15min) 40dB or the prevailing RBL plus 5dBA, whichever is the greater, and/or
- LAmax 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**.

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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 LA90	NML dB LAeq(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 LAeq(period)	ANL dB LAeq(period) ²	PANL dB LAeq(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 LAeq(15min) is the limiting criteria for residential receivers.

Table 8 Project Noise Trigger Levels				
Catchment	Assessment Period ¹	PINL dB LAeq(15min)	PANL dB LAeq(15min)	PNTL dB LAeq(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 LAmax 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		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)	Proposed road projects and traffic generating developments	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.

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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 CONCAWE¹. 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	154	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 D1 of 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. Receiver PR1 is project related and therefore has not been assessed.

Table 16 Predicted Construction Noise Levels

Receiver	Description/Address	Predicted Noise Level Range dB LAeq(15min) ¹	Highest Predicted Noise Level dB LAeq(15min)	NML Standard Hours dB LAeq(15min)	Compliance Achieved
R01	3759 Yarrie Lake Road	32-51	51	45	✗
R02	3797 Yarrie Lake Road	<30-46	46	45	✗
R03	3799 Yarrie Lake Road	<30-48	48	45	✗
R04	3809 Yarrie Lake Road	30-49	49	45	✗
R05	3833 Yarrie Lake Road	31-50	50	45	✗
R06	3837 Yarrie Lake Road	32-51	51	45	✗
R07	3841 Yarrie Lake Road	36-56	56	45	✗
R08	3845 Yarrie Lake Road	33-52	52	45	✗
R09	3906 Yarrie Lake Road	<30-41	41	45	✓
R10	3935 Yarrie Lake Road	<30-39	39	45	✓

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 11dB at eight receivers when works are at their nearest proximity during standard construction hours. Exceedances at these receivers are expected from all construction activities (piling, trenching & assembly), however, would be of a temporary nature and short duration.

Therefore, it is recommended that mitigation measures be implemented for when piling activities are occurring. Notwithstanding, noise predictions will satisfy the highly noise affected noise management level of 75dB, LAeq(15min).

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. Receiver PR1 is project related and therefore has not been assessed.

Table 17 Predicted Operational Noise Levels

Receiver	Description/Address	Predicted Noise Level	PNTL dB LAeq(15min)	Compliance
		dB LAeq(15min)	Day/Eve/Night ¹	Achieved
R01	3759 Yarrie Lake Road	<30	40/35/35	✓
R02	3797 Yarrie Lake Road	<30	40/35/35	✓
R03	3799 Yarrie Lake Road	<30	40/35/35	✓
R04	3809 Yarrie Lake Road	<30	40/35/35	✓
R05	3833 Yarrie Lake Road	<30	40/35/35	✓
R06	3837 Yarrie Lake Road	<30	40/35/35	✓
R07	3841 Yarrie Lake Road	<30	40/35/35	✓
R08	3845 Yarrie Lake Road	<30	40/35/35	✓
R09	3906 Yarrie Lake Road	<30	40/35/35	✓
R10	3935 Yarrie Lake Road	<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 is from the Newell Highway at Narrabri via Mooloobar Street, Baranbar Street, Goobar Street onto Yarrie Lake Road. 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 $LA_{eq}(15hr)$	60dB $LA_{eq}(15hr)$	✓
Local Roads	15m	48dB $LA_{eq}(1hr)$	55dB $LA_{eq}(1hr)$	✓

Results demonstrate that project construction traffic noise levels would comply with the relevant RNP criteria.

Existing road traffic flows on the Kamilaroi 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.

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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 Wee Waa, NSW.

The results of the Noise Assessment demonstrate that construction noise levels have potential to exceed relevant construction NMLs at eight 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.

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Appendix A – Glossary of Terms

A number of technical terms have been used in this report and are explained in **Table A1**.

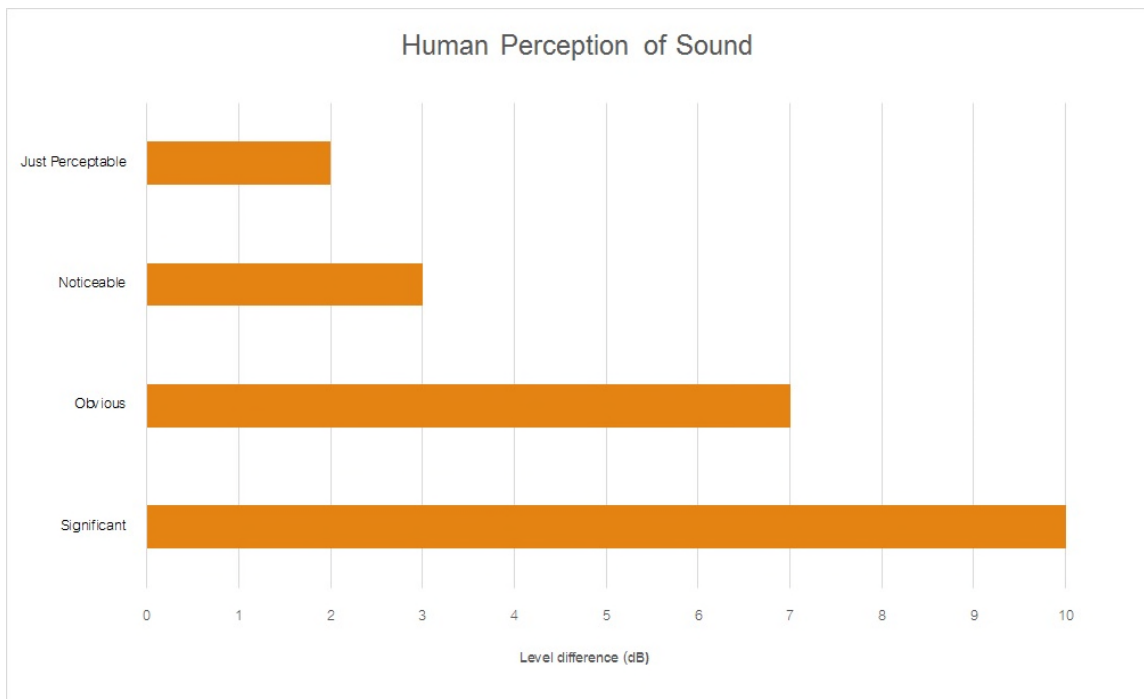
Table A1 Glossary of Acoustical Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI 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.
LAmx	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 $10 \cdot \log_{10} (W/W_0)$. 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

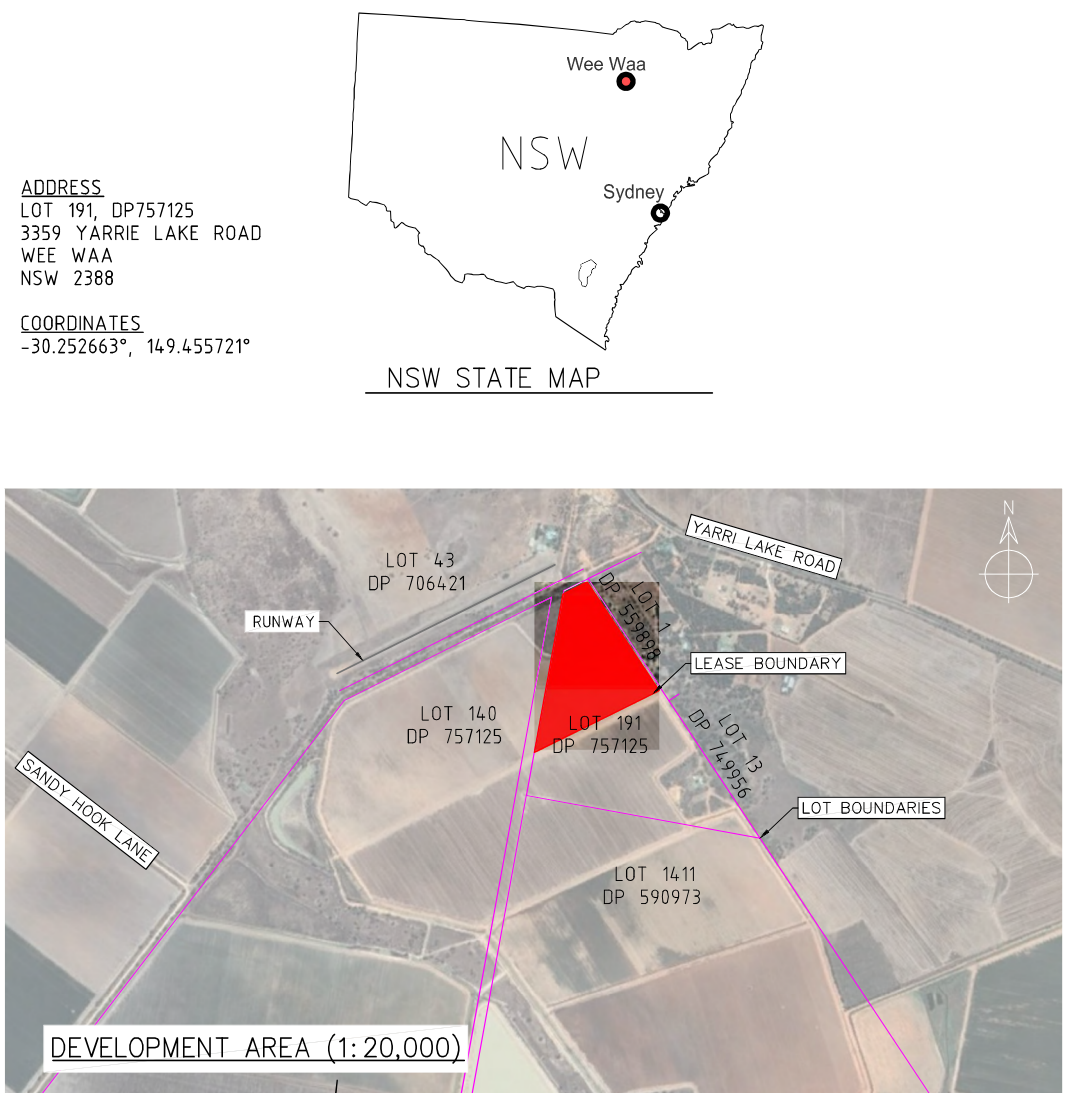
Source	Typical Sound Pressure Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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Appendix B – Project Layout



ADDRESS
LOT 191, DP757125
3359 YARRIE LAKE ROAD
WEE WAA
NSW 2388

COORDINATES
-30.252663°, 149.455721°



NSW STATE MAP

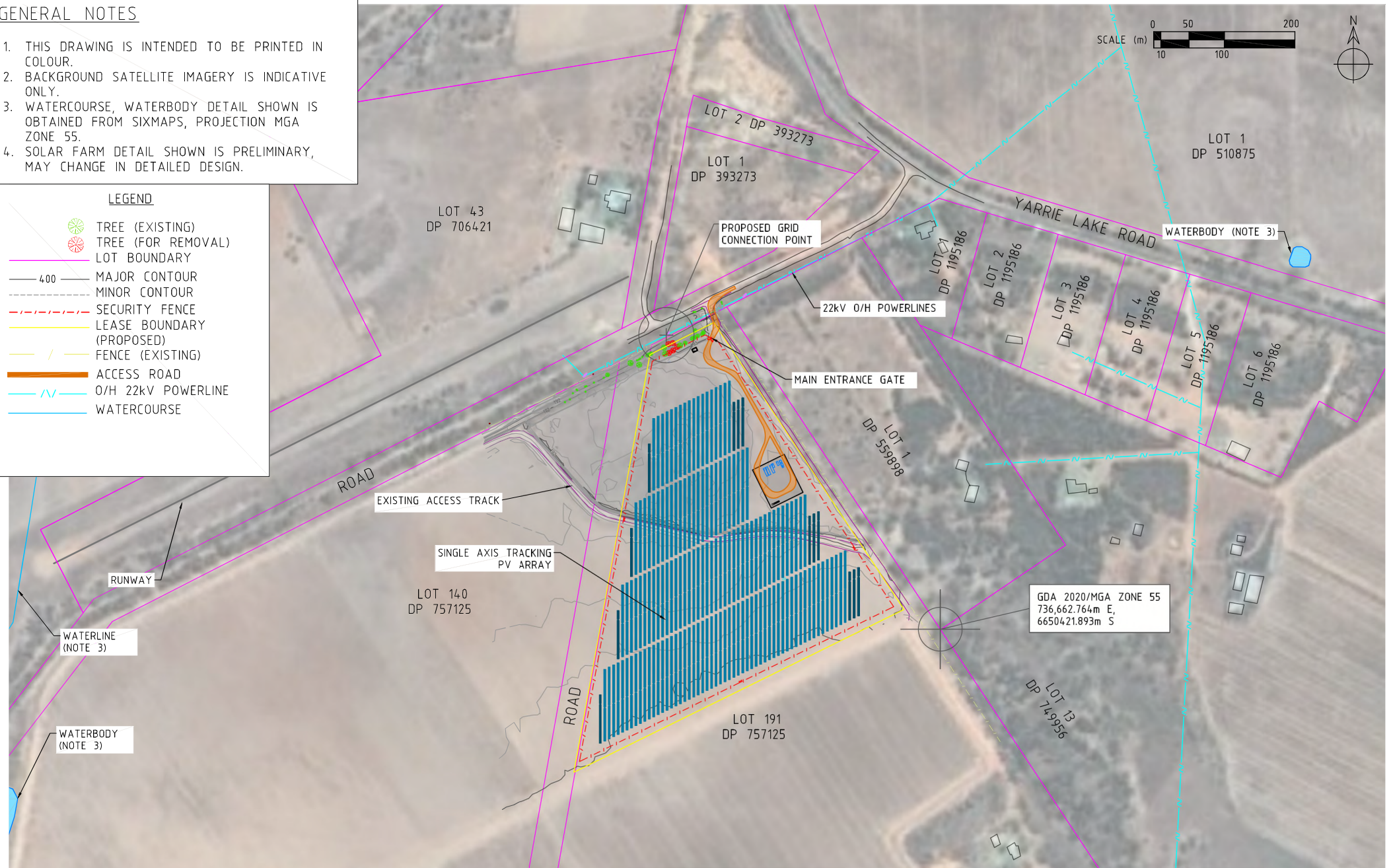
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										REVISION A
										PAPER SIZE A3
	REVISIONS									
	A	2021.01.21	FIRST ISSUE		JM	JM	SS	JM		
	REV.	DATE	DESCRIPTION		DRWN.	DESIGNED	CHKD.	APPR.	DWG No.	10090-G-GAD-01-1

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
 4.00 MAJOR CONTOUR
 MINOR CONTOUR
 SECURITY FENCE
 LEASE BOUNDARY (PROPOSED)
 FENCE (EXISTING)
 ACCESS ROAD
 O/H 22kV POWERLINE
 WATERCOURSE



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											REVISION A
											PAPER SIZE
											A3
	REVISIONS										
		A	2021.01.22	FIRST ISSUE		JM	JM	SS	JM		
		REV.	DATE	DESCRIPTION	DRWN.	DESIGNED	CHKD.	APPR.			

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
- WATERCOURSE

SYSTEM SUMMARY

ELECTRICAL CONFIGURATION:

TOTAL PV PLANT CAPACITY (DC): 6.789 Mwp
 TOTAL INVERTER CAPACITY (AC): 4.95MVA
 PV PLANT MAXIMUM EXPORT CAPACITY (AC): 4.95MW
 DC:AC RATIO: 1.371
 STRINGS OF 28 PV MODULES.
 424/425 PV STRINGS PER INVERTER.
 449 PV STRINGS TOTAL.

PV MODULES:

MFR: LONGI SOLAR
 MODEL: LR5-72HPH-540M
 NAMEPLATE: 540wp
 QUANTITY: 12,572 MODULES

INVERTERS:

MFR: SUNGROW
 MODEL: SG2475HV-MV
 NAMEPLATE: 2475kVA
 QUANTITY: 2

MV POWER STATION:

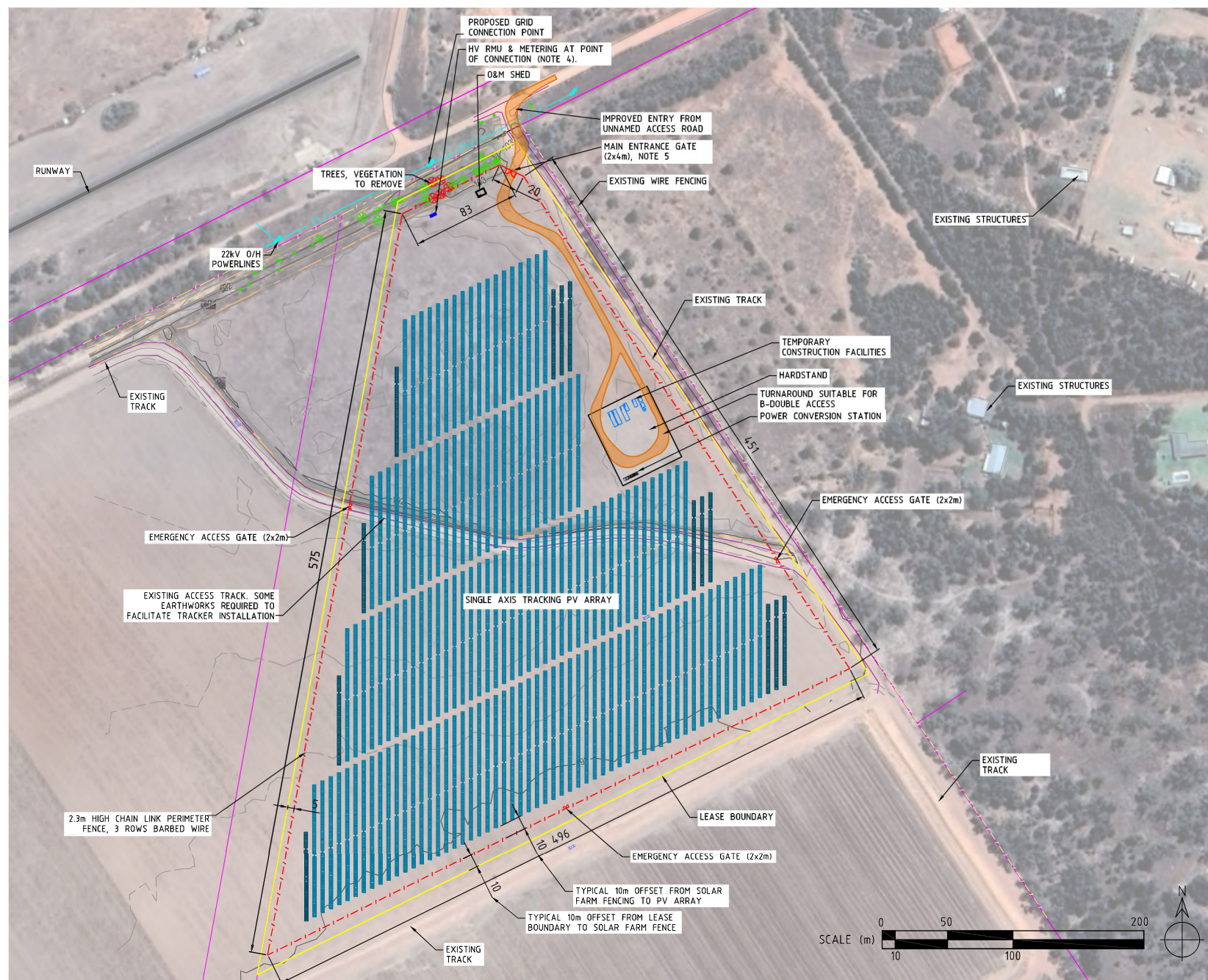
MFR: SUNGROW
 MODEL: SG4950HV-MV
 QUANTITY: 1

TRACKER ARRAY:

TYPE: GROUND MOUNT SINGLE AXIS TRACKING
 CONFIGURATION: INDEPENDENT TYPE
 RANGE OF MOTION: $\pm 60^\circ$
 PITCH: 6.30m
 GCR: 35.81%
 QUANTITY: 154 TABLES (13 SHORT, 141 FULL)
 FENCED AREA: 136,146 m²
 LEASE AREA: 149,989 m²

GENERAL NOTES:

- SITE ACCESS VIA UNNAMED ROAD CONNECTING TO YARRIE LAKE ROAD.
- DETAIL SHOWN IS PRELIMINARY, MAY CHANGE IN DETAILED DESIGN.
- CLEARANCE BETWEEN SOLAR TRACKER ARRAY & SITE SECURITY FENCE TYPICALLY 10m
- HV RMU & METERING (LOCATION AND TYPE TO BE DETERMINED, IS SUBJECT TO ESSENTIAL ENERGY FEEDBACK).
- FOR SECURITY GATE DETAILS REFER TO DRAWING 10090-C-DET-01-1.
- WATERCOURSE, WATERBODY DETAIL FROM SIXMAPS, MGA ZONE 55 PROJECTION.
- REFER TO CIVIL DETAIL DRAWING 10090-C-DET-01-1.



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DWG No.	10090-G-GAD-02-1	REVISION	A
		PAPER SIZE	A3

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P: +61 2 4920 1833
www.mulleracoustic.com



A wide-angle photograph of a rural landscape. The foreground is a dry, reddish-brown dirt road or field. The middle ground is a flat, open area with sparse green grass and some small shrubs. In the background, there is a line of trees under a blue sky with scattered white clouds.

TRAFFIC IMPACT ASSESSMENT

**SOLAR PHOTOVOLTAIC (PV) POWER GENERATING FARM
& ASSOCIATED SUPPORTIVE INFRASTRUCTURE**

**LOT 191 DP 757125
3843 YARRIE LAKE ROAD, WEE WAA**

PREPARED FOR: PROVIDENCE ASSET GROUP

JANUARY 2021

20/194

**TRAFFIC IMPACT ASSESSMENT
PROVIDENCE ASSET GROUP****SOLAR PHOTVOLTAIC (PV) POWER FARM**
LOT 191 DP757125
3843 YARRIE LAKE ROAD

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	30/12/20	Draft	JG
B	31/12/20	Edit	JG
C	29/01/21	Final Proof	JG
D	29/01/21	Approved	JG

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Date 29th January 2021**Disclaimer**

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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 191 DP 757125 – 3843 Yarrie Lake Road, Wee Waa.

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 the existing access road off Yarrie Lake Road approximately 3 km south-east of Wee Waa. 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 southern side of Yarrie Lake Road, Wee Waa approximately 1.4 km south of Culgoora Road and approximately 3 kilometres south-east of the Wee Waa town centre. The site currently contains vacant rural pasture used for agricultural purposes.

The property has the formal title of Lot 191 DP757125, 3843 Yarrie Lake Road, Wee Waa with road frontage access off an unnamed gravel access road off Yarrie Lake 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 via the existing gravel access to the site off Yarrie Lake Road approximately 1.4 km south of Culgoora Road. Deliveries to the site will use the identified delivery road shown on **Figure 1**, being via Yarrie Lake Road to Narrabri and then the Kamilaroi Highway from the south from Sydney and Newcastle or from the north from Brisbane. Yarrie Lake Road, whilst not being an approved B-Double route, is identified as an exception route and is currently used by road trains. It is therefore considered that Yarrie Lake Road is suitable to carry the proposed construction traffic for the development, including B-Double delivery vehicles, with large road trains already using Yarrie Lake Road. **Photograph 1** below shows the existing development site from the gravel access road off Yarrie Lake Road while **Photograph 2** shows the gravel access road intersection with Yarrie Lake Road.

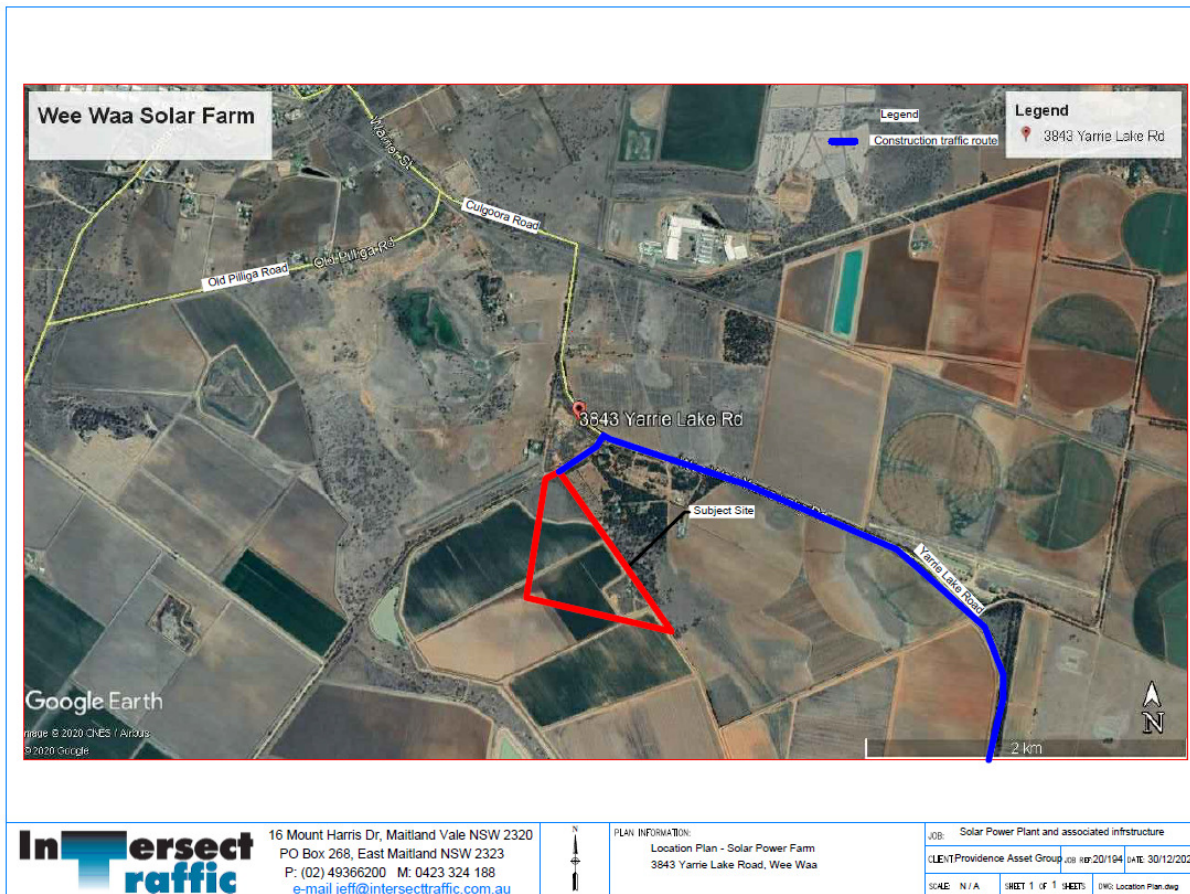


Figure 1 – Site Location



Photograph 1 – Development site from gravel access road



Photograph 2 – Gravel access road off Yarrie Lake Road.

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. Near Narrabri the speed zoning is 100 km/h and 60 km/h 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 Yarrie Lake Road / Mooloobar Street / Goobar Street

Yarrie Lake Road is a local sealed rural road with its primary function to collect and distribute traffic from the rural areas north-west of Narrabri to the arterial road network, as well as provide vehicular access to properties along its length. Yarrie Lake Road becomes Goobar Street and Mooloobar Street through Narrabri before connecting to Kamilaroi Highway via a single lane roundabout. As a local road this length of road it is under the care and control of Narrabri Shire Council and a 50 km/h speed zoning would apply to Mooloobar Street and Goobar Street while a 100 km/h speed zoning applies to Yarrie Lake Road. Whilst not a designated (approved) B-Double route, this route is listed as an exception route, being currently used by road trains and considered suitable for use by the construction vehicles required by the development.

Yarrie Lake Road has a minimum 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. It currently services a number of rural properties along its length and connects Narrabri to Wee Waa. At the time of inspection Yarrie Lake Road, Goobar Street and Mooloobar Street were all found to be in good condition as shown in **Photographs 4, 5 & 6** below. The Kamilaroi Highway / Mooloobar Street roundabout is shown in **Photograph 7**.



Photograph 4 – Yarrie Lake Road near site.



Photograph 5 – Goobar Street, Narrabri.



Photograph 6 – Mooloobar Street, Narrabri.



Photograph 7 – Kamilaroi Highway / Mooloobar Street roundabout.

4.0 ALTERNATIVE TRANSPORT MODES

Forest Coach Lines provide regular public transport (bus) services within Narrabri but does not extend its services to Wee Waa. Therefore it is concluded that the site is not serviced at all by public transport services. 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.

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 existing gravel access off Yarrie Lake 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 (vtp/h) 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 south-east towards 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 Northern Transport Planning and Engineering on behalf of Intersect Traffic with a traffic classifier count undertaken on Yarrie Lake Road approximately 100 metres south-east of the site access road from Thursday 26th November 2020 until Wednesday 2nd December 2020 a period of 1 week. Intersect Traffic also undertook manual traffic counts at the Kamilaroi Highway (Cooma Street) / Mooloobar Street roundabout during the likely peak AM and PM traffic periods (road network) i.e. 8 am – 9 am and 4.00 pm – 5.00 pm on Monday 1st December 2020 and Tuesday 2nd 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**. Note the traffic classifier count identified a heavy vehicle percentage of traffic of 5%.

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.

- Yarrie Lake Road south-east of site access - 30 vtph in the AM peak and 33 vtph in the PM peak.
- Kamilaroi Highway south-west of Mooloobar Street – 368 vtph in the AM peak and 336 vtph in the PM peak.
- Kamilaroi Highway north-east of Mooloobar Street – 548 vtph in the AM peak and 467 vtph in the PM peak; and
- Mooloobar Street north of Kamilaroi Highway – 199 vtph in the AM peak and 139 vtph in the PM peak.

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 level for Yarrie Lake Road is 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 for Yarrie Lake Road is 970 vtp. h.

Within Narrabri, the Kamilaroi Highway (Cooma Street) and Mooloolbar Street are urban roads for which Table 4.3 of *RTA’s Guide to Traffic Generating Developments*, reproduced as **Table 2** below, provides guidance on mid-block capacity for a level of service C. Noting the Kamilaroi Highway and Mooloolbar Street as two-way two-lane undivided roads, the one-way capacity of these streets is 900 vtp. h and the two-way mid-block capacity is 1,800 vtp. h.

Therefore the two-way mid-block road capacity thresholds adopted in this assessment are.

- Kamilaroi Highway and Mooloolbar Street – 1,800 vtp. h; and
- Yarrie Lake Road – 970 vtp. h.

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 and state road network has sufficient spare two-way mid-block capacity to cater for the construction and operation of the Solar Farm.

Table 2 – Urban Road mid-block capacity table (LoS C).**Table 4.3**
Typical mid-block capacities for urban roads with interrupted flow

Type of Road	One-Way Mid-block Lane Capacity (pcu/hr)	
Median or inner lane:	Divided Road	1,000
	Undivided Road	900
Outer or kerb lane:	With Adjacent Parking Lane	900
	Clearway Conditions	900
	Occasional Parked Cars	600
4 lane undivided:	Occasional Parked Cars	1,500
	Clearway Conditions	1,800
4 lane divided:	Clearway Conditions	1,900

Source: - RTA's Guide to Traffic Generating Developments (2002)

The addition of up to 18 vtpd 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 and state road network mid-block efficiency.

6.3 – Intersection Capacity

The main intersections impacted by the construction of the development is the Kamilaroi Highway (Cooma Street) / Mooloolbar Street roundabout and the Yarrie Lake Road / site access road stop sign controlled T-intersection. However traffic volumes at these intersections are generally below the thresholds sourced from Austroads *Guide to Traffic Management Part 6 – Intersections, Interchanges and Crossings (2010)*, reproduced below in **Table 3** 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 3 – 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 the Kamilaroi Highway (Cooma Street) being generally less than 500 vtpd and traffic flows on Mooloolbar Street being less than 200 vtpd, then it is concluded that the intersection is currently operating with uninterrupted flow conditions, confirmed by observation on site. The additional 18 vtpd 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 Kamilaroi Highway (Cooma Street) / Mooloolbar Street roundabout will continue to operate with uninterrupted flow conditions. Similarly, the Yarrie Lake Road operates with traffic flows less than 200 vtpd and as the site access road would operate with traffic flows less than 30 vtpd during the construction of the solar farm, the site access road would also continue to operate with uninterrupted flow conditions during construction. Therefore it is reasonable to conclude that the development does not adversely impact on the operation of these intersections 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 the unnamed laneway 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*. The current access conditions to the site were observed to be satisfactory in terms of width to accommodate the largest delivery vehicle whilst complying with the Australian Standards requirements.

Sight distance at the existing access off Yarrie Lake 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. Sight distance at the site access off the site access road was also observed to be in excess of 105 metres which would be compliant with Figure 3.2 of Australian Standard *AS2890.1-2004 Parking Facilities – Part 1 Off-street car parking* for a reduced speed environment of 80 km/h which is realistically the maximum speed likely on the site access road.

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 Yarrie Lake Road has a sealed pavement a minimum 7 metres wide and therefore complies with Austroads Standards for Rural Roads with more than 500 vtp/h. It would therefore allow two heavy vehicles to pass each other at normal speed. Similarly the site access road has an unsealed pavement width in excess of 7 metres wide which also allows 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.

Overall, it is considered the local and state 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 the responsibility

of the applicant to also provide sufficient on-site car parking for construction employees during the duration of the construction of the development for 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 this 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 as well as being 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 considered 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 Yarrie Lake Road and the site access road will be undertaken in a forward direction.

8.0 ALTERNATIVE 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 191 DP 757125 – 3843 Yarrie Lake Road, Wee Waa 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 vtpd during the operation of the Solar Farm.
- The existing peak traffic volumes on the local and state road network are well below the two-way mid-block capacity threshold of 1,800 vtpd for the urban sections of the Kamilaroi Highway (Cooma Street) and Mooloobar Street (LoS C) as well as the two-way mid-block rural road capacity (LoS) of 970 vtpd for Yarrie Lake Road. Traffic volumes will remain below these thresholds during the construction and operation of the development.
- The Kamilaroi Highway (Cooma Street) / Mooloobar Street roundabout and the Yarrie Lake Road / site access road stop sign controlled 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 these intersections resulting from the development.
- It is also reasonable to conclude the development will not adversely impact on the intersections on the wider state road network given the high levels of intersection control on the major intersections.
- 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.
- 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.

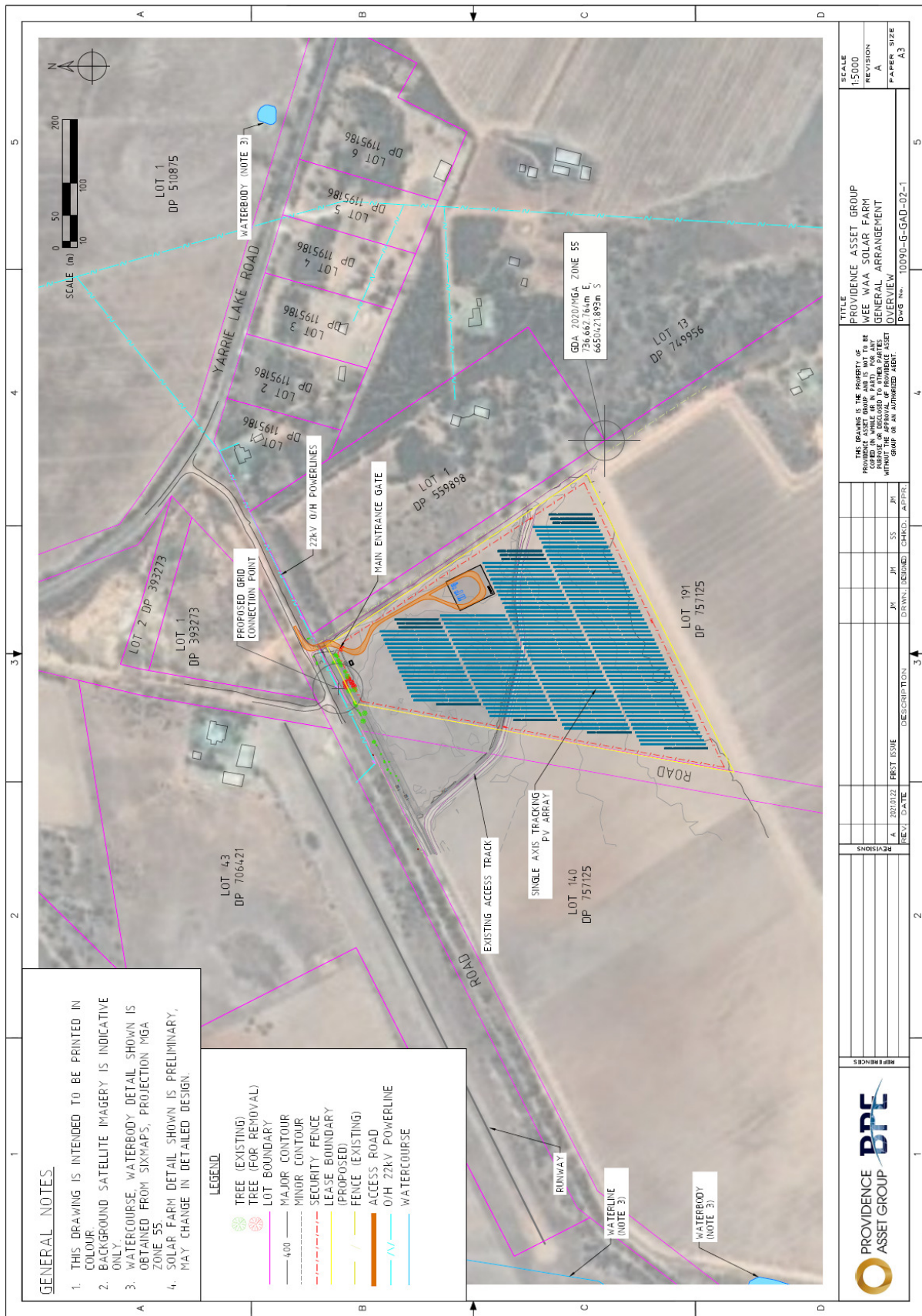
10.0 RECOMMENDATION

Having carried out this traffic and parking assessment for the proposed Solar Photovoltaic (PV) Power Farm (up to 5MW) on Lot 191 DP 757125 – 3843 Yarrie Lake Road, Wee Waa, it is recommended that the proposal can be supported from a traffic perspective as the development will not adversely impact on the local 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

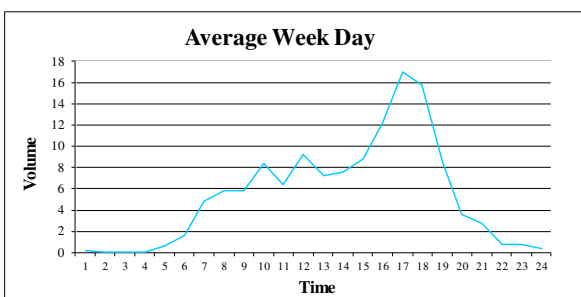


ATTACHMENT B

TRAFFIC COUNT DATA

Site 2 Yarrie Lake Rd 1.5km E of Culgoora Rd [80]
Eastbound

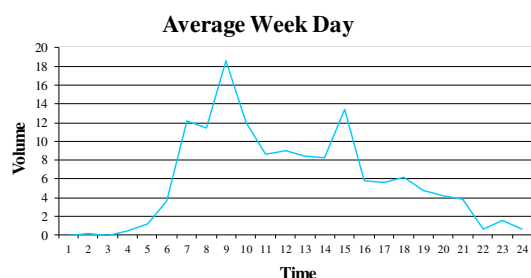
Day Time	Thu 26/11/2020	Fri 27/11/2020	Sat 28/11/2020	Sun 29/11/2020	Mon 30/11/2020	Tue 1/12/2020	Wed 2/12/2020	W/Day Ave.	W/End Ave.	7 Day Ave
0:00	0	0	2	1	0	0	1	0	2	1
1:00	0	0	0	0	0	0	0	0	0	0
2:00	0	0	0	0	0	0	0	0	0	0
3:00	0	0	0	0	0	0	0	0	0	0
4:00	1	1	0	1	0	1	0	1	1	1
5:00	1	1	2	0	2	3	1	2	1	1
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16:00	17	21	9	6	17	11	19	17	8	14
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18:00	6	7	7	9	8	10	12	9	8	8
19:00	3	5	1	0	3	7	0	4	1	3
20:00	4	2	4	3	2	2	4	3	4	3
21:00	0	3	1	5	0	1	0	1	3	1
22:00	0	1	0	0	1	0	2	1	0	1
23:00	1	0	1	0	0	0	1	0	1	0
Total	115	159	113	119	123	113	132	128	116	125



Summary			
	from	to	
AM Peak	9:00 AM	10:00 AM	16
PM Peak	4:00 PM	5:00 PM	21
Week Day Average			128
Weekend Day Average			116
7 Day Average			125

Site 2 Yarrie Lake Rd 1.5km E of Culgoora Rd [80]
Westbound

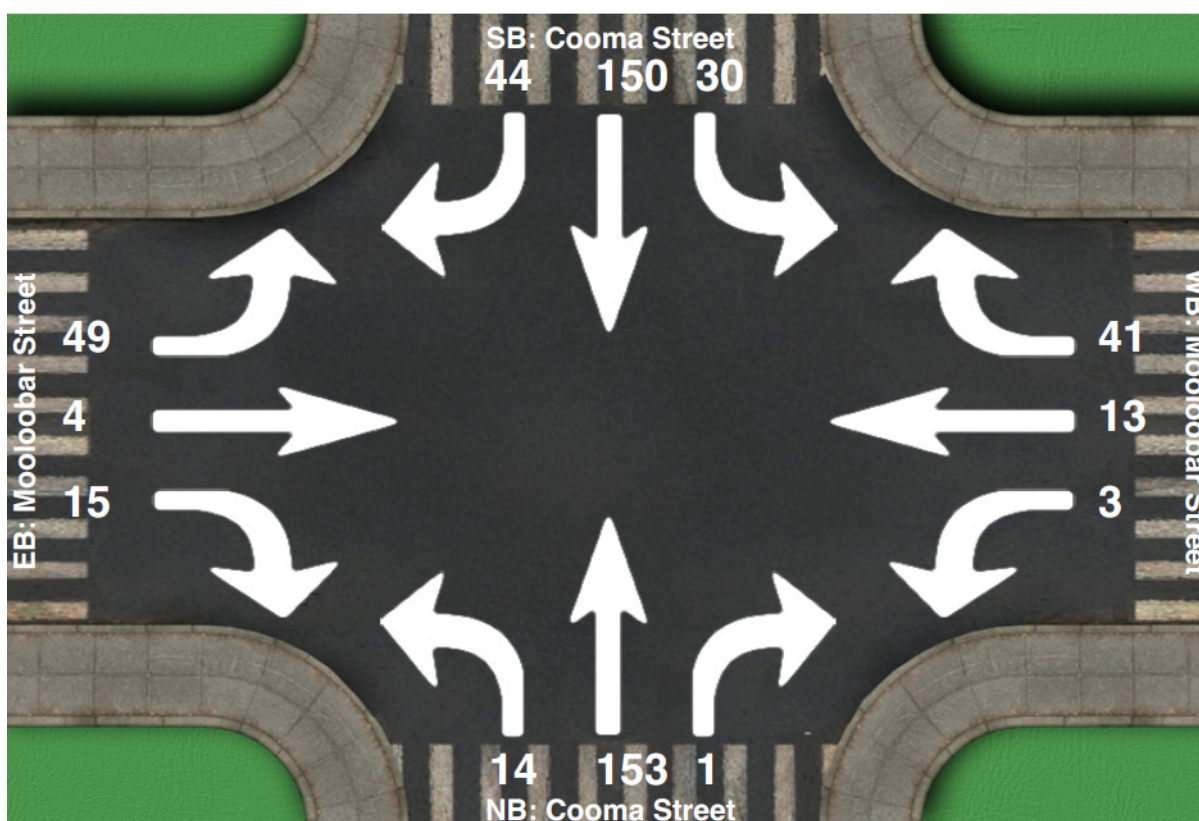
Day Time	Thu 26/11/2020	Fri 27/11/2020	Sat 28/11/2020	Sun 29/11/2020	Mon 30/11/2020	Tue 1/12/2020	Wed 2/12/2020	W/Day Ave.	W/End Ave.	7 Day Ave
0:00	0	0	2	0	0	0	0	0	1	0
1:00	0	1	0	0	0	0	0	0	0	0
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5:00	4	3	5	2	2	5	4	4	4	4
6:00	16	9	2	1	17	7	12	12	2	9
7:00	12	13	9	2	11	12	9	11	6	10
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21:00	1	1	2	2	1	0	0	1	2	1
22:00	2	2	0	1	2	2	0	2	1	1
23:00	0	0	0	0	0	2	1	1	0	0
Total	136	151	119	108	150	129	136	140	114	133


Summary

	from	to	
AM Peak	8:00 AM	9:00 AM	23
PM Peak	2:00 PM	3:00 PM	16
Week Day Average			140
Weekend Day Average			114
7 Day Average			133

Intersection Peak Hour

Location: Cooma Street at Mooloolbar Street, Narrabri
 GPS Coordinates:
 Date: 2020-12-02
 Day of week: Wednesday
 Weather:
 Analyst: Jeff



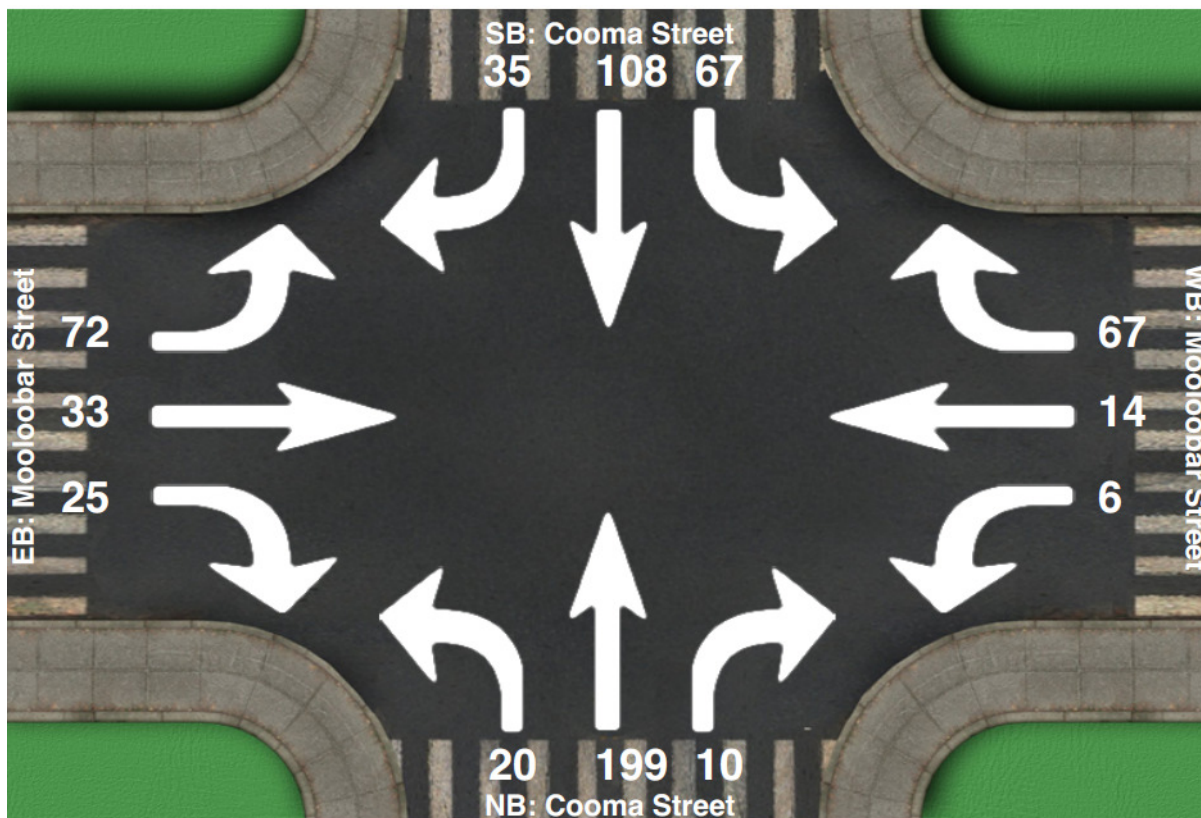
Intersection Peak Hour

16:00 - 17:00

	SouthBound			Westbound			Northbound			Eastbound			Total
	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	
Vehicle Total	30	150	44	3	13	41	14	153	1	49	4	15	517
Factor	0.68	0.91	0.73	0.25	0.65	0.64	0.70	0.89	0.25	0.72	0.33	0.75	0.91
Approach Factor	0.90			0.68			0.91			0.74			

Intersection Peak Hour

Location: Cooma Street at Mooloolobar Street, Narrabri
 GPS Coordinates: Lat=-30.344281, Lon=149.762128
 Date: 2020-12-03
 Day of week: Thursday
 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	67	108	35	6	14	67	20	199	10	72	33	25	656
Factor	0.49	0.77	0.67	0.50	0.39	0.42	0.50	0.87	0.42	0.82	0.49	0.69	0.73
Approach Factor	0.78			0.42			0.88			0.68			

ATTACHMENT C

TRAFFIC GENERATION INFORMATION

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.

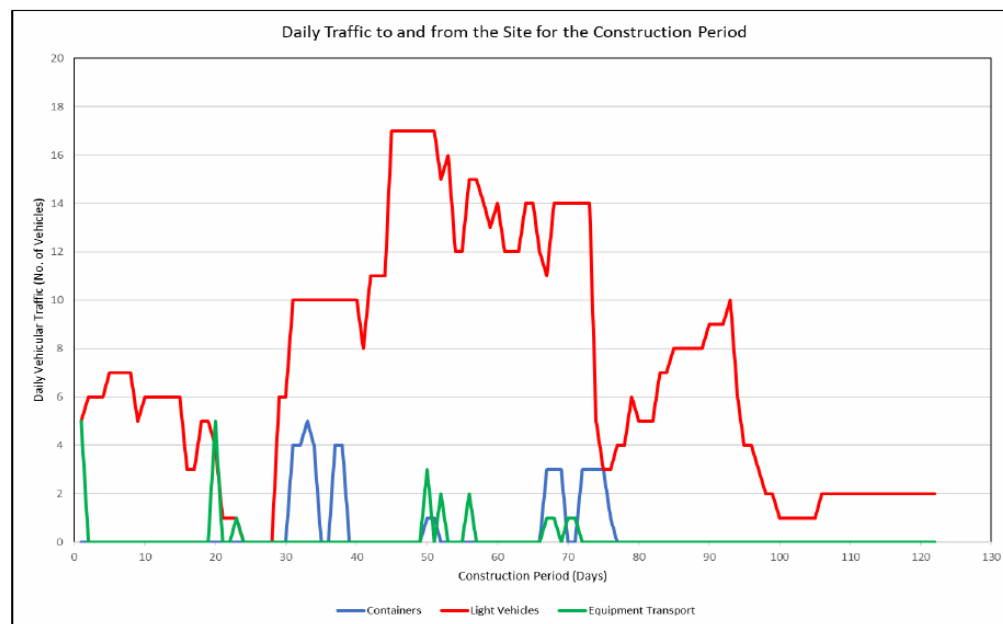


Figure 1 - Daily Traffic to and from Site for the Construction Period

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	

04 March 2021

Providence Asset Group
704 / 99 Bathurst Street
SYDNEY NSW 2000

Attention: Narrabri Shire

Waste Management Plan

Address: 3843 Yarrie Lake Road, Wee Waa NSW 2388

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 labourer's during the construction stage.

The site manager will erect a sign on site for waste areas and will inform the builder's 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	
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

TYPE OF WASTE GENERATED	ESTIMATED VOLUME PER WEEK	REUSE AND RECYCLING		DISPOSAL
		ON SITE	OFF SITE	
Green Waste	20L			Disposed of at local recycle plant by waste contractor on an as needs basis

Yours sincerely



RACHEL PETTITT
Project Consultant

Checked/
Authorised by: