Bonshaw Solar Farm

Environmental Impact Statement

18 October 2019

Project No.: 0470861

The business of sustainability

ERM

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CERTIFICATION

The submission of this Environmental Impact Statement has been made in accordance with Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979*.

Prepared by

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Applicant

GAIA Australia Pty Ltd

ABN: 67607860597

PO Box 1940 Macquarie Centre, NSW 2113

Description of Development

The Applicant, GAIA Australia Pty Ltd, is seeking to develop a large-scale solar farm facility and associated infrastructure with the capacity of 200 megawatts situated near the locality of Bonshaw. A detailed description of the proposed development of the Bonshaw Solar Farm is provided in Section 2 below.

Land to be developed

The legal property description of the land to be developed is:

Lot 2 of Deposited Plan 1039185

Certification

We hereby certify that the contents of this Environmental Impact Statement has been prepared in accordance with *Schedule 2* of the *Environmental Planning and Assessment Regulation 2000* and the Secretary's Environmental Assessment Requirements as issued for the Bonshaw Solar Farm on 16 August 2018. The information contained in this Environmental Impact Statement, to the best of our knowledge, is accurate and contains all information relevant to the environmental assessment of which the development relates to date. The material provided is neither false nor misleading.

Lachlan Giles	**Michael Rookwood**	**Dr David Dique**
18 October 2019	18 October 2019	18 October 2019

Signature page

18 October 2019

Bonshaw Solar Farm

Environmental Impact Statement

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Acronyms and Abbreviations

Name	Description
AHD	Australian Height Datum
ASC	Australia Soil Classification
ASS	Acid Sulphate Soils
BAR	Biodiversity Assessment Report
BC Act	Biodiversity Conservation Act 2016
BESS	Battery Energy Storage System / Battery Storage
BSAL	Biophysical Strategic Agricultural Land (BSAL)
CIV	Capital Investment Value
Council	Inverell Shire Council
DEE	Department of the Environment and Energy (Commonwealth)
Development Footprint	Portion of the Project Site subject to disturbance during construction and / or operations of the Project.
DP&E	Department of Planning and Environment (former), now DPI&E from 1 July 2019
DPI&E	Department of Planning, Industry and Environment
DPI	Department of Primary Industries
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EMF	Electromagnetic Fields
EP&A Act	Environmental Planning and Assessment Act 1979
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
EPA	Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPL	Environmental Protection Licence
ERM	Environmental Resources Management Pty Ltd
ESS	Energy Storage System
FTE	full time equivalent
GAIA	GAIA Australia Pty Ltd
GHG	Greenhouse Gas
ha	hectare
Heritage Act	Heritage Act 1977
km	kilometres
kV	kilovolt
LEP	Local Environmental Plan

Name	Description
LGA	Local Government Area
Li-ion	Lithium-ion
LSC	Land and Soil Capability
m	metre
MNES	Matters of National Environmental Significance, under the EPBC Act (c.f.)
NPW Act	National Parks and Wildlife Act 1974
MW	megawatt
MWh	Megawatt hours
NEM	National Electricity Market
NSW	New South Wales
OEH	Office of Environment and Heritage
PHA	Preliminary Hazard Analysis
POEO Act	Protection of the Environment Operations Act 1997
Project	Bonshaw Solar Farm
Project Site	Lot 2 DP 1039185 within which the Project is proposed
PV	Photovoltaic
SEARs	Secretary’s Environmental Assessment Requirements
SEED	Sharing and Enabling Environmental Data
SEPP	State Environmental Planning Policy
ISEPP	State Environmental Planning Policy (Infrastructure) 2007 (NSW)
SRD SEPP	State Environmental Planning Policy (State and Regional Development) 2011 (NSW)
SSD	State Significant Development
TWh	Terawatt hours (equivalent of 1,000,000MWh)
VIA	Visual Impact Assessment
WM Act	Water Management Act 2000

EXECUTIVE SUMMARY

This Environmental Impact Statement (EIS) has been prepared for GAIA Australia Pty Ltd (GAIA) to assess the environmental matters relating to the proposed development of the Bonshaw Solar Farm (the 'Project') at Bonshaw, within the Inverell Local Government Area in New South Wales (NSW).

The Project site comprises Lot 2 of Deposited Plan (DP)1039185, covering approximately 353 hectares (ha) ('Project Site'), of which the proposed development area occupies approximately 167 ha ('Development Footprint'). The Project is located approximately 66 km north of Inverell, with site access fronting Bruxner Highway.

The Project requires approval under Part 4 of the *Environmental Planning and Assessment Act 1979* as it meets the criteria of a State Significant Development (SSD) under clause 20, Schedule 1 of *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP).

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by GAIA to coordinate the technical assessments and prepare this EIS to support the SSD application. This EIS has been prepared in accordance with the EIS preparation requirements as outlined in Schedule 2 of the Environmental Planning and Assessment Regulation 2000 and with due regard to the Department Planning and Environment's (DPE) *NSW Large Scale Solar Energy Guideline for State Significant Development* (December 2018) (now Department of Planning, Industry and Environment (DPI&E)).

E.1 Project Description

The proposed development seeks approval to develop a large-scale solar photovoltaic (PV) generation facility with a capacity of 200 megawatts (MW) and associated infrastructure, including a Lithium-ion Energy Storage System (ESS/Li-ion).

The Project incorporates arrays of PV modules (solar panels), transmission infrastructure and switch yard to enable connection into the existing electricity transmission network via the existing 330 kilovolt (kV) Dumaresq Substation neighbouring the Project Site. The Project will have a targeted 'sent out' electricity generating capacity of up to 200 megawatts (MW) (AC) and a BESS/battery storage with up to 300 MW (AC).

The Proponent has entered long-term lease agreements with the landholders for the construction and operation of the Project. Following completion of construction, the agricultural use of the site will return, with livestock (sheep) grazing continuing during the operational stage of the Project. The solar farm is expected to operate for approximately 30 years.

E.2 Project Justification

The Project will support the Commonwealth and NSW Governments in achieving their respective renewable energy and greenhouse gas emission reduction targets. The aim of the Commonwealth Government's Renewable Energy Target (RET) is to create a market for renewable energy to deliver around 23.5% of electricity from renewable sources by 2020, including the target of providing 33 terawatt hours (TWh) through large-scale renewables by 2020. Likewise, the NSW Renewable Energy Action Plan (REAP) supports the RET, by outlining 24 actions under 3 goals that detail the NSW Government's commitment to work closely with NSW communities and the renewable energy industry to increase renewable energy production in NSW to reach 20% of all energy generated by 2020.

According to the Clean Energy Australia Report 2019 (Clean Energy Council, 2019), in 2018 in NSW, the state generated 69,085 gigawatt hours (GWh) of energy, with the total renewable energy generation comprising 10,355 GWh, or 15.0%.

The Project would generate 420 GWh of electricity contributed to the NEM per annum. The Project will assist the Commonwealth and NSW Governments in reaching the reduction targets of the RET and REAP respectively.

E.3 Consultation

Community and stakeholder engagement is an integral part of any major development. GAIA is committed to effective and genuine engagement with key stakeholders and the local community to seek feedback to help inform the Project design and layout.

Following a stakeholder mapping exercise to identify key stakeholders (community and regulatory), a range of engagement tools were deployed to engage with and seek input from the various stakeholders, including:

- Face-to-Face Meetings;
- Letter Box Drop;
- Letters to relevant stakeholders;
- Website;
- Advertisement; and
- Email and Phone calls.

Applicable feedback and issues raised by stakeholders have been considered in the refinement of the Development Footprint and size of the Project. Should the Project be approved, consultation and engagement with the local community will occur throughout the construction and operational phases of the Project

E.4 Environmental Assessment

A detailed assessment of the likely environmental impacts of the development has been undertaken, including supporting specialist assessments where required. The assessment involved a review of the existing environmental context, an assessment of the likely impacts, and development of measures to minimise and mitigate adverse impacts where possible.

The outcomes of the environmental assessment are summarised below:

Biodiversity

A Biodiversity Development Assessment Report was prepared for the Project (refer to Appendix C) which involved biodiversity surveys being undertaken during three periods (spring, summer and autumn). The results of the assessment have informed the Project design, in order to avoid and minimise the potential impact on biodiversity values. The mitigation hierarchy approach “avoid-minimize-offset” was followed to reduce, as far as practicable, potential impacts on the biodiversity values identified within the Project.

The Project will result in the following direct impacts to biodiversity values:

- Clearing 47.52 ha of mapped native vegetation;
- Clearing 46.09 ha of heavily disturbed grassland with vegetation integrity score >17;
- Clearing 72.49 ha of heavily disturbed grassland with vegetation integrity score <17; and
- Loss of five paddock trees and 34 hollow-bearing trees;

Direct impacts to native vegetation and fauna habitat requiring offsets include:

- Impacts on PCT 516 – Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion, requiring 89 ecosystem credits;
- Impacts on PCT 594 – Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion ad Nandewar Bioregion, requiring 837 ecosystems credits;
- Impacts on PCT 596 – Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion, requiring 244 ecosystem credits;
- Loss of five Paddock Trees, requiring 5 ecosystem credits;

- Impacts on Bristle-faced Free-tailed Bat habitat, requiring 1,578 species credits; and
- Impacts on Eastern Cave Bat foraging habitat, requiring 2,365 species credits.

Overall, the development area is considered of moderate biodiversity value with impacts related to direct clearance of native vegetation and fauna habitat. The residual impact of the Project will require 1,191 ecosystem credits and 3,943 species credits to be offset.

Heritage

A Cultural Heritage Assessment was prepared for the Project (refer to Appendix D), which involved field surveys, desktop assessment and consultation. The assessment identified the potential impacts of the Project on Aboriginal and historical cultural heritage. Direct impact to some sites is considered unavoidable.

Of the 35 Aboriginal heritage sites (and three associated Potential Archaeological Deposits (PADs)) that have been recorded within the Project Site, 29 of these sites were stone artefacts including isolated finds and stone artefact scatters. Seven scarred trees were also identified, one of the scarred trees was identified as part of an artefact scatter site. Careful detailed design of the Project footprint has successfully avoided nine of these sites, including BSF1 and BSF14, which are considered to have moderate archaeological significance.

Two surface scatters of historical items were identified during field surveys. These sites are not considered to reach the threshold for local historic heritage significance.

Recommendations have been developed for the Project to assist with the ongoing management of identified heritage sites, including the commitment for the relocation and salvaging of any and all Aboriginal artefacts where impacts cannot be avoided.

Land

An assessment of the existing agricultural land use, soils, contamination, landform and geology has been undertaken for the Project. The assessment identified the following observations:

- with the implementation of management strategies, conflicts are unlikely to arise with the existing adjacent land uses (refer to Appendix E);
- the Development Footprint encompasses 58.3ha of mapped Biophysical Strategic Agricultural Land (BSAL). The use of the BSAL mapped area will have limited impacts as the current use of the land for grazing can continue concurrently with the operation of the solar farm;
- The soil profile of the Project Site does not exhibit a significant constraint that cannot be managed through considered design and construction technique or operation management measure/potential amelioration;
- No existing contamination within the Project Site; and
- There are no mineral, coal or petroleum titles located within the Project Site.

Mitigation measures have been developed, and are to be implemented to manage land use, soils and contamination during construction and operation.

Visual

The Visual and Glare Assessment has identified that other than for a location immediately north of the site on the Bruxner Highway, all visual impacts are low to none (refer to Appendix F).

The visual impact from the Bruxner Highway is deemed as medium to low impact, however given the short frontage and period of time the facility is seen, the low traffic volumes along this route and the setback from the road means that the overall impacts from this locality are localised and therefore low. The provision of a five metre landscape strip along the northern boundary and a 400 m portion of the north western boundary will also reduce visual impacts from the Bruxner Highway.

An assessment of potential glare impacts found that no glare impacts are predicted and therefore no mitigation measures are required for glare.

Noise

An assessment of noise impacts was completed to identify potentially sensitive receptors situated in the vicinity and identify significant noise generating equipment and/or activities (refer to Appendix G). Noise levels were predicted (and compared to criteria) to establish compliance, evaluate potential impacts and establish potential mitigation measures where necessary to reduce levels and minimise impacts.

The assessment has identified that construction noise levels have the potential to exceed the applicable criteria, limits and thresholds. Therefore, mitigation measures and provisions for monitoring were established for the proposed construction of the Project.

Based on the findings of the operational noise assessment, noise levels for existing and proposed operations are compliant and are anticipated impacts to all receptors are negligible. As such, no recommendations for noise mitigation, management measures or monitoring options are warranted, however suitable safeguards and provisions have been provided.

Transport

The Traffic Impact Assessment identified construction traffic can safely and efficiently access the site with minimal impact for existing road users (refer to Appendix H). There is considerable spare capacity to cater for the additional traffic movements associated with construction stage of the Project. Post construction, the operational traffic demands are very low with few people working on site, and occasional heavy vehicle movements associated with facility maintenance.

Prior to commencing the construction of the works on site, a new access point will be constructed on the Bruxner Highway to cater for the heavy vehicles accessing the Project Site.

All vehicle access to the Project site will be direct off the Bruxner Highway with a new access point to be constructed to facilitate site access. The majority of deliveries are expected to be shipped to either the Port of Brisbane or Port of Newcastle, and transported to site via the New England Highway. A review of the access route shows that the layout of the intersection of the Bruxner Highway and the New England Highway does not safely cater for the right turn out movement. The sight distance for this right run is restricted and the width of the New England Highway in this location does not allow for a run off area for vehicles. It is proposed that as part of the construction traffic management plan, southbound empty trucks leaving the site shall turn left onto the Bruxner Highway then proceed south via Bonshaw-Inverell Road to Inverell then along the Gwydir Highway to connect to the New England Highway via Glen Innes.

A Traffic Control Plan will be in place during construction work to ensure safety for road users and construction workers is managed in an appropriate manner.

Water

An assessment of impacts to water was completed to identify the potential for the Project to impact upon surface water, groundwater resources, related infrastructure, adjacent licensed water users and basic landholder rights, and to develop mitigation measures where necessary.

The Project is located directly south of Dumaresq River. The Project Site drains to ephemeral watercourses onsite, a number of unnamed tributaries of the Dumaresq River. These tributaries flow from their source from the south to the north through the Project Site. The combined catchment area of the unnamed tributaries upstream of the Project Site is approximately 1,245 ha.

The Project and upslope catchment areas are predominantly rural land use. Existing infrastructure downstream of the Project Site includes three culvert crossings at the Bruxner Highway. Additionally, the existing 330 kV Transgrid Dumaresq Substation is located on the Project boundary with the substation access road running along the western boundary of the Project Site.

The Project would not impact on the quality or quantity of water available at the Project Site. Therefore, the Project will not impact adjacent licensed water users or basic landholder rights during construction or operation.

The Development Footprint has considered the potential impacts to existing water resources. The Project has been refined to the greatest extent practicable including the provision of a 40m buffer from infrastructure to the top of creek banks, and minimised the number of waterway crossings required.

Access to groundwater resources will not be required for the Project, as the relatively minor water demands required during the construction and operation stages will be satisfied by water trucked in. Foundation and other earthworks for the installation of project infrastructure and associated accesses are relatively shallow and will not intersect groundwater.

A Flood Impact Assessment (refer to Appendix I) was undertaken to ascertain the potential impacts of the Project on flood flows and behaviours. The flood assessment considers the associated catchment areas that the Project intersects with and the potential impacts on flooding flows and behaviours of these watercourses as well as flood levels and flood extent of the Dumaresq River. The use of flood modelling has indicated that the proposed development, including construction of accesses across the ephemeral watercourses onsite, will not significantly increase peak flows or peak flood levels either upstream or downstream of the Project Site including at Dumaresq River.

Hazards & Risks

Hazardous Materials

A screening assessment has been undertaken for the Project in accordance with the requirements of SEPP 33 (refer to Appendix J), which considers the risk to people, property and the environment at the Project location. It has been recognised that the Project is to include small quantities of hazardous materials, which do not trigger the SEPP33 threshold.

With consideration of the insignificant quantity of materials stored on site, along with the significant distance to neighbouring properties, it can be concluded that the risks associated with storage and transportation of hazardous materials are unlikely to be significant or pose a risk to public safety.

Potentially offensive impacts have been previously assessed as minimal, and are to be managed as specified within the relevant technical reports.

Bushfire

A Bushfire Hazard Assessment has been completed for the Project (refer to Appendix K). The greatest hazard is a combination of undesirable fire weather (i.e. hot and dry winds and low humidity during summer) and the potential for a fire to spread towards farm assets in the surrounding area. Under the most extreme weather, a fire could spread between and under solar panels even in the heavily grazed grass and embers may breach any fire break. Therefore, the Asset Protection Zones recommended may only be reliable up to Very High fire danger.

Construction and ongoing maintenance of the solar farm will be a potential source of ignitions, with a greater risk within the declared fire danger period (typically from August to March). The bushfire hazard associated with the construction activities is considered manageable and would be minimised through the implementation of fire and bushfire mitigation measures, including the preparation of an Emergency Response Plan. Any bushfire risk associated with decommissioning of the Project would be similar the construction phase and would be subject to the same management and mitigation measures.

An Asset Protection Zone of 10 m will be maintained around all buildings at the site including the solar farm substation, inverters, control building and external perimeter of the PV arrays throughout the operational phase of the Project.

The perimeter road will be 6m wide (located within the 10m wide perimeter APZ), with internal access tracks a minimum of 4 m wide allowing adequate access for emergency vehicles including fire trucks.

Electromagnetic Fields

A desktop assessment of the potential hazards and risks associated with electro and magnetic fields (EMFs) in relation to the Project has been undertaken. The desktop assessment considered that impacts are minor and temporary in nature.

Construction of the Project includes installation of infrastructure that will be involved in the generation, transmission and distribution of electricity, and consequently EMFs will be produced by the Project. The EMFs produced by the Project will be strongest closest to their respective sources.

Staff involved in the construction and decommissioning stages of the Project will be exposed to EMFs during works on the connection infrastructure. Staff exposure levels will be below the recommendations for general public and occupational exposure through the construction and decommissioning of the connection infrastructure.

Once operational, the Project infrastructure will be capable of generating EMFs. The degree of exposure to EMFs within the site boundary will vary depending on proximity to different components of the Project infrastructure. Staff exposure during operation will be intermittent and limited to exposure encountered during ongoing maintenance of the site and project infrastructure. The combination of low exposure rates and the intermittent exposure of staff to elements of the Project infrastructure, capable of generating EMFs, indicate that adverse impacts from EMFs are unlikely.

The Project substation will be located within the Development Footprint, close to the site’s western boundary. This location is right next to the existing Dumaresq switching station and any EMF will be significantly less than those emitted from the switching station, which has a higher current carrying capacity than the Project substation.

Public exposure to EMFs is reduced by locating the Project substation with a 1.4km offset from Bruxner Highway and by restricting access to the site throughout the life of the Project through security fencing.

Socio-Economic

The socio-economic assessment provides a clear examination of key demographic, economic and infrastructure aspects of the surrounding area to assist in determining potential impacts associated with the Project.

It has been determined that the Project is likely to have a long-term positive impact for the region through local employment and economic benefits, as a result of increased demand for local goods and services throughout the Inverell LGA and western portions of the neighbouring Tenterfield LGA. These benefits will include demand for local contracting and manufacturing services utilised during construction such as earthworks, cabling and civil works. The influx of workers during the construction stage will generate large economic gain for local businesses and industries, particularly the increased demand for accommodation, hospitality and retail services.

The provision of a suitable Community Benefit Fund will offer a long-term benefit of the local community to offset the adverse impacts caused through the Projects lifespan, and will be appropriately determined through discussions with Council.

There is a broader socioeconomic and environmental advantage of the Project through further development of renewable energy sources, utilising the abundant solar resources available in NSW and transitioning to a more diverse energy generation.

Waste

A waste assessment has been prepared to provide guidance on the classification and removal of wastes generated as a result of the construction and operation of the Project.

Best practice for waste management is to implement the resource management hierarchy principles, in accordance with the *Waste Avoidance and Resource Recovery Act 2001* and the principles of ecologically sustainable development:

- Avoidance of unnecessary resource consumption;
- Resource recovery (including reuse, reprocessing, recycling and energy recovery); and
- Disposal.

Detailed quantities of each waste stream will not be available until the detailed design stage of the Project has been completed. A Waste Management Plan (WMP) will be prepared and implemented, outlining the proposed management methods for each waste classification type and relevant quantities.

E.5 Management Measures

The anticipated environmental impacts of the Project have been assessed, and various mitigations measures developed to manage adverse ecological, social and economic impacts where possible. The Project would be constructed and operated in accordance with, among other requirements, the mitigation measures provided in Chapter 7 of this Environmental Impact Statement.

E.6 Conclusion

The Project involves the operation of a 200MW solar PV electricity generation facility, which would generate 420 GWh of electricity contributing to the National Electricity Market (NEM) per annum. The Project will assist the Commonwealth and NSW Government in reaching the reduction targets of the RET and REAP respectively, through an increase in renewable energy supply and reduction in carbon emissions.

The Project offers significant NSW investment, with a Capital Investment Value (CIV) of $237,680,000 and offering employment of up to 190 full time equivalent (FTE) persons during construction, and up to 10 FTE persons during operations.

The Project has been strategically identified in a region of NSW that experiences one of the highest daily average solar exposures in the State. The utility of the land is further enhanced by the opportunity for the Site to continue with its current land use during operation. In agreement with the landholder, dual occupancy of the land will allow solar energy product to occur alongside livestock grazing beneath the solar panels.

Through the Project scoping and preliminary investigation, as well as during further detailed technical investigations, extensive consideration has been made to site selection and refinement, in order to avoid and minimise environmental, social and economic impacts where possible. Relevant environmental constraints and stakeholder consultation has fed into this assessment. This has ensured that a Project Site and Development Footprint have been selected that gave due consideration to and minimisation of environmental impacts whilst achieving a feasible and efficient Project concept design. This process has actively identified and minimised environmental impacts for the Project development.

Environmental management and mitigation measures, including requirements to prepare and issue specific management plans, have been identified to reduce and manage potential environmental impacts arising from the Project. With the implementation of proposed mitigation measures, the impacts of the Project can be appropriately managed. Accordingly, the potential environmental impacts of the Solar Farm have been assessed as minor.

The proposal of the Bonshaw Solar Farm represents a positive and sustainable planning outcome for the Site.

1. INTRODUCTION

1.1 Project Overview

GAIA Australia Pty Ltd (GAIA) is seeking approval to develop a large-scale solar photovoltaic (PV) generation facility with a capacity of 200 megawatts (MW) and associated infrastructure, including a Lithium-ion Energy Storage System (ESS/Li-ion). The development is situated near the locality of Bonshaw in New South Wales (NSW), referred to as the Bonshaw Solar Farm (the 'Project'). The Project is located approximately 16 kilometres (km) south of Bonshaw and 66 km north of Inverell and is wholly contained within the Inverell Local Government Area (LGA) (refer Figure 1-1*)*.

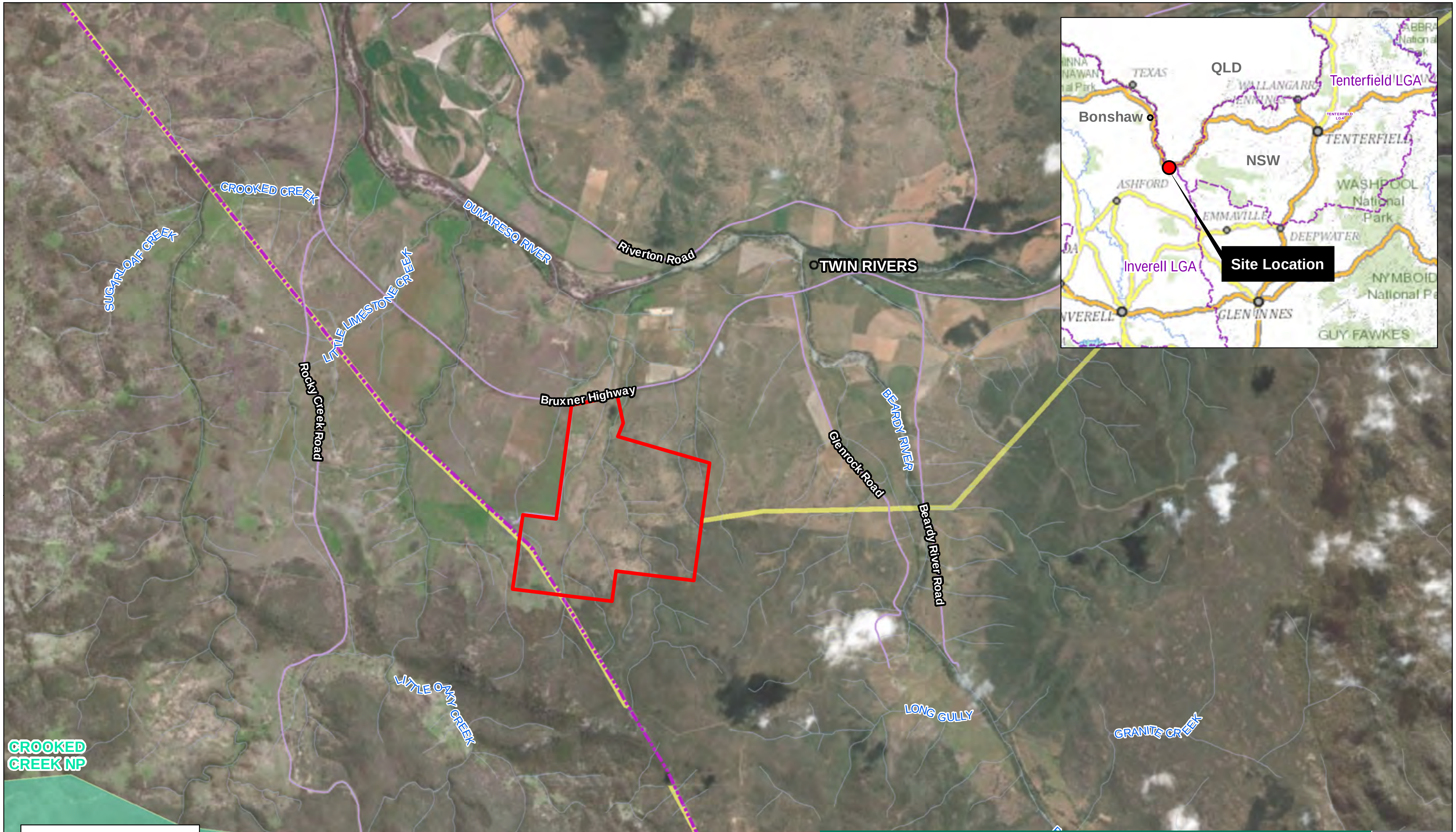
The Project incorporates arrays of PV modules (commonly referred to as "solar panels"), transmission infrastructure and switch yard to enable connection into the existing electricity transmission network via the 330 kilovolt (kV) Dumaresq Substation. The Project will have a targeted 'sent out' electricity generating capacity of up to 200 megawatts (MW) (AC) and a battery energy storage system (BESS or 'battery storage') with up to 300 MW (AC) . The exact method and point of connection is being developed in conjunction with TransGrid in parallel with this planning application and the detailed infrastructure layout developed during detailed design will confirm the generating capacity of the Bonshaw Solar Farm.

The key elements of the Project include the construction and operation of:

- a network of PV modules in a fixed tilt or single axis tracking arrangement;
- associated battery energy storage system (BESS) / battery storage;
- a switch yard to be connected to the 330 kV TransGrid Dumaresq Substation, on the boundary of the Project Site;
- underground or overhead cabling for connection between arrays and inverters and transformers;
- operations and maintenance (O&M) infrastructure, including O&M buildings incorporating a control room, meeting facilities, a temperature controlled spare parts storage facility, supervisory control and data acquisition (SCADA) facilities, a workshop and associated infrastructure (e.g. kitchen, toilets and other facilities), and car parking facilities;
- Access point to the site via the Bruxner Highway;
- a new internal road network to enable access from surrounding local roads to the array areas during construction and operations including internal access tracks, creek crossing & perimeter security fencing; and
- Temporary facilities during construction.

The Project Site covers approximately 353 hectares (ha), of which the proposed development area occupies approximately 167ha. The Project Site and broader region is predominately agricultural grazing land. An existing TransGrid-owned 330 kV transmission line runs through the Project Site.

The Project's Capital Investment Value (CIV) has been confirmed by Hanna Newman Associates Pty Ltd (independent quantity surveyor), to be $237,680,000 (refer to Appendix B). During construction, the Project will employ up to 190 full time equivalent (FTE) persons, with up to 10 FTE employees during operations.



Legend

- 🟥 Project Area
- ─ Waterway
- ┅ Electricity Transmission Line
- 🟨 Easement
- 🟩 National Park

Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Inset : NSW DFSI Base Map

Site Locality and Regional Context Map

F 1.1

Drawing No: 0470861m_BSF_EIS_G001_R4.mxd		Bonshaw Solar Farm, NSW
Date: 05/09/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: AA	Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

This figure may be based on third party data or data which has not been verified by ERM and it may not be specific to be used. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

1.2 The Proponent

GAIA Australia Pty Ltd (GAIA) was established in 2015 to take the lead in renewable energy developments in Australia with a clear target and vision to become an active large scale solar farm developer in NSW. GAIA is partnered with GAIA Korea, a renowned infrastructure developer in Korea with a focus on renewable energy development sector in Australia.

GAIA is committed to working closely with all stakeholders to ensure success for the Project and providing environmental and economic benefit to Australia. GAIA as a company is committed to the principles of social responsibility and will apply these principles through the whole process of development from planning to operation.

Proponent details are provided in Table 1-1.

Table 1-1 Bonshaw Solar Project – Proponent Details

Proponent Name	GAIA Australia Pty Ltd
Postal Address	PO Box 1940 Macquarie Centre NSW 2113
ABN	67607860597
Nominated Contact	Luke Kim
Contact Details	Web page: http://www.gaiaau.com Email: Luke.Kim@gaiaau.com

1.3 State Significant Development Application

1.3.1 Overview

The Project requires approval under Part 4 of the *Environmental Planning and Assessment Act 1979* as it meets the criteria of a State Significant Development (SSD) under clause 20, Schedule 1 of *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP).

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by GAIA to coordinate the technical assessments and prepare this Environmental Impact Statement (EIS) to support the SSD application. This EIS has been prepared in accordance with the EIS preparation requirements as outlined in Schedule 2 of the Environmental Planning and Assessment Regulation 2000 and with due regard to the Department Planning and Environment's (DPE) *NSW Large Scale Solar Energy Guideline for State Significant Development* (December 2018) (now Department of Planning, Industry and Environment (DPI&E)).

1.3.2 Environmental Assessment Team

The environmental assessment team consists of ERM's in-house technical experts and sub-consultants. Table 1-2 provides a summary of the environmental assessment team and their contributions to the EIS and supporting specialist assessments:

Table 1-2 Environmental Assessment Team

Company	Technical Component	Appendix Reference
ERM	Biodiversity Assessment	Appendix C
	Aboriginal and Historic Heritage Assessment	Appendix D
	Land Use Conflict and Risk Assessment	Appendix E
	Visual and Glare Assessment	Appendix F
	Noise and Vibration Impact Assessment	Appendix G

Company	Technical Component	Appendix Reference
	SEPP 33 Screening Assessment Bushfire Risk Assessment	Appendix J Appendix K
SECA Solution	Traffic Impact Assessment	Appendix H
Engeny Water Management	Flooding Assessment	Appendix I

1.3.3 Structure and Content of the EIS

The EIS has been prepared to ensure that the Project is described adequately, addresses the SEARs, assesses the potential environmental impacts, and identifies proposed mitigation measures. The overall structure of the EIS is outlined in Table 1-3.

Table 1-3 Structure of the EIS

Chapter No.	EIS Chapter	Description
1	Introduction	Provides an overview of the Proposed project and introduces the Proponent, project history and alternatives.
2	Project Description	Provides a detailed description of the proposed development including the key components for both the construction and operational phases of the Project.
3	Project Justification	Details how the Project supports the shift towards renewable energy options, including the commitment at National and State levels to reduce greenhouse gas emissions. The Project also provides greater energy security, and supports the continued development of the solar power industry for the generation and supply of electricity.
4	Strategic and Statutory Context	Provides a strategic justification of the proposed development focusing on site selection and the suitability of the proposed site. Describes the SSD Planning Approval Process and relevant Commonwealth, State and local legislative framework in relation to the Project.
5	Community and Stakeholder Engagement	Summarises the consultation activities undertaken with key stakeholders (including landowners, local community, government agencies and authorities.).
6	Environmental Impact Assessment	Describes the methodology, existing environment and assessment associated with the potential and actual environmental risks and impacts of the Project, and mitigation and management measures proposed to minimise these risks and impacts.
7	Mitigation Measures	Provides an overview of the environmental management framework for the Project, including a summary of the mitigation measures and commitments made throughout the EIS for implementation during construction, operation and decommissioning of the Project.
8	Evaluation and Conclusion	Presents the conclusions of the EIS.
	References	Consolidates all material references contained within the EIS.

1.3.4 Secretary's Environmental Assessment Requirements (SEARs)

SEARs were issued by DP&E on 16 August 2018 and form the basis of the environmental impact assessment for the Project (refer to Appendix A).

Table 1-4 provides a summary of the SEARs and includes a reference to where each requirement has been addressed in the EIS and corresponding technical assessments.

Table 1-4 SEARs (SSD 9438)

Requirement	Location within EIS
General Requirements	
The Environmental Impact Statement (EIS) for the development must comply with the requirements in Schedule 2 of the Environmental Planning and Assessment Regulation 2000.	
In particular, the EIS must include: ■ a standalone Executive Summary;	Executive Summary
■ a full description of the development including: - details of construction, operation and decommissioning - a site plan showing all infrastructure and facilities (including any infrastructure that would be required for the development, but the subject of a separate approvals process); - a detailed constraints map identifying the key environmental and other land use constraints that have informed the final design of the development;	- Chapter 2 - Figure 2-1 - Figure 2-1
■ a strategic justification of the development focusing on site selection and the suitability of the proposed site with respect to potential land use conflicts with existing and future surrounding land uses (including other proposed or approved solar farms, rural residential development and subdivision potential);	Section 4.1
■ an assessment of the likely impacts of the development on the environment, focusing on the specific issues identified below, including: - a description of the existing environment likely to be affected by the development; - an assessment of the likely impacts of all stages of the development, (which is commensurate with the level of impact), including any cumulative impacts of the site and existing or proposed developments, taking into consideration any relevant legislation, environmental planning instruments, guidelines, policies, plans and industry codes of practice; a description of the measures that would be implemented to avoid, mitigate and/or offset the impacts of the development (including draft management plans for specific issues as identified below); and - a description of the measures that would be implemented to avoid, mitigate and/or offset the impacts of the development (including draft management plans for specific issues as identified below); and - a description of the measures that would be implemented to monitor and report on the environmental performance of the development;	Chapter 6 & Chapter 7

Requirement	Location within EIS
■ a consolidated summary of all the proposed environmental management and monitoring measures, identifying all the commitments in the EIS;	Chapter 7
■ the reasons why the development should be approved having regard to: - relevant matters for consideration under the *Environmental Planning and Assessment Act 1979*, including the objects of the Act and how the principles of ecologically sustainable development have been incorporated in the design, construction and ongoing operations of the development; - the suitability of the site with respect to potential land use conflicts with existing and future surrounding land uses; and - feasible alternatives to the development (and its key components),including the consequences of not carrying out the development.	- Section 4.2.2 - Appendix E - Section 3.3
■ a detailed consideration of the capability of the Project to contribute to the security and reliability of the National Electricity Market, having regard to local system conditions and the Department's guidance on the matter.	Section 3.1
The EIS must also be accompanied by a report from a suitably qualified person providing: ■ a detailed calculation of the capital investment value (CIV) (as defined in clause 3 of the Regulation) of the proposal, including details of all assumptions and components from which the CIV calculation is derived; and	Section 1.1 and Appendix B
■ certification that the information provided is accurate at the date of preparation.	Certification
The development application must be accompanied by the consent in writing of the owner/s of the land (as required in clause 49(1)(b) of the Regulation).	Submitted to DPI&E
Specific Issues	
The EIS must address the following specific issues:	
Biodiversity – including: ■ an assessment of the biodiversity values and the likely biodiversity impacts of the Project in accordance with Section 7.9 of the Biodiversity Conservation Act 2016 (NSW), the Biodiversity Assessment Method (BAM) and documented in a Biodiversity Development Assessment Report (BDAR), unless OEH and DPE determine that the proposed development is not likely to have any significant impacts on biodiversity values; ■ the BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the BAM; and ■ an assessment of the likely impacts on listed aquatic threatened species, populations or ecological communities, scheduled under the Fisheries Management Act 1994, and a description of the measures to minimise and rehabilitate impacts.	Section 6.1 and Appendix C

Requirement	Location within EIS
Heritage – including an assessment of the likely Aboriginal and historic heritage (cultural and archaeological) impacts of the development, including consultation with the local Aboriginal community in accordance with the Aboriginal Cultural Heritage Consultation Requirements for Proponents	Section 6.2 and Appendix D
Land – including: ■ an assessment of the potential impacts of the development on existing land uses on the site and adjacent land, including: - a consideration of agricultural land, flood prone land, Crown lands (including Crown Reserve 91645), mining, mineral or petroleum rights; - a soil survey to determine the soil characteristics and consider the potential for erosion to occur; and - a cumulative impact assessment of nearby developments ■ an assessment of the compatibility of the development with existing land uses, during construction, operation and after decommissioning, including: - consideration of the zoning provisions applying to the land, including subdivision; - completion of a Land Use Conflict Risk Assessment in accordance with the Department of Industry’s *Land Use Conflict Risk Assessment Guide*; and - a description of measures that would be implemented to remediate the land following decommissioning in accordance with *State Environmental Planning Policy No 55 - Remediation of Land*.	Section 6.3 and Appendix E
Visual – including an assessment of the likely visual impacts of the development (including any glare, reflectivity and night lighting) on surrounding residences, scenic or significant vistas, air traffic and road corridors in the public domain, including a draft landscaping plan for on-site perimeter planting, with evidence it has been developed in consultation with affected landowners	Section 6.4 and Appendix F
Noise – including an assessment of the construction noise impacts of the development in accordance with the *Interim Construction Noise Guideline* (ICNG), and cumulative noise impacts (considering other developments in the area), and a draft noise management plan if the assessment shows construction noise is likely to exceed applicable criteria	Section 6.5 and Appendix G
Transport – including: ■ an assessment of the peak and average traffic generation, including over-dimensional vehicles and construction worker transportation; ■ an assessment of the likely transport impacts to the site access route (including Bruxner Highway, Glenrock Road and Rocky Creek Road), site access point, rail safety issues, any Crown land, particularly in relation to the capacity and condition of the roads; ■ a cumulative impact assessment of traffic from nearby developments (including cumulative impacts from Sundown Solar Farm, Sapphire Solar Farm and White Rock Solar Farm); ■ a description of any proposed road upgrades developed in consultation with the relevant road and rail authorities (if required); and	Section 6.7 and Appendix H

Requirement	Location within EIS
■ a description of the measures that would be implemented to mitigate any transport impacts during construction	
Water – including: ■ an assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources (including Beady River, Little Oaky Creek, Little Limestone Creek and Dumaresq River, drainage channels, wetlands, riparian land, farm dams, groundwater dependent ecosystems and acid sulfate soils), related infrastructure, adjacent licensed water users and basic landholder rights, and measures proposed to monitor, reduce and mitigate these impacts; ■ details of water requirements and supply arrangements for construction and operation; and ■ a description of the erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with *Managing Urban Stormwater: Soils & Construction* (Landcom 2004)	Section 6.8 and Appendix I
Hazards and Risks – including: ■ a preliminary risk screening in accordance with *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development* and *Applying SEPP 33* (DoP, 2011), and if the preliminary risk screening indicates the development is “potentially hazardous”, a Preliminary Hazard Analysis (PHA) must be prepared in accordance with *Hazard Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis* (DoP, 2011) and *Multi-Level Risk Assessment* (DoP, 2011); and ■ an assessment of all potential hazards and risks including but not limited to bushfires, spontaneous ignition, electromagnetic fields or the proposed grid connection infrastructure	Section 6.9, Appendix J and Appendix K
Socio-Economic – including an assessment of the likely impacts on the local community and a consideration of the construction workforce accommodation.	Section 6.10
Consultation	
During the preparation of the EIS, you should consult with relevant local, State or Commonwealth Government authorities, infrastructure and service providers, community groups, affected landowners, exploration licence holders, quarry operators and mineral title holders. In particular, you must undertake detailed consultation with affected landowners surrounding the development and Inverell Shire Council. The EIS must describe the consultation process and the issues raised, and identify where the design of the development has been amended in response to these issues. Where amendments have not been made to address an issue, a short explanation should be provided.	Chapter 5

2. PROJECT DESCRIPTION

This Chapter of the EIS provides a full description of the development, including details of construction, operation and decommissioning, and an indicative concept layout.

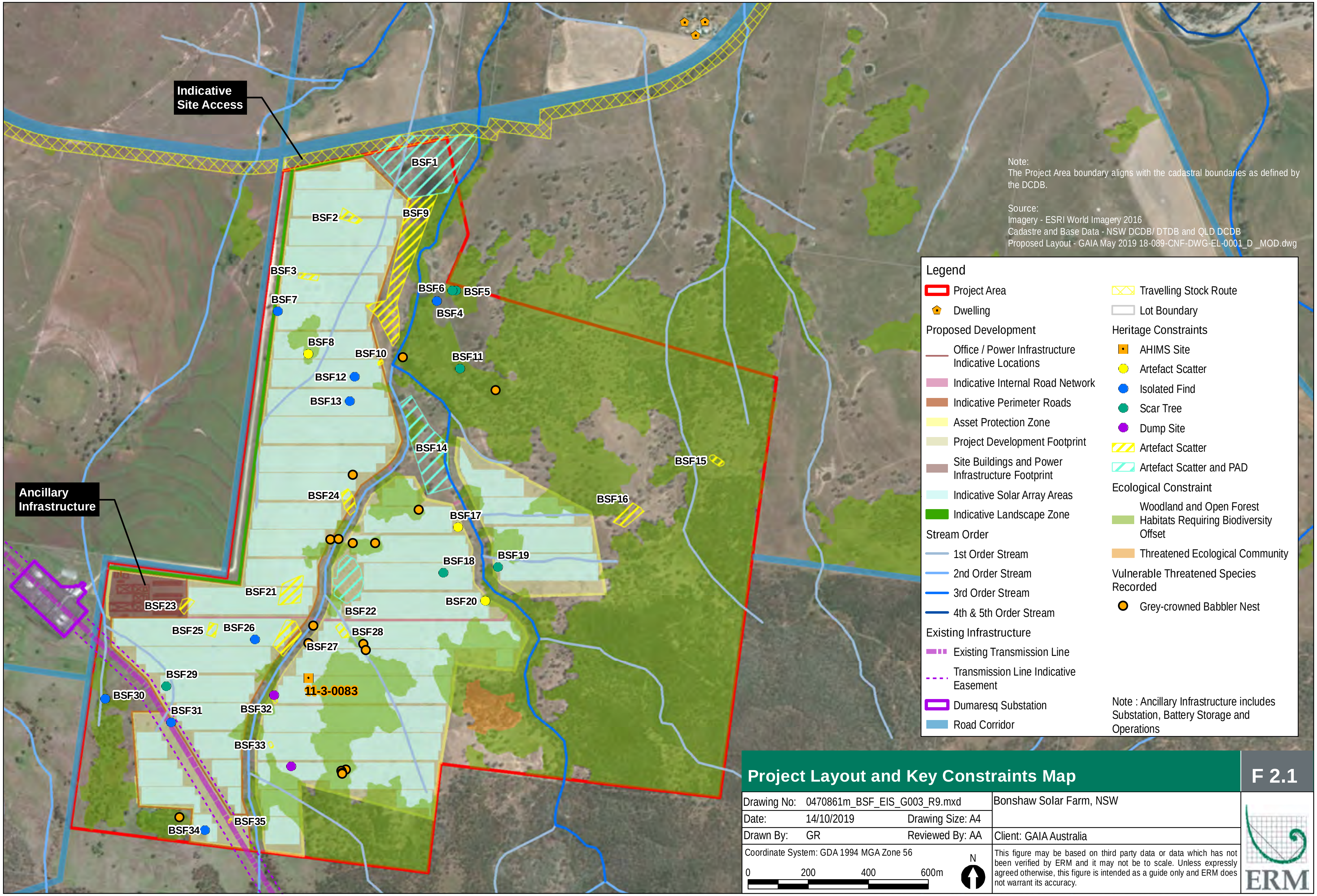
2.1 Overview

The Project includes the construction and operation of a 200MW solar PV electricity generation facility. Key elements of the Project are detailed in Table 2-1. The Development Footprint and indicative concept layout is detailed in Figure 2-1.

Table 2-1 Project and Site Description

Project / Site Element	Description
Main physical, construction and operational elements	■ Solar Photovoltaic (PV) modules using solar panels and either a fixed or tracking arrangement across three solar array areas. ■ Estimated 630,000 PV solar panels and 4,800 string inverters ■ BESS/battery storage with up to 300 MW (AC). ■ Switching station. ■ Underground / overhead electrical reticulation and fibre optic cabling connecting the arrays to the switching station and the Project to Dumaresq Substation. ■ Access point to the site via the Bruxner Highway. ■ An internal private road network (up to a combined total length of approximately 13.7 km) connecting the arrays and other proposed infrastructure to the public road network. ■ Operations and maintenance buildings with associated car parking. ■ Creek crossings. ■ Vegetation clearing. ■ Security fencing.
Location and extent	■ Lot 2 DP 1039185. ■ Above ground connection to Dumaresq Substation located on Lot 210 on DP 879480.
Construction phasing and workforce	■ Temporary facilities during construction. ■ Estimated 190 FTE.
Project Site	■ Area of allotment 353 ha.
Development Footprint	■ Development Footprint of approximately 167 ha.
Panel set up	■ fixed tilt or single axis tracking arrangement across three solar array areas.
General Infrastructure	■ control room. ■ meeting facilities. ■ temperature controlled spare parts storage facility. ■ supervisory control and data acquisition (SCADA) facilities. ■ Workshop. ■ associated infrastructure (e.g. kitchen, toilets and other facilities). ■ car park.

Project / Site Element	Description
Operational Workforce	■ Estimated 10 FTE.
Project Lifecycle	■ Project lifecycle of approximately 30 years.
Site Description	■ The Project Site and broader region is predominately agricultural grazing land. An existing TransGrid-owned 132 kV transmission line runs through the Project Site. ■ The Site consists of open space, and creek and bush areas. Aerial imagery suggests that a significant proportion of the land across the Project Site has previously been cleared with portions historically being used for agriculture purposes. ■ Existing access to the Dumaresq substation from the Bruxner Highway runs along the western boundary of the Project Site. The Dumaresq substation is located immediately adjacent to the western property boundary on Lot 210 on DP879480. ■ The Site fronts the Bruxner Highway and has ready access to the regional road network via the New England Highway to the east.
Land Zoning and land use	■ The land within the Project Site is zoned RU1 Primary Production under the Inverell LEP (Figure 4-2). ■ Surrounding allotments are also zoned RU1 Primary Production. ■ The Project Site has been modified by historical land use practices and past disturbances associated with land clearing, cropping and intensive livestock grazing. The Project Site is currently primarily used for sheep grazing, together with some cattle grazing.
Grid Connection	■ GAIA, in consultation with Transgrid, have proposed connection to the energy grid through overhead transmission line from the solar farm’s ancillary infrastructure to the Dumaresq Substation. No additional land consent is required. The grid connection will be obtained separately, in accordance with Part 5 – Infrastructure and Environmental Impact Assessment of the EP&A Act 1979.



Note:
The Project Area boundary aligns with the cadastral boundaries as defined by the DCDB.

Source:
Imagery - ESRI World Imagery 2016
Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg

Legend

- 🟥 Project Area
- ⌂ Dwelling

Proposed Development
- ― Office / Power Infrastructure Indicative Locations
- ▬ Indicative Internal Road Network
- ▬ Indicative Perimeter Roads
- ▬ Asset Protection Zone
- ▬ Project Development Footprint
- ▬ Site Buildings and Power Infrastructure Footprint
- ▬ Indicative Solar Array Areas
- 🟩 Indicative Landscape Zone

Stream Order
- ― 1st Order Stream
- ― 2nd Order Stream
- ― 3rd Order Stream
- ― 4th & 5th Order Stream

Existing Infrastructure
- ▬ Existing Transmission Line
- ┄ Transmission Line Indicative Easement
- ▭ Dumaresq Substation
- ▬ Road Corridor

- ▨ Travelling Stock Route
- ▭ Lot Boundary

Heritage Constraints
- ▣ AHIMS Site
- ● Artefact Scatter
- ● Isolated Find
- ● Scar Tree
- ● Dump Site
- ▨ Artefact Scatter
- ▨ Artefact Scatter and PAD

Ecological Constraint
- ▬ Woodland and Open Forest Habitats Requiring Biodiversity Offset
- ▬ Threatened Ecological Community

Vulnerable Threatened Species Recorded
- ○ Grey-crowned Babbler Nest

Note : Ancillary Infrastructure includes Substation, Battery Storage and Operations

Project Layout and Key Constraints Map

F 2.1

Drawing No: 0470861m_BSF_EIS_G003_R9.mxd		Bonshaw Solar Farm, NSW
Date: 14/10/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: AA	Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

0 200 400 600m

N

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

2.2 Infrastructure Design and Layout

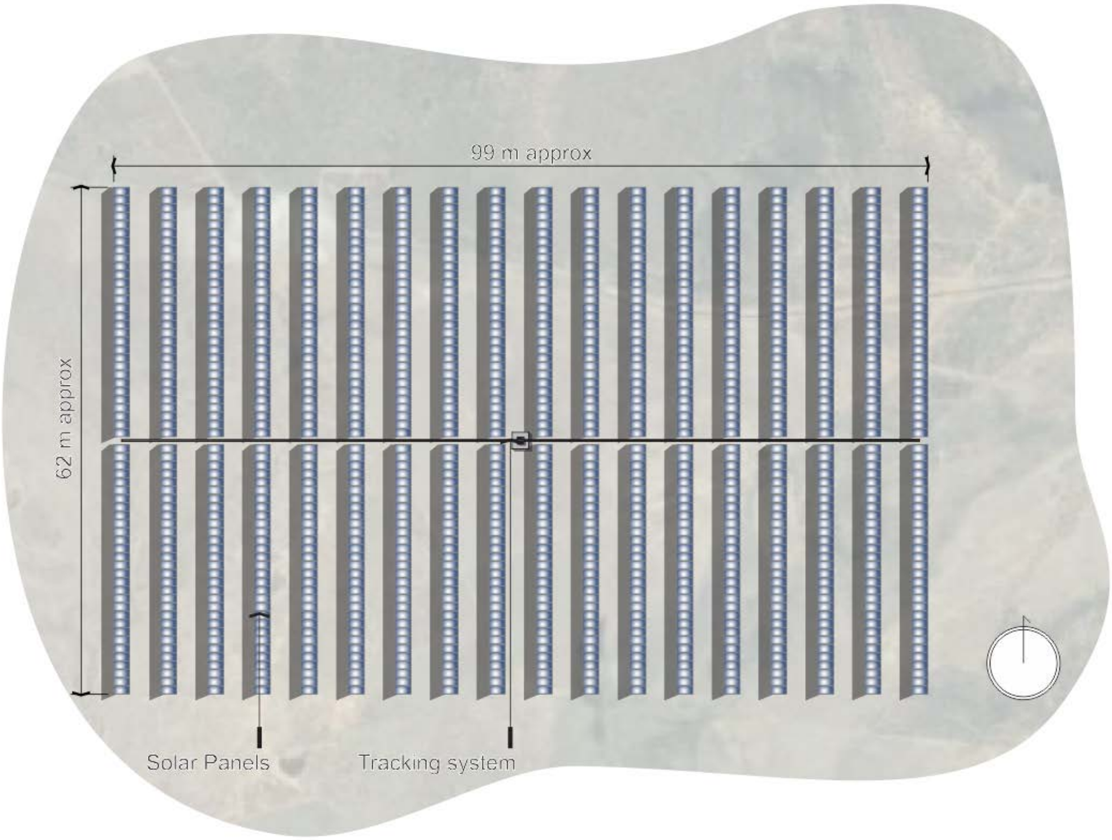
The concept layout for the Project is detailed in Figure 2-1 above.

2.2.1 Solar Panel Layout

The PV array will be the largest component of the Project. The Project proposes PV modules using solar panels and either a fixed or tracking arrangement across three solar array areas. The Project is estimated to include 630,000 PV panels and 4,800 string inverters. However, the final number of PV modules within the three array areas will be dependent on detailed design, availability and commercial considerations at the time of construction.

The final configuration of the PV layout will be subject to final choice of technology and design. The Project will be similar to that described within this section. For the purposes of this report, the assessment has been based on a typical block design approximately 100 m long by 62.0 m wide with rows spaced approximately 5.0 m apart. These dimensions may alter based on site constraints such as boundaries, riparian zone, existing vegetation and access tracks. Figure 2-2 shows the indicative layout and arrangement.

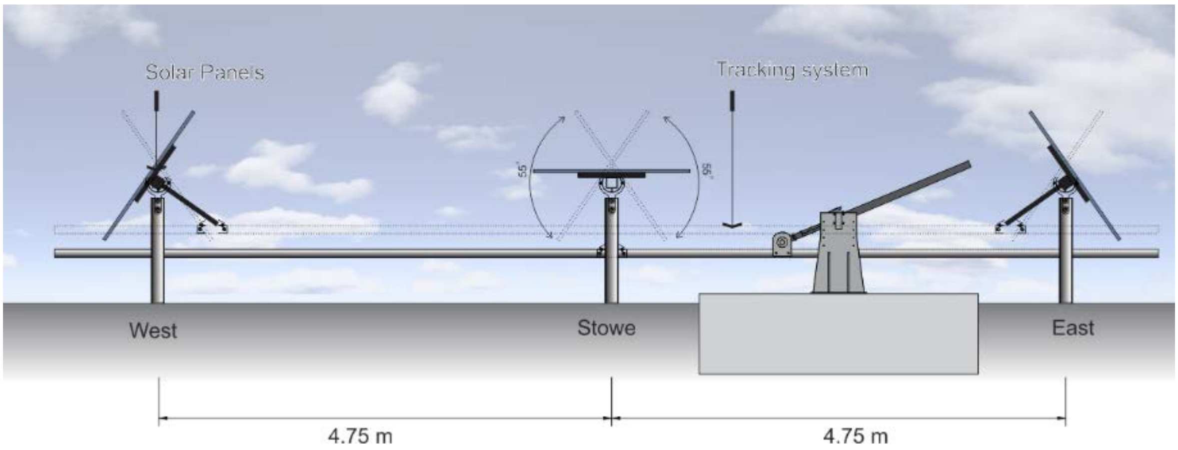
Figure 2-2 Indicative photovoltaic block



The array comprises of PV solar modules mounted horizontally, east west orientated, on a single-axis fixed or tracking system support frame, which runs from north to south. Each panel is approximately 2 m high x 1 m wide. The tracking system follows the sun path from the east in the morning through to the west in the afternoon, to maintain the best possible sun angle for the PV modules throughout the day. A backtracking function ensures that the module rows are not shading each other to achieve the 'optimal sun angle', the system tracks back to a point where shading is avoided. After sunset, the panels will return to face east.

Figure 2-3 shows the indicative tracking system and rotational angles of the PV panel configurations.

Figure 2-3 Indicative tracking system and rotation angle



The operational rotation range of the tracking system is approximately 120 degrees from east to west depending on the system used. The height of the PV panels above natural ground is approximately 1.4 to 4.2 m based on tracker option to be used.

Individual PV panels are constructed using a “high-transmission, low-iron” glass which has lower reflectance and therefore glare than that of normal glass. A coating applied to the panel surface applies a stippled finish to further diffuse the reflected light and therefore energy. The stippled finish gives the panel a hazy appearance as opposed to standard glass.

A solar panel comprises photovoltaic cells, which are either mounted on a supporting frame behind a non-reflective tempered glass layer. Alternatively, if the modules are based on the latest dual-glass (also known as “glass-glass” or bifacial) design, no frames are involved, which significantly reduces the potential for glint and glare. The specific PV modules for the Project have not yet been selected and will not be selected until closer to the commencement of construction.

To be conservative the EIS has assumed the use of a traditional framed panel design.

2.2.2 Battery and energy storage system

The Project includes the addition of a battery energy storage system (BESS). A 1.5 ha footprint area has been set aside for the installation of the BESS. The proposed BESS is designed to a height of 2.4 m.

Given the substantial advances in storage technologies over time, the exact storage capacity cannot be confirmed at this time, however it is anticipated that a 100MW facility, expandable by a further 200MW would allow the optimisation of the Project in the National Electricity Market (NEM) and aide as frequency stabilizer and safety net of the nearby transmission and distribution system. The option to build up to 300MW capacity BESS for safety net is currently under discussion with Transgrid as a part of ‘Expanding NSW-QLD Transmission Transfer Capacity’ program.

The major components for each BESS include batteries, inverters, transformers, heating ventilation air conditioning (HVACs) and fire protection. The specific design details for the BESS will not be finalised until the completion of the detailed design stage of the Project. The general description of the alternatives for the BESS are as follows:

- **Multiple individual cubicles** each of between 130kW and 160kWh. These would be skid mounted and pre-commissioned in packs of 8 to 10 battery cubicles with 2 inverters. The cubicle system manages fire risk via containment; each cubicle is a fire-rated and sealed system which prevents the spread of fire from one cubicle to another and the fire can quickly burn out without a material loss of battery capacity or capital value across the system as a whole; or
- **A containerised system** of approximately 10MW capacity per container. A containerised system has a fire suppression system (typically inert gas or water deluge) to prevent the spread of fire within the container.

Both options would have a similar appearance, as the individual cubicles would be arranged in such a way as to appear as a single container. The BESS facility will encompass a surface area of up to 15,000m^2 and include a series of concrete pads, suitably spaced for optimum operations and maintenance and separated by gravel/road-base to assist in fire management. The final decision on the preferred technology provider and detailed technology specification would be confirmed during the detailed design phase of the Project, and would comply with applicable Australian standards, licences and codes.

Indicative battery modules would be of the order of 2.5 metres in height. An example battery pack is shown in Figure 2-4.

Figure 2-4 Example Battery Storage

2.2.3 Switching Station - Network Connection

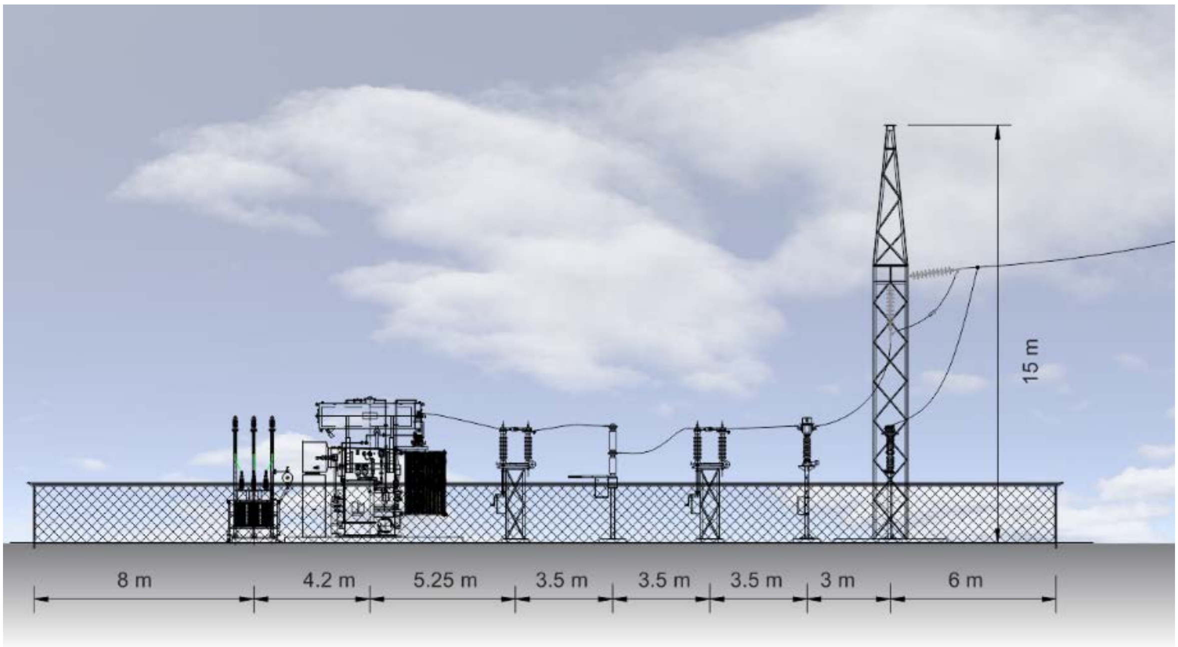
The Project would connect into the existing TransGrid Dumaresq 330kV substation and would supply electricity as part of the NEM. A new 33/330kV switchyard, comprising of one or more 33/330kV transformers, switchgear, metering, protection and communications infrastructure would be constructed adjacent to the TransGrid substation and connect via augmentation to the existing TransGrid 330kV overhead gantry.

The connection to the TransGrid substation will make use of an existing spare 330kV bay. Additional electrical switching equipment would be installed within the existing bay. Any augmentation works to the TransGrid Dumaresq substation would occur within the current TransGrid substation fence boundary and/or on the adjacent land within the Project Site.

The switch yard will be located within a fenced enclosure at the south-western boundary of the Project Site, adjacent to the existing Dumaresq substation (refer to Figure 2-1). Overhead connection is proposed to be used to connect between the switch yard and Dumaresq substation, in consultation with Transgrid.

The switching station will generally comprise of voltage switching equipment, protection and control equipment, one or multiple transformers and circuit breakers as shown indicatively in Figure 2-5 (indicative dimensions, proposed height of 2.5m).

Figure 2-5 Typical Switch yard layout



Electrical infrastructure will generally comprise of open air infrastructure similar to that within the adjacent Dumaresq Substation albeit at a smaller scale. There are few, if any reflective surfaces.

The indicative height of the switch yard is 2.5m, although the final design will be no taller than 6 m, except the overhead connection tower to Dumaresq substation (refer to Figure 2-5). The detail design and final location of the switch yard will be determined following permissions and approvals and prior to the construction phase.

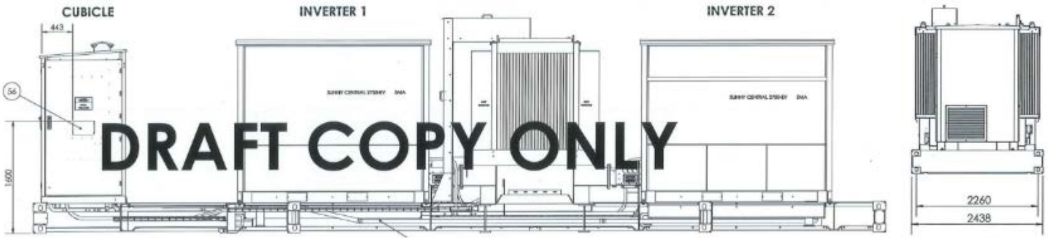
2.2.4 Inverters

Inverters will convert direct current (DC) electricity generated by the PV modules to alternating current (AC) for reticulation around the site and connection to the electricity grid.

Inverters will either be containerised or skid mounted in an open-air configuration. A containerised solution means inverters and transformers would be housed in shipping containers. The containerised option would be the larger and potentially more noticeable of the two options.

Figure 2-6 shows a skid mounted inverter arrangement, as proposed for the Project.

Figure 2-6 Skid Mounted Inverter Arrangement



The inverter containers (enclosed or open) are similar, if not smaller, in size and scale to many structures found in the area such as sheds and equipment storage.

2.2.5 Control Building, parts and maintenance shed and car park

The control building and maintenance shed each will be approximately 400 - 800 m^2 and approximately 5 m in height. The control building, maintenance shed and car park are proposed close to the proposed substation in the south-west of the site.

These buildings are similar in size, scale and cladding to many other farm sheds, buildings and structures found in the landscape.

During operations, up to 10 FTE employees will occupy these premises. Whilst most maintenance activity is anticipated to occur during business hours Monday to Friday, access to the solar farm site will be required on a 24 hour basis, seven days a week.

2.2.6 Site Access and Internal Access Roads

The Project is located adjacent to Bruxner Highway, which provides direct access to the proposed internal access road network. Vehicle access to the Project Site is proposed from one access point in the north-western corner of the lot, as shown in Figure 2-1. The access road will be constructed from the Bruxner Highway to the site access location identified in Figure 2-1 (discussed further in Table 4-2).

The construction and maintenance of the Project will require construction of up to 13.75 km of private roads within the Development Footprint. The roads will provide ongoing access to the solar arrays and other Project infrastructure. Where possible, the internal road network will be aligned on the route of Asset Protection Zones (APZs) and / or existing farm or other access roads. The perimeter road will be 6m wide and all internal roads are 4m wide, which will have additional buffering for the Asset Protection Zone (APZ). The APZ will be up to 10m wide along perimeter roads and 6m wide along all internal roads. The proposed internal road network is shown in Figure 2-1.

Where possible, existing farm tracks will be upgraded to reduce the construction of new access tracks. Construction of new access tracks will require removal of topsoil to a suitable founding layer. The running surface will be constructed by placing and compacting a road base layer (typically 200mm).

2.3 Construction

The period from commencement of construction through to completed tests following commissioning of the Project is expected to be approximately 12 months. This period is dependent on weather and ground conditions, as well as detailed design and delivery of equipment. Construction activities, which are likely to have a landscape and/or visual impact, are likely to be the following:

- Temporary construction compound(s);
- Internal site access tracks;
- Establishing foundations and hardstands;
- Substation and grid connection networks;
- Excavation of trenches and the laying of power and instrumentation cables;
- Erecting PV Arrays; and
- Vehicular traffic.

The most noticeable element of the Project would be the PV array.

2.3.1 Construction Activities

Construction activities will include:

- **Site preparation:** geotechnical investigations to confirm ground conditions; site survey to confirm allotment boundary, riparian zone, and infrastructure positioning and placement; installation of fencing, internal access tracks, establishment of foundations and hardstands; office and car parking area;
- **Construction activities:** including installation of mounting structures and tracker tubes; securing PV modules to tracker tubes; installation of cabling and switching station, establishment of BESS and maintenance compounds and associated site infrastructure; and testing and commissioning;
- **Plant and Equipment:** will include earthmoving plant and equipment for site preparation and clearing; cable trenching and laying equipment; pile drive equipment; forklifts and cranes; water truck for dust suppression and machinery equipment for construction of BESS and associated facilities.

2.3.2 Hours of Construction and Duration

Construction activities at the Project Site would be restricted to standard daytime construction working hours, being:

- 7:00 am to 6:00 pm (Monday to Friday).
- 8:00 am to 1:00 pm (Saturday).
- No construction would occur on Sundays or Public Holidays.

In accordance with the ICNG, construction outside these hours may be permitted in the following circumstances:

- For the delivery of materials required outside these hours by the NSW Police or other authorities for safety reasons.
- Where it is required in an emergency to avoid the loss of lives, property and / or prevent environmental harm.
- Construction outside these hours may be permitted with agreement by the Secretary.

Construction will be undertaken over a period of approximately 12 months.

2.3.3 Delivery of construction materials and infrastructure

Peak demand levels for the construction work will vary with up to 190 people for a 6 month duration and a lower level outside of this peak period. The staff will be sourced locally where appropriate with some specialist and project management staff being temporarily located in Tenterfield, Inverell and potentially Goondiwindi. Staff will be encouraged and supported to car pool as appropriate with other staff transferred to and from the site via mini coaches to reduce vehicle demands. Due to the size of the site footprint, these same vehicles will also be used on site to move staff across the site.

The number of heavy vehicles accessing the site will vary across the Project timeframe. At the beginning of the Project there will be a requirement for some earth moving equipment to construct the access road and some minor earthworks across the site as required. This may require a scraper or bull dozer which will be transported to site on a low loader. This machinery will remain on site for the duration of the earthworks portion of the Project construction work. All of the plant will be located on site and will therefore be only required to access the site once for the construction works.

While extensive earthworks are not proposed, some land forming (including localised cut and fill areas) may be undertaken to achieve more consistent gradients beneath the PV modules. Additionally, earthworks are required for trenching works. All of the plant will be located on site and will therefore be only required to access the site once for the construction works.

The solar panels and equipment are expected to be delivered from either the Port of Newcastle or Port of Brisbane. Other specialist equipment is generally sourced from Newcastle or Brisbane as required whilst consumables such as concrete and general material supplies will be sourced locally from the Tenterfield area.

2.3.4 Workforce

During the peak construction period, it is estimated that a workforce of up to 190 FTE will be required. There is no accommodation facility proposed as part of this application and it is not envisaged that a single accommodation source for the entire workforce would be available within a reasonable distance of the Project Site, including Inverell, Tenterfield and Texas.

The issue of accommodation has been discussed with Inverell Shire Council and Inverell Chamber of Commerce. Both organisations indicated a willingness to work with the proponent to ensure workers could be housed within the region and that the Inverell business community could gain the associated benefits of the housing and living spend within the LGA.

Tenterfield Shire Council has also been consulted and initially raised concerns due to the New England Highway Upgrade at Mount Bolivia which was due to continue through 2019. It is likely that the works will be completed or substantially completed by the time the construction of the Project has commenced, thereby providing an additional source of accommodation.

Based on the above it is anticipated that there will be a sufficient local accommodation source for the fluctuating workforce.

2.4 Operations

During operations, it is expected that a workforce of up to 10 FTE employees will be required and will be associated day-to-day maintenance and management of the facility.

Following completion of construction, the agricultural use of the site will return, with livestock (sheep) grazing continuing during the operational stage of the Project.

2.5 Decommissioning and Rehabilitation

The Proponent has entered long-term lease agreements with the landholders for the construction and operation of the Project. The solar farm has an expected 30 year operating life, at the end of which there are three main options for consideration:

- continue use of the site as a solar farm using the existing panels;
- replace panels with technology current at that time and continue the use of the site as a solar farm for a further term; or
- decommission the Project and remove the panels and associated infrastructure in accordance with a Decommissioning and Rehabilitation Plan.

It is the responsibility of GAIA or the solar farm owner at the time of decommissioning to fund and execute the decommissioning of the Project. In general, all above ground structures will be removed and the land rehabilitated to ensure it can be returned to agricultural use. It is anticipated that other below ground infrastructure will be left in situ and covered in clean fill material, with the area adequately graded to reflect the slope of the surrounding area and to minimise the risk of soil erosion.

3. PROJECT JUSTIFICATION

This Chapter of the EIS provides details of the strategic justification of the development, with consideration to site selection and the suitability of the Project Site.

3.1 Contribution to the National Electricity Market and Reduction Targets

The Project will support the Commonwealth and NSW governments in achieving their respective renewable energy and greenhouse gas (GHG) emission reduction targets. The aim of the Commonwealth Government’s Renewable Energy Target (RET) is to create a market for renewable energy to deliver around 23.5% of electricity from renewable sources by 2020, including the target of providing 33 terawatt hours (TWh) through large scale renewables by 2020. Likewise, the NSW Renewable Energy Action Plan (REAP) supports the RET, by outlining 24 actions under 3 goals that detail the NSW Government’s commitment to work closely with NSW communities and the renewable energy industry to increase renewable energy production in NSW to 20% of all energy generated by 2020.

The National Electricity Market (NEM) operates as a power system to deliver electricity from generators to market consumers, through an extensive transmission and distribution network comprising of around 40,000 km of transmission lines and cables. The NEM services the entire eastern and south-eastern coastline of Australia, connecting five states, and providing electricity to approximately 9 million customers. During 2016-17, power generation of the NEM totalled 196.5 TWh of electricity, which comprised of 77% coal (150.9 TWh), 9% gas (17.6 TWh), 8% hydro (15.5 TWh), 5% wind (10.6 TWh), 0.3% solar (0.6 TWh) and 0.7% other (1.3 TWh) (AEMO, undated).

According to the Clean Energy Australia Report 2019 (Clean Energy Council, 2019), in 2018 in NSW, the state generated 69,085 gigawatt hours (GWh) of energy, with the total renewable energy generation comprising 10,355 GWh, or 15.0%.

The Project would generate 420 GWh of electricity contributed to the NEM per annum. The Project will assist the Commonwealth and NSW Government in reaching the reduction targets of the RET and REAP respectively. In doing so, the Project seeks to:

- provide a source of renewable energy to supplement NSW and National energy requirements and assist in reducing greenhouse gas (GHG) emissions;
- contribute to the additional generating capacity required to meet the growing energy demand in NSW;
- contribute to NSW and Commonwealth targets for renewable energy;
- provide additional income streams for the involved landholder;
- provide both direct and indirect employment opportunities during construction and operation;
- liaise and work with the community and all potentially affected stakeholders in the identification, mitigation and / or monitoring of any potential environmental effects;
- ensure quality, safety and environmental standards are maintained;
- recycle and reuse material where practical and economically feasible; and
- minimise all potential and adverse environmental impacts and where practical, maximise all potential positive environmental effects.

3.2 Project Background and Site Selection

3.2.1 Site Selection and Development Footprint Refinement

During Project scoping and preliminary investigation, as well as during further detailed technical investigations as part of the EIS, site selection and refinement occurred on the basis of environmental constraints and opportunities analysis, stakeholder engagement and project conceptual design considerations. This ensured a Project Site and Development Footprint were selected that gave due consideration to and minimisation of environmental impacts whilst achieving a feasible and efficient concept design and Development Footprint. The process has sought to actively identify and minimise environmental impacts as part of the Project development. This process of site selection and refinement is detailed Table 3-1 and Table 3-2, and displayed in Figure 3-1 and Figure 2-1.

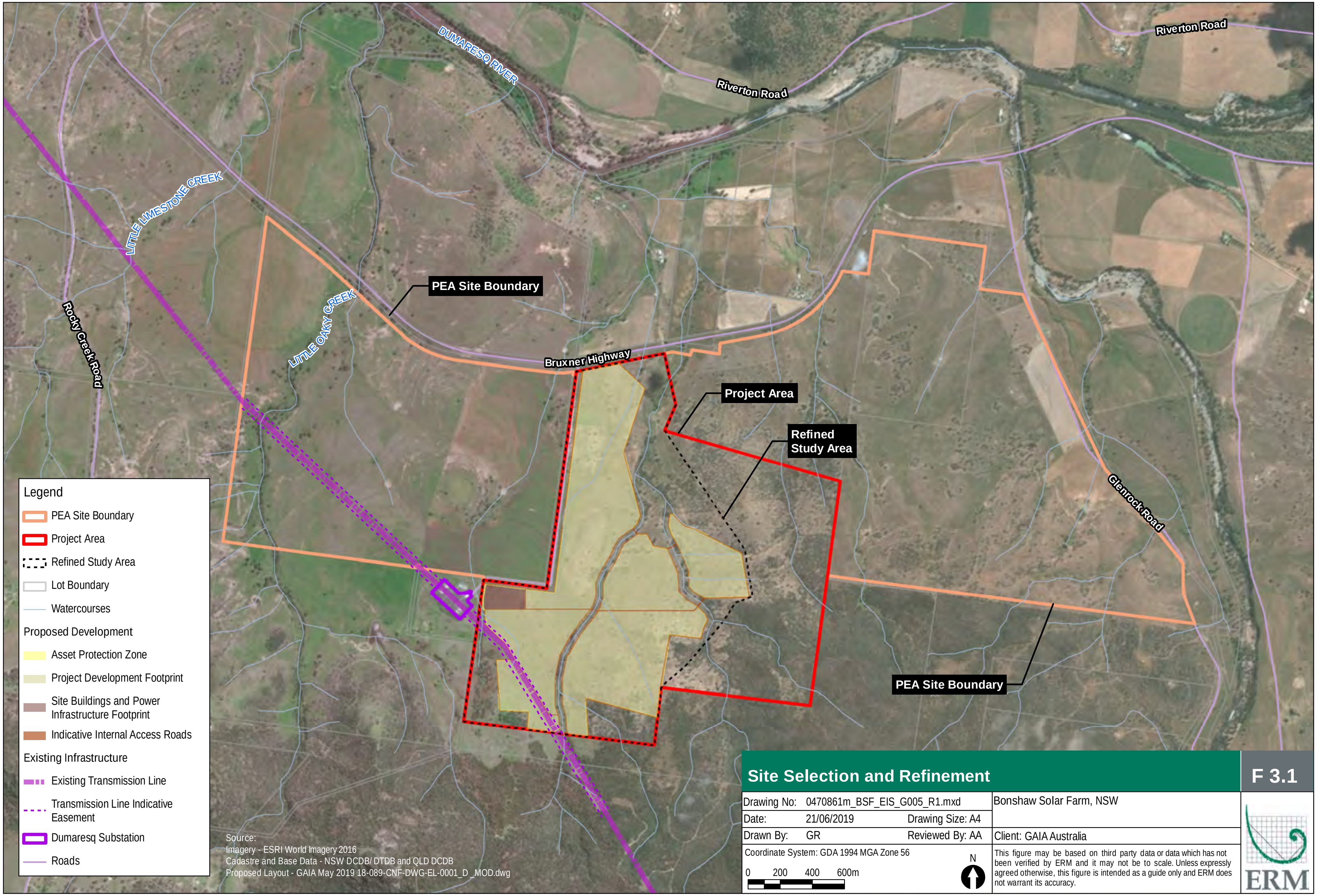
Table 3-1 Site Selection and Project Site Refinement Considerations

Footprint	Area (ha)	Description	Key Selection / Refinement Elements
Locality Selection	Bonshaw area broadly	■ General area in vicinity of Bonshaw and surrounds	■ Proximity to 330 kV electricity transmission network ■ Limited large scale development in the locality to date ■ Elevation and high solar irradiance ■ Reduced land use conflicts
PEA Site Boundary	1,097 ha	■ Completed preliminary desktop review to map potential environmental and land use constraints and opportunities	■ Subject to constraints and opportunities analysis ■ Proximity to the existing Dumaresq Substation ■ Access to local and regional road network ■ Modified landscape
Preliminary Study Area (Project Site / allotment)	353 ha	■ Proponent negotiation with landowner for lease agreement	■ Agreement with landowner ■ Minimise road traffic and intersection issues
Refined Study Area	249 ha	■ Technical environmental investigations have identified environmental and land use constraints	■ Minimise biodiversity impacts ■ Minimise heritage impacts ■ Topography restrictions (steep areas)
Development / Project Footprint	Approx. 167 ha	■ Detailed technical environmental investigations have identified environmental and land use constraints that have informed the site selection process, Development Footprint and infrastructure layout.	■ Minimise impacts on identified aboriginal artefact scatters and PAD sites ■ Minimise impacts on biodiversity values and vegetation clearance requirements following detailed associated under the BAM requirements ■ Minimise impacts on higher order watercourses

Table 3-2 Environmental Constraints and Opportunities Influencing Site Selection and Refinement

Environmental Aspect	Considerations
Biodiversity	■ A total of 143 flora species in 47 families were recorded within the assessment area. This included a total of 111 native (78 %) and 32 exotic (22 %) species. No threatened flora species were recorded within the Development Footprint. Vegetation within the Development Footprint includes cleared land and native vegetation within three plant community types (PCT) at differing conditions. None of the PCTs present within the Development Footprint correspond to listed Threatened Ecological Communities. ■ A total of 75 fauna species were recorded across the Development Footprint, including eleven threatened species. Threatened species included eight vulnerable microchiropteran bats (Little Pied Bat, Eastern Bent-wing Bat, Corben's Long-eared Bat, Yellow-bellied Sheath-tailed Bat, Eastern Cave Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Hoary Wattled Bat), one endangered microchiropteran bat (Bristle-faced Free-tailed bat), one vulnerable bird (Grey-crowned Babbler) and one migratory bird (Cicadabird). Out of the eight Vulnerable microchiropteran bats, six were definite call identifications and two (Greater Broad-nosed Bat and Hoary Wattled Bat) were potential calls. ■ Through continued detailed design the Project will avoid the following areas of high biodiversity value: - Avoid the large areas of intact vegetation communities within the eastern and south eastern portion of the Project Site; - Avoid all areas mapped as TEC; - Avoidance of five rocky areas; - Retention of the second and third order streams.
Heritage	35 Aboriginal heritage sites (and three associated Potential Archaeological Deposits) have been recorded within the Project Site (ERM, 2019b). 29 of these sites were stone artefacts including isolated finds and stone artefact scatters. Seven scarred trees were also identified. Careful detailed design of the Project footprint has successfully avoided several of these sites and they will be retained and protected from any direct and/or indirect impacts.
Land use and Agriculture	Within the Project Site, approximately 86ha of Biophysical Strategic Agriculture Land (BSAL) mapped area was likely to be affected, as defined by Strategic Regional Land Use Policy (SRLUP) of the New England North West Region. Where possible, GAIA have designed the solar layout with consideration to minimise the impacts on BSAL land. Consequently, the Development Footprint and solar array has been amended to include only 58.3ha of the BSAL area, a 33% reduction, to significantly reduce impacts to this strategic area. To minimise the negative impacts caused through loss of agricultural land use, the site will continue to be utilised for sheep grazing following construction.
Visual	The Visual Impact Assessment (refer to Appendix F) has identified that other than for a location immediately north of the site on the Bruxner Highway, all visual impacts are **low to none**. The impact from the Bruxner Highway is deemed as **medium to low** impact, however given the short frontage and period of time the facility is seen, the low traffic volumes along this route and the setback from the road means that the overall impacts from this locality are localised and therefore low. The provision of five meter landscape strip along the northern and a 400 m portion of the north-western boundaries will reduce visual impacts from the Bruxner Highway.

Environmental Aspect	Considerations
	No glare impacts are predicted and therefore no mitigation measures are required for glare.
Noise	The acoustic assessment identified that construction noise levels have the potential to exceed the applicable criteria, limits and thresholds, however these levels can be mitigated and / or minimised with the successful implementation of recommended noise mitigation measures. The recommendations will assist to ensure that any residual impacts to the closest and/or potentially most affected receptors, and the broader community is minimised as far as is practically achievable. Based on the predicted operational compliance and anticipated negligible impact to all receptors a set of suitable safeguards and provisions were provided.
Transport	Ready access to the Bruxner Highway and New England Highway to the east. The Traffic Impact Assessment concluded that the construction traffic can safely and efficiently access the site with minimal impact for existing road users. The management plan for the construction traffic access ensures that the trucks accessing the site shall have an acceptable impact on the road network and safety with traffic managed via a Traffic Control Plan during construction. Once operational, the traffic demands are minimal and shall have little impact upon the local road network.
Water	Minimisation of impacts to watercourse by creating an offset from the riparian corridor. The riparian zone will be surveyed prior to detailed designed to ensure the Development Footprint is offset and outside third order and higher riparian corridors.
Hazards and Risks	The Project includes small quantities for hazardous materials, to be sorted within the south western portion of the Site. There is a considerable distance to neighbouring stakeholders. The SEPP 33 assessment concluded that the storage and transportation of hazardous materials are unlikely to be significant pose a risk to public safety.
Topography	The Project Site is dominated by a gently undulating landscape to the north, forming steep slopes to the south and east dissected by second and third order streams. Based on a review of topographic maps and aerial imagery, landforms present within the Subject Land include drainage depressions, gentle to steeply inclining slopes, and upper flat ridges. The elevation at the Bruxner Highway (north boundary) is approximately 335 m and rises up to approximately 420 m in the south-western portion of the site. The ridgelines to the south of the Project rise up to approximately 660 m forming the dominant landscape feature. The Development Footprint has avoided areas of steep and rocky terrain within the eastern and south eastern portion of the site.
Natural Hazards	The second and third order watercourses will be avoided through detailed design and survey, with riparian buffers to be applied either side of the streams, measured from the edge of the top of bank. The buffers applied within the biodiversity assessment were 20m either side of the second order stream and 30m to either side of the third order streams.



Source:
Imagery - ESRI World Imagery 2016
Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg

Site Selection and Refinement

F 3.1

Drawing No: 0470861m_BSF_EIS_G005_R1.mxd
Date: 21/06/2019
Drawing Size: A4
Drawn By: GR
Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

3.3 Feasible Alternatives

Alternatives to the Bonshaw Solar Farm have been explored, including alternative sourcing of energy, alternative site locations, alternative site layouts and the ‘do nothing’ approach for the Project.

3.3.1 Alternative Sourcing of Energy

The alternative to solar energy is the continued use of fossil fuels, including coal (both black and brown) and natural gas. The reliance on these energy sources however, results in the release of greenhouse gas (GHG) emissions such as CO_2 and contributes to the harmful effects of climate change. The RET and REAP discussed in Section 4.1 outline the commitment by Australia and NSW in reducing greenhouse gas emissions and have set targets for increasing the generation of renewable energy.

Other forms of large-scale renewable energy accounted for in the RET include hydro, biomass, wind and tidal energy. With the exception of wind energy, these alternative sources are in the early stages of development and are generally not ‘market ready’. More importantly, these energy sources are not as viable as solar in Australia. Australia has one of the largest solar irradiances in the world, and the area to accommodate large-scale facilities.

3.3.2 Alternative Site Location

Initial site selection investigations undertaken by GAIA through consultation with the network operator to understand the capacity to export electricity from the Project to the National Electricity Market (NEM). The Bonshaw area was selected due to its suitability for large-scale solar PV and lower level of large-scale solar PV development compared with other suitable regions. As such, excess capacity available at the Dumaresq substation was used as a primary identifier.

Alternative locations were considered by GAIA as part of the site identification process described in Table 3-1. The Bonshaw Site was identified as the preferred location due to its abundant solar source, proximity to Dumaresq substation, low population density surrounding the site, landholder support, and topography of site likely to limit visual impact. The initial PEA Site Boundary contained additional landholdings however these have not progressed to the final project.

Selection of an appropriate site is an integral part of a solar farm development. DP&E *Large-Scale Solar Energy Guideline* (2018) provides a list of key site constraints that would indicate the suitability, or lack thereof, for a site, summarised below:

- Visibility and topography – sites with high visibility, such as those on prominent or high ground positions, or sites which are located in a valley with elevated nearby residences with views toward the site. This is particularly important in the context of significant scenic, historic or cultural landscapes.
- Biodiversity – areas of native vegetation or habitat of threatened species or ecological communities within and adjacent to the site.
- Residences – residential zones or urbanised areas.
- Agriculture – important agricultural lands, including Biophysical Strategic Agricultural Land (BSAL), irrigated cropping land, and land and soil capability classes 1, 2 and 3.
- Natural Hazards – areas subject to natural hazards such as flooding and land instability.
- Resources – prospective resource developments, including areas covered by exploration licences, and mining and petroleum production leases.
- Crown Lands – if any part of the Project or associated transmission or distribution infrastructure will cross Crown Lands, it may be subject to legislative requirements that restrict access to the land.

As detailed in Table 3-2, various environmental aspects and values identified across the allotment have resulted in the Development Footprint being reduced.

3.3.3 Alternative Site Layout Options

Original site selection also considered other neighbouring properties in the immediate vicinity proposed Site. However existing land use of these neighbouring properties did not offer the same opportunity to continue livestock grazing during operation of the Project and presented potential land use conflict issues.

The Project Site has had extensive environmental investigation and assessment which has informed the current concept layout. The layout has been reassessed and reduced to minimise the impact made upon the environment, as discussed in Table 3-1 and Table 3-2.

Careful consideration of the existing environmental constraints has seen the total Development Footprint reduced from 1097 ha to 167 ha. The Project Site has a large area of native vegetation (Woodland and Open Forest Habitats) which would require biodiversity offsetting, primarily located in the eastern and southern portions. Various waterways traverse the Project Site, which fork and meander primarily in a north-south manner. The Project Site also contains a number of heritage sites, with various artefact scatters, scar trees, isolated finds and a historic dump site, located within the Project boundary. Where possible these constraints have been considered in order to minimise adverse impacts. Environmental constraints mapping is shown in Figure 2-1 above.

3.3.4 Alternative Technologies

Alternative solar technology has also been considered for the Project, with GAIA considering two solar panel design options, determining which would be most suitable for the Project and the landowners continuing livestock use. The two options include:

- Mono panel and inverter; or
- Bi-facial with sting inverter.

Option 1 is the current preferred option, which the current layout is based on.

Option 2 module is approximately 4m high and may require ground condition improvement for better reflection purposes (i.e. white sand).

3.3.5 Do Nothing

The Project Site is currently used for livestock grazing. Although the ‘do nothing’ scenario would allow for continued use of the site for agricultural production, it will also lead to a missed opportunity to generate additional renewable energy and to reduce Australia’s dependency on fossil fuels for energy generation and the consequential emissions of GHGs. The Project is expected to results in savings of approximately 600,000 tonnes of GHGs per annum. The electricity generated could supply up to 70,000 households with energy annually.

In addition, the local area and wider region would not realise the economic benefits of the Project including:

- The economic benefits to the local and regional community provided directly and indirectly by the employments associated with the Project;
- a capital investment of $237M creating direct and indirect employment during construction and operations; and
- contributions to local community facilities and infrastructure through the Community Benefit Fund.

4. STRATEGIC AND STATUTORY CONTEXT

This Chapter of the EIS provides details ascertaining to Project's capability to contribute to the energy system in the National Electricity Market, and the statutory context.

4.1 Strategic Context

Australia has the highest average solar radiation per square metre of any continent in the world (DP&E, 2017). The *Large-Scale Solar Energy Guideline* (2018) acknowledges that large-scale energy proposal provide an opportunity to:

- address the aims of the International Paris Agreement on reducing greenhouse gas emissions;
- contribute to NSW achieving net-zero emissions by 2050 as set out in the NSW Climate Change Policy Framework;
- contribute to the Commonwealth's renewable energy target;
- deliver on commitments in the NSW Renewable Energy Action Plan; and
- assist in meeting energy demand and improving energy security for NSW in the context of the regulatory framework for the National Electricity Market.

The Bonshaw Solar Farm will deliver 200 MW of renewable energy to the NEM, equating to 420 GWh per annum.

4.1.1 Commonwealth Renewable Energy Target

The Renewable Energy Target (RET) is an Australian Government scheme designed to reduce emissions of greenhouse gases in the electricity sector and encourage the additional generation of electricity from sustainable and renewable sources. The RET works by allowing both large-scale power stations and the owners of small-scale systems to create large-scale generation certificates and small-scale technology certificates for every megawatt hour of power they generate.

The large-scale RET is an Australian Government policy which commenced in 2001 with the aim of having at least 20% of Australia's electricity consumption derived from renewable sources by 2020. Following review in early 2015, the RET was confirmed as 33,000 gigawatt hours (GWh) of electricity by 2020. To meet the RET, significant new renewable energy capacity is needed.

The RET incentivise the development of renewable energy in Australia through a regulated market for the creation and sale of large-scale generation certificates (LGCs). Liable entities are required to buy LGCs from the market and surrender these certificates to the Clean Energy Regulator on an annual basis.

4.1.2 National Electricity Supply and Reliability

According to the Australian Energy Update 2018 (Department of the Environment and Energy, 2018), in 2016-17, Australia's energy consumption experienced a 1.1% increase, reaching 1707 TWh. This compares with an average growth of 0.8 per cent a year over the past ten years. Coal and natural gas fired generation accounted for approximately 83% of total electricity generation in 2016-17. Renewable generation increased by 6 per cent in 2016–17, contributing 16 per cent of total generation (Commonwealth Department of Environment and Energy, Australian Energy Update, August 2018).

The State of the Energy Market 2018 (Australian Energy Regulator, 2018) stated that coal fired generators are being retired as they reach the end of their economic life, withdrawing 4200 MW of capacity from the market since 2014, however 4300 MW of large scale wind and solar capacity was added over the same period. Significant amounts of new capacity will be required in the medium to long term to compensate for the retirement of various coal plants and to help achieve emissions reduction targets.

Therefore, a range of energy generation methods, such as solar are required to ensure security of energy supply on the national grid network (National Energy Security Assessment, DRET 2011).

The Project will assist in provided an additional source of solar generation and will contribute to securing renewable energy supply on the national grid network.

4.1.3 NSW Renewable Energy Action Plan (REAP)

The REAP guides NSW's renewable energy development and supports the achievement of national renewable energy targets. The NSW Government's vision is for a secure, reliable, affordable and clean energy future for NSW (NSW Government, 2013). The REAP positions NSW to increase the use of energy from renewable sources.

The REAP details three goals and a number of actions to most efficiently grow renewable energy generation in NSW:

- Attract renewable energy investment;
- Build community support; and
- Attract and grow renewable energy expertise.

The Project will assist in achieving the NSW Government's goals of increasing renewable energy generation in NSW to help achieve renewable energy targets. Through creating new solar employment opportunities, the Project will contribute to growing expertise in renewable energy.

4.1.4 New England North West Regional Plan 2036

The *New England North West Regional Plan 2036* (the Regional Plan) is a 20-year blueprint for the future, guiding the NSW Government's land use planning priorities and decisions in the New England North West region to 2036 (DP&E, 2017). The New England North West region encompasses 12 LGAs in regional NSW including the Inverell Shire LGA. The Regional Plan sets the following regionally focused goals:

- A strong and dynamic regional economy;
- A healthy environment with pristine waterways;
- Strong infrastructure and transport networks for a connected future; and
- Attractive and thriving communities

Direction 3 of the Regional Plan aims to protect and enhance productive agricultural lands. This involves limiting urban and rural residential development on important agricultural land, including mapped Biophysical Strategic Agricultural Land, unless it is in a strategy that is:

- agreed between council and the DP&E; and
- consistent with the guidelines for councils on important agricultural land.
- The Project Site contains approximately 86 ha of land mapped as BSAL (refer to Section 6.3), however only 58.3ha is located within the Development Footprint. Due to the nature of the Proposed Solar Farm, it is unlikely to have large or permanent detrimental impacts on the land. Following construction, sheep grazing will continue across the Development Footprint. Considerations to potential impacts to land is contained within Section 6.3.

Direction 5 of the Plan aims to grow New England North West as the renewable energy hub of NSW. It identifies the potential of renewable energy sources in the region specifically noting that it is the second highest solar penetration region in NSW, receiving 19 to 20 megajoules per square metre daily (MJ/m^2 per day) of solar exposure (DP&E, 2017). One of the specific actions identified in the Regional Plan is aimed at encouraging renewably energy development in areas with ease of access to the infrastructure of the existing electricity network. (DP&E, 2017).

This Project is consistent with the overall objectives of the Plan, noting that it will generate employment and investment from construction, operations and connection to the State's electricity grid. The Project is also strategically located to connect easily to the existing electricity network infrastructure, leveraging the opportunity to connect directly to the neighbouring Dumaresq substation.

4.1.5 Northern Tablelands Local Strategic Plan 2016-2021

The five year Northern Tablelands Local Strategic Plan (NSW Local Land Services, 2016a) contributes to the goals set in the State Strategic Plan 2016-2026 (NSW Local Land Services, 2016b). Each of the 11 Local Land Services (LLS) regions have developed a Local Strategic Plan (LSP), identifying local priories and determining how best goals and strategies of the State Strategic Plan (SSP) are best achieved. The Northern Tablelands Local Strategic Plan identifies four goals:

- Resilient, self-reliant and prepared local communities;
- Biosecure, profitable, productive and sustainable primary industries;
- Healthy, diverse and connected natural environments; and
- Board members and staff who are collaborative, innovative and commercially focused.

The Project Site is within the sub-region of 'Cod Country', characterised by dry land and irrigation cropping, and livestock production. The priorities for this sub-region defined in the LSP include:

- Partnerships with Queensland;
- Weed and pest management, including feral pigs; and
- Travelling Stock Reserve management.

To ensure that the overall objectives of this LSP are met, the Project has; undergone community consultation (refer to Section 5), assessed the impacts of securing sustainable land use (refer to Section 6.3), and assessed the impacts to the natural environment (refer to Section 6.1).

A travelling stock route (TSR) on Crown land is identified adjacent to the Bruxner Highway road reserve, along the northern boundary of the allotment. However, ongoing access to the TSR will not be impacted as a result of the development.

4.2 Statutory Context

4.2.1 Commonwealth Legislation

4.2.1.1 Environmental Protection and Biodiversity Conservation Act 1999

The *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) relates to the protection of the environment and the conservation of biodiversity. The EPBC Act incorporates an assessment and approvals system for:

- actions that have a significant impact on matters of national environmental significance (MNES);
- actions that have a significant impact on the environment of Commonwealth land; and
- actions carried out by the Commonwealth Government.

A search for MNES using the Department of the Environment (DoE) Protected Matters Search Tool (PMST) was undertaken, with a 5 km buffer, on 8 January 2019. The search was conducted as part of a Biodiversity Development Assessment Report (BDAR) prepared for the Project and is provided in Appendix C of this EIS. The results of the search are summarised in Table 4-1.

Table 4-1 Relationship of the Project to MNES

MNES	Application to the Project	Relevant Section
World Heritage Areas	Not identified within the Subject Land	Not applicable
National Heritage Places	Not identified within the Subject Land	Not applicable
Great Barrier Reef Marine Park	Not identified within the Subject Land	Not applicable
Wetlands of International Importance (listed under the Ramsar Convention)	Not relevant	Not applicable
Nationally listed threatened species and ecological communities	Threatened species have been recorded within the locality and have potential habitat available within the Subject Land (Development Site). No Threatened Ecological Communities (TEC) are present.	Section 6.1 & Appendix C
Nationally listed migratory species	Migratory species are identified as potentially occurring within the Subject Land.	Section 6.1 & Appendix C
All nuclear actions	Not applicable	Not applicable
Commonwealth Marine Areas	Not identified within the Subject Land	Not applicable
Water resource, in relation to coal seam gas development and large coal mining development.	Not applicable	Not applicable

4.2.1.2 Biosecurity Act 2015

The Commonwealth *Biosecurity Act 2015* came into effect on 1 July 2017, effectively replacing the *Noxious Weeds Act 1993*, and 13 other Acts, with a single Act. Under the *Noxious Weeds Act 1993* all landowners have a responsibility to control noxious weeds on their property. Similarly, under the *Biosecurity Act 2015* the same responsibility will apply and will be known as a General Biosecurity Duty.

The General Biosecurity Duty states "*Any person who deals with biosecurity matter or a carrier and who knows, or ought reasonably to know, the biosecurity risk posed or likely to be posed by the biosecurity matter, carrier or dealing has a biosecurity duty to ensure that, so far as is reasonably practicable, the biosecurity risk is prevented, eliminated or minimised.*" The general biosecurity duty applies to all weeds listed in Schedule 3 of the *Biosecurity Act 2015* (also included as Weeds of National Significance (WoNS).

With relevance to the Project, a total of 32 exotic species, including five high threat exotic (HTE) were recorded within the Development Footprint. Two of those exotic species, Tiger Pear (*Opuntia aurantiaca*) and Velvet Tree Pear (*Opuntia tomentosa*) are listed as Weeds of national significance (WoNS) (refer Section 6.1). Weed management measures have been developed for implementation as part of the Project. These measures are outlined in Section 6.1 and included in the mitigation measures of Section 7.

4.2.2 NSW Legislation

4.2.2.1 Environmental Planning and Assessment Act 1979

The principal NSW planning legislation is the *Environmental Planning and Assessment Act 1979* (EP&A Act). The EP&A Act provides a system of environmental planning and assessment administered by the NSW Department of Planning, Industry and Environment (DPI&E). The EP&A Act establishes when and how a development or activity is to be assessed and who is the relevant approval or determining authority.

Section 4.36 (2) of the EP&A Act states that *"a State environmental planning policy may declare any development, or any class or description of development, to be State significant developmen*t*"*.

Part 2 Clause 8 of the State Environmental Planning Policy (State and Regional Development) 2011 (State and Regional Development SEPP) states that:

Development is declared to be State significant development for the purposes of the Act if:

- the development on the land concerned is, by the operation of an environmental planning instrument, not permissible without development consent under Part 4 of the Act, and
- the development is specified in Schedule 1 or 2.

Schedule 1 and 2 of the State and Regional Development SEPP contains an extensive list of developments that are considered State Significant Development (SSD). Schedule 1 Clause 20 identifies the following as SSD:

Electricity generating works and heat or co-generation

*Development for the purpose of electricity generating works or heat or their co-generation (using any energy source, including gas, coal, biofuel, distillate, waste, hydro, wave, **solar** or wind power) that:*

- has a capital investment value of more than $30 million, or
- has a capital investment value of more than $10 million and is located in an environmentally sensitive area of State significance.

The Project is a development for the purpose of electricity generation using a solar energy source, and has a capital investment value (CIV) of more than $30 million (refer Section 1.1).

Permissibility of the Project is provided under clause 34 (7) of State Environmental Planning Policy (Infrastructure) 2007, which states:

Solar energy systems

Except as provided by subclause (8), development for the purpose of a solar energy system may be carried out by any person with consent on any land.

The Project meets both the requirements of clause 8 of the State and Regional Development SEPP as it is not permissible without development consent and is development specified in Schedule 1. Therefore, the Project is SSD for the purposes of the EP&A Act.

EP&A Objectives

The relevant objectives of the EP&A Act for this development are to:

- to promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources;
- to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment;
- promote the orderly and economic use and development of land;

- to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats;
- to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage);
- to promote good design and amenity of the built environment; and
- to provide increased opportunity for community participation in environmental planning and assessment.

These objectives have been considered throughout the site selection and environmental assessment process. The Project will contribute to the sustainable transition to cleaner energy generation and following decommissioning, the land can return to agricultural production.

The Project Site and Development Footprint have been selected with due consideration to and minimisation of environmental impacts whilst achieving a feasible and efficient Project concept design. This process has actively identified and minimised environmental impacts for the Project development and will not result in a significant environmental impact.

Whilst there will some reduction in agricultural utilisation within the Development Footprint, this is mitigated by:

- choice of PV module technology during detailed design to maximise the land available for ongoing grazing;
- ongoing grazing activities during operations;
- site selection and refinement which reduced the total area of BSAL located within the Development Footprint;
- return to agricultural land at the completion of the Project’s operations; and
- land management practises will avoid or minimise potential impacts to neighbouring agricultural operations that have been identified during engagement with the local community and as part of the LUCRA (Appendix E).

4.2.3 Other Relevant NSW Legislation

Table 4-2 summarises NSW legislation and policies considered applicable to the Project.

Table 4-2 Statutory Approval Framework

Statutory Requirements	Description and Objectives	Relevance to the Project	Location in EIS
NSW Legislation			
Biodiversity Conservation Act 2016 (BC Act)	The purpose of the BC Act is 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. The BC Act establishes mechanisms for： ■ The management and protection of listed threatened species of native flora and fauna (excluding fish and marine vegetation) and threatened ecological communities (TECs). ■ The listing of threatened species, TECs and key threatening processes. ■ The development and implementation of recovery and threat abatement plans. ■ The declaration of critical habitat. ■ The consideration and assessment of threatened species impacts in development assessment process. ■ Biodiversity Offsets Scheme, including the Biodiversity Values Map and method to identify serious and irreversible impacts (SAII). The BC Act also establishes the regulatory framework for assessing and offsetting biodiversity impacts on proposed developments. Where development consent is granted, the authority may impose as a condition of consent an obligation to retire a number and type of biodiversity credits determined under the Biodiversity Assessment Method (BAM). A Biodiversity Values Map and Biodiversity Offsets Scheme Entry Threshold (BOSET) tool are available to identify the presence of mapped biodiversity values within land proposed for development as well as the clearing thresholds that would trigger application of the BAM.	In terms of the proposed solar farm, the proposed development must take into account species likely to occur within available habitat based on existing records of threatened species and ecological communities, as well as those species likely to occur based on geographic distribution and presence of potential habitat.	Section 6.1 provides an assessment of biodiversity impacts. Appendix C – Biodiversity Development Assessment Report
Heritage Act 1977	The *Heritage Act 1977* is administered by the Office of Environment and Heritage (OEH) and aims to protect the natural and cultural heritage of NSW. It provides blanket protection for surface and sub-surface relics and for heritage	The proposed development must assess and take into account historic heritage values of the site.	Heritage section 6.2 of the EIS

Statutory Requirements	Description and Objectives	Relevance to the Project	Location in EIS
	items of state significance listed on the State Heritage Register. The Act defers to local planning instruments under the EP&A Act for the protection of items of local significant.		Appendix D– Cultural Heritage Assessment
National Parks and Wildlife Act 1974	The object of the *National Parks and Wildlife Act 1974* (NPW Act) is to consolidate and amend the law relating to the establishment, preservation and management of national parks, historic sites, certain other area, and the protection of certain fauna, native plants and Aboriginal objects.	In terms of the proposed solar farm, the proposed development must assess and take into account aboriginal cultural heritage values of the site. Under the provisions of section 4.4.1 of the EPA Act, a Section 90 Aboriginal heritage impact permit is not required for SSD projects.	Heritage section 6.2 of the EIS Appendix D– Cultural Heritage Assessment
Wilderness Act 1987	The *Wilderness Act 1987* aims to provide for the permanent protection and proper management of wilderness areas. It also aims to promote the education of the public in the appreciation, protection and management of wilderness.	No land within or in close proximity to the Project Site has been declared as a wilderness area for the purposes of the Wilderness Act and is therefore not subject to any wilderness protection agreement or conservation agreement. Further consideration of the Act is therefore not required.	Not Applicable.
Roads Act 1993	The *Roads Act 1993* addresses authorities, function and regulation of activities relating to the use and type of roads. Approval under section 138 of the Roads Act is required to impact or carry out work on or over a public road.	Section 4.42 of the EP&A Act provides that an approval under section 138 of the Roads Act cannot be refused if it is necessary for carrying out SSD that is authorised by a development consent. Consultation with the Roads and Maritime Services (RMS) and Inverell Shire Council will be undertaken to determine access and necessary upgrading of access points to the proposed project.	Traffic Section 6.7 of the EIS Appendix H– Traffic Impact Assessment

Statutory Requirements	Description and Objectives	Relevance to the Project	Location in EIS
Water Management Act 2000	Part 4.41 of the EP&A Act lists authorisations not required for State significant development. Included in this list is: (g) a water use approval under section 89, a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) under section 91 of the Water Management Act 2000.	The Project Site is covered by the NSW Border Rivers Unregulated and Alluvial Water Sharing Plan (WSP) and therefore the provisions of the Water Management Act 2000 apply. The Project will not interfere with the aquifer and hence will not require approval under this Act.	Section 6.8 provides a preliminary water assessment.
Protection of the Environment Operations Act 1997 (POEO Act)	The POEO Act is the primary piece of legislation regulating pollution control and waste disposal in NSW. Schedule 1 of the POEO Act defines scheduled activities for which an Environmental Protection Licence is required.	Solar energy generation does not fall under the definition of electricity generation under Clause 17 of Schedule 1 of the POEO Act.	Section 6.11 provides an assessment for waste management.
Rural Fires Act 1997 (RF Act)	The RF Act aims to prevent, mitigate and suppress bush and other fires in local government areas of the NSW. Section 63(2) of the RF Act requires the owners of land to prevent the ignition and spread of bushfires on their land.	Under Part 4.41 of the EP&A Act, a bush fire safety authority under Section 100B of the RF Act is not required for SSD that is authorised by a development consent.	Section 6.9.2 assess the risk and mitigation measures of bushfire. Appendix K – Bushfire Risk Assessment
Dangerous Goods (Road and Rail Transport) Act 2008	The Dangerous Goods (Road and Rail Transport) Act 2008 regulates the transport of dangerous goods by road and rail in order to promote public safety and protect property and the environment.	The Project will involve the transportation of the storage batteries which are likely to be defined as dangerous goods.	Section 6.9 assess hazards and risks associated with the Project

Statutory Requirements	Description and Objectives	Relevance to the Project	Location in EIS
Crown Land Management Act 2016	The *Crown Land Management Act 2016* (CLM Act) commenced on 1 July 2018. The objects of the CLM Act are: a) to provide for the ownership, use and management of Crown land of New South Wales, b) to provide clarity concerning the law applicable to Crown land, c) to require environmental, social, cultural heritage and economic considerations to be taken into account in decision-making about Crown land, d) to provide for the consistent, efficient, fair and transparent management of Crown land for the benefit of the people of New South wales, e) to facilitate the use of Crown land by the Aboriginal people of New South Wales because of the spiritual, social, cultural and economic importance of land to Aboriginal people and, where appropriate, to enable to co-management of dedicated or reserved Crown land, and f) to provide for the management of Crown land having regard to the principles of Crown land management.	There is a small parcel of Crown Land is located along the northern boundary of the Project Site (Figure 4-1) and contains a travelling stock route. However, ongoing access to the TSR will not be impacted as a result of the development.	The access road to the Project is proposed to cross the Crown land, which is consistent with how access is provided for all other adjacent allotments fronting the Crown land / TSR. A licence under *Crown Lands Management Act 2016* may be required for this crossing. Landowner's consent for lodgement of the application has also been provided by Crown Land NSW.
Local Land Services Act 2013	The NSW legislation regarding regulation of native vegetation clearing, within land that has been classified Rural, transitioned on 25 August 2017 with the commencement of the amended Local Land Services Act 2013. This Act's purpose includes the establishment of a Native Vegetation Panel responsible for approving native vegetation clearing that does not require development consent, or assessment under Part 5 of the EP&A Act. This Act also manages the use of travelling stock reserves and public roads.	As the Project requires development consent under Part 4 of the EP&A Act, any native vegetation clearing required for the proposed works will fall under the regulations set out in the BC Act. The access road proposed for the Project connects to Bruxner highway, intersecting the TSR running parallel to the north boundary of the Site. Section 75 permits an occupier the right of access over TSRs, to and from the road nearest to the land.	Section 6.1 and BDAR (Appendix C) Local Land Services have confirmed access to the Site is possible subject to further discussions.

Statutory Requirements	Description and Objectives	Relevance to the Project	Location in EIS
State Environmental Planning Policies (SEPP)			
State Environmental Planning Policy (State and Regional Development) 2011	State and Regional Development SEPP identifies development that is SSD. Schedule 1, Cl 20 includes: Development for the purpose of electricity generating works or heat or their co-generation (using any energy source, including gas, coal, biofuel, distillate, waste, hydro, wave, solar or wind power) that: a) has a capital investment value of more than $30 million.	The Project is a development for the purpose of electricity generation using a solar energy source, and will have a capital investment value of more than $30 million.	Section 4.2.2
State Environmental Planning Policy (Infrastructure) 2007	The Infrastructure SEPP provides development controls for infrastructure and services. Clause 34 (7) of the SEPP provides provisions for development that is permitted with consent. Clause 34 (7) states: Solar energy systems Except as provided by subclause (8), development for the purpose of a solar energy system may be carried out by any person with consent on any land.	Sub-clause (8) limits the use of photovoltaic electricity generating systems in residential zones. The Site is not within a residential zone and, therefore, is not affected by this sub-clause. The Project is therefore permissible with development consent.	Figure 4-2
State Environmental Planning Policy (Primary Production and Rural Development) 2019	The Primary Production and Rural Development SEPP replaced SEPP (Rural Lands 2008). The new SEPP aims to: a) to facilitate the orderly economic use and development of lands for primary production, b) to reduce land use conflict and sterilisation of rural land by balancing primary production, residential development and the protection of native vegetation, biodiversity and water resources, c) to identify State significant agricultural land for the purpose of ensuring the ongoing viability of agriculture on that land, having regard to social, economic and environmental considerations, d) to simplify the regulatory process for smaller-scale low risk artificial waterbodies, and routine maintenance of artificial water supply or drainage, in irrigation areas and districts, and for routine and emergency work in irrigation areas and districts,	The Project is not mapped as occurring within the state significant agricultural land as defined in Schedule 1 of the SEPP. The Development Footprint contains approximately 58.3 ha of land mapped as BSAL (refer to *Section 6.3*). Due to the nature of the Proposed Solar Farm, it is unlikely to have large or permanent detrimental impacts on the land. Following construction, sheep grazing will continue across the Development Footprint. Considerations to potential impacts to land is contained within *Section 6.3.*	Section 6.3 Appendix E – Land Use Conflict Assessment

Statutory Requirements	Description and Objectives	Relevance to the Project	Location in EIS
	e) to encourage sustainable agriculture, including sustainable aquaculture, f) to require consideration of the effects of all proposed development in the State on oyster aquaculture, g) to identify aquaculture that is to be treated as designated development using a well-defined and concise development assessment regime based on environment risks associated with site and operational factors.		
State Environmental Planning Policy No 33 (Hazardous and Offensive Development)	SEPP 33 aims to ensure that in considering any application to carry out potentially hazardous or offensive development, the consent authority has sufficient information to assess whether the development is hazardous or offensive and to impose conditions to reduce or minimise any adverse impact. SEPP 33 applies to any development which falls under the policy's definition of 'potentially hazardous industry' or 'potentially offensive industry'.	A preliminary risk screening assessment has been undertaken in accordance with the SEPP 33 for the Project. The findings of the assessment determined that the Project is considered unlikely to be potentially hazardous or offensive, and as such a Preliminary Hazard Analysis (PHA) has not been prepared nor warranted.	Section 6.9
State Environmental Planning Policy No. 44 – Koala Habitat Protection	The objectives of State Environmental Planning Policy No 44 Koala Habitat Protection (SEPP 44) is to conserve and manage areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline.	Inverell Shire is a local government listed in Schedule 1 of SEPP 44 and therefore the SEPP applies. If the Site is deemed to be core koala habitat, there must be a plan of management prepared in accordance with Part 3 of SEPP 44.	Section 6.1 Appendix C – BDAR
State Environmental Planning Policy No. 55 – Remediation of Land	SEPP 55 aims to provide a state wide planning approach to the remediation of contaminated land and in particular promotes the remediation of contaminated land for the purpose of reducing risk of harm to human health and any other aspect of the environment. Under Clause 7 of SEPP 55 a consent authority must not consent to the carrying out of any development on land unless it has considered whether the land is contaminated.	The use of land within the Project Site has been historically and currently used for agricultural purposes.	Section 6.3

4.2.4 Local Legislation

4.2.4.1 Inverell Local Environment Plan

The Project Site is situated within the Inverell Shire and Inverell Local Environmental Plan 2012 (Inverell LEP) applies. The Project Site is zoned RU1 Primary Production under the Inverell LEP (Figure 4-2). The objectives of the zone are:

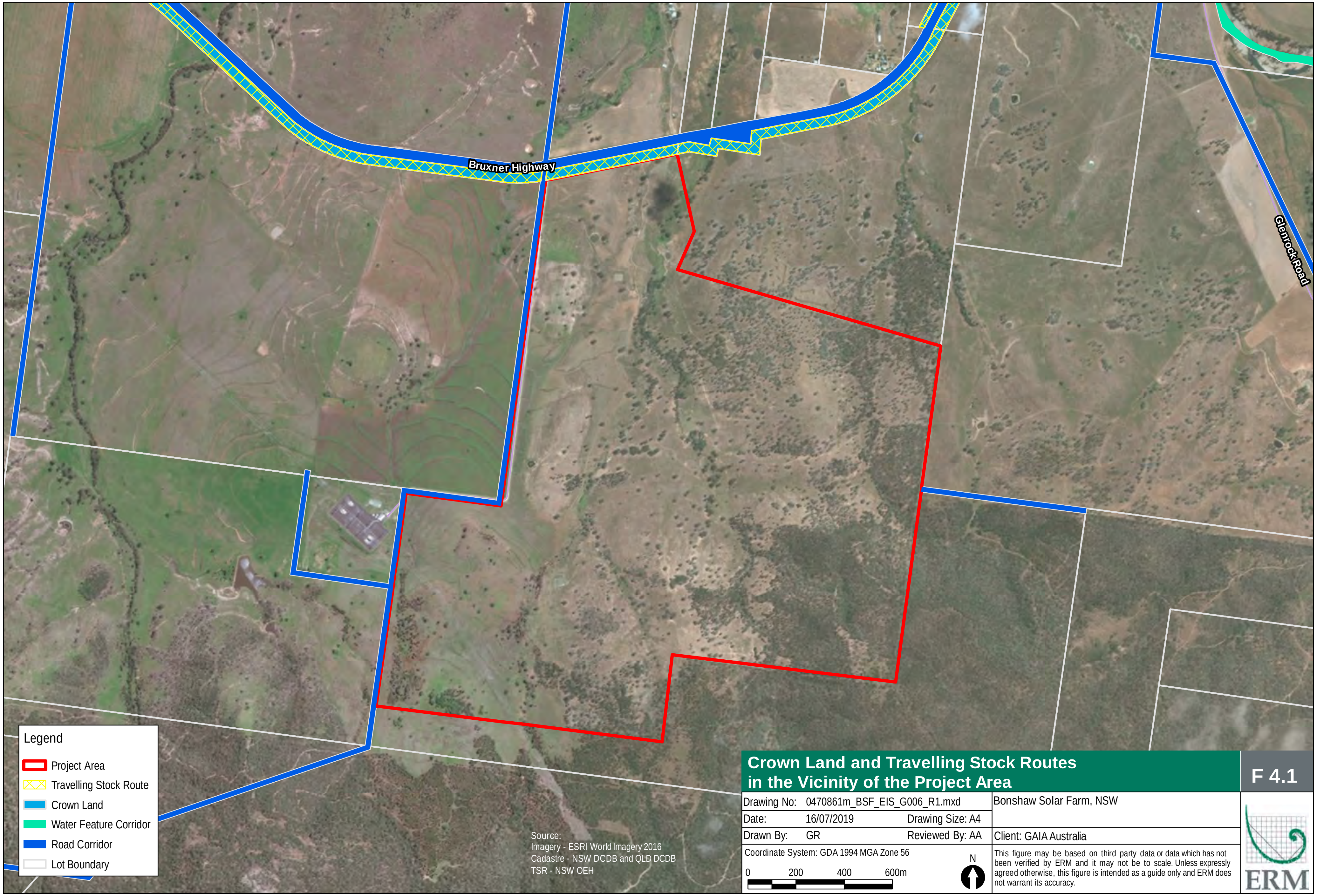
- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To encourage diversity in primary industry enterprises and systems appropriate for the area.
- To minimise the fragmentation and alienation of resource lands.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.

Development for the purpose of electricity generation is not specified in item 2 or 3 of the Inverell LEP for the specified zone, and is therefore ‘Prohibited’. As stated in Section 4.2.3, permissibility of the solar energy development is provided by way of Clause 34 (7) of the Infrastructure SEPP.

Table 4-3 summarises the planning controls relevant to the Site under the Inverell LEP 2012.

Table 4-3 Inverell LEP 2012 Mapping

Inverell LEP 2012 Mapping Attribute	Relevance to Project Site
Land Zoning	Zoned RU1 Primary Production
Minimum Lot Size	200 ha
Heritage	The Project Site is not mapped as containing a heritage item.
Designated Buffer Area	The Project Site is not mapped as being a designated buffer area.



Legend

- ▭ Project Area
- ▨ Travelling Stock Route
- 🟦 Crown Land
- 🟩 Water Feature Corridor
- 🟦 Road Corridor
- ☐ Lot Boundary

Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
TSR - NSW OEH

Crown Land and Travelling Stock Routes in the Vicinity of the Project Area

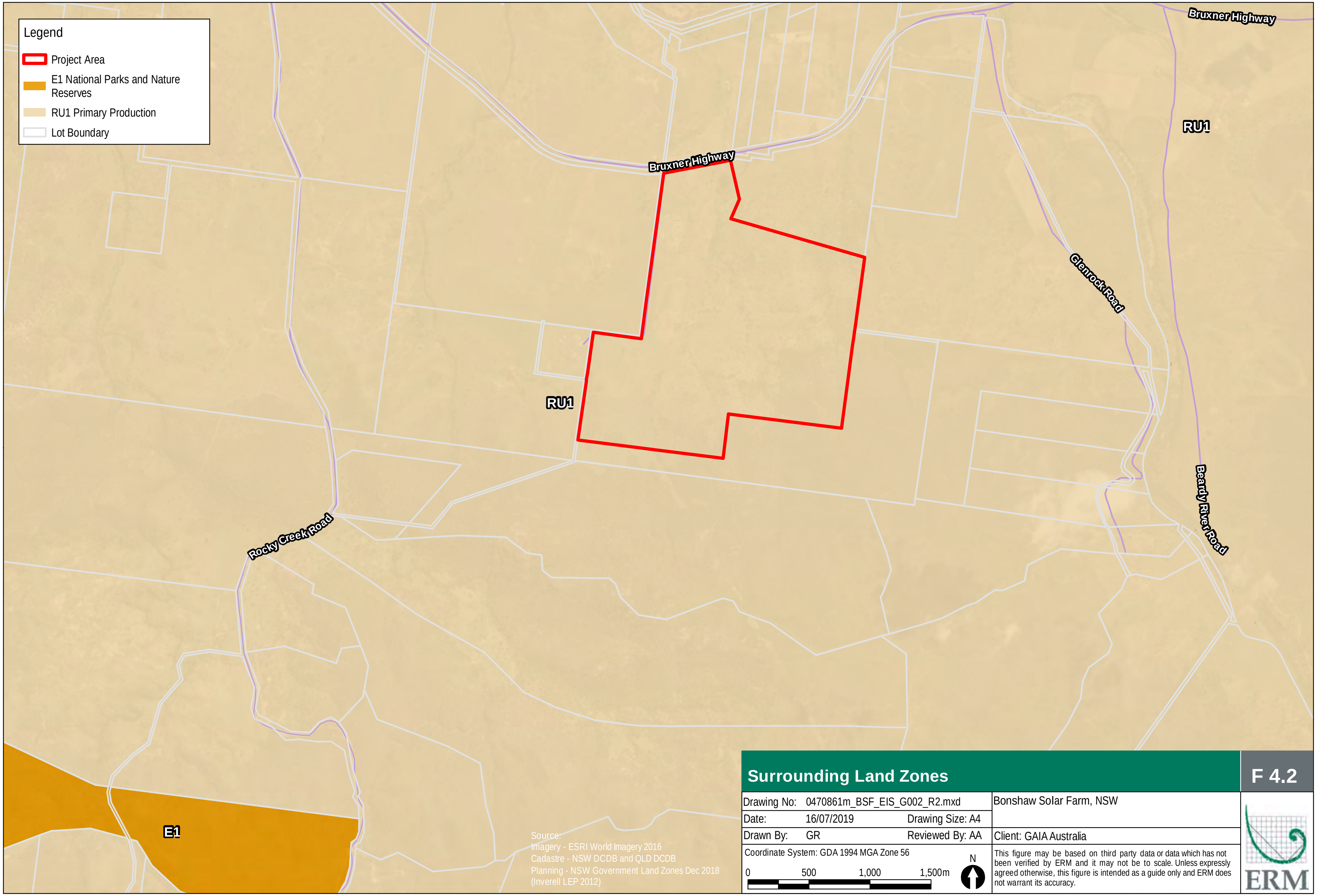
F 4.1

Drawing No: 0470861m_BSF_EIS_G006_R1.mxd
Date: 16/07/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

ERM



Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Planning - NSW Government Land Zones Dec 2018 (Inverell LEP 2012)

Surrounding Land Zones

F 4.2

Drawing No: 0470861m_BSF_EIS_G002_R2.mxd

Date: 16/07/2019 Drawing Size: A4

Drawn By: GR Reviewed By: AA

Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

4.2.5 Large Scale Solar Energy Guideline

The NSW Government released a new guideline for large-scale solar energy proposals on 11 December 2018, to complement the Secretary's environmental assessment requirements. This guideline provides the community, industry, applicants and regulators with information on the planning framework for the assessment and approval of State significant large-scale solar energy proposals.

Table 4-4 below outlines where the items raised in the *Large-Scale Solar Energy Guideline* are addressed in the EIS.

Table 4-4 Application of Guideline to Project

Section of Guideline	Guideline Reference	Guideline Item	Reference in EIS
Planning Framework	2.1	Applicability of 'State Significant Development'	Section 1.1 & Section 1.3
	2.2	Permissibility of solar farm development	Section 4.2
	2.3	Relevance of other approvals	Section 4.2
Stakeholder Engagement	3	Stakeholder engagement	Chapter 5
Site Selection	4.1	Site selection	Section 3.2
	4.2	Site constraints	Section 3.2 & Table 3-2
	4.3	Site selection and constraint mapping	Section 3.2 & Figure 2-1
Assessment Issues	5	Key assessment issues:	-
		■ Strategic Context	Section 4.1
		■ Land Use Conflicts	Section 6.3.3 & Appendix E
		■ Traffic and Transport	Section 6.7 & Appendix H
		■ Batteries	Section 6.9.1 & Appendix J
	5	Other environmental issues:	-
		■ Biodiversity	Section 6.1 & Appendix C
		■ Heritage	Section 6.2 & Appendix D
		■ Visual Impacts	Section 6.4 & Appendix F
		■ Water	Section 6.8 & Appendix I
		■ Hazards and Risks	Section 6.9, Appendix J & Appendix K
		■ Health	Section 6.9.3
		■ Waste	Section 6.11
		■ Cumulative Impacts	Section 6.12
		■ Social and Economic Impacts	Section 6.10
		■ Noise	Section 6.6 & Appendix G
		■ Public Interest	Chapter 3, Chapter 5 & Section 8.3.2

5. COMMUNITY AND STAKEHOLDER ENGAGEMENT

This Chapter of the EIS provides details of consultation undertaken with local, State and Commonwealth authorities, the local community, relevant stakeholders and affected landholders.

5.1 Introduction

Community and stakeholder engagement is an integral part of any major development. GAIA is committed to effective and genuine engagement with key stakeholders and the local community to seek feedback to help inform the Project design and layout. Consultation commenced in January 2017 and has been undertaken in accordance with the Community and Stakeholder Engagement Plan prepared for the Project (ERM 2019) and as required by the following documents:

- SEARs as issued 16 August 2018;
- Draft Guideline 6 on Community and Stakeholder Engagement (DPE, 2017b); and

Issues raised by stakeholders have been considered in the refinement of the Development Footprint and size of the Project.

5.2 Engagement Objectives

The key objectives of the consultation and engagement process are to:

- ensure key stakeholders and issues are identified and mapped appropriately;
- ensure stakeholders have access to balanced, objective, timely and up-to-date information about the Project and the planning and environmental assessment process;
- ensure community issues and concerns in relation to the Project are identified at an early stage of the environmental assessment;
- ensure there are various mechanisms and multiple opportunities for stakeholders to provide feedback on the Project and to inform the Project design and layout;
- ensure accurate recording of any feedback provided;
- manage project-related expectations and misconceptions;
- ensure the community understands how their input has informed the development of appropriate solutions to avoid, minimise or offset any negative impacts associated with the Project and has ultimately influenced the Project design and development; and
- ensure compliance with consultative requirements under the SEARs, the Draft Guideline 6 on Community and Stakeholder Engagement and other relevant planning instruments and guidelines.

5.3 Engagement Approach

Following a stakeholder mapping exercise to identify key stakeholders (community and regulatory), a range of engagement tools were deployed to engage with and seek input from the various stakeholders. This included:

- **Face-to-Face Meetings**: specific, targeted meetings with selected key stakeholders has been undertaken to discuss the Project and facilitate in-depth engagement and transfer of Project information. This included meetings with various regulatory authorities and stakeholders, together with sensitive receptors and neighbouring properties. These stakeholders included:
    - Inverell Shire Council;
    - Tenterfield Shire Council;
    - NSW Office of Environment and Heritage;

  - NSW DP&E;
  - Surrounding land owners; and
  - Registered Aboriginal Parties

- **Letter Box Drop:** A letterbox drop was undertaken to initially notify surrounding residences of the Project and to enable subsequent face to face meetings.
- **Letters:** As part of the heritage assessment, letters advising of the Project and actively seeking their input were distributed to relevant stakeholders, including:
  - Moombahlene Local Aboriginal Land Council (LALC);
  - Local Land Services (LLS) South-East Region;
  - National Native Title Tribunal (NNTT);
  - Native Title Services Corporation (NTS Corp);
  - NSW OEH Regional Operations Coffs Harbour Branch;
  - Office of the Registrar, Aboriginal Land Rights Act (1983);
  - Tenterfield Shire Council; and
  - Inverell Shire Council.
- **Website:** A Project website was developed providing a central location for Project information and status. It provides project information, latest news and is a point of contact for interested stakeholders, offering the option to submit an inquiry
- **Advertisement:** As part of the heritage assessment, advertisements were placed in the Inverell Times and Tenterfield Star and published on 6 July 2018 and 11 July 2018 respectively.
- **Email and Phone calls:** Throughout the Project, ongoing communication with key landowners will utilise either email or phone calls to maintain a stakeholder relationship, offer a point of contact and provide further information upon stakeholder request.
- **Newsletters:** Throughout the Project, ongoing communication with the surrounding landowners will be undertaken at key milestones. This will ensure that the local community is informed about the progression of the Project and provide information on how to request further information if required.

5.4 Engagement Outcomes

Stakeholders engaged, interests and engagement outcomes are detailed in Table 5-1 for the regulatory authorities, government stakeholders, non-government stakeholders and community organisations

Table 5-1 Stakeholders, Potential Interests and Consultation Outcomes

Stakeholder	Project Interests	Issues Raised	Project Response
Regulatory Authorities and Government Stakeholders			
■ NSW Department of Planning and Environment (now Department of Planning, Industry and Environment)	■ Planning and approvals ■ Environmental impacts ■ Consultation	■ Stakeholder engagement and consultation. ■ Environmental impact assessment.	■ The EIS has been prepared consistent with the requirements of the SEARs. ■ Consultation with relevant stakeholders has been undertaken throughout the preparation of the preliminary Environmental Assessment Report and EIS. ■ Reduction in footprint from that originally proposed in the PEA to minimise environmental impacts.
■ NSW Office of Environment and Heritage	■ Biodiversity ■ Heritage	■ Preliminary survey results, ■ Survey methodology, ■ Identification of the Bristle-faced Free-tailed Bat (*Mormopterus elecryi*), and ■ Inclusion of Common Couch (*Cynodon dactylon*) in BAM calculations, regardless of its introduction to the area as a pasture species.	■ Additional field surveys were undertaken to ensure effective coverage in accordance with OEH advice. ■ Additional 28 floristic survey plots to ensure effective coverage of the all areas of grassland in accordance with OEH advice. ■ ERM have obtained a supplementary report to confirm the accuracy of the species identification. ■ ERM have updated the assessment and Common Couch (*Cynodon dactylon*) is now included within the calculations. ■ 35 Aboriginal heritage sites (and three associated Potential Archaeological Deposits) have been recorded. 29 of these sites were stone artefacts including isolated finds and stone artefact scatters. Seven scarred trees were also identified. ■ Careful detailed design of the Project footprint has successfully avoided several of these heritage sites and biodiversity values. Areas avoid will be retained and protected from any direct and/or indirect impacts.

Stakeholder	Project Interests	Issues Raised	Project Response
■ NSW Department of Primary Industries	■ Agricultural land	■ No response.	■ Agricultural grazing with the Development Footprint will continue post construction.
■ NSW Department of Industry – Crown Lands and Water	■ Crown lands ■ Water resources	■ No response.	■ Minimisation of impacts to watercourse by creating an offset from the riparian corridor. The riparian zone will be surveyed prior to detailed designed to ensure the Development Footprint is offset and outside second and third order streams.
■ NSW Environment Protection Authority	■ Pollution ■ Licensing	■ No response.	■ No licence is required. ■ The Project will not have any discharges from site.
■ NSW Roads and Maritime Services	■ Road safety ■ Traffic impacts ■ Construction	■ Construction activities and heavy vehicle access. ■ Construction workforce traffic movements. ■ Access routes ■ Operational characteristics and decommissioning.	■ Traffic impact assessment has been completed. ■ A Traffic Control Plan will be in place during construction work to ensure safety for road users and construction workers is managed in an appropriate manner.
■ NSW Local Land Services	■ Travelling Stock Reserves ■ Construction	■ Impacts to Travelling Stock Reserves along the north boundary through the construction of proposed access road.	■ Discussions with Local Land Services have confirmed access to the site is possible subject to further discussions.
■ NSW Rural Fire Service	■ Bushfire ■ Fire safety	■ No response.	■ Bushfire assessment has been undertaken to address the requirements of the SEARs and Planning for Bushfire Protection Guidelines.
■ Civilian Aviation Safety Authority (CASA)	■ Aviation safety ■ Glare	■ Response provided – no issues raised.	■ The visual impact assessment includes an assessment of glare, with impacts to be minimal. ■ The solar panels are made of a non-reflective coating to increase efficiency.

Stakeholder	Project Interests	Issues Raised	Project Response
■ Inverell Shire Council	■ Traffic and road safety ■ Visual ■ Environmental impacts ■ Economic and social benefits	■ Council will not be assessing the EIS and will provide comments to ensure key issues considered. ■ Positive experience with previous renewable projects. ■ Accommodation and housing. ■ Timing and scale of project construction.	■ The General Manager and Councillors have been briefed on the Project and received a very positive response. ■ The Manager of Development Service has been briefed. The information was appreciated and it was indicated that Council would like to be kept informed of the Project. ■ Further consultation with Council was undertaken in relation to the transport route arrangements prior to lodgement of the DA.
■ Tenterfield Shire Council	■ Economic and social benefits ■ Traffic implications of construction traffic passing through Tenterfield LGA	■ Accommodation and housing – would like Tenterfield to realise economic benefits of worker accommodation. ■ Timing and scale of project construction in light of New England Highway Upgrade at Mount Bolivia through 2019.	■ It is likely that the New England Highway Upgrade at Mount Bolivia will be completed or substantially completed by the time the construction of the Bonshaw Solar Farm is commenced, thereby providing an additional source of accommodation.
Non-Government Agencies and Organisations			
■ Inverell Chamber of Commerce	■ Socioeconomic	■ The Chamber will assist in ensuring its members are able to provide a coordinated response to resourcing worker accommodation.	The Project will require ongoing consultation with the Chamber to ensure timing and resourcing is clear.

Stakeholder	Project Interests	Issues Raised	Project Response
▪ Registered Aboriginal Parties	▪ Aboriginal heritage	▪ Impacts to Aboriginal heritage.	▪ 35 Aboriginal heritage sites (and three associated Potential Archaeological Deposits) have been recorded. 29 of these sites were stone artefacts including isolated finds and stone artefact scatters. Seven scarred trees were also identified. ▪ Careful detailed design of the Project footprint has successfully avoided several of these heritage sites. Areas avoided will be retained and protected from any direct and/or indirect impacts.
▪ Electricity network service providers (TransGrid)	▪ Grid connection	▪ No issues raised.	▪ Capacity of grid network confirmed ▪ Ongoing discussions regarding connection to Dumaresq substation and electricity provision.

5.5 Surrounding Community

The Proponent is committed to establishing a comprehensive program of community consultation in accordance with available best practice engagement guidelines. The following sections 5.5.1 – 5.5.4 details measures that have been undertaken to inform and empower the surrounding community. These actions have been further recorded within Table 5-2, which provides a summary of the surrounding community engagement actions.

5.5.1 SEARS and Community and Other Stakeholder Participation

Stakeholder mapping was undertaken and identified all adjoining and surrounding sensitive receptors within 2km of the original project site with these landowners contacted initially via letter box drop to notify them of the project. Since this initial contact, the Project has been revised to include a smaller Development Footprint and therefore some landowners engaged are beyond 2km from the site, as shown in Figure 5-1.

GAIA met with fifteen surrounding residences on-site on the 15th June 2018. During this process one resident voiced concerns in relation to ‘heat island effects’ and ‘visual amenity’ impacts. GAIA met with this individual to discuss the project further and provided additional information on the proposed solar farm layout. This ensured that the resident was appropriately informed and their concerns were resolved.

Ongoing liaison with surrounding residences and stakeholders is being undertaken throughout the assessment of the EIS via email, phone, face-to-face meetings and newsletters at key milestones. Additionally, a consultation log has been developed to track the engagement activities, key issues, actions and outcomes.

5.5.2 Community and Stakeholder Engagement Plan

A Community and Stakeholder Engagement Plan (CSEP) has been prepared as an active document. The document has been developed and communicates the following:

- The outcomes of the participation by the community and key stakeholders;
- Engagement activities that were and are available to the community and key stakeholders; and
- All available project information that is available to the public.

This document describes the detailed consultation approach that the Proponent has undertaken during the preparation of the EIS to achieve the outcomes of the Scoping Report and SEARs. The CSEP has been guided based on the information that was obtained during the initial and continued consultation of the community and key stakeholders.

Additionally, the Proponent has utilised the ‘engagement toolkit’ techniques within the ‘Community and Stakeholder Engagement - Draft Environmental Impact Assessment Series 2017’. The Proponent has developed a website, which is continually updated at key milestones within the Project. A newsletter format has also been developed and is circulated as key milestones are reached. The Proponent has also ensured that their contact details are available if any community member has a concern. Lastly, the Proponent has also undertaken site meetings and briefing to relay the Project to the surrounding community and ensure they have been provided a platform to communicate any concerns they may have.

5.5.3 Reporting on Community and Other Stakeholder Participation

A detail spreadsheet has been developed to record all activities the Proponent has undertaken within the surrounding community. Specifically, follow up phone calls, website updates and newsletters at key milestones has been provided to the surrounding community post EIS submission.

5.5.4 Evaluating Community and Other Stakeholder Participation

During the scoping phase it was proposed to develop a larger area, however, based on community consultation this area was reduced. This mitigated against potential visual amenity impacts that were a concern of one adjoining owner.

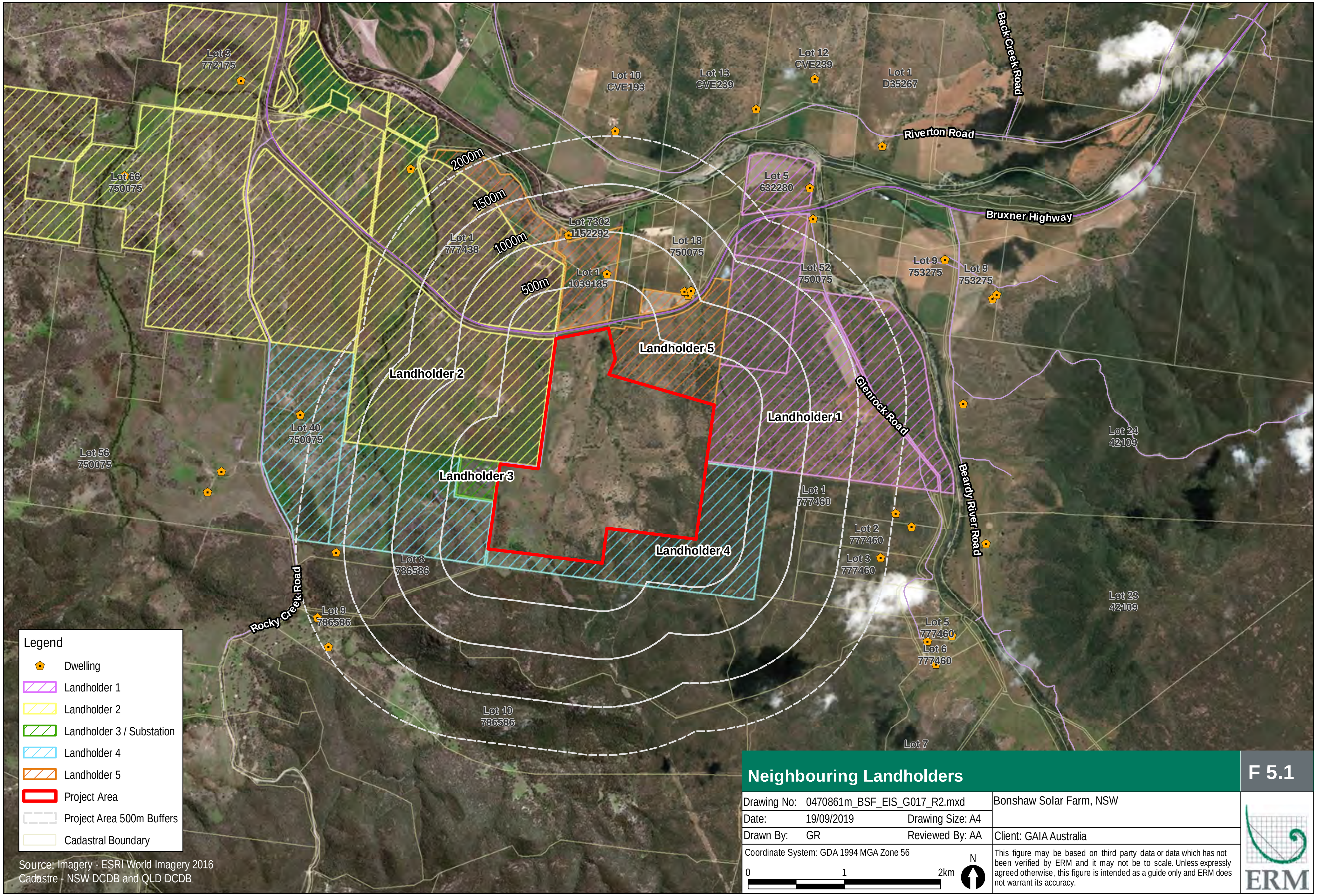
Table 5-2 Surrounding Community

Land Owners	Level of Engagement	Issues Raised	Project Response
Adjoining Owners			
Landowner 1 Lot 29 on DP 750075 Lot 5 on DP632280 Lot 52 on 750075	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting ■ Individual 'Face to Face' meeting ■ Receives newsletter when key milestones have been met.	No issues raised Interested in opportunities for further Solar Farm development.	Will receive newsletter when key milestones have been met.
Landowner 2 Lot 200 on DP 879480 Lot 1 on DP777438 Lot 3 on DP772175 Lot 66 on DP750075	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting ■ Individual 'Face to Face' meeting ■ Receives newsletter when key milestones have been met.	No issues raised, very excited about solar farm development Interested in opportunities for further Solar Farm development.	Will receive newsletter when key milestones have been met.
Landowner 3 – TransGrid Lot 201 on DP879480	Please refer to Table 5-1		
Landowner 4 Lot 40 on DP 750075	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting ■ Individual 'Face to Face' meeting ■ Receives newsletter when key milestones have been met.	Owns land for grazing and is concerned about potential 'heat island impacts'. Would like a hedge for visual amenity reasons.	A 'Face to Face' individual meeting was held to discuss how PV solar operates. Additionally, information was provided on how PV generation will not cause heat island effects on their land. The project area has been refined and the visual impacts have been resolved.
Landowner 5 Lot 1 on DP1039185 Lot 5 on DP632280	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting ■ Individual 'Face to Face' meeting	No issues raised. Interested in opportunities for further Solar Farm development.	Will receive newsletter when key milestones have been met.

Land Owners	Level of Engagement	Issues Raised	Project Response
	■ Receives newsletter when key milestones have been met. ■ Opportunities for further Solar Farm development.		
Sensitive Receptors			
Lot 18 on DP750075	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 1 on DP1039185	■ Letter box drop – advising of community meeting and website details ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 8 on DP786586	■ Letter box drop – advising of community meeting and website details ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 9 on DP786586	■ Letter box drop – advising of community meeting and website details ■ Receives newsletter when key milestones have been met	Letter sent back	Will receive newsletter when key milestones have been met.
Lot 10 on DP786586	■ Letter box drop – advising of community meeting and website details ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 1 on DP777460	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 2 on DP777460	■ Letter box drop – advising of community meeting and website details ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.

Land Owners	Level of Engagement	Issues Raised	Project Response
Lot 3 on DP777460	■ Letter box drop – advising of community meeting and website details ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Other Surrounding Sensitive Receptors			
Lot 1 on D35267 (QLD)	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting ■ Individual ‘Face to Face’ meeting ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 12 on CVE239 (QLD)	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 13 on CVE239 (QLD)	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 10 on CVE 193 (QLD)	■ Letter box drop – advising of community meeting and website details ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 56 on DP750075	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 9 on DP753275	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting	No issues raised, but very excited about the	Will receive newsletter when key milestones have been met.

Land Owners	Level of Engagement	Issues Raised	Project Response
	■ Receives newsletter when key milestones have been met	employment benefit to the community	
Lot 24 on DP42109	■ Letter box drop – advising of community meeting and website details ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 23 on DP42109	■ Letter box drop – advising of community meeting and website details ■ Attended site meeting ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 5 on DP777460	■ Letter box drop – advising of community meeting and website details ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 6 on Dp777460	■ Letter box drop – advising of community meeting and website details ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.
Lot 7 on DP 777460	■ Letter box drop – advising of community meeting and website details ■ Receives newsletter when key milestones have been met	No issues raised	Will receive newsletter when key milestones have been met.



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB

Neighbouring Landholders

F 5.1

Drawing No: 0470861m_BSF_EIS_G017_R2.mxd		Bonshaw Solar Farm, NSW
Date: 19/09/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: AA	Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

5.6 Ongoing Commitment to Stakeholder Engagement

GAIA is committed to continued ongoing and thorough community engagement with all stakeholders. The ongoing stakeholder engagement detailed in the subsequent sections is proposed during the approvals process and post approval during the construction and operational phases of the Project.

5.7 Public Exhibition of the EIS

In accordance with the statutory requirements, the EIS will be exhibited for a minimum of 30 days for public comment. A copy of the EIS will be made available on DPI&E's Major Projects website.

During the public exhibition period, there are further opportunities for the community to engage with the Proponent, and the expert consultants that undertook the specialist technical assessments supporting the EIS. A community information session will coincide with the public exhibition period. This will provide the community with an opportunity to meet with the representatives of GAIA and technical specialists to discuss the EIS process; learn about the Project and the approach undertaken to assess project benefits and impacts.

5.8 Future Consultation Activities

Should the Project be approved, consultation and engagement with the local community will occur throughout the construction and operational phases of the Project. Consultation activities will be similar to that undertaken to date and will likely involve:

- continued presence of the dedicated Project website to provide direct information and formal feedback options to stakeholders and the community;
- newsletters providing regular updates on the progress of the Project and important dates and events;
- regular community information sessions at key stages of the Project; and
- briefings with key stakeholders including the DPI&E, Inverell Council and Tenterfield Council.

6. ENVIRONMENTAL IMPACT ASSESSMENT

This Chapter of the EIS addresses the following specific issues in accordance with the SEARs: Biodiversity, Heritage, Land, Visual, Noise, Transport, Water, Hazards & Risks, Socio-Economic and Waste.

6.1 Biodiversity

A Biodiversity Development Assessment Report (BDAR) has been prepared by ERM (2019) to assess biodiversity values of the Project (refer to Appendix C). The BDAR was prepared in accordance with the requirements of the NSW *Biodiversity Conservation Act 2016*, including the Biodiversity Assessment Method (BAM) and Offsets Scheme. Other requirements considered included the Commonwealth *Environmental Biodiversity Assessment Act 1999* and SEARs provided for the Project. Other legislation taken into account during preparation of the BDAR included:

- NSW Biosecurity Act 2015;
- NSW Water Management Act 2000;
- NSW Fisheries Management Act 1994;
- NSW State Environmental Planning Policy (SEPP) No. 44 – Koala Habitat Protection; and
- Commonwealth Environmental Protection and Biodiversity Conservation Act 1999.

6.1.1 Methodology

Preparation of the BDAR included the following:

- Desktop assessment including identification of landscape features, review of historical record of threatened species and existing vegetation mapping by consulting databases, including:
  - NSW Office of Environment and Heritage’s Threatened Species Data Collection (TSDC) via BioNet Atlas, Vegetation information system (VIS) and threatened biodiversity profiles;
  - NSW Government Sharing and Enabling Environmental Data (SEED) portal;
  - Review of Maters of National Environmental Significance in the Commonwealth’s Department of Environment and Energy (DoEE) Protected Matters Search Tool;
  - DoEE’s threatened species profiles (SPRAT); and
  - Review of existing vegetation mapping as per the State Vegetation Type Map – Borders Rivers Gwydir / Namoi (VIS ID 4681).
- Surveys were undertaken during three periods, spring (10 and 14 September 2018), summer (10 and 14 December 2018) and autumn (25 and 29 March 2019). Surveys included:
  - Rapid flora observations, vegetation ground-truthing and fauna habitat observations along random meander transects;
  - Flora surveys: vegetation integrity plots (42) and paddock tree assessment; and
  - Fauna surveys: play call back surveys for amphibians, camera trapping for target arboreal fauna, recording of microchiroptean echolocation calls, reptile surveys in rocky areas and bird surveys.
- Assessment of Biodiversity values in accordance with the Biodiversity Assessment Method (BAM), including:
  - Review of the Biodiversity Values Map;
  - Vegetation assessment;
  - Vegetation integrity plots;
  - Paddock tree assessment; and

  - Use of the Calculator to assess vegetation integrity scores, identify and assess ecosystem and species credit species.
- Impact assessment.

6.1.2 *Existing Environment*

The Project Site and the locality has undergone a long history of disturbance, including clearing for agricultural and grazing land use. The Development Footprint is mainly cleared land and its current land use is low intensity grazing.

Landscape Features

The key landscape features reported within the Project Site are:

- The Project is located in the NSW Nandewar Norther Complex IBRA Subregion, part of the Nandewar IBRA Bioregion. It is part of the Ashford Mole Valley Mitchell Landscape; and
- The Project Site contains un-named tributaries of the Dumaresq River, including third, second and first order streams. Aquatic habitat within the Development Footprint includes six first order streams and six man-made farm dams.

Vegetation Communities

The Development Footprint occupies 166.76 ha, of which approximately 66% (109.92ha) is cleared land and 34% (56.84 ha) constitutes native vegetation.

Vegetation ground-truthing identified three Plant Community Types (PCTs) in various conditions (woodland and derived grasslands) (see Figure 6-1). None of these PCT constitute part of any Threatened Ecological Community (TEC).

The PCTs are:

- PCT 516 – Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion. This PCT is present as moderate and very low condition vegetation;
- PCT 594 – Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion. This PCT is present in moderate and low condition; and
- PCT 596 – Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion. Four vegetation zones of PCT 596 are present, moderate, low, very low and as derived grasslands.

A total of 5 paddock trees are present within the Development Footprint (see Figure 6-2).

Flora and Weeds

A total of 143 flora species in 47 families were recorded within the Development Footprint. This included a total of 111 native (78 %) and 32 exotic (22 %) species. The most numerous families were Poaceae (30 species), Asteraceae (21 species) and Fabaceae (Faboideae) (10 species). Exotic species included two Weeds of National Significance (WoNS) (Tiger Pear (*Opuntia aurantiaca*) and Velvet Tree Pear (*Opuntia tomentosa*).

Priority weeds for the Northern Tablelands include Fireweed (*Senecio madagascariensis*) which was commonly encountered across the Project Site.

Fauna and Fauna Habitat

Fauna and fauna habitat identified within the Development Footprint included:

- 34 hollow-bearing trees, eleven rocky areas, 39 termite/ant mounds, 20 bird nests and farm dams (see Figure 6-3).
- A total of 75 fauna species were recorded across the Development Footprint, including eleven threatened species (see Figure 6-4). Recorded threatened species are:
  - Grey-crowned Babbler (*Pomatostomus temporalis*) (Vulnerable under the BC Act)
  - Cicadabird (*Coracina tenuirostris*) (Migratory EPBC Act)
  - Definite echolocation call of six vulnerable (BC Act) microchiropteran bats: Little Pied Bat (*Chalinolobus picatus*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Corben's Long-eared Bat (*Nyctophilus corbeni*), Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*), Eastern Cave Bat (*Vespadelus troughtoni*) and Eastern False Pipistrelle (*Falsistrellus tasmaniensis*).
  - Definite echolocation call of the endangered (BC Act) Bristle-faced Free-tailed Bat (*Mormopterus eleryi*).
  - Potential echolocation call of two vulnerable (BC Act) species: Greater Broad-nosed Bat (*Scoteanax rueppellii*) and Hoary Wattled Bat (*Chalinolobus nigrogriseus*).

In accordance with the 'Species Credit' threatened bats and their habitats guide (OEH 2018), the threatened microchiropteran bat species fall into the following credit species types:

- Ecosystem Credit Species:
  - Little Pied Bat (*Chalinolobus picatus*) (V)
  - Eastern Bent-winged Bat (*Miniopterus schreibersii oceanensis*) (V) – Foraging Habitat only
  - Corben's Long-eared Bat (*Nyctophilus corbeni*) (V)
  - Eastern False Pipistrelle (Falsistrellus tasmaniensis) (V)
  - Greater Broad-nosed Bat (*Scoteanax rueppellii*) (V)
  - Hoary Wattled Bat (Chalinolobus nigrogriseus) (V)
  - Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*) (V)
- Species Credit Species:
  - Bristle-faced Fee-tailed Bat (*Mormopterus eleryi*) (E)
  - Eastern Cave Bat (*Vespadeuls vulturnus*) (V)
  - Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) (V) – Breeding habitat only listed as SCS.

6.1.3 Assessment

Impacts on Vegetation

The Project will result in clearing of 47.52 ha of mapped native vegetation and 46.09 ha of disturbed grassland (with vegetation integrity score >17) pertaining to three PCTs and in differing condition including:

- 9.79 ha of PCT 516 – Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion;
- 71.73 ha of PCT 594 – Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion; and
- 12.09 ha of PCT 596 – Tumbledown Red Gum - White Cypress Pine - Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion.

Ecosystem Credit Species

A total of eight ecosystem credit species were recorded within the Development Footprint, one bird (Grey-crowned Babbler) and seven microchiropteran bats (Little Pied Bat, Eastern Bent-winged Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat, Hoary Wattled Bat and Yellow-bellied Sheath-tailed Bat).

The Cicadabird was also recorded in the Development Footprint. Although this species is not listed under the BC Act, the species was considered for assessment of impacts due to its national listing as a matter of national environmental significance (migratory species). A significant impact assessment in accordance with DoE (2013) *Matters of National Environmental Significance. Significant Impact Guidelines 1.1 under the Environment Protection and Biodiversity Conservation Act 1999* (See Appendix C). The assessment concluded that the Project would not result in significant effects on the long-term survival of the Cicadabird.

Grey-crowned Babbler

The Grey-crowned Babbler was observed during surveys in September and December 2018 and heard during the March 2019 survey. In December 2018, the Grey-crowned Babbler was recorded in 20 points within the Development Footprint and a total of 17 bird nests likely to belong to the species were observed. The records included six individuals observed, 21 calls heard with an additional two potential calls heard at distance. A pair was observed adding twigs to a nest located on the lower branches of a Silver-leaved Ironbark (*Eucalyptus melanophloia*). The species was recorded in PCT 594 and 516. The Project will result in loss of habitat for the species, including removal of eight trees with nests. A test of significance was undertaken for the species, including mitigation measures such as salvage and translocated of nests. It was concluded that, based on the implementation of the mitigation measures provided, the Project will not result in significant effects on the long-term survival of the species.

Microchiropteran Bats

A risk assessment was undertaken for the seven microchiropteran bats classified as ecosystem credit species and it was concluded that the Project is unlikely to have a significant impact on these highly mobile mammals.

Species Credit Species

Three microchiropteran bat species classified as species credit species were recorded, Bristle-faced Free-tailed Bat, Eastern Cave Bat and Eastern Bentwing Bat. The Eastern Bentwing Bat is a species credit species only with regards to breeding habitat. The Bristle-faced Free-tailed Bat is assumed to depend on hollow-bearing trees as habitat for roosting and breeding, whereas the Eastern Cave Bat and Eastern Bentwing Bat depend on caves, scarps, cliffs, disused mine structures as breeding habitat. Suitable breeding habitat for the Eastern Cave Bat and Eastern Bentwing Bat is not present within the Development Footprint.

Habitat polygons for Species Credit Species (SCS) were assessed in accordance with Step 5 of Section 6.4 of the BAM (OEH 2017 and OEH 2018). Based on the analysis of habitat availability for SCS within the Development Footprint (see Appendix C), species polygons for SCS are only required for the Bristle-faced Free-tailed Bat. The other microchiropteran bat within the SCS credit class recorded within the assessment area are not considered to have suitable breeding and/or roosting habitat within the Development Footprint.

The habitat polygon for the Bristle-faced Free-tailed Bat includes land within 500m of a creek line. Based on this requirement, the entire Development Footprint is mapped habitat for the species.

Serious and Irreversible Impacts

A Serious and Irreversible Impact (SAII) is listed under the BC Act as an impact that is likely to contribute significantly to the risk of extinction of a threatened entity. In accordance with the BAM, species and ecological communities with a 'very high' biodiversity risk weighting will be a potential serious and irreversible impact (SAII). Whenever potential SAII are identified for a Development Site, those SAII need to be addressed as per Section 10.2 of the BAM (OEH 2017a).

The following guidelines were consulted to identify potential SAII:

- OEH (2017b) Guidance to assist a decision-maker to determine a serious and irreversible impact.
- OEH (2018b) 'Species Credit' threatened bats and their habitats guide.

Based on candidate ecosystem credit species, records of species credit species, the results of the extensive field surveys and lack of any caves or rocky outcrops SAII are not present in the Project Site.

6.1.4 Mitigation Measures

The mitigation hierarchy approach avoid-minimize-offset was followed to reduce as far as practicable potential impacts on the biodiversity values identified within the Project.

Avoiding and Minimising Impacts

GAIA has undertaken significant steps to avoid, minimize and mitigate impacts on biodiversity values (native vegetation and fauna habitat), including:

- Various options relating to location, technology and scale of the Project were evaluated in developing the proposal. The site was selected as being a suitable site for a solar plant based on;
  - A mostly cleared landscape with minimal vegetation removal required;
  - Compatible land use zoning of the land; and
  - Proximity to the transmission network.
- identification of biodiversity values through comprehensive, rigorous and thorough biodiversity surveys;
- communication of identified values to the Project team;
- consultation between the design team and project ecology leader to consider direct and indirect impacts and work through the design process to achieve a feasible project with the least biodiversity impact; and
- Consultation with OEH, to seek input and discuss measures proposed to avoid and minimise impacts (see Table 5-1).

Through continued detailed design, the Project will avoid the following areas of high biodiversity value:

- Avoid the large areas of intact vegetation communities within the eastern and south eastern portion of the Project Site;
- Avoid all areas mapped at TEC within the Project Site;
- The second and third order watercourses will be avoided through detailed design and survey, with riparian buffers to be applied either side of the streams, measured from the edge of the top of bank. The buffers applied to this BDAR are 20m either side of the second order stream and 30m to either side of the third order streams;
- Locating ancillary facilities in areas where there are minimal biodiversity values; and

- Select solar panel design which will reduce net loss of native vegetation within the solar panel fields. Based on this, clearing will result in net loss of native vegetation in 40% of the Development Footprint, whereas clearing in the remaining 60% will only result in reduction of the vegetation integrity score. This will be the case as only trees and shrubs will be removed on 60% of the Development Footprint, whereas groundcover under the solar arrays (albeit shaded) will continue to be available for grazing (sheep).

Mitigation measures

The key measures required to mitigate the impacts of the proposal is provided below Table 6-1.

Table 6-1 Recommended mitigation measures for residual impacts

Impact	Mitigation Measure	Responsibility	Timing	Reporting
Loss of Species Credit Species Habitat or Individuals	Vegetation clearance: ■ Preparation and implementation of a vegetation clearing protocol. ■ Clearing to be supervised by an experienced fauna catcher / ecologist. ■ Time works to avoid critical life cycle events such as breeding. ■ Monitoring of the hollows prior to removal to avoid impacting any breeding females or juveniles. If Bristle-cased Freetail Bat is confirmed utilising any of the hollow bearing trees, the trees will be left undisturbed and managed in accordance with the Biodiversity Management Plan. ■ Replacement of trees at a rate of 2:1 (i.e. two trees will be planted to replace each hollow bearing tree removed). This results in planting of 68 new trees within the riparian corridor. In the event that a newly-planted tree dies during the lifespan of the solar farm, the client has the responsibility to replace it in order to achieve a 100% recruitment of 68 trees. ■ Nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm. ■ No stockpiling or storage within dripline of any mature trees.	■ Principal contractor to ensure implementation of vegetation clearing protocol. ■ Experienced fauna catcher / ecologist to supervise clearing and relocate native fauna.	■ Vegetation clearing protocol to be prepared by an ecologist prior to vegetation clearing. ■ Clearing supervision to occur during the entire clearing process. ■ Letter with results of clearing to be prepared by the fauna catcher/ecologist supervising the clearance. Letter to be available for review by delegated authority (if requested).	Vegetation Clearing Protocol as part of Biodiversity Management Plan

Impact	Mitigation Measure	Responsibility	Timing	Reporting
	■ Approved clearing limits to be clearly delineated with temporary fencing or similar prior to construction commencing.			
Grey-crowned Babbler habitat	Nest removal: ■ Approved clearing limits to be clearly delineated with temporary fencing or similar prior to construction commencing. ■ Removal of trees with nests will be included in the vegetation clearing protocol including any seasonal constraints to avoid impacting any juveniles or unfledged chicks. ■ Removal of trees with nests will be supervised by an experienced fauna catcher or ecologist. ■ A portion of felled trees will be salvaged as habitat for fauna and translocated in suitable areas in the remainder of the Project Boundary.	■ Principal contractor to ensure implementation of vegetation clearing protocol. ■ Experienced fauna catcher / ecologist to supervise clearing and relocate native fauna.	■ Clearing supervision to occur during the entire clearing process. ■ Letter with results of clearing to be prepared by the fauna catcher/ ecologist supervising the clearance. Letter to be available for review by delegated authority (if requested).	Vegetation Clearing Protocol as part of Biodiversity Management Plan

Impact	Mitigation Measure	Responsibility	Timing	Reporting
Loss of Hollow Bearing Trees	■ Replacement of trees at a rate of 2:1 (i.e. two trees will be planted to replace each hollow bearing tree removed). This results in planting of 68 new trees within the riparian corridor. In the event that a newly-planted tree dies during the lifespan of the solar farm, the client has the responsibility to replace it in order to achieve a 100% recruitment of 68 trees. ■ nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm.	■ GAIA to appoint a qualified ecologist for preparation of the monitoring plan. ■ GAIA to liaise with relevant authority regarding outcomes. ■ Appointed ecologist to undertake monitoring as required.	■ Monitoring Plan to be prepared and approved prior to commencement of clearing. ■ Monitoring to be implemented as required.	Tree Replacement and Nest Box Monitoring Plan as part of Biodiversity Management Plan
Impacts of Development on the Habitat of Threatened Species or Ecological Communities	■ A tree replacement and nest box monitoring plan will be prepared for the Project. The plan will provide details of monitoring and Key Performance Indicators (KPIs) to ensure objectives of tree replacement and nest box monitoring is achieved. ■ Monitoring and reporting to be undertaken by a qualified ecologist. Avoidance of use of chemicals, such as pesticides and herbicides, within the solar farm during the construction and operational phases to prevent contributing to the global decline in insect population and diversity. ■ Facilitation natural revegetation of native ground cover within viable solar farm footprint (e.g. under solar panel arrays) and in retained areas. This will include management of weeds.	■ GAIA to appoint a qualified ecologist for preparation of the monitoring plan. ■ GAIA to liaise with relevant authority regarding outcomes. ■ Appointed ecologist to undertake monitoring as required.	■ Monitoring Plan to be prepared and approved prior to commencement of clearing. ■ Monitoring to be implemented as required.	Tree Replacement and Nest Box Monitoring Plan as part of Biodiversity Management Plan

Impact	Mitigation Measure	Responsibility	Timing	Reporting
Impacts of Development on the Habitat of EPBC Listed Migratory Species	None required	NA	NA	NA
Impacts of Development on Water Quality, Water Bodies and Hydrological Processes that sustain Threatened Species and TECs	■ An erosion and sediment control plan (ESCP) would be prepared in conjunction with the final design and implemented. ■ Design of creek crossings to meet best practice industry standards. ■ ESCP to include requirements for water quality monitoring, chemical use and control.	■ GAIA has overall responsibility to ensure meeting that they are meeting environmental commitments.	■ ESCP to be prepared and approved prior to commencement of works. ■ Reporting, evaluation and auditing as per the ESCP.	CEMP ESCP
Impacts of Vehicle Strikes on Threatened Species of animals or on animals that are part of a TEC	Actions to minimize mortality of wildlife involved in vehicle strikes: ■ Reduced vehicle speeds and signage to be installed within the solar farm. ■ Protocol detailing actions to be undertaken in the event of a vehicle strike. ■ Identification of a wildlife veterinary and/or wildlife carer group and agreement for injured wildlife to be taken care of or being humanely euthanized.	■ GAIA has overall responsibility to ensure meeting that they are meeting environmental commitments.	■ CEMP to be prepared and approved prior to commencement of works. ■ Reporting, evaluation and auditing as per the CEMP.	CEMP
	■ Avoid Night Works. ■ Direct lights away from retained native vegetation.	■ GAIA has overall responsibility to ensure meeting that they are meeting environmental commitments.	■ CEMP to be prepared and approved prior to commencement of works. ■ Reporting, evaluation and auditing as per the CEMP.	CEMP

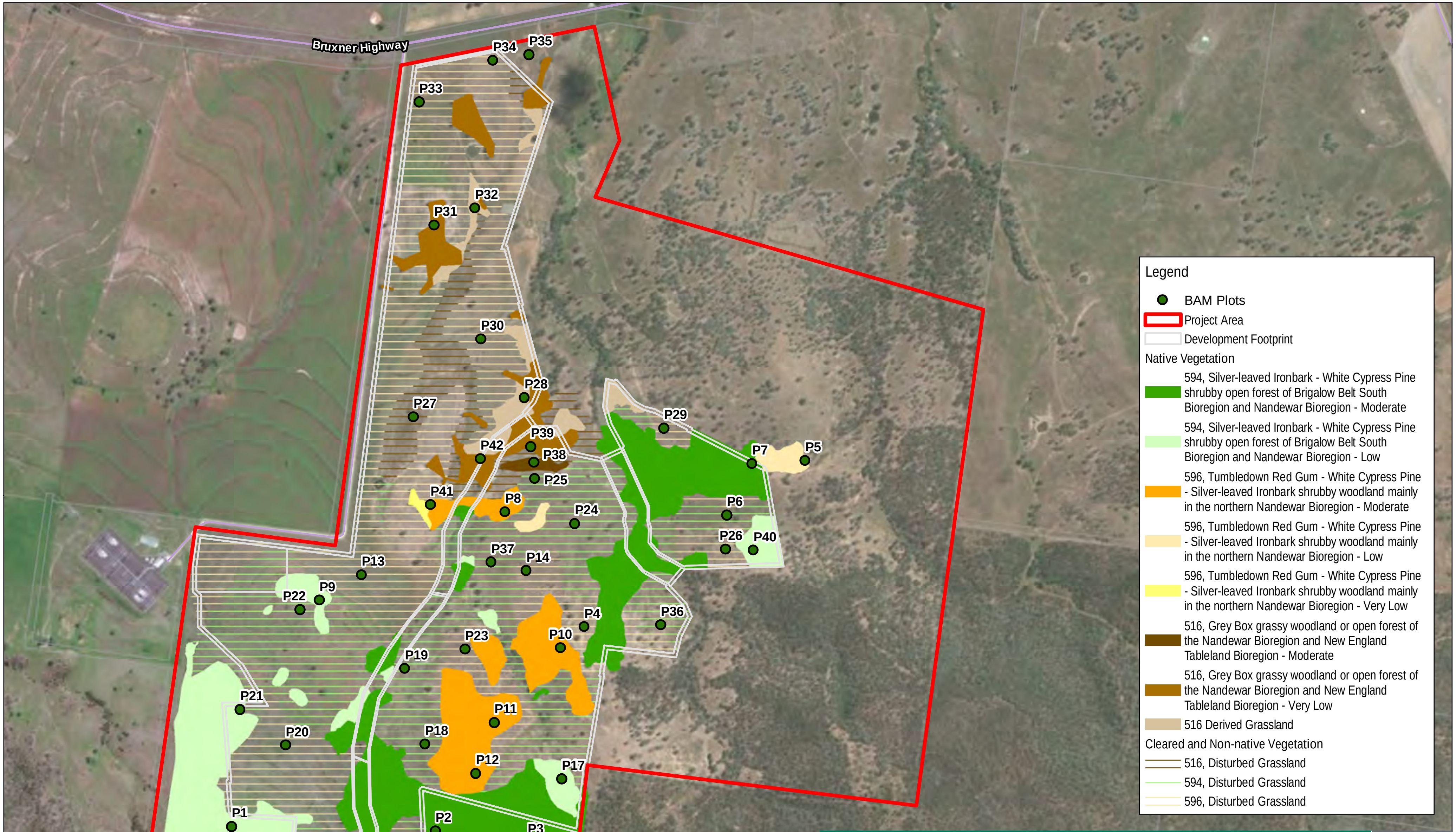
Impact	Mitigation Measure	Responsibility	Timing	Reporting
Invasive Species	■ CEMP will include a management protocol for declared priority weeds under the *Biosecurity Act 2015* during and after construction. ■ Hygiene protocols to prevent the spread of weeds or pathogens between infected areas and uninfected areas. ■ Monitoring and management protocol for invasive feral /pest species, including cats, foxes and cane toads.	■ GAIA has overall responsibility to ensure meeting that they are meeting environmental commitments.	■ CEMP to be prepared and approved prior to commencement of works. ■ Reporting, evaluation and auditing as per the CEMP.	CEMP

Offset Requirements

Direct impacts to native vegetation and fauna habitat requiring offsets include:

- Impacts on three vegetation zones of PCT 516 – Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion, requiring 89 ecosystem credits;
- Impacts on three vegetation zones of PCT 594 – Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion ad Nandewar Bioregion, requiring 837 ecosystems credits;
- Impacts on three vegetation zones of PCT 596 – Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion, requiring 244 ecosystem credits;
- Loss of five Paddock Trees, requiring 5 ecosystem credits;
- Impacts on Bristle-faced Free-tailed Bat habitat, requiring 1,578 species credits; and
- Impacts on Eastern Cave Bat foraging habitat, requiring 2,365 species credits.

Overall the Development Footprint is considered of moderate biodiversity value with impacts related to direct clearance of native vegetation and fauna habitat. The residual impact of the Project will require 1,191 ecosystem credits and 3,943 species credits to be offset in accordance with the Biodiversity Conservation Regulation 2017 and the NSW Biodiversity Offsets Scheme.



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Vegetation, BAM Plot - ERM Groud truth 2019

PCTs and BAM Plot locations

F 6.1

Drawing No: 0470861m_BSF_EIS_G007_R1.mxd

Bonshaw Solar Farm, NSW

Date: 09/09/2019 Drawing Size: A4

Drawn By: DR / GR Reviewed By: AA

Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

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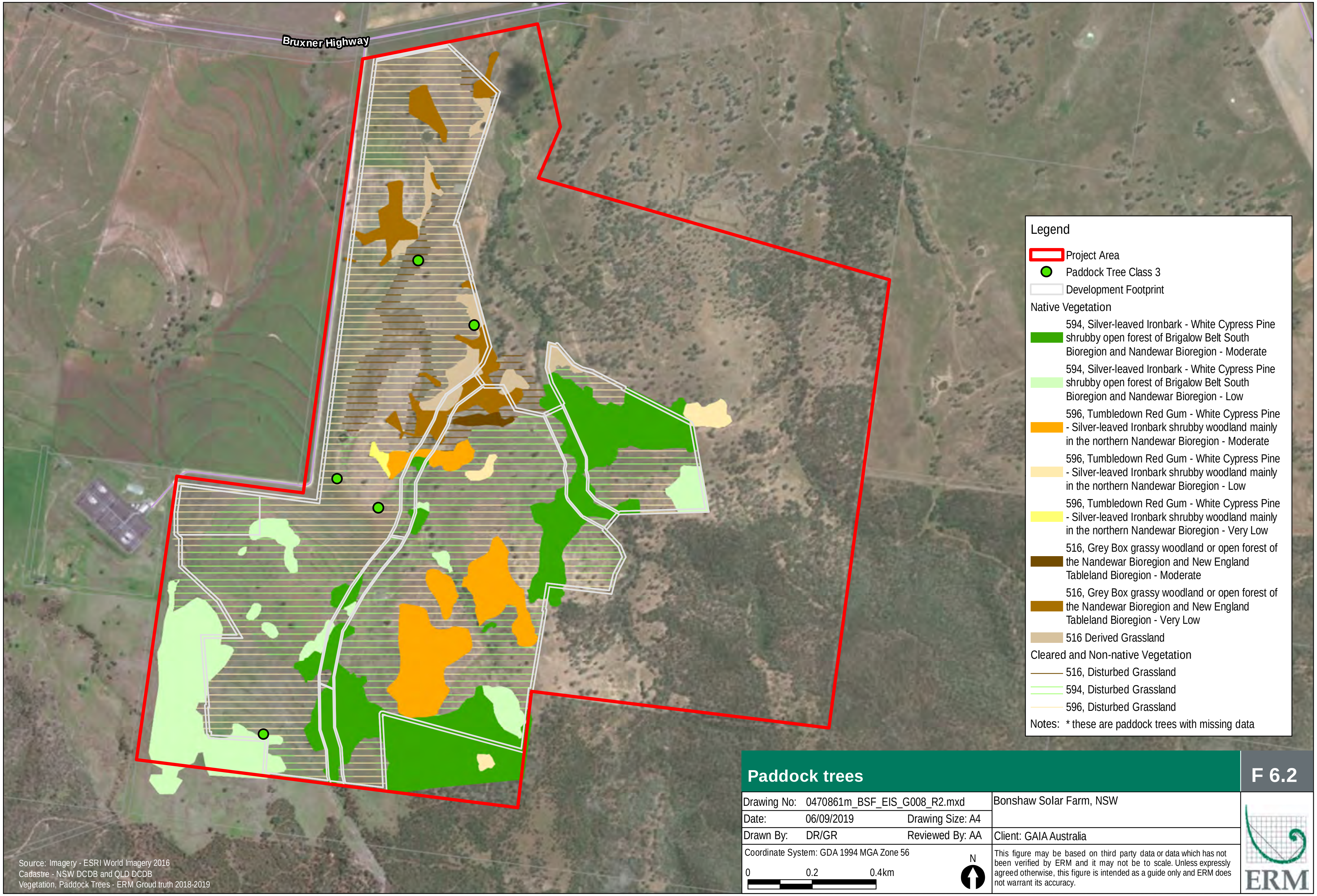
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Vegetation, Paddock Trees - ERM Groud truth 2018-2019

Paddock trees

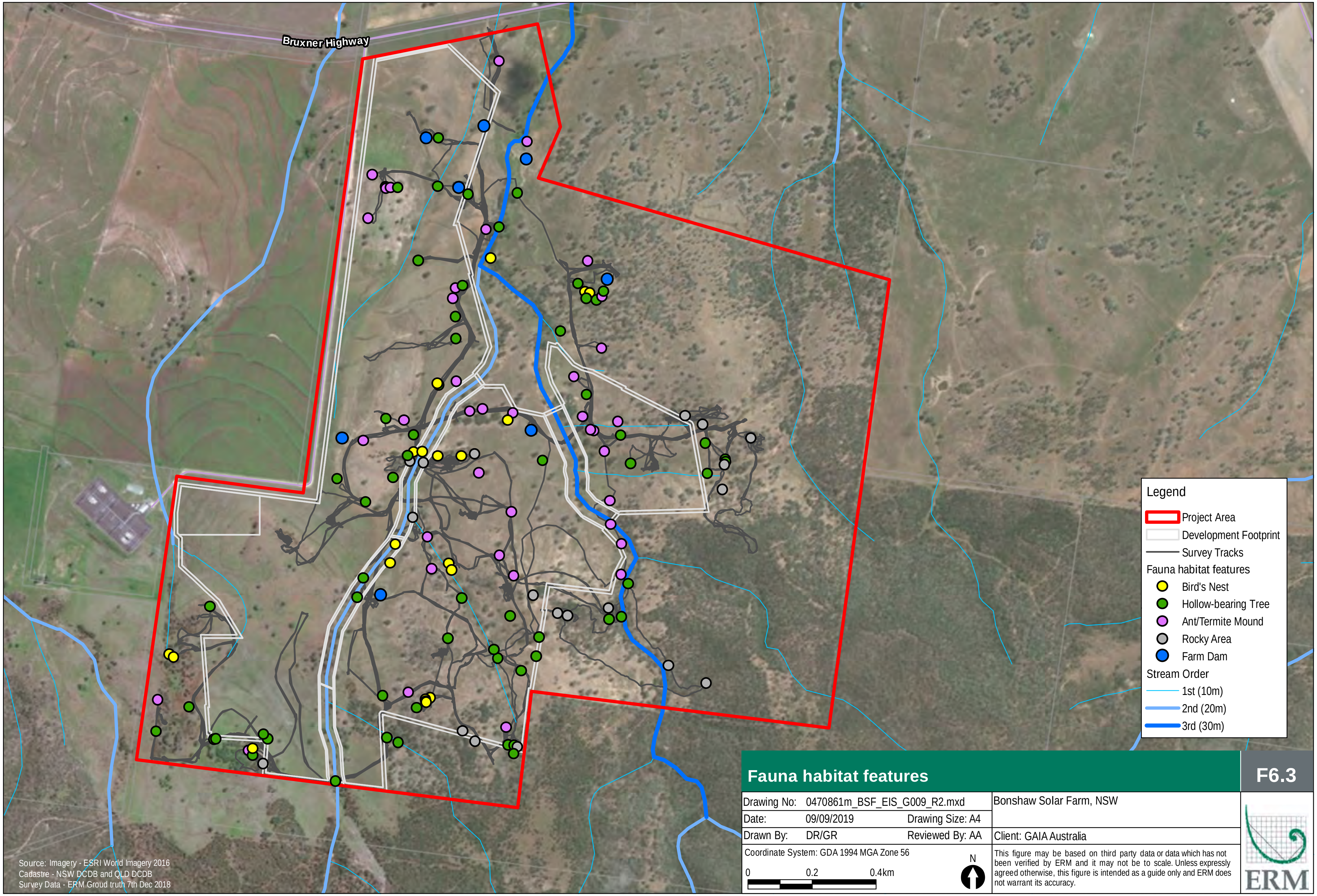
F 6.2

Drawing No: 0470861m_BSF_EIS_G008_R2.mxd
Date: 06/09/2019 Drawing Size: A4
Drawn By: DR/GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

ERM



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Survey Data - ERM Groud truth 7th Dec 2018

Fauna habitat features

F6.3

Drawing No:	0470861m_BSF_EIS_G009_R2.mxd	Bonshaw Solar Farm, NSW
Date:	09/09/2019 Drawing Size: A4	
Drawn By:	DR/GR Reviewed By: AA	Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

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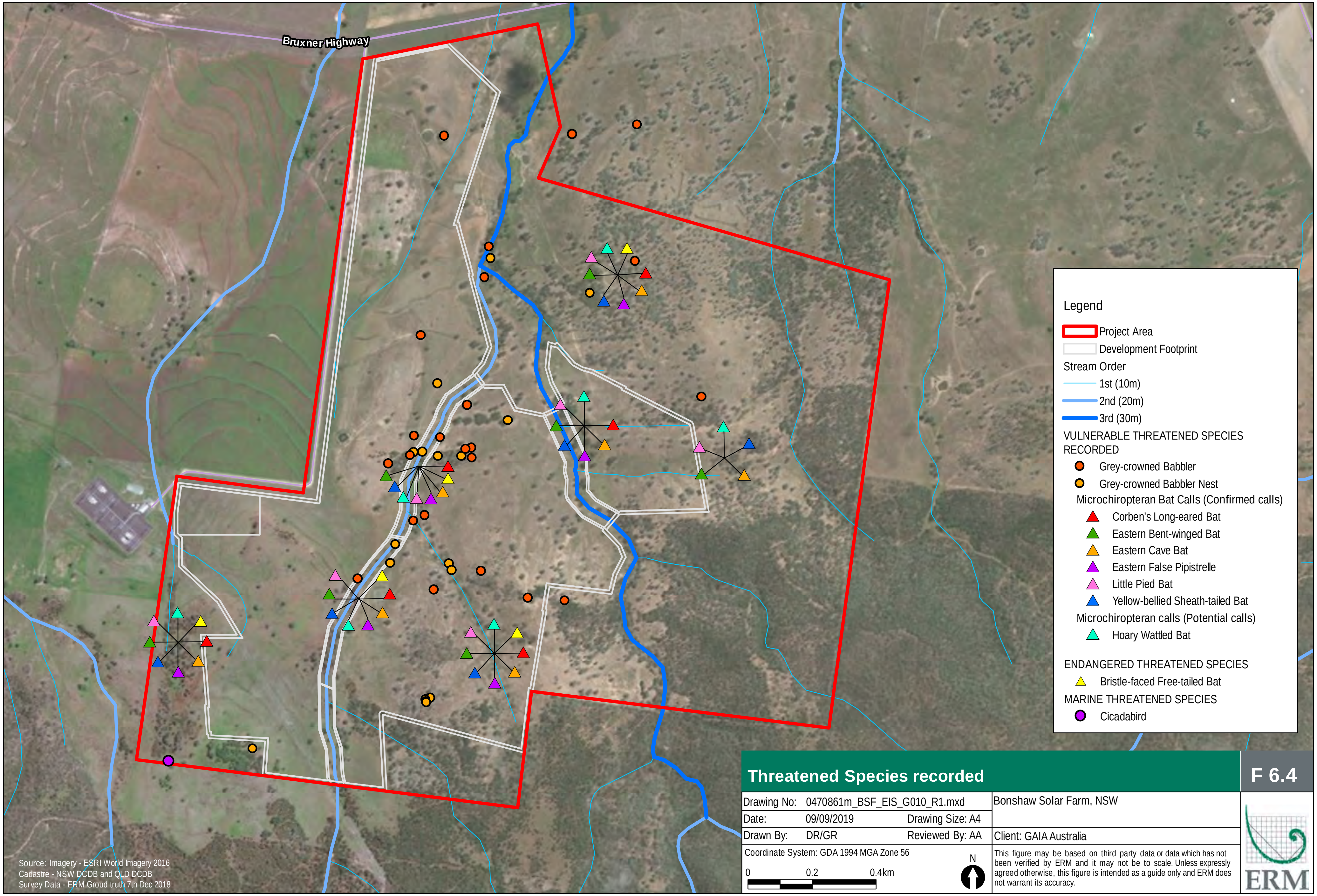

Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Survey Data - ERM Groud truth 7th Dec 2018

Threatened Species recorded

F 6.4

Drawing No: 0470861m_BSF_EIS_G010_R1.mxd		Bonshaw Solar Farm, NSW
Date: 09/09/2019	Drawing Size: A4	
Drawn By: DR/GR	Reviewed By: AA	Client: GAIA Australia
Coordinate System: GDA 1994 MGA Zone 56		This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

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6.2 Heritage

A Cultural Heritage Assessment (CHA) was prepared by ERM (2019) to support this EIS (refer to Appendix D). The CHA assesses the potential impacts of the Project on Aboriginal and historical cultural heritage, and prepares strategies to manage risks to identified heritage values during construction and operation. The assessment has been prepared to address the specific requirements of the SEARs relating to heritage and with regard to the following legislation and government policies:

- National Parks and Wildlife Act 1974 (NSW);
- Heritage Act 1977 (NSW);
- Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Commonwealth);
- Code of Practice for Archaeological Investigations of Aboriginal Objects in New South Wales (DECCW 2010a);
- Aboriginal Cultural Heritage Consultation requirements for Proponents (DECCW 2010b);
- Guide to investigating, assessing and reporting on aboriginal cultural heritage in NSW (OEH);
- The Australia ICOMOS Charter for Places of Cultural Significance, The Burra Charter, 2013 (Australia ICOMOS 2013a); and
- NSW Heritage Manual.

6.2.1 Methodology

The CHA incorporated the following scope of works:

- Consultation with Aboriginal communities in relation to the Project;
- Review of the landscape and natural resources of the Project Site in order to establish background parameters;
- Research of local and regional context of Aboriginal literature and archaeological records;
- Review of relevant heritage databases including Australian Heritage Database, the NSW Office of Environment and Heritage (OEH) Aboriginal Heritage Information Management System (AHIMS) database; the NSW State Heritage Inventory, and Schedule 5 of the *Inverell Local Environmental Plan 2012;*
- Review of the Projects non-Aboriginal history to gain an understanding and appreciation of past land uses and associated historical ground disturbance;
- Archaeological surveys of the Project Site were conducted between 11 and 13 September 2018.

6.2.2 Existing Environment

A targeted search of the AHIMS database conducted on 5 March 2018 and again on 28 February 2019 identified one previously recorded Aboriginal heritage site, and another nine sites previously recorded within 1.5 km of the Project Site (refer to Figure 6-5).

There are no places listed on the Commonwealth Heritage List within or near the Project Site.

A search of the State Heritage Inventory (SHI) indicated that there are no places listed under the NSW Heritage Act (NSW State Heritage Register) within or near the Project Site.

There are hundreds of places of heritage significance items located within the Inverell Council area that are listed on the LEP Schedule 5: Part 1 Heritage Items. In Bonshaw itself, three places are listed, all of which are located in the Bonshaw village approximately 16 km NNW of the Project Site, and these are:

- Bonshaw Cemetery, Spark Street (Item #I019);
- Church, 10986 Bruxner Highway (Item #I018); and
- Memorial Hall, Miller Street (Item #I021).

No items of local historic heritage are located within or near the general Project Site.

Previous Archaeological Research of the Locality

A review of previous archaeological studies indicated that there has been limited previous archaeological research within the Project Site, however at least one project has been undertaken in its proximity that has required cultural heritage assessment.

Between 2009 and 2011 OzArk EHM undertook Aboriginal and Historic heritage assessments as part of a project which proposed a transmission line between the Dumaresq Switching Station (approximately 75m from the Project Site's western boundary) and the Lismore Substation in far north NSW (OzArk 2011). In 2011, an assessment was carried out on the section of the proposed transmission line easement. Prior to completing the assessment information about previously recorded sites in proximity were gathered from AHIMS, it was noted that 49.2% of previously recorded sites in the area were open sites / artefacts scatters, and 15.2% were modified (scarred) trees. The assessment identified 50 previously unrecorded Aboriginal cultural heritage sites. The assessment found that most cultural heritage sites were located near a water source and that sites in the area are likely to be artefact scatters or modified trees.

Survey Results

The Project Site was surveyed over three days in September 2018 by Katherine Deverson and representatives of the Registered Aboriginal Parties (RAPs) as outlined in Appendix D. The methodology was adopted to pursue the discovery of new archaeological sites, to ensure accuracy of recording such sites and provide sufficient information to provide an assessment of the Projects cultural significance.

During the field survey, 35 previously unidentified Aboriginal heritage sites were recorded. The sites were located within 3 km of the Dumaresq River to the north, often along small creek lines (Figure 6-6). 29 of these sites were stone artefacts including isolated finds and stone artefact scatters. Seven scarred trees were also identified, one of the scarred trees was identified as part of an artefact scatter site. Previously unrecorded Aboriginal cultural heritage sites located during the survey were recorded, and artefacts and features identified were left *in situ*. These surveyed sites are described in Table 6-2 below.

AHIMS Site 11-3-0083 was identified within the Project Site in 2011 during surveys for the Dumaresq to Lismore 330kV Transmission Line. This site was not re-identified during the 2018 surveys, however given the seven years between surveys and the exposed nature of the location and the relatively poor ground visibility observed in this survey unit during the 2018 survey it is possible that all or some of this site remain *in situ.* It is also possible that some small artefact scatter identified during the 2018 surveys, including BSF33, BSF2, and BSF28 (refer to Figure 6-6) may form part of Site 11-3-0083, which was recorded as a large site complex.

Two areas with historical items were observed during the field survey (refer to Figure 6-6):

- A surface scatter of several miscellaneous historical items; and
- A smaller surface scatter of glass bottles to the north of the first surface scatter.

The surface scatter of historical items included three small ceramic fragments, car parts, bottle fragments, and other metal domestic items. The items were sparsely strewn across an area of approximately 25 m x 20 m on the high bank side of an unnamed small creek. Items appeared to approximately date from (after) the 1940s, which is evidenced by the presence of bottles labelled as property of the Australasian Pickle Company Ltd. There was no evidence of any previous structure at the site nor any indication of a Potential Archeological Deposit (PAD).

The separate surface scatter of bottles, located approximately 230 m NNW of the domestic dump, consists of five complete bottles siting on the ground surface. The bottles include:

- one brown glass long necked beer bottle;
- one clear cylindrical bottle labelled “Pick-me-up (regd trade mark)” “this bottle is the property of Pick-Me-Up Condiment Co. Ltd Sydney 1946”; and
- three oblong shaped clear bottles, one of which is labelled as “Clements Tonic”.

Given the date on the cylindrical bottle it is likely that this smaller bottle dump dates to a similar period as the domestic dump to the south (from/after the late 1940s).

Table 6-2 Aboriginal Cultural Heritage Field Survey Results

Site	Survey Unit	Landform	Description		Associated PAD
BSF1	SU31	Plain	**Large Artefact Scatter / Open Camp** This site comprises a high number of stone artefacts. It is not likely that all surface artefacts were identified and recorded at this site, however more than 50 artefacts were noted, across an area of approximately 350 m (east to west) by 200 m (north to south). The site is located at northern boundary of property along small creek line and vehicle access track. The site is located on a plain set in a wider landscape context of rolling hills. BSF1 is considered to have a moderate potential for further archaeological deposits due to the number of artefacts found with a corresponding low ground surface visibility, as well as its landscape setting and association with the nearby water course. Artefacts located included chert, tuff, basalt and quartz material, a silcrete retouched axe head and quartz round grindstone. Given its location on the creek that (to the south) contains a site also considered to be an occupation site (BSF14) indicating extended or repeated use, and its subsurface potential, it is considered likely that BSF1 may be part of a complex of occupation sites along the creek beginning at BSF1 and continuing south through BSF14 to BSF22.	 	Yes

Site	Survey Unit	Landform	Description		Associated PAD
BSF2	SU32	Plain	**Artefact Scatter** This small artefact scatter of approximately six stone artefacts, including silcrete and basalt flakes and cores, and potentially a quartzite grindstone is located across an area of approximately 75 m (east to west) by 25 m (north to south). The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from the nearby hill to the south.		No
BSF3	SU30	Upper Slope	**Artefact Scatter** This small artefact scatter of four stone artefacts, including dilite/diorite flakes was identified by RAPS on a slope near the hillcrest on a track. It is located across an area of approximately 75 m (east to west) by 25 m (north to south). The site is located on an upper slope set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from the nearby hill top.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF4	SU31	Plain	**Isolated Find** Broken Granite manuport artefact. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF5	SU14	Plain	**Scarred Tree** During the survey RAPs identified a felled scarred tree located within proximity to another standing but dead scarred tree (BSF6). The oval shaped scar was approximately 1.4 m in length and 40 cm wide. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No
BSF6	SU14	Plain	**Scarred Tree** During the survey RAPs identified a standing (but dead) scarred tree, with an oval shaped scar. Within proximity to another felled scarred tree (BSF5). The oval shaped scar was approximately 1.2 m in length and 25 cm wide. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF7	SU30	Mid Slope	**Isolated Find** Silcrete core located on slope set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF8	SU28	Mid Slope	**Artefact Scatter** Small artefact scatter consisting of at least seven blue chert flakes scattered within a 3 m x 5 m area may have been formed as the result of a single knapping event. The site is located on a slope set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

BSF9	SU29	Plain	**Large Artefact Scatter / Open Camp** This site comprises a widespread surface artefact scatter evident along a track and yard across an area of approximately 500 m (north to south) by 100 m (east to west), the site also contains an associated scar tree. There is no evidence for subsurface material and it is possible that the site could have been caused by wash down from the nearby hill to the west of from the nearby occupation sites at BSF1 and BSF14. It is located near creek line and on a vehicle access track. The site is located on a plain set in a wider landscape context of rolling hills. The site contains more than 40 artefacts which are mostly flakes including silcrete, chert, and quartz, flakes; basalt and tuff artefacts were also identified. The site associated with a scar tree identified by RAPs during survey which has been recorded as part of the site. Given its location near the creek that (to the north and south) contains a sites that are considered to be occupation sites (BSF1 and BSF14), it is considered likely that BSF9 may form part of an area of wider occupation sites at BSF1 and continuing south through BSF 9, BSF14, and BSF22.	 	No

Site	Survey Unit	Landform	Description		Associated PAD
BSF10	SU29	Plain	**Artefact Scatter** Small artefact scatter, comprising 2 x basalt hammerstones. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.	 	No

Site	Survey Unit	Landform	Description		Associated PAD
BSF11	SU26	Plain	**Scarred Tree** During the survey RAPs identified a standing, live, scarred tree. The roughly oval shaped scar was approximately 1 m in length, 40 cm wide, and very close to the ground. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No
BSF12	SU29	Plain	**Isolated Find** Silcrete core located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF13	SU29	Plain	**Isolated Find** Silcrete core located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF14	SU25	Plain	**Large Artefact Scatter / Open Camp** This site comprises a high number of stone artefacts. It is not likely that all surface artefacts were identified and recorded at this site, however more than 50 artefacts were noted, across an area of approximately 110 m (east to west) by 330 m (north to south). Located along and extending between two small creek lines and vehicle access track. The site is located on a plain set in a wider landscape context of rolling hills. The site is considered to have a high potential for further archaeological deposits due to the number of artefacts found with a corresponding low ground surface visibility, as well as its landscape setting and association with the nearby water course. Sub-surface artefacts were visible in the soil profile along eroded creek line at southern end of site. Artefacts located included chert, granite, basalt and quartz material. Given its location on the creek that (to the south) contains a site also considered to be an occupation site (BSF14) indicating extended or repeated use, and its subsurface potential, it is considered likely that		Yes

Site	Survey Unit	Landform	Description		Associated PAD
			BSF1 may be part of a complex of occupation sites along the creek beginning at BSF1 and continuing south through BSF14 to BSF22. It is not likely that all surface artefacts were identified and recorded at this site, however more than 50 artefacts were noted, across an area of approximately 350 m (east to west) by 200 m (north to south).		
BSF15	SU15	Plain	**Artefact Scatter** This site comprises1 x silcrete flake and 1 x broken silcrete hammerstone. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.	 	No

Site	Survey Unit	Landform	Description		Associated PAD
BSF16	SU16	Plain	**Artefact Scatter** This site comprises1 x silcrete flake and 1 x silcrete hammerstone. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF17	SU23	Mid Slope	**Artefact scatter** This site comprises approximately eight stone artefact including blue chert flakes, silcrete flakes and one core, across an area of approximately 80 m (NW to SE) by 30 m (SW to NE). The site is located on a slope set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from BSF14 which is nearby to the north.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF18	SU22	Plain	**Scarred Tree** During the survey RAPs identified a standing, live, scarred tree. The oval shaped scar was approximately 1.7 m in length, 40 cm wide, and had significant overgrowth. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF19	SU8	Plain	**Scarred Tree** During the survey RAPs identified a standing, live, scarred tree with a 1.5 m (length) narrow scar that was approximately 40 cm from the ground and showed significant overgrowth. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No
BSF20	SU7	Plain	**Artefact Scatter** This site comprises a three chert flakes. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from larger sites, such as BSF14 which is along the same creek line to the north.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF21	SU24 & SU 27	Plain	**Artefact Scatter** This site comprises five stone artefacts, including a quartz flake, a large coarse grained flake with evidence for retouch, a large blue/grey coarse grained flake, a chert flake displaying at least 50% cortex, and a basalt axe. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from nearby sites along the creek to the north (such as BSF14) or from a small lightly wooded rise immediately to its north, although no artefacts were identified on the rise.		No
BSF22	SU22	Plain	**Artefact Scatter** This site comprises a small artefact scatter with approximately 20 artefacts across a ground surface area on approximately 50 m (NW to SE) by 30 m (SW to NE). The site contains mostly basalt flakes and cores, and at least one chert flake. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site is considered to have potential for further archaeological deposits due to noted evidence for sub-surface artefacts in the soil profile in the eroded creek line along the western edge of site. The presence of the site on the high bank of a creek that (further to the north) contains occupation sites, indicating extended or repeated use, and its noted subsurface potential means that it may also be an occupation site and a southern extension of what may be a complex of occupation sites along the creek beginning at BSF1 and continuing south through BSF14 to BSF22.	 	Yes

Site	Survey Unit	Landform	Description		Associated PAD
BSF23	SU5	Crest/Upper Flat	**Artefact Scatter** This site comprises two artefacts a smooth grained modified stone artefact and a granite hammerstone. The site is located on a rocky upper flat set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF24	SU25	Plain	**Artefact Scatter** This site comprises a small artefact scatter of four fine grained (possibly chert) flakes across an area 75 m 40 m. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from nearby sites along the creek to the north (such as BSF14).		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF25	SU24	Mid Slope	**Artefact Scatter** This site comprises two artefacts, 1 x basalt hammerstone and 1 x granite axe. The site is located on a slope set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from nearby sites and terraced landforms to the west.		No
BSF26	SU24	Plain	**Isolated Find** This site comprises a silcrete flake. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

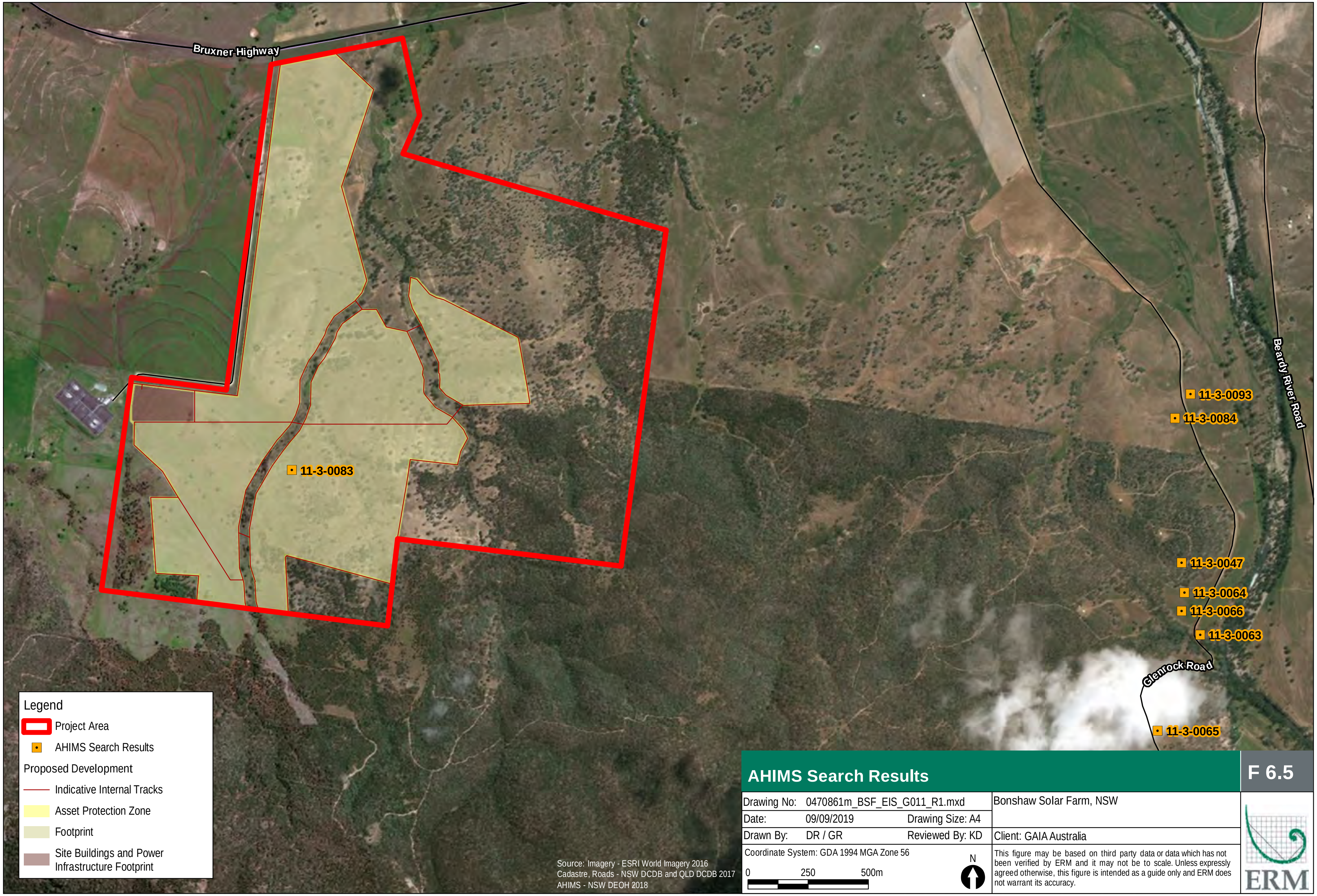
Site	Survey Unit	Landform	Description		Associated PAD
BSF27	SU24	Plain	**Artefact Scatter** This site comprises a small artefact scatter of eight stone artefacts including five chert flakes, two basalt flakes and a hammerstone granite. The site is located in a ploughed field across an area of approximately 25 m (SW to NE) by 50 m (NW to SE), on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF28	SU21	Plain	**Artefact Scatter** This site comprises a small artefact scatter of three artefacts with a chert, and quartz flakes identified and a quartzite core, across an area of approximately 110 m (SW to NE) by 50 m (NW to SE). The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from nearby sites along the creek to the north (such as BSF14).		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF29	SU5	Plain	**Scarred Tree** During the survey RAPs identified a standing, but dead, scarred tree. The long oval shaped scar was approximately 2 m in length and 40 cm wide. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No
BSF30	SU1	Plain	**Isolated Find** This site comprises a granite artefact. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF31	SU1	Plain	**Isolated Find** This site comprises a grindstone. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF32	SU4	Plain	**Artefact scatter –** This site comprises a small artefact scatter, 1 x basalt scraper and 1 x basalt flake. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF33	SU4	Plain	**Artefact scatter** – This site comprises a small artefact scatter, 1 x fine-grained core and 1 x basalt core. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF34	SU2	Mid Slope	**Isolated Find** This site comprises a grindstone. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF35	SU2	Plain	**Artefact scatter** This site comprises a small artefact scatter comprising 3 x blue chert flakes identified in ploughed field located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No



Source: Imagery - ESRI World Imagery 2016
Cadastre, Roads - NSW DCDB and QLD DCDB 2017
AHIMS - NSW DEOH 2018

AHIMS Search Results

F 6.5

Drawing No: 0470861m_BSF_EIS_G011_R1.mxd
Date: 09/09/2019 Drawing Size: A4
Drawn By: DR / GR Reviewed By: KD
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

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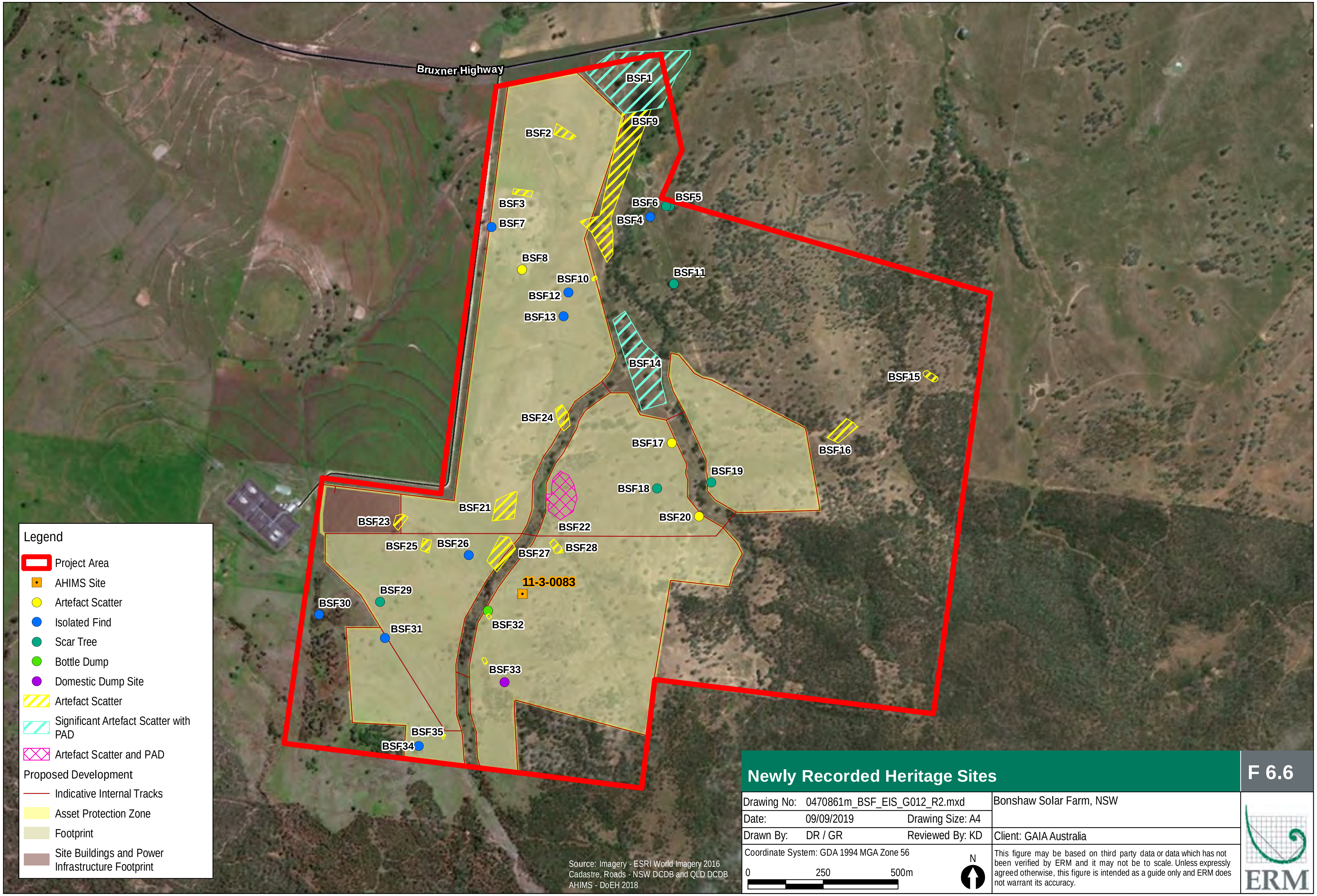

Source: Imagery - ESRI World Imagery 2016
Cadastre, Roads - NSW DCDB and QLD DCDB
AHIMS - DoEH 2018

Newly Recorded Heritage Sites

F 6.6

Drawing No: 0470861m_BSF_EIS_G012_R2.mxd
Date: 09/09/2019 Drawing Size: A4
Drawn By: DR / GR Reviewed By: KD
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

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6.2.3 Assessment

The CHA provides a heritage values significance assessment for the Project Site (refer to Appendix D). This comprehensive assessment of significance considers the social, historical, scientific and aesthetic values as outline in the Burra Charter (ICOMOS, 2013).

Aboriginal Heritage Statement of Significance

The Project Site contains 35 Aboriginal sites and three associated PADs (all recorded as part of the CHA). The majority of these sites are stone artefact sites including open camp sites and isolated finds. The sites recorded in the CHA study have been assigned scientific significance in terms of rarity, representativeness, archaeological landscape, connectedness, integrity and condition, complexity, and archaeological sensitivity.

The significance rating of the identified stone artefact sites is higher or lower based on the presence of particular stone artefact types, formal tool types, diverse or unusual raw stone materials and the potential for stratified subsurface deposits. The sites identified within the Project Site are common site types at a local and regional level. Stone artefact sites are the main site type represented in the region and those located within the Project Site have not demonstrated a significantly greater diversity or complexity in comparison to other known sites within the region. Scarred tree sites have also been identified as part of this assessment.

It is for this reason that all but two sites (BSF1 and BSF14) located within the Project Site have been assessed as having low archaeological significance (separate to cultural significance).

BSF1, BSF14, BSF22 were all within close proximity to watercourses and located within flat terrain with relative shelter from the elements (areas of known Aboriginal occupation) were identified as having moderate potential for subsurface archaeological deposits based on observations of possible subsurface artefacts in soil profiles. These areas incorporate prominent landscape types within the Project Site (i.e. flat terrain and slightly sloping areas near a water source). Such areas are likely to contain as yet unrecorded Aboriginal sites and/or objects. Careful detailed design of the solar farm following initial heritage survey results has successfully avoided these two sites, however BSF22 may still be impacted by the Project. Given the site’s proximity to other significant sites thought to indicate extended or repeated occupation on the banks of the same creek as BSF22 to the north, it is possible that though the surface expression of artefacts at BSF22 is less dense than at sites to the north (BSF1, BSF9, and BSF14). It may also be an occupation site and a southern extension of what may be a complex of occupation sites along the creek (refer to Figure 6-7).

Impact Assessment

The proposed works involve the following actions that have the potential to impact on Aboriginal heritage sites and values:

- site establishment, including the provision of access and construction compounds and laydown areas/material storage facilities;
- centreline surveying and existing services location;
- topsoil stripping and stockpiling in windrows along the edge of the trench;
- trench excavation and stockpiling of the spoil on the opposite side to the topsoil;
- installation of a sand bed layer;
- laying of conductor and earth cables, incorporating direct bury of cable joints (located approximately every 500 m to 1000 m) and marking of those with electronic marker devises;
- trench reinstatement consisting of placement of sand coverage of cables, installation of a hard cover, then backfilling/compaction of spoil and respread of topsoil;

- the grading of roads and upgrading of existing access roads;
- vehicle movement across eroded tracks;
- the development of new access roads;
- clearance of vegetation;
- the construction of hardstands and laydown areas; and
- for the construction period on-site equipment storage areas.
- Of the 35 Aboriginal heritage sites (and three associated PADs) that have been recorded within the Project Site, 26 have been assessed to incur a possibly or partially be impacted by the Project, as outline in Table 6-3 below. Overall, 29 of these sites were stone artefacts including isolated finds and stone artefact scatters. Seven scarred trees were also identified, one of the scarred trees was identified as part of an artefact scatter site. Careful detailed design of the Project footprint has successfully avoided several of these sites, including BSF1 and BSF14 which are considered to have moderate archaeological significance (refer to Table 6-3 and Figure 6-7).

Table 6-3 Summary Impact Assessment of Aboriginal Heritage Sites

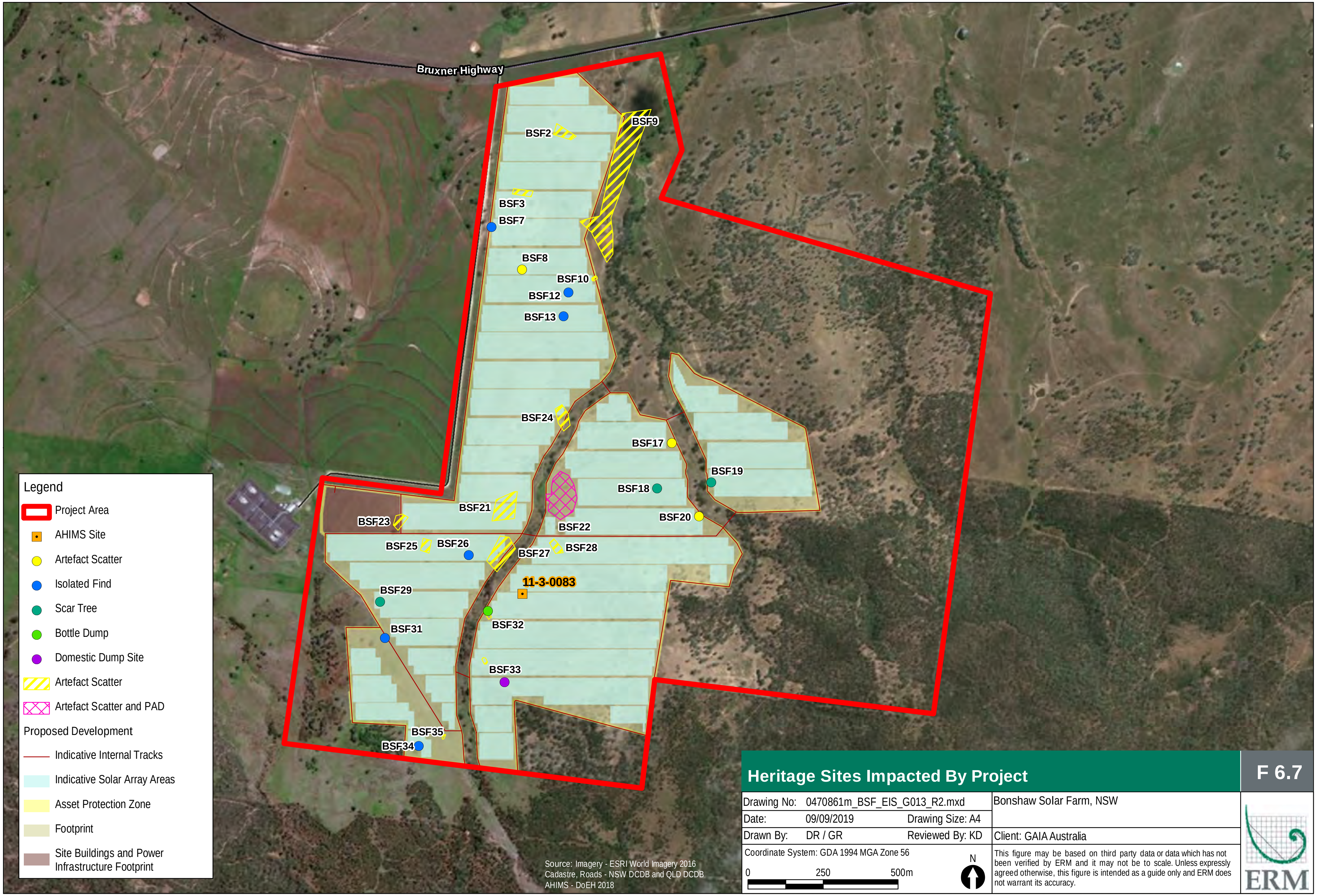
Site ID	AHIMS	Overall Significance Level	Assessment of Potential Impact
BSF1	TBD	Moderate	No Impact Careful detailed design of the Development Footprint has successfully avoided this site and PAD
BSF2	TBD	Low	<u>Possible Impact</u> Artefact scatter may be impacted by project works
BSF3	TBD	Low	<u>Possible Impact</u> Artefact scatter may be impacted by project works
BSF4	TBD	Low	No Impact Careful detailed design of the Development Footprint has successfully avoided this site
BSF5	TBD	Low	No Impact Careful detailed design of the Development Footprint has successfully avoided this scarred tree
BSF6	TBD	Low	No Impact Careful detailed design of the Development Footprint has successfully avoided this scarred tree
BSF7	TBD	Low	<u>Possible Impact</u> Isolated find may be impacted by project works
BSF8	TBD	Low	<u>Possible Impact</u> Artefact scatter may be impacted by project works
BSF9	TBD	Low	<u>Partial Impact</u> Careful detailed design of the Development Footprint has successfully avoided most of this site, however a small section of the site may be impacted
BSF10	TBD	Low	<u>Possible Impact</u> Artefact scatter may be impacted by project works
BSF11	TBD	Low	No Impact

Site ID	AHIMS	Overall Significance Level	Assessment of Potential Impact
			Careful detailed design of the Development Footprint t has successfully avoided this scarred tree
BSF12	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF13	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF14	TBD	Moderate	No Impact Careful detailed design of the Development Footprint has successfully avoided this site and PAD
BSF15	TBD	Low	No Impact Careful detailed design of the Development Footprint has successfully avoided this site
BSF16	TBD	Low	No Impact Careful detailed design of the Development Footprint has successfully avoided this site
BSF17	TBD	Low	Partial Impact Careful detailed design of the Development Footprint has successfully avoided most of this site, however a small section of the site may be impacted
BSF18	TBD	Low	Possible Impact Scarred tree may be impacted by project works
BSF19	TBD	Low	Possible Impact Scarred tree may be impacted by project works
BSF20	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF21	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF22	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF23	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF24	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF25	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF26	TBD	Low	Possible Impact Isolated find may be impacted by project works
BSF27	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF28	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF29	TBD	Low	Possible Impact Scarred tree may be impacted by project works
BSF30	TBD	Low	No Impact

Site ID	AHIMS	Overall Significance Level	Assessment of Potential Impact
			Careful detailed design of the Development Footprint has successfully avoided this site
BSF31	TBD	Low	Possible Impact Isolated find may be impacted by project works
BSF32	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF33	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF34	TBD	Low	Possible Impact Isolated find may be impacted by project works
BSF35	TBD	Low	Possible Impact Artefact scatter may be impacted by project works

Assessment of Historic Heritage Significance

Two surface scatters of historical items were identified during the 2018 surveys, however no research into these sites has been undertaken. As these sites are fairly sparse scatter with limited historic artefacts and no evidence for structures or subsurface expressions were noted during the survey, it is considered that these are dumpsites that were utilised once (or twice) by a local household sometime in the last 70 years. No items identified are considered rare or representative, or of containing any value for further research. It is considered likely that other properties in the area contain similar sites. Although the identification of five complete historic glass bottles is interesting, these sites are not considered to reach the threshold for local historic heritage significance.



Source: Imagery - ESRI World Imagery 2016
Cadastre, Roads - NSW DCDB and QLD DCDB
AHIMS - DoEH 2018

Heritage Sites Impacted By Project

F 6.7

Drawing No: 0470861m_BSF_EIS_G013_R2.mxd
Date: 09/09/2019 Drawing Size: A4
Drawn By: DR / GR Reviewed By: KD
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

6.2.4 Mitigation Measures

Careful detailed design of the Development Footprint has successfully avoided nine of these sites, including BSF1 and BSF14 which are considered to have moderate archaeological significance. The following recommendations are made to assist in ongoing management of identified heritage sites.

Aboriginal Heritage

Based on the information presented in this report the following general recommendations have been developed:

- personnel involved with ground breaking activities in the Project Site should undertake cultural awareness training in line with the recommendations provided in the CHA (refer to Appendix D);
- during works, the location of all recorded Aboriginal heritage sites should be clearly marked on all construction plans for the Project and site foremen informed of their presence and the need to avoid disturbance;
- if suspected Aboriginal heritage objects are found during works, the Unexpected Find Procedure outlined below should be followed and applies to the entire Project Site;
- Ongoing consultation with the Aboriginal community and registered Aboriginal stakeholders for the Project should occur during the construction of the Project. The triggers for consultation with the community during construction may include:
    - Any additional heritage assessments for changes in Project scope;
    - The implementation of the Unexpected Finds Procedure; and
    - Endorsement of the heritage information to be contained in the Project induction material.
- Relocation and salvage of any and all Aboriginal artefacts where impacts cannot be avoided.

Historic Heritage

While the historic items identified during the this assessment have been assessed as not meeting the threshold for local historic heritage significance, the items at these sites should be carefully collected and offered to a local heritage museum or organisation prior to commencement of Project works.

Should suspected historic heritage objects be found during works, the Unexpected Find Procedure outlined below should be followed and applies to the entire Project Site.

Unexpected Finds Procedure

If any heritage objects and/or relics, as protected under NSW legislation, are uncovered during the Project, then the following steps should be followed:

- all activity in the immediate area should cease;
- an appropriately qualified heritage professional should be consulted;
- OEH should be immediately contacted; and
- an appropriately qualified heritage professional should record the location and attributes of the site and determine the significance of the find.

In the event of the discovery of human skeletal material (or suspected human skeletal material) during project activities in the Project Site the following steps should be followed:

- all activities and/or works in the immediate area must cease;
- the NSW Police must be contacted along with the OEH; and
- any sand/soils removed from the near vicinity of the find must be identified and set aside for assessment by the investigating authorities.

6.3 Land

6.3.1 Methodology

Agricultural Land Use Resources

Various sources of information are used to identify agricultural industries and their dependent resources for land use planning purposes. The agricultural land capability of the Project Site was assessed using the most relevant available online databases as detailed in the Department of Primary Industries (DPI*) Agricultural Land Use Mapping Resources in NSW – User guide* (DPI, 2017). DPI resources utilised included:

- Land and Soil Capability (LSC) mapping for NSW, which uses eight key soil and landscape limitations to assess the capability of land according to an eight class system; and
- Biophysical Strategic Agricultural Land (BSAL) mapping under the NSW Strategic Regional Land Use Policy (SRLUP), which maps strategic agricultural land capable of sustaining high levels of productivity or critical industry clusters.

The guidance document (Department of Primary Industries, 2011) also references Important Agricultural Land, Regional Farmland Mapping, Critical Industry Cluster and Agricultural Land Classification mapping; however, these sources are not applicable to the Project Site.

Further indication of the land use of the Project is provided by a review of:

- The Local Environmental Plan (LEP) zoning map (Inverell Shire Council, 2012);
- Review to determine any mining and mineral titles within or in the vicinity of the Project Site has been undertaken based on information in the Sharing and Enabling Environmental Data (SEED) (OEH, 2019); and
- A Land Use Conflict Risk Assessment (LUCRA) was undertaken in accordance with *Land Use Conflict Risk Assessment Guide* as prepared by the Department of Primary Industries (DPI, 2011). The LUCRA is provided in Appendix E and summarised in this Section.

Soils, Geology and Landform

In addition to the land capability mapping outlined above, information was extracted from the SEED Portal (OEH, 2019), including the following datasets:

- the Australia Soil Classification (ASC) Soil Type map of NSW, which provides soil types across NSW using the Australian Soils Classification at Order level;
- the Estimated Inherent Soil Fertility of NSW, which uses the best available soils and natural resource mapping to describe soil fertility in NSW according to a five class system; and

A desktop investigation of soil profile and soil map information by:

- Search of eSPADE data for NSW (OEH, 2012), including Soil Profiles, Bioregions and Hydrologic Soil Groups; and
- Site based soil sampling was not undertaken given the availability of the aforementioned online resources and the limited soil disturbance associated with the construction and operation of the solar farm.

Contamination

A desktop investigation of potential contamination sources was undertaken by:

- reviewing historic aerial imagery; and
- conducting searches of contamination registers.

6.3.2 Existing Environment

Agricultural Land Use Resources

Land and Soil Capability

The OEH have established the land and soil capability (LSC) to inform the inherent physical capacity of the land to sustain a range of land uses and management practices in the long term without degradation to soil, land, air and water resources. The LSC assessment scheme uses biophysical features of the land and soil, including landform position, slope gradient, drainage, climate, and soil type and soil characteristics, to derive detailed rating tables for a range of land and soil hazards. These hazards include water erosion, wind erosion, soil structure decline, soil acidification, salinity, waterlogging, shallow soils and mass movement. The mapping is based on an eight class system with values ranging between 1 and 8 which represent a decreasing capability of the land to sustain productive agricultural land use. Class 1 represents land capable of sustaining most land uses including those that have a high impact on the soil (e.g., regular cultivation), whilst class 8 represents land that can only sustain very low impact land uses (e.g., nature conservation), as shown in Table 6-4*.*

Table 6-4 Land and soil Capability Scheme Classification

LSC Class	General Definition
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation).	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land**: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping and cultivation.
3	**High capability land**: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, gazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land**: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	**Moderate–low capability land:** Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature)	
6	**Low capability land**: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation

LSC Class	General Definition
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land**: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land:** Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

Figure 6-8 demonstrates the land soil classifications within the Project Site.

The southwest corner of the Project Site has been attributed the lowest limitation class of the site, being assessed under the LSC scheme to be rated Class 3, having moderate to severe limitations. Class 3 land has limitations that must be managed to prevent soil and land degradation. However, a range of widely available and readily implemented land management practices can overcome the limitations. Included are sloping lands (3–10%) with slopes longer than 500 m. It is important to minimise soil disturbance, maintain stubble cover and maintain good organic matter levels. This class includes other soils with acidification and soil structure limitations that are sufficient to require the application of specific management practices.

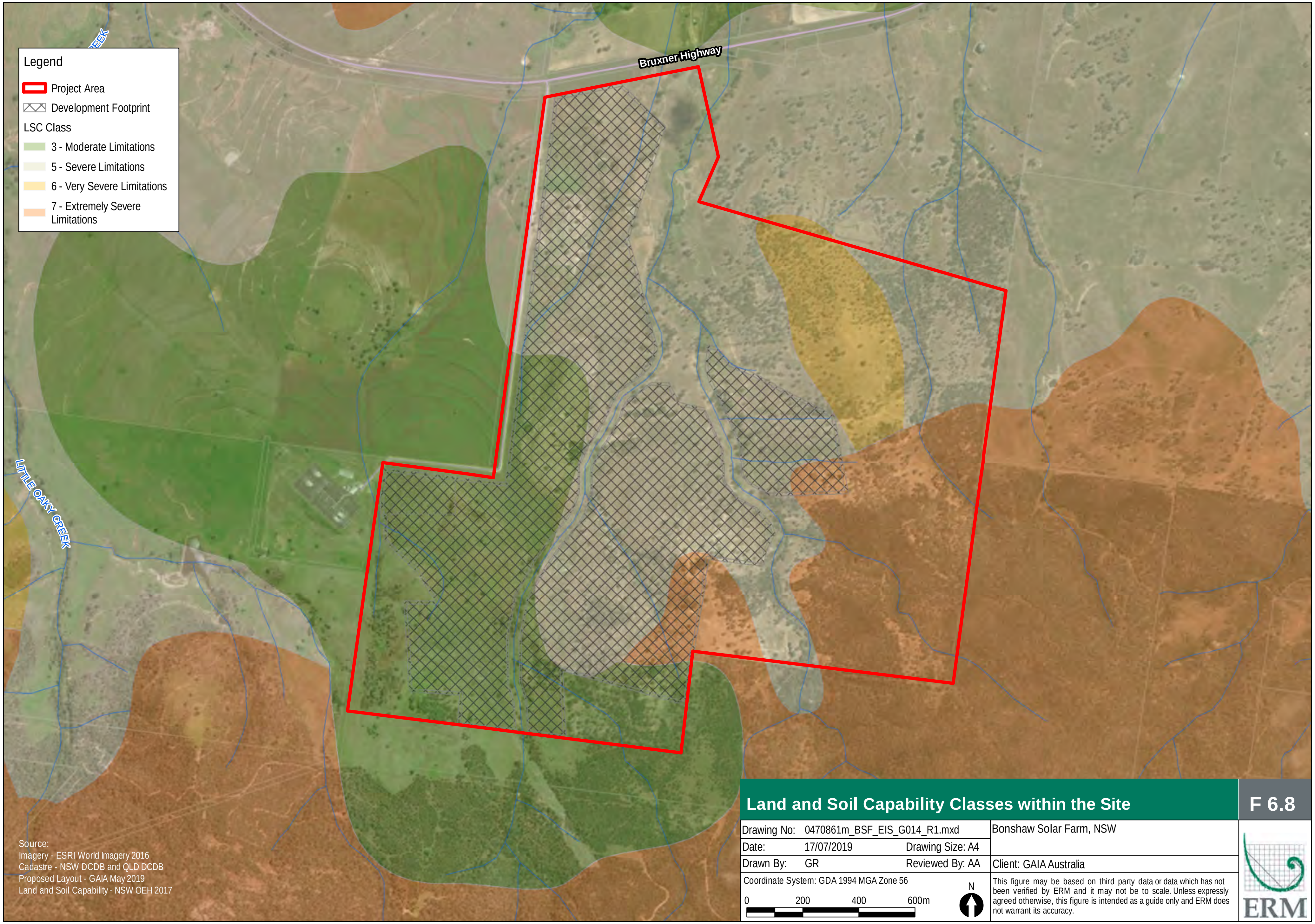
The northern portion of the Project Site has been rated LSC Class 5, having severe limitations. Class 5 land has severe limitations for high impact land management uses such as cropping. There are few management practices generally available to overcome these limitations. Class 5 land includes sloping lands (10–20% slope) with highly erodible soils and/or significant existing soil erosion, or land that will be subject to wind erosion when cultivated and left bare. Other limitations include shallow soils, stoniness, climatic limitations, acidification, and potential for structure decline and salinity hazards.

A small portion of the central eastern portion of the Project Site has been rated as LSC Class 6, having very severe limitations. Class 6 land has very severe limitations for a wide range of land uses and few management practices are available to overcome these limitations. Land generally is suitable only for grazing with limitations and is not suitable for cultivation. Class 6 land includes steeply sloping lands (20–33% slope) that can erode severely even without cultivation, or land that will be subject to severe wind erosion when cultivated and left exposed.

The southern portion of the Project Site has been rated LSC Class 7, having extremely severe limitations. This land has extremely severe limitations for most land uses. It is unsuitable for any type of cropping or grazing because of its limitations. Use of this land for these purposes will result in severe erosion and degradation. It may be too steep, rocky, swampy or fragile for grazing.

Biophysical Strategic Agricultural Land

Indicative Biophysical Strategic Agricultural Land (BSAL) maps identify the inherent land and water resources that are important on a national and state level for agriculture. The lands identified intrinsically have the best quality soil and water resources, topography, and are naturally capable of sustaining high levels of agricultural productivity and require minimal management practices to maintain this. A total of 58.3 ha of BSAL has been identified within the Development Footprint (refer to Figure 6-9).



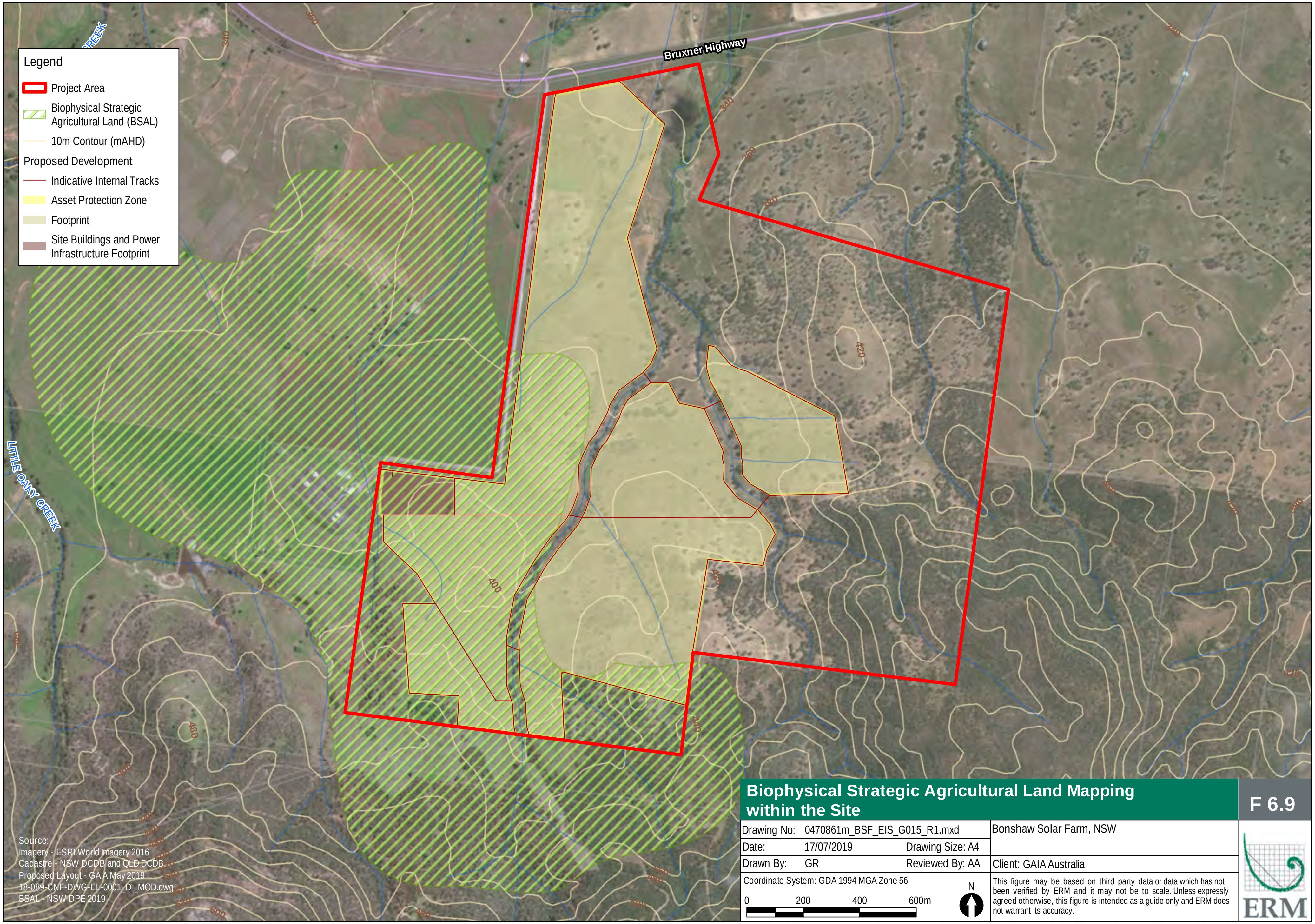
Land and Soil Capability Classes within the Site

F 6.8

Drawing No: 0470861m_BSF_EIS_G014_R1.mxd		Bonshaw Solar Farm, NSW
Date: 17/07/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: AA	Client: GAIA Australia
Coordinate System: GDA 1994 MGA Zone 56		This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Proposed Layout - GAIA May 2019
Land and Soil Capability - NSW OEH 2017



Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Proposed Layout - GAIA May 2019
18-089-CNF-DWG-EL-0001_D _MOD.dwg
BSAL - NSW DPE 2019

Biophysical Strategic Agricultural Land Mapping within the Site

F 6.9

Drawing No: 0470861m_BSF_EIS_G015_R1.mxd		Bonshaw Solar Farm, NSW
Date: 17/07/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: AA	Client: GAIA Australia
Coordinate System: GDA 1994 MGA Zone 56		This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

Mining and Minerals Titles

There are no mineral, coal or petroleum titles located within the Project Site (source SEED data base) (OEH, 2019). The nearest mineral title (EL 8335) and coal title (EL 6450) are located approximately 8 km east and 17 km west, from the Project respectively.

Geology

Geology

The surface geology of the site is mapped in the Inverell 1:250 000 Geological Map (Chestnut & Cameron, 1971). The majority of the Project Site is mapped as Texas beds (Low grade regionally metamorphosed, variably deformed lithic wacke, conglomerate, siltstone, mudstone, chert, basalt and rare tuff) with the remainder being Central Province (Basalt; undifferentiated basaltic flows). A small portion on the western boundary of the site is a part of the Morphstratigraphic Units (Scroll plain of meander belt; sand, silt and clay).

Landform

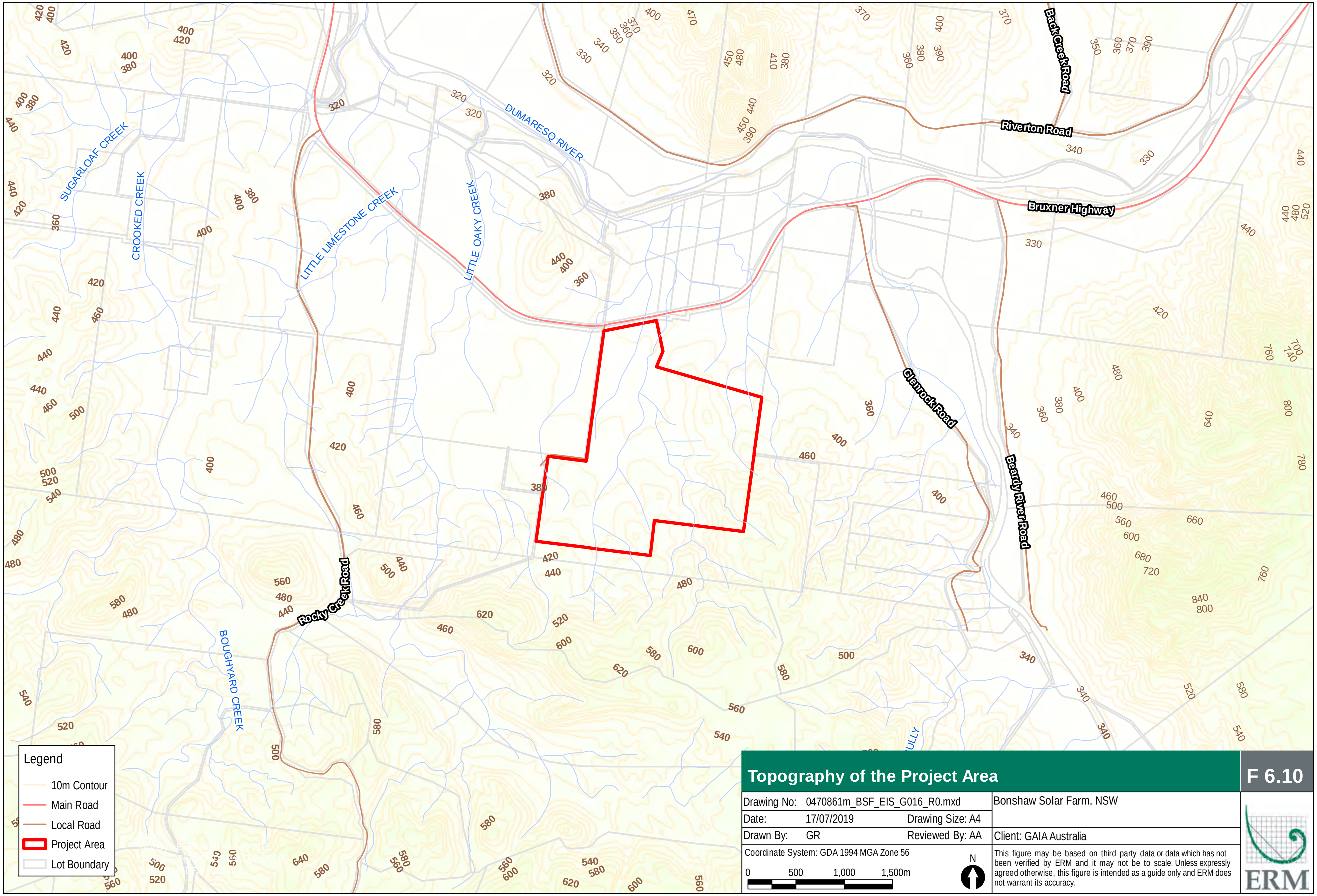
Bioregions - Landform and Elevation

Bioregions are relatively large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems. Subregions are based on finer differences in geology, vegetation and other biophysical attributes and are the basis for determining the major regional ecosystems (Morgan & Terrey, 1992). The Project Site in within the Nandewar Northern Complex IBRA Sub-region of the Nandewar Bioregion. Features of the Nandewar Northern Complex Interim Biogeographic Regionalisation of Australia (IBRA) as described by Morgan & Terrey (1992) is presented in Table 6-5.

Table 6-5 Nandewar Northern Complex IBRA Sub-region

Feature	Description
Geology	Large areas of coarse grained granite and gently folded Carboniferous quartz sandstones and shale. Isolated limestone outcrops.
Characteristic landforms	Low hills and ranges, more rugged on granites with abundant rock outcrop and tors. Short, steep gorges of major rivers. Karst landscapes on limestone.
Typical soil	Harsh texture contrast soils with subsoils prone to gully development. Gritty shallow profiles on granite. Dark, alkaline, pedal clays on limestone.
Vegetation	Red ironbark with white cypress pine, grey box, forest red gum, and bull oak on granites. Lower colluvial slopes as above with pale bloodwood, and hill red gum. River red gum, river oak and rough-barked apple on creeks. Silver-leaved ironbark and white cypress pine on shale and sandstone with white box on lower slopes. Poplar box, brigalow. Bulloak on finer alluvium, forest red gum and Moreton Bay ash on coarser alluvium. Diverse understorey shrubs.

Elevations across the site ranges from 340-440 m Australian Height Datum (AHD) from the north to the south respectively (NSW Spatial Services & GDA, 2017). Topography of the Project Site is presented in Figure 6-10.



Topography of the Project Area

F 6.10

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Date: 17/07/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: AA	Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

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Contour banks are present in the north western portion of the Project Site. These contour banks should be considered in the detailed design of the solar panel arrays and remain unbreached to continue to manage erosion on the site. Any existing breaches should be repaired and level spreaders that outlet captured runoff from banks are to be protected from impacts (avoid disturbance from vehicles).

Soils

Australian Soils Classification

A search of the Australian Soil Classification (ASC) Soil Type Map of NSW (OEH, 2019) reveals that the Project Site is largely dominated by the Sodosols soil type. They are not highly acidic, yet show strong texture contrast with highly sodic B horizon which leads to high erodibility, poor structure and low permeability. Sodosols generally have very low agricultural potential.

The ASC Soil Type Map of NSW also revealed, to a lesser extent, the presence of Tenosols (alluvial), Vertosols, and Ferrosols soil types.

Soil Hydrologic Groups

A search of the OEH eSPADE view (OEH, 2017) was utilised to identify the Hydrologic Groups within the Project Site. Hydrological Grouping of soils in NSW is a four class system, that identifies the soils infiltration and permeability characteristics. Across the Project Site, the soils are assigned ratings of B and D, representing the soils having moderate to very slow infiltration respectively. These two soil classes are described as:

> B – soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission and low to moderate runoff potential.
>
> D – soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission and very high runoff potential.

The Project Site consists of multiple tributaries that primarily flow northward into Dumaresq River. Soil types within areas immediately surrounding the vicinity of these waterways are categorised primarily as Sodosols.

Inherent Soil Fertility

Espade provides inherent soil fertility mapping at the Project Site. The inherent soil fertility at the site is predominately rated as moderately low. The limited soil disturbance associated with the construction process, and the mitigation measures focussing on soil handling and sampling to understand potential amelioration for revegetation are satisfactory to manage soil fertility impacts associated with the Project.

Modelled Soil Characteristics

ESpade provides modelled soil properties for the state and has been used to gain a broad understanding of the likely site soil characteristics that will be encountered. The modelled soil properties considered relevant to the Project Site are provided in the sections below.

Soil Acidity

ESpade soil acidity modelling demonstrates that across the Project Site, soil acidity ranges between a pH of 5 and 7 in the 0-30cm layer. The soil acidity in the 30-100cm layer becomes less acidic, ranging between 5.5 and 7.5. These soil pH characteristics are not considered to be restrictive to construction activities or any required revegetation activities that may be required.

Exchangeable sodium percentage (ESP)

ESP is a measure of soil sodicity, with values of greater than 6% indicative of sodic soils. Issues related to sodic soils include:

- water permeability issues;
- surface crusting;
- more susceptible to erosion; and
- high sediment load in runoff that will not settle out over time.

Espade soil modelling for the Project Site identifies that in the 0-30cm soil profile, ESP is predominately less than 4%. With increasing depth, in the 30-100cm soil profile, the majority of the site remains less than 4% though areas between 4-6% are observed, with isolated, small pockets between 6-8%. To manage these potentially sodic subsoils, management measures and limited soil sampling are to be implemented as detailed in Section 6.3.4 such as topsoil and subsoil separation.

Contamination

Contaminated Land

A search of the EPA's contaminated land public record of notice (EPA, 2019) identified that there were no contaminated land records for the suburb of Bonshaw or the wider Inverell Shire LGA. The list of NSW contaminated sites notified to the EPA (EPA, 2019) identified no contaminated sites within Bonshaw, there were seven contaminated sites identified within the Inverell LGA, all located within the town of Inverell.

Acid Sulfate Soils

Review of acid sulfate soil risk mapping has identified that no potential acid sulfate soils (PASS) are expected to occur across the Project Site (Naylor, et al., 1998).

6.3.3 Assessment

Construction Impacts

Soils will be subject to disturbance during construction activities to allow for site establishment, installation of infrastructure and replacement of soils for revegetation. Specific construction activities that will potentially impact soils, and resultant potential downstream watercourse impacts, are outlined in Table 6-6.

Table 6-6 Potential Construction Impacts to Soils and Water

Construction Activities	Potential Impacts to Soil and Water
Unsealed Road Network	■ Creation of fugitive dust due to vehicle movements; ■ erosion of unsealed roadways and resultant sedimentation of run-off from road surfaces; ■ erosion of roads and roadside drainage in steep terrain or in inappropriately 'finished' locations; and ■ mud tracking at confluence of internal access roads with public road network.
Watercourse Crossings	■ Erosion of drainage lines and subsequent sedimentation; and ■ removal of vegetation and subsequent increased erosion potential.
Establishment of Pad Sites (e.g. Laydown yard)	■ Erosion of relatively large disturbed areas during establishment and subsequent sedimentation of run-off.

Construction Activities	Potential Impacts to Soil and Water
Trenching	■ Erosion of trench sites; ■ erosion from trench spoil stockpiles and subsequent sedimentation should it reach a waterway; and ■ water collected in the trench following rainfall events may have high sediment content and if not managed appropriately, dewatering could contaminate surface waters.
Dewatering of Site	■ Introduction of contaminated water to natural surface waters, including release of water with high suspended solids.
Stockpile Management	■ Erosion of stockpiles and loss of soil resource; and ■ introduction of contaminated water to natural surface waters.
General Construction Activities	■ Hydrocarbon spills from machinery (burst hoses, mechanical failures, leaking machinery, etc); ■ contamination of waterways from hazardous substances due to incorrect storage (including drums and containers and spent oil filters etc.); ■ increased refuse in streams due to littering; ■ contamination of soils and waterways from poor refuelling practices; and ■ discovery of previously contaminated sites.

Potential Operational Impacts to Soils

Specific operational activities that will potentially impact soils, and resultant potential downstream watercourse impacts, are outlined in Table 6-7.

Table 6-7 Potential Operational Impacts to Soil and Water

Operational Activities	Potential Impacts to Soil and Water
Driving on unsealed Road Network	■ Creation of fugitive dust due to vehicle movements; ■ erosion of unsealed roadways and resultant sedimentation of run-off from road surfaces; ■ erosion of roads and roadside drainage in steep terrain or in inappropriately ‘finished’ locations; and ■ mud tracking at confluence of internal access roads with public road network.
Watercourse Crossings	■ Erosion of drainage lines and subsequent sedimentation; and ■ removal of vegetation and subsequent increased erosion potential.
Establishment of Pad Sites (e.g. Laydown yard)	■ Erosion of relatively large disturbed areas during establishment and subsequent sedimentation of run-off.
Shading by solar panels	■ Underlying ground cover establishment may be negatively impacted by shade dependent on time of year and time of day.
Overgrazing under panels	■ Grazing will be employed to manage vegetation height under panels. Overgrazing could reduce groundcover and increase potential for erosion and resultant sediment laden runoff.

Agricultural Land Use

Land Soil Capability

Table 6-4 above describes the classification system. The Land and Soil Capability classifications across the Project Site range from:

- LSC Class 3 land of approximately 20% of the total Project Site;
- LSC Class 5 land of approximately 50% of the total Project Site;
- LSC Class 6 land of approximately 10% of the total Project Site; and
- LSC Class 7 land of approximately 20% of the total Project Site.

None of the land within the Project Site is in the highest LSC classes of land that is capable of a wide range of land uses. The largest percentage of the land within the Project Site is LSC Class 5, moderate-low capability land. This land classification restricts land use to an agricultural land use of grazing.

The next largest area is LSC Class 3 land that is high capability and has only moderate limitations in sustaining high impact land uses. Grazing is suitable to this land classification. Small portion of LSC Class 7, very low capability land and LSC Class 6, low capability land are present in the Project Site. Class 6 land is suitable for grazing and the class 7 land is recommended to have limited on-going disturbance from agricultural activities limited.

The land classifications are not restrictive to the construction and operation of a solar farm. Grazing can still be undertaken concurrently with the solar farm operation. Grazing suits the land classification and will be beneficial to the solar far by managing vegetation height under the panels. Construction of the solar farm will be of a limited timeframe and management measures as outlined in Section 6.3.4 will be implemented to prevent loss of topsoil and treat any identified soil chemistry issues.

Biophysical Strategic Agricultural Land

Review of the Strategic Regional Land Use Policy (SRLUP) mapping available on the NSW Government Sharing and Enabling Environmental Data (SEED) website identified that a portion of the Project Site interacts with biophysical strategic agricultural land (BSAL).

Approximately 86 ha of the Project Site is mapped within a broad, regional area of BSAL as defined by the Strategic Agricultural Land Map – New England North West regional mapping presented in State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (the Mining SEPP), however only 58.3ha of this is located within the Development Footprint.

A total of 2.8 million ha of BSAL has been identified and mapped at a regional scale across NSW, including over 1.5 million ha within the New England North West Region, which encompasses a total of 12 LGAs in regional NSW including the Inverell Shire LGA (DPE, 2018). BSAL is land with high quality soil and water resources capable of sustaining high levels of productivity.

The Development Footprint encompasses 58.3 ha of BSAL, approximately 0.00002% of the total land area mapped as BSAL within NSW. The use of the BSAL mapped area will have limited impacts as the current use of the land for grazing can continue concurrently with the operation of the solar farm.

Once the Project reaches the end of its investment and operational life, the Project infrastructure will be decommissioned and the Development Footprint returned to its pre-existing land use, or other land use in consultation with the landholders, as far as practicable.

Land Use Zoning

The Project site is zoned as RU1 – Primary Production under the 2012 Inverell Shire Local Environmental Plan. The permissibility of the solar energy development is provided by way of Clause 34 (7) of the Infrastructure SEPP.

Soils

A search of OEH eSPADE (OEH, 2017) identified three soil profiles recorded adjacent to the Site.

1. Survey Number 1002073, Profile number 1;
2. Survey Number 1004244, Profile number 8; and
3. Survey Number: 1004770, Profile number 55:

Soil Profile 1 and 55 had a moderate to high erosion hazard rating, respectively. Soil profile 8 did not have an erosion hazard rating. ESpade identified for 15 of the 17 soil profiles taken within an approximately 6km radius, that no salting was evident. The remaining two were not rated for evidence of salting.

The soils do not exhibit a significant constraint that cannot be managed through considered design and construction technique or operation management measure/potential amelioration.

Contamination

No existing contamination was identified. An unexpected contamination find procedure will be developed and included in the soil and water management plan prior to the commencement of construction activities.

Compatibility with Other Land Uses

The site has historically been used for agricultural purposes, noting land clearing of the area to allow for agricultural utility. Existing land uses of neighbouring landowners is limited exclusively to farming and grazing as permitted under the land zoning (Primary Production) of the Inverell LEP (as previously shown in Figure 4-2). Through landowner consultation and site inspections, the surrounding land uses has been summarised in Table 6-8 below, with a visual representation of their locality provided in **Error! Reference source not found.**.

Table 6-8 Activities of Adjoining Properties

Landholder	Lot	Orientation from Project	Land use activities
Landholder 1	Lot 29 DP 750075	Eastern side	Farming and grazing
Landholder 2	Lot 200 DP 879480	Western side	Farming and grazing
Landholder 3	Lot 201 DP 879480	Western side	Substation
Landholder 4	Lot 46 DP 750075	Southern side	Unoccupied Land
Landholder 5	Lot 1 DP 1039185	Northern side	Grazing

GAIA have met with adjoining landowners during earlier stages of the Project during the consultation process and have not found objections to the Project, nor any concerns raised over conflicting land uses.

The LUCRA process uses the Risk Ranking Matrix. The matrix is used to rank the identified potential land use conflicts, by assessing the environmental, public health and amenity impacts according to the:

- Probability of occurrence, and
- Consequence of the impact.

The Risk Ranking Matrix yields a rank from 25 to 1. A rank of 25 is the highest magnitude of risk (aka. an almost certain and severe risk) while a rank of 1 represents the lowest (aka. a rare and negligible risk). Each activity associated with the Project has been assigned an initial risk ranking determined through the risk ranking matrix.

For those activities which score a risk ranking of 10 or lower, these are considered to be of a low risk for conflict to arise and subsequently do not need further management to reduce their potential impact. However, for activities that were identified to have a risk ranking above 10, the LUCRA is designed to define controls through various management strategies to reduce the risk for conflict.

In order to lower the risk values of activities associated with the proposed development, relevant risk reduction controls are identified for each identified potential conflict as management strategies. Consideration is given to lower both the probability and the negative consequences. The risk reduction controls will allow a revision of the risk level on the basis of the implementation of the management strategies. The objective is to identify and define controls that lower the risk ranking score to 10 or below.

In this way, management strategies are developed to minimise such effects or potential for land use conflict to arise. For each of the management strategies, performance targets are identified as well as details of how the effectiveness of the strategy will be monitored.

The LUCRA has identified and assessed the potential for activities associated with the Project to potentially cause land use conflict. The management strategies listed in Table 6-9 provide plans to reduce identified potential conflict items that originally received a Risk Rating above 10. In order to ensure these management strategies are successfully implemented, performance monitoring is an important ongoing tool throughout the construction and operation stages of the Project. Performance targets are outlined below in Table 6-9.

Table 6-9 Management Strategy

Identified Potential Conflict	Management Strategy (Method of Control)	Revised Risk Ranking (RRR)	Performance Target
Adjacent Land Use Activities	■ Consideration of neighbouring activities will be taken during the preparation of the Operational Environment Management Plan (OEMP). ■ On-site dust suppression will be adopted to minimise the potential of dust dispersion generated from the Project impacting upon neighbouring land. ■ Conversely, adjacent land uses are not anticipated to significantly impact upon the operation and functionality of the Project.	Probability: D Consequence: 4 RRR: 5	Comply with CoA, and Management measures in CEMP and OEMP
Noise	■ The Noise and Vibration Impact Assessment has assessed the noise impacts of construction and operation for the Project and provide mitigation measures, as outlined in Section 6.5 of the EIS. ■ Construction activities will be limited to standard working hours: - Monday to Friday, 7am to 6pm - Saturday, 8am to 1pm - No construction work is to take place on Sundays or public holidays. ■ Construction noise management and mitigation will be addressed in the Construction Environment Management Plan (CEMP).	Probability: D Consequence: 4 RRR: 5	Comply with CoA Management measures CEMP, OEMP and Noise Management sub-plan
Visual	■ The Visual Impact Assessment has considered the visibility of Project infrastructure and has provided mitigation measures as outlined in Section 6.4 of the EIS. ■ Provision of landscaping vegetation screening at appointed sections of the Site boundary will be installed to reduce the level of visual impact.	Probability: C Consequence: 4 RRR: 8	Successful implementation of landscape management measures, and Monitoring of landscaping management measures will be monitored in accordance with the CEMP and OEMP.
Aviation	■ Glare impacts are assessed in the Visual and Glare Assessment. No mitigation measures are required as no impacts are predicted. ■ Solar panels are proposed to be constructed with anti-glare PV panels. ■ The Project is located approximately 65km from Tenterfield Aerodrome, 30 km from Ashford Aerodrome and 43km from Texas Aerodrome. This is considered to be a sufficient distance from these aerodromes to not be of any concern to air navigation.	Probability: E Consequence: 4 RRR: 3	Installation of anti-glare PV panels.

Identified Potential Conflict	Management Strategy (Method of Control)	Revised Risk Ranking (RRR)	Performance Target
Air Quality	■ Dust generated during the construction and decommissioning stages of the Project are to be managed using water carts where required. ■ During operation, dust is not expected to generate a significant potential conflict, however this will be managed in accordance with the OEMP.	Probability: C Consequence: 4 RRR: 8	Comply with CoA, and Management measures in CEMP and OEMP Management measures in OEMP
Soil Erosion	■ Soil erosion measures will be implemented during construction and operation in accordance with the CEMP and OEMP.	Probability: C Consequence: 4 RRR: 8	Comply with CoA, and Management measures in CEMP and OEMP
Water	■ Water management measures will be implemented during construction and operation in accordance with the CEMP and OEMP.	Probability: C Consequence: 4 RRR: 8	Comply with CoA, and Management measures in CEMP, OEMP and Flood Management sub-plan.
Bushfire	■ Implementation of a Bushfire Management Plan will significantly reduce the potential for a bushfire arising during operation of the solar farm, and also to reduce the threat of damaging Project infrastructure. ■ Management will include the concurrent use of the Project Site as a solar farm and for sheep grazing, assisting in keeping the grass down post-construction as a bushfire prevention method.	Probability: D Consequence: 3 RRR: 9	Implementation of mitigation measures through the Project CEMP and Bushfire Management Plan

6.3.4 Mitigation Measures

The following mitigation measures are to be implemented to manage land use and soils during construction and operation:

- prepare a detailed Soil and Water Management Plan (SWMP) prior to construction commencing. The SWMP should be prepared by a suitably qualified person;
- prepare Progressive Erosion and Sediment Control Plans as the Project progresses to address management requirements at individual work sites/specific activities;
- employ dust management measures during construction activities;
- design and construct the Project to minimise land disturbance and therefore reduce the erosion hazard;
- stage construction activities to minimise the duration and extent of land disturbance;
- divert upslope (clean) stormwater around the disturbed sites and capture sediment-laden run-off from within the disturbed site for diversion to sediment control devices;
- regularly inspect and maintain erosion and sediment control devices for the duration of the Project (at intervals outlined in the SWMP); and
- minimise disturbance during construction by using existing access tracks and roads until proposed final designs are implemented;
- detailed design to minimise potential for negative impact to underlying vegetation from panel shading;
- actively manage grazing practices to prevent loss of ground cover and subsequent potential for erosion;
- avoid disturbance to existing contour banks and level spreaders on-site and ensure they are considered in the detailed design;
- Adopt relevant Management Strategies outlined in LUCRA into CEMP to ensure activities with an identified potential conflict are properly managed; and
- Monitoring of management strategy implementation through their alignment with the identified Performance Targets.

Contamination

- develop an unexpected contamination find procedure and include in the soil and water management plan to be developed prior to the commencement of construction activities.
- ensure appropriate procedures are in place for the transport, storage and handling of fuels, oils and other hazardous substances, including availability of spill clean-up kits.

Soil Management

- topsoil and subsoils are to be separated during excavation activities and returned in original order.
- manage topsoil resources to minimise the risk of erosion and sedimentation, and maximise reuse of topsoil during rehabilitation;
- where excavation activities are required, soil testing at 0-30cm and 30-100cm will be undertaken during the geotechnical investigation phase or prior to construction to determine if ameliorants are to be added to soils to address fertility/soil chemistry issues.

- progressive revegetation of disturbed areas should be undertaken where practicable throughout the construction.

6.4 Visual

A Visual and Glare Assessment (VGA) has been undertaken by ERM (2019) to ensure the Project addresses the likely visual and glare impacts of the development. The VGA provides an assessment of the likely visual impacts on the development (including any glare, reflectivity and night lighting) on surrounding residences, scenic or significant vistas, air traffic and road corridors in the public domain, including a draft landscaping plan for on-site perimeter planting, with evidence it has been developed in consultation with affected landowners. The VGA is attached below as Appendix F.

6.4.1 Methodology

Visual Assessment Methodology

In assessing the visual impact of a solar project from the public domain, the assessment of visual impact is based on four criteria, namely visibility, distance, landscape character & viewer sensitivity and the number of viewers.

- **Visibility**: The visibility can be affected by intervening topography, vegetation and buildings.
- **Distance**: Visibility decreases as distance increases. The Zones of Visual Impact (ZVI) give an indication of the impact based solely on distance.
- **Landscape character and viewer sensitivity**: The character of the surrounding landscape, both around the site and adjacent to the viewing location, must be considered. Generally, a modified landscape such as farmland is considered of low sensitivity, whereby a pristine landscape such as a national park is considered highly sensitive. Similarly a greater sensitivity to visual change is afforded to a residential area or township than that of an industrial landscape.
- **Number of viewers**: The level of visual impact decreases where there are fewer people able to view the Project. Alternatively, the level of visual impact may increase where views are from a recognised vantage point. Viewer numbers from a recognised vantage point would be rated as high.

These four criteria need to be considered in the assessment of each viewpoint. However, the ratings of each criterion are not numerically based and cannot be simply added together and averaged to arrive at an overall rating.

Glare Assessment Methodology

The assessment of potential for solar glare impacts utilises the Solar Glare Hazard Analysis Tool (SGHAT) developed by Sandi National Laboratory to predict the potential glare from selected locations.

Glare hazard is the human impact caused by exposure to reflected light. Factors that contribute to glare hazard for a solar farm include:

- Reflectivity of surfaces;
- Angle of incidence;
- Strength of the light source;
- Receptors; and
- Distance.

Glare can only occur where there is direct line of site to the Project. Views that are filtered or screened by vegetation would reduce the potential for glare affects to occur.

6.4.2 Existing Environment

The existing environment is identified through an understanding of the Project's landscape character. The landscape character is defined by areas with similar visual characteristics in terms of topography and geological features such as creeks and drainage lines, soil, vegetation and land use.

Land Use

The predominant land use in the proximity of the Project is rural landscape used for grazing and some cropping with natural waterways and vegetated ridgelines. The 330 kV TransGrid Dumaresq Substation is located to the south-west of the proposed site with a 264 kV power lines running roughly in a south-easterly direction in the southern portion of the site.

The area to the north of the Project Site between the Bruxner Highway and the Dumaresq River (which form the border between New South Wales and Queensland), is relatively flat land used for cropping and grazing, with some irrigation. Isolated farmsteads with associated out buildings and cattle yards are located in the area.

The land to the north of the Bruxner Highway is predominately grazing and some cropping. The land use of the Project Site is largely grazing, with a few tree lined creeks. The area to the west of the site is cleared land and used for cropping. The land to the east is used largely for grazing. The land to the south of the Project Site is heavily vegetated with native woodland.

Topography

The Project Site is located on the southern edge of the Dumaresq River floodplain and on the foothills of the ridge line running between Hetherington's Sugarloaf and Hasselmann Pinnacle. The topography within the Project Site is gently undulating and located between two low ridge lines, thereby forming a slight bowl. The land in proximity to the Bruxner Highway is relatively flat and becomes progressively steeper to the south.

The elevation at the Bruxner Highway (north boundary) is approximately 335 m and rises up to approximately 420 m in the south-western portion of the Project Site. The ridgelines to the south of the Project rise up to approximately 660 m forming the dominant landscape feature as displayed on the topographic map in Figure 6-10 above.

A smaller hill is located to the north-west of the Project Site between the Bruxner Highway and the Dumaresq River which screens the site from views from the north and north-west.

Vegetation

The Dumaresq River valley consists largely of natural grasslands on basalt and fine textured alluvial plains of northern New South Wales and southern Queensland. The flood plain is largely cleared of native vegetation with isolated larger trees scattered across the landscape where irrigated fields and grazing dominate. The Dumaresq River is lined on both sides by various large eucalypt tree species.

The area to the south of the Bruxner highway is dominated by open grasslands with wooded waterways with the vegetation becoming progressively denser further south into the foot hills. Larger eucalypt species on granite become more prevalent to the south of the Project Site.

6.4.3 Assessment

The first part of the visual and glare assessment is to identify areas where the proposed development may be visible from. Using Geographical Information Systems (GIS) mapping, the theoretical Project visibility is plotted. This theoretical Site Visibility Analysis does not take into account screening offered by vegetation, minor topographic changes and buildings, which may reduce the visibility from many locations. For these reasons, the GIS analysis is a conservative visibility map and is useful to determine locations from which to assess the Visual and Glare Impacts of the Project.

Figure 6-11 is a Site Visibility Analysis which identifies the location of the solar farm, the areas where any part of the proposed development that may be seen from and the amount of the area seen as a percentage. The distances between surrounding sensitive receptors and the Project Site are mapped in Figure 6-11.

Areas where no shading exists means that no part of the proposed development is visible form these areas and therefore have no potential for visual or glare impacts.

Viewpoints

A site visit was undertaken to verify the findings and refine the location of viewpoints based on actual visibility. The site visit also provided insight into the landscape character of the area.

Eight viewpoints (refer to Figure 6-12) have been selected that have theoretical visibility of the Project.

Viewpoints are selected on the following basis:

- their potential to indicate the scale and extent of the Project at varying distances;
- where a viewer has a likelihood to pause and have a view to the Project such as gaps in roadside vegetation or near road intersections; and
- where it is indicative of the landscape characters defined within the Project Site.

Viewpoints are typically located where direct or clear views to the Project are available. In some viewpoints, vegetation within road reserves, river or on private properties may filter views to the Project.

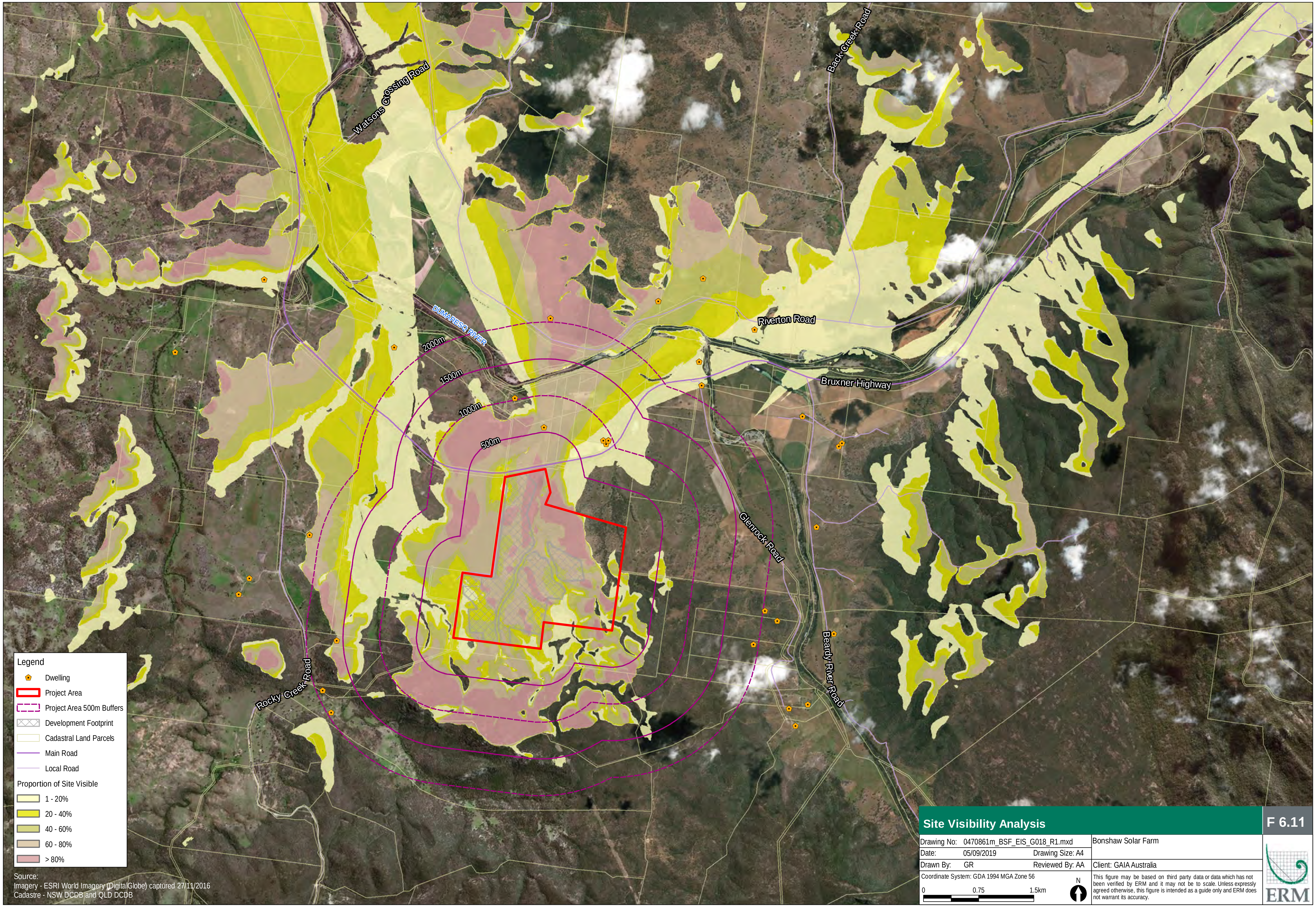
Visual and Glare Assessment

The VGA has identified that other than for a location immediately north of the Project Site on the Bruxner Highway, all visual impacts are **low to none**.

The impact from the Bruxner Highway is deemed as **medium to low** impact, however given the short frontage and period of time the facility is seen, the low traffic volumes along this route and the setback from the road means that the overall impacts from this locality are localised and therefore low. The provision of a five meter landscape strip along the northern and a 400 m portion of the north-western boundaries will reduce visual impacts from the Bruxner Highway.

No photomontage has been undertaken as the visual impacts are low to medium and the level terrain close to the Bruxner Highway means that the arrays in the foreground would effectively screen the views of those further back. The dark grey colour of the panels are also considered to be in-keeping with the rural landscape where cattle yard structures, large sheds and irrigation systems are scattered in the landscape. The inverter structures are relatively small and largely screened by the solar arrays and where visible are not dissimilar to small rural structures.

No glare impacts are predicted and therefore no mitigation measures are required for glare.



Source:
Imagery - ESRI World Imagery (DigitalGlobe) captured 27/11/2016
Cadastre - NSW DCDB and QLD DCDB

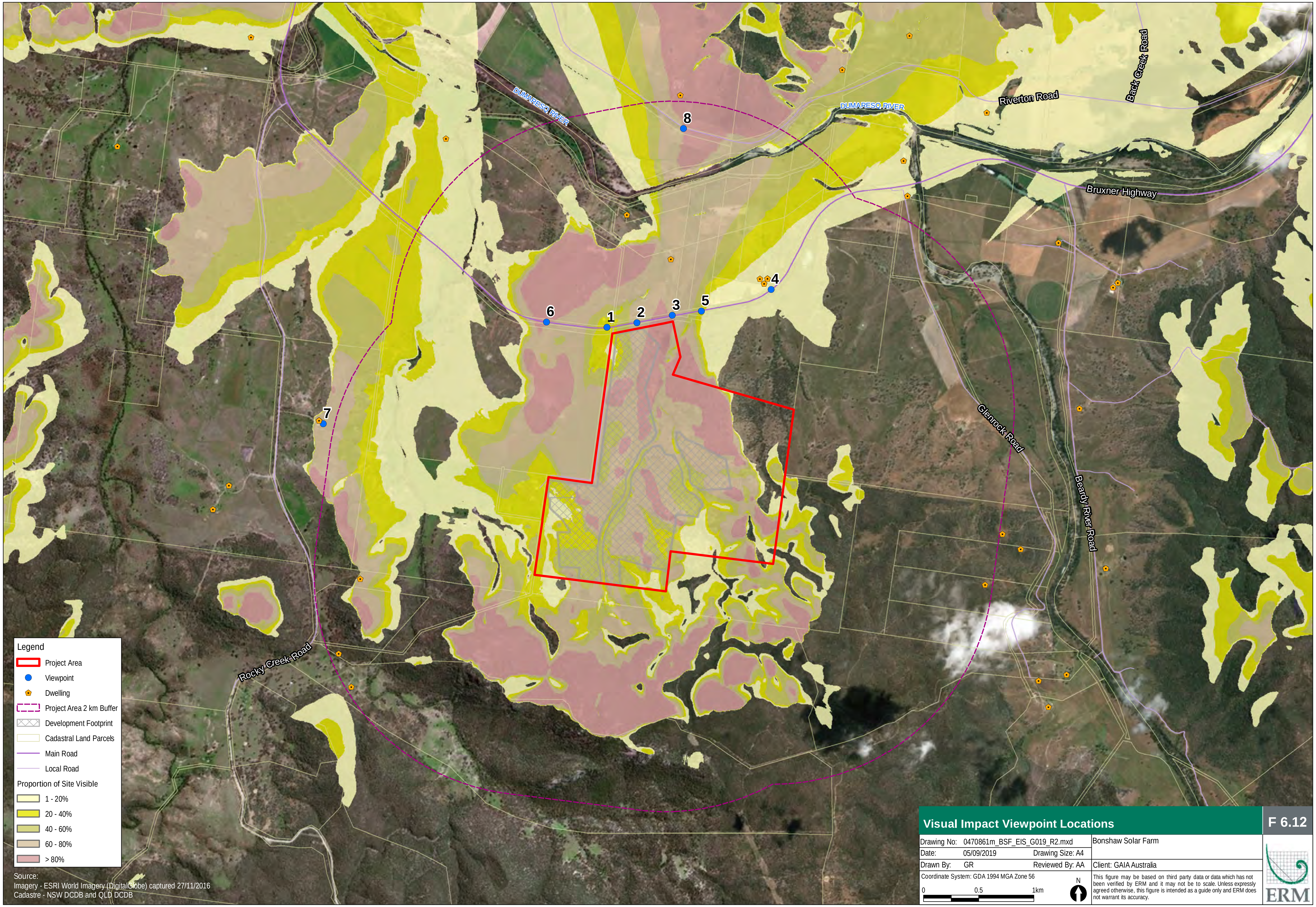
Site Visibility Analysis

F 6.11

Drawing No: 0470861m_BSF_EIS_G018_R1.mxd
Date: 05/09/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm

Client: GAIA Australia



Source:
Imagery - ESRI World Imagery (DigitalGlobe) captured 27/11/2016
Cadastre - NSW DCDB and QLD DCDB

Visual Impact Viewpoint Locations

F 6.12

Drawing No: 0470861m_BSF_EIS_G019_R2.mxd
Date: 05/09/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm

Client: GAIA Australia

ERM

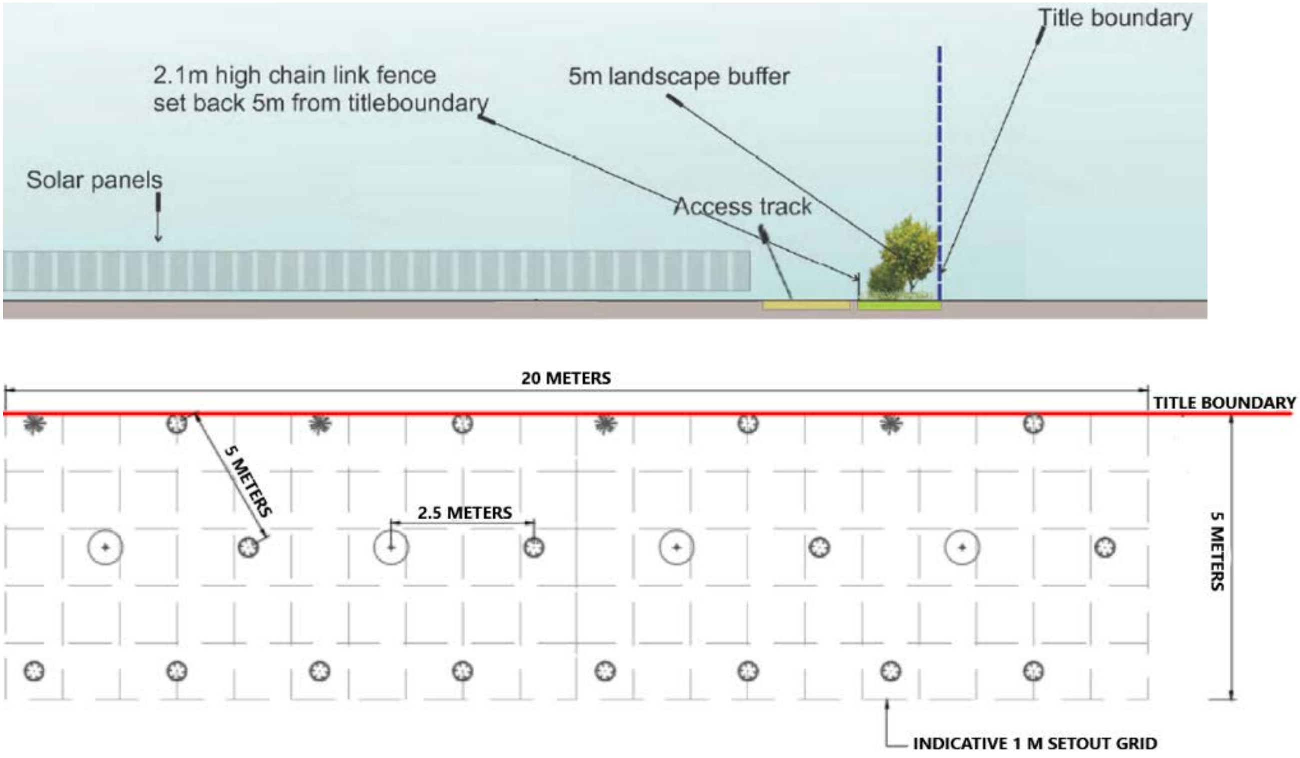
6.4.4 Mitigation Measures

As detailed in the VGA (refer to Appendix F) the proposed Project will have no adverse glare effects on any of the sensitive receptors or along the Bruxner Highway. This is to be expected given the location of the receptors to the north of the facility, the limited views of the site, and the use of a tracking system that reduces glare affects, vegetation screening and the elevations of most of the receptors being below that of the facility. No mitigation for glare is therefore required.

However, to mitigate impacts of visual impacts, the landscape mitigation measures are proposed along the Bruxner Highway frontage and for 400 m along the north-western boundary adjacent to the Transgrid Dumaresq Substation access road and take in the rural landscape setting.

These mitigation measures include a 10 metre setback to solar farm infrastructure that includes a 5 metre landscape strip between the property boundary and Project fencing, with a perimeter access track between the fence and solar farm infrastructure (refer to Figure 6-13 Proposed Landscape MitigationFigure 6-13 below). The proposed landscaping treatment will utilise native species endemic to the area that will survive the climatic conditions and require minimal maintenance, while filtering the visual impact of the solar farm.

Figure 6-13 Proposed Landscape Mitigation



✱	Ground Covers	Plant Density: 4 Ground Covers/100m^2
❁	Shrubs	Plant Density: 15 Shrubs/100m^2
⊙	Trees	Plant Density: 4 Trees/100m^2

6.5 Air Quality

6.5.1 Existing Environment

The Project Site and the locality has undergone a long history of disturbance, including clearing for agricultural and grazing land use. The Development Footprint is mainly cleared land and its current land use is low intensity grazing.

6.5.2 Assessment

Construction impacts may include short-term dust and particulate emissions associated with excavation of trenches, ground preparations and vehicular movements in the laydown areas.

There will be no operational impacts associated with the operation of the solar farm.

6.5.3 Mitigation Measures

The implementation of construction air quality safeguards and management measures will reduce the extent of air quality impacts. The following management measures should be realised to minimise dust generation:

- employ dust management measures during construction activities;
- watering or covering exposed areas;
- works are not to be carried out during strong winds or in weather conditions where high levels of dust or airborne particulates are likely;
- vehicles transporting waste or other materials that may produce odours or dust are to be covered during transportation;
- stockpiles or areas that may generate dust are to be managed to suppress dust emissions where possible; and
- any exposed areas are to be reinstated with fast growing local provenance grasses.

6.6 Noise

This section summarises the Noise and Vibration Impact Assessment completed for the Project (refer to Appendix G). It discusses all acoustical features considered in that assessment. It then focuses on the key issues that could impact the nearby receptors situated within the potential area of influence of the Project Site.

6.6.1 Methodology

The assessment methodology adopted to assess potential construction and operational noise and vibration impacts at the closest and/or potentially most affected sensitive receptors situated in the vicinity of the Project is provided below. An acoustics glossary of relevant acoustical concepts and terminology is provided in the Appendix G assessment report.

Scope of Work

To assess project construction and operational noise/vibration, the following scope of work has been completed:

- Review and validate the available project and third-party data and information as considered relevant to the assessment.
- Review aerial photography, zoning data, cadastre data and third-party project data to identify potential residential (dwelling) and other sensitive (commercial and industrial) receptors situated within the potential area of influence of the site.
- Identify significant noise generating plant, equipment and machinery that may be in use or activities that will be undertaken as part of the Project and their source emission level to develop applicable assessment scenarios.
- Develop a project-specific noise model to predict project construction, and operational levels for each of the assessment scenarios developed. Following this, predicted levels were compared to project-specific criteria to identify any noise levels that exceed criteria and determine the magnitude and extent of any impacts.
- Recommend noise reducing mitigation, management measures and/or provisions for monitoring suitable to the predicted levels and anticipated impacts. These measures are designed to reduce project noise emissions to compliant levels and to minimise impacts as far as may be feasible, reasonable and practical to implement.

Relevant Policy, Guidelines and Standards

A full list of applicable policy, guidelines and standards is provided in the Appendix G assessment report that was conducted with due regard to and in accordance with the following key policy and guidelines.

NSW Interim Construction Noise Guideline: For this project the ICNG, 2009 is the suitable guideline document to quantifiably assess potential noise emissions and impacts associated with project construction. The ICNG, 2009 assessment methodology has been adopted to develop project-specific construction noise management levels assess potential impacts and recommend any necessary mitigation, management measures or provisions for monitoring.

NSW Noise Policy for Industry: For this project the NPI, 2017 is the suitable guideline document to quantifiably assess potential noise emissions and impacts associated with the Project's operation. The NPI, 2017 assessment methodology has been adopted to quantify existing conditions, develop project-specific operational noise criteria, assess potential impacts and recommend any necessary mitigation, management measures or provisions for monitoring.

NSW Road Noise Policy: In this case the RNP, 2011 is the suitable guideline document to quantifiably assess potential noise emissions and impacts associated with the Project's construction and operational road traffic noise. The RNP, 2011 assessment methodology has been adopted to develop project-specific road noise criteria, assess potential impacts and recommend any necessary mitigation, management measures or provisions for monitoring.

Qualitative Assessments

The Appendix G assessment report presents a qualitative assessment of lower risk acoustical factors that were considered during the preliminary stages of data and information review. This included:

- Vibration – Construction and Operation; and
- Ground-Bourne Noise – Construction and Operation.

The remainder of the assessment focuses on higher risk acoustical factors, construction and operational noise.

Cumulative Impacts

Noise impact assessments are generally based on predicting project-specific levels at the closest and/or most affected receptors and then comparing these to criteria or management levels that apply to the type of emission being considered.

In the case of construction and operational emissions, the noise criteria are derived based on existing noise levels for the area, for road traffic fixed values generally apply. To assess potential cumulative impacts a varied approach has therefore been adopted as described below.

The construction noise criteria (ICNG, 2009) and management levels are also based on existing noise levels surrounding the Project Site but focus on the direct impacts from the site under assessment, cumulative impacts are beyond the control of GAIA, are temporary in most circumstances and are best managed by local or state consent authorities for significant projects. Therefore, a qualitative assessment of potential cumulative impacts has been conducted but limited discussion regarding cumulative impacts is required.

The operational noise criteria are based on existing noise levels or rating background levels (RBLs) of the site under assessment, such that existing conditions and industrial noise contributions are considered as part of the assessment approach. The NPI, 2017 criteria are designed to prevent any long-term increase in cumulative industrial noise. Therefore, they address potential cumulative impacts without further discussion required.

With the above features in mind, the focus of any discussion regarding cumulative impacts is associated with operational noise.

Noise Modelling

Key features, inputs and assumptions that have informed the noise modelling and assessment are reproduced or outlined in Table 6-10 below.

Table 6-10 Noise Modelling Features, Inputs and Assumptions

ID	Feature	Description
1	Noise Modelling Software	■ Brüel & Kjær's Predictor 7810 (Version 12.00) noise modelling software package was utilised to calculate construction and operational noise levels using the ISO9613:2 noise propagation algorithms, international method for general purpose: 1/1 or 1/3 octaves in Hertz (Hz). ■ The BK Predictor 7810 (Version 12.00) software package allowed 3D elevation data (obtained from the NSW Government - Land & Property Information (LPI) with cadastre and Local Government Area (LGA) zoning data) to be combined with ground regions, foliage, barriers, significant building structures etc. and receptor locations, to create a detailed and accurate representation of the site and surrounding area. The model computed the noise propagation in the assessment area to specifically quantify A-weighted decibels (dBA) at identified receptors, in the applicable $L_{eq,\ 15\ minute}$ and L_{max} (operations only) parameter.
2	Construction and Operational Noise Modelling – ICNG, 2009 and NPI, 2017	■ The Sound Power Level data (overall L_W and spectral (Hertz, Hz) values, in dBA) that was adopted for this assessment was established based on publicly available data for known items of operational plant, equipment and machinery. For the construction of the Project, all source values have been assumed for this assessment based on data presented in AS2436 or from the ERM noise emission source database. L_W is a measure of the total power radiated by a source; it is a fundamental property of the source and is independent of the surrounding environment. L_W differs from a Sound Pressure Level (L_P) which is the level of sound pressure as measured at a distance by a standard sound level meter with a microphone. L_P is the received sound (e.g. $L_{eq,\ 15\ minute}$ in dBA) as opposed to L_W which is the sound 'intensity' at the source. ■ Preliminary noise contour mapping and LGA zoning data were utilised to identify the receptor locations where compliance has been assessed. A total of fifteen locations were identified, and noise levels were calculated at 1.5 metres above ground level. In all cases, noise has been assessed at the most-affected point at or within the property boundary, with receptor points selected in accordance with the requirements of the NPI, 2017.
3	Road Traffic Noise Modelling (construction and operations) – RNP, 2011	■ For road traffic noise, the BK Predictor 7810 (Version 12.00) software package was again used but adopting the United Kingdom (UK) – *Calculation of Road Traffic Noise* (CoRTN) calculative methods, as adapted to Australia conditions. ■ For the project-specific road traffic noise models, a line source was utilised with the vehicle flows and mixes input to the model directly, overall L_W and spectral (Hz) values are not required for the CoRTN algorithm. ■ A ground factor of 0.7 was applied for the general modelling area. ■ The model allowed for the quantification of noise levels based on the input traffic flows and mixes and computed the noise propagation at representative distance offsets (rather than at specific receptor points) to quantify A-weighted decibels (dBA), in the applicable $L_{eq,\ 15\ hour}$, $L_{eq,\ 9\ hour}$ and $L_{eq,\ 1\ hour}$ in parameters.

ID	Feature	Description
4a	General Modelling Meteorological Conditions	General meteorological conditions for the project-specific noise models included a temperature of 10.2°C (annual mean minimum), and humidity of 72% (annual mean for 9 AM statistics), representative of average conditions for the Bonshaw area. An assumed atmospheric pressure of 101.33 kPA was adopted. These temperature and humidity values were determined based on annual average weather data publically available from the Bureau of Meteorology (BOM) Weather Station situated at Pindari Dam: Site number: 054104, Location: Latitude: 29.39° South and Longitude: 151.24° East and Elevation: 462 metres.
4b	Effects of Meteorological Conditions	As per the NPI, 2017 meteorological conditions need to be considered for the operational phase of industrial activity, under a range of meteorological conditions. Accordingly, a precautionary approach was adopted and potential worst-case noise-enhancing meteorological conditions have been considered, for the operational noise modelling, based on the following meteorological parameters: *Noise-enhancing meteorological conditions: daytime and evening Pasquill–Gifford stability Category D conditions, light source-to-receiver winds (3 m/s) and a night-time stability Category F temperature inversion condition, light source-to-receiver winds (2 m/s).* Construction noise modelling has adopted a stability Category D condition only (representing stable conditions commonly experienced during the daytime period, when works will occur) and calm winds for all scenarios.

6.6.2 Existing Environment

A key element in assessing noise impacts is an understanding of the existing ambient and background noise levels in the vicinity of the closest and/or potentially most affected noise sensitive receptors situated near the Project Site.

The noise environment in the vicinity of the Project receptors is best described as ‘rural’ defined by the NPI, 2017 as an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. This area often has evening ambient noise levels defined by the natural environment and human activity.

A “rural” area may be located in either a rural landscape, large lot residential, primary production, primary production small lots or environmental living zone, as defined on a council zoning map (i.e. Local Environmental Plan (LEP) or other planning instruments).

Due to the rural setting of the Project, the existing noise environment of the surrounding area experiences low ambient and background noise levels. The minimum assumed rating background noise levels have therefore been considered in this assessment (Table 2.1 of the NPI, 2017). This is further outlined in below.

Potentially Sensitive Noise Receptors

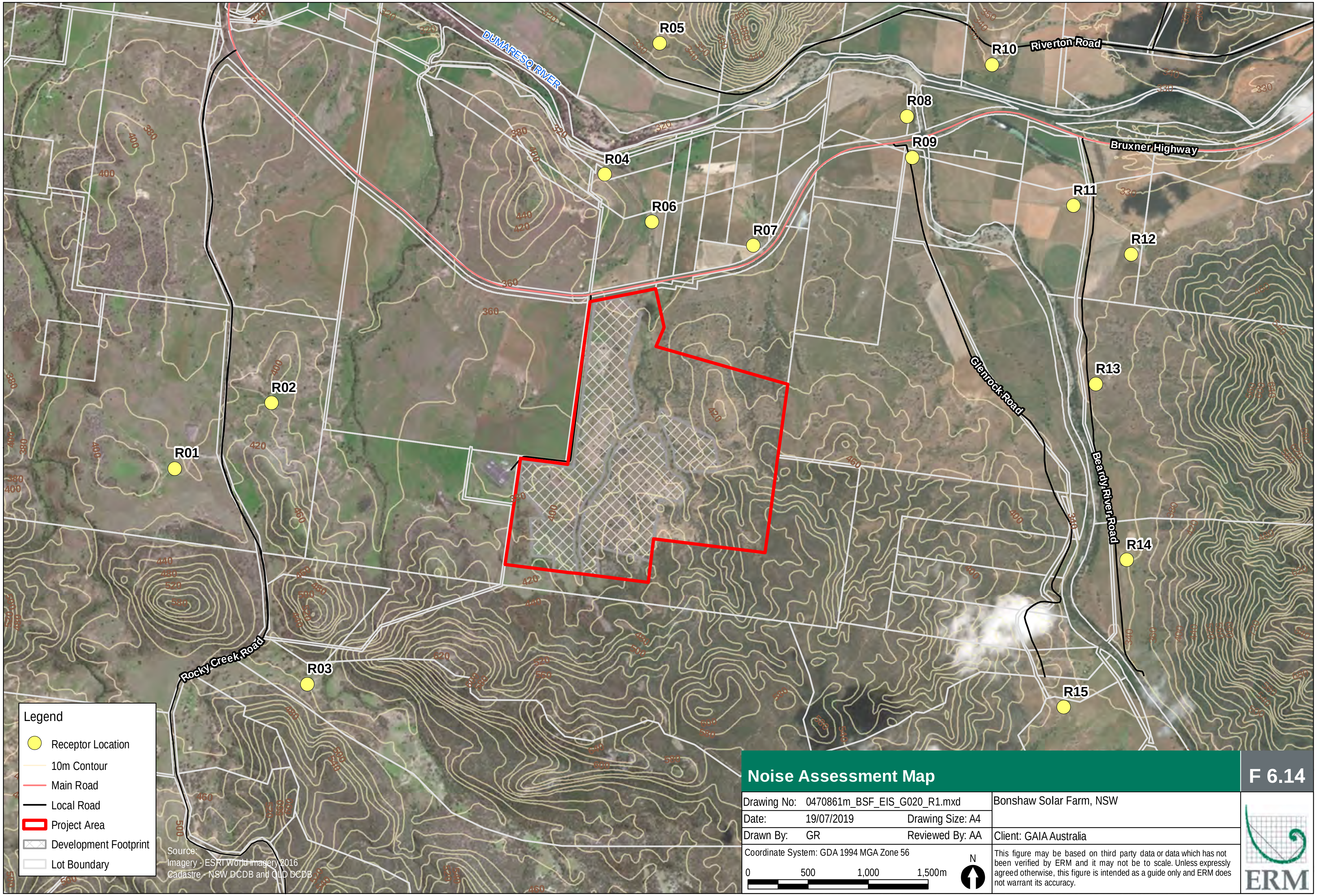
The potentially sensitive noise receptors where compliance has been assessed are presented below in Table 6-11 as identified in Figure 6-14 below, that reproduces the information shown in Figure 1.3 of the Appendix G assessment report.

Guidance Note

The locations identified below were established based on the following:

- information provided by or on behalf of GAIA;
- a subsequent review of aerial photography;
- review of land use zoning data; and
- the results of preliminary noise modelling, where receptor positions were optimised to predict likely worst-case noise levels.

These locations do not represent every receptor located in the vicinity of the Project but have been selected for this noise assessment as they are considered to be representative of the locations that will potentially experience the highest or worst-case impacts associated with the construction and ongoing operation.



Legend

- ● Receptor Location
- 10m Contour
- Main Road
- Local Road
- ▭ Project Area
- ▨ Development Footprint
- ▭ Lot Boundary

Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB

Noise Assessment Map

F 6.14

Drawing No: 0470861m_BSF_EIS_G020_R1.mxd
Date: 19/07/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

Table 6-11 Potentially Sensitive Receptors

ID	Type	Description	GPS Co-ordinates (UTM, Zone 56J)		Ground Height	Approximate Distance from project, metres	Direction from project
			Easting	Northing			
R01	Residential (Dwelling)	“Needlewood” - 3835 Rocky Creek Rd, Bonshaw NSW 2361	334856	6768390	387	2800	West
R02	Residential (Dwelling)	3894 Rocky Creek Rd, Bonshaw NSW 2361	335677	6768969	399	2100	West
R03	Residential (Dwelling)	“Long Ridge” - 3650 Rocky Creek Rd, Rocky Creek NSW 2371	335966	6766605	398	2000	South West
R04	Residential (Dwelling)	Property to South of Dumaresq River, off Bruxner Hwy, Bonshaw NSW 2361	338430	6770819	336	1200	North
R05	Residential (Dwelling)	Property to North of Dumaresq River, off Riverton Rd, Watsons Crossing, QLD	338891	6771931	281	2300	North
R06	Residential (Dwelling)	“Glen Hill” - 9024 Bruxner Hwy, Bonshaw NSW 2361	338815	6770428	339	830	North
R07	Residential (Dwelling)	“Coo-Ee” - 8930 Bruxner Hwy, Bonshaw NSW 2361	339635	6770241	339	1000	North
R08	Residential (Dwelling)	“St Elmo” - 8782 Bruxner Hwy, Bonshaw NSW 2361	340931	6771313	325	2700	North East
R09	Residential (Dwelling)	Property to South of Bruxner Highway, off Glenrock Rd, Bonshaw NSW 2361	340988	6770977	328	2500	North East
R10	Residential (Dwelling)	Property to North of Dumaresq River, off Riverton Rd, Maidenhead, QLD	341691	6771754	325	3500	North East
R11	Residential (Dwelling)	Property to South of Bruxner Highway, off Beardy River Rd, Dumaresq Valley NSW 2372	342344	6770580	334	3500	North East
R12	Residential (Dwelling)	Property to South of Bruxner Highway, off Beardy River Rd, Dumaresq Valley NSW 2372	342859	6770241	339	4000	North East
R13	Residential (Dwelling)	“Stackhavon” - 207 Beardy River Rd, Dumaresq Valley NSW 2372	342513	6769093	346	3500	East
R14	Residential (Dwelling)	“Haystack” - 345 Beardy River Rd, Dumaresq Valley NSW 2372	342751	6767638	340	3400	East
R15	Residential (Dwelling)	“Glenrock Homestead” - 540 Glenrock Rd, Rocky Creek NSW 2371	342257	6766423	352	3300	East

Rating Background Noise Levels

The Rating Background Noise Levels (RBL) for the daytime (L90, 11 hour), evening (L90, 4 hour) and night-time (L90, 9 hour) are presented in Table 6-12 below for all potential noise-sensitive receptors, as established based on the NPI, 2017 minimum assumed rating background noise levels.

The RBL values are adopted to establish ICNG, 2009 construction noise management levels and NPI, 2017 operational criteria for residential (dwelling) receptors as identified in the Appendix G assessment report.

Table 6-12 Rating Background Noise Levels

ID	Receptor Type	Rating Background Noise Levels (RBL), dBA		
		L90, 11 hour (Daytime)[1]	L90, 4 hour (Evening)[2]	L90, 9 hour (Night-time)[3]
R01 – R15	Residential (Dwelling)	35	30	30

1. *Daytime: 7:00 am – 6:00 pm,*
2. *Evening: 6:00 pm – 10:00 pm*
3. *Night-time: 10:00 pm – 7:00 am*

6.6.3 Assessment

Project-Specific Assessment Criteria

The construction and operational noise assessment criteria have been established for the Project with due regard to the existing conditions described above and in accordance with the ICNG, 2009, the NPI, 2017 and RNP, 2011.

NSW Interim Construction Noise Guideline

The project-specific construction "Noise Management Levels" (NML), for works within and outside the recommended standard hours for construction, are presented in Table 6-13 below.

These NML have been established with due regard to the requirements of the ICNG, 2009 for all identified residential (dwelling) and other sensitive (commercial) receptors.

In accordance with the ICNG, 2009 NML values for other sensitive receptors, i.e. nearby commercial or industrial premises, are fixed levels based on usage. They do not rely on the RBL utilised for residential receptors. No industrial or commercial premises have been identified for this assessment however the applicable construction noise management levels are provided in Table 6-13 below.

Table 6-13 Construction Noise Management Levels (NML)

Description	Construction Noise Management Levels, dBA			HNML, Leq, 15 minute, dBA	Sleep Disturbance Criteria, dBA	
					Night-time only	
	Day	Evening	Night	Daytime (Standard Hours)	Leq, 15min	Lmax
Residential Receptors	45	35	35	75	40	52
Industrial Receptors	75	75	75	-	-	-
Commercial Receptors	70	70	70	-	-	-

1. Dash "-" indicates that this criteria does not apply at that receptor.

NSW Noise Policy for Industry

The project-specific intrusiveness noise level, recommended amenity noise level (residential receptors) and the Project amenity noise levels are detailed in the Appendix G assessment report. These criteria represent the operational noise criteria used to assess potential impacts, with the most stringent of these values adopted as the project-specific "Noise Trigger Level", PTNL, presented in Table 6-14 below.

In accordance with the NPI, 2017, PTNL for other sensitive receptors, i.e. nearby commercial or industrial premises, are fixed levels based on usage. They do not rely on the RBL utilised for residential receptors. No industrial or commercial premises have been identified for this assessment however the applicable PTNL are provided below.

The NPI, 2017 assessment periods are defined as follows: daytime is the period from 7 AM to 6 PM, Monday to Saturday; or 8 AM to 6 PM on Sundays and public holidays. The evening is the period from 6 PM to 10 PM, Monday to Sunday (seven days per week) and night-time is all remaining periods.

Table 6-14 Project-specific Noise Trigger Levels (PTNL)

Description	PTNL Leq, 15 minute in dBA			Sleep Disturbance Criteria, dBA	
				Night-time only	
	Day	Evening	Night	Leq, 15min	Lmax
Residential Receptors	45	35	35	40	52
Industrial Receptors	65	65	65	-	-
Commercial Receptors	70	70	70	-	-

1. Dash "-" indicates that this criteria does not apply at that receptor.

NSW Road Noise Policy

The road traffic noise criteria applicable to the Project (construction and operation), are presented in Table 6-15 below. These road traffic criteria have been established with due regard to the requirements of the RNP, 2011. In accordance with the RNP, 2011 criteria are fixed levels based on road type, they do not rely on the RBL utilised for residential receptors. These criteria are applicable to residential receptors and are assessed at the building façade.

Table 6-15 Road Traffic Noise Criteria

Assessment Classification	RNP Road Traffic Noise Criteria	
	Daytime (7am to 10pm) assessment period	Night time (10pm to 7am) assessment period
Road traffic noise criteria for existing residences affected by **additional traffic on existing sub-arterial roads** generated by land use developments.	$L_{eq,\ 15\ hour}$ 60 dB (external)	$L_{eq,\ 9\ hour}$ 55 dB (external)
Road traffic noise criteria for existing residences affected by **additional traffic on existing local roads** generated by land use developments.	$L_{eq,\ 1\ hour}$ 55 dB (external)	$L_{eq,\ 1\ hour}$ 50 dB (external)

Construction Noise Assessment

Chapter 5 of the Appendix G assessment report presents the construction noise assessment completed as per the requirements of the ICNG, 2009. It presents two key construction assessment scenarios and associated data as follows:

- **CON01: Site Preparation and Establishment** including the use of multiple forklifts, telescopic handlers, Manitou, Water Truck, Commuter van, 4x4 vehicles, self bunded mobile fuel cell.
- **CON02: Installation/Construction of Infrastructure** include the use of multiple forklift, Manitou, telescopic handler, water truck, screw pile drivers, 4x4 vehicles, self bunded mobile fuel cell.

These scenarios and associated data are representative of general construction works that are anticipated for the Project and were adopted to predict noise levels and comparison to management levels. Due to the large area over which the Project Site is situated, each construction scenario has been modelled to occur at three different locations: a) the northern portion of the site; b) the central portion of the site; and c) the southern portion of the site. A modifying correction factor (penalty) for any annoying noise characteristics such as tonality, low-frequency components etc. was considered as per the requirements of NPI, 2017.

Predicted Construction Noise Levels

Based on the construction assessment scenarios and associated data summarised above, $L_{eq,\ 15\ minute}$ noise levels (in dBA) have been predicted and then compared to the NML. The resultant values (and an assessment of compliance, predicted minus criteria) are presented in the Appendix G assessment report. This compliance assessment is provided for the most stringent evening and night-time assessment periods, as construction works could potentially be conducted outside standard hours for construction as presented in the ICNG. The results of the construction noise assessment are summarised below.

Discussion of Results

The results presented above identify the following:

- Predicted $L_{eq, 15 minute}$ noise levels range between 21 and 49 dBA (29 dBA on average) for the construction works and activities envisaged for the Project. The highest $L_{eq, 15 minute}$ noise levels are predicted at the closest residential receptor (R06) situated north of the site.
- Predicted $L_{eq, 15 minute}$ noise levels exceed the night-time NML at the most affected residential (dwelling) receptors by between 1 and 14 dBA (5 dBA on average, where levels are above the NML). Based on this compliance assessment, the most affected residential (dwelling) receptor is R06, where levels exceeding the night-time NML by ~14 dBA are predicted. The next most affected residential (dwelling) receptor is R07 (to the north of the site), where levels exceeding the night-time NML by ~9 dBA are predicted.
- Predicted Leq, 15 minute noise levels are lower for the first scenario (CON01 – Installation / Construction of Infrastructure) where noise levels are predicted to exceed the NML at R06 by ~10 dBA and R07 by ~5 dBA.
- Predicted $L_{eq, 15 minute}$ noise levels exceed the daytime NML at the most affected residential (dwelling) receptor (R06) during both CON01 and CON02 while works are being undertaken at the northern portion of the site (i.e. CON01a and CON02a).
- All predicted $L_{eq, 15 minute}$ noise levels are below the daytime HNML (for works within the recommended standard hours of construction) value of $L_{eq, 15 minute} \leq 75$ dBA applicable at residential (dwelling) receptors.
- All predicted Lmax noise levels are below the Lmax sleep disturbance criteria (for works outside the recommended standard hours of construction) value of $L_{max} \leq 52$ dBA applicable at residential (dwelling) receptors.

Summary of Findings

The predicted noise levels identified above are typical of construction works and activities are undertaken in the vicinity of rural/residential land use precincts. These predicted values do not represent a constant noise emission that would be experienced by the community on a daily basis throughout the Project's construction schedule. The predicted noise levels will only be experienced for limited periods of time when works are occurring and will not be experienced over the whole daytime, evening or night time periods. Construction noise emissions will be temporary and do not represent a permanent impact on the community and the surrounding environment.

Some noise from construction sites is inevitable, such that the ICNG, 2009 focuses on minimising construction noise impacts, rather than only on achieving numeric noise levels. These results identify that general good-practice construction noise management techniques should be sufficient to maintain acceptable noise levels at all receptors. It also highlights that construction works should be limited (where reasonable and feasible) to the recommended standard hours for construction to maintain compliance and should be avoided outside the recommended hours (daytime, evening and night) to limit any construction noise impacts to the daytime (standard hours) assessment period.

Construction Road Traffic

To assess potential noise impacts associated with construction road traffic, vehicle movements were estimated based on the construction data provided by GAIA. This construction traffic assessment presents estimated (maximum) light vehicle and heavy vehicle movements that could be expected during the construction phase of the Project. These vehicle movements are outlined below:

- A total of 220 vehicles per daytime period (15 hours) made up of 50 light vehicles, 20 mini buses, and 10 heavy vehicles per hour.
- A peak daytime period (1 hour) of 45 vehicles made up of 25 light vehicles, 10 mini buses and 10 heavy vehicles.

- A total of 35 vehicles per the night-time period (9 hours), although not anticipated, this is made up of 25 light vehicles and 10 mini buses potentially arriving before 7am.
- Similarly, the peak night-time (1 hour) of 35 vehicles, made up of 25 light vehicles and 10 mini buses potentially arriving before 7am.

Assumed posted speed limits of 100 km/h for sub-arterial and 60 km/h for local roads have been adopted to predict construction road traffic noise levels for comparison to the RNP criteria i.e. $L_{eq,\ 15\ hour}$, $L_{eq,\ 9\ hour}$ and $L_{eq,\ 1\ hour}$.

Due to the varying distance offsets to nearby residential receptors, road traffic noise levels were predicted at a range of distances; 50m, 100m, 150m and 200m. This precautionary approach was adopted as actual road and dwelling façade distances will vary from property to property along the length of the overall road alignments. The predicted construction road traffic noise levels are presented in Table 6-16 below.

Table 6-16 Predicted Construction Road Traffic Noise Levels and Compliance

Assessment Classification	RNP Road Traffic Noise Criteria		Predicted Noise Level (Day / Night) and Distance from Road Alignment, m				
	Daytime (7am to 10pm) assessment period	Night time (10pm to 7am) assessment period	Assessment Type	50 m	100 m	150 m	200 m
Road traffic noise criteria for existing residences affected by **additional traffic on existing sub-arterial roads** generated by land use developments.	$L_{eq,\ 15\ hour}$ 60 dB (external)	$L_{eq,\ 9\ hour}$ 55 dB (external)	Maximum	53/44	49/40	47/38	45/36
Road traffic noise criteria for existing residences affected by **additional traffic on existing local roads** generated by land use developments.	$L_{eq,\ 1\ hour}$ 55 dB (external)	$L_{eq,\ 1\ hour}$ 50 dB (external)	Maximum	53/51	50/47	47/45	45/43

1. *Predicted road traffic noise levels include a +2.5 dB façade correction.*
2. *All noise levels are dBA re 2 x 10^{-5} Pa.*

Discussion of Results

The results presented above identify the following:

- Predicted construction road traffic noise levels on sub-arterial roads are below the RNP criteria values at all assessed distances from the road during the daytime period (15 hour).
- Predicted construction road traffic noise levels on sub-arterial roads are below the RNP criteria values at all assessed distances from the road during the night-time period (9 hour).
- Predicted construction road traffic noise levels on local roads are below the RNP criteria values at all assessed distances from the road during the daytime peak period (1 hour).

- Predicted construction road traffic noise levels on local roads are above the RNP criteria values at a distance of 50m from the road during the night-time peak period (1 hour).
- Predicted construction road traffic noise levels on local roads are below the RNP criteria values at all assessed distances greater than 50m from the road during the night-time peak period (1 hour).

Summary of Findings

In summary, and with consideration of the data presented above, construction road traffic noise levels are predicted to comply with the relevant daytime RNP criteria despite the increase in proposed construction traffic. The night-time RNP criteria for local roads is predicted to exceed where residential receptors are within 50m from the road.

Some noise from construction sites is inevitable, however these results highlight that construction road traffic should be limited (where reasonable and feasible) to the recommended standard hours for construction to maintain compliance and should be avoided outside the recommended hours (night-time) to limit any construction noise impacts to the daytime (standard hours) assessment period.

Construction road traffic noise from the Project may be audible at times, but noise levels will be reduced and impacts (if any) minimised with the successful implementation of the recommendations and safeguards provided in this report.

Potential Cumulative Construction Noise Impacts

The NML is based on existing background noise levels measured at locations surrounding the Project and focus on the direct impacts from the site under assessment. Furthermore, cumulative impacts are beyond the control of GAIA, are temporary and are best managed by local consent authorities for significant projects.

Although cumulative impacts are unlikely, as it is understood that there are no other significant construction projects proposed for the area, due care may be required of the local consent authority to manage/coordinate any other works occurring concurrently.

Where issues arise, GAIA may be able to assist by scheduling certain works or activities to minimise cumulative impacts. Given that the predicted construction noise levels are compliant with the HNML for all residential receptors (during the recommended standard hours of construction), cumulative noise issues are unlikely to occur or to be dominated by the Project.

Construction Noise Assessment

The operational noise assessment that was completed for the Project is summarised below. The potential worst-case future noise generating scenario (all plant and equipment operating concurrently) was considered, as applicable to the proposed usage. The potential effect of noise enhancing meteorological conditions is also considered in this section as per the assessment methodology presented above.

Noise Assessment Scenario

An operational assessment scenario and associated data were developed based on publicly available data for known items of operational plant, equipment and machinery and then adapted for the Project. In summary this scenario included:

- One 2.5 MW Inverter / Transformer (per array).
- 25 panel tracking motors (per array).

A modifying correction factor (penalty) for any annoying noise characteristics such as tonality, low frequency components etc. was considered as per the requirements of NPI, 2017.

Operational Noise Levels

Based on the operational assessment scenario and associated data presented summarised above, daytime, evening and night time $L_{eq,\ 15\ minute}$ noise levels (in dBA) have been predicted for representative worst-case conditions, i.e. concurrent equipment usage across the Project Site.

These predicted values have then been compared to the PNTL.

All predicted operational noise levels are inclusive of the noise enhancing meteorological conditions. The resultant values and a summary of compliance (predicted minus criteria for unmanaged and managed scenarios) are presented in Table 6-17 below. Further detail of results including a noise contour map for the worst-case (night-time) conditions is presented in the Appendix G assessment report.

Table 6-17 Predicted Operational Noise Levels and Compliance

ID	Scenario	Predicted Operational Noise levels $L_{eq\ 15\ minute}$, dBA			Compliant?
		Day	Evening	Night	
R01	OP01	21	21	21	Y
R02		26	26	26	Y
R03		22	22	22	Y
R04		27	27	27	Y
R05		22	22	22	Y
R06		32	32	32	Y
R07		29	29	29	Y
R08		21	21	21	Y
R09		22	22	22	Y
R10		18	18	18	Y
R11		19	19	19	Y
R12		18	18	18	Y
R13		20	20	20	Y
R14		19	19	19	Y
R15		18	18	18	Y

Discussion of Results

The results presented above identify the following:

- Predicted $L_{eq,\ 15\ minute}$ (dBA) noise levels for proposed operations are below the PNTL at all the identified residential receptors and are compliant with the NPI, 2017 for the daytime, evening and night-time periods.
- Predicted Leq, 15 minute (dBA) noise levels for proposed operations are below the Leq, 15-minute sleep disturbance criteria (40 dBA) at all the identified residential receptors and are compliant with the NPI, 2017 for the night-time period.
- Due to the nature of operational activities on the site, an L_{max} model was not considered necessary. The operation of the Solar Farm equipment generally involves a constant noise emission; therefore, the $L_{eq,\ 15\ minute}$ is the key assessment parameter for sleep disturbance.

Summary of Findings

The predicted noise levels and compliance status summarised above, are as expected for a Solar Farm operation of this nature proposed in the vicinity of rural/residential land use precincts.

It should also be noted that as per typical solar farm operations, there will be minimal load on the inverters/transformers during the night-time period, resulting in minimal noise impacts. This assessment has conservatively assumed that all operations will remain the same for each assessment period (i.e. daytime, evening and night-time). Dispute this approach, predicted $L_{eq,\ 15\ minute}$ (dBA) noise levels are complaint with the NPI, 2017 for the daytime, evening and night-time periods.

Operational Road Traffic Noise

To assess potential noise impacts associated with operational road traffic, vehicle movements were estimated based on previous experience with operational road traffic assessments. This operational traffic assessment presents estimated (maximum) light vehicle and heavy vehicle movements that could be expected during the construction phase of the Project. These vehicle movements are outlined below:

- A total of 21 vehicles per daytime period (15 hours) made up of 20 light vehicles, and one heavy vehicle per hour.
- A peak daytime period (1 hour) of 11 vehicles made up of 10 light vehicles, one heavy vehicle.
- A total of 10 vehicles per the night-time period (9 hours), although not anticipated, this is made up of 10 light vehicles potentially arriving before 7am.
- Similarly, the peak night-time (1 hour) of 10 vehicles, 10 light vehicles potentially arriving before 7am.

Assumed posted speed limits of 100 km/h for sub-arterial and 60 km/h for local roads have been adopted to predict construction road traffic noise levels for comparison to the RNP criteria i.e. $L_{eq,\ 15\ hour}$, $L_{eq,\ 9\ hour}$ and $L_{eq,\ 1\ hour}$.

Due to the varying distance offsets to nearby residential receptors, road traffic noise levels were predicted at a range of distances; 50m, 100m, 150m and 200m. This precautionary approach was adopted as actual road and dwelling façade distances will vary from property to property along the length of the overall road alignments. The predicted operational road traffic noise levels are presented in Table 6-18 below.

Table 6-18 Predicted Operational Road Traffic Noise Levels and Compliance

Assessment Classification	RNP Road Traffic Noise Criteria		Predicted Noise Level (Day / Night) and Distance from Road Alignment, m				
	Daytime (7am to 10pm) assessment period	Night time (10pm to 7am) assessment period	Assessment Type	50 m	100 m	150 m	200 m
Road traffic noise criteria for existing residences affected by **additional traffic on existing sub-arterial roads** generated by land use developments.	$L_{eq,\ 15\ hour}$ 60 dB (external)	$L_{eq,\ 9\ hour}$ 55 dB (external)	Maximum	35/33	31/28	29/26	27/24

Assessment Classification	RNP Road Traffic Noise Criteria		Predicted Noise Level (Day / Night) and Distance from Road Alignment, m				
	Daytime (7am to 10pm) assessment period	Night time (10pm to 7am) assessment period	Assessment Type	50 m	100 m	150 m	200 m
Road traffic noise criteria for existing residences affected by **additional traffic on existing local roads** generated by land use developments.	$L_{eq,\ 1\ hour}$ 55 dB (external)	$L_{eq,\ 1\ hour}$ 50 dB (external)	Maximum	42/38	38/34	36/31	34/30

1. *Predicted road traffic noise levels include a +2.5 dB façade correction.*
2. *All noise levels are dBA re 2 x 10^{-5} Pa.*

Discussion of Results

The results presented above identify the following:

- Predicted operational road traffic noise levels on sub-arterial roads are below the RNP criteria values at all assessed distances from the road during the daytime (15 hour) and night-time (9 hour) assessment periods.
- Predicted operational road traffic noise levels on local roads are below the RNP criteria values at all assessed distances from the road during the daytime peak and night-time periods (1 hour).

Summary of Findings

In summary, and with consideration of the data presented above, operational road traffic noise levels are predicted to comply with the relevant daytime and night-time RNP criteria despite the increase in proposed operational traffic on existing roads.

Operational road traffic noise from the Project may be audible at times, but the traffic management measures outlined in the broader environmental assessment for the Project, will assist any adverse effects to be maintained at acceptable levels. The measures described in the broader environmental assessment are considered adequate to reduce the potential impacts (if any) associated with operational road traffic. Therefore, no further recommendations for operational road traffic noise mitigation and management measures are warranted or provided in this assessment.

Potential Cumulative Operational Noise Impacts

The operational criteria (PTNL) are based on rating background noise levels adopted for the Project and focus on the direct impacts from the site under assessment. Based on the predicted noise levels, project noise emissions are unlikely to significantly increase (by a perceptible margin) the overall ambient (L_{eq}) and background (L_{90}) noise levels of the area.

6.6.4 Mitigation Measures

Any recommendations for construction and operational noise mitigation, management measures; or provisions for monitoring are reproduced in Table 6-19 below from the Appendix G assessment report.

They are designed to reduce project construction noise emissions towards achieving compliant levels and to minimise impacts to an acceptable value as far as may be feasible, reasonable and practical to implement.

These recommendations also provide a general reassurance that suitable safeguards and provisions for monitoring are documented in this report, to manage construction and operational noise if other issues arise.

Table 6-19 Recommended Mitigation Measures

Project Phase	Recommendation
Construction	■ Noise generating work and activities should be limited to the ICNG, 2009 recommended standard hours (i.e. 7 AM to 6 PM Monday to Friday and 8 AM to 1 PM Saturdays), with no work on Sundays or public holidays. Any unforeseen work that is required outside the recommended standard hours must be suitably mitigated and managed with a goal of achieving inaudible noise levels at all residential receptors or undertaken with agreement from the appropriate consent authority and any potentially affected neighbours. ■ Where unforeseen works will occur close to a receptor, and these works are anticipated to generate high levels of noise e.g. > 75 dBA, potential respite periods, e.g. three hours of work, followed by one hour of respite should be applied. Respite should be implemented if it is the preference of the affected receptor/s and if they are feasible and reasonable, and practical, to implement during the works. In some circumstances respite may extend the duration of works and inadvertently increase noise impacts; hence due care should be taken when considering this management measure. ■ During the construction design, choose appropriate plant, equipment and/or machinery for each task and adopt efficient work practices to minimise the total construction period and the number of noise sources on the site. Select the quietest item of plant, equipment and machinery available where options that suit the design permit. ■ During the works, avoid unnecessary noise due to idling diesel engines, and fast engine speeds when equipment can be powered down and/or lower speeds are sufficient. ■ During the works, instruct drivers to travel directly to the site and avoid any extended periods of engine idling at or near residential areas, especially at night. ■ During the works, ensure all plant, equipment and/or machinery used on the site are in good condition, with particular emphasis on exhaust silencers, covers on engines and transmissions and squeaking or rattling components. Excessively noisy machines should be repaired or removed from the site. ■ During the works, ensure that all plant, equipment and vehicles movements are optimised in a forward direction to avoid triggering motion alarms that are typically required when these items are used in reverse. Where it is possible tonal motion alarms should be replaced with broadband “squash duck” motion alarms. ■ If any unforeseen night works must occur, all activities with the potential to generate impulsive noise should be avoided. These types of events are particularly annoying; especially at night and have the limited potential to generate sleep disturbance or awakening impacts. Any impulsive or transient noise events expected to exceed the sleep disturbance criteria at residential receptors should be strictly avoided at night. ■ If any validated noise complaints are received, operator attended noise validation and compliance measurements should be undertaken to measure and compare the site noise level contributions to a) the predicted values; and b) the NMLs presented in this report. All site noise levels should be measured in the absence of any influential source not associated with the Project. If the measured site noise levels are below the predicted values and comply with the NMLs presented in this report, no further mitigation or management measures are required.

	■ If the measured site noise levels are above the predicted noise levels or NML presented in this report, further mitigation and/or management measures should be considered.
Operation	All predicted Leq, 15 minute (dBA) noise levels for the proposed project operations are below the PNTL at all the identified residential receptors and are compliant with the NPI, 2017 for the day, evening and night-time periods. As such no recommendations for noise mitigation, management measures or monitoring options are warranted, however suitable safeguards and provisions have been provided below. **Provisions and Safeguards:** Given that operational compliance has been attained with the assumption that the Inverters/ Transformers will achieve individual LW of 92 dBA and Panel Tracking Motors will achieve individual LW of 78 dBA, the following safeguards and provisions are provided. ■ During equipment procurement, ensure that the Inverters/Transformers will achieve individual LW of 92 dBA and Panel Tracking Motors will achieve individual operational LW of 78 dBA. ■ If any validated noise complaints are received, operator attended noise validation, and compliance measurements should be undertaken to measure and compare the site noise level contributions to a) the predicted values; and b) the PNTLs presented in this report: - All site noise levels should be measured in the absence of any influential source not associated with the Project; - If the measured site noise levels are below the predicted values and comply with the PNTLs presented in this report, no further mitigation or management measures are required; and - If the measured site noise levels are above the predicted noise levels or PNTLs presented in this report, further mitigation and/or management measures should be considered.

6.7 Transport

6.7.1 Methodology

The traffic assessment incorporated the following scope of works:

- A site survey was undertaken on 11 September 2018, to gain an understanding of the Project Site and local road network;
- A desktop assessment of the local and regional road network, including their capacity, traffic volumes and the potential vehicle routes for delivery of materials to Project Site;
- Review of relevant SEARs as they apply to traffic management;
- Review of available traffic data as provided by RMS;
- Assessment of the design requirements of site access; and
- Preparation of a Traffic Impact Assessment and Management Plan (refer to Appendix H).

6.7.2 Existing Environment

The Bruxner Highway is a state classified road, which runs to the north of the Project Site with an east-west orientation providing connection between the New England Highway to the east and Boggabilla to the west where it connects with the Newell Highway. The south, east and west boundaries of the Project Site are defined by neighbouring agricultural lots with some sections of unnamed, unsealed rural roads. The Bruxner Highway is sealed (refer Figure 6-15 below) and provides a width of approximately 6 metres passing the site allowing for 2-way traffic movements as required. It operates under the posted speed limit of 100 km/h.

Figure 6-15 View along Bruxner Highway

The Bruxner Highway connects with the New England Highway to the east of the site at a four way give way controlled intersection with the New England being the priority road and Old Ballandean Road being the opposite minor road (refer to Figure 6-16).

The New England Highway is a state classified road that is a key freight route in NSW and forms part of the road network designated by the Roads and Maritime to carry oversize, over mass vehicles. It typically provides a single lane of travel in both directions and operates under the posted speed limit of 110 km/h outside of the urban areas where the alignment permits. As part of the state road network, the New England Highway carries a mixture of local, regional and inter-state traffic with a significant number of trucks including B-double combinations. The Cunningham Highway operate in a similar manner providing key transport routes between Ipswich and the New England Highway at Warwick.

Bonshaw Road is a local road managed by Inverell Shire Council, located to the west of the site. It is a sealed two-way road with an overall width in the order of 7 metres. It intersects with the Bruxner Highway via a simple give way controlled intersection with the Bruxner Highway being the priority road. This road continues south and connects with Ashford Road in Ashford to provide a road link through to Inverell. This route provides a consistent road standard and forms part of the approved B-double road network in NSW.

As part of the Project, it is proposed that all heavy vehicles will travel via the roads identified above (refer to Figure 6-16). Local supplies could be sourced from Goondiwindi, Inverell or Tenterfield as well as accommodation for workers associated with the Project.

Existing Traffic Volumes

Traffic volumes in the immediate vicinity of the subject site are very low, reflective of the rural environment. The Bruxner Highway carries relatively low traffic flows, reflective of its rural setting with a mixture of local traffic as well as regional traffic demands. Observations on site during a typical morning period (Tuesday, 11 September 2018) shows that the current road network in the vicinity of the subject site operates very well with no delays. The route proposed to be used for the Project carries low traffic flows and operates with no delays except for those associated with drivers slowing down to observe traffic flows on the approaches to the various intersections and negotiating the intersections.

The RMS webpage provides traffic data on the Bruxner Highway at Mingoola (station Id 91170), approximately 15 kms east of the Project Site. The traffic data from 2011 shows that the daily traffic flow was 213 vehicles per day with around 23% heavy vehicles, reflective of rural demands in this location. It is considered that there has been limited growth in traffic since this time and as such the current daily traffic flows are considered to be similar.

The same web page shows that in 2011 the daily traffic flow on the New England Highway to the immediate north of Tenterfield (station Id 91577) was 2421. It is considered that there has been limited growth in this area since 2011 and as such the daily traffic flows would be similar. In 2012 the traffic flows on Bonshaw Road were 232 vehicles per day northbound. Assuming southbound flows to be the same would give daily flows in the order of 500 vehicles per day. It is considered that these flows would not have altered much since 2012.

6.7.3 Assessment

Project Traffic Volumes

The construction period of the Project will have the largest vehicular movement, with the typical vehicle movements during the peak construction period (over 6 months) are in the order of 65 light and 20 heavy vehicles two-way (65/20 inbound, 65/20 outbound) per day. For the light vehicles, the vast majority of these will be inbound movements in the morning bringing workers to the site with these vehicles then remaining on site for the full working day before leaving at the end of the working day. It is expected that there will be limited light vehicle movement outside of these periods, other than support staff e.g. office staff or the occasional visitor to the site.

For the heavy vehicles, these will typically be spread across the working day. For the solar panel deliveries, these trucks are arriving from either the Port of Brisbane or the Port of Newcastle and the journey length will be over 5 or 7 hours respectively, seeing a spread of these vehicles not all arriving at the same time. Allowing for each truck to be emptied on site one at a time, the outbound movements will also be spread out and not all leave at the same time. All other heavy vehicles will also be spread out across the normal working day with no concentration of heavy movements expected.

Outside of the peak period of construction, the staff levels will be lower and the daily light vehicle numbers will be less than 65 inbound and outbound per day. The heavy vehicle numbers will also be lower outside of the peak construction activity and less than 20 vehicles inbound and outbound per day.

Connection to Road Network

The trucks accessing the site will all travel along the regional and state road network, which currently carries heavy vehicle movements including B-doubles. The site is located in a rural setting and as such the hourly and daily traffic flows along the Bruxner Highway and the New England Highway in this location are relatively low. As such there is considerable spare capacity to cater for the additional traffic movements associate with the Project construction stage. During construction, the Project will generate 70 inbound vehicle movements in the morning associated with the construction staff with a similar number of vehicles leaving the site in the late afternoon. The site will also generate approximately 20 trucks inbound and outbound per day, associated with the delivery of material and specialist equipment to the site.

Prior to commencing the construction of the works on site, a new access will be constructed on the Bruxner Highway to cater for the heavy vehicles accessing the site. With the vast majority of the heavy vehicles accessing the site from the east (via the New England Highway) it is proposed to provide a left turn deceleration lane for the site access to allow for a safe entry for the construction traffic. With limited demand for access to the west of the site, there is no requirements for a sheltered right turn lane to be provided at the access point.

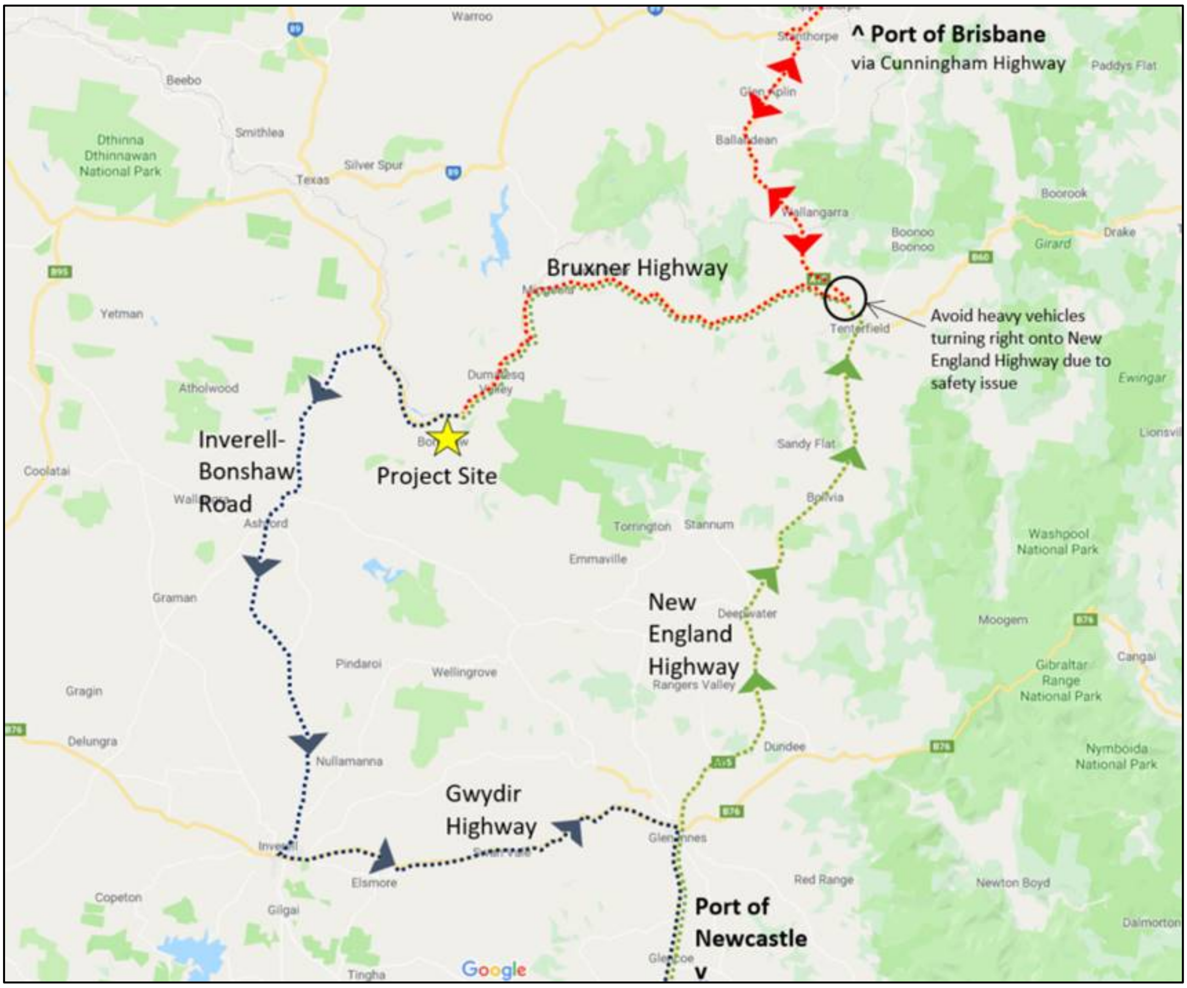
A review of the access route shows that the layout of the intersection of the Bruxner Highway and the New England Highway does not safely cater for the right turn out movement. The sight distance for this right run is restricted and the width of the New England Highway in this location does not allow for a run off area for vehicles. It is proposed that as part of the construction Traffic Control Plan, It is proposed that as part of the construction traffic management plan, southbound empty trucks leaving the site shall turn left onto the Bruxner Highway then proceed south via Bonshaw-Inverell Road to Inverell then along the Gwydir Highway to connect to the New England Highway via Glen Innes. For all other movements at the intersection of the Bruxner Highway and the New England Highway the existing intersection controls are considered to be appropriate.

For traffic from the north turning right onto the Bruxner Highway, there is a sheltered right turn lane and visibility south exceeds 250 metres permitting a driver to safely judge an appropriate gap to turn right across the opposing traffic lane. For traffic from the south on the New England Highway, the forward visibility is good allowing a driver to adjust their vehicle speed to cater for a vehicle in front turning left onto the Bruxner Highway. The traffic flows on the New England Highway in this location are relatively low and as such this will create minimal delays for other drivers.

Operational Traffic Demands

Post construction, the operational traffic demands are very low with around 10 people working on the site on any one day. There will not be any need for regular heavy vehicle access to the site once the solar farm is operational except for the occasional heavy vehicle for emergency repairs or irregular maintenance.

Figure 6-16 Designated Vehicle Access Route



6.7.4 *Mitigation Measures*

From the details above the following mitigation measures are proposed.

- Provide a temporary Traffic Control Plan (TCP) on the site frontage on the Bruxner Highway, adjacent to the site access, for construction work associated with upgrading the access and for traffic entering and exiting the site;
- A Traffic Control Plan will be in place during Project construction work to ensure safety for road users and construction workers is managed in an appropriate manner.

- Provide regular community updates for residents along the Bruxner Highway in the vicinity of the site to advise of construction activities and increased heavy vehicle movements along this road;
- Preparation of a Construction Traffic Management Plan (CTMP);
- The intersection of Bruxner Hwy and New England Hwy causes a hazard for trucks returning southbound. It is proposed that the CTMP will include an alternative route, being that trucks are leaving the site heading south utilise the Bonshaw-Inverell Road route;
- Construction vehicle movement on internal roads could lead to dust generation. A water truck will be used for dust suppression to minimise the production of dust, with the amount of water spreading adjusted accordingly to respond to the conditions.
- Any significant deposits of dirt and other construction materials will be promptly removed from public roadways;
- All drivers associated with the Project construction work will adhere to the road rules as applicable and will be advised of the school bus operation on the Bruxner Highway;
- The residents along the Bruxner Highway will be notified in writing of the construction works and the activities as required;
- A protocol will be provided for both undertaking dilapidation surveys and making any necessary repairs to the road pavement following construction to Bruxner Highway to within 200 metres to both sides of the site access; and
- Emergency repairs to road pavement will be made in accordance with the relevant authority standard.

6.8 Water

The assessment has been prepared to address the requirements specified in the SEARs pertaining to water supply, water quality and hydrology and having regard to the following relevant legislation:

- Water Management Act 2000;
- Environment Planning and Assessment Act 1979; and
- Protection of the Environment Operations Act 1997.

6.8.1 Methodology

The assessment incorporated the following scope of works:

- A desktop assessment of climate data, topographic maps, aerial imagery, publically accessible surface water and groundwater data and previous soil survey information;
- Review of climate, topography and soil conditions of the Project Site and their potential influence on erosion and sedimentation of the Site, particularly during the construction phase;
- Preparation of a Stormwater Management Plan, including an assessment of stormwater flows onsite and requirements to safely covey stormwater through the Site;
- The preparation of a Flood Assessment Report which includes:
    - Hydrological modelling;
    - A flood frequency analysis;
    - Hydraulic modelling; and
    - Model verification;
- Consultation with key government agencies and local council; and
- Addressing key issues raised by stakeholders.

6.8.2 Existing Environment

Climate

A desktop assessment of data made available through the Bureau of Meteorology (BoM) weather stations with specific consideration to temperature, rainfall and evaporation was undertaken. Data collected from weather stations assisted in understanding the existing climatic context of the Project Site, and expected conditions.

Climate data is available from BoM weather stations located in Bonshaw Campbell St (054007) and Pindari Dam (054104) located approximately 10km north-west and 22.5km south-west of the Site respectively.

Temperature

Temperature data from the Pindari Dam (054104), which has been in operation since 1971, indicates on average January is the warmest month with a mean daily maximum of 31.6ºC and the coolest month is July with a mean daily minimum temperature of 17.7ºC. Table 6-20 provides a summary of mean temperature for all months, with the hottest and coolest recorded month highlighted in red and blue respectively.

Table 6-20 Summary Temperature Statistics for 1971-2019 (ºC)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Max	31.6	30.9	29.1	25.7	21.8	18.2	17.5	19.2	22.5	25.8	28.1	30.5	25.1
Mean Min	17.7	17.3	15.0	10.7	6.6	3.2	2.1	2.8	6.3	10.3	13.7	16.2	10.2

Rainfall

Monthly rainfall data from the Bonshaw Campbell St (054007), which has been in operation since 1884, was considered a more robust data source for annual average rainfall offering extensive historical data for the mean monthly rainfall in the locality of the Site.

The mean monthly precipitation is summarised in Table 6-21 below, with the highest and lowest rainfall records for each month highlighted in red and blue respectively.

Table 6-21 Monthly Precipitation Data for 1884-2019 (mm)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	88.2	76.5	60.8	34.8	39.8	42.0	42.0	37.7	39.6	63.7	69.4	83.4	684.9
Lowest	2.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	1.0	0.0	284.1
Median	76.2	61.2	49.6	27.8	32.7	31.2	39.4	33.2	34.6	54.1	60.6	74.1	666.6
Highest	244.1	333.2	309.8	241.4	166.9	129.3	173.9	145.8	159.8	232.5	302.1	236.3	1178.7

Evaporation

Average daily evaporation from the Pindari Dam (054104) for each month is summarised in Table 6-22. The highest and lowest monthly average evaporation experienced highlighted in red and blue respectively.

Table 6-22 Mean Monthly Evaporation Data for 1971-2019 (mm)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Daily	232.5	193.2	182.9	126	83.7	57	65.1	89.9	126	170.5	195	223.2	1,752

Surface Water

The Project is located directly south of Dumaresq River. The Project Site drains to ephemeral watercourses onsite, a number of unnamed tributaries of the Dumaresq River. These tributaries flow from their source from the south to the north through the Project Site. Major watercourses surrounding the Project Site include Little Oaky Creek and Little Limestone Creek to the west and the Beardy River to the east. The Project Site has been revised following issue of the SEARs. The Project no longer exists within the Little Oaky Creek, Little Limestone Creek or Beardy River catchments, and as such, the assessment of water impacts in these catchment is no longer relevant.

The combined catchment area of the unnamed tributaries upstream of the Project Site is approximately 1,245 ha. Figure 6-17 shows the existing waterways relevant to the Project Site and the local Dumaresq River catchment. Figure 6-17 also provides an indicative view of the Development Footprint being designed to exclude the creeks flowing south to north, minimising the Project’s impact on surface water flows.

The Project Site contains eight man-made dams according to available datasets, however field surveys of the Project Site have revealed these dams have dried. Of these, there are six dams located within the Development Footprint, which may be retained where required for stormwater management purposes through the detailed design process, or otherwise filled and managed through the CEMP.

The Project and upslope catchment areas are predominantly rural land use. Existing infrastructure downstream of the Project Site includes three culvert crossings at the Bruxner Highway. Additionally, the existing 330 kV Transgrid Dumaresq Substation is located on the Project boundary with the substation access road running along the western boundary of the Project Site. Streamflow data was available at two nearby WaterNSW gauging stations on the Dumaresq River, as outlined in Table 6-23.

Table 6-23 Streamflow Data

Gauge Name	Gauge Number	Site Commence	Catchment Area (km^2)	Proximity to Site
Dumaresq at Bonshaw	416007	09/08/1934	7,280	Approx. 28 km Downstream (West)
Dumaresq at Roseneath	416011	22/01/1937	5,550	Approx. 16 km Upstream (East)

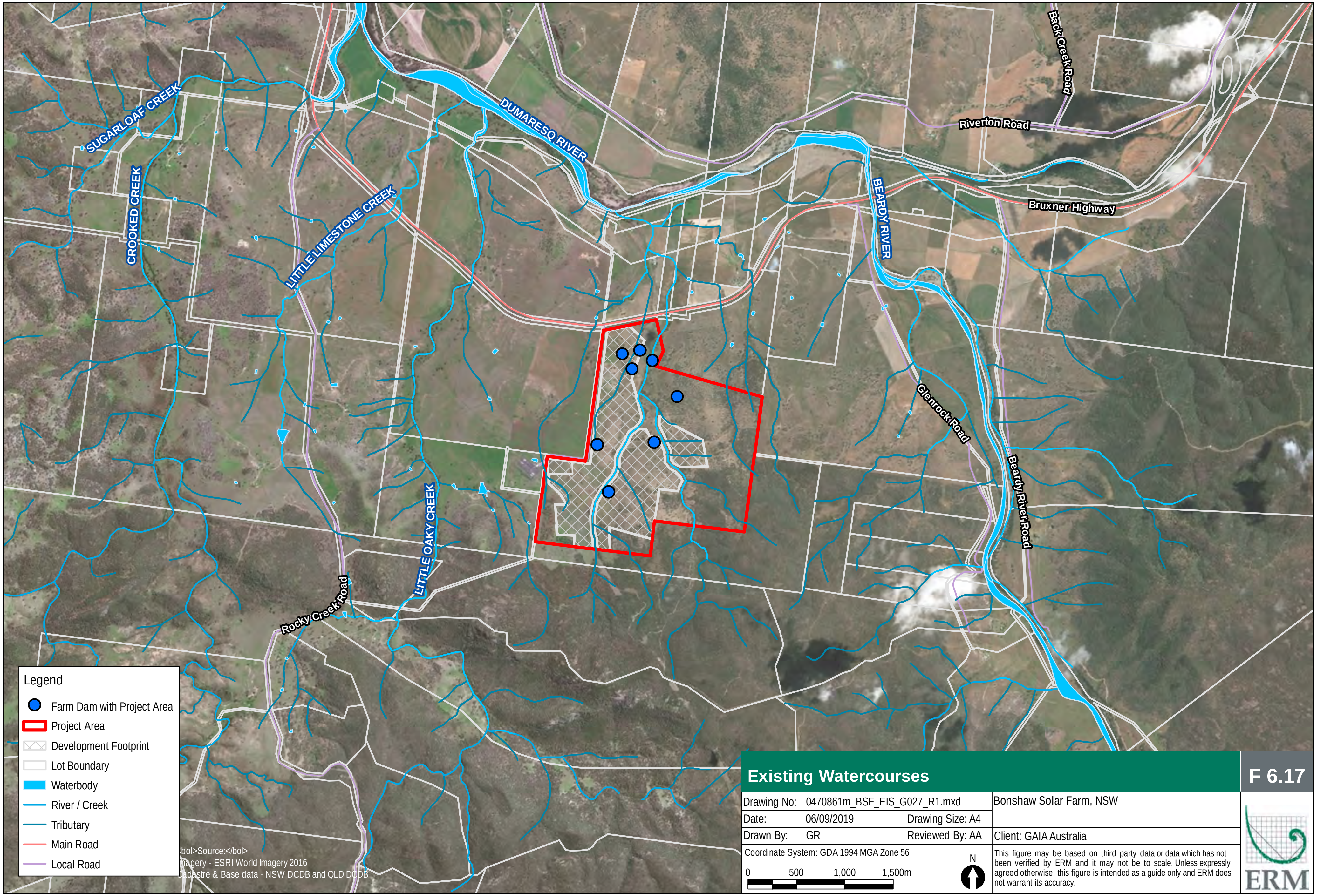
Groundwater

A search of the Australian Bureau of Meteorology (BoM) National Groundwater Information System identified that no groundwater bores are registered within the Project Site. There are however, four bores located within 2 km of the Project boundary, the closest being a bore located 1 km to the North.

Data from the four bores has affirmed that groundwater use in the vicinity is related to rural agricultural. Bores have been installed between 15 m to 62 m in depth. One bore provides lithology information with indicative lithology as follows: soil (0-2m), gravel (2-4m), clay (4-9m), gravel (9-17m), shale (17-42m) and mineral (42-62). A summary of the groundwater data is provided in Table 6-24.

Table 6-24 Groundwater Bores Data

Bore ID	Latitude	Longitude	Purpose	Bore Depth (m)	Lithology Available
GW900488.1.1	-29.179397	151.350491	Irrigation	62	Y
GW900488.1.2	-29.179397	151.350491	Irrigation	62	N
GW018155.1.1	-29.190367	151.324158	Stock and Domestic	15.2	N
GW055284.1.1	-29.2012	151.316381	Unknown	21.3	N



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magery - ESRI World Imagery 2016
Cadastre & Base data - NSW DCDB and QLD DCDB

Existing Watercourses

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Drawing No: 0470861m_BSF_EIS_G027_R1.mxd
Date: 06/09/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

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6.8.3 Assessment

The Development Footprint has considered the potential impacts to existing water resources. The Project has been refined to the greatest extent practicable including the provision of a 40m buffer from infrastructure to the top of creek banks, and minimised the number of waterway crossings required.

Groundwater

Foundation and other earthworks for the installation of Project infrastructure and associated accesses are relatively shallow and will not intersect groundwater. The Project does not involve the use or storage of other than minor volumes of fuels and chemicals and given there are no direct pathways to groundwater the proposal is unlikely to have any impacts to groundwater resources or beneficial uses of groundwater during construction and operation of the Project. Further geotechnical assessment will take place prior to construction, which would confirm the adequacy of depth required for Project infrastructure.

Access to groundwater resources will not be required for the Project, as the relatively minor water demands required during the construction and operation stages will be satisfied by water trucked in.

Flooding Impact Assessment

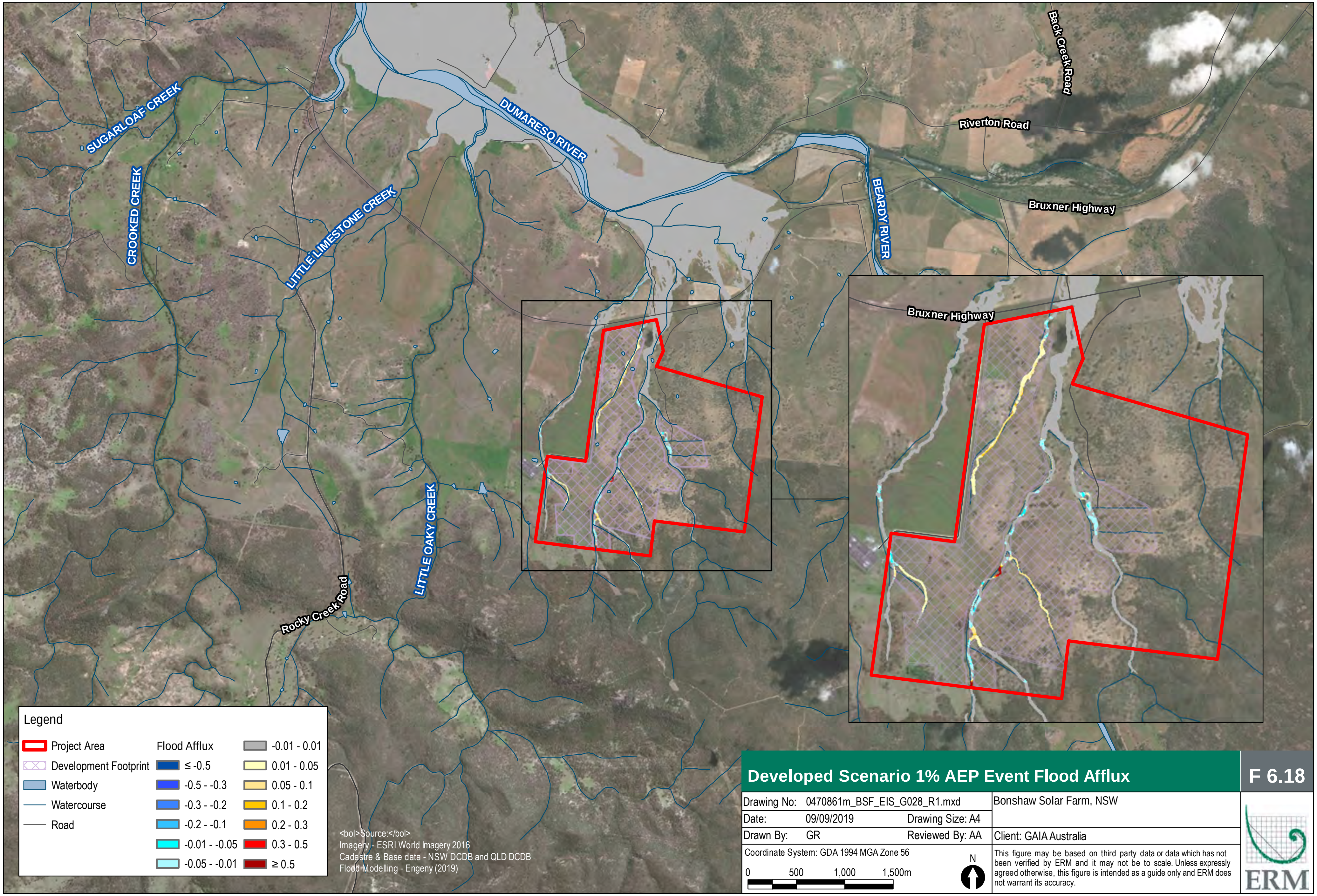
A Flood Impact Assessment, prepared by Engeny Water Management (Engeny) assessed the potential impacts of the Project on flooding flows and behaviours (refer to Appendix I). The flood assessment considers the associated catchment areas that the Project intersects with and the potential impacts on flooding flows and behaviours of these watercourses as well as flood levels and flood extent of the Dumaresq River.

The Dumaresq at Bonshaw gauge (416007) was selected for use in the Flood Frequency Analysis for the Flood Assessment, due to the long historical record of flood levels and having larger recorded flows than the Dumaresq at Roseneath gauge. This data, along with consideration of topography, drainage and surface roughness, among others, have been used to model the peak flood depths for pre and post development for the 1 in 100 Annual Exceedance Probability (1% AEP) flood event.

Modelling considered runoff from the local catchment of the Project Site, and included two model scenarios, comparing the existing scenario and developed scenario, which includes the change in the catchment due to installation of the solar arrays and the installation of two pipe culverts at nominated vehicle access crossings.

No modelled increases in peak flood levels were observed outside of the Site boundary including at Dumaresq River. There is a small localised increase to flood levels in the 1% AEP event at each of the modelled crossings locations, however these minor increases (between 0 and 0.1 m) are due to the small increase in impervious area and are contained in watercourse channel (refer to Figure 6-18). The model results did not indicate any changes to flow dynamics. The modelled results indicate that any appropriately designed culvert crossings can convey the 1% AEP event with only localised impacts to flood levels.

The Flood Impact Assessment modelling confirms the proposed development including construction of accesses across the ephemeral watercourses onsite will not significantly increase peak flows or peak flood levels either upstream or downstream of the Site including at Dumaresq River (refer to Figure 6-18).



<bol>Source:</bol>
Imagery - ESRI World Imagery 2016
Cadastre & Base data - NSW DCDB and QLD DCDB
Flood Modelling - Engeny (2019)

Developed Scenario 1% AEP Event Flood Afflux

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Drawing No: 0470861m_BSF_EIS_G028_R1.mxd
Date: 09/09/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

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Construction Period

During the construction period, water will need to be sourced for the following purposes:

- construction of roads, hardstands and miscellaneous construction work;
- dust suppression; and
- potentially watering of revegetated areas.

Based on an understanding of the construction requirements and the construction schedule, likely quantities of water use volumes have been estimated.

Information used to determine likely water requirements included:

- The perimeter road is 6m wide and all internal roads are 4m wide (these are located within the APZ). The internal road network is 13.75km. The total area of roads is 8.254ha. It is assumed that the access roads will be constructed to a depth of 0.3-0.4m.
- During construction, water would be added to aid compaction of the road base at a rate of approximately 4% by weight (assuming the bulk density of the imported gravel is 1.5 tonnes/m^3). It is noted that this is an average, with lesser quantities likely to be required during wet/cool conditions, and greater quantities during hot/dry conditions. The total water requirement for road construction is approximately 2 ML. Allowing a 50% contingency factor results in a total water demand of 3 ML.
- An additional conservative allowance of 50 kL/day is provided for road maintenance, dust suppression and wash down, for the 12 month construction period (assumed full days on Monday to Friday and half days on Saturdays).
- Rehabilitation requirements are dependent on the meteorological conditions during the growing period, however a conservative estimate of 20kL/week for six weeks during the plant establishment phase has been assumed as a conservative guide. Should the establishment period of the vegetation be during a higher percentile annual rainfall year, this estimate may not be required.

The total water demand over the 12 month construction period is approximately 17.42 ML. The estimated total construction water demand is summarised in Table 6-25.

Table 6-25 Construction Water Demand

Water Demand by Construction Activity (ML)			
■ Roads	■ Dust Suppression	■ Rehabilitation	■ Total
■ 3	■ 14.3	■ 0.12	■ 17.42

Operation Period

Operational water requirements are expected to be minimal, with the largest requirement likely to be water required for cleaning the panels. Similar operations have estimated an operational water use volume for cleaning of 1.5ML/year, dependent on meteorological conditions (and resultant accumulated dust on panels). Water will be sourced as per similar arrangements to the water used during the construction period.

Water Supply

Water required during construction and operation will be sourced by purchasing commercial potable or suitable quality water from local council or other approved local supplier, to be transported to site. Farm dams are present within the Project Site but are unlikely to contain viable volumes of water for long-term use. This has been determined based on review of estimated dam sizes from aerial imagery, conservative estimates of dam depths, and site surveys identifying many farm dams have dried. Any water within farm dams may not be relinquished by the landowner for construction purposes given other farm related purposes (livestock watering for example).

Adjacent Landowner Water Users

As discussed above, the Project would not impact on the quality or quantity of water available at the Site. Therefore, the Project will not impact adjacent licensed water users or basic landholder rights during construction or operation.

6.8.4 Mitigation Measures

The following water management measures are to be implemented for the Project:

- Investigate alternative water sources to limit the use of potable water if reasonably practicable;
- Where practicable, utilise polymers to limit the requirements for dust suppression requirements;
- The road crossings over the minor watercourses in the Project Site will be designed to minimise interruptions to flows; and
- The design of the Development Footprint includes the provision of a 40 m buffer from infrastructure to the top of creek banks, and to minimise the number of waterway crossings required to the greatest extent practicable.

6.9 Hazards and Risks

This chapter provides an assessment of environmental hazards and risks that could arise during the operation of the Project and management strategies to address these hazards and risks. Specifically, this chapter considers hazardous materials, bushfire risk, and electromagnetic fields.

There may be additional health and safety hazards that are not specifically considered in this EIS and would be addressed by the construction contractor.

6.9.1 Hazardous Materials

A screening assessment has been undertaken for the Project, which considers the risk to people, property and the environment at the Project location. The assessment also determines whether the Project should be considered a hazardous or potentially hazardous industry under the *State Environmental Planning Policy 33 – Hazardous and Offensive Development* (SEPP 33) (refer to Appendix J).

6.9.1.1 Methodology

A desktop assessment was carried out to identify environmental hazards and risks that could arise during the construction and operation of the Project, as well as mitigation measures to address such issues.

The assessment focused on those hazards and risks with the potential to adversely affect the quality of the surrounding environment, land uses and communities, with consideration of the following relevant policies and guidelines:

- State Environmental Planning Policy 33 – Hazardous and Offensive Development (SEPP 33);
- Hazardous and Offensive Development Application Guidelines: Applying SEPP 33 (Department of Planning, 2011);
- Hazardous Industry Planning Advisory Paper No 6: Hazard Analyses (Department of Planning, 2011);
- *Multi-level Risk Assessment* (Department of Planning, 2011);
- Australian Standard 1940: The storage and handling of flammable and combustible liquids (AS 1940:2017);
- Australian Standard 4332: The storage and handling of gases in cylinders and welding gases (AS 4332:2004);
- Australian Standard 4839: The safe use of portable and mobile oxy-fuel gas systems for welding, cutting, heating and allied processes (AS 4839:2001);
- International Standard (ISO / IEC 31010) Risk Management – Risk Assessment Technique;
- Australian Code for the Transport of Dangerous Goods by Road and Rail (7.5th edition) (National Transport Commission, 2007); and
- Storage and Handling of Dangerous Goods Code of Practice (WorkCover, 2005).

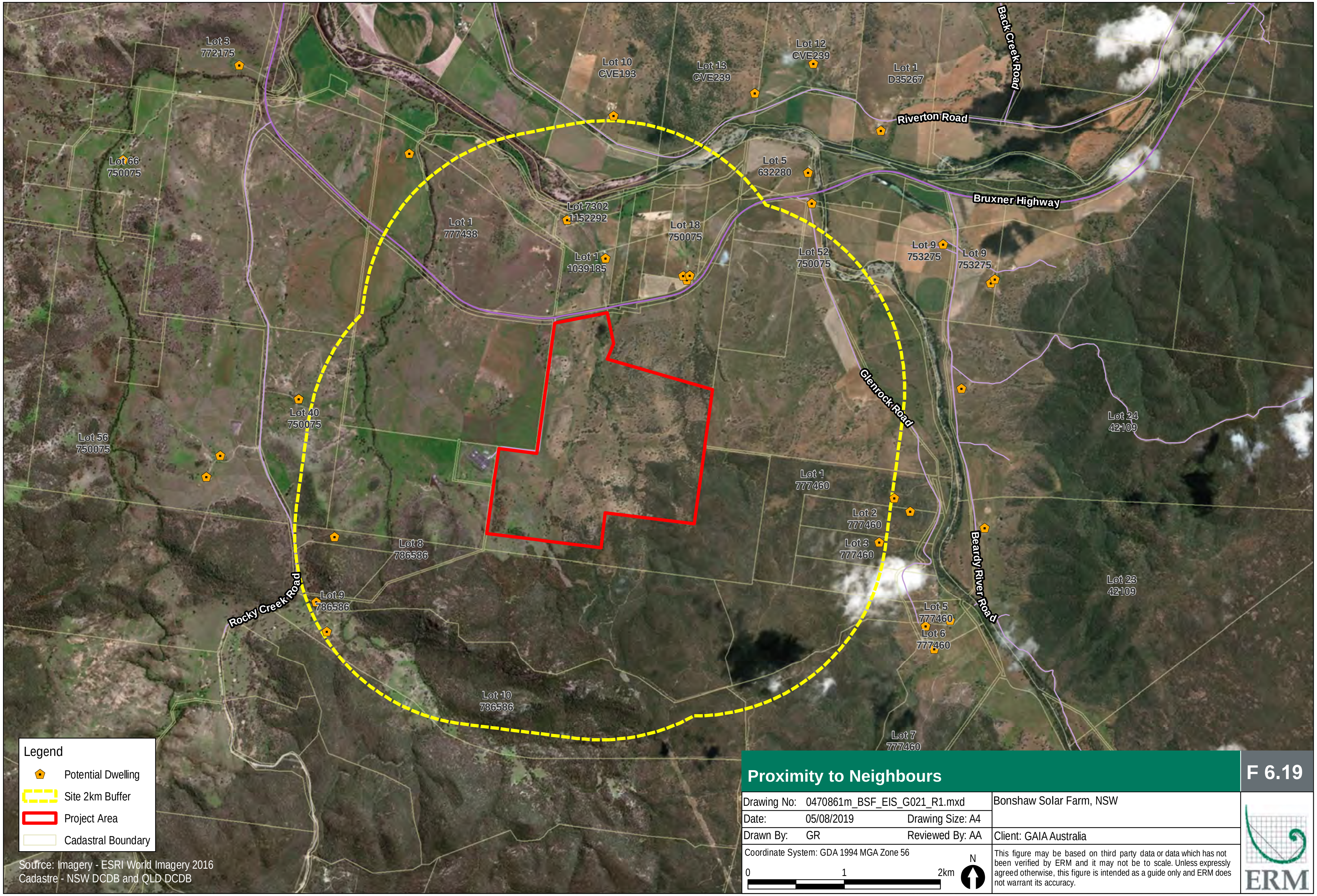
6.9.1.2 Existing Environment

Industries or projects determined by the risk screening process to be hazardous or potentially hazardous require the preparation of a Preliminary Hazard Analysis (PHA) in accordance with Clause 12 of SEPP 33.

The screening assessment recognises the relative proximity of neighbouring properties to consider the likely significance of impacts upon neighbours of the Project. Given the rural setting of the area, neighbouring landowner dwellings are scattered over a vast area, with the closest being located just over 2 km from the battery energy storage system. The substantial distance, in regards to proximity, provides a sufficient buffer, rendering the potential for impacts insignificant. The proximity to neighbouring landowner dwellings are outlined in Table 6-26 and displayed in Figure 6-19 below.

Table 6-26 Proximity of Neighbours to Battery Components

Landowner	Direction from Site	Approximate Distance to Dwelling
Lot 200 DP 879480	West	3.2 km *(Dwelling of property owner located in Lot 1 DP 77438)*
Lot 201 DP 879480	West	N/A – Dumaresq Substation
Lot 46 DP 750075	West, South and East	N/A – Unoccupied Land
Lot 29 DP 750075	East	3.7 km *(Dwelling of property owner located in Lot 52 DP 750075)*
Lot 16 DP 750075	North	2.3 km *(Dwelling of property owner located in Lot 18 DP 750075)*
Lot 1 DP 1039185	North	2.1 km
Lot 1 DP 777438	North-west	3.2 km



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB

Proximity to Neighbours

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Drawing No: 0470861m_BSF_EIS_G021_R1.mxd		Bonshaw Solar Farm, NSW
Date: 05/08/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: AA	Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

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6.9.1.3 Assessment

Preliminary risk screening of the proposed development is required under SEPP 33 to determine the need for a Preliminary Hazard Analysis (PHA). The screening identifies classes and quantities of dangerous goods to be used, stored or produced on site with respect to storage depot locations as well as transported to and from the site.

In assessing the Project, the emphasis is on preventing hazardous incidents on-site or offsite, such as spontaneous combustion and fire, or the contamination of land by the use of significant quantities of toxic or biologically harmful materials that could result in substantial effects.

Hazard Screening

Potential hazards and risks during construction and operation include (but are not limited to):

- the on-site storage, use and transport of dangerous goods and hazardous substances; and
- risk of damage to existing infrastructure due to ground movement and geotechnical instability.

These hazards and risks are described further in the Screening Assessment (refer to Appendix J). An indicative list of the types of potentially hazardous materials anticipated to be used, stored and transported during construction and operation of the Project is provided in Table 6-27 along with the relevant storage and transport thresholds established under Applying SEPP 33.

The thresholds in applying SEPP 33 represent the maximum quantities of hazardous materials that can be stored or transported without causing a significant off-site risk.

In most instances, low volumes of potentially hazardous materials would be stored on site. The volume required to be stored on site would largely depend on the anticipated rates of consumption, with deliveries of dangerous goods coordinated to match consumption rates.

The risk screening process for the storage of hazardous materials at the Project site and the transportation of hazardous materials to/from the site demonstrates that in all cases, types and quantities would be below the Applying SEPP 33 thresholds. For storage, this demonstrates that operational inventories would not pose a significant risk of harm beyond the site boundary. For transportation, this also demonstrates that risks are unlikely to be significant.

It can be concluded that the risks associated with storage and transportation of hazardous materials are unlikely to be significant or pose a risk to public safety. Given that Applying SEPP 33 thresholds are not exceeded, the Project is not considered to be a hazardous or potentially hazardous industry under SEPP 33*.* Therefore a PHA is not required to be undertaken for the Project.

Table 6-27 Proposed Hazardous Material Storage at Bonshaw Solar Farm (Construction and Operation)

Material	Australian Dangerous Goods Class	Storage Location	Storage Method	Quantity (T)	Applying SEPP 33 Threshold		
					Min quantity	Min. storage distance from sensitive receptors	Transport
Chemicals	Various	Workshop	Domestic Storage	Domestic Quantities	N/A	N/A	N/A
Welding Cylinders	Class 2.1, 2.2	Workshop	Cylinders (AS 4332, AS 4839)	5 Welding Sets (<0.1 T)	0.5 T	N/A	N/A
Lithium Battery	Class 9	Battery Energy Storage System	Container	Undefined	N/A	N/A	N/A
Diesel	Combustible	South Gate	Self bunded tank AST (AS 4332, AS 4839)	2000 T	5000 T	3m (AS 1940)	N/A
Oil Store	Combustible	Workshop	Domestic Storage (AS 4332, AS 4839)	<10 T	N/A	N/A	N/A

Offensive Screening

The assessment of the suitability of the Project Site to accommodate existing or proposed development of a potentially offensive nature is based on consideration of:

- the nature and quantities of materials stored and processed on the site;
- the type of plant and equipment in use;
- the adequacy of proposed technical, operational and organisational safeguards;
- the surrounding land uses or likely future land uses; and
- the interactions of these factors.

The potential polluting discharges a development of this type could generate that would be deemed offensive and cause adverse impacts if unmitigated are outlined in Table 6-28. Discussion of where these issues are addressed in Chapter 6 above and hence why they are considered to be mitigated is also outlined.

Table 6-28 Potentially Offensive Assessment

Potential Impacts	Discussion
Noise	No issues identified. Refer to Section 6.6 and Appendix G (Noise and Vibration Impact Assessment).
Odour	Given the nature of the Solar Farm, any odour is unlikely to arise, and is therefore not required to be assessed as a requirement of the SEARs.
Air emissions	Given the nature of the Solar Farm, no air emissions are likely to arise, and is therefore not required to be assessed as a requirement of the SEARs.
Water discharge/runoff	No issues identified. Refer to Section 6.8.
Ground contamination	No issues identified. Refer to Section 6.3.

6.9.1.4 Mitigation Measures

It has been recognised that the Project is to include small quantities of hazardous materials which do not trigger the threshold. With consideration of the insignificant quantity of materials stored on site, along with the significant distance to neighbouring properties, it can be concluded that the risks associated with storage and transportation of hazardous materials are unlikely to be significant or pose a risk to public safety. Given that Applying SEPP 33 thresholds are not exceeded, the Project is not considered to be a hazardous or potentially hazardous industry under SEPP 33*.* Therefore a PHA is not required to be undertaken for the Bonshaw Solar Farm.

Potentially offensive impacts have been previously assessed as minimal, and are to be managed as specified within relevant technical reports and as outlined within Chapter 7.

6.9.2 Bushfire

A Bushfire Hazard Assessment has been prepared by ERM, in accordance with the requirements of the SEARs (refer to Appendix K). The need for a Bushfire Hazard Assessment was identified within the Secretary's Environmental Assessment Requirements (SEARs) for the further assessment and subsequent approval of the Project and the *Rural Fires Act 1997* imposes obligations on land managers to take all reasonable measures to prevent the occurrence and spread of wildfire to adjoining lands from lands under their care and management.

6.9.2.1 Methodology

Bushfire risks associated with the Project have been assessed in accordance with *Planning for Bushfire Protection 2018* (PBP 2018).

The following steps were undertaken in the assessment process:

- determine whether the Development Footprint has been mapped as bushfire prone land and requires compliance with PBP 2018 (Figure 6-21);
- identify the assets within and surrounding the Project Site requiring protection;
- identify the bushfire risk factors such as bushfire history and known bushfire behaviour in the Project Site and within the surrounding lands;
- map the bushfire hazard at a site specific scale following the relevant guidelines and compare with bushfire prone area mapping (Figure 6-21); and
- produce risk mitigation and management treatments and satisfy PBP 2018 requirements.

6.9.2.2 Existing Environment

The Project is set amongst a historically cleared landscape where rolling hills dominate and the majority of native vegetation has been partially or fully cleared for grazing and cropping. However, patches of woodland and open forest remain along riparian corridors and within the undeveloped eastern portion of the property (outside of the Project Site).

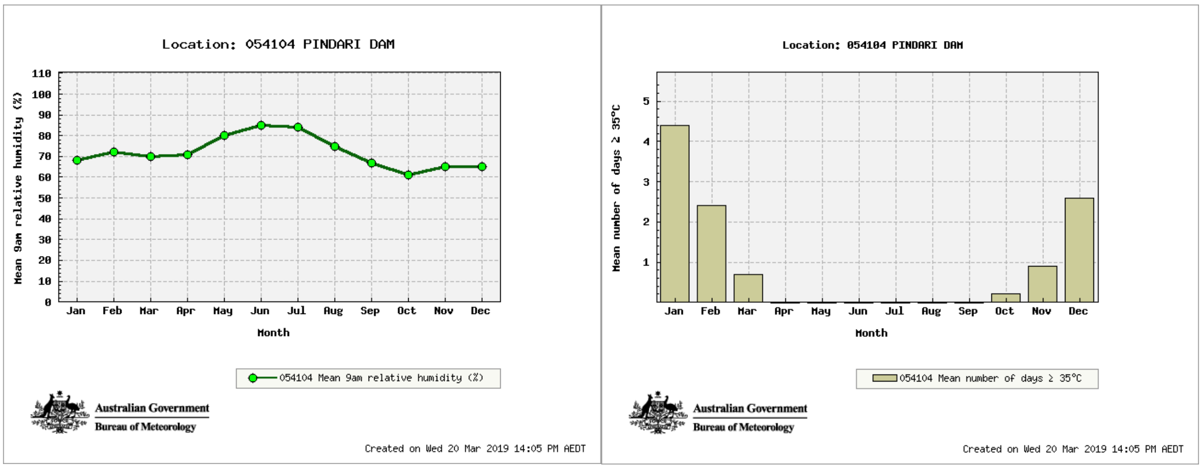
Existing Climate

As reported by BFMC (2011), the typical/average climate in the Northern Tablelands is consistent with a Temperate Zone (warm summer, cool winter). Autumn and spring are the most comfortable seasons in most parts. The weather is more changeable than in the tropics, with cool cloudy days alternating with warmth and sunshine. Rain falls occasionally but doesn’t usually last very long and the bushfire season generally runs from August to March annually.

Prevailing weather conditions associated with the bushfire season in the Northern Tablelands BFMC area are north-westerly winds accompanied by high daytime temperatures and low relative humidity. Dry lightning storms occur frequently during the bushfire season (BFMC 2011).

Data from the Bureau of Meteorology weather station at Pindari Dam, which is 4 km from the solar farm site, confirms that both low humidity and high temperature occur within the bushfire season and would contribute to the fire hazard within this region (refer to Figure 6-20).

Figure 6-20 Low Humidity and High Temperature within the Bushfire Season (BoM, 2019)



Data from the Bureau of Meteorology weather station at Pindari Dam indicates that north westerly winds are uncommon within the region, with strong north easterly winds being more common during the bushfire season.

Vegetation

The vegetation of the Project Site is typical of an agricultural landscape of the Northern Tablelands region of NSW. Generally, the vegetation is a combination of grasslands (both native and non-native pastures) with scattered patches (or ‘islands’) of woodland (refer to Figure 6-22). The Project Site is comprised of 35% native vegetation types and 65% non-native or highly disturbed vegetation types and other land covers (dams and watercourses).

Descriptions of the vegetation types including species composition and structural diversity is provided in the Bonshaw Solar Farm Biodiversity Development Assessment Report (ERM 2019a).

The vegetation has been simplified in line with the vegetation formations as per Keith (2004). The vegetation types have been classified into fuel groups using the following parameters:

- frequency that the vegetation provides ‘available fire fuel’;
- structure of the vegetation and the ability of ground level fuels to carry fire into higher vegetation levels eg. from understorey into crown fire;
- arrangement of the fuel within the vegetation type, eg fine fuels that are elevated, such as in heath, contribute more to fire intensity than a similar quantity of leaf litter fuel; and
- amount of fuel that accumulates after a long period without fire.

Table 6-29 Descriptions and Characteristics of Fuel Groups

Bushfire Fuel Group	Characteristics	Plant Community Type within the Project Site	Keith Formation (2004)
High	Continuous fuels, higher quantity, available to burn during average seasons (higher fire intensity expected e.g. woodland and forest fuels).	PCT 594_Moderate	Dry Sclerophyll Forests (Shrub/grass sub-formation)
		PCT 596_Moderate	Dry Sclerophyll Forests (Shrub/grass sub-formation)
		PCT 516_Moderate	Grassy Woodlands
Medium	Less continuous fuels, medium level quantity, available to burn during average seasons but may be less often than high (medium or high fire intensity expected).	PCT 594_Low	Grassy Woodlands
		PCT 596_Low	Grassy Woodlands
		PCT 516_Low	Grassy Woodlands
		PCT 596_Very Low	Native Grassland
		PCT 516_Very Low	Native Grassland

Bushfire Fuel Group	Characteristics	Plant Community Type within the Project Site	Keith Formation (2004)
		PCT 516_Derived	Native Grassland
		PCT 596_Derived	Native Grassland
Low	Possibly discontinuous fuels, low-medium fuel quantity, moister fuels unlikely to contribute to high intensity fires in average season, fuel structure facilitates easier control, (fire intensities expected range from low-high and generally regarded as easier to control e.g. moist and wet forests).	PCT 516_Disturbed Grassland	Disturbed Grassland
		PCT 594_Disturbed Grassland	Disturbed Grassland
		PCT 596_Disturbed Grassland	Disturbed Grassland
Minimal	Unlikely to burn or always burn within controllable limits.	Farm Dams	N/A

The risk of a grassfire should not be underestimated within the Project Site. The areas of moderate quality native grassland have been given a Medium classification compared to the areas of heavily grazed low quality grasslands (Low). The difference in spread rate between a fire in the heavily grazed pasture and areas of native grassland is only about 20%, although the native grasslands will generally have taller flames that may burn across tracks or firebreaks (Bradstock et al 2012) attributing it to the higher classification in Table 6-29 above.

Slope

Steeper slopes can also significantly increase the rate of spread of fires, and the relationship of the steepness of slope, and whether a fire moves upslope or downslope, is vital to understanding bushfire behaviour potential. Slope and wind are often the major factors determining the direction of fire spread.

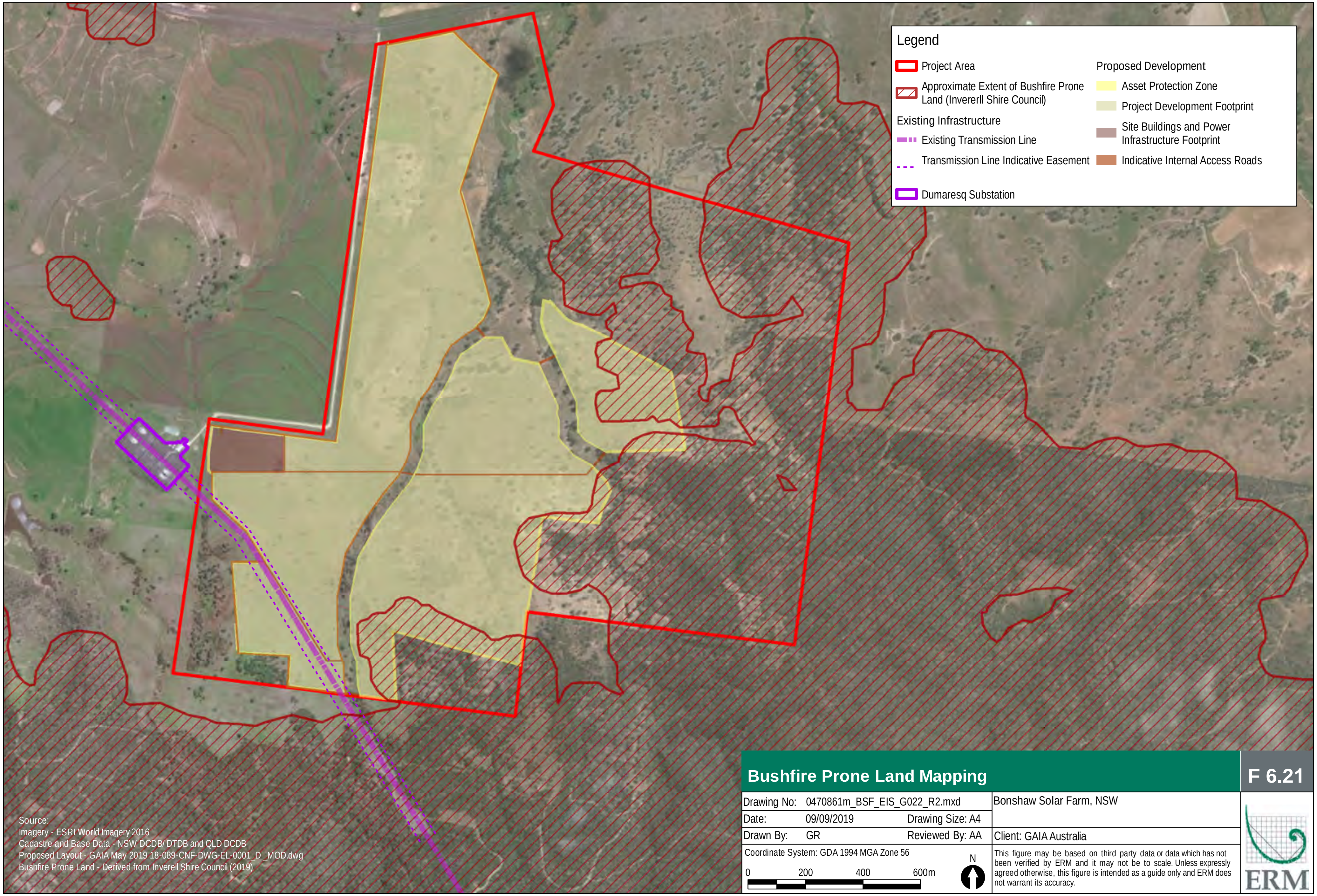
The Project Site is dominated by a gently undulating landscape to the north, forming steep slopes to the south and east dissected by second and third order streams. Based on a review of topographic maps and aerial imagery, landforms present within the Project Site include drainage depressions, gentle to steeply inclining slopes, and upper flat ridges. The elevation at the Bruxner Highway (north boundary) is approximately 335 m and rises up to approximately 420 m in the south-western portion of the site. The ridgelines to the south of the Project rise up to approximately 660 m forming the dominant landscape feature.

The slope map is included as Figure 6-23.

Fire History

No fire history is available from the Project Site itself although large scale fires are known to occur within the Northern Tableland Region. A review of the RFS Fire History Mapping available via SEED maps shows three major fires within the past 10 years:

- Black Creek and Granite Creek fires burnt 23391 ha in 2009/2010;
- South Valley Road fire burnt 1328 ha in 2009/2010; and
- Emmaville Road fire burnt 4555 ha in 2012/2013.



Source:
Imagery - ESRI World Imagery 2016
Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D_MOD.dwg
Bushfire Prone Land - Derived from Inverell Shire Council (2019)

Bushfire Prone Land Mapping

F 6.21

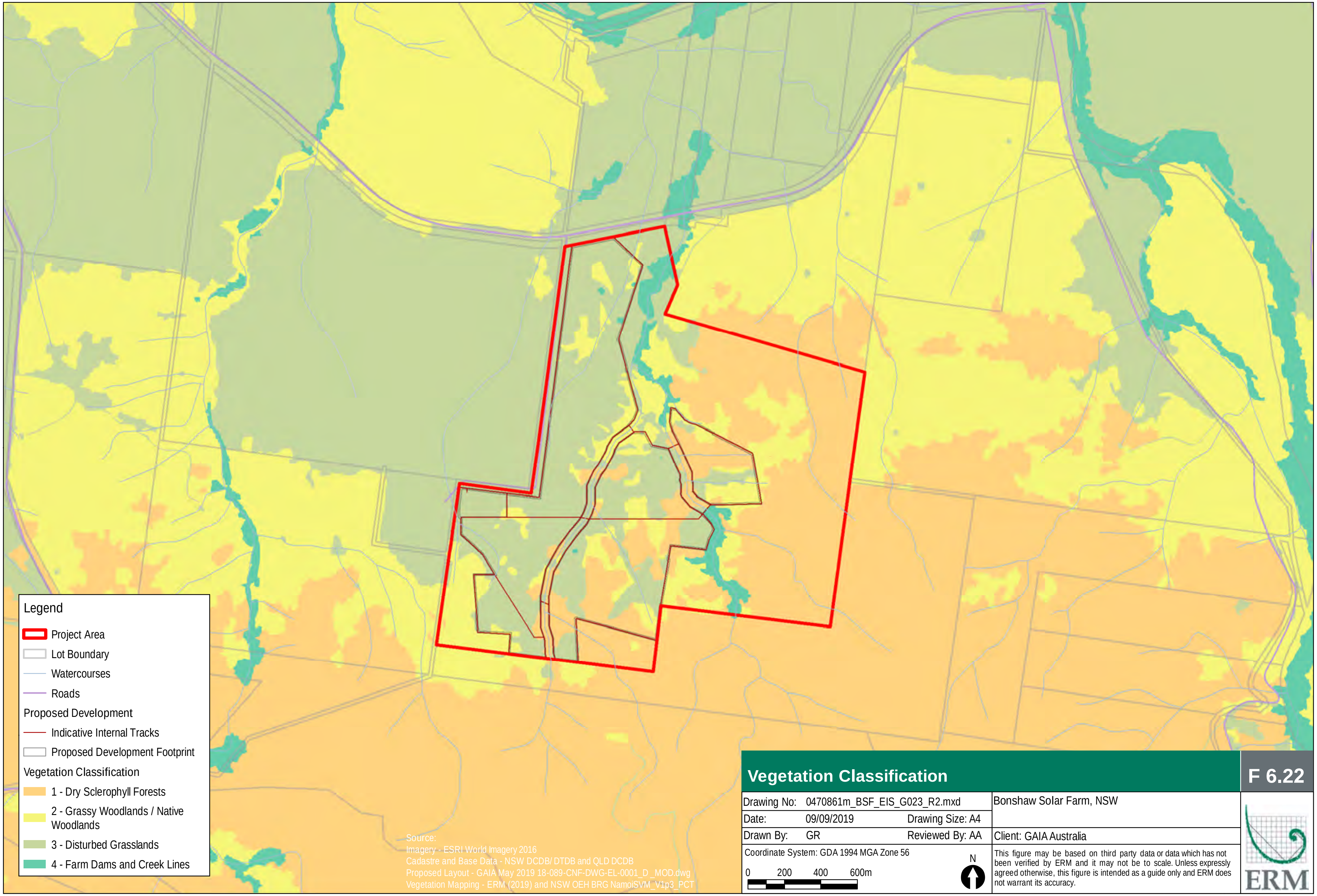
Drawing No: 0470861m_BSF_EIS_G022_R2.mxd
Date: 09/09/2019
Drawing Size: A4
Drawn By: GR
Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM



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Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg
Vegetation Mapping - ERM (2019) and NSW OEH BRG NamoiSVM_V1p3_PCT

Vegetation Classification

F 6.22

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Date: 09/09/2019 Drawing Size: A4

Drawn By: GR Reviewed By: AA

Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

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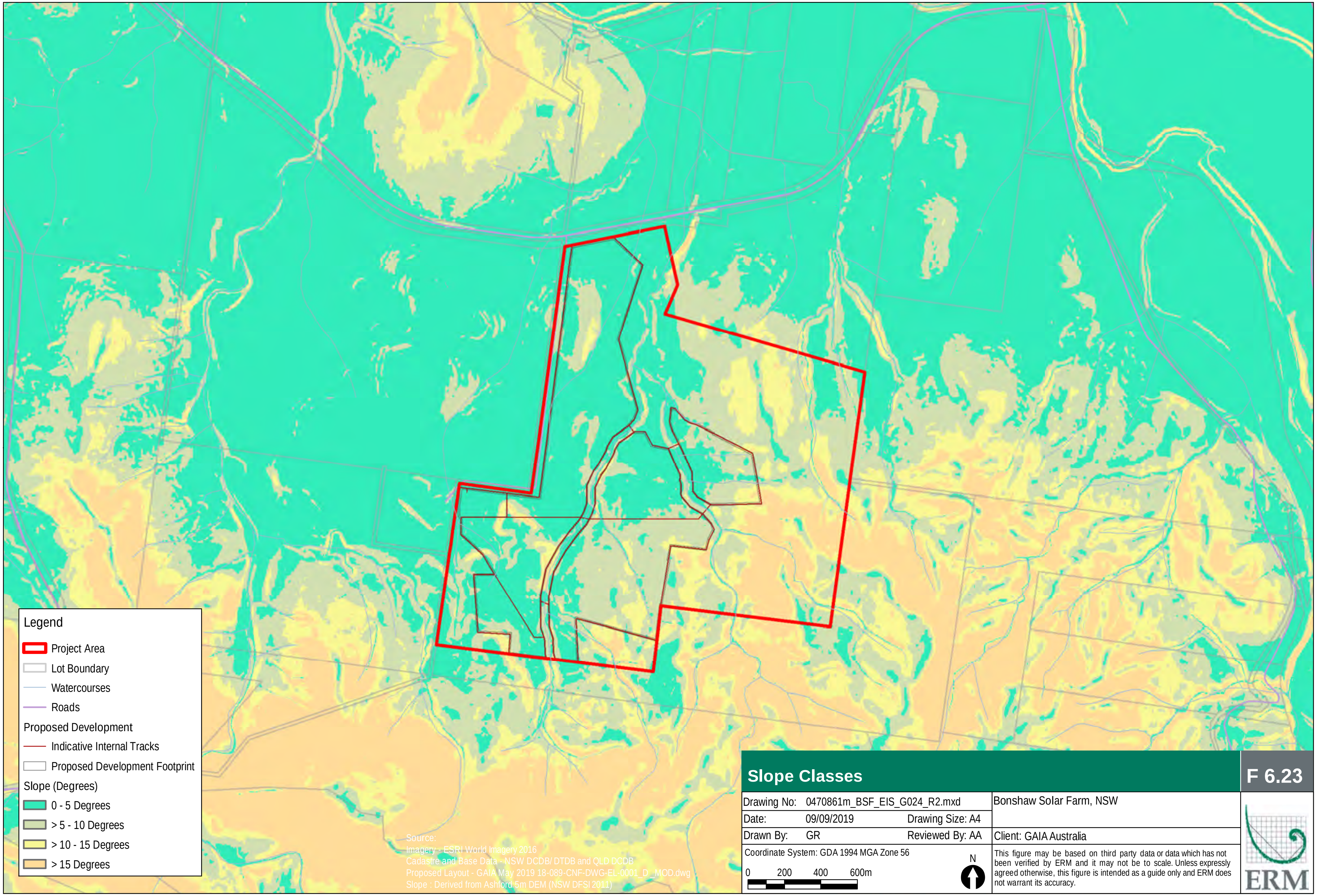
ERM

Slope Classes

F 6.23



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Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg
Slope : Derived from Ashford 5m DEM (NSW DFSI 2011)

Drawing No: 0470861m_BSF_EIS_G024_R2.mxd		Bonshaw Solar Farm, NSW
Date: 09/09/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: AA	Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

6.9.2.3 Assessment

Bushfire hazard classes were identified across the landscape by applying relative weightings to the varying fuel groups (refer Table 6-29 above) and combining them with available slope classes (i.e. 0-5°, 5-10°, 10-15°, >15°) within a Geographic Information System (GIS) model. The vegetation fuel load and slope data sets were loaded into a Weighted Overlay Model, to combine the data and highlight areas of overall higher hazard considering both fuel load and slope. Slope was calculated in degrees and bushfire hazard rating based on steepness and movement speeds of potential bushfire up or down these slopes. The model assumed in this case that both slope and fuel load were equally important or weighted the same in the analysis process.

The result is a Risk Assessment Overlay that identifies overall bushfire hazard classes for the entire Project site, as shown in Figure 6-24. This analysis does not indicate how often an area will receive potentially damaging fires or the actual intensity of a fire, it does however, provide a useful comparative ranking, identifying sites of higher and lower potential fire behaviour compared to others in an area.

Based on the information provided in the fire weather and fire hazard analysis above, the greatest hazard is a combination of undesirable fire weather (i.e. hot and dry winds and low humidity during summer) and the potential for a fire to spread towards farm assets in the surrounding area. Strong north easterly winds are common during the bushfire season in this region (based on BOM data from the nearby Pindari Dam) and would quickly carry a bushfire or grassfire from surrounding properties towards the solar farm assets. A fire under the influence of wind may travel very fast, reaching assets before fire fighters can attend the scene.

Grassfires should not be under estimated and can start and spread quickly. They can travel up to 25 km per hour and pulse even faster over short distances. As described by Bradstock et al (2012), grass is a fine, high surface area to volume ratio fuel with high thermal conductivity, low density and vertical orientation, which rapidly ignites (and rapidly burns out). Grassfires are also generally more open to wind than forest fuels (Cheney and Sullivan 2008) making them unpredictable. Grassfires tend to be less intense and produce fewer embers than bushfires, but still generate enormous amounts of radiant heat. Grassfires can also start earlier in the day than bushfires, because grass dries out more quickly when temperatures are high and humidity is low.

The difference in spread rate between a fire in the heavily grazed pasture and areas of native grassland is only about 20%, although the native grasslands will generally have taller flames that may burn across tracks or firebreaks (Bradstock et al 2012). Under the most extreme weather, a fire could spread between and under solar panels even in the heavily grazed grass and embers may breach any fire break. Therefore, the asset protection zones recommended may only be reliable up to Very High fire danger.

Construction (and Decommissioning)

Earth moving equipment, power tools (e.g. welders, grinders), mowers and slashers are well known for starting bushfires under conditions of high temperature, low humidity and high wind. Activities associated with solar farm construction that may cause or increase the risk of bushfire include:

- Site maintenance activities such as mowing, slashing and using other petrol-powered tools.
- Hot works, including welding and soldering activities.
- Operating a petrol, LPG or diesel vehicle in grassland areas.
- Operating plant fitted with power hydraulics in grassland areas.
- Smoking and disposal of cigarettes on site.

Construction and ongoing maintenance of the solar farm will be a potential source of ignitions, with a greater risk within the declared fire danger period (typically from August to March). Site access would be formalised at the beginning of the construction stage, which would increase the ability to access and suppress any fire onsite or on adjoining sites.

The bushfire hazard associated with the construction activities listed above is considered manageable and would be minimised through the implementation of fire and bushfire mitigation measures outlined below, including the preparation of an emergency response plan.

Any bushfire risk associated with decommissioning of the Project would be similar the construction phase and would be subject to the same management and mitigation measures.

Consideration is given to whether the proposed Solar Farm will result in people congregating in large numbers. The operation of the proposed Solar Farm is considered to be a low intensity use in terms of the number of people on site at any one time, with only 10 full time staff on site during the operational phase. However, there could be up to 190 people on site during construction phase over a period of up to 52 weeks. Although the construction period does not pertain to the expected end use of the Project Site, the number of people who could be on site at one time does warrant consideration in terms of providing adequate defendable space and access as the first stage of construction.

Operation

Repairs and maintenance activities during operation could also increase bushfire risk.

GAIA have confirmed the following information regarding the fire risk for the PV panels:

- All electrical components are required to be manufactured in material that does not allow self-combustion and ignition and should self-extinguish. In addition, the electrical equipment is fitted with over current protection devices and isolation switches along with earth leakage protection devices as standard components.
- The PV panels will be made of tempered glass with aluminium frames. GAIA have also advised that the solar panels to be used meet the IEC 61730 and UL1703 (Type 1) fire resistance test standards under fire conditions.
- It is intended that the vegetation fuel under and between the PV panels will be maintained in a low fuel state by sheep grazing and other land management activities such as mowing and application of pesticides. It is recognised that a fire could still spread in this fuel under severe fire weather conditions.
- The likelihood of a fire spreading within the area of the proposed PV panels, by propagating from panel to panel in a solar farm installation, is difficult to assess as no fire history within a solar farm was found from within Australia. GAIA have confirmed that solar panels are non-reflective and present no risk of ignitions from concentrated solar energy. All electrical LV and MV components are in enclosures that will contain any arcing should a fault occur.
- The risk of a fire spreading widely from panel to panel is likely to be very low because of the panel construction materials (i.e. fire resistance rating) and the time of flame exposure to initiate these materials.

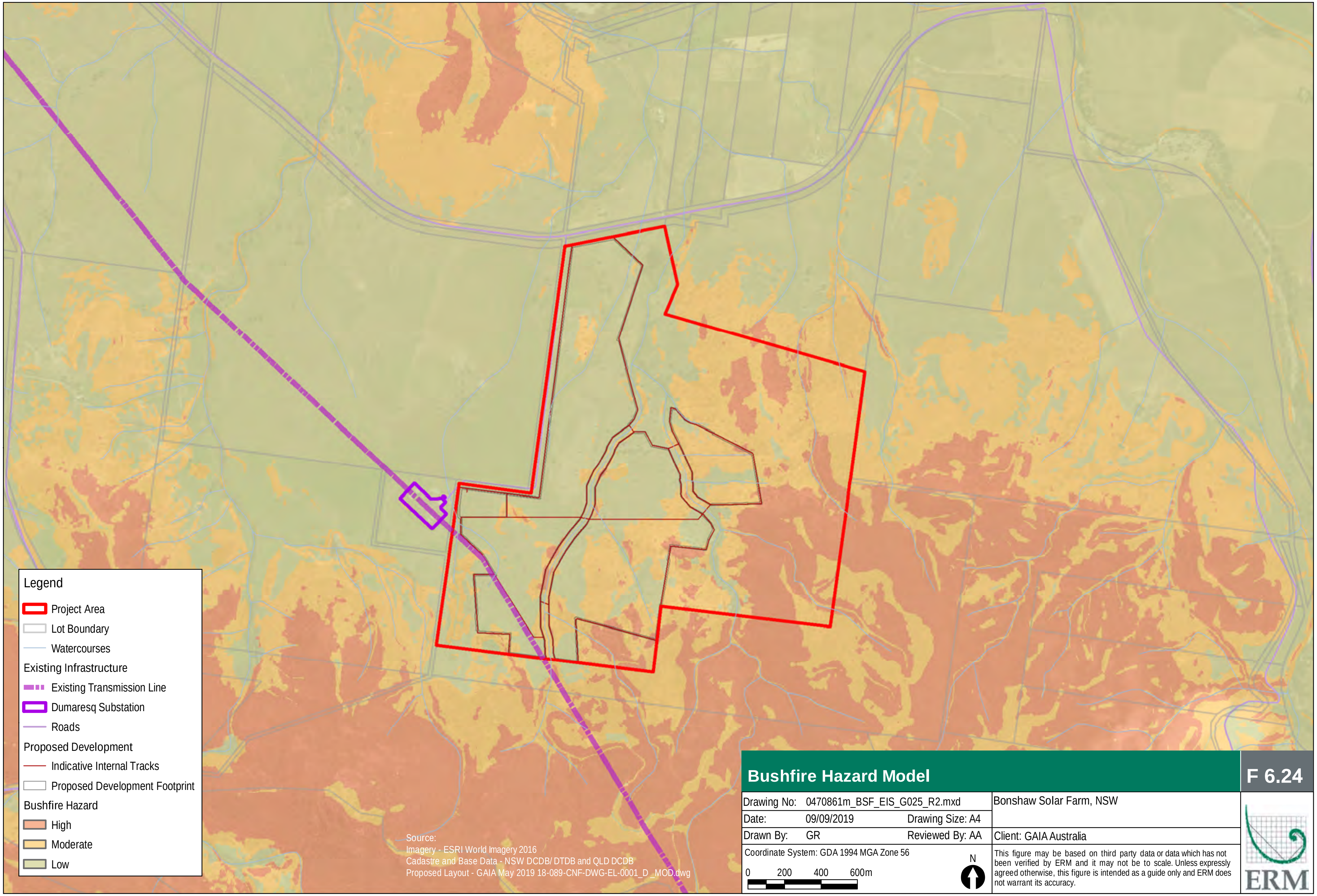
The level of risk from faults cannot be assessed at this stage because there is no case history available and it is not possible to compare the ignition risk from existing farm operations (e.g. grazing) relative to solar farm operation.

An Asset Protection Zone of 10 m will be maintained around all buildings at the site including the solar farm substation, inverters, control building and external perimeter of the PV arrays throughout the operational phase of the Project. It is anticipated that TransGrid would continue to maintain their adjacent substation infrastructure to minimise bushfire ignition risks.

The perimeter road will be 6m wide (located within the 10m wide perimeter APZ), with internal access tracks a minimum of 4 m wide allowing adequate access for emergency vehicles including fire trucks.

Bushfire Hazard Model

F 6.24



Source:
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Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
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Drawing No: 0470861m_BSF_EIS_G025_R2.mxd
Date: 09/09/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

ERM

6.9.2.4 Mitigation Measures

Mitigation strategies are guided by the following factors that contribute to bushfire risk:

- Fuels, weather, topography and predicted fire behaviour;
- Suppression resources (air and ground), access (roads, tracks) and water supply; and
- Values and assets

Mitigation must be a combination of complementary strategies, all of which are required to provide the best possible protection outcome for the solar farm and the community.

Table 6-30 below provides a summary of the mitigation measures, as outlined in the Bushfire Assessment.

Table 6-30 Summary of Mitigation Measures

Mitigation Strategy	Action	Timing
Asset Protection Zone (APZ)	A minimum 10m wide APZ is to be established around the perimeter of the solar farm and around the control room, electricity compounds and substations. The specifications recommended for the APZ are: ■ mineral earth fire break i.e. dirt or gravel. ■ no trees and shrubs planted within the APZ. ■ 6m wide perimeter access track can be located within this 10m wide APZ.	The APZ and perimeter road must be constructed as the first stage of development.
Solar farm construction	Should construction of the solar farm take place between 1 December and 31 March (increased fire weather), the following measures are recommended to control the risk of grass fire ignitions: ■ Ensure that appropriate permits have been issued for work during the Fire Danger Period, and that any conditions on permits are adhered to; ■ Adhere to restrictions on Total Fire Ban or days of high fire danger; ■ Carry fire extinguishers or firefighting equipment in vehicles; ■ Carry emergency communications equipment; ■ Ensure vehicles keep to tracks whenever possible; ■ Restrict smoking to prescribed areas, and provide suitable ash and butt disposal facilities; ■ the APZ and perimeter road must be constructed as the first stage of development; ■ all plant, vehicles and earth moving machinery are cleaned of any accumulated flammable material (e.g. soil and vegetation); ■ suitable fire fighting equipment (specific requirements to be confirmed in consultation with RFS) is present on site with at least two personnel trained in bushfire fighting;	During Construction

Mitigation Strategy	Action	Timing
	■ on days when Very High fire danger or worse is forecast, the “fires near me’ app is to be checked hourly for the occurrence of any fires likely to threaten the site; and ■ all operations involving earth moving equipment, vehicles, slashers and hot works (e.g. grinders, welders) cease while the Grassfire Danger Index (GFDI) is or forecast to be 35 or greater (Rural Fire Service 2018).	
Access roads and road network	The perimeter road and site access points must be constructed as the first stage of development. One main entry/exit point to the Bruxner Highway to the north and an additional two access points on the western and southern boundaries of the site must be maintained for the life of the Project.	During construction and operation
Solar farm ongoing operations	Maintain minimal fuel load by grazing, slashing or mowing. Continued grazing is recommended within the Bonshaw Project site to ensure that grass is maintained below 100mm high. No vegetation within the Substation or within the 10m wide APZ. Suspend site maintenance operations when GFDI >=35.	During construction and operation
Fire-fighter safety	Emergency Response Plan prepared and stored at ‘Emergency Information Cabinet’ at main entrance to solar farm and provided to local emergency responders. The ERP must include: ■ a safe method of shutting down and isolating the PV system; ■ control and coordination arrangements for emergency response (eg evacuation procedures, emergency assembly areas and procedures for response to hazards); ■ agreed roles and responsibilities of on-site personnel (eg equipment isolation, liaison, evacuation management); ■ up-to-date contact details of site personnel and any relevant off-site personnel who could provide technical support during an emergency; ■ a manifest (and safety data sheets) for any battery, diesel or other dangerous goods storage/handling, including the class identification, quantity, type (bulk or packaged) and location. Appropriate material (including absorbent, neutralisers, equipment and personal protective equipment) for the clean-up of spills is to be provided and available on-site; ■ clearly states work health safety risks and procedures to be followed by fire-fighters, including personal protective clothing; ■ minimum level of respiratory protection; ■ minimum evacuation zone distances; ■ activation of water spray/foam systems and any other response/protection measures; and	ERP to be developed and approved by both NSWRFS and NSWFS prior to construction.

Mitigation Strategy	Action	Timing
	■ any other risk control measures required to be followed by fire-fighters. A schedule for ongoing site familiarisation to account for changing personnel, site infrastructure and hazards should be developed in conjunction with the local RFS.	
Shielding of solar farm components	Shield all heat sensitive components from potential flame contact. Design should consider the following features: ■ burial of cables underground; ■ shielding of above ground cables (e.g. metal conduit).	Considered during project design. Maintained for life of the Project
Water storage	Water supply should be designed to provide filling points for fire tanker units near the solar farm entrance only as internal access may not be possible. A storage of 50,000 litres is recommended, based on refilling six tanker units (4,000 litres) twice each although the required capacity will be confirmed in consultation with RFS.	Considered during project design. Maintained for life of the Project

6.9.3 Electromagnetic Fields

6.9.3.1 Methodology

A desktop assessment of the potential hazards and risks associated with electro and magnetic fields (EMFs) in relation to the Project has been undertaken. This involved a review of publicly available information and research on EMFs associated with electricity generation infrastructure. This information was compared with applicable guidelines recommended by industry bodies to identify the potential impacts that may occur with solar farm development. The desktop assessment considered that impacts are minor and temporary in nature.

6.9.3.2 Background

EMFs exist wherever electricity is generated, transmitted, distributed or used, and are strongest closest to their source. Electric fields are produced by voltage, while magnetic fields are produced by current. In Australia, EMFs associated with the use of electricity are generated at a frequency of 50 hertz (Hz). This frequency falls within the extremely low frequency (ELF) range of 0–3,000 Hz, as defined by the Australian Radiation Protection and Nuclear Safety Agency. Subsequently, power lines, substations, transformers and other electrical sources all emit ELF EMFs (ARPANSA 2015).

The units commonly used to express the strength of a magnetic field include the Tesla (T) or microtesla (μT) and the Gauss (G) or milligauss (mG), where 1 mG is equal to 0.1 μT. The typical values of magnetic fields measured near significant electrical infrastructure in Australia, including distribution lines, substations and transmission lines are provided in Table 6-31. It should be noted that distribution lines operate at significantly lower voltage than transmission lines (ARPANSA 2016).

Table 6-31 Typical Values of Magnetic Fields Measured Near Powerlines and Substations

Source	Location of measurement	Range of measurements (mG)*
Distribution line	Directly underneath	2–30
Distribution line	10 m away	0.5–10
Substation	At substation fence	1–8
Transmission line	Directly underneath	10–200
Transmission line	At edge of easement	2–50

Notes: * Levels of magnetic fields may vary from the range of measurements shown.
Source: ARPANSA (2016).

Extensive research has been conducted to determine whether exposure to ELF EMFs produces adverse health consequences (WHO 2007). As noted by the World Health Organisation (WHO 2007), the health effects related to short-term, high-level exposure to EMFs have been established and form the basis of two international exposure limit guidelines. These are the ‘Guidelines for limiting exposure to time varying electric, magnetic and electromagnetic fields (up to 300 GHz)’ by the International Commission on Non-Ionizing Radiation Protection (ICNIRP 1998), and the ‘Standard for safety levels with respect to human exposure to electromagnetic fields, 0–3kHz’ by the Institute of Electrical and Electronics Engineers (IEEE) Standards Coordinating Committee (2002).

As noted by ARPANSA (2015), the majority of research indicates that ELF EMFs exposure levels normally encountered in the environment, including in the vicinity of power lines, does not pose a risk to human health. Further, there is no established evidence that exposure to magnetic fields from power lines, substations, transformers or other electrical sources causes any health effects (ARPANSA 2015). Nonetheless, the ICNIRP guidelines (1998) define reference levels for occupational and general public exposure to prevent potential adverse health effects from exposure to EMFs. These reference levels are shown in Table 6-32 below. The ranges of measurements listed within the table are well below the exposure limits of 2,000 mG or 200 µT, as defined by international guidelines (ARPANSA 2016).

Table 6-32 ICNIRP Reference Levels for Occupational and General Public Exposure

Exposure Characteristics	Electric field strength [kilo volts per metre - kV/m]	Magnetic flux density [µT]
Occupational	10	1000
General public	5	200

Source: ICNIRP (1998).

A study by Chang and Jennings (1994) investigated the level of EMFs generated at two utility-scale PV solar developments in the United States. Specifically, the study compared the magnetic fields generated by these developments with published data on more prevalent magnetic field sources. The study concluded that magnetic fields, considered by Chang and Jennings (1994) to be of greatest public concern, generated by PV solar panel arrays were significantly less than for common household applications. For example, magnetic field measurements taken from the back of a PV solar panel were recorded as significantly less than those recorded from within close proximity of a hair dryer, microwave and television, respectively. Therefore, Chang and Jennings (1994) concluded that EMFs generated by PV solar panel arrays should not generate concern.

Other infrastructure installed as part of the PV solar developments assessed by Chang and Jennings (1994), such as transformers, exhibited more significant magnetic fields. However, these sources were found to be localised and could not be detected at the perimeters of each of the developments assessed (Chang and Jennings 1994). Further, it was noted that concerns about EMFs generated by transformers would also apply to several other electricity generation and storage technologies (Chang and Jennings 1994).

6.9.3.3 Assessment

The Transgrid 330 kV transmission line traverses the site. Based on the typical values of magnetic fields provided by ARPANSA (2016), the level of exposure from the existing transmission line will be significantly below the exposure limit of 2,000 mG or 200 µT, which is defined by international guidelines. Additionally, the nature of exposure to EMFs generated by the existing transmission line will be intermittent for staff involved in the construction, operation and decommissioning stages of the Project.

In addition to Transgrid's 330 kV transmission line, staff involved in the construction and decommissioning stages of the Project will also be exposed to EMFs during works on the connection infrastructure. Staff exposure levels will be below the recommendations for general public and occupational exposure through the construction and decommissioning of the connection infrastructure.

Construction of the Project includes the installation of electrical infrastructure within the site boundary including cabling, inverters, switchgear and the onsite substation, as well as, connection infrastructure to connect the Project to the Dumaresq Substation and the installation of a large number of PV solar panels. As this infrastructure will be involved in the generation, transmission and distribution of electricity, EMFs will be produced by the Project. The EMFs produced by the Project will be strongest closest to their respective sources.

Once operational, the Project infrastructure will be capable of generating EMFs. The degree of exposure to EMFs within the site boundary will vary depending on proximity to different components of the Project infrastructure. Staff exposure during the operational stage of the Project will be intermittent and limited to exposure encountered during ongoing maintenance of the site and project infrastructure. The combination of low exposure rates and the intermittent exposure of staff to elements of the Project infrastructure, capable of generating EMFs, indicate that adverse impacts from EMFs are unlikely.

The Project substation will be located within the Development Footprint, close to the site's western boundary. This location is right next to the existing switching station and any EMF will be significantly less than those emitted from the switching station, which has a higher current carrying capacity than the Project substation. Further, the Project substation will be offset from Bruxner Highway by approximately 1.4 km.

The transmission line to connect the Project to the Dumaresq Substation will be less than 150 m long and is directly adjacent to the existing 330kV transmission line and thus limit the potential exposure to ELF EMF.

6.9.3.4 Mitigation Measures

All designs will be in accordance with the Guidelines for limiting exposure to Time varying Electric, Magnetic and Electromagnetic Fields (ICNIRP, 1998; ICNIRP, 2010b) and relevant codes and industry best practice standards in Australia.

All relevant procedures in relation to a high voltage installation will be adhered to throughout the life of the Project.

The security system for the site, including safety fencing and closure of gates, will be maintained throughout the construction and operation, to provide safe exposure distances to the public.

Public access to the site will be restricted throughout the life of the Project.

6.10 Socio-Economic

Large-scale developments have the potential to create opportunities, and cause adverse impacts, for the local community. Opportunities arise through the provision of employment and increased local trade. Conversely, impacts can occur through creating strains on existing infrastructures (including accommodation facilities, public transport, etc.). Therefore, a socio-economic assessment provides a clear examination of key demographic, economic and infrastructure aspects of the surrounding area to assist in determining potential impacts associated with the Project. This section investigates the socio-economic profile of the region to understand and assess the potential impacts of the Project on the local community.

6.10.1 Methodology

Key demographic and economic data was sourced for the Inverell LGA and compared to data for the greater NSW region (excluding the greater Sydney metropolitan area) as a representative baseline for rural NSW. Data was sourced from the Australian Bureau of Statistics Census to provide an understanding of the existing socioeconomic context.

In addition, a desktop review of the following documents was undertaken

- Community Strategic Plan 2009-2029, Inverell Shire Council (2017);
- Operational Plan 2018-2019, Inverell Shire Council (2018);
- Delivery Plan 2017-2021, Inverell Shire Council (2018);
- New England North West Regional Plan 2036, DPE (2017); and
- Traffic Impact Assessment, SECA Solutions (2019).

6.10.2 Existing Environment

Demographic Profile

The Inverell Shire covers an area of some 8,623 km^2, and is a region comprising of rural and urban residents, including, among others, the village of Bonshaw. Inverell Shire Council describe their region in their *Operational Plan 2018-2019* (Inverell Shire Council, 2018) as follows:

Inverell Shire is a dynamic and creative community that provides an opportunity for its residents to enjoy a quality lifestyle. The area is endowed with natural resources and residents who adopt a progressive and inclusive approach to life. These values are encapsulated in the Shire's vision – A Community for Everyone

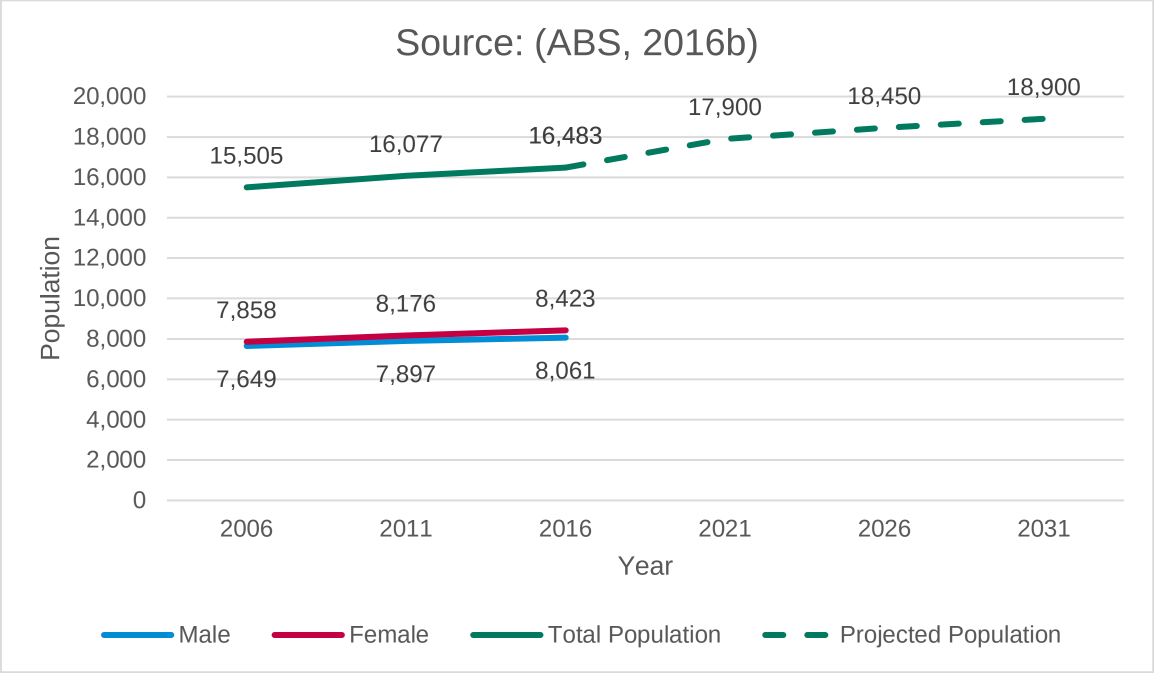
The Inverell region, dubbed 'the Sapphire City' has a rich history founded on the production of fine gemstones. The region character has become more diverse, with census data revealing the most common industries of employment are; health care, agriculture, retail trade and manufacturing (ABS, 2016a).

Population

In the 2016 Census, there were 16,483 people in the Inverell LGA. Of these 48.9% were male and 51.1% were female (ABS, 2016). The population of the Inverell Shire is predicted to grow by 12.2 per cent by 2031, with the area projected to grow to a population of 18,900 (Inverell Shire Council, 2017 and DPE 2016). Figure 6-25 shows the population trends, indicated by green. The blue and red lines representing males and females respectively depict the population split between genders within the Inverell LGA.

Between 2006 and 2016, the population grew by 6.3%. This represents marginal growth when compared to Rural NSW, which grew by 9.2% between 2006 and 2016.

Figure 6-25 Inverell Shire LGA Population Trends 2006 - 2031



Employment

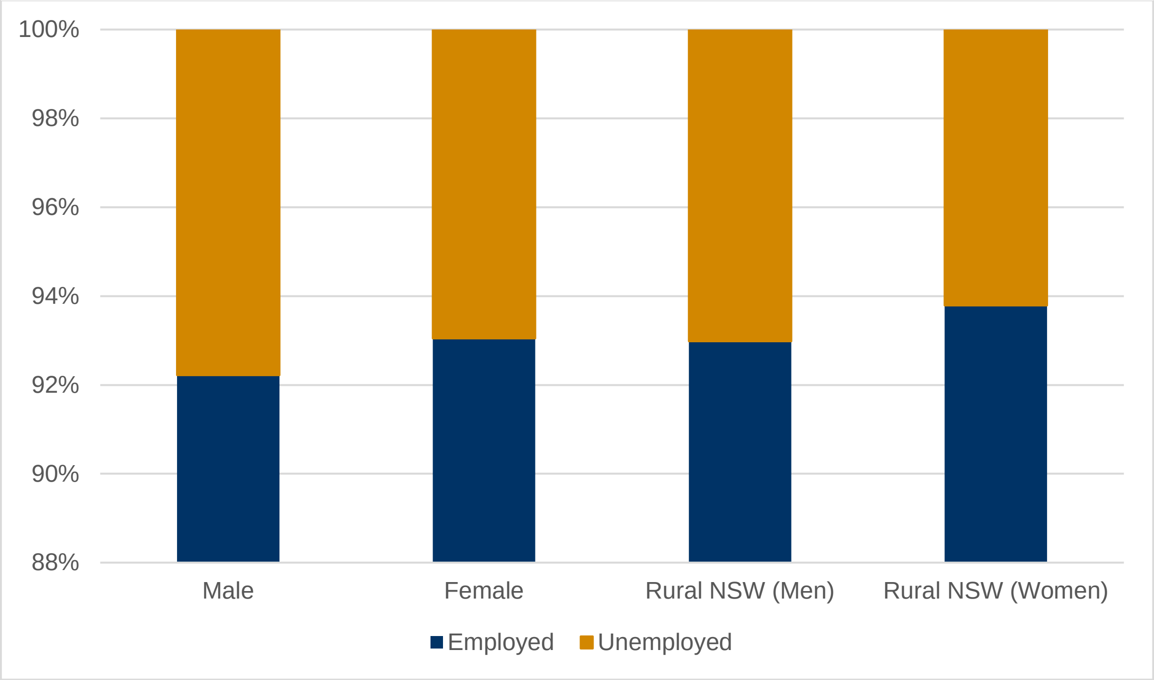
The Inverell Shire Council's *Community Strategic Plan 2009-2029* provides an insight to the existing context and strategic focus of Council's approach to future economic growth for the community. It identifies that Inverell Shire has a labour force of 6,339 states:

"Inverell Shire contributes a Gross Regional Product of $819 million to the economy and our agriculture sector dominates industry output, driven by broadacre cropping and cattle. The largest employer in Inverell Shire is Bindaree Beef, with other prominent employers including BOSS Engineering, McLean Memorial Retirement Village and Inverell Shire Council." (Inverell Shire Council, 2017)

Of the total labour force recorded in the 2016 Census, there were 3,353 men and 3,039 women employed in the Inverell LGA. In terms of unemployment, there were 283 men and 227 recorded, representing 7.8% of men and 6.9% of women. This is shown in Figure 6-26 below, where the percentage of the labour force that is employed is represented by dark blue and the percentage of the unemployment in the labour force is represented by orange. In comparison to Rural NSW, unemployment rates are 7.0% for men and 6.6% for women, showing slightly higher rates of unemployment in the Inverell LGA.

In 2016, the split of the main employing types in the Inverell LGA is Health Care and Social Assistance (13.3%), Agriculture, Forestry and Fishing (12.4%), Retail Trade (12.1%), Manufacturing (11.4%) and Education and Training (8.6%).

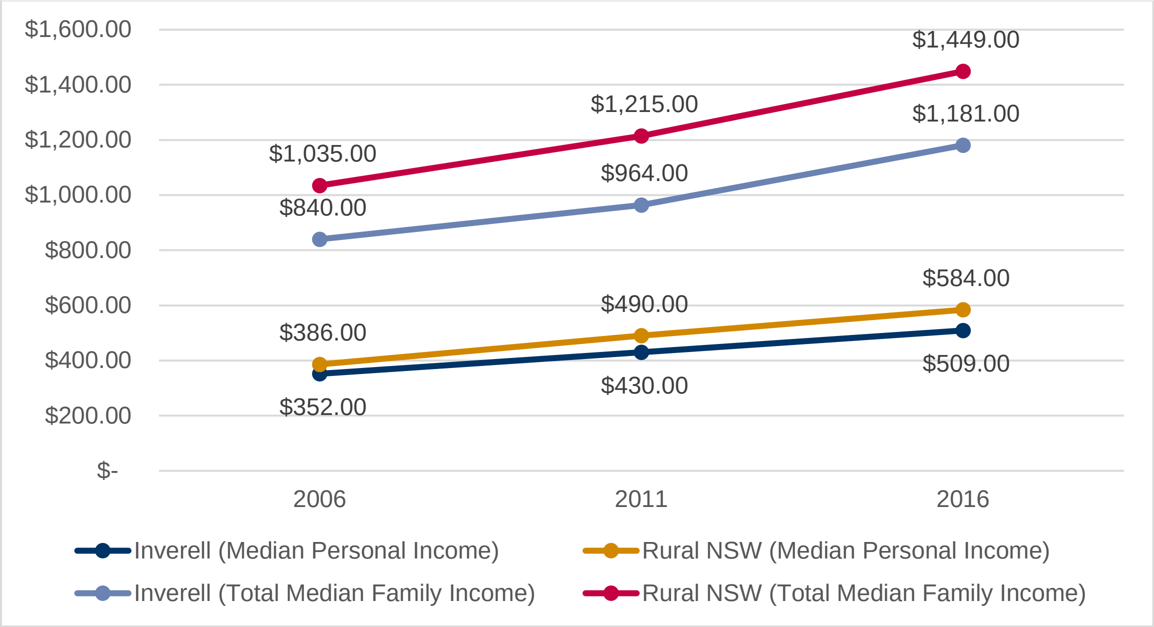
Figure 6-26 Unemployment Percentage



Income

A comparative analysis of the median incomes for the Inverell LGA and Rural NSW for the 2006-2016 census periods. The median incomes in the Inverell LGA are consistent with Rural NSW though slightly below, which reflects limited economic and employment opportunities. Although incomes are increasing, as shown in Figure 6-27, the gap has increased by 4.0% for median income, whilst the gap has remained relatively consistent for total median family income, in fact has marginally lessened by 0.35% between 2006 and 2016.

Figure 6-27 Median Incomes of Inverell and Rural NSW



Other Solar Farm Developments in the Region

There are three other Solar Farms in the Inverell LGA, all situated between Inverell and Glen Innes. These three Solar Farms, along with their status, are outlined below:

- Sapphire Solar – Determination: Approved.
- Sundown Solar Farm – Prepare EIS.
- White Rock Solar – Determination: Approved.

These Solar Farms, along with their respective socio-economic impacts, will not significantly enhance the impacts of the Project as their proximity is considerably distant. All three Solar Farms are located in the southeast corner of the Inverell LGA, while the Project is situated over 50km to the north, in the northeast corner of the Inverell LGA.

6.10.3 Assessment

Workforce

The Project will positively contribute to the local and wider community through the creation of approximately 190 full-time equivalent jobs during the 9-12 month construction period, and up to 10 permanent jobs during operation. The accommodation needs of the construction workforce will be sourced in the surrounding towns of Texas, Ashford and Tenterfield. Considering the remote setting of the Project, the majority of the workforce accommodation will need to be spread across a larger area, rather than in the immediate vicinity as typically viable for developments located in more urbanised areas.

The influx of workers during the construction stage will generate large economic gain for local businesses and industries, particularly the increased demand for accommodation, hospitality and retail services.

Industry

Minor negative impacts anticipated due to the temporary loss of utilised agricultural land during construction, as livestock will need to be relocated while the Project structures and roads are being constructed. However, the Project has been developed so that during operation, livestock will be able to graze beneath the PV solar array, providing a dual use of the Site and mitigating the potential lose of 58.3ha of Biophysical Strategic Agricultural Land (BSAL).

There will be an overall positive impact through diversification of local industry types as a result of increased demand for local goods and services throughout the Inverell LGA and western portions of the neighbouring Tenterfield LGA. These benefits will include demand for local contracting and manufacturing services utilised during construction such as earthworks, cabling and civil works. Where possible, GAIA will adopt the ‘buy local’ principle in an attempt to involve local contractors and businesses to ensure benefits to the local industries are realised. This ‘buy local’ principle will be practiced for the purchasing of goods and services, dependent on their relative competiveness in terms of price and quality.

There is a broader socioeconomic and environmental advantage of the Project through further development of renewable energy sources, utilising the abundant solar resources available in NSW and transitioning to a more diverse energy generation. The Project will also support the Commonwealth and NSW governments in achieving their respective renewable energy and greenhouse gas (GHG) emission reduction targets, as discussed in Section 3.1 above.

Traffic

Additional traffic movements during construction, as well as the disruptions to local traffic during the construction of the access road are anticipated to cause minimal impact for existing road users (as shown in Traffic Assessment, refer to Appendix H). The development of the access road will bring positive improvements to the local road network for locals in the long term.

Community Benefits Fund

GAIA are committed to providing a suitable Community Benefit Fund, in line with level of adverse impact caused to the local community through the Project's construction and lifetime. This will be determined through discussions with Council, to determine the most appropriate implementation for a Community Benefit Fund for the long-term benefit of the local community.

6.10.4 Mitigation Measures

The following mitigation measures are to be implemented to manage possible socioeconomic impacts during construction and operation:

- ongoing use of the Project Site for livestock grazing during operation (dual use), to mitigate the potential loss of strategic agricultural land;
- a Traffic Control Plan will be developed to manage the impacts to local traffic along Bruxner Highway during the construction of the Site access road;
- a suitable Community Benefit Fund will be provided, in consultation with Council, to address the adverse impacts caused to the local community through the Project's lifetime;
- the Project will adopt a 'buy local' principle to enhance positive outcomes for the local community. This will include in an attempt to involve local contractors and businesses to ensure benefits to the local industries are realised;
- the 'buy local' principle will also be practiced for the purchasing of goods and services, dependent on their relative competiveness in terms of price and quality; and
- the accommodation needs of the construction workforce will be sourced locally, to generate large economic gain for local businesses and industries, particularly the increased demand for accommodation, hospitality and retail services.

6.11 Waste

6.11.1 Methodology

This waste assessment has been prepared to provide guidance on the classification and removal of wastes generated as a result of the construction and operation of the Project.

While Waste Management is not directly referenced in the SEARs, an accompanying submission by Inverell Shire Council states that it expects the SEARs to consider:

> *"Waste management should be an additional specific issue to be addressed within the EIS, noting that waste will not be accepted at the Bonshaw or Ashford Waste Transfer Stations*"

Regulatory guidelines referred to in the preparation of this assessment include:

- Waste Classification Guidelines (EPA, 2014); and
- Resource Recovery Orders and Exemptions prepared by the NSW EPA.

The requirements of the following legislation will be adhered to during construction and operation of the Project, to ensure the effective management of wastes on-site:

- Protection of the Environment Operations Act 1997 (POEO Act);
- Protection of the Environment Operations (Waste) Regulations 2005; and
- Waste Avoidance and Resource Recovery Act 2001.
- Best practice for waste management is to implement the resource management hierarchy principles, in accordance with the *Waste Avoidance and Resource Recovery Act 2001* and the principles of ecologically sustainable development:
- Avoidance of unnecessary resource consumption;
- Resource recovery (including reuse, reprocessing, recycling and energy recovery); and
- Disposal.

6.11.2 Existing Environment

The Site currently operates as livestock grazing. The management of all waste streams generated by these agricultural activities exclusively rests with the current landowner.

There are six landfills within the Inverell Shire, including the Bonshaw Landfill and Ashford Rural Waste Transfer Station, which are in closest proximity to the Project.

6.11.3 Assessment

Identified Waste Streams

Waste is classified in groups that pose similar risks to human health and the environment. This allows for correct management of these waste types and their disposal. The Waste Classification Guidelines identify six waste classes, including:

- Special waste;
- Liquid waste;
- Hazardous waste;
- Restricted solid waste;
- General solid waste (putrescible); and
- General solid waste (non-putrescible).

The anticipated waste types generated by the Project have been categorised into these waste streams, and provided in Table 6-33.

Table 6-33 Waste Streams

Waste Type	Classification
Construction	
Employee generated waste	General solid waste (putrescible)
Sewage	General solid waste (putrescible)
Timber pallets	General solid waste (non-putrescible)
Cardboard	General solid waste (non-putrescible)
Plastic film	General solid waste (non-putrescible)
Excavated soil	General solid waste (non-putrescible) (Virgin excavated natural material)
Concrete	General solid waste (non-putrescible) (materials recycled where possible)
Metal	General solid waste (non-putrescible) (materials recycled where possible)
Building materials	General solid waste (non-putrescible) (Building and demolition waste)
Operation	
Employee generated waste	General solid waste (putrescible)
Sewage	General solid waste (putrescible)
Oil and grease	Liquid waste

Detailed quantities of each waste stream will not be available until the detailed design stage of the Project has been completed. The proposed management methods for each waste classification type will be clearly defined within a detailed Waste Management Plan (WMP).

It is anticipated that construction material will be transported to the Site from Sydney, and waste material either transported on the vehicular return trip to Sydney, via a local waste treatment facility, or managed by a waste facility in the transporting contractors home depot city. The WMP will include measures to ensure waste materials do not over exhaust available waste facility acceptance limits. Consultation with Inverell Shire Council, and, if necessary with neighbouring councils, to ensure capacity of waste management facilities to manage the relevant waste quantities generated during construction.

Resource Use

The construction of the internal road network will require key resources including gravel, sand, water, etc. The anticipated quantities of these materials is unlikely to pose a significant pressure on resource availability.

During operation is there is no anticipated need for additional resources to be sourced, other than as needed for occasional maintenance of the road network and relevant infrastructure.

6.11.4 Mitigation Measures

In order to mitigate the potential impacts of poorly managed waste, a WMP will detail all appropriate measures to be incorporated, in order to avoid potential contamination to land and water, and human and wildlife health impacts. Specific measures to be included in the WMP would include the following:

- packaging waste is expected from loads transporting materials to the Site. The packaging waste is to be removed and taken to a waste facility on the truck's return trip, or otherwise managed through local waste treatment to be outlined in the WMP;
- separation of recyclable and non-recyclable materials will take place where possible and be stored in designated receptacles;
- waste receptacles will be collected on a regular basis by licensed contractors or Council collection service and transported for off-site disposal at an appropriately licenced landfill or recycling facility;
- all waste disposal will be in accordance with the POEO Act and *Waste Classification Guidelines* (EPA, 2014);
- waste tracking will occur for any types and quantities of waste that trigger the requirement for tracking;
- waste management measures will be incorporated into the site Construction and Operation Environmental Management Plan, which will outline measures to avoid waste generation and promote reuse, recycling and reprocessing of waste where possible; and
- the WMP will include the objective of ensuring that any use of local waste management facilities does not exhaust available capacity, nor disadvantage the local community.

6.12 Potential Cumulative Impacts

The SEARs require an assessment of the likely stages of the development commensurate with the level of impact, including any cumulative impacts of the Project and existing or proposed developments.

Cumulative impacts can occur in the context of concurrent construction projects and/or during operations.

6.12.1 Other Developments

The Project is located within a rural area predominantly low intensity grazing. Early consultation with both Inverell and Tenterfield councils and DPI&E's Major Projects website identified the following potential cumulative construction and / operational impacts:

- Concurrent construction projects in the general area include the Sapphire Solar Farm, Sapphire Wind Farm, Sundown Solar Farm and White Rock Solar Farm. The Sapphire Wind Farm and White Rock Solar Farm are constructed. The under construction Sapphire Solar and the proposed, not yet approved Sundown Solar farm are located in closer proximity to Glen Innes. Accommodation for the Bonshaw solar farm project is proposed to be predominately serviced from Inverell, Texas and Tenterfield.
- The issue of accommodation has been discussed with Inverell Shire Council and Inverell Chamber of Commerce. Both organisations indicated a willingness to work with the proponent to ensure workers could be housed within the region and that the Inverell business community could gain the associated benefits of the housing and living spend within the LGA.
- From a traffic perspective, there is little interaction between these projects with the Bonshaw site on the Bruxner Highway (refer Section 6.12.3); and

- Tenterfield Shire Council has also been consulted and initially raised concerns due to the New England Highway Upgrade at Mount Bolivia which was due to continue through 2019. It is likely that the works will be completed or substantially completed by the time the construction of the Bonshaw Solar Farm is commenced thereby providing an additional source of accommodation.

Based on the above it is anticipated that there will be a sufficient local accommodation source for the fluctuating workforce and limited interaction between the Bonshaw Solar Farm project and other nearby current and proposed projects.

6.12.2 Agriculture Production and Land Use

The Project is located on 167 ha of land that is currently used for grazing. The majority of the land in the Development Footprint has been modified by historical land practices and past disturbances associated with land clearing and livestock grazing.

The Development Footprint of 167 ha presents approximately 0.019% of the total land area within the Inverell LGA. Whilst portions of the Development Footprint are mapped as containing BSAL, this represent less than 0.00003% of the total land area mapped as BSAL within NSW.

As part of the Project refinement process, the area within the Development Footprint that is mapped as BSAL has reduced from approximately 86 ha (within the Project Site (allotment) to approximately 58.3 ha within the development Footprint. The utilisation of agricultural land by the Project will result in a temporary negligible reduction in the overall agricultural productivity of the Inverell LGA and the New England / Northern Tablelands region.

Whilst there will some reduction in agricultural utilisation within the Development Footprint, this is mitigated by:

- choice of PV module technology during detailed design to maximise the land available for ongoing grazing;
- ongoing grazing activities during operation of the solar farm;
- site selection and refinement which reduced the total area of BSAL located within the Development Footprint;
- return to agricultural land – the Development Footprint can be returned to agricultural land use at the completion of the Project's operations; and
- Land management practises will avoid or minimise potential impacts to neighbouring agricultural operations that have been identified during engagement with the local community and as part of the LUCRA (Appendix E).

6.12.3 Traffic

Potential cumulative traffic impacts may occur as a result of concurrent construction and or operation of various developments. As stated above, within the Inverell LGA, concurrent construction projects in the general area include the Sapphire Solar Farm, Sapphire Wind Farm, Sundown Solar Farm and White Rock Solar Farm. Consideration of cumulative traffic impacts is detailed below:

Table 6-34 Potential Cumulative Traffic Impacts

Project	Cumulative Construction Impacts	Cumulative Operational Impacts
Sundown Solar (EIS in preparation)	Site located off Gwydir Highway between Inverell and Glen Innes. No overlap with construction along Gwydir Highway. If constructed at same time cumulative impact along New England Highway. As a state highway there is adequate capacity to accommodate these vehicles movements.	Operational traffic would be expected to be less than 10 light vehicles per day in the morning and afternoon and no impact with traffic for Bonshaw Solar Farm site.
Sapphire Solar Farm	Site located off Gwydir Highway and currently under constructed. This site will be fully constructed before the Bonshaw Solar Farm commences construction.	Operational traffic would be expected to be less than 10 light vehicles per day in the morning and afternoon and no impact with traffic for Bonshaw Solar Farm site.
White Rocks Solar Farm	Construction complete.	Operational traffic would be expected to be less than 10 light vehicles per day in the morning and afternoon and no impact with traffic for Bonshaw Solar Farm site.

7. MITIGATION MEASURES

This chapter collates the mitigation measures identified throughout the impact assessment process and wider EIS prepared for the proposed development.

As described in Chapter 6, the environmental assessment identified the environmental and social impacts associated with the Project. Environmental sensitivities and potential impacts have been identified and assessed through the specialist assessments undertaken in support of the EIS.

Environmental management and mitigation measures, including requirements to prepare and issue specific management plans, have been identified to reduce and manage potential environmental impacts arising from the Project. These commitments have been informed by the mitigation measures recommended in the specialist assessments contained in Appendix C to K and summarised in Chapter 6 of this EIS. Table 7-1 provides a summary of the measures identified to avoid, minimise and where necessary, offset the potential environmental impacts associated with the Project.

Table 7-1 Summary of Project Mitigation Measures

Aspect	Mitigation Measure
Biodiversity	**Loss of Species Credit Species Habitat or Individuals** Vegetation clearance: ■ Preparation and implementation of a vegetation clearing protocol as part of a Biodiversity Management Plan. ■ Clearing to be supervised by an experienced fauna catcher / ecologist. ■ Time works to avoid critical life cycle events such as breeding. ■ Monitoring of the hollows prior to removal to avoid impacting any breeding females or juveniles. If Bristle-cased Freetail Bat is confirmed utilising any of the hollow bearing trees, the trees will be left undisturbed and managed in accordance with the Biodiversity Management Plan. ■ Replacement of trees at a rate of 2:1 (i.e. two trees will be planted to replace each hollow bearing tree removed). This results in planting of 68 new trees within the riparian corridor. In the event that a newly-planted tree dies during the lifespan of the solar farm, the client has the responsibility to replace it in order to achieve a 100% recruitment of 68 trees. ■ Nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm ■ No stockpiling or storage within dripline of any mature trees. ■ Approved clearing limits to be clearly delineated with temporary fencing or similar prior to construction commencing. **Grey-crowned Babbler habitat** Nest removal: ■ Approved clearing limits to be clearly delineated with temporary fencing or similar prior to construction commencing. ■ Removal of trees with nests will be included in the vegetation clearing protocol including any seasonal constraints to avoid impacting any juveniles or unfledged chicks. ■ Removal of trees with nests will be supervised by an experienced fauna catcher or ecologist. ■ A portion of felled trees will be salvaged as habitat for fauna and translocated in suitable areas in the remainder of the Project boundary. **Loss of Hollow Bearing Trees** ■ Replacement of trees at a rate of 2:1 (i.e. two trees will be planted to replace each hollow bearing tree removed). This results in planting of 68 new trees within the riparian corridor. In the event that a newly-planted tree dies during the lifespan of the solar farm, the client has the responsibility to replace it in order to achieve a 100% recruitment of 68 trees. ■ nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm.

Aspect	Mitigation Measure
	Impacts of Development on the Habitat of Threatened Species or Ecological Communities ■ A tree replacement and nest box monitoring plan will be prepared for the Project as part of a Biodiversity Management Plan. The plan will provide details of monitoring and Key Performance Indicators (KPIs) to ensure objectives of tree replacement and nest box monitoring is achieved. ■ Monitoring and reporting to be undertaken by a qualified ecologist. Avoidance of use of chemicals, such as pesticides and herbicides, within the solar farm during the construction and operational phases to prevent contributing to the global decline in insect population and diversity. ■ Facilitation natural revegetation of native ground cover within viable solar farm footprint (e.g. under solar panel arrays) and in retained areas. This will include management of weeds. **Impacts of Development on Water Quality, Water Bodies and Hydrological Processes that sustain Threatened Species and TECs** ■ An erosion and sediment control plan (ESCP) would be prepared in conjunction with the final design and implemented. ■ Design of creek crossings to meet best practice industry standards. ■ ESCP to include requirements for water quality monitoring, chemical use and control. **Impacts of Vehicle Strikes on Threatened Species of animals or on animals that are part of a TEC** Actions to minimize mortality of wildlife involved in vehicle strikes: ■ Reduced vehicle speeds and signage to be installed within the solar farm. ■ Protocol detailing actions to be undertaken in the event of a vehicle strike . ■ Identification of a wildlife veterinary and/or wildlife carer group and agreement for injured wildlife to be taken care of or being humanely euthanized. **General** ■ Avoid night works. ■ Direct lights away from retained native vegetation. **Invasive Species** ■ CEMP will include a management protocol for declared priority weeds under the *Biosecurity Act 2015* during and after construction. ■ Hygiene protocols to prevent the spread of weeds or pathogens between infected areas and uninfected areas. Monitoring and management protocol for invasive feral /pest species, including cats, foxes and cane tods.

Aspect	Mitigation Measure
Heritage	**Aboriginal Heritage** Based on the information presented in this report the following general recommendations have been developed: ■ personnel involved with ground breaking activities in the Project Site should undertake cultural awareness training in line with the recommendations provided in the CHA (refer to Appendix D); ■ during works, the location of all recorded Aboriginal heritage sites should be clearly marked on all construction plans for the Project and site foremen informed of their presence and the need to avoid disturbance; ■ if suspected Aboriginal heritage objects are found during works, the Unexpected Find Procedure outlined below should be followed and applies to the entire Project Site; ■ Ongoing consultation with the Aboriginal community and registered Aboriginal stakeholders for the Project should occur during the construction of the Project. The triggers for consultation with the community during construction may include: - Any additional heritage assessments for changes in the Project scope; - The implementation of the Unexpected Finds Procedure; and - Endorsement of the heritage information to be contained in the Project induction material. ■ Relocation and salvage of any and all Aboriginal artefacts where impacts cannot be avoided. **Historic Heritage** While the historic items identified during the this assessment have been assessed as not meeting the threshold for local historic heritage significance, the items at these sites should be carefully collected and offered to a local heritage museum or organisation prior to commencement of Project works. Should suspected historic heritage objects be found during works, the Unexpected Find Procedure outlined below should be followed and applies to the entire Project Site. **Unexpected Finds Procedure** If any heritage objects and/or relics, as protected under NSW legislation, are uncovered during the Project, then the following steps should be followed: ■ all activity in the immediate area should cease; ■ an appropriately qualified heritage professional should be consulted; ■ OEH should be immediately contacted; and ■ an appropriately qualified heritage professional should record the location and attributes of the site and determine the significance of the find. In the event of the discovery of human skeletal material (or suspected human skeletal material) during project activities in the Project Site the following steps should be followed: ■ all activities and/or works in the immediate area must cease; ■ the NSW Police must be contacted along with the OEH; and

Aspect	Mitigation Measure
	■ any sand/soils removed from the near vicinity of the find must be identified and set aside for assessment by the investigating authorities.
Land	The following mitigation measures are to be implemented to manage land use and soils during construction and operation: ■ prepare a detailed Soil and Water Management Plan (SWMP) prior to construction commencing. The SWMP should be prepared by a suitably qualified person; ■ prepare progressive Erosion and Sediment Control Plans as the Project progresses to address management requirements at individual work sites/specific activities; ■ employ dust management measures during construction activities; ■ design and construct the Project to minimise land disturbance and therefore reduce the erosion hazard; ■ stage construction activities to minimise the duration and extent of land disturbance; ■ divert upslope (clean) stormwater around the disturbed sites and capture sediment-laden run-off from within the disturbed site for diversion to sediment control devices; ■ regularly inspect and maintain erosion and sediment control devices for the duration of the Project (at intervals outlined in the SWMP); and ■ minimise disturbance during construction by using existing access tracks and roads until proposed final designs are implemented; ■ detailed design to minimise potential for negative impact to underlying vegetation from panel shading; ■ actively manage grazing practices to prevent loss of ground cover and subsequent potential for erosion; ■ avoid disturbance to existing contour banks and level spreaders on-site and ensure they are considered in the detailed design; ■ Adopt relevant management strategies outlined in LUCRA into CEMP to ensure activities with an identified potential conflict are properly managed; and ■ Monitoring of management strategy implementation through their alignment with the identified performance targets. **Contamination** ■ develop an unexpected contamination find procedure and include in the soil and water management plan to be developed prior to the commencement of construction activities. ■ ensure appropriate procedures are in place for the transport, storage and handling of fuels, oils and other hazardous substances, including availability of spill clean-up kits; **Soil Management** ■ topsoil and subsoils are to be separated during excavation activities and returned in original order. ■ manage topsoil resources to minimise the risk of erosion and sedimentation, and maximise reuse of topsoil during rehabilitation;

Aspect	Mitigation Measure
	■ where excavation activities are required, soil testing at 0-30cm and 30-100cm will be undertaken during the geotechnical investigation phase or prior to construction to determine if ameliorants are to be added to soils to address fertility/soil chemistry issues. ■ progressive revegetation of disturbed areas should be undertaken where practicable throughout the construction.
Visual	■ the landscape mitigation measures are proposed along the Bruxner Highway frontage and for 400 m along the north-western boundary adjacent to the Transgrid Dumaresq Substation access road and take in the rural landscape setting. ■ These mitigation measures include a 10 metre setback to solar farm infrastructure that includes a 5 metre landscape strip between the property boundary and Project fencing, with a perimeter access track between the fence and solar farm infrastructure (refer to Figure 6-13 below). The proposed landscaping treatment will utilise native species endemic to the area that will survive the climatic conditions and require minimal maintenance, while filtering the visual impact of the solar farm. ■ No mitigation for glare is required.
Air Quality	■ employ dust management measures during construction activities; ■ watering or covering exposed areas; ■ works are not to be carried out during strong winds or in weather conditions where high levels of dust or airborne particulates are likely; ■ vehicles transporting waste or other materials that may produce odours or dust are to be covered during transportation; ■ stockpiles or areas that may generate dust are to be managed to suppress dust emissions where possible; and ■ any exposed areas are to be reinstated with fast growing local provenance grasses.
Noise	**Construction** ■ Noise generating work and activities should be limited to the ICNG, 2009 recommended standard hours (i.e. 7 AM to 6 PM Monday to Friday and 8 AM to 1 PM Saturdays), with no work on Sundays or public holidays. Any unforeseen work that is required outside the recommended standard hours must be suitably mitigated and managed with a goal of achieving inaudible noise levels at all residential receptors, or undertaken with agreement from the appropriate consent authority and any potentially affected neighbours. ■ Where unforeseen works will occur close to a receptor, and these works are anticipated to generate high levels of noise e.g. > 75 dBA, potential respite periods, e.g. three hours of work, followed by one hour of respite should be applied. Respite should be implemented if it is the preference of the affected receptor/s and if they are feasible and reasonable, and practical, to implement during the works. In some circumstances respite may extend the duration of works and inadvertently increase noise impacts; hence due care should be taken when considering this management measure. ■ During the construction design, choose appropriate plant, equipment and/or machinery for each task and adopt efficient work practices to minimise the total construction period and the number of noise sources on the site. Select the quietest item of plant, equipment and machinery available where options that suit the design permit. ■ During the works, avoid unnecessary noise due to idling diesel engines, and fast engine speeds when equipment can be powered down and/or lower speeds are sufficient.

Aspect	Mitigation Measure
	■ During the works, instruct drivers to travel directly to the site and avoid any extended periods of engine idling at or near residential areas, especially at night. ■ During the works, ensure all plant, equipment and/or machinery used on the site are in good condition, with particular emphasis on exhaust silencers, covers on engines and transmissions and squeaking or rattling components. Excessively noisy machines should be repaired or removed from the site. ■ During the works, ensure that all plant, equipment and vehicles movements are optimised in a forward direction to avoid triggering motion alarms that are typically required when these items are used in reverse. Where it is possible tonal motion alarms should be replaced with broadband “squash duck” motion alarms. ■ If any unforeseen night works must occur, all activities with the potential to generate obtrusive noise should be avoided. These types of events are particularly annoying; especially at night and have the limited potential to generate sleep disturbance or awakening impacts. Any impulsive or transient noise events expected to exceed the sleep disturbance criteria at residential receptors should be strictly avoided at night. ■ If any validated noise complaints are received, operator attended noise validation and compliance measurements should be undertaken to measure and compare the site noise level contributions to a) the predicted values; and b) the NMLs presented in this report. All site noise levels should be measured in the absence of any influential source not associated with the Project. If the measured site noise levels are below the predicted values and comply with the NMLs presented in this report, no further mitigation or management measures are required. If the measured site noise levels are above the predicted noise levels or NML presented in this report, further mitigation and/or management measures should be considered. **Operation** All predicted Leq, 15 minute (dBA) noise levels for the proposed project operations are below the PNTL at all the identified residential receptors and are compliant with the NPI, 2017 for the day, evening and night-time periods. As such no recommendations for noise mitigation, management measures or monitoring options are warranted, however suitable safeguards and provisions have been provided below. **Provisions and Safeguards:** Given that operational compliance has been attained with the assumption that the Inverters/ Transformers will achieve individual LW of 92 dBA and Panel Tracking Motors will achieve individual LW of 78 dBA, the following safeguards and provisions are provided. ■ During equipment procurement, ensure that the inverters/transformers will achieve individual LW of 92 dBA and panel tracking motors will achieve individual operational LW of 78 dBA. ■ If any validated noise complaints are received, operator attended noise validation, and compliance measurements should be undertaken to measure and compare the site noise level contributions to a) the predicted values; and b) the PNTLs presented in this report: ■ All site noise levels should be measured in the absence of any influential source not associated with the Project; ■ If the measured site noise levels are below the predicted values and comply with the PNTLs presented in this report, no further mitigation or management measures are required; and ■ If the measured site noise levels are above the predicted noise levels or PNTLs presented in this report, further mitigation and/or management measures should be considered.

Aspect		Mitigation Measure
Transport		■ Provide a temporary Traffic Control Plan (TCP) on the site frontage on the Bruxner Highway, adjacent to the site access, for construction work associated with upgrading the access and for traffic entering and exiting the site; ■ A Traffic Control Plan will be in place during Project construction work to ensure safety for road users and construction workers is managed in an appropriate manner. ■ Provide regular community updates for residents along the Bruxner Highway in the vicinity of the site to advise of construction activities and increased heavy vehicle movements along this road; ■ Preparation of a Construction Traffic Management Plan (CTMP); ■ The intersection of Bruxner Hwy and New England Hwy causes a hazard for trucks returning southbound. It is proposed that the CTMP will include an alternative route, being that trucks are not to turn right (south) at this intersection. Rather, trucks leaving the site heading southbound utilise the Bonshaw-Inverell Road access route; ■ Construction vehicle movement on internal roads could lead to dust generation. A water truck will be used for dust suppression to minimise the production of dust, with the amount of water spreading adjusted accordingly to respond to the conditions. ■ Any significant deposits of dirt and other construction materials will be promptly removed from public roadways; ■ All drivers associated with the Project construction work will adhere to the road rules as applicable and will be advised of the school bus operation on the Bruxner Highway; ■ The residents along the Bruxner Highway will be notified in writing of the construction works and the activities as required; ■ A protocol will be provided for both undertaking dilapidation surveys and making any necessary repairs to the road pavement following construction to Bruxner Highway to within 200 metres to both sides of the site access; and ■ Emergency repairs to road pavement will be made in accordance with the relevant authority standard.
Water		■ Investigate alternative water sources to limit the use of potable water if reasonably practicable; ■ Where practicable, utilise polymers to limit the requirements for dust suppression requirements; ■ The road crossings over the minor watercourses in the Project Site will be designed to minimise interruptions to flows; and ■ The design of the Development Footprint includes the provision of a 40 m buffer from infrastructure to the top of creek banks, and to minimise the number of waterway crossings required to the greatest extent practicable.
Hazards and Risks	Hazardous Materials	With consideration of the insignificant quantity of materials stored on site, along with the significant distance to neighbouring properties, it can be concluded that the risks associated with storage and transportation of hazardous materials are unlikely to be significant or pose a risk to public safety. Potentially offensive impacts have been previously assessed as minimal, and are to be managed as specified within relevant technical reports and as outlined within Chapter 7.

Aspect		Mitigation Measure
	Bushfire	A minimum 10m wide APZ is to be established around the perimeter of the solar farm and around the control room, electricity compounds and substations. The specifications recommended for the APZ are: ■ mineral earth fire break i.e. dirt or gravel. ■ no trees and shrubs planted within the APZ. ■ 6m wide perimeter access track can be located within this 10m wide APZ. Should construction of the solar farm take place between 1 December and 31 March (increased fire weather), the following measures are recommended to control the risk of grass fire ignitions: ■ Ensure that appropriate permits have been issued for work during the Fire Danger Period, and that any conditions on permits are adhered to; ■ Adhere to restrictions on Total Fire Ban or days of high fire danger; ■ Carry fire extinguishers or firefighting equipment in vehicles; ■ Carry emergency communications equipment; ■ Ensure vehicles keep to tracks whenever possible; ■ Restrict smoking to prescribed areas, and provide suitable ash and butt disposal facilities; ■ the APZ and perimeter road must be constructed as the first stage of development; ■ all plant, vehicles and earth moving machinery are cleaned of any accumulated flammable material (e.g. soil and vegetation); ■ suitable fire fighting equipment (specific requirements to be confirmed in consultation with RFS) is present on site with at least two personnel trained in bushfire fighting; ■ on days when Very High fire danger or worse is forecast, the “fires near me’ app is to be checked hourly for the occurrence of any fires likely to threaten the site; and ■ all operations involving earth moving equipment, vehicles, slashers and hot works (e.g. grinders, welders) cease while the Grassfire Danger Index (GFDI) is or forecast to be 35 or greater (Rural Fire Service 2018). The perimeter road and site access points must be constructed as the first stage of development. One main entry/exit point to the Bruxner Highway to the north and an additional two access points on the western and southern boundaries of the site must be maintained for the life of the Project. Maintain minimal fuel load by grazing, slashing or mowing. Continued grazing is recommended within the Bonshaw Project Site to ensure that grass is maintained below 100mm high. No vegetation within the Substation or within the 10m wide APZ. Suspend site maintenance operations when GFDI >=35. Emergency Response Plan prepared and stored at ‘Emergency Information Cabinet’ at main entrance to solar farm and provided to local emergency responders. The ERP must include: ■ a safe method of shutting down and isolating the PV system;

Aspect		**Mitigation Measure**
		■ control and coordination arrangements for emergency response (eg evacuation procedures, emergency assembly areas and procedures for response to hazards); ■ agreed roles and responsibilities of on-site personnel (eg equipment isolation, liaison, evacuation management); ■ up-to-date contact details of site personnel and any relevant off-site personnel who could provide technical support during an emergency; ■ a manifest (and safety data sheets) for any battery, diesel or other dangerous goods storage/handling, including the class identification, quantity, type (bulk or packaged) and location. Appropriate material (including absorbent, neutralisers, equipment and personal protective equipment) for the clean-up of spills is to be provided and available on-site; ■ clearly states work health safety risks and procedures to be followed by fire-fighters, including personal protective clothing; ■ minimum level of respiratory protection; ■ minimum evacuation zone distances; ■ activation of water spray/foam systems and any other response/protection measures; and ■ any other risk control measures required to be followed by fire-fighters. A schedule for ongoing site familiarisation to account for changing personnel, site infrastructure and hazards should be developed in conjunction with the local RFS. Shield all heat sensitive components from potential flame contact. Design should consider the following features: ■ burial of cables underground; ■ shielding of above ground cables (e.g. metal conduit). Water supply should be designed to provide filling points for fire tanker units near the solar farm entrance only as internal access may not be possible. A storage of 50,000 litres is recommended, based on refilling six tanker units (4,000 litres) twice each although the required capacity will be confirmed in consultation with RFS.
	Electromagnetic Fields	All designs will be in accordance with the Guidelines for limiting exposure to Time varying Electric, Magnetic and Electromagnetic Fields (ICNIRP, 1998; ICNIRP, 2010b) and relevant codes and industry best practice standards in Australia. All relevant procedures in relation to a high voltage installation will be adhered to throughout the life of the Project. The security system for the site, including safety fencing and closure of gates, will be maintained throughout the construction and operation, to provide safe exposure distances to the public. Public access to the site will be restricted throughout the life of the Project.
Socio-Economic		The following mitigation measures are to be implemented to manage possible socioeconomic impacts during construction and operation: ■ ongoing use of the Project Site for livestock grazing during operation (dual use), to mitigate the potential loss of strategic agricultural land; ■ a Traffic Control Plan will be developed to manage the impacts to local traffic along Bruxner Highway during the construction of the Site access road;

Aspect	Mitigation Measure
	■ a suitable Community Benefit Fund will be provided, in consultation with Council, to address the adverse impacts caused to the local community through the Project's lifetime; ■ the Project will adopt a 'buy local' principle to enhance positive outcomes for the local community. This will include in an attempt to involve local contractors and businesses to ensure benefits to the local industries are realised; ■ the 'buy local' principle will also be practiced for the purchasing of goods and services, dependent on their relative competiveness in terms of price and quality; and ■ the accommodation needs of the construction workforce will be sourced locally, to generate large economic gain for local businesses and industries, particularly the increased demand for accommodation, hospitality and retail services.
Waste	A Waste Management Plan (WMP) will detail all appropriate measures to be incorporated, in order to avoid potential contamination to land and water, and human and wildlife health impacts. Specific measures to be included in the WMP would include the following: ■ packaging waste is expected from loads transporting materials to the Site. The packaging waste is to be removed and taken to a waste facility on the truck's return trip, or otherwise managed through local waste treatment to be outlined in the WMP; ■ separation of recyclable and non-recyclable materials will take place where possible and be stored in designated receptacles; ■ waste receptacles will be collected on a regular basis by licensed contractors or Council collection service and transported for off-site disposal at an appropriately licenced landfill or recycling facility; ■ all waste disposal will be in accordance with the POEO Act and *Waste Classification Guidelines* (EPA, 2014); ■ waste tracking will occur for any types and quantities of waste that trigger the requirement for tracking; ■ waste management measures will be incorporated into the site Construction and Operation Environmental Management Plan, which will outline measures to avoid waste generation and promote reuse, recycling and reprocessing of waste where possible; and ■ the WMP will include the objective of ensuring that any use of local waste management facilities does not exhaust available capacity, nor disadvantage the local community.

8. EVALUATION AND CONCLUSION

8.1 Strategic Need

The Project would generate 420 GWh of electricity contributed to the NEM. The Project will assist the Commonwealth and NSW Government in reaching the reduction targets of the RET and REAP respectively. In doing so, the Project will:

- provide a source of renewable energy to supplement NSW and National energy requirements and assist in reducing greenhouse gas (GHG) emissions;
- contribute to the additional generating capacity required to meet the growing energy demand in NSW;
- contribute to NSW and Commonwealth targets for renewable energy;
- be consistent with land use zoning and permissibility under relevant legislative provisions;
- provide additional income stream for the involved landholder and diversity of land use;
- provide both direct and indirect employment opportunities during construction and operation for both the Inverell and Tenterfield LGAs, thus creating economic stimulus and support to rural communities;
- liaise and work with the community and all potentially affected stakeholders in the identification, mitigation and / or monitoring of any potential environmental effects;
- ensure quality, safety and environmental standards are maintained;
- recycle and reuse material where practical and economically feasible; and
- minimise all potential and adverse environmental impacts and where practical, maximise all potential positive environmental effects.

8.2 Development Design

During Project scoping and preliminary investigation, as well as during further detailed technical investigations as part of the EIS, site selection and refinement has occurred on the basis of environmental constraints and opportunities analysis, stakeholder engagement and project conceptual design considerations. This ensured a Project Site and Development Footprint were selected that gave due consideration to and minimisation of environmental impacts whilst achieving a feasible and efficient Project concept design and Development Footprint. The process has sought to actively identify and minimise environmental impacts as part of Project development.

During detailed design and prior to the commencement of construction, it is anticipated that the placement of infrastructure and extent of construction activities described in Section 2.4 will be further refined to ensure avoidance and minimisation objectives are met.

8.3 Environmental and Socio-Economic Impacts

8.3.1 Environmental

Biodiversity:

- A total of 143 flora species in 47 families were recorded within the assessment area. This included a total of 111 native (78 %) and 32 exotic (22 %) species. No threatened flora species were recorded within the Development Footprint. Vegetation within the Development Footprint includes cleared land and native vegetation within three plant community types (PCT) at differing conditions. None of the PCTs present within the Development Footprint correspond to listed Threatened Ecological Communities.

A total of 75 fauna species were recorded across the Development Footprint, including eleven threatened species. Threatened species included eight vulnerable microchiropteran bats (Little Pied Bat, Eastern Bent-wing Bat, Corben's Long-eared Bat, Yellow-bellied Sheath-tailed Bat, Eastern Cave Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Hoary Wattled Bat), one endangered microchiropteran bat (Bristle-faced Free-tailed bat), one vulnerable bird (Grey-crowned Babbler) and one migratory bird (Cicadabird). Out of the eight Vulnerable microchiropteran bats, six were definite call identifications and two (Greater Broad-nosed Bat and Hoary Wattled Bat) were potential calls.

- Through continued detailed design the Project will avoid the following areas of high biodiversity value:
- Avoid the large areas of intact vegetation communities within the eastern and south eastern portion of the Project Site;
- Avoid all areas mapped as TEC;
- Avoidance of five rocky areas;
- Retention of the second and third order streams

Heritage

35 Aboriginal heritage sites (and three associated Potential Archaeological Deposits) have been recorded within the Project Site (ERM 2019b). 29 of these sites were stone artefacts including isolated finds and stone artefact scatters. Seven scarred trees were also identified. Careful detailed design of the Project footprint has successfully avoided several of these sites and they will be retained and protected from any direct and/or indirect impacts.

Land use and Agriculture

Within the Project Site, approximately 86 ha of Biophysical Strategic Agriculture Land (BSAL) mapped area was likely to be affected, as defined by Strategic Regional Land Use Policy (SRLUP) of the New England North West Region. Where possible, GAIA have designed the solar layout with consideration to minimise the impacts on BSAL land. Consequently, the Development Footprint and solar array has been amended to include only 58.3 ha of the BSAL area, a 33% reduction, to significantly reduce impacts to this strategic area.

To minimise the negative impacts caused through loss of agricultural land use, the site will continue to be utilised for sheep grazing following construction.

Visual

The Visual Impact Assessment has identified that other than for a location immediately north of the site on the Bruxner Highway, all visual impacts are **low to none**. The impact from the Bruxner Highway is deemed as **medium to low** impact, however given the short frontage and period of time the facility is seen, the low traffic volumes along this route and the setback from the road means that the overall impacts from this locality are localised and therefore low. The provision of five meter landscape strip along the northern and a 400 m portion of the north-western boundaries will reduce visual impacts from the Bruxner Highway. No glare impacts are predicted and therefore no mitigation measures are required for glare.

Noise

The acoustic assessment identified that construction noise levels have the potential to exceed the applicable criteria, limits and thresholds, however these levels can be mitigated and / or minimised with the successful implementation of recommended noise mitigation measures. The recommendations will assist to ensure that any residual impacts to the closest and/or potentially most affected receptors, and the broader community is minimised as far as is practically achievable.

Based on the predicted operational compliance and anticipated negligible impact to all receptors a set of suitable safeguards and provisions were provided.

Transport

The Project is serviced by ready access to the Bruxner Highway and New England Highway to the east. The Traffic Impact Assessment concluded that the construction traffic can safely and efficiently access the site with minimal impact for existing road users. The management plan for the construction traffic access ensures that the trucks accessing the site shall have an acceptable impact on the road network and safety concerns at the intersection of the Bruxner Highway and the New England Highway are address through the drivers code of conduct. Once operational, the traffic demands are minimal and shall have little impact upon the local road network

Water

The Project will minimise impacts to watercourse by creating an offset from the riparian corridor. The riparian zone will be surveyed prior to detailed designed to ensure the Development Footprint is offset and outside third order and higher riparian corridors.

Hazards and Risks

The Project includes small quantities for hazardous materials, to be sorted within the south western portion of the Site. There is a considerable distance to neighbouring stakeholders. The SEPP 33 assessment concluded that the storage and transportation of hazardous materials are unlikely to be significant pose a risk to public safety.

Topography

The Project site is dominated by a gently undulating landscape to the north, forming steep slopes to the south and east dissected by second and third order streams. Based on a review of topographic maps and aerial imagery, landforms present within the Subject Land include drainage depressions, gentle to steeply inclining slopes, and upper flat ridges. The elevation at the Bruxner Highway (north boundary) is approximately 335 m and rises up to approximately 420 m in the south-western portion of the site. The ridgelines to the south of the Project rise up to approximately 660 m forming the dominant landscape feature.

The Development Footprint has avoided areas of steep and rocky terrain within the eastern and south eastern portion of the site.

8.3.2 Socio-Economic

The Project will positively contribute to the local and wider community through the creation of approximately 190 full-time equivalent jobs during the 9-12 month construction period, and up to 10 permanent jobs during operation. The accommodation needs of the construction workforce will be sourced in the surrounding towns of Texas, Ashford and Tenterfield. Considering the remote setting of the Project, the majority of the workforce accommodation will need to be spread across a larger area, rather than in the immediate vicinity as typically viable for developments located in more urbanised areas.

There will be an overall positive impact through diversification of local industry types as a result of increased demand for local goods and services throughout the Inverell LGA and western portions of the neighbouring Tenterfield LGA. These benefits will include demand for local contracting and manufacturing services utilised during construction such as earthworks, cabling and civil works. Where possible, GAIA will adopt the ‘buy local’ principle in an attempt to involve local contractors and businesses to ensure benefits to the local industries are realised. This ‘buy local’ principle will be practiced for the purchasing of goods and services, dependent on their relative competiveness in terms of price and quality.

There is a broader socioeconomic and environmental advantage of the Project through further development of renewable energy sources, utilising the abundant solar resources available in NSW and transitioning to a more diverse energy generation. The Project will also support the Commonwealth and NSW governments in achieving their respective renewable energy and greenhouse gas (GHG) emission reduction targets.

8.4 Conclusion

The Project involves the operation of a 200MW solar PV electricity generation facility, which would generate electricity and contributed to the National Electricity Market (NEM). The Project will assist the Commonwealth and NSW Government in reaching the reduction targets of the RET and REAP respectively, through an increase in renewable energy supply and reduction in carbon emissions.

The Project offers significant NSW investment, with a Capital Investment Value (CIV) of $237,680,000 and offering employment of up to 190 full time equivalent (FTE) persons during construction, and up to 10 FTE persons during operations.

The Project is considered to be justified and in the public interest as:

- it is generally consistent with the objects of the EP&A Act and will enable the orderly and logical use of natural, physical and human resources existing within the local area and greater New England North West region;
- it is consistent with the principal of inter-generational equity. It will contribute to the sustainable transition to cleaner energy generation and following decommissioning, the land can return to agricultural production;
- it is suitably located in a region of NSW that experiences one of the highest daily average solar exposures in the State;
- it is in close proximity to existing infrastructure with adequate capacity;
- the utility of the land is further enhanced by the opportunity for the Site to continue with its current land use during operation;
- the Project Site and Development Footprint have been selected with due consideration to and minimisation of environmental impacts whilst achieving a feasible and efficient Project concept design. This process has actively identified and minimised environmental impacts for the Project development and will not result in a significant environmental impact.
- the socioeconomic benefits of the Project, including direct and indirect employment and diversification of local industry types; and
- once operations have ceased the site will be rehabilitated with the removal of infrastructure;
- Environmental management and mitigation measures are to be implemented including requirements to prepare and issue specific management plans to reduce and manage potential environmental impacts arising from the Project;
- The proposal of the Bonshaw Solar Farm represents a positive and sustainable planning outcome for the Site.

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APPENDIX A SEARS

Environmental Assessment Requirements

State Significant Development

Section 4.12(8) and 4.12(9) of the *Environmental Planning and Assessment Act 1979 and* Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*

Application Number	SSD 9438
Proposal	Bonshaw Solar Farm which includes: • the construction and operation of a solar photovoltaic (PV) generation facility with an estimated capacity of 500 MW; and • associated infrastructure, including a grid connection and battery storage with 500 MWh capacity.
Location	Approximately 16 km south of Bonshaw, between the Bruxner Highway, Glenrock Road and Rocky Creek Road in the Inverell Shire Council local government area.
Applicant	Gaia Australia
Date of Issue	16 August 2018
General Requirements	The Environmental Impact Statement (EIS) for the development must comply with the requirements in Schedule 2 of the *Environmental Planning and Assessment Regulation 2000.* In particular, the EIS must include: • a stand-alone executive summary; • a full description of the development, including: – details of construction, operation and decommissioning; – a site plan showing all infrastructure and facilities (including any infrastructure that would be required for the development, but the subject of a separate approvals process); – a detailed constraints map identifying the key environmental and other land use constraints that have informed the final design of the development; • a strategic justification of the development focusing on site selection and the suitability of the proposed site with respect to potential land use conflicts with existing and future surrounding land uses (including other proposed or approved solar farms, rural residential development and subdivision potential); • an assessment of the likely impacts of the development on the environment, focusing on the specific issues identified below, including: – a description of the existing environment likely to be affected by the development; – an assessment of the likely impacts of all stages of the development, (which is commensurate with the level of impact), including any cumulative impacts of the site and existing or proposed developments, taking into consideration any relevant legislation, environmental planning instruments, guidelines, policies, plans and industry codes of practice; – a description of the measures that would be implemented to avoid, mitigate and/or offset the impacts of the development (including draft management plans for specific issues as identified below); and – a description of the measures that would be implemented to monitor and report on the environmental performance of the development; • a consolidated summary of all the proposed environmental management and monitoring measures, identifying all the commitments in the EIS; and • the reasons why the development should be approved having regard to: – relevant matters for consideration under the *Environmental Planning and Assessment Act 1979*, including the objects of the Act and how the principles of ecologically sustainable development have been

	incorporated in the design, construction and ongoing operations of the development; – the suitability of the site with respect to potential land use conflicts with existing and future surrounding land uses; and – feasible alternatives to the development (and its key components), including the consequences of not carrying out the development. • a detailed consideration of the capability of the project to contribute to the security and reliability of the electricity system in the National Electricity Market, having regard to local system conditions and the Department's guidance on the matter. The EIS must also be accompanied by a report from a suitably qualified person providing: – a detailed calculation of the capital investment value (CIV) (as defined in clause 3 of the Regulation) of the proposal, including details of all assumptions and components from which the CIV calculation is derived; and – certification that the information provided is accurate at the date of preparation. The development application must be accompanied by the consent in writing of the owner/s of the land (as required in clause 49(1)(b) of the Regulation).
Specific Issues	The EIS must address the following specific issues: • **Biodiversity** – including: – an assessment of the biodiversity values and the likely biodiversity impacts of the project in accordance with Section 7.9 of the *Biodiversity Conservation Act 2016* (NSW), the Biodiversity Assessment Method (BAM) and documented in a Biodiversity Development Assessment Report (BDAR), unless OEH and DPE determine that the proposed development is not likely to have any significant impacts on biodiversity values; – the BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the BAM; and – an assessment of the likely impacts on listed aquatic threatened species, populations or ecological communities, scheduled under the *Fisheries Management Act 1994*, and a description of the measures to minimise and rehabilitate impacts; • **Heritage** – including an assessment of the likely Aboriginal and historic heritage (cultural and archaeological) impacts of the development, including consultation with the local Aboriginal community in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents*; • **Land** – including: - an assessment of the potential impacts of the development on existing land uses on the site and adjacent land, including: o a consideration of agricultural land, flood prone land, Crown lands (including Crown Reserve 91645), mining, mineral or petroleum rights; o a soil survey to determine the soil characteristics and consider the potential for erosion to occur; and o a cumulative impact assessment of nearby developments; - an assessment of the compatibility of the development with existing land uses, during construction, operation and after decommissioning, including: o consideration of the zoning provisions applying to the land, including subdivision, and; o completion of a Land Use Conflict Risk Assessment in accordance with the Department of Industry's *Land Use Conflict Risk Assessment Guide*; and

  - a description of measures that would be implemented to remediate the land following decommissioning in accordance with *State Environmental Planning Policy No 55 - Remediation of Land.*

- **Visual** – including an assessment of the likely visual impacts of the development (including any glare, reflectivity and night lighting) on surrounding residences, scenic or significant vistas, air traffic and road corridors in the public domain, including a draft landscaping plan for on-site perimeter planting, with evidence it has been developed in consultation with affected landowners;

- **Noise** – including an assessment of the construction noise impacts of the development in accordance with the *Interim Construction Noise Guideline* (ICNG), and cumulative noise impacts (considering other developments in the area), and a draft noise management plan if the assessment shows construction noise is likely to exceed applicable criteria;

- **Transport** – including:
  - an assessment of the peak and average traffic generation, including over-dimensional vehicles and construction worker transportation;
  - an assessment of the likely transport impacts to the site access route (including Bruxner Highway, Glenrock Road and Rocky Creek Road), site access point, rail safety issues, any Crown land, particularly in relation to the capacity and condition of the roads;
  - a cumulative impact assessment of traffic from nearby developments (including cumulative impacts from Sundown Solar Farm, Sapphire Solar Farm and White Rock Solar Farm);
  - a description of any proposed road upgrades developed in consultation with the relevant road and rail authorities (if required); and
  - a description of the measures that would be implemented to mitigate any transport impacts during construction;

- **Water** – including:
  - an assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources (including Beady River, Little Oaky Creek, Little Limestone Creek and Dumaresq River, drainage channels, wetlands, riparian land, farm dams, groundwater dependent ecosystems and acid sulfate soils), related infrastructure, adjacent licensed water users and basic landholder rights, and measures proposed to monitor, reduce and mitigate these impacts;
  - details of water requirements and supply arrangements for construction and operation; and
  - a description of the erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with *Managing Urban Stormwater: Soils & Construction* (Landcom 2004);

- **Hazards and Risks** – including:
  - a preliminary risk screening in accordance with *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development* and *Applying SEPP 33* (DoP, 2011), and if the preliminary risk screening indicates the development is "potentially hazardous", a Preliminary Hazard Analysis (PHA) must be prepared in accordance with *Hazard Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis (*DoP, 2011) and *Multi-Level Risk Assessment* (DoP, 2011); and
  - an assessment of all potential hazards and risks including but not limited to bushfires, spontaneous ignition, electromagnetic fields or the proposed grid connection infrastructure; and

- **Socio-Economic** – including an assessment of the likely impacts on the local community and a consideration of the construction workforce accommodation.

Consultation	During the preparation of the EIS, you should consult with relevant local, State or Commonwealth Government authorities, infrastructure and service providers, community groups, affected landowners, exploration licence holders, quarry operators and mineral title holders. In particular, you must undertake detailed consultation with affected landowners surrounding the development and Inverell Shire Council. The EIS must describe the consultation process and the issues raised, and identify where the design of the development has been amended in response to these issues. Where amendments have not been made to address an issue, a short explanation should be provided.
Further consultation after 2 years	If you do not lodge a development application and EIS for the development within 2 years of the issue date of these EARs, you must consult further with the Secretary in relation to the preparation of the EIS.
References	The assessment of the key issues listed above must take into account relevant guidelines, policies, and plans as identified. While not exhaustive, the following attachment contains a list of some of the guidelines, policies, and plans that may be relevant to the environmental assessment of this proposal.

ATTACHMENT 1

Environmental Planning Instruments, Policies, Guidelines & Plans

Biodiversity	
	Biodiversity Assessment Method (OEH)
	Threatened Species Assessment Guidelines - Assessment of Significance (OEH)
	Biosecurity Act 2015
	Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (DPI)
	Policy and Guidelines for Fish Habitat Conservation and Management (DPI)
	Fisheries Management Act 1994
Heritage	
	Aboriginal Cultural Heritage Consultation Requirements for Proponents (OEH)
	Code of Practice for Archaeological Investigations of Objects in NSW (OEH)
	Guide to investigating, assessing and reporting on aboriginal cultural heritage in NSW (OEH).
	NSW Heritage Manual (OEH)
Land	
	Primefact 1063: Infrastructure proposals on rural land (DPI)
	Establishing the social licence to operate large scale solar facilities in Australia: insights from social research for industry (ARENA)
	Local Land Services Act 2013
	Australian Soil and Land Survey Handbook (CSIRO)
	Guidelines for Surveying Soil and Land Resources (CSIRO)
	The land and soil capability assessment scheme: second approximation (OEH)
	Land Use Conflict Risk Assessment Guide (DoI – L&W)
Noise	
	NSW Noise Policy for Industry (EPA)
	Interim Construction Noise Guideline (EPA)
	NSW Road Noise Policy (EPA)
Light	
	Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring (DPE)
Transport	
	Guide to Traffic Generating Developments (RTA)
	Austroads Guide to Road Design & relevant Australian Standards
	Austroads Guide to Traffic Management Part 12: Traffic Impacts of Development
Water	
	Managing Urban Stormwater: Soils & Construction (Landcom)
	Floodplain Development Manual (OEH)
	Guidelines for Controlled Activities on Waterfront Land (DPI Water)
	Water Sharing Plans (DPI Water)
	Floodplain Management Plan (DPI Water)
	Guidelines for Watercourse Crossings on Waterfront Land (DPI Water)
Hazards and Risks	
	Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis (DPE)
	Multi-Level Risk Assessment (DPE)
Waste	
	Waste Classification Guidelines (EPA)
Electromagnetic Interference	
	ICNIRP Guidelines for limiting exposure to Time-varying Electric, Magnetic and Electromagnetic Fields

Environmental Planning Instruments

State Environmental Planning Policy (State and Regional Development) 2011
State Environmental Planning Policy (Infrastructure) 2007
State Environmental Planning Policy (Rural Lands) 2008
State Environmental Planning Policy No. 44 – Koala Habitat Protection
State Environmental Planning Policy No. 55 – Remediation of Land
Inverell Local Environmental Plan 2012

APPENDIX B CAPITAL INVESTMENT VALUE REPORT

HANNA NEWMAN ASSOCIATES PTY LIMITED
ABN 73 093 260 685

19 The Strand
Penshurst NSW 2222
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Directors
Greg M Newman FAIQS
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QUANTITY SURVEYORS

PROJECT MANAGERS

ICEC

AIQS CPD Accredited
International Cost Engineering Council

Managing Director / CEO
GAIA Australia
PO Box 1940 Macquarie Centre NSW 2113

Attention: Mr Luke Kim

Dear Luke,

Re: Proposed Solar Farm Development – Bonshaw, NSW

As commissioned, we have prepared a Preliminary Estimate of Costs for determination of a "**Capital Investment Value (CIV)**" for the Solar Farm Project, in accordance with the provisions of Planning Circular PS13-002 – EP&A Regulation 2000.

The Estimate has been prepared from the "Preliminary Concept Drawings" prepared CNF & Associates.
Estimates for siteworks, infrastructure and electrical works have been determined and allowed on the basis of measured Elemental Quantities and rates, based on recent information with similar project.

Our opinion of the anticipated "Capital Investment Value" (CIV) for the project is **$237,680,000.00** as summarised follows:

Item	**Estimated Construction Cost**
Construction Cost	$156,730,000
ESS Battery Storage	$48,000,000
Grid Connection	$8,000,000
Contractor's Preliminaries and Margin	$22,600,000
Sub-Total – Anticipated Construction Value	**$235,330,000**
Design Development Costs	$2,350,000
Total 'CIV' (excl. GST)	**$237,680,000**

(in accordance with Planning Circular PS 10-008 GST is excluded)

Please refer to the attached Construction Cost Report for descriptive details and breakdown of the above.
We trust the above meets with your requirements.

Yours faithfully
HANNA NEWMAN ASSOCIATES PTY LIMITED
Per

Sgd. John Jung

John Jung
Attach.

Energy Park Develpment - Elemental Summary

Project:	Energy Park Develpment	**Details:**	Preliminary Estimate (June 19) Preliminary Cost Estimate for Bonshaw Solar Farm Development HNA 41/2019
Building:	Bonshaw Solar Farm		

Code	Description	Quantity	Unit	Rate	Total
	DOCUMENTS & NOTES				0
	BONSHAW SOLAR FARM (200MW)				
	Site Preparation & Facilities	1	item		770,000
	Civil Works	1	item		4,780,000
	PV Array Equipment	1	item		117,980,000
	Electrical System & Commissioning	1	item		22,900,000
	Logistics and Camp	1	item		10,300,000
	ESS Battery Storage	1	item		48,000,000
	Grid Connection	1	item		8,000,000
	Contractor's Preliminary and Margin	1	item		22,600,000
	Total (excl. GST)				**235,330,000**

Energy Park Develpment - Elemental Detail

Project: Energy Park Develpment
Building: Bonshaw Solar Farm

Details: Preliminary Estimate (June 19)
Preliminary Cost Estimate for Bonshaw
Solar Farm Development

HNA 41/2019

1 DOCUMENTS & NOTES

Code	Description	Quantity	Unit	Rate	Total
	DRAWINGS & DOCUMENTS				
	Preliminary drawings sets (issue A) issued by CNF & Associates				
1	EL-0001 A Site Layout				
2	EL-0001-1 A Site Layout				
3	EL-0001-2 A Site Layout				
4	EL-0101 A Typical Inverter Skid				
5	EL-0102 A Typical Tracker Group				
6	EL-0103 A Typical Battery Bank / Transformer				
7	EL-0104 A Buried Electrical Services				
8	EL-0111 A Typical Inverter Group				
9	EL-0112 A 415V/33KV Power Distribution				
10	EL-0113 A 33V/330KV Power Distribution				
	EXCLUSIONS				
11	- Authorities fees and charges				
12	- Professional fees				
13	- Hazardous material removal				
14	- Design/Construction contingency				
15	- GST				

DOCUMENTS & NOTES 0

2 Site Preparation & Facilities

Code	Description	Quantity	Unit	Rate	Total
	Site Preparation				
1	Surface preparation incl. removal of vegetables, shrub, etc	1	item	100,000.00	100,000
2	Site fence	1	item	570,000.00	570,000
3	Allow site facilities incl. concrete base	1	item	100,000.00	100,000

Site Preparation & Facilities 770,000

3 Civil Works

Code	Description	Quantity	Unit	Rate	Total
	Civil Works				
1	Site access road; compacted gravel	1	item	690,000.00	690,000
2	Trench excavation and fill	1	item	300,000.00	300,000
3	Extra over for concrete fill for conduits	1	item	610,000.00	610,000
4	Bored piers	1	item	3,180,000.00	3,180,000

Civil Works 4,780,000

Energy Park Develpment - Elemental Detail

Project: Energy Park Develpment
Building: Bonshaw Solar Farm

Details: Preliminary Estimate (June 19)
Preliminary Cost Estimate for Bonshaw Solar Farm Development

HNA 41/2019

Code	Description	Quantity	Unit	Rate	Total
4	PV Array Equipment				
	PV Array Equipment				
1	Steel columns incl. fixings and plates	1	item	8,820,000.00	8,820,000
2	Tracker system incl. rotation control package	1	item	80,160,000.00	80,160,000
3	Supply and install PV Cells	1	item	29,000,000.00	29,000,000
	PV Array Equipment				**117,980,000**
5	Electrical System & Commissioning				
	Electrical System				
1	Allowance for electrical system incl. conduit/cable installation, inverters, connection, etc	1	item	21,900,000.00	21,900,000
2	Allow for commissioning	1	item	1,000,000.00	1,000,000
	Electrical System & Commissioning				**22,900,000**
6	Logistics and Camp				
	Logistics and Camp				
1	Allow for logistics and Camp to locality factor	1	item	10,300,000.00	10,300,000
	Logistics and Camp				**10,300,000**
7	ESS Battery Storage				
	ESS Battery Storage				
1	Allow for battery storage 300MWH	1	item	48,000,000.00	48,000,000
	ESS Battery Storage				**48,000,000**
8	Grid Connection				
	Grid				
1	Allow for connection	1	item	8,000,000.00	8,000,000
	Grid Connection				**8,000,000**
9	Contractor's Preliminary and Margin				
	Preliminaries				
1	Temporary works, direct labour & supervision, coordination, site services, fees, insurance, survey, consulting, etc	1	item	15,700,000.00	15,700,000
2	Margin	1	item	6,900,000.00	6,900,000
	Contractor's Preliminary and Margin				**22,600,000**

GFA: 0.00 m2

APPENDIX C BIODIVERSITY DEVELOPMENT ASSESSMENT REPORT

GAIA Bonshaw Solar EIS

Biodiversity Development Assessment Report

26 July 2019

Project No.: 0470861

The business of sustainability

ERM

Document details	
Document title	GAIA Bonshaw Solar EIS
Document subtitle	Biodiversity Development Assessment Report
Project No.	0470861
Date	26 July 2019
Version	1.0
Author	Adriana Corona Mothe BAM Accreditation BAAS 18113
Client Name	GAIA Australia

Document history

				ERM approval to issue		
Version	Revision	Author	Reviewed by	Name	Date	Comments
Draft	01	Adriana Corona Mothe	Joanne Woodhouse	Paul Douglass	1 July 2019	
Final	01	Adriana Corona Mothe	Joanne Woodhouse	Paul Douglass	26 July 2019	

Signature Page

26 July 2019

GAIA Bonshaw Solar EIS

Biodiversity Development Assessment Report

aantcliff

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Acronyms and Abbreviations

Name	Description
AoS	Assessment of Significance (under the EPBC Act)
AOBV	Areas of Outstanding Biodiversity Value
APZ	Asset Protection Zone
Assessment Area	Assessment Area refers to the 1,500m buffer area surrounding the Subject Land and other areas requiring consideration as part of the biodiversity values assessment in Stage 1 of the BAM
BAM	Biodiversity Assessment Method
BC Act	NSW *Biodiversity Conservation Act 2016*
BDAR	Biodiversity Development Assessment Report
BIA	Biodiversity Impact Assessment
BOSET	Biodiversity Offset Scheme Entry Threshold
Buffer area	All land within 1500 m of the Subject Land.
BV Map	Biodiversity Values Map
Candidate species	Threatened species requiring assessment other than 'ecosystem credit species' and 'species credit species'
Development Site	The area of land that is subject to either temporary or permanent impact. At the proposed Bonshaw solar farm, the development site includes the land proposed to install the solar arrays, perimeter fence, access roads, transmission line and ancillary construction areas. The development site is approximately 166.76 ha.
Ecosystem credits	Is a measurement of the value of threatened ecological communities, threatened species habitat for species that can be reliably predicted to occur with a PCT and PCTs generally. Ecosystem credits measure the loss in biodiversity values at a development site.
Ecosystem Credit Species	Are threatened species identified as such in the Threatened Biodiversity Data Collection and whose selection was based on the likelihood of occurrence of the species or elements of the species' habitat can be predicted by vegetation surrogates and landscape features, or for which targeted survey has a low probability of detection.
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Commonwealth Environment Protection and Biodiversity Conservation Act 1999*
ERM	Environmental Resources Australia Pty Ltd
FM Act	*NSW Fisheries Management Act 1994*
GAIA	GAIA Australia
Ha	Hectares
HBT	Hollow Bearing Tree
IBRA Bioregion	a bioregion identified under the Interim Biogeographic Regionalisation for Australia (IBRA) system, which divides Australia into bioregions on the basis of their dominant landscape-scale attributes
IBRA Sub-region	a sub-region of a bioregion identified under the IBRA (Interim Biogeographic Regionalisation for Australia) system
KFH	Key Fish Habitat

Name	Description
Km	Kilometres
LEP	Local Environmental Plan
M	Metres
NSW	New South Wales
OEH	New South Wales' Office of Environment and Heritage
PCT	Plant Community Type
Project Boundary	Project Boundary referred to in this report refers to Lot 2 DP 1039185
SAII	Serious and Irreversible Impacts
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy (State and Regional Development) 2011
Species Credits	Species Credits is the class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates.
Species credit species	Species Credit Species are threatened species or components of species habitat that are identified in the Threatened Species Data Collection as requiring assessment for species credits.
SSD	Stage Significant Development
Subject Land	Is the land to which the BAM is applied to assess the biodiversity values. In this assessment, the Subject Land is the same area as the Development Site. It represents the development footprint of the solar farm and associated infrastructure. It is restricted to the western portion of the property and has been the subject of all of our detailed assessments.
TEC	Threatened Ecological Community
ToS	Test of Significance (under BC Act 2016)
The Project	The construction, operation and maintenance of a solar PV generation facility and associated infrastructure with a capacity of up to 500 MW, supplying electricity to the national electricity grid.
VIS	Vegetation Information System
WM Act	NSW Water Management Act 2000
WoNS	Weeds of National Significance

EXECUTIVE SUMMARY

Environmental Resources Australia Pty Ltd (ERM) was commissioned by GAIA Australia (GAIA) to prepare a Biodiversity Development Assessment Report (BDAR) to support an Environmental Impact Statement (EIS) for the proposed solar farm located within Lot 2 DP1039185, Bonshaw NSW..

The Project will involve the construction, operation and maintenance of a solar PV generation facility and associated infrastructure with a capacity of up to 200 MW and associated infrastructure, including a Lithium-ion Energy Storage System, supplying electricity to the national electricity grid. The Development Site includes all supporting infrastructure and site access points.

The present BDAR was prepared in accordance with the requirements of the NSW Biodiversity Conservation Act 2016, including the Biodiversity Assessment Method (BAM) and Offsets Scheme. Other requirements considered included the Commonwealth Environmental Biodiversity Assessment Act 1999 and SEARs provided for the Project.

Flora and fauna surveys were undertaken at the Development Site across three survey periods (11-13 September 2018 (spring), 11-14 December 2018 (summer) and 25-28 March 2019 (autumn)). Flora surveys included vegetation mapping along random meander transects and over 100 vegetation community observation points, a paddock tree assessment and 42 BAM flora plots. Fauna surveys included amphibian call payback (three surveys), bird surveys (eight surveys), reptile surveys (eight surveys), arboreal/tree hollow dependent fauna surveys (eight camera trap over 28 trap nights), microchiropteran bat call recording (eight SongMeters totalling 28 trap nights) and fauna habitat observations (hollow bearing trees, ant/termite mounds, rocky areas, bird nests and creek lines).

The Project Boundary is located in highly disturbed land whose current and historical land uses include farming and grazing. A total of eight farm dams are present across the Property Boundary. Several creeks (first, second and third order) tributaries of the Dumaresq River are present within the Project Boundary. The majority of the Development Site consists of cleared grazing land (65.9%), with only 34% of the land comprising native woodland vegetation.

A total of 143 flora species in 47 families were recorded within the assessment area. This included a total of 111 native (78 %) and 32 exotic (22 %) species. No threatened flora species were recorded within the Development Site. Vegetation within the Development Site includes cleared land and native vegetation within three plant community types (PCT) at differing conditions. The PCTs within the Development Site are:

- PCT 594 – Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion. Two vegetation zones of this PCT are present: moderate and low condition.
- PCT 596 – Tumbledown Red Gum - White Cypress Pine - Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion. Four vegetation zones of this PCT are present: moderate condition, low condition, very low condition and derived grassland.
- PCT 516 – Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion. Four vegetation zones of this PCT are present: moderate condition, very low condition and derived grassland.

None of the PCTs present within the Development Site correspond to listed Threatened Ecological Communities.

A total of 75 fauna species were recorded across the Development Site, including eleven threatened species. Threatened species included eight vulnerable microchiropteran bats (Little Pied Bat, Eastern Bent-wing Bat, Corben’s Long-eared Bat, Yellow-bellied Sheath-tailed Bat, Eastern Cave Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Hoary Wattled Bat), one endangered microchiropteran bat (Bristle-faced Free-tailed bat), one vulnerable bird (Grey-crowned Babbler) and one migratory bird (Cicadabird). Out of the eight Vulnerable microchiropteran bats, six were definite call identifications and two (Greater Broad-nosed Bat and Hoary Wattled Bat) were potential calls.

An assessment of the impacts of the project on Matters of National Environmental Significance (MNES) within the Development Site was undertaken. A likelihood of occurrence and risk assessment was undertaken for each entity identified as likely to occur within the Project's locality. It was concluded that all TECs and threatened species as identified in the PMST would have low residual risk as result from the Project. Therefore, assessments of significance and referral of the project to the Commonwealth Minister for the Environment for assessment is not required.

GAIA has undertaken significant steps to avoid, minimise and mitigate impacts to biodiversity. As part of the project refinement process, ERM provided advice to GAIA on areas which were of the highest priority for avoidance. This led to third and second order creeks to be avoided.

The Project will result in the following direct impacts to flora and fauna:

- Clearing 47.52 ha of mapped native vegetation pertaining to three PCTs and in differing condition.
- Clearing 46.09 ha of heavily disturbed grassland with vegetation integrity >17.
- Clearing 72.49 ha of heavily disturbed grassland with vegetation integrity <17.
- Loss of up to 28 paddock trees, including 13 hollow-bearing paddock trees.
- Impacts to suitable foraging habitat for the Eastern Cave Bat in treed areas of PCTs 516, 594 and 516.
- The entire Development Site classifies as suitable habitat for the Bristle-faced Free-tailed Bat, therefore the project will result in loss of 166.76 ha of habitat for this threatened species.

Potential indirect impacts result of the proposed development have been identified, including edge effects, fragmentation, and sedimentation and pollutant run-off. Based on management and mitigation measures proposed, it is expected potential indirect impacts will be minimize so that their residual impact will be negligible.

Direct impacts to native vegetation and fauna habitat requiring offsets include:

- Impacts on PCT 516 – Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion, requiring 89 ecosystem credits.
- Impacts on PCT 594 – Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion ad Nandewar Bioregion, requiring 837 ecosystems credits
- Impacts on PCT 596 – Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion, requiring 244 ecosystem credits
- Loss of 28 Paddock Trees, requiring 21 ecosystem credits.
- Impacts on Bristle-faced Free-tailed Bat habitat, requiring 1,578 species credits.
- Impacts on Eastern Cave Bat foraging habitat, requiring 2,365 species credits

A total of 1,191 ecosystem credits and 3,943 species credits are required to offset the impacts of the project.

This assessment has been completed in accordance with the BAM (OEH 2017a, 2018a) on behalf of GAIA. Overall the Development Site is considered of moderate biodiversity value with impacts related to direct clearance of native vegetation and fauna habitat. The residual impact of the project will require 1,191 ecosystem credits and 3,943 species credits to be offset in accordance with the Biodiversity Conservation Regulation 2017 and the NSW Biodiversity Offsetting Scheme.

STAGE 1: BIODIVERSITY ASSESSMENT

1. INTRODUCTION

GAIA Australia (GAIA) is seeking to develop a large scale solar photovoltaic (PV) generation facility and associated infrastructure with the capacity of 200 megawatts (MW) situated near Bonshaw in the Inverell Shire Council (ISC) of New South Wales (NSW) (the Project).

The Project is classified as State Significant Development (SSD) in accordance with Clause 20 Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (SEPP) and will be assessed under Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This Biodiversity Development Assessment Report (BDAR) assesses the impacts of the Project according to the NSW Biodiversity Assessment Methodology (BAM) as required by the Secretary's Environmental Assessment Requirements (SEARs) for the proposal.

The aim of this BDAR is to undertake biodiversity and impact assessment of ecological values of the Subject Land in accordance with the BC Act. This BDAR also addresses the assessment requirements of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

1.1 Assessment requirements

On 16 August 2018, the Department of Planning and Environment (DPE) provided Secretary's Environmental Assessment Requirements (SEARs) for the Bonshaw Solar Farm (the Project).

A copy of the SEARs is attached to the EIS as Appendix A. The assessment requirements that specifically relate to biodiversity, are listed in Table 1.1.

Table 1.1 SEARs requirements and how they have been addressed.

Requirement	Section Addressed
An assessment of the biodiversity values and the likely biodiversity impacts of the project in accordance with Section 7.9 of the *Biodiversity Conservation Act 2016* (NSW) the Biodiversity Assessment Method (BAM) and documented in a biodiversity development assessment report (BDAR), unless OEH and DPE determine that the proposed development is not likely to have any significant impacts on biodiversity values.	This BDAR has been prepared in accordance with the *Biodiversity Conservation Act 2016*, Biodiversity Conservation Regulation 2017 and the Biodiversity Assessment Method (BAM).
The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the BAM.	Stage 2 of this BDAR, Chapter 6 to 8.
An assessment of the likely impacts on listed aquatic threatened species, populations or ecological communities, scheduled under the *Fisheries Management Act 1994,* and a description of the measures to minimise and rehabilitate impacts.	Section 5.2.

To inform preparation of the SEARs, DPE invited other government agencies to recommend matters to be addressed in the EIS. These matters were taken into account by the Secretary for DPE when preparing the SEARs. A copy of the NSW Office of Environment and Heritage (OEH) advice to DPE was attached to the SEARs and matters relevant to the BDAR are listed in Table 1.2.

Table 1.2 Government agency (OEH) requirements

Requirement	Section Addressed
DPI Fisheries	
Aquatic Ecological Assessment The aquatic ecological environmental assessment should include the following information; ▪ A recent aerial photograph (preferably colour) of the locality (or reproduction of such a photograph) should be provided. ▪ Area which may be affected either by the development or activity should be identified and shown on an appropriately scaled map (and aerial photographs). ▪ Waterways within the area of development are to be identified. ▪ The extent of aquatic habitat removal and riparian vegetation removal or modification which may result from the proposed development, ▪ Details of the location and design of the waterway crossings or underground cabling through waterways. ▪ Details of the methodology (e.g. trenching, boring) for any underground cabling passing through waterways.	Aquatic habitat is described in Section 4.2.6.3. Waterways are shown on the aerial photo in Figure 3.2, noting that they were dry (or very low water levels) during all survey periods due to extended drought conditions. The second and third order watercourses will be avoided through detailed design (including 20-30m riparian buffer zones measured from the high bank of the streams). Any waterway crossings required as a result of the Project will be designed in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management and the Policy and Guidelines for Fish Friendly Waterway Crossings. Construction methodology is further detailed in the EIS.
Waterway Crossings The construction of permanent or temporary access tracks or underground cables through Little Oaky Creek, Little Limestone Creek and unnamed creeks running into the Beardy River should be in accordance with DPI Fisheries Guideline document: Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013).	The activities at the Development Site will not require any access track or cables through Little Oaky Creek, Little Limestone Creek or tributaries to Beardy River. Any waterway crossings required as a result of the Project will be designed in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management and the Policy and Guidelines for Fish Friendly Waterway Crossings.

Requirement	Section Addressed
Threatened Species, Populations And Ecological Communities The proposal should include a threatened aquatic species assessment (as per part 7A Fisheries Management Act 1994) to address whether there are likely to be any significant impacts on listed threatened species, populations or ecological communities listed under the Fisheries Management Act 1994. It should be specifically noted that the proposal is located within an area considered habitat of the threatened species Purple Spotted Gudgeon (*Mogurnda adspersa*). This species is known or expected to occur in Little Oaky Creek and a number of nearby creeks. Threatened fish species mapping distributions are available at: http://www.dpi.nsw.gov.au/fishing/species-protection/threatened-speciesdistributions-in-nsw	A description of the aquatic habitat including consideration of the Purple Spotted Gudgeon is provided in Section 5.2 and an Assessment of Significance is provided in Appendix E.
OEH	
1. Biodiversity impacts related to the proposed development are to be assessed in accordance with Section 7.9 of the Biodiversity Conservation Act 2017, the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the *Biodiversity Conservation Act 2016* (s.6.12), Biodiversity Conservation Regulation 2017 (s6.8) and Biodiversity Assessment Method, unless OEH and DPE determine that the proposed development is not likely to have any significant impacts on biodiversity values.	This BDAR has been prepared in accordance with the *Biodiversity Conservation Act 2016*, Biodiversity Conservation Regulation 2017 and the Biodiversity Assessment Method (BAM).
2. The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the Biodiversity Assessment Method.	Chapter 7
3. The BDAR must include details of the measures proposed to address the offset obligations as follows: ■ The total number and classes of biodiversity credits required to be retired for the development/project; ■ The number and classes of like-for0like biodiversity credits proposed to be retired; ■ The number and classes of biodiversity credits proposed to be retired in accordance with the variation rules; ■ Any proposal to fund a biodiversity conservation action; ■ Any proposal to conduct ecological rehabilitation (if a mining project); ■ Any proposal to make a payment to the Biodiversity Conservation Fund. If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits.	Chapter 9
4. The BDAR must be submitted with all spatial data associated with the survey and assessment as per Appendix A of the BAM.	All spatial data (ArcGIS format) will be provided to OEH in electronic format.

Requirement	Section Addressed
5. The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under s.6.10 of the *Biodiversity Conservation Act 2016*.	The BDAR has been co-prepared by Dr Adriana Corona Mothe (BAM Accreditation BAAS18113) with input and technical direction by Joanne Woodhouse (BAM trained) and others as required.

1.2 The Project

The Project will involve the construction, operation and maintenance of a solar PV generation facility and associated infrastructure with a capacity of up to 500 MW, supplying electricity to the national electricity grid. The Project is located approximately 16 kilometres (km) south of Bonshaw and 66 km north of Inverell and is wholly contained within the Inverell Local Government Area (LGA) (Figure 1.1). The Project would connect directly to the 330 kilovolt (kV) Dumaresq Substation located to the immediate west of the Project boundary .

The Project incorporates arrays of PV modules (commonly referred to as “solar panels”), transmission infrastructure and substations to enable connection into the existing electricity transmission network (Figure 1.2). The exact method and point of connection is being developed with TransGrid in parallel with this planning application and the detailed infrastructure layout developed during detailed design will confirm the generating capacity of the Bonshaw Solar Farm.

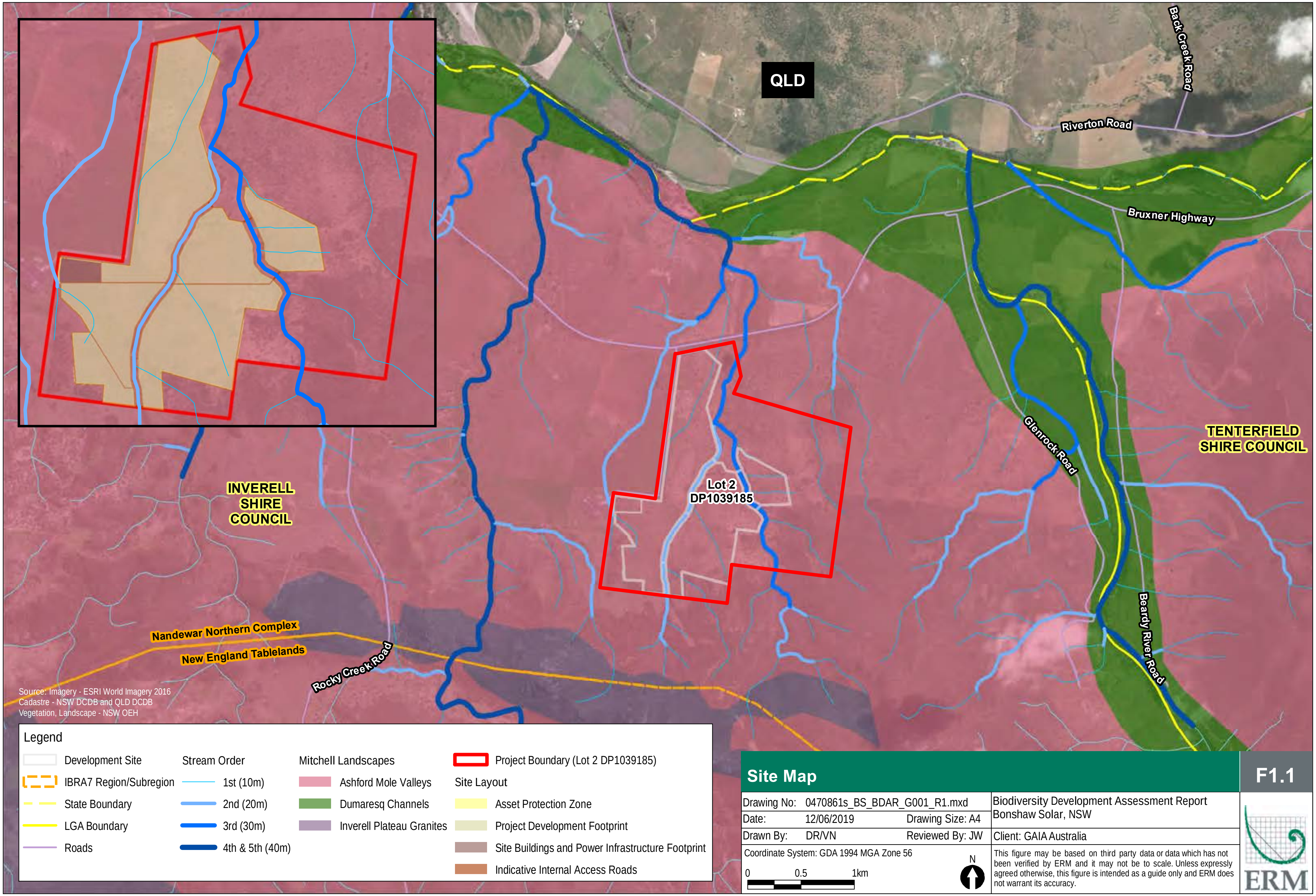
The key elements of the project include the construction and operation of:

- a network of PV modules in a fixed tilt or single axis tracking arrangement;
- associated BESS(s) / battery storage;
- a switch yard to be connected to the 330 kV TransGrid Dumaresq Substation, on the boundary of the Project Area;
- underground or overhead cabling for connection between arrays and inverters and transformers;
- operations and maintenance (O&M) infrastructure, including O&M buildings including a control room, meeting facilities, a temperature controlled spare parts storage facility, supervisory control and data acquisition (SCADA) facilities, a workshop and associated infrastructure (eg kitchen, toilets and other facilities) car parking facilities;
- Access point to the site via the Bruxner Highway;
- a new internal road network to enable access from surrounding local roads to the array areas during construction and operations including internal access tracks, creek crossing & perimeter security fencing; and
- Temporary facilities during construction.

A full description of the Project is provided in the EIS and the final layout of the Project will be dependent on detailed design, availability and commercial considerations at the time of construction, however in terms of assessing biodiversity impacts, the following project features were considered:

- Four riparian crossings (indicative location on third and second order streams shown in Figure 1.2);
- Clearing of vegetation to be restricted to the identified 166.76ha development footprint, noting that grazing beneath the solar panels will continue during operation of the solar farm (the height of the PV panels above natural ground is approximately 1.4 to 4.2 m based on tracker option to be used);

- Excavation of trenches and the laying of power and instrumentation cables;
- Main access point to the site via the Bruxner Highway;
- An internal private road network (up to a combined total length of approximately 13.7 km) connecting the arrays and other proposed infrastructure to the public road network; and
- A 10m wide bushfire asset protection zone around the perimeter of the solar farm (located inside the identified development footprint).



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Vegetation, Landscape - NSW OEH

Site Map

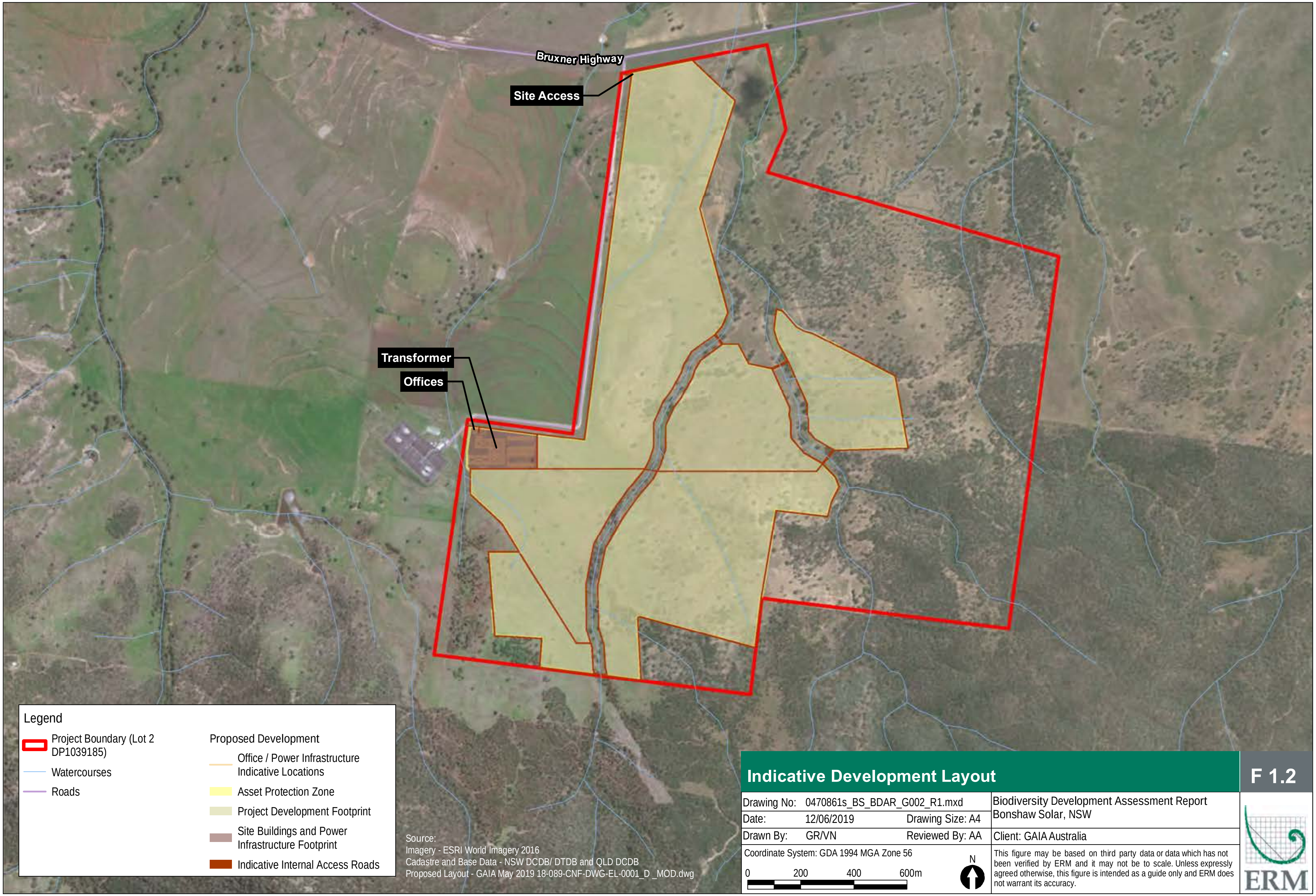
F1.1

Drawing No: 0470861s_BS_BDAR_G001_R1.mxd
Date: 12/06/2019 Drawing Size: A4
Drawn By: DR/VN Reviewed By: JW
Coordinate System: GDA 1994 MGA Zone 56

Biodiversity Development Assessment Report
Bonshaw Solar, NSW

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.



Source:
Imagery - ESRI World Imagery 2016
Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg

Indicative Development Layout

F 1.2

Drawing No: 0470861s_BS_BDAR_G002_R1.mxd
Date: 12/06/2019 Drawing Size: A4
Drawn By: GR/VN Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Biodiversity Development Assessment Report
Bonshaw Solar, NSW

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

1.3 Site Description

Key features of the Subject Land are summarised in Table 1.3 below.

For the purposes of this BDAR report:

- The **Project Boundary** refers to Lot 2 DP 1039185.
- The **Subject Land** is the area that would be directly impacted by the Project. In accordance with the BAM (OEH 2017a), the term Subject Land is used in the Stage 1 – Biodiversity Assessment and the term **Development Site** is used in the Stage 2 – Impact Assessment.
- The term **Assessment Area** is used in Stage 1 of this BDAR to refer to the 1,500m buffer surrounding the Subject Land and other areas requiring consideration as part of the biodiversity values assessment in Stage 1 of the BAM (OEH 2017).

Table 1.3 Key Features of the Subject Land

Key Feature	Description
Location Description	The proposed Bonshaw Solar Farm is located 16 km south of Bonshaw and 66 km north of Inverell.
Lot Description (Project Boundary)	Lot 2 DP 1039185
Subject Land	The Subject Land corresponds to the western portion of Lot 2 DP1039185 and is partially bounded on its northern boundary by Bruxner Highway. To the south and east it is bounded by rural land and to the west, an unsealed road extends from Bruxner Highway to the existing 330kV TransGrid Dumaresq Substation located at the south-western corner.
Local Government Area	Inverell Local Government Area (LGA)
Elevation	The Project site is dominated by a gently undulating landscape to the north, forming steep slopes to the south and east dissected by second and third order streams. Based on a review of topographic maps and aerial imagery, landforms present within the Subject Land include drainage depressions, gentle to steeply inclining slopes, and upper flat ridges. The elevation at the Bruxner Highway (north boundary) is approximately 335 m and rises up to approximately 420 m in the south-western portion of the site. The ridgelines to the south of the project rise up to approximately 660 m forming the dominant landscape feature.
Previous Land Use	The Subject Land has undergone vegetation clearing associated with former land use for cropping and is currently used for sheep and cattle grazing.

1.4 Consultation

Following completion of the Spring 2018 and Summer 2018 survey periods, ERM's principal ecologist Joanne Woodhouse met with OEH (Krister Wearn) to discuss the survey methodology and preliminary survey results, particularly the positive identification of the Bristle-faced Free-tailed Bat (*Mormopterus eleryi*). The results of this meeting and follow up consultation were used to guide the Autumn 2019 survey methodology (additional BAM plots within the areas of native grasslands) and supplementary bat call analysis to confirm the positive species identification. A summary of the consultation is provided in Table 1.4 below.

Table 1.4 Summary of Consultation with OEH during preparation of the BDAR

Date	Contact Name	Summary	Response/Action
12 March 2019	Meeting at OEH Grafton Office attended by: ■ Krister Waern (OEH) ■ Joanne Woodhouse (ERM) ■ Luke Kim (GAIA, by phone)	ERM requested the meeting with OEH to discuss the survey methodology and preliminary survey results to date, particularly the positive identification of the Bristle-faced Free-tailed Bat (*Mormopterus eleryi*). Key points of discussion: Given the lack of information of the ecology of the Bristle-faced Free-tailed Bat (*Mormopterus eleryi*) ERM was seeking clarification on the species polygon determination and any additional survey requirements given that we already have a positive species identification. Given that acoustic detectors were the only survey method used, breeding habitat will be assumed to be present. Common Couch (*Cynodon dactylon*) is listed as native species in NSW however it is not listed in any of the PCT's identified within the Subject Land and has been introduced to the site as a pasture species. ERM was seeking clarification that we can exclude this species in the species richness calculations. ERM confirmed that the threatened flora surveys were undertaken as part of general observations and BAM plot areas, rather than parallel linear transect searches across the entire subject land.	OEH confirmed that information on the Bristle-faced Free-tailed Bat is not extensive and they would seek clarification from OEH's threatened species specialist. For other records of threatened microchiropteran bats eg. Eastern Cave Bat (*Vespadelus troughtoni*) no additional targeted survey for breeding habitat is required although it is recommended that photographic evidence is provided as justification. Photos of rocky outcrops to be provided to confirm no viability as breeding habitat for this species. OEH will provide advice on the proposed exclusion of Common Couch as a native species within the Subject Land. Additional floristic plots required in derived native grasslands and cleared land. Derived native grassland determination to be updated based on vegetation integrity scores. Offset requirements to be determined based on integrity scores of: >15 (if PCT is a TEC), >17 (if PCT is associated with TS habitat) or >20 (if PCT is not a TEC or is associated with TS habitat). Vegetation mapping to be updated to merge PCT patches which are located within 100m of each other. OEH agreed that the threatened flora survey methodology was reasonable and should be supported by a figure to confirm that the Subject Land was effectively covered during the survey period.

Date	Contact Name	Summary	Response/Action
21 March 2019	Letter OEH to ERM	OEH provided formal advice following the meeting held on 12 March and confirmed that: ■ Each vegetation zone (including areas of high weed occurrence and improved pasture areas) are required to detail the vegetation integrity survey plots as described in the BAM. ■ All native plants in NSW (including Common Couch) are required to be considered as native plants for the purposes of applying the BAM, even if they do not naturally occur within the nominated PCT. ■ The draft vegetation mapping appears to be focused on the canopy of the trees. The vegetation mapping should also consider the mid-storey and native ground cover to map the broader extent of the PCT. This is particularly important where canopy spacing within open forest and woodland communities can be up to 100m apart. ■ OEH information suggests that *Mormopterus eleryi* cannot be easily distinguished from *Scotorepens greyii* by anabat call. Catching the bat is the most reliable way to determine the species presence. If Mormopterus eleryi is confirmed on site, and based on ERMs current records and the habitat requirements of the species, most of the subject property may be captured when determining the species polygon.	■ ERM undertook and additional four days in the field and an additional 28 floristic survey plots to ensure effective coverage of the all areas of grassland in accordance with advice from OEH and the requirements of the BAM. ■ ERM have updated the assessment and Common Couch (*Cynodon dactylon*) is now included within the calculations. ■ Vegetation mapping and calculations of areas have been updated. ■ ERM have obtained a supplementary report to confirm the accuracy of the *Mormopterus eleryi* call identification. Greg Ford (Balance! Environmental) is a recognised expert on Australian bats, with specialist expertise in acoustic analysis of bat echolocation calls for species identification. As described in Appendix I, analysis by Balance! Environmental of numerous full-spectrum data-sets from several regions where *S.eleryi* and *S. greyii* are known to co-exist has consistently found examples of two distinctive foraging sequence types that concur with the diagnostic descriptions of Corben (2010). An overview of these findings and promotion of the inclusion of feeding buzz analysis in call identification reporting was presented recently at the International Society of Ecoacoustics Congress (Ford 2018). Support for the use of this approach has also been received from several bat-call analysis experts based throughout eastern Australia. Based on this advice, ERM has prepared this assessment based on the results of the call identification and does not consider that harp trapping is required in this instance to confirm presence. Refer to Section 5.7.4.1 and ToS in Appendix E for detailed discussion and assessment. The species polygon has been prepared based on the advice from OEH and is provided in Section 5.7.4.1.

1.5 Key Sources of Information used in the Assessment

The following key information sources were used in preparation of this BDAR: Proposed development layers and project footprint as provided by GAIA.

Key Sources of Information used in the Assessment
Online resources:
Australian Government's Species Profiles and Threats (SPRAT) database. Accessed online at http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl
NSW Office of Environment and Heritage (OEH) Threatened Biodiversity Profile Search. Accessed online at http://www.environment.nsw.gov.au/threatenedspeciesapp/
NSW Department of Primary Industry (DPI) profiles of threatened species, populations and ecological communities. Accessed online at https://www.dpi.nsw.gov.au/fishing/threatened-species
Commonwealth Department of Environment and Energy (DEE) Protected Matters Search Tool Accessed online at http://www.environment.gov.au/epbc/protected-matters-search-tool
Australia's IBRA Bioregions and sub-bioregions. Accessed online at http://www.environment.gov.au/land/nrs/science/ibra/australias-bioregions-maps
NSW Department of Environment and Climate Change (DECC) (2002). Descriptions for NSW (Mitchell) Landscapes, Version 2.
NSW OEH Mitchell Landscapes database v3 2011. Accessed via https://data.gov.au/dataset/e64597db-453c-46be-a352-360b775d2852
NSW OEH's Biodiversity Assessment Method (BAM) calculator. Accessed online via https://www.lmbc.nsw.gov.au/bamcalc
NSW OEH's BioNet Atlas of threatened biodiversity data collection (TBDC). Accessed online at http://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx
NSW OEH's Vegetation Classification Database. Accessed online via login at http://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx
OEH VIS mapping. Accessed online via http://www.environment.nsw.gov.au/research/VISmap.htm
OEH (2017) Biodiversity Assessment Method.
OEH (2018a) Biodiversity Assessment Method Operational Manual – Stage 1.
NSW Government SEED Mapping. Accessed online via https://geo.seed.nsw.gov.au/Public_Viewer/index.html?viewer=Public_Viewer&locale=en-AU
NSW Biodiversity Values Map. Accessed online via https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=BVMap
Literature Review
OEH (2015) BRG-Namoi Regional Native Vegetation Mapping. Technical Notes. NSW Office of Environment and Heritage, Sydney.
Peacock R., Rolhauser A., Thönell J. and Law E. (2009) Extant and potential natural vegetation of Yallaroi, Ashford, Bingara and Inverell 1:100,000 scale map sheet, NSW. NSW Department of Environment, Climate Change and Water.

Other literature consulted during preparation of this BDAR is referenced within the text.

The aerial imagery used in this BDAR is sourced from ESRI World Imagery (DigitalGlobe) dated 27 November 2016. Mapping has been produced using Geographic Information System (GIS). The following maps and data are provided:

- Digital mapping with aerial photography showing 1:1000 or fine
- Site Map (Figure 1.1) as described in subsection 4.2.1.1 and 4.2.1.3 of the BAM
- Location Map (Figure 3.2) as described in subsection 4.2.1.2 and 4.2.1.3 of the BAM

2. LEGISLATIVE CONTEXT

The project has been assessed against key biodiversity legislation and government policy, including:

- Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act);
- NSW Environmental Planning and Assessment Act 1979 (EP&A Act);
- NSW Biodiversity Conservation Act 2016 (BC Act);
- NSW Fisheries Management Act 1994 (FM Act); and
- NSW Biosecurity Act 2015 (BS Act).

Table 2.1 Applicable Legislation, Plan and Guidelines

Commonwealth Legislation

Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires approval of the Commonwealth Minister for Environment (formerly the Minister of Sustainability, Environment, Water, Population and Communities) for actions that may have a significant impact on Matters of National Environmental Significance (MNES). The EPBC Act is administered by the Commonwealth Department of Environment and Energy (DoEE) and lists threatened species, ecological communities and other MNES. Any proposed action that is expected to have an impact on MNES must be referred to the Minister for assessment under the EPBC Act, or assessed under the accredited process between the Commonwealth and the State of NSW.

Matters of National Environmental Significance	Application to the Subject Land	Addressed
World heritage properties	Not identified within the Subject Land	Not applicable
National heritage places	Not identified within the Subject Land	Not applicable
Ramsar wetlands of international importance	Not identified within the Subject Land	Not applicable
Listed threatened species and communities	Threatened species have been recorded within the locality and have potential habitat available within the Subject Land (Development Site). No Threatened Ecological Communities (TEC) are present.	*Chapter 5 and Appendix C & D*
Internationally protected migratory species	Migratory species are identified as potentially occurring within the Subject Land.	*Appendix C & D*
Commonwealth marine areas	Not identified within the Subject Land	Not applicable
The Great Barrier Reef Marine Park	Not identified within the Subject Land	Not applicable
Nuclear actions	Not applicable	Not applicable
A water resource, in relation to coal seam gas development and large coal mining development	Not applicable	Not applicable

Statutory Legislation and Guidelines

Biodiversity Conservation Act 2016 (BC Act)

The NSW *Biodiversity Conservation Act 2016* came into effect on 25 August 2017. The BC Act replaced the NSW *Threatened Species Conservation Act 1995*, the NSW *Nature Conservation Trust Act 2001* and parts of the NSW *National Parks and Wildlife Act 1974*. The BC Act establishes mechanisms for:

- The management and protection of listed threatened species of native flora and fauna (excluding fish and marine vegetation) and threatened ecological communities (TECs).
- The listing of threatened species, TECs and key threatening processes.
- The development and implementation of recovery and threat abatement plans.
- The declaration of critical habitat.
- The consideration and assessment of threatened species impacts in development assessment process.
- Biodiversity Offsets Scheme, including the Biodiversity Values Map and method to identify serious and irreversible impacts (SAII).

The BC Act establishes a new regulatory framework for assessing and offsetting biodiversity impacts on proposed developments. Where development consent is granted, the authority may impose as a condition of consent an obligation to retire a number and type of biodiversity credits determined under the Biodiversity Assessment Method (BAM). A Biodiversity Values Map and Biodiversity Offsets Scheme Entry Threshold (BOSET) tool are available to identify the presence of mapped biodiversity values within land proposed for development as well as the clearing thresholds that would trigger application of the BAM.

The Biodiversity Offsets Scheme applies to all local developments, major projects or the clearing of native vegetation where the State Environmental Planning Policy (Vegetation in Non‐Rural Areas) 2017 applies. Any of these will also require entry into the Biodiversity Offsets Scheme if they occur on land mapped on the Biodiversity Values Map. ERM has reviewed and can confirm that part Lot 202 DP874273, is not currently mapped on the Biodiversity Values Map (see BOSET report in *Appendix A*) although as a major project, it does trigger the Biodiversity Offsets Scheme.

In terms of the proposed solar farm, the proposed development must take into account species likely to occur within available habitat based on existing records of threatened species and ecological communities, as well as those species likely to occur based on geographic distribution and presence of potential habitat (refer to *Appendix D*)

Water Management Act 2000

A controlled activity approval under the Water Management Act 2000 (WM Act) is required for certain types of developments and activities that are carried out in or within 40 m of a river, lake or estuary.

The WM Act provides a number of mechanisms for protection of water sources via the water management planning process. If a ‘controlled activity' is proposed on ‘waterfront land', an approval is required under Section 91(2) of the WM Act. ‘Controlled activities' include; the construction of buildings or carrying out of works; the removal of material or vegetation from land by excavation or any other means; the deposition of material on land by landfill or otherwise. ‘Waterfront land' is defined as ‘the bed of any river or lake, and any land lying between the river or lake and a line drawn parallel to and 40 metres inland from either the highest bank or shore’.

Major projects are exempt from requiring approvals under the Water Management Act 2000.

Biosecurity Act 2015

The NSW Biosecurity Act 2015 came into effect on 1 July 2017, effectively replacing the Noxious Weeds Act 1993, and 13 other Acts, with a single Act. Under the Noxious Weeds Act all landowners have a responsibility to control noxious weeds on their property. Under the Biosecurity Act the same responsibility will apply and will be known as a General Biosecurity Duty.

The General Biosecurity Duty states "Any person who deals with biosecurity matter or a carrier and who knows, or ought reasonably to know, the biosecurity risk posed or likely to be posed by the biosecurity matter, carrier or dealing has a biosecurity duty to ensure that, so far as is reasonably practicable, the biosecurity risk is prevented, eliminated or minimised." The general biosecurity duty applies to all weeds listed in Schedule 3 of the Biosecurity Act (also included as Weeds of National Significance (WoNS).

As detailed in Section 5.7.1, a total of 32 exotic species, including five high threat exotic (HTE) were recorded within the Subject Land. Two of those exotic species, Tiger Pear (*Opuntia aurantiaca*) and Velvet Tree Pear (*Opuntia tomentosa*) are listed as WoNS. A weed species of genus *Senecio* was also recorded, and the potential presence of Fireweed (*Senecio madagascariensis*) cannot be precluded.

A strategic plan for each WoNS has been developed to define responsibilities and identify strategies and actions to control the weed species. These can be downloaded from:
http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html

Fisheries Management Act 1994

The Fisheries Management Act 1994 provides for the conservation, protection and management of fisheries, aquatic systems and habitats in NSW. Similar to the BC Act, the Fisheries Management Act 1994 lists threatened species, populations and ecological communities of fish and marine vegetation. Consideration of likely occurrence of threatened fish in the waterways in the Subject Land is provided in Section 5.2.

Any waterway crossings along the internal access roads will need to consider an appropriately designed structure that does not obstruct fish passage and will be designed in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management and the Policy and Guidelines for Fish Friendly Waterway Crossings. Notwithstanding this, it is noted that a permit under section 219 would not be required for waterway crossings as section 89J(e) of the EP&A Act excludes projects approved under Part 4 of the EP&A Act from requiring "a permit under section 201, 205 or 219 of the Fisheries Management Act 1994".

SEPP No. 44 – Koala Habitat Protection

SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline. A review of SEPP 44 is currently under consideration. The key changes proposed in the amended SEPP 44 relate to the definitions of koala habitat; list of tree species; list of councils; and development assessment process.

SEPP 44 currently applies to land in relation to which a development application has been made within the LGAs as listed in Schedule 1, which includes Inverell LGA. An assessment of Koala habitat values has been provided in Section 5.1.

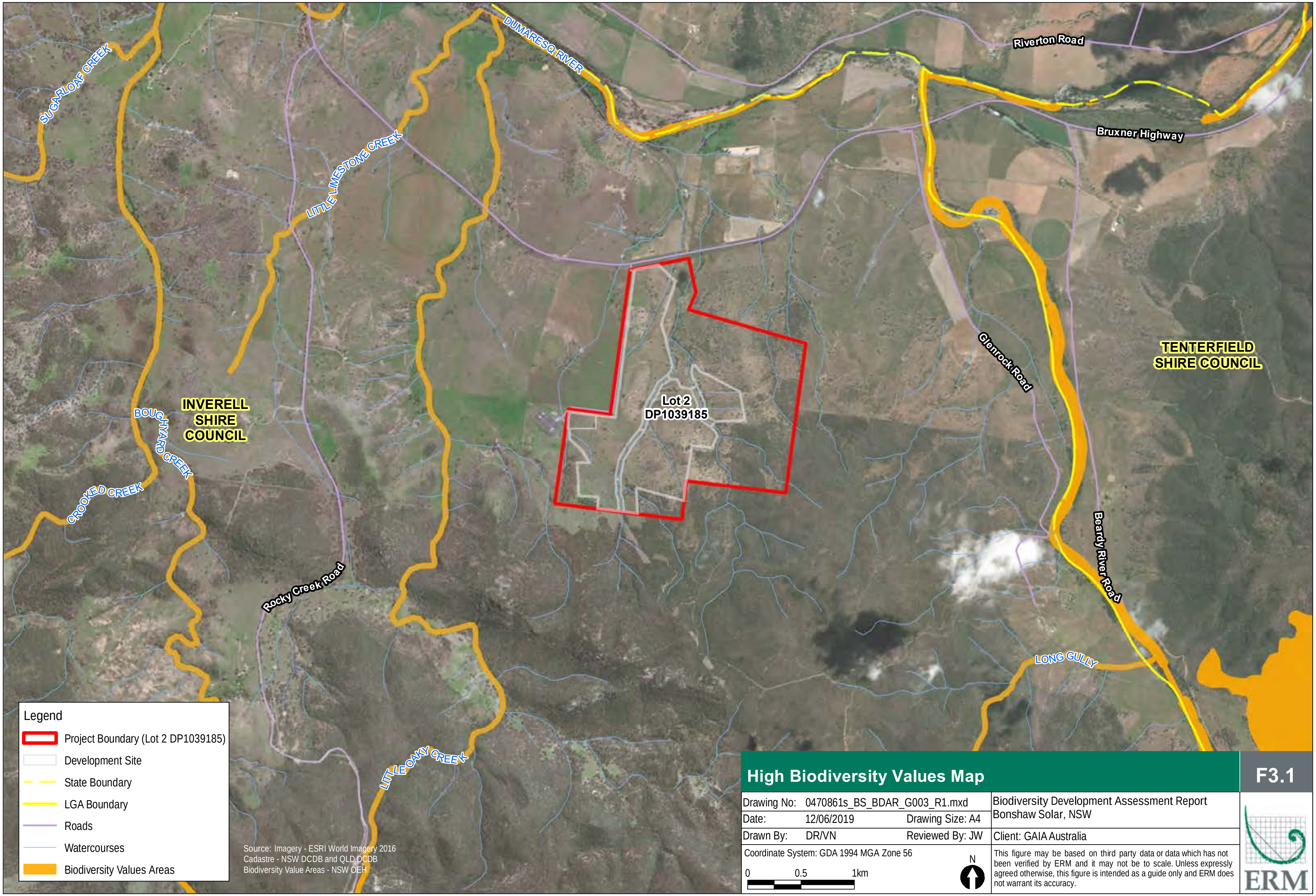
3. LANDSCAPE FEATURES

The identification of landscape features within the Subject Land was determined in accordance with Section 4 of the BAM (OEH 2017a), as summarised in Table 3.1 below.

Table 3.1 Summary of Landscape Features

Landscape Feature	Description
IBRA Bioregion	Bioregions are large, geographically distinct areas of land with common characteristics such as geology, landform patterns, climate, ecological features, and flora and fauna communities. The Subject Land is located within the NSW Nandewar Bioregion. The Nandewar region consists of hills on Palaeozoic sediments; lithosols and earths, including *Eucalyptus albens* woodlands. This region is characterized by summer rainfall (Environment Australia 2000).
IBRA Subregion	The Subject Land is located within the NSW Nandewar Northern Complex subregion. This subregion is described as low hills and ranges with abundant rock (granite) outcrop and tors. Short, steep gorges of major rivers. Karst landscapes on limestone. This IBRA Subregion is mapped as a Priority 4 investment region (OEH 2017b).
NSW Landscape Regions and Area	The Subject Land is mapped in the Ashford Mole Valleys Mitchell Landscape.
Percent Native Vegetation	A combination of existing mapping and ground truthed vegetation was used to estimate the Percent Native Vegetation Cover as follows: ■ Existing vegetation mapping was used to estimate the percent native vegetation within the 1500 m buffer area surrounding the Subject Land (see Figure 3.2). In the buffer area, PCTs were allocated based on existing vegetation mapping of the Inverell Shire as mapped by Peacock et. al. (2009) (VIS ID 3794) and aerial imagery. GIS was used to estimate the area. ■ Ground-truthed vegetation was used to estimate the portion of native vegetation within the Subject Land. PCT allocation was based on existing mapping and current vegetation condition (see Chapter 4). ■ The Percent Native Vegetation Cover was calculated by estimating the percent cover of native vegetation in the buffer area and Subject Land relevant to the benchmark for the PCT. Ten PCTs are mapped in the 1500 m buffer area (Table 4.1), covering approximately 1,347.27 ha. Within the Subject Land, a total of three PCTs in various conditions (woodland and derived grasslands) are present including 56.84 ha of mapped native vegetation (Table 4.2). Therefore, a total of 1,404.11 ha (68.49 %) of native vegetation cover is present within the assessment area.
Cleared Areas	Approximately 109.92 (65.92 %) of land within the Subject Land is cleared grazing land. Cleared areas are primarily grazed land (cattle and sheep), which provides limited foraging habitat for native species. Sheep can graze very close to the ground and like other livestock can lead to loss of vegetation and soil erosion particularly during the dry conditions encountered during the survey period.

Landscape Feature	Description
Rivers, Streams and Estuaries	Three major un-named creeks (tributaries of the Dumaresq River) are present within the Project Boundary (Lot 2 in DP 1039185). The largest of these creeks traverses the development site in a general north-southerly direction and is mapped as a third order stream (Strahler, 1952). The other two creeks are mapped as First Order Streams, and are located to the east and west of the third order stream. These streams were all noted to be dry (or very low water levels) at the time of the survey due to extended drought conditions. A review of the NSW Department of Infrastructure (DPI) threatened freshwater fish records (accessed via SEED), confirms that these creeks are not mapped as habitat of threatened aquatic species. The nearest creek with threatened aquatic species habitat is Little Oak Creek, located approximately 1.7 km west from the Subject Land. Aquatic habitat is described further in Section 4.2.6 and a preliminary aquatic impact assessment is provided in Section 4.2.6.3.
Wetlands	No wetlands occur in or adjacent to the Development Site. Aerial photographs show six farm dams are present within the Subject Land. These dams were all noted to be dry (or very low water levels) at the time of the survey due to extended drought conditions.
Connectivity Features	A wildlife corridor is a link of wildlife habitat, generally native vegetation, which joins two or more larger areas of similar wildlife habitat. Corridors are critical for the maintenance of ecological processes including allowing for the movement of animals and the continuation of viable populations. The Subject Land is located immediately north of a regional vegetated corridor that connects Crooked Creek National Park and Torrington State Conservation Area. Isolated paddock trees scattered across the development site also represent limited connectivity features for highly mobile species to travel across the landscape. The creeks present within the Subject Land have the potential to provide aquatic connectivity to Dumaresq River although it is noted that these streams were all dry (or very low water levels) at the time of the survey due to extended drought conditions and any connectivity would be seasonal at best. The Subject Land is not located within (or close to) any identified migratory bird flyways including the East Asian – Australasian Flyway and the West Pacific Flyway.
Areas of Geological Significance	No karsts, caves, crevices or cliffs or other areas of geological significance occur within the Development Site or are likely to occur within the broader Subject Land.
Areas of Outstanding Biodiversity Value (AOBV)	No Areas of Outstanding Biodiversity Value occur within the Development Site or the broader Subject Land.
High Biodiversity Values Map	In accordance with the NSW Biodiversity Values Map (See Figure 3.1 and BOSET report in Appendix A), the Subject Land does not contain high biodiversity values. The nearest area mapped with high biodiversity values are Little Oak Creek and Beardy River, located at approximately 1.7 km to the west and 2.3 km to the east, respectively.



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Biodiversity Value Areas - NSW OEH

High Biodiversity Values Map

F3.1

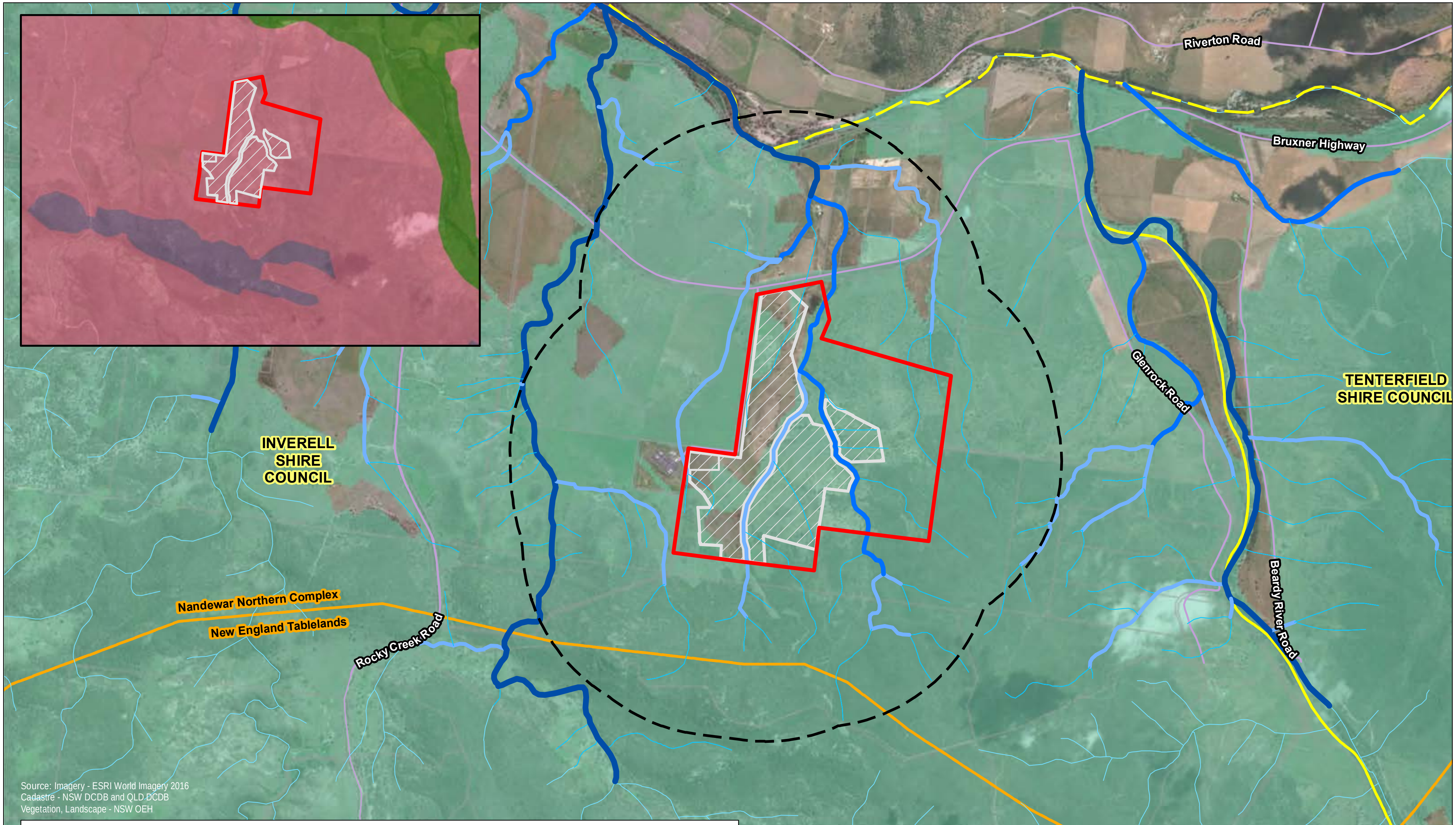
Drawing No: 0470861s_BS_BDAR_G003_R1.mxd
Date: 12/06/2019
Drawing Size: A4
Drawn By: DR/VN
Reviewed By: JW
Coordinate System: GDA 1994 MGA Zone 56

Biodiversity Development Assessment Report
Bonshaw Solar, NSW

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Vegetation, Landscape - NSW OEH

Legend

- 🟥 Project Boundary (Lot 2 DP1039185)
- ▨ Development Site
- ▭ 1500m Buffer
- 🟩 Native Vegetation

Stream Order
- 1st (10m)
- 2nd (20m)
- 3rd (30m)
- 4th & 5th (40m)

- State Boundary
- LGA Boundary
- Roads
- IBRA7 Region/Subregion

Mitchell landscapes
- 🟥 Ashford Mole Valleys
- 🟩 Dumaresq Channels
- 🟪 Inverell Plateau Granites

Location Map

F3.2

Drawing No: 0470861s_BS_BDAR_G004_R1.mxd
Date: 12/06/2019 Drawing Size: A4
Drawn By: DR/VN Reviewed By: JW
Coordinate System: GDA 1994 MGA Zone 56

0 0.5 1km

N

Biodiversity Development Assessment Report
Bonshaw Solar, NSW

Client: GAIA Australia

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ERM

4. NATIVE VEGETATION

The extent of native vegetation within the development site was determined in accordance with Section 5 of the BAM (OEH 2017a).

The development site is currently primarily used for sheep and cattle grazing. Native vegetation is highly modified by both historical and ongoing management practices including clearance of the original vegetation type, livestock grazing and weed invasion. A large portion of the development site is cleared and disturbed land, the majority of which no longer reflects the species composition of the community from which it was likely derived. Forb diversity and coverage is very low, dominated by those species tolerant of heavy grazing.

Woodland areas show evidence of different degrees of impact, the most notable one is on-going clearing and presence of monospecific stands (e.g. White Cypress Pine) due to a long history of timber removal. Vegetation within the development site comprises:

- 46.06 ha Native Vegetation;
- 12.78 ha Derived Native Grasslands; and
- 109.92 ha Cleared Land, Disturbed Grasslands and Dams.

Paddock trees throughout the development site were assessed under the streamlined assessment module – clearing paddock trees (Appendix 1 of the BAM) and incorporated into this report. They are considered both in terms of ecosystem credits and as habitat for threatened species and any credits generated are additional to those created by applying the full BAM.

4.1 Native Vegetation Assessment Methodology

4.1.1 Review of existing information

A search was undertaken of the OEH Vegetation Information System (VIS) database and NSW SEED (Sharing and Enabling Environmental Data) mapping to access existing vegetation mapping information within the Subject Land. The State Vegetation Type Map – Borders Rivers Gwydir / Namoi (VIS ID 4681) provides vegetation mapping for the Inverell Shire. This state vegetation type map (SVTM) is based on regional mapping in Peacock *et. al.* (2009) (VIS ID 3794) and identifies seven Plant Community Types (PCTs) within the Subject Land and eleven PCTs within the 1500m buffer area as listed in Table 4.1 below.

Table 4.1 Mapped Vegetation Communities (SVTM VIS 4681) within the Buffer Area and Subject Land (not ground-truthed)

PCT ID	PCT Name	Extent in Buffer Area (ha)	Extent in Development Site (ha)
NA	Cleared Land	533.94	88.50
1	Candidate Native Grasslands	467.83	52.34
78	River Red Gum riparian tall woodland / open forest wetland in the Nandewar Bioregion and Brigalow Belt South Bioregion	27.39	
84	River Oak – Rough-barked Apple – Red Gum – Box riparian tall woodland (wetland) of the Brigalow Belt South and Nandewar Bioregions	28.36	1.33
505	Black Cypress Pine - Tumbledown Red Gum - Narrow-leaved Ironbark - Stringybark She Oak open forest on acid volcanics of the western New England Tableland Bioregion	1.07	
516	Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion	45.10	7.19

PCT ID	PCT Name	Extent in Buffer Area (ha)	Extent in Development Site (ha)
544 *	Rough-barked Apple – White Cypress Pine – Blakely's Red Gum riparian open forest / Woodland of the Nandewar Bioregion and New England Tableland Bioregion	3.55	
549	Silver-leaved Ironbark – Black Cypress Pine +/- White Box shrubby open forest mainly in the northern Nandewar Bioregion	213.74	0.66
578	Tumbledown Red Gum - Black Cypress Pine - Caley's Ironbark shrubby open forest of the Nandewar Bioregion and western New England Tableland Bioregion	2.96	
594	Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion	173.88	16.84
596	Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion	379.64	0.02
599	Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion	0.71	

** PCT 544 corresponds to the BC Act listed endangered ecological community (EEC) "White Box Yellow Box Blakely's Red Gum Woodland", which also corresponds to part of the EPBC listed critically endangered ecological community (CEEC) "White Box Yellow Box Blakely's Red Gum Woodland".*

4.1.2 Targeted Floristic Survey

Based on the results of the desktop assessment presented in Table 4.1 above, flora surveys were undertaken in September 2018, December 2018 and March 2019 as follows:

- The first survey was undertaken between the 10th and 14th September 2018 by ERM ecologists, Joanne Woodhouse and Dr Adriana Corona Mothe. The aim of the initial survey was to determine the PCTs on the development site and their condition on site. Random meander transects were conducted in areas of native vegetation and rapid vegetation assessments were undertaken to record the presence of native vegetation, threatened flora and to ground-truth existing mapping. PCT's were identified from the native species present, landforms and physiography and location within the IBRA subregion with reference to the BioNet Vegetation Classification Database. The subject land was then stratified into areas of similar condition class to determine vegetation zones for each PCT and detailed floristic surveys were undertaken on 11 - 12 September 2018.
- The second survey was undertaken between the 10th and 14th December 2018 by ERM ecologists Tom Cotter and Dr Adriana Corona Mothe. Vegetation integrity plots (20m by 50m) were established in each vegetation zone over three days on the 11 - 13 December 2018. Data was collected on the composition, structure and function of the vegetation in accordance with the methodology presented in the BAM 2017 and under the directions of persons accredited under the BAM. The number of plots for each zone was based on the area of each zone and the minimum number of plots and transects required per zone area as specified by the BAM.
- The third survey was undertaken between the 25 and 29 March by Dr Toivo Zoete and Dr Adriana Corona Mothe and included additional vegetation integrity plots over four days from 25 to 28 March 2019.

A total of nine native vegetation zones plus cleared land were identified in the Subject Land as listed in Table 4.4 and mapped in *Figure 4.2*. Based on the assessment of each PCT, it was decided to stratify each of the three PCTs based on the following:

- Absence of upper stratum, condition of the stratum and composition. Due to the high level of disturbance at the Development Site, treed areas were commonly represented by a single species of trees or the presence of trees were significantly reduced when compared with tree composition and structure as per PCTs descriptions.
- Structure and function of the vegetation in other stratum, e.g. ground cover.
- Presence of exotic species and their abundance/cover as well as bare ground.

Each vegetation zones was considered homogeneous and well represented by the plot data. As outlined in Table 4.2, a total of 42 flora plots were collected in accordance with section 5 of the BAM (OEH 2017) by ecologists trained in the BAM (Joanne Woodhouse and Adriana Corona Mothe) and under the direction of Dr Adriana Corona Mothe who is accredited under the BAM. At each plot location the following was undertaken:

- one 20 x 20 m plot for assessment of composition and structure; and
- one 20 x 50 m plots for assessment of function, including a series of five 1 x 1 m plots to assess average leaf litter cover.

The assessment of composition and structure recorded species name, stratum, growth form, cover and abundance rating for each species present within the plot. Cover (foliage cover) was estimated for all species rooted in or overhanging the plot, and recorded using decimals (if less than 1%, rounded to whole number (1 - 5%) or estimated to the nearest 5% (5 - 100%). Abundance was counted (up to 20) and estimated above 20.

The assessment of function recorded the number of large trees, the presence of tree stem size class, tree regeneration, number of trees with hollows and length of fallen logs, as well as leaf litter cover within the 20 x 50 m plot and five 1 x 1 m subplots. The minimum number of plots and transects per vegetation zone was determined using Table 4 of the BAM (OEH 2017a). Portions of the land within the study area are either cleared land, cropped or consist of exotic grassland. Under the BAM (OEH 2017a), land not containing native vegetation is not subject to assessment beyond Section 5.4 (determination of a vegetation integrity score). A large proportion grassland occurs within the development site, ranging from exotic with few native grass species, to areas of low diversity native pasture. Cleared land and disturbed grasslands were assigned to the most likely PCT and mapped as “Disturbed Grasslands”.

4.1.3 PCT identification

The method used for PCT identification included the following:

- Use of the BioNet Vegetation Classification’s Community Identification keys. Search Criteria used included Vegetation Formation, Vegetation Class, IBRA Region and selected community species in the upper / mid / low stratum. This search produced a shortlist of potential PCTs.
- Selection of the PCT was undertaken by comparing the descriptions of each potential PCT with characteristics of the vegetation such as landform location, species composition and other landscape features relevant to the vegetation community. When the vegetation community under assessment was likely to conform to more than one PCT, the decision on a given PCT over other options was based on presence of characteristic species, species richness and other aspects of the PCT description.
- The condition of the PCT was defined based on the absence of upper stratum, dominance of exotics over natives and percentage bare land present.
- Where derived grasslands were identified, the most likely PCT was allocated based on number of native species shared with a given PCT, its location, landscape features and the neighbouring PCTs.

4.1.4 Paddock Tree Assessment

Isolated trees present in cleared and disturbed grasslands were assessed in accordance with the streamlined paddock trees assessment protocol as per Appendix 1 of the BAM (OEH 2017). Assessment of paddock trees was undertaken by a combination of on-site observations and aerial photo interpretation. In the BAM, vegetation meets the definition of paddock trees if:

- The trees are located on category 2 land are surrounded by category 1 land on the regulatory maps under the Biodiversity Conservation Act (The Native Vegetation Regulatory Map was accessed via: https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=NVRMap), or
- The native vegetation that comprises the groundcover is:
    - Less than 50% of the cover of indigenous species of vegetation; and
    - Not less than 10% of the area is covered with vegetation (whether dead or alive); and
    - The assessment is made at the time of the year when the proportion of the amount of indigenous vegetation in the area to the amount of non-indigenous vegetation in the area is likely to be at its maximum; and
- The foliage cover for the tree growth form group is less than 25% of the benchmark for tree cover for the most likely plant community type, or
- It is a tree located more than 50m away from any living tree that is greater than 20cm DBH and the tree is located on category 2 land that is surrounded by category 1 land; or it is a group of three (3) or fewer living trees within a distance of 50m of each other, that in turn, are greater than 50m from the next living tree that is greater than 20cm DBH and located on category 2 land that is surrounded by category 1 land.

Paddock trees were mapped in the field using a handheld geographic information system (GPS) and/or tablet with map layer (ArcGIS). Trees were identified to genus and species. The Diameter at Breast Height (DBH) of the tree was assessed and assigned a paddock tree class relevant to the large tree benchmark. The large tree benchmark for PCTs 516, 594 and 596 is 50cm DBH. The trees were visually assessed from the ground to determine whether any hollows were present.

4.2 PCTs Identified in the Subject Land

Determination of PCTs within the Subject Land identified the presence of three Plant Community Types (PCT) as shown in Table 4.2 below.

Table 4.2 Plant Community Types mapped within the Subject Land

Plant Community Type		Vegetation Formation	Vegetation Class	Area (ha)
ID No	Name			
516	Derived Native Grasslands of Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion	Grassy Woodlands	Western Slopes Grassy Woodlands	9.79
594	Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)	North-west Slopes Dry Sclerophyll Woodlands	25.64
596	Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)	North-west Slopes Dry Sclerophyll Woodlands	21.41

A detailed description of each of these PCTs follows in Table 4.3 to Table 4.5.

Table 4.3 PCT 594: Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion

PCT 594: Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion		
Vegetation Formation	Dry Sclerophyll Forest (Shrub/grass sub-formation)	
Vegetation Class	North-west Slopes Dry Sclerophyll Woodlands	
Vegetation Type	PCT ID:	594
	PCT's Common Name:	Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion
	Condition	Moderate Low
Description	Tall woodland to open forest dominated by Silver-leaved Ironbark (*Eucalyptus melanophloia*) and Black Cypress Pine (*Callitris endlicheri*). Other trees may include White Box (*Eucalyptus albens*), White Cypress Pine (*Callitris glaucophylla*), Tumbledown Red Gum (*Eucalyptus dealbata*), Narrow-leaved Ironbark (*Eucalyptus crebra*) and less often Smooth-barked Apple (*Angophora leiocarpa*) The shrub layer is sparse to mid-dense and includes *Olearia elliptica*, *Notelaea microcarpa var. microcarpa*, *Hibbertia obtusifolia*, *Melichrus urceolatus*, *Xanthorrhoea johnsonii*, *Acacia elongata*, *Breynia cernua*, *Acacia leiocalyx subsp. leiocalyx*, *Acacia penninervis* var. *penninervis*, *Beyeria viscosa* and *Pimelea neo-anglica*. The ground layer is sparse with frequent grass species including *Eragrostis leptostachya*, *Enneapogon gracilis*, *Aristida ramosa*, *Cymbopogon refractus*, *Austrostipa scabra* and *Aristida vagans*. Forb species include *Dichondra repens*, *Vittadinia cuneata*, *Brunoniella australis*, *Dichondra* sp. A, *Rostellularia adscendens* subsp. *adscendens*, *Scleria mackaviensis* and *Phyllanthus virgatus*. The rock ferns *Cheilanthes sieberi* subsp. *sieberi* and *Cheilanthes distans* are common. Climbers include *Parsonsia eucalyptophylla*, *Desmodium brachypodum* and *Desmodium varians*. Occurs on shallow loamy sand soils mostly derived from sandstone on hills with rocky outcrops mainly in the northern Nandewar Bioregion from north of Bingara to Arakoola with outliers in the Mole River district. The PCT is found on conglomerate and sandstone on hills and low hills. At the Subject Land the PCT is present in both moderate and low condition. Dominant tree species recorded were Silver-leaved Ironbark, White Box and White Cypress Pine. Some areas of the community lack Eucalypt trees completely and identification of likely PCT was based on landform and characterisic ground cover species. Species characteristic of the community include *Oxalis perennans*, Poison Pimelea (*Pimelea neo-anglica*), *Mielichrus urceolatus*, Purple Wiregrass (*Aristida ramosa*), Speargrass (*Austrostipa scabra subsp. scabra*), Yellow Burr-daisy (*Calotis lappulacea*), Slender Flat-sedge (*Cyperus gracilis*), Barbed Wrie Grass (*Cymbopogon refractus*), *Cheilates sieberi*, *Glycine clandestina* and Corrugated Sida (*Sida corrugata*).	
Approximate extent within Subject Land	Moderate: 18.78 ha Low: 7.02 ha	
BAM Plots in PCT	Moderate: Four plots (P2, P7, P15 and P16) Low: five plots (P1, P9, P17, P21 and P40)	
Justification of evidence used to identify the PCT	PCTs 594 and 596 had similar distributional patterns and a total of nine species characteristic of each PCT was recorded in some of these plots, including White Cypress Pine, which is listed as a dominant species in both PCTs.	

PCT 594: Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion	
	The decision was made to select PCT 594 based on the abundance of *Austrostipa scabra subsp. scabra*, *Sporobolus creber* and/or Poison Pimelea which is are characteristic species of PCT 594 and are absent in PCT 596. This PCT was identified relying on the presence of species typical of the PCT as follows: Upper stratum: dominated by Silver-leaved Ironbark and/or White Box Mid-stratum: presence of White Cypress Pine and/or Poison Pimelea Ground stratum: presence of *Oxalis perennans*, *Austrostipa scabra subsp. scabra, Cymbopogon refractus and Aristida ramosa* The condition of this PCT was selected based on the presence of upper stratum, low level of exotic species (e.g. Tiger Pear), low intensity of sheep and cattle grazing.
TEC Status	PCT 594 is not associated with a TEC
Estimate of percent cleared	53%
Images of PCT within the Subject Land	 **Photograph 4-1 View of PCT 594 in Plot 2**

PCT 594: Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion

Photograph 4-2 View of PCT 594 in Plot 21

PCT – Plant Community Type; TEC – Threatened Ecological Community

Table 4.4 PCT 596: Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion

PCT 596: Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion		
Vegetation Formation	Dry Sclerophyll Forest (Shrub/grass sub-formation)	
Vegetation Class	North-west Slopes Dry Sclerophyll Woodlands	
Vegetation Type	PCT ID:	596
	PCT's Common Name:	Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion
	Condition	Moderate Low Very Low Derived Native Grassland

PCT 596: Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion

Description	Mid-high to low woodland or open forest dominated by Tumbledown Red Gum (*Eucalyptus dealbata*), White Cypress Pine (*Callitris glaucophylla*) and Silver-leaved Ironbark (*Eucalyptus melanophloia*). Other tree species may include Caley's Ironbark (*Eucalyptus caleyi subsp. caleyi*), Rough-barked Apple (*Angophora floribunda*), Long-fruited Bloodwood (*Corymbia dolichocarpa*), Black Cypress Pine (*Callitris endlicheri*) and Rusty Fig (*Ficus rubiginosa*). There is usually a dense shrub/small tree layer of species such as *Leptospermum brevipes*, *Acacia cheelii*, *Notelaea microcarpa var. microcarpa*, *Melichrus urceolatus*, *Xanthorrhoea johnsonii* and *Leucopogon muticus*. The vine *Pandorea pandorana* is often abundant. The ground layer is sparse with *Cheilanthes distans*, *Cheilanthes sieberi subsp. sieberi*, *Aristida vagans*, *Cymbopogon refractus*, *Entolasia stricta* and *Aristida ramosa* most frequent. Forb species include *Plectranthus parviflorus*, *Commelina cyanea*, *Scleria mackaviensis*, *Dichondra* species A, *Calotis lappulacea*, *Phyllanthus virgatus*, *Vittadinia sulcata* and *Galium guadichaudii*. Occurs on shallow loamy sand soils in hilly areas at low altitudes. At the Subject Land, the PCT is present in a disturbed state due to the long history of clearing, grazing and timber removal. Upper stratum is represented by Tumbledown Red Gum (*Eucalyptus dealbata*), Silver-leaved Ironbark (*Eucalyptus melanophloia*), Orange Gum (*Eucalyptus prava*), Black Cypress Pine (*Callitris endlicheri*) and White Cypress Pine (*Callitris glaucophylla*). Other species present include: Purple Wiregrass (*Aristida ramosa*), Bristly Cloak Fern (*Cheilanthes distans*), Barbed Wire Grass (*Cymbopogon refractus*), Slender Flat-sedge (*Cyeprus gracilis*), Slender Tick-trefoil (*Desmodium varians*), Urn-heath (*Melichrus urecolatus*), Thargomindah Nightshade (*Solanum sturtianum*), Yellow Burr-daisy (*Calotis lappulacea*), Johnson's Grass Tree (*Xanthorrhoea johnsonii*), *Glycine clandestina* and *Vittadina sulcata*.
Approximate extent within the Subject Land	Moderate: 11.40 ha Low: 0.42 ha Very Low: 0.30 ha Derived Grassland in Low condition: 9.29
BAM Plots in PCT	Moderate: four plots (P8, P10, P11 and P12) Low: two plots (P3 and P5) Very Low: one plot (P41) Derived Grassland in Low condition: four plots (P14, P23, P26 and P29)
Justification of evidence used to identify the PCT	This PCT was identified relying on the presence of dominant tree species and other typical species of the PCT as follows: ■ Upper stratum: dominated by Tumbledown Red Gum, Orange Gum and Silver-leaved Ironbark ■ Mid-stratum: dominated by White Cypress Pine, presence of other species such as Black Cypress Pine ■ Ground stratum: presence of *Cheilantes distans*, a frequent species in the PCT; along with other species such as Thargomindah Nighshade. The condition of this PCT was selected based on the presence of upper stratum, number of exotic species (e.g. Tiger Pear) and intensity of sheep and cattle grazing.
Species relied upon for PCT identification	Orange Gum, Silver-leaved Ironbark, Black Cypress Pine, White Cypress Pine, Barbed Wire Grass and Bristly Cloak Fern (*Cheilantes distans*).
TEC Status	PCT 596 is not associated with a TEC
Estimate of percent cleared	38%

PCT 596: Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion	
Images of PCT within the Development Site	 13:25 13/DEC/2018 **Photograph 4-3 View of PCT 596 in Plot 10**  12:12 12/SEP/2018 **Photograph 4-4 View of PCT 594 in Plot 5**
Notes: PCT – Plant Community Type; TEC – Threatened Ecological Community	

Table 4.5 PCT 516: Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion

PCT 516: Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion		
Vegetation Formation	Grassy Woodlands	
Vegetation Class	Western Slopes Grassy Woodlands	
Vegetation Type	PCT ID:	516
	PCT's Common Name:	Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion
	Condition	Moderate Very Low Derived Native Grasslands in Moderate condition
Description	This PCT is described as widespread, mid-high to very tall woodland or open forest occurring on flat to undulating sites at low to mid elevation, mainly on fine-grained soils on sedimentary and metasedimentary substrates. It is dominated by Grey Box (*Eucalyptus moluccana*) (crossing with *Eucalyptus albens* at sites with basalt influence) which is associated with Blakely's Red Gum (*Eucalyptus blakelyi*), Yellow Box (*Eucalyptus melliodora*) and/or White Cypress Pine (*Callitris glaucophylla*), with occasional Rough-barked Apple (*Angophora floribunda*). A sparse shrub layer of *Notelaea microcarpa var. microcarpa* and/or *Dodonaea viscosa subsp. spatulata* is sometimes present. The ground layer is dense and diverse, containing a mix of grasses and forbs including *Cymbopogon refractus*, *Austrostipa scabra subsp. scabra*, *Aristida ramosa*, *Asperula conferta*, *Bothriochloa decipiens*, *Daucus glochidiatus*, *Dichanthium sericeum subsp. sericeum*, *Carex inversa*, *Chrysocephalum apiculatum*, *Cymbonotus lawsonianus*, *Dichondra* sp. A, *Glycine tabacina*, *Poa sieberiana*, *Desmodium varians*, *Eremophila debilis*, *Austrodanthonia racemosa var. obtusata, Austrostipa verticillata, Dichondra repens, Hydrocotyle laxiflora, Plantago debilis, Rostellularia adscendens subsp. adscendens, Chloris ventricosa, Geranium solanderi var. solanderi, Cyperus gracilis, Hypericum gramineum*, and (rarely) *Panicum paludosum*. This community is found in the undulating floors of the major river valleys of the Nandewar and far western New England bioregions. At the Subject Land, the community is highly disturbed with few characteristic species present, including: White Cypress Pine (*Callitris glaucophylla*), Silver-leaved Ironbark (*Eucalyptus melanophoia*), Small-leaf Bluebush (*Maireana microphylla*), Purple Wiregrass (*Aristida ramosa*), *Dichondra* sp. A, Red Grass (*Botriochloa decipiens*) and Speargrass (*Austrostipa scabra subsp. scabra*),	
Approximate extent within the Subject Land	Moderate: 0.57 ha Very Low: 5.72 ha Derived Grassland in Moderate condition: 3.46 ha	
BAM Plots in PCT	Moderate: one plot (P38) Very Low: three plots (P31, P39 and P42) Derived Grassland in Moderate condition: two plots (P28 and P32)	
Justification of evidence used to identify the PCT	PCT 516 was identified based on the presence of characteristic species of this vegetation community and its distribution at landform elements such as drainage depression.	

PCT 516: Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion	
	This PCT was identified relying on the presence of species typical of the PCT as follows: ■ Upper stratum: Silver-leaved Ironbark ■ Mid-stratum: presence of Small-leaf Bluebush ■ Ground stratum: presence of Dichondra sp. A, Purple Wiregrass, Speargrass and Red GrassDistribtuion near drainage depression The condition of this PCT was selected based on the presence of upper stratum, low level of exotic species (e.g. Tiger Pear), low intensity of sheep and cattle grazing.
Species relied upon for PCT identification	Small-leaf Bluebush, Purple Wiregrass, *Dichondra* sp. A, Red Grass and Speargrass
TEC Status	PCT 516 is not associated with a TEC
Estimate of percent cleared	85%
Images of PCT within the Subject Land	 10:29 28/MAR/2019 **Photograph 4-5 View of Moderate Condition PCT 516 in Plot 38**

PCT 516: Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion

Photograph 4-6 View of Very Low Condition PCT 516 in Plot 42

Notes: PCT – Plant Community Type; TEC – Threatened Ecological Community

4.2.1 Cleared and Disturbed Land

Cleared and disturbed land within the Subject Land has a long history of heavy grazing and do not correspond to any known PCT. However to facilitate this assessment and in accordance with the BAM (and advice from OEH confirming that Common Couch is to be included in the BAM calculator as a native species), they have been assigned a likely PCT based on surrounding vegetation and location within the landscape. Three vegetation zones for cleared and disturbed land were assessed:

- 516_Disturbed Land: a total of 8.71 ha of cleared and/or highly disturbed land. A total of three BAM plots were undertaken in this vegetation zone (P27, P33 and P35).
- 594_Disturbed Land: a total of 45.95 ha of cleared and/or highly disturbed land. A total of eight BAM plots were undertaken in this vegetation zone (P6, P18, P19, P22, P24, P25, P36 and P37).
- 596_Disturbed Land: a total of 54.44 ha of cleared and/or highly disturbed land. A total of five BAM plots were undertaken in this vegetation zone (P4, P13, P20, P30 and P34).

Cleared and disturbed land was widespread across the Subject Land which is consistent with its historical and current land uses which include clearing, cropping and grazing. Cows and sheep were present across the Subject Land and a very intense level of grazing was observed. Flora species included a mix of native and exotic species, including high threat exotics (see flora list in Appendix H). Upper and mid-stratum were generally absent, with exception of some isolated scattered trees as shown in photographs below.

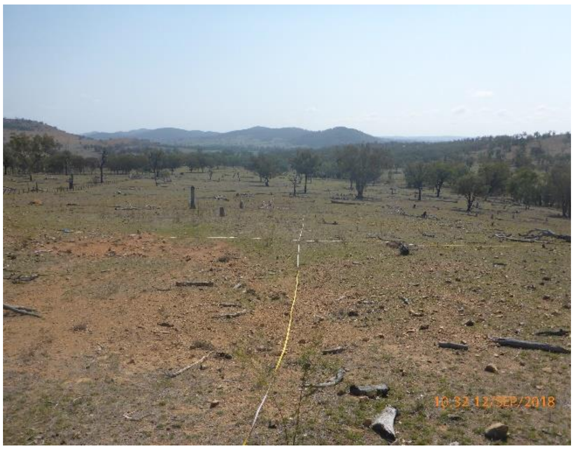
4.3 Vegetation Integrity Assessment

4.3.1 Vegetation zones and survey effort

The random meander surveys and detailed floristic plots have been used to assist the delineation of zones. Each of the identified PCTs were stratified into zones with a similar broad condition state. These zones were defined based on the overstorey condition, understorey condition and observed land management practices.

A total of nine native vegetation zones plus cleared land were identified in the development site as listed in Table 4.6 and mapped in Figure 4.2.

A total of 42 vegetation integrity plots were collected in accordance with section 5 of the BAM (OEH 2017) to determine their condition.



Photograph 4-7: View of cleared land in plot P4

Photograph 4-8: View of cleared land in plot P13

Photograph 4-9: View of cleared and disturbed land in plot P35

Photograph 4-10: View of cleared and disturbed land in plot P22

Table 4.6 Vegetation Zones within the Development Site

Zone ID	PCT ID	Stratification Unit / Condition Class	Extent within development site (ha)	No BAM plots required	Survey effort (Number of Plots)	Patch Size (ha) (Number of patches)	PCT and its Vegetation Zones described in Table
Native Vegetation							
1	594_ Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion	Moderate	18.62	3	4	<5 ha (4), 5-24 ha (2)	Table 4.3
2	594_ Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion	Low	7.02	3	5	<5 ha (11)	
3	596_ Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion	Moderate	11.40	3	4	<5 ha (3); 5-24 ha(1)	Table 4.4
4	596_ Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion	Low	0.39	1	2	<5 ha (3)	
5	596_ Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion	Very Low	0.30	1	1	< 5 ha (1)	
6	596_Derived	Low	9.32	3	4	<5 ha (5)	
7	516_Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion	Moderate	0.57	1	1	5-24 ha (1)	Table 4.5
8	516_Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion	Very Low	5.76	3	3	<5 ha (8)	

Zone ID	PCT ID	Stratification Unit / Condition Class	Extent within development site (ha)	No BAM plots required	Survey effort (Number of Plots)	Patch Size (ha) (Number of patches)	PCT and its Vegetation Zones described in Table
9	516_Derived	Moderate	3.46	2	2	<5 ha (7)	
Cleared Land and Disturbed Grasslands							
NA	Farm Dams	NA	0.35	NR	NR	NA	See Section 4.2.6
10	516_Disturbed Grassland	Other	8.71	3	3	<5 ha (4), 5-24 ha (1)	See Section 4.2.3.1
11	594_Disturbed Grassland	Other	45.95	4	8	<5 ha (7), 25-100 ha (1)	
12	596_Disturbed Grassland	Other	54.44	5	5	<5 ha (6); 5-24 ha (2), 25-100 ha (1)	
13	Cleared Land	Other	0.312	-	-	<5 ha (at least 2 road sections)	

NA = Not applicable; NR = Not required under the BAM; PCT = Plant Community Type; Other – cleared/disturbed land with no identifiable condition to a known PCT

4.3.2 Paddock Trees

In accordance with the Native Vegetation Regulatory Map (accessed on 12 April 2019), the Subject Land (located on the western portion of Lot 2 DP 139185) is not Category 1 or Category 2.

Paddock trees included in the present assessment were located outside of mapped woodland zones and the ground cover was grazed, cleared or exotic grassland.

A total of 28 paddock trees were recorded in cleared land on the north-western portion of the Subject Land on 13 September 2018. Additional opportunistic observations of paddock trees were made throughout the various survey periods. Paddock trees recorded included:

- A total of 20 Paddock Trees assessed in detail as outlined within Appendix 1 of the BAM (OEH 2017a):
  - Class 2: A total of 13 trees, one tree with hollows and 12 trees without hollows;
  - Class 3: A total of seven trees, four trees with hollows and three trees without hollows.
- Eight additional paddock trees for which opportunistic observations were made. The DBH of those trees was not measured, but all of them have been recorded as hollow-bearing trees (HBT). As a precautionary measure, these trees were allocated to Class 3.

The paddock trees occurring in the Subject Land are shown in Table 4.7 and shown in *Figure 4.4*.

Threatened species that would use the paddock trees are assumed to be the same threatened species that are returned by the BAM Calculator for the vegetation zones. Where targeted fauna surveys were required for the BAM Calculations, paddock trees were also included in the surveys. Assessments of threatened species that would use the paddock trees as habitat has been incorporated into this BDAR under Section 4 and 5.

Table 4.7 Paddock Trees within the Development Site

ID	Latitude	Longitude	Scientific Name	Common Name	Height (m)	DBH (cm)	DBH above benchmark (50cm)	Paddock Tree Class	Hollows Present	Impacted by Proposal
1	-29.1954	151.3385	*Eucalyptus melanophloia*	Silver-leaved Ironbark	23	32	No	Class 2	None	Yes, to be cleared
2	-29.1953	151.3370	*Eucalyptus albens*	White Box	22	34	No	Class 2	None	Yes, to be cleared
3	-29.1953	151.3370	*Eucalyptus albens*	White Box	26	42	No	Class 2	None	Yes, to be cleared
4	-29.1944	151.3365	*Eucalyptus albens*	White Box	24	46	No	Class 2	None	No, outside footprint
5	-29.1937	151.3391	*Eucalyptus albens*	White Box	24	42	No	Class 2	Small (<5 cm)	Yes, to be cleared
6	-29.1939	151.3392	*Eucalyptus albens*	White Box	24	38	No	Class 2	None	Yes, to be cleared
7	-29.1939	151.3392	*Eucalyptus albens*	White Box	22	26	No	Class 2	None	Yes, to be cleared
8	-29.1939	151.3392	*Eucalyptus albens*	White Box	26	52	Yes	Class 3	Small (<5 cm)	Yes, to be cleared
9	-29.1946	151.3402	*Eucalyptus albens*	White Box	28	74	Yes	Class 3	None	Yes, to be cleared
10	-29.1946	151.3402	*Eucalyptus albens*	White Box	22	35	No	Class 2	None	Yes, to be cleared
11	-29.1898	151.3418	*Eucalyptus albens*	White Box	21	31	No	Class 2	None	Yes, to be cleared
12	-29.1903	151.3412	*Angophora floribunda*	Rough-barked Apple	29	54	Yes	Class 3	Small (<5 cm)	Yes, to be cleared
13	-29.1906	151.3411	*Eucalyptus albens*	White Box	25	43	No	Class 2	None	Yes, to be cleared
14	-29.1914	151.3412	*Angophora floribunda*	Rough-barked Apple	26	53	Yes	Class 3	None	Yes, to be cleared
15	-29.1914	151.3411	*Eucalyptus albens*	White Box	26	49	No	Class 2	None	Yes, to be cleared
16	-29.1912	151.3422	*Angophora floribunda*	Rough-barked Apple	22	38	No	Class 2	None	Yes, to be cleared
17	-29.1913	151.3385	*Eucalyptus melanophloia*	Silver-leaved Ironbark	26	54	Yes	Class 3	Medium (5-20 cm)	Yes, to be cleared
18	-29.1913	151.3389	*Eucalyptus albens*	White Box	28	56	Yes	Class 3	None	Yes, to be cleared
19	-29.1913	151.3389	*Eucalyptus albens*	White Box	29	48	No	Class 2	None	Yes, to be cleared
20	-29.1918	151.3391	*Eucalyptus albens*	White Box	25	57	Yes	Class 3	Small (<5 cm)	Yes, to be cleared
21	-29.1968	151.3401	*Eucalyptus albens*	White Box	-	-	Yes*	*Class 3**	Medium (5-20 cm)	Yes, to be cleared
22	-29.2	515.344	*Eucalyptus melanophloia*	Silver-leaved Ironbark	-	-	Yes*	*Class 3**	Medium (5-20 cm)	Yes, to be cleared
23	-29.194	151.3381	*Eucalyptus albens*	White Box	-	-	Yes*	*Class 3**	Medium (5-20 cm)	Yes, to be cleared
24	-29.2022	151.3378	*Eucalyptus melanophloia*	Silver-leaved Ironbark	-	-	Yes*	*Class 3**	Medium (5-20 cm)	Yes, to be cleared
25	-29.2029	151.3369	*Eucalyptus albens*	White Box	-	-	Yes*	*Class 3**	Medium (5-20 cm)	Yes, to be cleared
26	-29.2022	151.336	*Eucalyptus albens*	White Box	-	-	Yes*	*Class 3**	Medium (5-20 cm)	Yes, to be cleared
27	-29.2077	151.3418	*Eucalyptus melanophloia*	Silver-leaved Ironbark	-	-	Yes*	*Class 3**	Large (≥20 cm)	Yes, to be cleared
28	-29.2071	151.3409	*Eucalyptus melanophloia*	Silver-leaved Ironbark	-	-	Yes*	*Class 3**	Large (≥20 cm)	Yes, to be cleared

DBH = Diameter at Breast height;
** DBH of these trees was not measured, but all are hollow-bearing trees. Therefore, as a precautionary measure, it has been assumed that the trees are above the benchmark for PCTs at the site (i.e. Class 3 Paddock Trees).*

4.3.3 Vegetation Integrity Assessment Results

A total of 134 plant species were recorded within the 42 vegetation integrity survey plots (see Table H.6 in Appendix H). The field data sheets with results of the vegetation plots and photos of each plot are shown in Appendix G.

The plot data from the vegetation integrity survey plots were entered into the BAM calculator. The results of the vegetation integrity assessment are provided in Table 4.8.

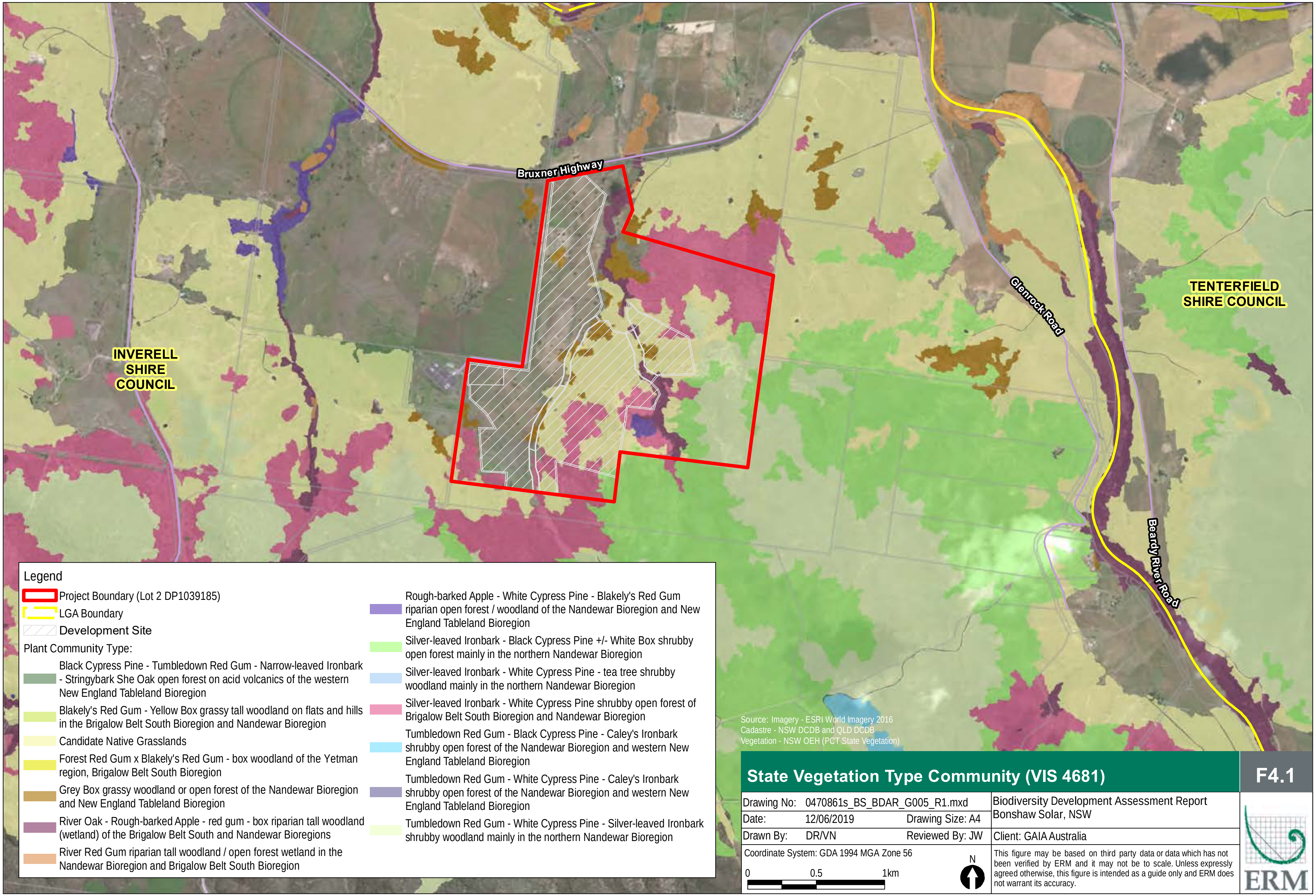
Table 4.8 Summary of Vegetation Integrity Scores

No	Vegetation Zone ID	Composition Score	Structure Score	Function Score	Vegetation Integrity Score[1]
1	PCT 594_Moderate	52.9	43.6	99.8	61.3
2	PCT 594_Low	39.3	18.4	50.9	33.3
3	PCT 596_Moderate	67.4	43.1	69.4	58.7
4	PCT 596_Low	18.9	40.9	71.8	38.2
5	PCT 596_Very Low	18.4	22.7	31.6	23.6
6	*PCT 596_Derived_Low*	*48.7*	*0.4*	*29.3*	*8*
7	PCT 516_Moderate	13.4	19.6	48.8	23.4
8	PCT 516_Very Low	31.6	11.2	24.9	20.7
9	PCT 516_Derived_Moderate	20	50.3	15	24.7
10	*516_Disturbed Grasslands*	*19.3*	*13.5*	*15*	*15.8*
11	*594_Disturbed Grasslands*	*29.5*	*8.6*	*21.4*	*17.6*
12	*596_Disturbed Grasslands*	*17.7*	*0.9*	*11*	*5.6*

1. where the vegetation has a current vegetation integrity score of:
- *<15 for a PCT representative of a critically endangered ecological community (CEEC) or an endangered ecological community (EEC)*
- *<17 for a PCT that provides habitat for threatened species or is representative of a vulnerable ecological community (VEC)*
- *<20 for a PCT that is not representative of a TEC or associated with threatened species habitat*

does not require an offset in the form of ecosystem credits

It is noted that vegetation zone 11, which corresponds to disturbed land has been allocated as 594_Disturbed Grassland for assessment purposes only. This vegetation zone returned a vegetation integrity score >17, but it is not representative of a vulnerable ecological community and based on extensive field survey is heavily disturbed and has not been mapped in Figure 4.2 as native vegetation. For the purposes of this BDAR, this zone has been included in the current assessment however ERM recommend that it be removed from the final credit obligations.



Legend

- 🟥 Project Boundary (Lot 2 DP1039185)
- 🟨 LGA Boundary
- ▨ Development Site

Plant Community Type:

- 🟩 Black Cypress Pine - Tumbledown Red Gum - Narrow-leaved Ironbark - Stringybark She Oak open forest on acid volcanics of the western New England Tableland Bioregion
- 🟨 Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion
- 🟨 Candidate Native Grasslands
- 🟨 Forest Red Gum x Blakely's Red Gum - box woodland of the Yetman region, Brigalow Belt South Bioregion
- 🟫 Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion
- 🟪 River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South and Nandewar Bioregions
- 🟧 River Red Gum riparian tall woodland / open forest wetland in the Nandewar Bioregion and Brigalow Belt South Bioregion
- 🟪 Rough-barked Apple - White Cypress Pine - Blakely's Red Gum riparian open forest / woodland of the Nandewar Bioregion and New England Tableland Bioregion
- 🟩 Silver-leaved Ironbark - Black Cypress Pine +/- White Box shrubby open forest mainly in the northern Nandewar Bioregion
- 🟦 Silver-leaved Ironbark - White Cypress Pine - tea tree shrubby woodland mainly in the northern Nandewar Bioregion
- 🟥 Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion
- 🟦 Tumbledown Red Gum - Black Cypress Pine - Caley's Ironbark shrubby open forest of the Nandewar Bioregion and western New England Tableland Bioregion
- 🟪 Tumbledown Red Gum - White Cypress Pine - Caley's Ironbark shrubby open forest of the Nandewar Bioregion and western New England Tableland Bioregion
- 🟨 Tumbledown Red Gum - White Cypress Pine - Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion

Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Vegetation - NSW OEH (PCT State Vegetation)

State Vegetation Type Community (VIS 4681)

F4.1

Drawing No: 0470861s_BS_BDAR_G005_R1.mxd
Date: 12/06/2019 Drawing Size: A4
Drawn By: DR/VN Reviewed By: JW
Coordinate System: GDA 1994 MGA Zone 56

0 0.5 1km

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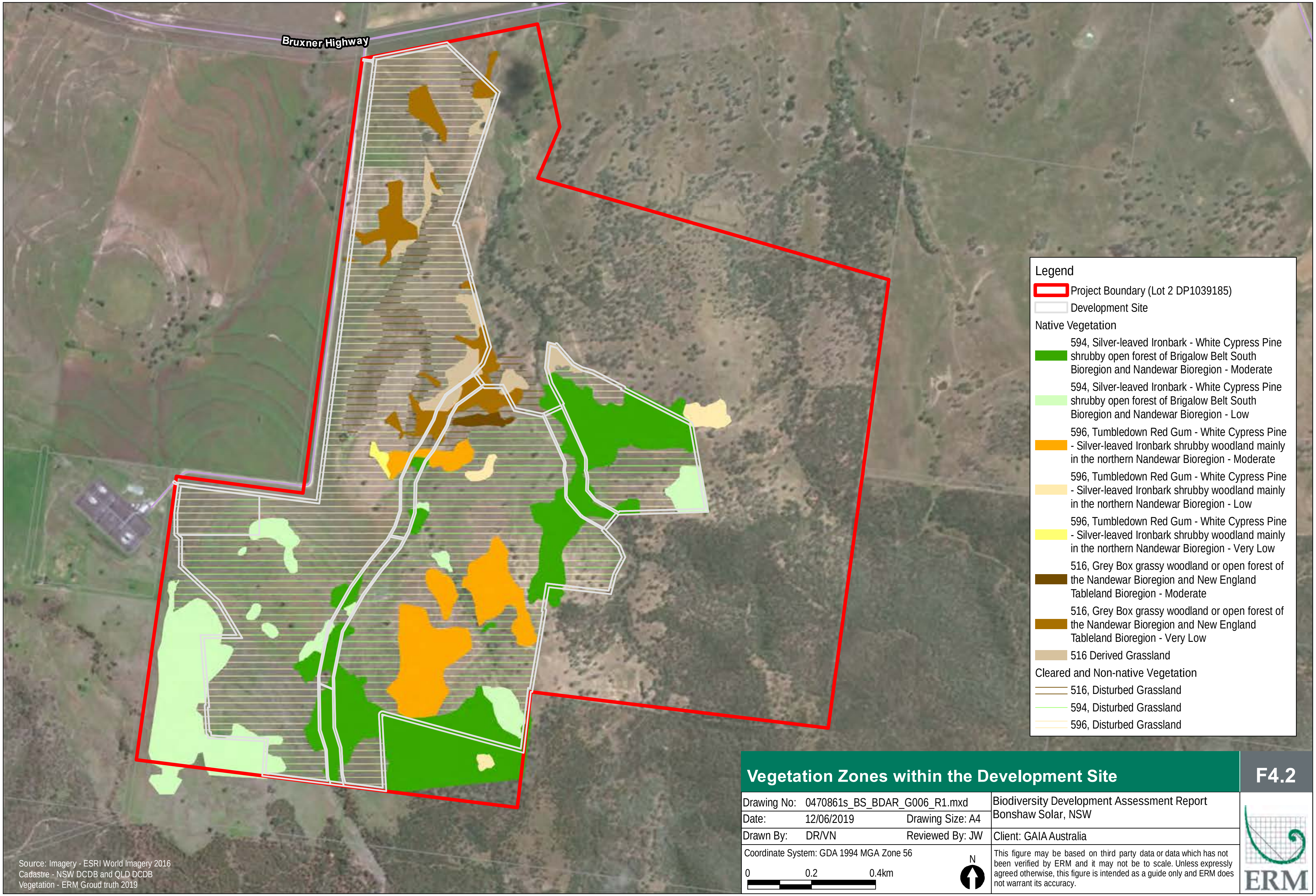
Biodiversity Development Assessment Report
Bonshaw Solar, NSW

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Vegetation - ERM Groud truth 2019

Vegetation Zones within the Development Site

F4.2

Drawing No:	0470861s_BS_BDAR_G006_R1.mxd		
Date:	12/06/2019	Drawing Size:	A4
Drawn By:	DR/VN	Reviewed By:	JW

Coordinate System: GDA 1994 MGA Zone 56

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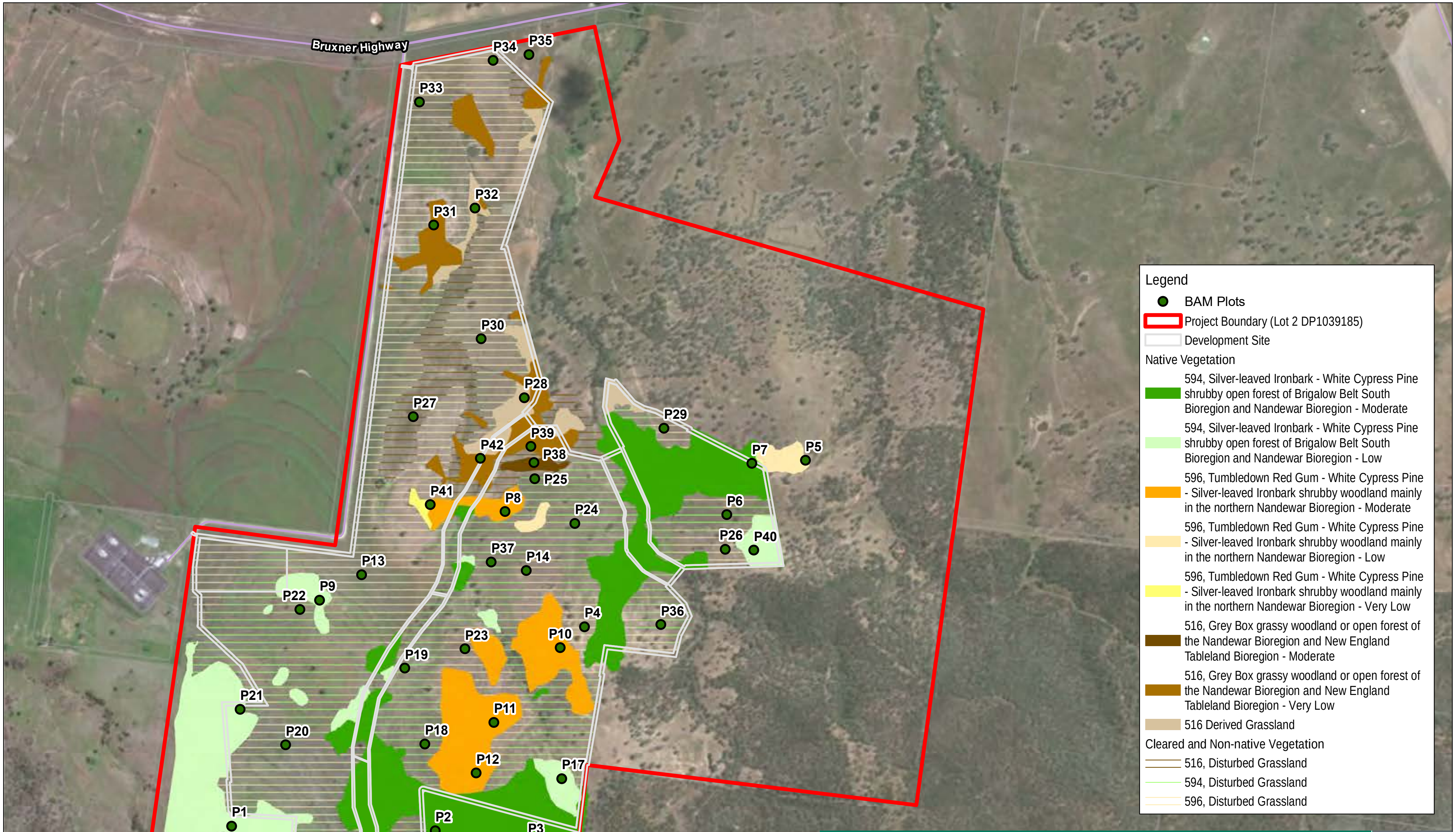

Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Vegetation, BAM Plot - ERM Groud truth 2019

PCTs and BAM Plot locations

F4.3

Drawing No: 0470861s_BS_BDAR_G007_R1.mxd
Date: 14/06/2019 Drawing Size: A4
Drawn By: DR/VN Reviewed By: JW
Coordinate System: GDA 1994 MGA Zone 56

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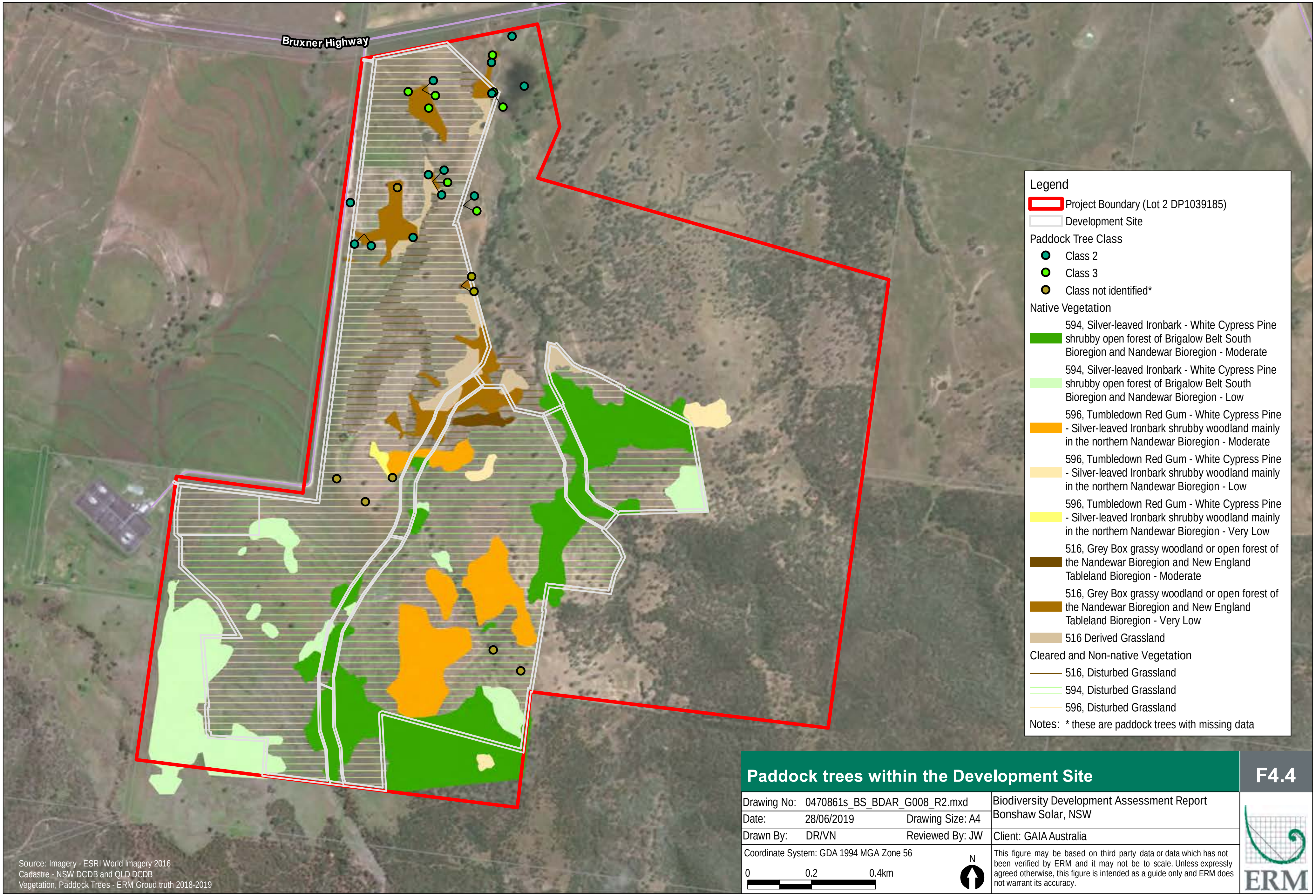


Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Vegetation, Paddock Trees - ERM Groud truth 2018-2019

Paddock trees within the Development Site

F4.4

Drawing No: 0470861s_BS_BDAR_G008_R2.mxd		Biodiversity Development Assessment Report Bonshaw Solar, NSW
Date: 28/06/2019	Drawing Size: A4	
Drawn By: DR/VN	Reviewed By: JW	Client: GAIA Australia
Coordinate System: GDA 1994 MGA Zone 56		This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

5. THREATENED SPECIES

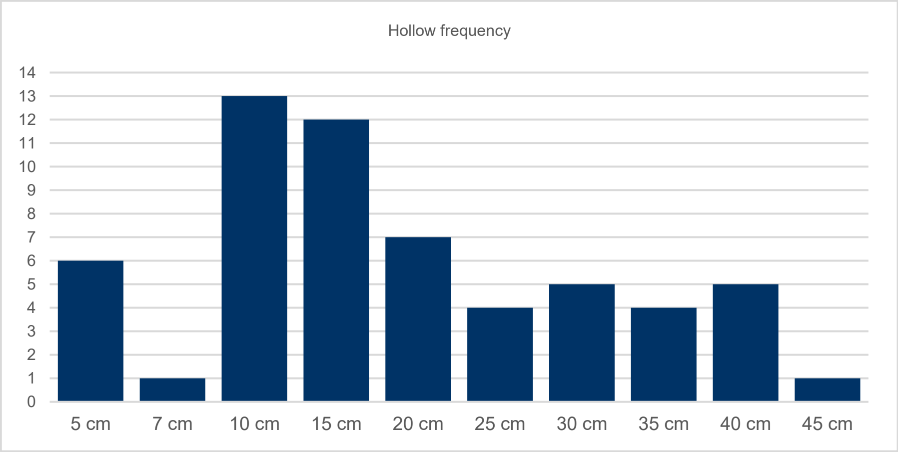
5.1 Fauna Habitat Assessment

A habitat assessment was undertaken seeking to identify the following fauna habitat features within the Subject Land:

- habitat trees;
- availability of flowering shrubs and feed tree species;
- waterway condition;
- quantity of ground litter and logs;
- searches for indirect evidence of fauna; and
- koala habitat values.

This habitat assessment identified that the majority of the Subject Land is highly disturbed, only supporting fauna species which are able to persist in highly modified agricultural landscapes and within woodland remnants. Additional habitat features assessed are provided in Table 5.1.

Table 5.1 Additional Habitat Features Considered

Habitat Features	Available with the Development Site
Occurrences of Karst, Caves, Crevices and Cliffs	Not present within the Development Site
Occurrences of Rock	A total of eleven rocky areas were recorded within the Subject Land (see *Figure 5.1*). Targeted reptile searches were undertaken in six of those rocky areas. Rocky areas were present on crests and hillsides as shown in Photograph 5-1 to Photograph 5-4 below. Threatened species that could occur in these rocky outcrops are the: ■ Pink - tailed Legless Lizard (*Aprasia parapulchella*) ■ Rodd's Star Hair (*Astrotricha roddii*) ■ Border Thick-tailed Gecko (*Uvidicolus sphyrurus*) As these species were not detected, the rocky outcrops were considered unlikely to provide habitat for threatened species.
Occurrences of Human made structures and Non-native Vegetation	The only human made structures present within the Subject Land are barb wire fences and gates. No build up structure, such as sheds or dwellings, are present.
Termite/ ant mounds	A total of 39 ant/termite mounds were observed across the Subject Land as shown in *Figure 5.1*. Example of mounds found at the Subject Land area shown in Photograph 5-5 and Photograph 5-6 below.
Hollows and Hollow Bearing Trees	A total of 60 hollow bearing trees were recorded across the Subject Land (see Table H.7 in Appendix H). Trees with hollows were eucalypt trees and stags (see Photograph 5-7 to Photograph 5-10). As shown in **Graph 5-1** below, most hollows were medium size of less than or equal to 20cm diameter, followed by large hollows (greater than 20cm diameter) and small hollows (less or equal to 5cm diameter).  **Graph 5-1** Tree hollow sizes and their frequency

Habitat Features	Available with the Development Site
Bird nests	A total of 20 bird nest were observed across the Subject Land (see Photograph 5-11 to **Photograph 5-14**). Grey-crowned Babbler were observed actively adding sticks to one nest which indicates that the Subject Land is occupied by a breeding population of this species. Sixteen additional nests were considered likely to be used by the Grey-crowned Babbler. Distribution of birds' nests are shown in *Figure 5.1*.
Koala Habitat Values	Only nine records of koala exists within the 10km locality as per BioNet atlas. The nearest records were recorded in 1999 at approximately 1.5km south from the Subject Land. Threatened species surveys indicated that no koalas, koala scats or evidence of koala scratches were observed within the Subject Land. This is not unexpected due to the high level of clearance and disturbance at the Subject Land. Only one species listed as Koala Feed Tree (SEPP44), White Box (*Eucalyptus albens*), was recorded within the Subject Land.

Photograph 5-1 View of rocky are on a hillside

Photograph 5-2 View of rocky area on a hillside

Photograph 5-3 View of rocky area on a hillside and crest

Photograph 5-4 View of rocky area on a hill crest

Photograph 5-5 Example of termite/ant mound

Photograph 5-6 Example of termite/ant mounds

Photograph 5-7 View of tree with hollow

Photograph 5-8 View of stag with hollow

Photograph 5-9 View of tree with hollows

Photograph 5-10 View of hollowed stag

Photograph 5-11 View of Grey-crowned Babbler nest

Photograph 5-12 Bird's nests on tree

Photograph 5-13 Tree with bird nest

Photograph 5-14 View of bird's nest on an Eucalypt tree

5.2 Rivers, Streams and Wetlands

Riparian areas and farm dams were inspected along random meander transects in the assessment area surrounding the Subject Land.

5.2.1 Creek lines

Third, second and first order un-named creek lines are present within Lot 2 in DP1039185 and are mapped tributaries of the Dumaresq River (see Figure 3.2). The creeks within the Project Boundary can be grouped as follows:

- Western Creek: This is a first order creek located within the Subject Land. This creek was dry during all the three survey periods (September 2018, December 2018 and March 2019) and provides very limited, if any aquatic habitat value.
- Central Creek and tributaries: This is a third order creek within the northern portion of the Project boundary and then diverges into a third order (eastern arm) and second order (western arm) to the south. These creeks were dry during all the three survey periods (September 2018, December 2018 and March 2019) and provides limited, seasonal aquatic habitat value only. Approximately six first order streams also converge into this central creek and provide very limited, if any aquatic habitat value.
- Eastern Creek: The southernmost portion of a first order stream is located on the eastern portion of the Project boundary (Lot 2 DP1039185) and outside of the Subject Land. This creek was not surveyed and will not be affected as part of the proposed development.

The overall condition of creek lines within the development footprint and the Project boundary is poor. Creek lines were dry during all three survey periods and erosion was noted along their banks (see **Photograph 5-15** to **Photograph 5-18**). Clearly defined river banks and channels are evident within the western, central and eastern creek lines indicating that at some point, these areas do contain large amounts of water and would provide some limited aquatic habitat for those species not dependent on a permanent water resource. The remaining 1st order creek lines within the Subject Land do not have conspicuous banks and bed and are not considered an aquatic habitat resource.

Riparian vegetation is mostly absent with scattered trees or patches of trees present. Several vehicle crossing are present on creek lines within the Project Boundary.

It is worth noting that in natural conditions, when an aquatic species is present in a major river, that species is expected to also be distributed in the tributaries of that river because the river system is connected and water flows freely across the tributaries of the system. Where natural connectivity in riparian systems occur, naturally occurring restrictions to aquatic biodiversity are related to species-specific habitat and ecological requirements. Natural connectivity between the Dumaresq River and its tributaries at the Project Boundary no longer exists based on the presence of Bruxner Way, which runs in a general east-west direction along the northern boundary of the Project Boundary and beyond. It is worth notiing that bridges were built on the highway at some of the major creeks and rivers intersections, such as Little Oaky Creek and Beardy River. This was not the case for tributaries crossing the Project Boundary.

Given that no connectivity exists between other tributaries of the Dumaresq River/Beardy River system and the creeks present at the Project Boundary, it is unlikely for those creeks to currently represent suitable habitat for aquatic biodiversity from the Dumaresq River.

Photograph 5-15 View of riparian area on the Project Boundary

Photograph 5-16 View of riparian area with vegetated bed.

Photograph 5-17 View of dry and eroded creek line with sparse trees on river bank

Photograph 5-18 View of creek near vehicle crossing

5.2.2 Farm Dams

A total of eight farm dams are located within the Subject Land. Most of the farm dams were dry during surveys although they would provide a catchment for overland flow. As shown in photographs below, no fringing or submerged aquatic vegetation was present in these farm dams. An unidentified turtle was observed.

Photograph 5-19 View of a farm dam with water within the assessment area

Photograph 5-20 View of a small farm dam within the assessment area

Photograph 5-21 View of dry farm dam within the assessment area

Photograph 5-22 View of farm dam within the assessment area

5.3 Ecosystem Credit Species

A list of ecosystem credit species predicted to occur within the Subject Land, based on the PCTs present and generated by the calculator associated within the BAM (OEH 2017a) is provided in Table 5.2. The potential for these species to occur within the Subject Land was assessed in accordance with Section 6.2 of the BAM (OEH 2017a).

One ecosystem credit species, the Glossy Black Cockatoo, was excluded from the assessment based on lack of foraging habitat across the Subject Land, all other species have been assumed to occur and contribute to ecosystem credits.

Table 5.2 Ecosystem Credit Species (BAM Calculator)

Ecosystem Credit Species	BC Act Listing	EPBC Act Listing	Justification for inclusion/exclusion
Anomalopus mackayi (Five-clawed Work skink)	E	V	Included. Potential habitat for the species is present within fallen logs and open paddocks with scattered trees.
Anthochaera phrygia (Regent Honeyeater) (Foraging)	CE	CE	Included. Potential foraging habitat is present. This woodland bird species forages in woodlands with significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. No habitat is available within the disturbed grasslands.
Artamus cyanopterus cyanopterus (Dusky Woodswallow)	V	-	Included. Potential foraging habitat is present in most woodland vegetation zones, excluding grasslands, cleared and disturbed land.
Calyptorhynchus lathami (Glossy Black-Cockatoo) (Foraging)	V	-	Excluded as the Subject Land does not contain preferred foraging resources (Allocasuarina or *Casuraina* sp) for the species
Chalinolobus picatus (Little Pied Bat)	V		Included. The species was recorded within the Subject Land.
Chthonicola sagittata (Speckled Warbler)	V	-	Included. Suitable habitat for the species might occur in the grassy woodlands. Grasslands and cleared (disturbed grasslands) are not suitable habitat for the species.
Circus assimilis (Spotted Harrier)	V	-	Included. Potential habitat for the species occurs across all vegetation zones in the Subject Land.
Climacteris picumnus victoriae (Brown Treecreeper (eastern subspecies))	V	-	Included. Potential habitat for the species occurs in woodland areas within the Subject Land.
Daphoenositta chrysoptera (Varied Sittella)	V	-	Included. Potential habitat for the species occurs in woodland vegetation within the Subject Land.
Glossopsitta pusilla (Little Lorikeet)	V	-	Included. Potential habitat for the species occurs in Eucalypt trees across all vegetation zones within the Subject Land.
Grantiella picta (Painted Honeyeater)	V	V	Included. Potential habitat for the species occurs in Box and Ironbark trees across the Subject Land.
Haliaeetus leucogaster (White-bellied Sea-eagle) (Foraging)	V	-	Excluded. Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. No foraging habitat available within the Subject Land.
Hieraaetus morphnoides (Little Eagle) (Foraging)	V	-	Included. Potential foraging habitat for the species occurs in woodland areas within the Subject Land.

Ecosystem Credit Species	**BC Act Listing**	**EPBC Act Listing**	**Justification for inclusion/exclusion**
Lathamus discolour (Swift Parrot) (Foraging)	E	CE	Included. Potential foraging habitat for the species occurs in Eucalypt trees in treed vegetation zones within the Subject Land. Derived grasslands and cleared (disturbed grasslands) excluded.
Lophoictinia isura (Square-tailed Kite) (Foraging)	V	-	Included. Potential foraging habitat for the species occurs over the canopy of woodlands along riparian zones within the Subject Land.
Macropus dorsalis (Black-striped Wallaby)	E		Included. Potential foraging habitat for the species occurs across the Subject Land.
Melanodryas cucullata cucullata (Hooded Robin (south-eastern form))	V	-	Included. Potential foraging habitat is present in woodland vegetation zones within the Subject Land.
Miniopterus schreibersii oceanensis (Eastern Bentwing-bat) (Foraging)	V	-	Included. The species' calls were recorded within the Subject Land. The species forages over the canopy of trees, so suitable habitat is provided within all woodland zones within the Subject Land.
Neophema pulchella (Turquioise Parrot)	V	-	Included. Suitable habitat for the species includes woodlands and native grasslands. Roosting and breeding habitat for this woodland bird are hollow-bearing trees in woodlands. It forages in woodlands and native grasslands.
Petroica boodang (Scarlet Robin)	V	-	Included. Limited suitable habitat for the species occurs in woodlands with fallen logs and timber in the Subject Land.
Petroica phoenicea (Flame Robin)	V	-	Included. Limited potential habitat is present in Eucalypt areas within the Subject Land.
Phascolarctos cinereus Koala (Foraging)	V	-	Included. Suitable feeding trees (e.g. *E. albens*) are present within the Subject Land. The species was not recorded on-site during surveys.
Pomatostomus temporalis temporalis Grey-crowned Babbler (eastern subspecies)	V	-	Included. Recorded on site. Foraging and breeding habitat for the species is present in woodland zones and derived grasslands. Cleared (i.e. disturbed grasslands) excluded.
Pteropus poliocephalus Grey-headed Flying-fox (Foraging)	V	V	Included. Potential foraging habitat is present in canopy of Eucalypt trees. Grasslands and cleared land excluded as potential foraging habitat.
Saccolaimus flaviventris Yellow-bellied Sheathtail-bat	V	-	Included. The species' calls were recorded in the assessment area and hollow bearing trees are present across the Subject Land.

Ecosystem Credit Species	BC Act Listing	EPBC Act Listing	Justification for inclusion/exclusion
Stagonopleura guttata Diamond Firetail	V	-	Included. Potential roosting and breeding habitat for the species occurs in woodlands, foraging habitat for the species occurs across the entire Subject Land.
Tyto novaehollandiae Masked Owl (Foraging)	V	-	Included as potential foraging habitat is present in eucalypt forests/woodlands and along their edges within the Subject Land.

5.4 Species Credit Species

An assessment of habitat constraints for threatened species was undertaken in accordance with Step 2 of Section 6.4 of the BAM (OEH 2017a). For those threatened species predicted to occur and for which habitat constraints are listed, an assessment was undertaken of the presence of the habitat features within the development site.

The species generated by the calculator with habitat constraints, as well as the results of the habitat constraints assessment, are shown in Table 5.3.

Under Section 6.4.1.17 of the BAM, a species credit species can be considered unlikely to occur on a development site (or within specific vegetation zones) if following field assessment, it is determined that the habitat is substantially degraded such that the species is unlikely to utilise the development site (or specific vegetation zones).

A total of eight candidate species credit species were excluded as no suitable habitat is present within the Subject Land (see Table 5.3). The species excluded are: Regent Honeyeater, White-bellied Sea Eagle, Swift Parrot, Square-tailed Kite, Masked Owl, Grey-headed Flying Fox, Eastern Bentwing Bat and Ovendern’s Ironbark.

Table 5.3 Species Credit Species

Species Credit Species	BC Act Listing	EPBC Act Listing	Habitat components and geographic restrictions	Sensitivity to gain class	Included or Excluded	Reason for inclusion or exclusion
Adelotus brevis Tusked Frog population in the Nandewar and New England Tableland Bioregion	E	-	-	Very High	Included	Six first order streams and several farm dams are present within the Subject Land although they do not provide any preferred habitat for this species. This species are usually found near creeks, ditches and ponds, and call while hidden amongst vegetation or debris. Limited riparian or and no fringing vegetation was noted in creeks and near the dams, respectively. Therefore, aquatic habitat is marginal at best
Amalosia rhombifer Zigzag Velvet Gecko	E	-	-	High	Included	Suitable habitat for the species occurs within the woodland habitats. This species is largely arboreal, living and foraging in trees.
Anthochaera phrygia Regent Honeyeater (Breeding)	CE	CE	-	High	Excluded	The Subject Land is not considered to be used as breeding or foraging habitat for the species. There are four known key breeding areas for this species, three of them in NSW - Capertee Valley, Bundarra-Barraba and Hunter Valley districts. For the Bundarra-Barraba area, three subsidiary foraging and breeding areas are known, Inverell-Ashford-Emmaville, Pilliga and Warrumbungles.
Astrotricha roddii Rodd's Star Hair	E	E	Rocky areas, Granite or acid volcanic outcrops	High	Included	A total of eleven rocky areas were recorded within the Subject Land and provide potential habitat for the species.
Burhinus grallarius Bush Stone-curlew	E	-	Fallen/standing dead timber including logs	High	Included	This species inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Potential habitat is available within the grassy woodlands only. The heavily grazed areas do not constitute preferred habitat.

Species Credit Species	BC Act Listing	EPBC Act Listing	Habitat components and geographic restrictions	Sensitivity to gain class	Included or Excluded	Reason for inclusion or exclusion
Calyptorhynchus lathami Glossy Black-Cockatoo (Breeding)	V	-	-	High	Included	Suitably sized hollows have been recorded with the Subject land although no preferred foraging habitat has been recorded which would limit the likelihood of this species nesting on site.
Dichanthium setosum Bluegrass	V	V	-	High	Included	The species has potential to occur in the Subject Land.
Digitaria porrecta Finger panic Grass	E	-	-	Moderate	Included	The species has potential to occur in the Subject Land.
Eucalyptus caleyi subsp. ovendenii Ovenden's Ironbark	V	V	-	High	Excluded	The preferred altitudes for the species are between 610 and 820 m, on granitic substrates. The Subject Land in located at much lower elevations between 335 and 420 m.
Geophaps scripta scripta Squatter Pigeon (southern)	CE	V	-	High	Included	The species has potential to occur within the woodland habitats although the species prefers sandy areas and usually close to water (within 3 km of water bodies or courses).
Haliaeetus leucogaster White-bellied Sea-Eagle (Breeding)	V	-	-	High	Excluded	Breeding habitat for this species consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat (not available within the Subject land). Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts'.
Hieraaetus morphnoides Little Eagle (Breeding)	V	-	-	Moderate	Included	Potential breeding habitat is available within the woodland habitats. This species nests in tall living trees within remnant vegetation where pairs build a large stick nest in winter.

Species Credit Species	BC Act Listing	EPBC Act Listing	Habitat components and geographic restrictions	Sensitivity to gain class	Included or Excluded	Reason for inclusion or exclusion
Homopholis belsonii Belson's Panic	E	V	-	NA	Included	Grows in dry woodland (e.g. Belah) often on poor soils, although sometimes found in basalt-enriched sites north of Warialda and in alluvial clay soils. The species has potential to occur in the Subject Land
Hoplocephalus bitorquatus Pale-headed Snake	V	-		High	Included	Suitable habitat for the species occurs within the Subject Land. A small number of historical records are known for the New England Tablelands from Glenn Innes and Tenterfield; however, the majority of records appear to be from sites of lower elevation. The species is found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest. It has limited potential to occur in the Subject Land
Indigofera baileyi Bailey's Indigo	E	-	-	High	Included	The species is known from around Inverell and Ashford in the western inland slopes. It prefers open woodlands on loam and clay loam soils, typically from granite or basalt, and has potential to occur in the Subject Land
Lathamus discolour Swift Parrot (Breeding)	E	CE	-	Moderate	Excluded	The species breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia.

Species Credit Species	BC Act Listing	EPBC Act Listing	Habitat components and geographic restrictions	Sensitivity to gain class	Included or Excluded	Reason for inclusion or exclusion
Lophoictinia isura Square-tailed Kite (Breeding)	V	-	-	Moderate	Excluded	No suitable breeding habitat for the species is present within the Subject Land, as the species prefers coastal and subcostal environments and inland wooded watercourses. Second and third order streams are excluded from the Subject Land. Scattered records of the species throughout NSW indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.
Miniopterus schreibersii oceanensis Eastern Bentwing-bat (Breeding)	V	-	-	Very High	Excluded	Caves are the breeding habitat for the species. Caves, suitable for maternity areas, are not present within the Subject Land. Being a dual credit species, foraging habitat resources are already accounted for in the ecosystem credits.
Petaurus norfolcensis Squirrel Glider	V	-	-	High	Included	Substandard suitable habitat is present in Eucalypt trees in the Subject Land.
Phascolarctos cinereus Koala (Breeding)	V	V	-	High	Included	Potential breeding habitat present in the Subject Land.
Pomaderris queenslandica Scant Pomaderris	E	-	-	High	Included	The species has potential to occur in the Subject Land
Pteropus poliocephalus Grey-headed Flying-fox (Breeding)	V	V	-	High	Excluded	No known breeding camp is present within the Subject Land.

Species Credit Species	BC Act Listing	EPBC Act Listing	Habitat components and geographic restrictions	Sensitivity to gain class	Included or Excluded	Reason for inclusion or exclusion
Swainsona sericea Silky Swainson-pea	V	-	-	High	Included	The species has the potential to occur within the Subject Land.
Thesium austral Austral Toadflax	V	V	-	Moderate	Included	The species has potential to occur in the Subject Land
Tyto novaehollandiae Masked Owl (Breeding)	V	-	-	High	Excluded	The Masked Owl is a large forest owl and prefers uncleared or lightly cleared areas with high densities of old hollow bearing trees. Although habitat is present on site that meets the breeding habitat constraint for this species (living or dead trees with hollows greater than 20cm diameter), it is considered unlikely that the Masked Owl would use these habitat features given the highly disturbed and highly fragmented context in which theses habitat features occur. As such, no breeding resources would be impacted by the proposal and no species credits have been generated for the Masked Owl. There is potential that the species may travel through and occasionally forage within the site and the species has been ‘assumed present’. Being a dual credit species, these foraging habitat resources are already accounted for in the ecosystem credits.
Uvidicolus sphyrurus Border Thick-tailed Gecko	V	V	-	High	Included	The species has potential to occur in the Subject Land

5.5 Additional Species Considered

Based on results of the BioNet Atlas search (see Appendix B), the PMST (see Appendix C) and the likelihood of occurrence assessment undertaken during desktop review (see Appendix D), the following species were also considered for assessment:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)
- Bristle-faced Free-tailed Bat (*Mormopterus eleryi*)
- Eastern Cave Bat (*Vespadeuls vulturnus*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*)
- Narrow-leaved Black Peppermint (*Eucalyptus nicholii*)
- Heath Wrinklewort (*Rutidosis heterogama*)

5.6 Candidate Species Surveyed

The species listed in Table 5.4 are those that are considered to have habitats present at the Subject Land. Surveys have been conducted for these species. The results are summarised in Table 5.5. Details of the survey methodologies for each surveyed species are provided in Appendix H. Targeted survey locations are mapped on *Figure 5.1*.

Species polygons have been defined for the species confirmed to be present on the site as mapped on *Figure 5.3*.

Table 5.4 CandidateSpecies Surveyed

Species Credit Species	BC Act Listing	EPBC Act Listing	Biodiversity Risk	Biodiversity Risk Weighting	Survey Time	Assumed to occur/survey/ expert report	Recorded during field surveys	Species polygon area or count
Adelotus brevis Tusked Frog population in the Nandewar and New England Tableland Bioregion	E	-	Very High	3	December	No	No	No
Amalosia rhombifer Zigzag Velvet Gecko	E	-	High	2	December	No	No	No
Anthochaera phrygia Regent Honeyeater	CE	CE	Very High	3	December	No	No	No
Astrotricha roddii Rodd's Star Hair	E	E	High	2	September December	No	No	No
Burhinus grallarius Bush Stone-curlew	E	-	High	2	December	No	No	No
Calyptorhynchus lathami Glossy Black-Cockatoo	V	-	High	2	No	No	No	No
Dichantium setosum Bluegrass	V	V	High	2	December March	No	No	No
Digitaria porrecta Finger Panic Grass	E	-	High	2	December March	No	No	No
Geophaps scripta scripta Squatter Pigeon (southern)	CE	V	Very High	3	December	No	No	No
Hieraaetus morphnoides Little Eagle	V	-	Moderate	1.5	December	No	No	No
Homopholis belsonii Belson's Panic	E	V	N/A	1	December March	No	No	No

Species Credit Species	BC Act Listing	EPBC Act Listing	Biodiversity Risk	Biodiversity Risk Weighting	Survey Time	Assumed to occur/survey/ expert report	Recorded during field surveys	Species polygon area or count
Hoplocephalus bitorquatus Pale-headed Snake	V	-	High	2	December	No	No	No
Indigofera baileyi Bailey's Indigo	E	-	High	2	September December	No	No	No
Lophoictinia isura Square-tailed Kite	V	-	Moderate	1.5	December	No	No	No
Mormopterus eleryi (syn. Setirostris eleryi) Bristle-faced Free-tailed Bat	E	-	High	2.0	December	Survey	Yes	Yes
Miniopterus schreibersii oceanensis Eastern Bentwing-bat	V	-	Very High	3.0	December	Survey	Yes	No
Petaurus norfolcensis Squirrel Glider	V	-	High	2	December	No	No	No
Phascolarctos cinereus Koala	V	V	High	2	December	No	No	No
Pomaderris queenslandica Scant Pomaderris	E	-	High	2	September December March	No	No	No
Pteropus poliocephalus Grey-headed Flying-fox	V	V	High	2	December	No	No	No
Swainsona sericea Silky Swainson-pea	V	-	High	2	September December	No	No	No
Thesium austral Austral Toadflax	V	V	Moderate	1.5	September December	No	No	No
Tyto novaehollandiae Masked Owl	V	-	High	2	None	Assumed Present	N/A	No

Species Credit Species	BC Act Listing	EPBC Act Listing	Biodiversity Risk	Biodiversity Risk Weighting	Survey Time	Assumed to occur/survey/ expert report	Recorded during field surveys	Species polygon area or count
Uvidicolus sphyrurus Border Thick-tailed Gecko	V	V	High	2	December	No	No	No
Vespadeuls vulturnus Eastern Cave Bat	V	-	Very High	3.0	December	Survey	Yes	No (see Section 5.7.4.2)

5.7 Targeted Survey Results

Targeted surveys for flora and fauna were undertake across the Subject Land. Description of survey method and effort is provided in Appendix F.

The flora and fauna survey effort undertaken across the Subject Land is shown in *Figure 5.1*.

5.7.1 Flora Species Recorded

No threatened flora species were recorded across the Subject Land during surveys.

The full flora species list is provided in Table H.6 (Appendix H).

A total of 143 flora species in 47 families were recorded within the assessment area. This included a total of 111 native (78 %) and 32 exotic (22 %) species. The most numerous families were Poaceae (30 species), Asteraceae (21 species) and Fabaceae (Faboideae) (10 species).

Exotic species included two HTE and WoNS, Tiger Pear (*Opuntia aurantiaca*) and Velvet Tree Pear (*Opuntia tomentosa*). Due to the high level of grazing and lack of reproductive material, identification of some flora specimens was only viable to genus level, including *Senecio* sp., *Hypericum* sp. and *Solanum* sp. Therefore, presence of an additional WoNS, Fireweed (*Senecio madagascariensis*), cannot be precluded. Fireweed is also listed as a Priority Weed in the Northern Tablelands. Similarly, exotic species within genera *Hypericum* and *Solanum* were recorded. Therefore, potential presence of priority weeds St John's Wort (*Hypericum perforatum*) and Silverleaf Nightshade *(Solanum elaeagnifolium*), cannot be precluded. As per the Biosecurity Act, all exotic species require management and preparation of a Weed Management Plant for the proposed solar farm will be required.

5.7.2 Fauna Species Recorded

A total of 75 fauna species were recorded across the Subject Land. A summary of species recorded is presented in Table 5.5 and a full species list is provided in Appendix H.

A total of eleven threatened species were recorded within the Subject Land (see Table 5.5 below). The species included eight vulnerable microchiropteran bats (Little Pied Bat, Eastern Bentwing-bat, Corben's Long-eared Bat, Yellow-bellied Sheath-tailed Bat, Eastern Cave Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Hoary Wattled Bat), one endangered microchiropteran bat (Bristle-faced Free-tailed bat), one vulnerable bird (Grey-crowned Babbler) and one migratory bird (Cicadabird). Out of the eight Vulnerable microchiropteran bats, six were definite call identifications and two (Greater Broad-nosed Bat and Hoary Wattled Bat) were potential calls.

Table 5.5 Summary of Fauna Species Recorded

Fauna Type	Number of Species	BC Act	EPBC Act
Woodland Birds	46	One species, the Grey Crowned Babbler is listed as Vulnerable and has been further assessed in Section 5.6.3	One species, the Cicadabird is listed as Marine and has been further assessed in Section 6.2.1
Forest Owls	0	No	No
Reptiles	7	No	No
Amphibians	3	No	No

Fauna Type	Number of Species	BC Act	EPBC Act
Terrestrial Mammals	7	No	No
Arboreal Mammals	1	No	No
Microchiropteran Bats	12 definite + 6 potential	Six Vulnerable species: Little Pied Bat, Eastern Bentwing-bat, Corben's Long-eared Bat, Yellow-bellied Sheath-tailed Bat, Eastern Cave Bat and Eastern False Pipistrelle Two potential Vulnerable species: Greater Broad-nosed Bat and Hoary Wattled Bat. One Endangered species: Bristle-faced Free-tailed Bat. These species have been further assessed in Section 5.6.4.	One vulnerable species: Corben's Long-eared Bat has been further assessed in Section 5.6.4.

Results of each threatened species recorded are summarised in sub-sections below.

5.7.3 Grey-crowned Babbler

The Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) is listed as an ecosystem credit species.

It 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. Its flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas. It lives in family groups that consist of a breeding pair and young from previous breeding seasons. A group may consist of up to fifteen birds. All members of the family group remain close to each other when foraging. It is insectivorous and it forages on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. It builds nests that are used as dormitory and roosting and uses them all year round. It breeds between July and February. Territory ranges from one to 50 hectares (usually ten hectares) and are defended all year (OEH 2019).

Grey-crowned Babblers are obligate communal breeders that form a family group, in which offspring from the previous season and other unrelated birds help to raise the current's year's brood. Young birds stay with the family group for at least one year after fledging and may remain for two or more years acting as non-breeding helpers. As breeding spaces become available in the population, some helpers may disperse to establish their own breeding group. In some populations, breeding success is related to the number of helpers. Population viability studies in Victoria suggests that a viable population is likely to contain more than ten family groups, while populations with less than ten family groups are likely to have high rate of extinction. In NSW, the species breeds between July and February (OEH 2019).

It has been suggested that cooperative breeder species, such as the Grey-crowned Babbler, are more sensitive to habitat fragmentation and loss (including loss due to fire) as availability of resources for breeding decreases (Fischer 2011). Habitat fragmentation and predation by introduced species being the major threats to the species. The species is capable to survive in disturbed landscapes, such as urban areas, where proportion of ground cover and leaf litter provides sufficient food (Lambert and Ford 2016, Stevens *et. al*. 2015).

The Grey-crowned Babbler was observed during surveys in September and December 2018 and heard during the March 2019 survey. In December 2018, the Grey-crowned Babbler was recorded in 20 points within the Subject Land and a total of 17 bird nests likely to belong to the species were observed (see *Figure 5.2*). The records included six individuals observed, 21 calls heard with an additional two potential calls heard at distance . Also, a pair was observed adding twigs to a nest located on the lower branches of a Silver-leaved Ironbark (*Eucalyptus melanophloia*).

The Grey-crowned Babbler was observed in the following vegetation types:

- 594_Moderate (Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion). A total of 18.78 ha is present across the Subject Land;
- 596_Moderate (Tumbledown Red Gum - White Cypress Pine - Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion),. A total of 11.40 ha are present across the Subject Land;
- 516_Very Low (Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion), a total of 5.72 ha are present across the Subject Land; and
- 516_Disturbed Grasslands (Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion). A total 8.71 ha are present within the Subject Land.

A Test of Significance for the species was undertaken and is included in Appendix E.

5.7.4 Microchiropteran Bats

A total of nine threatened microchiropteran bat species were recorded within the assessment area, including eight vulnerable species and one endangered species. In accordance with the '*Species Credit' threatened bats and their habitats* guide (OEH 2018b), the species fall into the following credit species types:

- Ecosystem Credit Species:
  - Little Pied Bat (*Chalinolobus picatus*) (V)
  - Eastern Bent-winged Bat (*Miniopterus schreibersii oceanensis*) (V) – Foraging Habitat only
  - Corben's Long-eared Bat (*Nyctophilus corbeni*) (V)
  - Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (V)
  - Greater Broad-nosed Bat (*Scoteanax rueppellii*) (V)
  - Hoary Wattled Bat (*Chalinolobus nigrogriseus*) (V)
  - Yellow-bellied Sheath-tailed Bat (*Saccolaimus flaviventris*) (V)
- Species Credit Species:
  - Bristle-faced Fee-tailed Bat (*Mormopterus eleryi*) (E)
  - Eastern Cave Bat (*Vespadeuls vulturnus*) (V)
  - Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) (V) – Breeding habitat only listed as SCS

Habitat polygons for Species Credit Species (SCS) were assessed in accordance with Step 5 of Section 6.4 of the BAM (OEH 2017a and OEH 2018a). Based on the analysis of habitat availability for SCS within the Subject Land (see Table 5.6), species polygons for SCS are only required for the Bristle-faced Free-tailed Bat and Eastern Cave Bat.

The Eastern Bentwing Bat is not considered to have suitable breeding and/or roosting habitat within the Subject Land

Table 5.6 Habitat Summary for microchiropteran bat Species Credit Species

Scientific Name Common Name	BC Act Listing	Habitat as per TBDC					Habitat Constraints		PCTs	Comments
		Roosting	Breeding	Foraging	Are paddock trees important habitat?	Patch Size	Description	Present		
Mormopterus eleryi (syn.Setirostris eleryi) Bristle-faced Free-tailed Bat	E	Hollows and tree fissures. Habitat is within 500m of riparian areas (including dry river/creek beds) and water bodies within the PCTs associated with the species.	Tree hollows (Ellis 2006)	Insectivorous species that forage typically well-above the canopy and only coming low in relatively open areas (Ellis and Wilson 1992)	No	5-24 ha	Land within 500 m of watercourses or dams surrounded by eucalypts containing hollows.	Yes	516, 594, 596	Hollow bearing trees within 500m of watercourses and dams are the relevant habitat for the species.
Vespadelus troughtoni Eastern Cave Bat	V	Caves, Scarps, cliffs, disused mine workings.	Potential breeding habitat is the PCTs associated with the species (as per the TBDC) within 100m of rocky areas, caves, overhangs crevices, cliffs and escarpments, or old mines or tunnels, old buildings and sheds within potential habitat.	Found in dry open forests and woodland, near cliffs or rocky overhangs.	No	5-24 ha	Caves within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds.	No	516, 594, 596	Trees and treed areas are foraging habitat for the species within the Subject Land. No roosting or breeding habitat is present.
Miniopterus schreibersii oceanensis Eastern Bentwing Bat	V	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures	Maternity caves. Potential breeding habitat is caves, tunnels, mines or other structures known or suspected to be used by the species	Being an insectivorous species it is assumed foraging habitat is treed areas. Within 300km range of maternity caves.	No	<5 ha	Breeding: Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records with microhabitat code "IC - in cave;" observation type code "E nest-roost;" with numbers of individuals >500	No	516, 594, 596	Trees and treed areas are foraging habitat for the species within the Subject Land. No roosting or breeding habitat is present.

5.7.4.1 Bristle-faced Free-tailed Bat

As shown in Table 5.6, the Bristle-faced Free-tailed Bat roosts in tree hollows and tree fissures, it breeds in tree hollows and forages for insects over canopy of trees (Ellis 2001, NSW SC 2004, OEH 2019). In defining the habitat polygon for the Bristle-faced Free-tailed Bat, ecological information from the TBDC and scientific literature was taken into account including the following from BioNet:

> *This species may move distances greater than 10km, dispersal distance of 100m - 10km was selected as this is the distance at which females regularly move to establish new colonies in available habitat. Additionally, selected <1 for average number of offspring because females do not give birth every (often miscarry etc).*
>
> *Potential habitat is riparian areas (including dry river/creek beds) within the PCTs associated with the species. Survey should sample the available range of suitable vegetation along riparian areas on the subject land. Traps or nets should be set near water holes (especially if isolated), under/beside large trees, in/beside creek beds, or in 'flyway' spaces between vegetation. NB. Use of acoustic detection alone is not suitable for this species as the call is difficult to distinguish from other common species. Refer to Threatened Bat Survey Guide.*
>
> *All habitat on the subject land where the subject land is within 500m of a river, creek or riparian area must be mapped. Use aerial imagery to map river, creek or riparian areas (including dry creek channels, former creek channels, billabongs etc.) on or within 500m of the subject land. Species polygon boundaries should align with PCTs on the subject land to which the species is associated that are within 500m of waterbodies mapped.*

In accordance with Table 1 of the OEH (2018b) '*Species Credit' threatened bats and their habitats guide*, the species polygon for the Bristle-faced Free-tailed Bat has been prepared and includes the following features:

- *All habitat on the subject land where the subject land is within 500m of a river, creek or riparian area*.

A review of information on the Bristle-faced Free-tailed Bat has been undertaken and is presented in Appendix E. It is acknowledged that little information is available regarding the ecology and biology of this species. It is assumed that the species roosts and breeds on tree hollows and tree fissures. Based on feeding behaviour of species within the *Mormopterus* genus, it is assumed that the species is aerial insectivorous and that is a vegetation dependent species which forage typically well above the canopy of any vegetation type when feeding. Therefore, suitable roosting, breeding and foraging habitat for the species within the Subject Land are trees, hollow-bearing trees and canopy of trees and treed areas; whereas cleared areas are not considered to be suitable habitat for the species.

Habitat polygon for the Bristle-faced Free-tailed Bat is shown in *Figure 5.3*.

5.7.4.2 Eastern Cave Bat

As shown in Table 5.6, the Eastern Cave Bat roosts in Caves, Scarps, cliffs, disused mine workings. Potential breeding habitat is the PCTs associated with the species (as per the TBDC) within 100m of rocky areas, caves, overhangs crevices, cliffs and escarpments, or old mines or tunnels, old buildings and sheds within potential habitat.

The BioNet Atlas indicates that the Eastern Cave Bat:

- "*Any impacts on breeding habitat could be considered potentially serious and irreversible. This species is retained as dual credit because foraging habitat is broad ranging but breeding habitat is highly specific. At lower altitudes this species is usually more abundant during winter months, the lower numbers of individuals from October to February are due to females moving to maternity sites. Additionally, selected <1 for average number of offspring because females do not give birth every (often miscarry etc)*."

- "*All breeding habitat including the cave, or other features, used for breeding and the area immediately surrounding this feature must be mapped. Species polygon boundaries should have a 100m radius buffer around an accurate GPS point location centred on the cave/feature entrance*."

In accordance with Table 1 of the OEH (2018b) '*Species Credit' threatened bats and their habitats guide*, the species polygon for the Bristle-faced Free-tailed Bat has been prepared and includes the following features:

- "*All habitat on the subject land where the subject land is within 2km of caves, scarps, cliffs, rock overhangs and disused mines*."
- "*Note: any breeding habitat identified for this species (see Table 2) is a potential serious and irreversible impact*."

In accordance with Table 2 of the OEH (2018b), the features and approach required to develop the species polygon for the Eastern Cave Bat, a species that require identification of breeding habitat are:

- "*All breeding habitat on or within 100m of the subject land and the area immediately surrounding the feature. Artificial structures should be inspected and included if the species is using these features for breeding (see Section 3.2)*."
- "*Note all habitat for this species should also be mapped if present (i.e. including that described in Table 1)*."

There are not roosting and breeding habitat for the Eastern Cave Bat within the Subject Land. Regarding the presence of roosting and breeding habitat within 2km from the Project Boundary, aerial images covering an area of 2km surrounding the Project Boundary was assessed with regards to potential presence of caves, scarps, cliffs, rock overahangs and disused mines. None of these suitable breeding and roosting habitat features were identified. Due to no suitable breeding or roosting habitat is present in the Subject Land and within 2km of the Project Boundary, a species polygon for the species is not present within the Subject Land and within 2km of the Project Boundary. A species polygon figure was not deemed required.

It is considered that only foraging resources for the Eastern Cave Bat are available within the Subject Land. In accordance with the TBDC, the three PCTs identified at the Subject Land (i.e. PCT516, 594 and 596) are habitat for the Eastern Cave Bat. The profile for the species (OEH 2019) indicates that "little is understood of its feeding or breeding requirements or behaviour". Thus, the possibility that treed and derived grasslands in these PCTs are foraging habitat for the Eastern Cave Bat.

A test of significance for the species is presented in Appendix E. Given the absence of roosting and breeding habitat for the species at the Subject Land, it is considered the impacts of clearing on potential foraging habitat are not significant.

5.7.5 Cicadabird

One individual of the Cicadabird (*Coracina tenuirostris*) was observed within the Subject Land during surveys. A significant impact assessment for the species was undertaken (see Appendix E) and it was concluded that significant impacts on this migratory/marine species are unlikely to result due to the proposed solar farm development. The Cicadabird is not further assessed.

5.7.6 Threatened Aquatic Species

No threatened aquatic species are considered likely to occur within the Development Site.

Threatened species maps prepared by the NSW Department of Primary Industries were reviewed (https://www.dpi.nsw.gov.au/fishing/species-protection/threatened-species-distributions-in-nsw/freshwater-threatened-species-distribution-maps) via the SEED Portal. The following threatened species listed under the NSW Fisheries Management Act have been considered:

- Southern Purple Spotted Gudgeon (*Mogurnda adspersa*): The Subject Land is located within the indicative distribution area of the Southern Purple Spotted Gudgeon, which is listed as Endangered under the FM Act. DPI's indicative distribution map indicates that none of the creeks within the Subject Land are mapped as habitat for the species (see Figure 5.4)The nearest creeks mapped as habitat for the Southern Purple Spotted Gudgeon are:
    - Dumaresq River: it is located at approximately 1.2 km north from the Development Site. This river runs in a general east-west direction.
    - Little Oaky Creek: it is located at approximately 1.7 km west from the Development Site. Little Oaky Creek is a tributary of Dumaresq River.
    - Crooked Creek: it is located at approximately 4.5 km west from the Development Site and 2.5 km west from Little Oaky Creek. Crooked Creek is a tributary of Dumaresq River.
    - Beardy River: is located to the east from the Development Site. The nearest point is located at approximately 3 km from the development footprint. Beardy River runs on a general north-south direction from its convergence with Dumaresq River. None of the first order tributaries of Beardy River are located within the Development Site.

  All creeks within the Development Site were dry during the three survey periods in September 2018, December 2019 and March 2019 and have low habitat value for the Southern Purple Spotted Gudgeon.

- Eel Tailed Catfish (*Tandanus tandanus*): The Subject Land is located within the indicative distribution area of the Murray-Darling Basin population of Eel Tailed Catfish (Endangered Population). DPI's indicative distribution map indicates that none of the creeks within the Subject Land are mapped as habitat for the species (see Figure 5.4). The nearest creeks mapped as habitat for the Eel Tailed Catfish are:
    - Dumaresq River: it is located at approximately 1.2 km north from the Subject Land. This river runs in a general east-west direction.
    - Beardy River: is located to the east of the Subject Land. The nearest point is located at approximately 3 km from the development footprint. Beardy River runs on a general north-south direction from its convergence with Dumaresq River. None of the first order tributaries of Beardy River are located within the Subject Land.
- Olive Perchlet (*Ambassis agassizii*): The Development Site is located within the indicative distribution area of the Western Population of Olive Perchlet which is listed as an endangered population under the FM Act. The nearest creeks mapped as habitat for the Olive Perchlet are:
    - Dumaresq River: it is located at approximately 1.2 km north from the Subject Land. This river runs in a general east-west direction.
    - Beardy River: is located to the east from the Subject Land. The nearest point is located approximately 3 km from the development footprint. Beardy River runs on a general north-south direction from its convergence with Dumaresq River. None of the first order tributaries of Beardy River are located within the Subject Land.

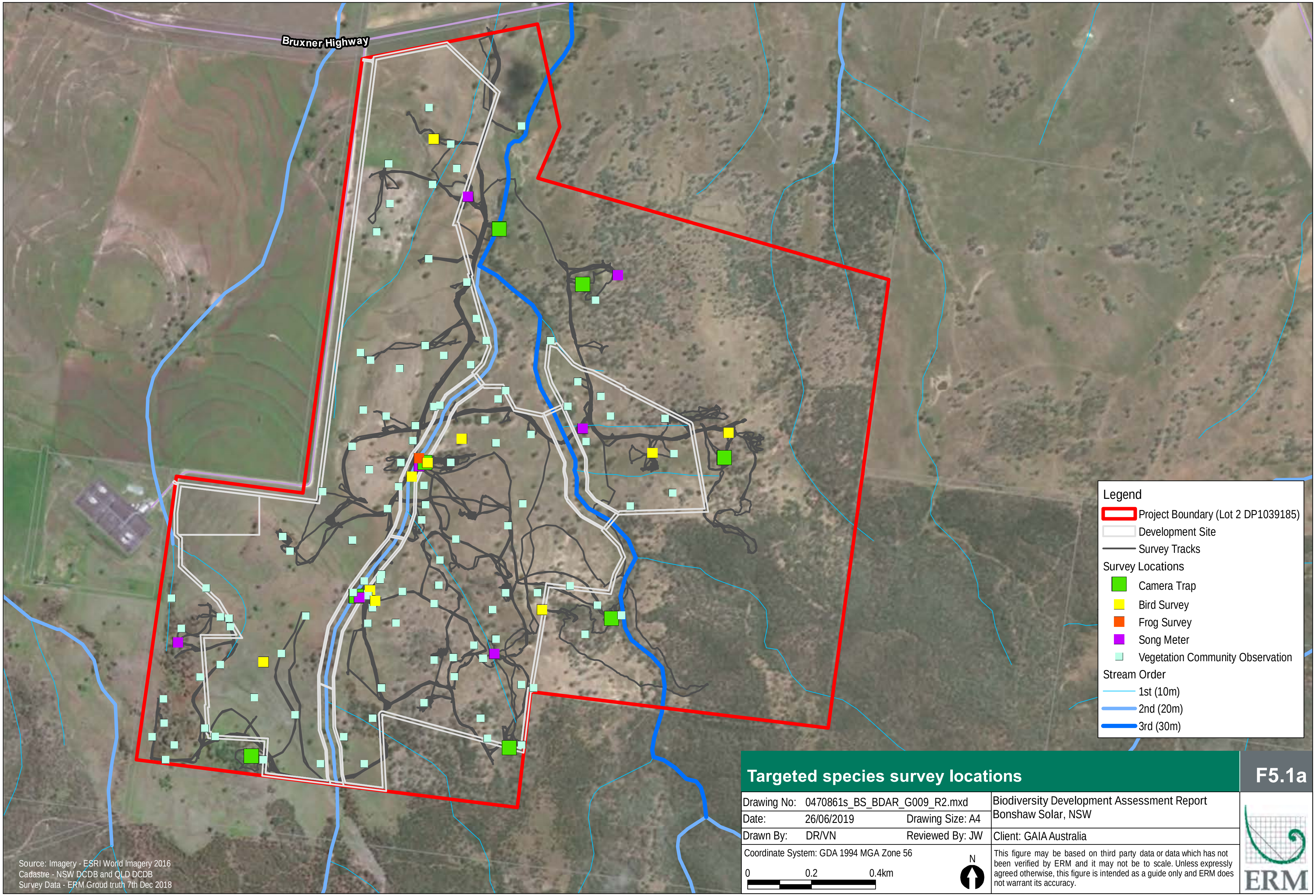
5.8 Limitations To Data

It is possible that some species were not recorded during the survey due to the timing of the survey outside their recommended survey period. Where survey effort or timing is not consistent with the BAM or relevant guidelines, this is stated explicitly in the assessment and measures identified to address the limitation; i.e. assumed occurrence of Masked Owl (foraging only) as the survey window could not be met.

The calculation of hollow-bearings trees, in particular the size and number of hollows, was made from ground level. It is possible that some hollows are present that were not visible from ground level, which may result in underestimates. The identification of paddock trees was based combination of on-site observations and aerial photo interpretation.

The combined impacts of sheep grazing and the extended drought may have altered the visible foliage cover of native grasses, forbs and high threat exotic species. Some native grasses or forbs may have been heavily grazed to the ground and would not have been visible during the time of survey. Likewise, some heavily grazed grasses were unidentifiable to species level.

It is also noted that at the surveys, all of the streams were dry and no detailed aquatic assessment has been undertaken at this site.



Targeted species survey locations

F5.1a

Legend

- 🟥 Project Boundary (Lot 2 DP1039185)
- ☐ Development Site
- — Survey Tracks

Survey Locations

- 🟩 Camera Trap
- 🟨 Bird Survey
- 🟧 Frog Survey
- 🟪 Song Meter
- ■ Vegetation Community Observation

Stream Order

- — 1st (10m)
- — 2nd (20m)
- — 3rd (30m)

Drawing No: 0470861s_BS_BDAR_G009_R2.mxd
Date: 26/06/2019 Drawing Size: A4
Drawn By: DR/VN Reviewed By: JW
Coordinate System: GDA 1994 MGA Zone 56

Biodiversity Development Assessment Report
Bonshaw Solar, NSW

Client: GAIA Australia

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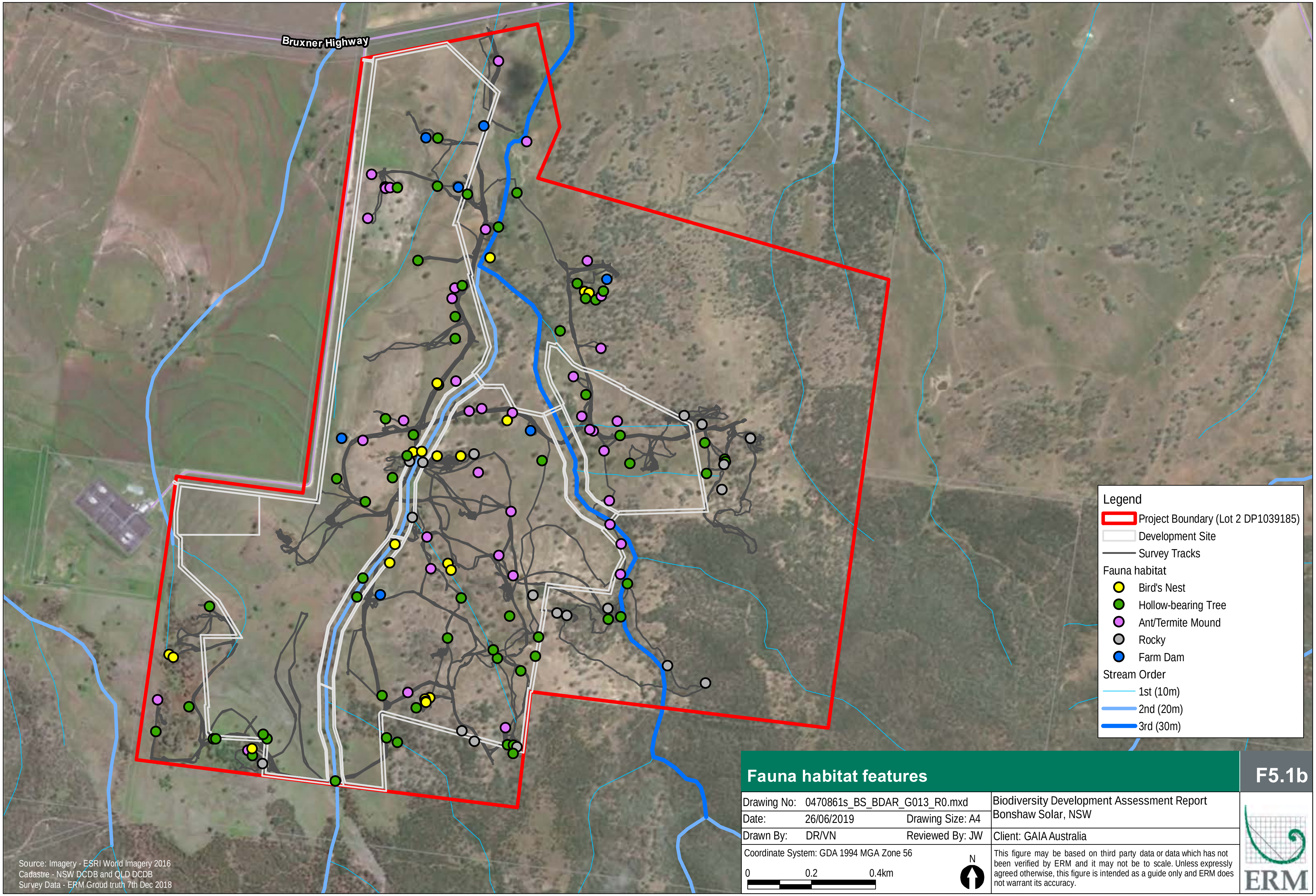
ERM

Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Survey Data - ERM Groud truth 7th Dec 2018



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Survey Data - ERM Groud truth 7th Dec 2018

Fauna habitat features

F5.1b

Drawing No:	0470861s_BS_BDAR_G013_R0.mxd		
Date:	26/06/2019	Drawing Size:	A4
Drawn By:	DR/VN	Reviewed By:	JW

Coordinate System: GDA 1994 MGA Zone 56

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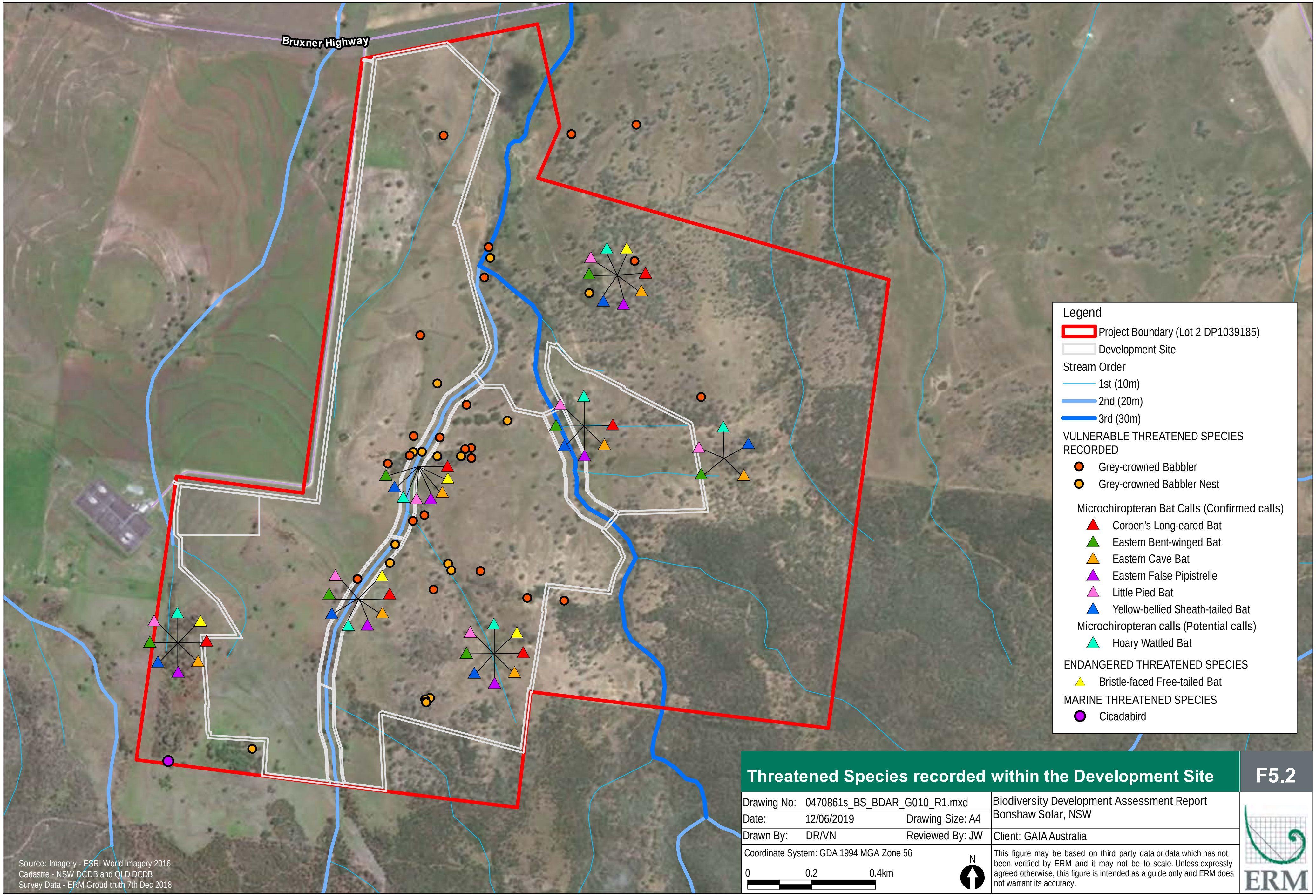

Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Survey Data - ERM Groud truth 7th Dec 2018

Threatened Species recorded within the Development Site

F5.2

Drawing No: 0470861s_BS_BDAR_G010_R1.mxd
Date: 12/06/2019 Drawing Size: A4
Drawn By: DR/VN Reviewed By: JW
Coordinate System: GDA 1994 MGA Zone 56

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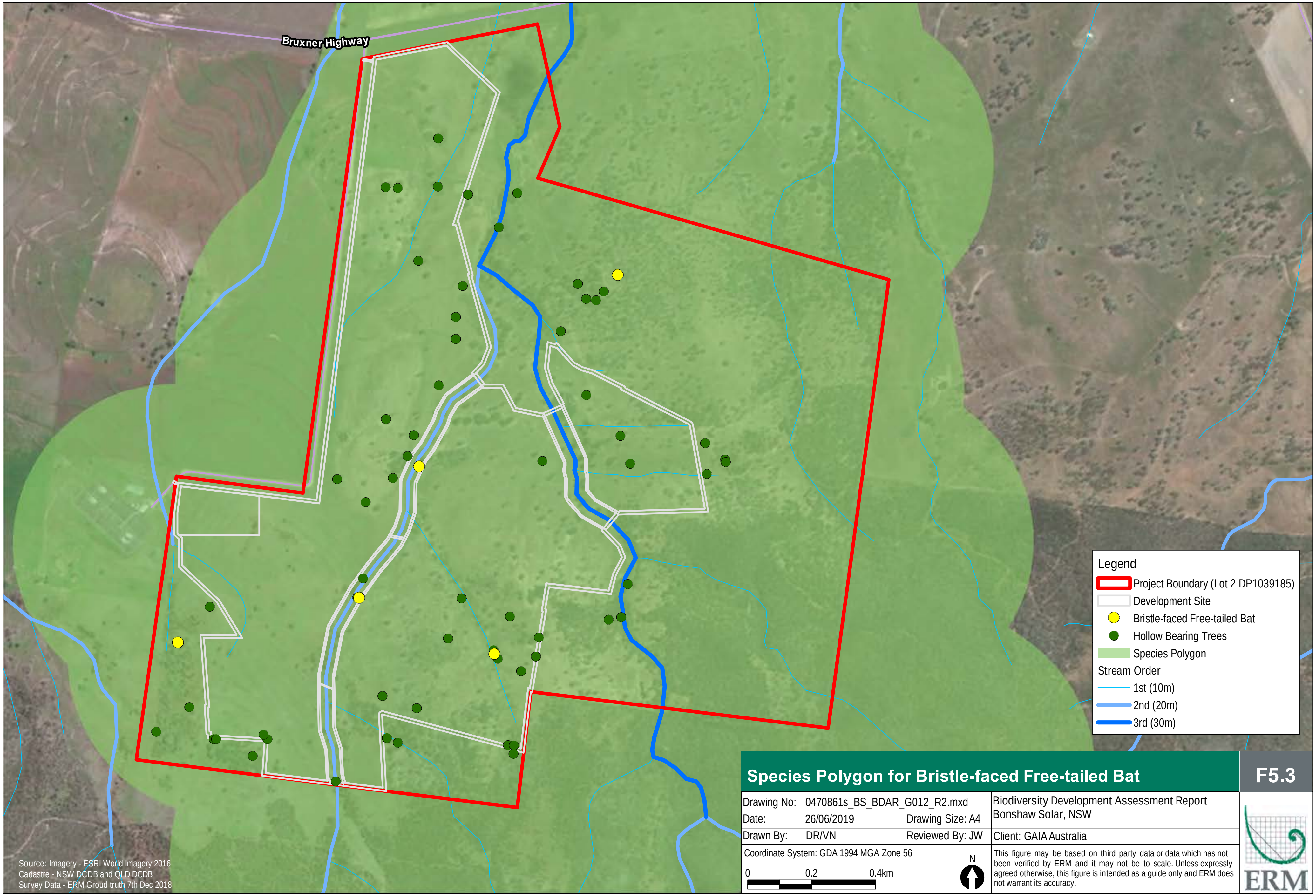

Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Survey Data - ERM Groud truth 7th Dec 2018

Species Polygon for Bristle-faced Free-tailed Bat

F5.3

Drawing No: 0470861s_BS_BDAR_G012_R2.mxd		Biodiversity Development Assessment Report Bonshaw Solar, NSW
Date: 26/06/2019	Drawing Size: A4	
Drawn By: DR/VN	Reviewed By: JW	Client: GAIA Australia

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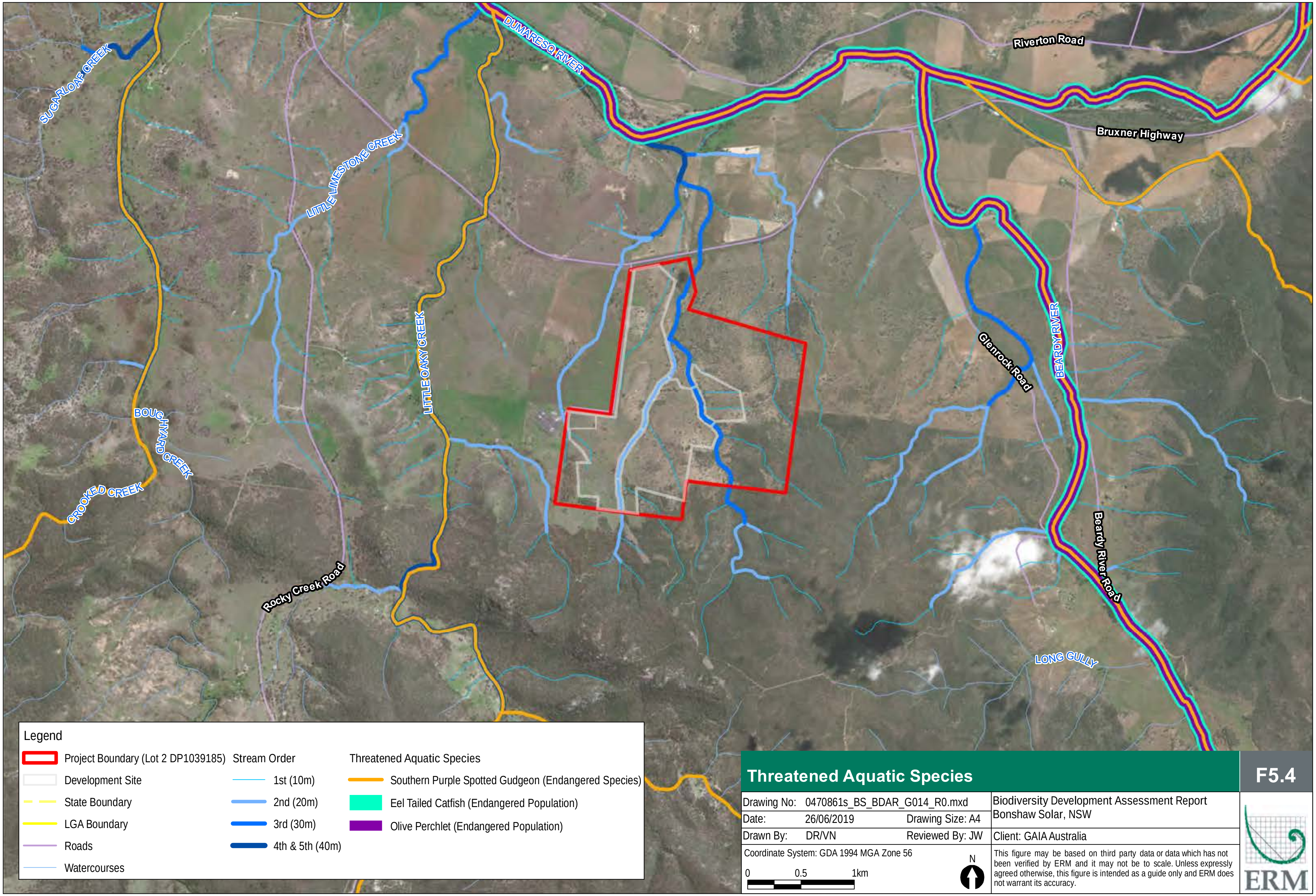

Threatened Aquatic Species

F5.4

Drawing No: 0470861s_BS_BDAR_G014_R0.mxd
Date: 26/06/2019 Drawing Size: A4
Drawn By: DR/VN Reviewed By: JW
Coordinate System: GDA 1994 MGA Zone 56

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Client: GAIA Australia

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ERM

STAGE 2: IMPACT ASSESSMENT (BIODIVERSITY VALUES)

6. IMPACT ASSESSMENT (BIODIVERSITY VALUES)

This chapter identifies the potential impacts of the project on the biodiversity values of the Development Site. Measures taken to date to avoid and minimise impacts are summarised and recommendations are provided, which will assist GAIA to design a development that further avoids, minimises and mitigates impacts.

6.1 Avoiding and Minimising Impacts On Native Vegetation and Habitat

As discussed in the EIS, various options relating to location, technology and scale of the project were evaluated in developing the proposal. The site was selected as being a suitable site for a solar plant based on;

- A mostly cleared landscape with minimal vegetation removal required;
- Compatible land use zoning of the land; and
- Proximity to the transmission network.

The development footprint is of a scale that allows for flexibility in the design, allowing ecological and heritage constraints to be avoided (refer to EIS for greater detail on the site selection process).

The Project site has had extensive environmental investigation and assessment which has informed the current concept layout. The layout has been reassessed and reduced to minimise the impact on the environment. Careful consideration of the existing environmental constraints has seen the total development footprint reduced from 1097 ha to 166.76ha.

In terms of biodiversity values, GAIA has undertaken significant steps to avoid, minimise and mitigate impacts, as per the process outlined below:

- identification of biodiversity values through comprehensive, rigorous and thorough biodiversity surveys;
- communication of identified values to the project team;
- consultation between the design team and project ecology leader to consider direct and indirect impacts and work through the design process to achieve a feasible project with the least biodiversity impact; and
- consultation with OEH, to seek input and discuss measures proposed to avoid and minimise impacts (see Table 1.4).

Through continued detailed design the Project will avoid the following areas of high biodiversity value:

- Avoid the large areas of intact vegetation communities within the eastern and south eastern portion of the Project Boundary;
- Avoid all areas mapped at TEC;
- The second and third order watercourses will be avoided through detailed design and survey, with riparian buffers to be applied either side of the streams, measured from the edge of the top of bank. The buffers applied to this BDAR are 20m either side of the second order stream and 30m to either side of the third order streams.
- Locating ancillary facilities in areas where there are minimal biodiversity values.

The development footprint and conceptual layout has not been able to completely avoid all areas of biodiversity value because the length and size of the solar panels means it is difficult to avoid small patches of vegetation and isolated paddock trees.

6.2 Avoiding and Minimising Prescribed Biodiversity Impacts

The BC Regulation (clause 6.1) identifies actions that are prescribed as impacts to be assessed under the biodiversity offsets scheme. Prescribed Biodiversity impacts relevant to the proposal are:

- Impacts of development on the habitat of threatened species associated with rocks.
- Impacts of development on the habitat of threatened species associated with human made structure.
- Impacts of development on the habitat of threatened species associated with non - native vegetation.
- Impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range.
- Impacts of development on movement of threatened species that maintains their life cycle.
- Impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities.
- Impacts of vehicle strikes on threatened species or on animals that are part of a TEC.

Prescribed impacts requiring assessment had been identified in Section 8.2.1.2 of the BAM (OEH 2017a), How these prescribed impacts have been avoided and minimised by the proposal is detailed in Table 6.1.

Table 6.1 Avoidance of Impacts

Impact	Avoidance Measures	Outcome
Prescribed Impact		
(a) Impacts of development on the habitat of threatened species or ecological communities associated with: ■ (i) karst, caves, crevices, cliffs and other geological features of significance, or ■ (ii) rocks, or ■ (iii) human made structures, or ■ (iv) non-native vegetation	A total of eleven rocky areas were recorded within the Subject Land. Five of these have been avoided by the proposal. Only two outcrops occur in the middle of the cleared paddocks and cannot be avoided by the development footprint. The remaining four may also be avoided during the detailed design and survey of the required riparian buffers and perimeter road. Vegetation within the Development Site comprises 109.92 ha of Cleared Land, Disturbed Grasslands and Dams. These areas were selected to be removed as they are areas where biodiversity value are lowest.	Avoidance of five rocky areas within the Project Boundary. Loss of only two rocky areas located in the centre of the Development Site. Four additional rocky areas likely to be avoided during detailed design.
(b) Impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range.	The predominantly cleared landscape provides low quality connectivity across the Development Site itself. Isolated paddock trees scattered across the Development Site represent limited connectivity features for highly mobile species to travel across the landscape. The second and third order creeks within the Development Site have some, albeit limited, potential to provide aquatic connectivity to Dumaresq River and have been avoided.	Retention of the second and third order streams which are the landscape features with highest potential as linking corridor.

Impact	Avoidance Measures	Outcome
(c) Impacts of development on movement of threatened species that maintains their life cycle	The predominantly cleared landscape provides low quality connectivity across the Development Site and the movement of the Grey-crowned Babbler largely confined to the woodland habitats and riparian corridors as this species has limited flying capacity. The riparian corridors (with a 20-30m buffer) have been avoided. Regarding the Cicadabird and microchiropteran bats, it is not considered the project will restrict the movement of these highly mobile aerial species and they will continue to utilise the habitats surrounding the solar farm.	Retention of the second and third order creek lines along which movement of threatened species will continue to occur.
(d) Impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including from subsidence or upsidence resulting from underground mining)	The second and third order watercourses will be avoided through detailed design (including 20-30m riparian buffer zones measured from the top of bank of the streams). Any waterway crossings required as a result of the Project will be designed in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management and the Policy and Guidelines for Fish Friendly Waterway Crossings. Six farm dams are present within the development site. These farm dams could not be avoided due to the size constraints of the solar panels. These farm dams would be filled in during construction of the solar farm. The impacts proposed to these dams are not anticipated to have any broader impacts for environments that sustain and interact with the rivers, streams and wetlands either on or offsite.	Avoidance of second and third order creek lines. Loss of six first order creeks and six farm dams.
(e) Impacts of wind turbine strikes on protected animals	Not applicable	Not applicable
(f) Impacts of vehicle strikes on threatened species or on animals that are part of a TEC.	The proposal would not directly increase impacts of vehicle strikes on threatened species. Threatened species would not be funnelled into transport corridors. An increase in vehicle traffic may indirectly increase vehicle strikes on native fauna. Site design would be unlikely to reduce impacts to vehicle strikes. Site management to enforce and reduce site speed limits would minimise impacts of vehicle strikes.	Increased traffic may indirectly increase vehicle strikes with fauna, including threatened species such as Grey-crowned Babbler.

Impact	Avoidance Measures	Outcome
Impacts to Other Biodiversity Values		
Loss of Species Credit Species Habitat or Individuals	Habitat for the Bristle-faced Free-tailed Bat will be retained within riparian buffers of 2nd and 3rd creek lines. The bat was also detected in one of the first order creeks to be retained. To further avoid impact, vegetation clearance can only be undertaken outside breeding period for the species to prevent miscarriage in gravid females. Hollow bearing trees within the development footprint will be inspected prior to removal. If this species is confirmed utisiling any of the hollow bearing trees, the trees will be left undisturbed until further advice is sought from OEH and a suitably recognised bat expert.	The species polygon for the Bristle-faced Free-tailed Bat occupies the entire Development Site. Offsets will be required to compensate for loss of that habitat features for the species.
Loss of habitat for the Grey-crowned Babbler	A total of 17 Grey-crowned Babbler nests were recorded across the assessment area, with three of these to be avoided. The predominantly cleared landscape provides low quality connectivity across the development site and the movement of the Grey-crowned Babbler is largely confined to the woodland and riparian corridors as this species has limited flying capacity. The riparian corridors (with a 20-30m buffer) have been avoided. To further avoid impacts, enhancement of linking corridor along 2nd and 3rd order riparian zone will be considered. This is expected to improve the current fragmented condition of the riparian corridor and assist movement of the Grey-crowned Babbler along creek-lines outside of the Development Site and beyond the solar panel fields.	Offsets will be required to compensate for loss of that habitat features for the species.
Loss of Hollow Bearing Trees (HBT)	A total of 60 hollow bearing trees were recorded across the assessment area, including 37 HBT within the development footprint. Trees will be planted at a rate of 2:1 with two new trees planted for each HBT removed. This results in planting of 74 new trees within the riparian corridor. In the event that a newly-planted tree dies during the lifespan of the solar farm, the client has the responsibility to replace it in order to achieve a 100% recruitment of 74 trees replacing loss of HBT. It is recognised that it takes around 100 years for natural small tree hollows, 200 years for medium size hollows and a lot more for large natural hollows to develop in Eucalypt trees (NPWS 1999). As naturally formed tree hollows will take many decades to develop,	The impacts of the loss of HBT will be minimised.

Impact	Avoidance Measures	Outcome
	nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm.	
Impacts of Development on the Habitat of Threatened Species or Ecological Communities	TECs were not recorded within the Development Site. Threatened species recorded within the Development Site included the Grey-crowned Babbler and microbats. The Grey-crowned Babbler habitat includes trees where the species roosts and nests and feeds. Microbats recorded within the Development Site included hollow-dependent species, which roost and breed in tree hollows, such as the Bristle-faced Free-tailed Bat.	Implementation of mitigation measures will result in negligible impact on remaining habitat of threatened species within the Development Site.
Impacts of Development on the Habitat of EPBC Listed Migratory Species	The project will not result in impacts on habitat of EPBC listed migratory species. One individual of the Cicadabird was recorded within the Development Site. The species occupies several types of vegetation across its range and forages on fruits and insects. **No species-specific avoidance measure has been proposed for the Cicadabird, however measures proposed for other threatened species will enhance roosting habitat and foraging resources availability for this migratory bird.**	**Implementation of mitigation measures will result in enhancement of habitat resources on remaining habitat of threatened species within the Development Site.**

6.3 Impact that Cannot be Avoided

6.3.1 Direct Impacts

The main impacts of project is generally associated with direct impacts arising from the clearing of native vegetation communities and loss of threatened species habitat.

Potential direct impacts that could arise during the construction and operation of the solar farm are outlined in Table 6.2:

Table 6.2 Potential impacts to biodiversity during the construction and operational phases

Nature of Impact	Area of impact	Frequency/Timing	Description of the Impact	Threatened species and habitats likely to be affected
Potential impacts to biodiversity during the construction and operational phases	167 ha	Construction	Direct loss of native flora and fauna habitat. Potential over - clearing of habitat outside proposed development footprint.	Grey-crowned Babbler Microchiropteran bats, such as Bristle-faced Free-tailed Bat

Nature of Impact	Area of impact	Frequency/Timing	Description of the Impact	Threatened species and habitats likely to be affected
			Injury and mortality of fauna during clearing of fauna habitat and habitat trees. Disturbance of fallen timber, and bush rock.	
Displacement of resident fauna	Unknown	Construction and Operation	Direct loss of native fauna. Decline in local fauna populations.	Grey-crowned Babbler Microbats
Injury or death of fauna	Unknown	Construction	Direct loss of native fauna. Decline in local fauna populations.	Mobile fauna (birds, microbats, arboreal fauna, reptiles)
Removal of important habitat features e.g. Hollow bearing trees	37 hollow trees to be removed	Construction	Direct loss of native fauna habitat Injury and mortality of fauna during clearing of fauna habitat and habitat trees.	Hollow dependent fauna, including arboreal mammals (e.g. Possum), microbats and birds
Bush Rock removal and disturbance	Up to six outcrops may be disturbed	Construction	Direct loss of native fauna habitat Injury and mortality of fauna during clearing of fauna habitat	Reptiles
Shading by solar infrastructure	Up to 167ha	Operation	Modification of ecosystem grassland composition.	Flora species

The likely changes in vegetation integrity scores as a result of clearing for the solar array, laydown areas and access roads are documented for each vegetation zone in Table 6.3. This is based on the estimated clearing of 40% of the development footprint, with only trees and shrubs to be removed on the remaining 60% of the footprint area. Groundcover under the solar arrays (albeit shaded) will continue to be available for grazing (sheep).

Table 6.3 Current and future vegetation integrity scores for each vegetation zone

Vegetation Zone		PCT	Area of Impact ^{A}	Vegetation integrity scores	
No	Name			Current	Future
1	594_Moderate	594	18.62	61.3	3
2	594_Low	594	7.02	33.3	2.9
3	596_Moderate	596	11.40	58.7	3.5
4	596_Low	596	0.39	38.2	0.4
5	596_Very Low	596	0.30	23.6	2.1
6	596_Derived_Low	596	9.32	8	0
7	516_Moderate	516	0.57	23.4	0
8	516_Very Low	516	5.76	20.7	2.9
9	516_Derived_Moderate	516	3.46	24.7	6.6

Vegetation Zone		**PCT**	**Area of Impact** [A]	**Vegetation integrity scores**	
No	**Name**			**Current**	**Future**
10	516_Disturbed Grassland	NA	8.71	15.8	1.6
11	594_Distrubed Grassland	NA	46.09	17.6	4.2
12	596_Disturbed Grassland	NA	54.46	5.6	1.3
13	Cleared Land	NA	0.312	-	-

6.3.2 Indirect Impacts

Identified indirect impacts that could occur as a result of the project include:

- increased noise, vibration and dust levels;
- increase sedimentation and erosion;
- increase mortality and/or fauna incidents associated with solar panels being confounded with water bodies;
- Reduction in foraging resources, such as herbs and grasses flower, nectar and seeds as well as insects;
- artificial lighting impacting nocturnal species behaviour; and
- Increase in invasive, species weeds and pathogens.

Table 6.4 Potential impacts to biodiversity during the construction and operational phases

Nature of Impact	Area of impact	Frequency/ Timing	Description of the Impact and Consequence for Bioregional Persistence	Threatened species and habitats likely to be affected
Increased noise, vibration and dust levels	Development Site	Working hours during the construction and operations phase	Construction activities may result in increased levels of noise and vibration. No significant impacts are anticipated as the fauna abundance is low across the development site and largely limited to highly mobile species. A total of five Grey-crowned Babblers and one confirmed nest were observed within the Development Site, family groups of the species stay together within their home range (generally 10 ha and up to 50 ha). It is expected that individuals of the local family group would move to roosting nests outside of the Development Footprint. No other threatened species are anticipated to rely on any of the habitats currently present and no sensitive receptors have been identified.	All fauna species, including the Grey-crowned Babblers
Increase sedimentation and erosion	Development Site & Project Boundary	All time during the Construction and Operation Phase	Mobilisation of soils/sediments may occur during inclement weather over disturbed soils and sediments in areas where vegetation has been cleared and/or areas where soil and construction material has been stockpiled. Reduction in watercourse bank stability following any nearby construction and any clearing of riparian vegetation could also result in bank erosion and input of sediments into watercourses.	Aquatic fauna and habitat within the Dumaresq riparian system
Artificial lighting impacting	Development Site & Project Boundary	Nigh during the Construction and Operation Phase	The project will require limited permanent night lighting, most likely for the operations and maintenance buildings and substations. Temporary, localised night lighting may be required during general maintenance activities conducted during the operational stage of the project. Lighting has the potential to impact species behaviour. Any impacts are anticipated to be highly localised and are not anticipated to be significant given the low diversity and abundance of fauna recorded within the Development Site.	All fauna, including the Grey-crowned Babbler and microbats
Increase in invasive species	Development Site & Project Boundary	Continuous during the construction and operational phase	Increased movement of vehicles has the potential to transport weeds and pathogens into the development site and adjacent vegetation. Given the high levels of disturbance within the development site, there is also the risk that weeds may be transported off-site. Infection of native plants by *Phytophthora cinnamomi* is listed as a key threatening process under the BC Act and EPBC Act. *P. cinnamomi* can lead to death of trees and shrubs, resulting in devastation of native ecosystems (DECC 2008). As described by DoE (2014), infection of susceptible communities with *P.cinnamomi* can lead to:	Predation of fauna species, including threatened birds (e.g. Grey-crowned Babbler) and microbats (e.g. Bristle-faced Free-tailed Bat)

Nature of Impact	Area of impact	Frequency/ Timing	Description of the Impact and Consequence for Bioregional Persistence	Threatened species and habitats likely to be affected
			■ changes in the structure and composition of native plant communities; ■ a significant reduction in primary productivity and functionality; and ■ habitat loss and degradation for dependent flora and fauna. Clearing of vegetation and construction of roads provides more access for invasive pest species to increase their distribution and establish themselves in new areas. Invasive species can also be unintentionally be transported in vehicles and machinery. Monitoring of invasive species, such as cats, foxes and cane toads should be monitored and managed.	
Impacts to Riparian Habitats	Development Site & Project Boundary	Continuous during the construction and operational phase	The second and third order watercourses will be avoided through detailed design. Riparian buffers will be applied to either side of the streams, measured from the edge of the high bank. The distances applied to this BDAR are 20m either side of the second order stream and 30m either side of the third order streams. Furthermore, watercourses within the Development Site are highly disturbed being heavily grazed and eroded. The project is unlikely to result in any increased impact to the aquatic habitat, and the change in land use may improve habitats by reducing stocking rate.	Movement of fauna species, including the Grey-crowned Babbler and microbats.
Increased Fragmentation	Development Site	Permanent after clearing	The removal of native vegetation has the potential to result in fragmentation of fauna habitat, with resultant effects on fauna species movement, reproduction and gene flow. The impact of this vegetation clearance in an already highly modified landscape is anticipated to be negligible given that no significant fauna movement corridors currently exist within the development site (excluding the riparian corridor).	All fauna species, including the Grey-crowned Babbler and microbats

6.3.3 Prescribed Impacts

Prescribed impacts requiring assessment had been identified in Section 8.2.1.2 of the BAM (OEH 2017a). These are discussed in Table 6.5 below.

Table 6.5 Identification of Prescribed Impacts triggered by the proposed Solar Farm

Prescribed Impact	Likely to occur as result of the proposed Solar Farm
(a) Impacts of development on the habitat of threatened species or ecological communities associated with: ■ karst, caves, crevices, cliffs and other geological features of significance, or ■ rocks, or ■ human made structures, or ■ non-native vegetation	A total of eleven rocky areas were recorded within the Development Site. Up to six of these may be impacted by the proposed development. No threatened species were observed, or likely to be dependant on these six outcrops. No threatened species are likely to be dependant on any areas on non-native vegetation.
(b) Impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range.	Isolated paddock trees scattered across the Development Site represent limited connectivity features for highly mobile species to travel across the landscape. The second and third order creeks within the Project Boundary have some, albeit limited, potential to provide aquatic connectivity to Dumaresq River and have been avoided. The Development Site is not a known major connectivity link for of the threatened species assessed and the proposal is not likely to disrupt the movement of threatened species across their range.
(c) Impacts of development on movement of threatened species that maintains their life cycle	A breeding population of Grey-crowned have been recorded on the Development Site. The movement of this species is largely confined to the woodland habitats and riparian corridors as this species has limited flying capacity. The riparian corridors (with a 20-30m buffer) have been avoided. Regarding the Cicadabird and microchiropteran bats, it is not considered the project will restrict the movement of these highly mobile aerial species and they will continue to utilise the habitats surrounding the solar farm. The development site is not a known migratory path for any threatened species. Due to the highly cleared and fragmented landscape the proposal is not likely to disrupt the movement of threatened species that maintains their lifecycle.

Prescribed Impact	Likely to occur as result of the proposed Solar Farm
(d) Impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including from subsidence or upsidence resulting from underground mining)	Six farm dams are present within the development site. These farm dams could not be avoided due to the size constraints of the solar panels. These farm dams would be filled in during construction of the solar farm. The impacts proposed to these dams are not anticipated to have any broader impacts for environments that sustain and interact with the rivers, streams and wetlands either on or offsite. The proposed development will affect six first order streams which are located within the proposed Development Site. These six first order creeks will be lost permanently. The proposal has the potential to affect surface water quality and quantity due to sediment runoff and/or contaminant runoff into adjacent watercourses. Pollutants to water courses are likely to be associated to vehicle movement, spill of chemicals used for solar panel maintenance/cleaning and maintenance of associated infrastructure. Appropriate drainage features would be constructed along internal access roads to minimise the risk of dirty water leaving the site or entering waterways. Ground cover would be maintained beneath the solar arrays and there would be a low risk of contamination in the event of a chemical spill (fuels, lubricants, herbicides etc.) as storage and emergency handling protocols must be implemented.
(e) Impacts of wind turbine strikes on protected animals	Not applicable
(f) Impacts of vehicle strikes on threatened species or on animals that are part of a TEC.	Vehicle strikes are likely to occur as result of the project construction and operational activities although a reduce speed limit and signage would greatly reduce this risk. The threatened species recorded within the Development Site are all highly mobile species (birds and bats) which also reduces the risk of vehicle strike. The Grey-crowned Babbler is a bird with limited flying capacity. As such, monitoring of its population will be required.

6.4 Impacts to Matters of National Environmental Significance

An assessment of the impacts of the project on MNES within the Development Site was prepared to determine whether referral of the project to the Commonwealth Minister for the Environment is required. Matters of MNES relevant to the development site are summarised in Table 6.6 below.

A likelihood of occurrence assessment considering each entity individually is provided in Appendix D. Based on results of likelihood of occurrence and risk assessment, all TECs and threatened species as identified in the PMST were concluded to have a low residual risk. Given that one individual of the Cicadabird was recorded on the Subject Land, an assessment of significance for the species was undertaken as a precautionary measure (see Appendix E).No assessments of significance were deemed required for other MNES (Appendix D).

Referral of the project to the Commonwealth Minister for the Environment for assessment is not required.

Table 6.6 Assessment of the Project against EPBC Act

MNES	Predicted MNES	Result
Wetlands of International Importance	Three wetlands of national importance were identified as being between 1,100 and 1,300 km form the Development Site: ■ Banrock Station Wetland Complex ■ Riverland ■ The Coorong, and lakes Alexandrina and Albert wetland.	No direct or indirect effects on these wetlands of international importance will result from the proposal.
Threatened Ecological Communities (TECs)	Four TECs were identified as likely to occur within the project area: Natural Grasslands on basalt and fine-textured alluvial plains of northern New South Wales and Southern Queensland (CEEC) New England Peppermint (Eucalyptus nova-anglica) Weeping Myall Woodland (CEEC) Weeping Myall Woodlands (EEC) White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CEEC)	A likelihood of occurrence analysis was undertaken for this TECs (see Table D.3 in Appendix D). It was concluded that the proposed development has no potential to affect these TECs.
Threatened Species	A total of 36 threatened species were predicted to occur within the project area, including: ■ Eight mammals ■ Seven birds ■ Four reptiles ■ One fish ■ 16 flora	Seven species were identified as likely to occur within the Development Site and were taken into account during survey design. No EPBC listed threatened species have been recorded within the Development Site.

MNES	Predicted MNES	Result
Migratory Species	A total of 11 migratory species were predicted to occur within the project area.	One migratory bird, Cicadabird (*Coracina tenuirostris*), was recorded during the surveys. A Significant Impact Assessment for this migratory species was undertaken (see Appendix E) and it was concluded that the species is unlikely to be significantly impacted as result of the proposed development. No further assessment for the Cicadabird is required.

7. MANAGEMENT AND MITIGATION MEASURES

The key measures required to mitigate the impacts of the proposal is provided below in Table 7.1.

Table 7.1 Recommended mitigation measures for residual impacts

Impact	Mitigation Measure	Responsibility	Timing	Reporting
Loss of Species Credit Species Habitat or Individuals	Vegetation clearance: ■ Preparation and implementation of a vegetation clearing protocol. ■ Clearing to be supervised by an experienced fauna catcher / ecologist. ■ Time works to avoid critical life cycle events such as breeding. ■ If Bristle-cased Freetail Bat is confirmed utilising any of the hollow bearing trees, the trees will be left undisturbed and managed in accordance with the Biodiversity Management Plan. ■ Replacement of trees at a rate of 2:1 (i.e. two trees will be planted to replace each hollow bearing tree removed). This results in planting of 74 new trees within the riparian corridor. In the event that a newly-planted tree dies during the lifespan of the solar farm, the client has the responsibility to replace it in order to achieve a 100% recruitment of 74 trees. ■ Nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm	■ Principal contractor to ensure implementation of vegetation clearing protocol. ■ Experienced fauna catcher / Ecologist to supervise clearing and relocate native fauna.	■ Vegetation clearing protocol to be prepared by an Ecologist prior to vegetation clearing. ■ Clearing supervision to occur during the entire clearing process. ■ Letter with results of clearing to be prepared by the fauna catcher/Ecologist supervising the clearance. Letter to be available for review by delegated authority (if requested).	Vegetation Clearing Protocol as part of the Biodiversity Management Plan

Impact	Mitigation Measure	Responsibility	Timing	Reporting
	■ No stockpiling or storage within dripline of any mature trees. ■ Approved clearing limits to be clearly delineated with temporary fencing or similar prior to construction commencing.			
Grey-crowned Babbler habitat	Nest removal: ■ Approved clearing limits to be clearly delineated with temporary fencing or similar prior to construction commencing. ■ Removal of trees with nests will be included in the vegetation clearing protocol including any seasonal constraints to avoid impacting any juveniles or unfledged chicks. ■ Removal of trees with nests will be supervised by an experienced fauna catcher or ecologist. ■ A portion of felled trees will be salvaged as habitat for fauna and translocated in suitable areas in the remainder of the Project Boundary.	■ Principal contractor to ensure implementation of vegetation clearing protocol. ■ Experienced fauna catcher / Ecologist to supervise clearing and relocate native fauna	■ Clearing supervision to occur during the entire clearing process. ■ Letter with results of clearing to be prepared by the fauna catcher/Ecologist supervising the clearance. Letter to be available for review by delegated authority (if requested).	Vegetation Clearing Protocol as part of the Biodiversity Management Plan

Impact	Mitigation Measure	Responsibility	Timing	Reporting
Loss of Hollow Bearing Trees	▪ Replacement of trees at a rate of 2:1 (i.e. two trees will be planted to replace each hollow bearing tree removed). This results in planting of 74 new trees within the riparian corridor. In the event that a newly-planted tree dies during the lifespan of the solar farm, the client has the responsibility to replace it in order to achieve a 100% recruitment of 74 trees. ▪ nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm	▪ GAIA to appoint a qualified ecologist for preparation of the monitoring plan. ▪ GAIA to liaise with relevant authority regarding outcomes. ▪ Appointed Ecologist to undertake monitoring as required.	▪ Monitoring Plan to be prepared and approved prior to commencement of clearing. ▪ Monitoring to be implemented as required.	Tree Replacement and Nest Box Monitoring Plan as part of the Biodiversity Management Plan
Impacts of Development on the Habitat of Threatened Species or Ecological Communities	▪ A tree replacement and nest box monitoring plan will be prepared for the Project. The plan will provide details of monitoring and Key Performance Indicators (KPIs) to ensure objectives of tree replacement and nest box monitoring is achieved. ▪ Monitoring and reporting to be undertaken by a qualified ecologist. Avoidance of use of chemicals, such as pesticides and herbicides, within the solar farm during the construction and operational phases to prevent contributing to the global decline in insect population and diversity. ▪ Facilitation natural revegetation of native ground cover within viable solar farm footprint (e.g. under solar panel arrays) and in retained areas. This will include management of weeds.	▪ GAIA to appoint a qualified ecologist for preparation of the monitoring plan. ▪ GAIA to liaise with relevant authority regarding outcomes. ▪ Appointed Ecologist to undertake monitoring as required.	▪ Monitoring Plan to be prepared and approved prior to commencement of clearing. ▪ Monitoring to be implemented as required.	Tree Replacement and Nest Box Monitoring Plan as part of the Biodiversity Management Plan

Impact	Mitigation Measure	Responsibility	Timing	Reporting
Impacts of Development on the Habitat of EPBC Listed Migratory Species	None required	NA	NA	NA
Impacts of Development on Water Quality, Water Bodies and Hydrological Processes that sustain Threatened Species and TECs	■ An erosion and sediment control plan (ESCP) would be prepared in conjunction with the final design and implemented. ■ Design of creek crossings to meet best practice industry standards. ■ ESCP to include requirements for water quality monitoring, chemical use and control.	■ GAIA has overall responsibility to ensure meeting that they are meeting environmental commitments.	■ ESCP to be prepared and approved prior to commencement of works. ■ Reporting, evaluation and auditing as per the ESCP.	CEMP ESCP
Impacts of Vehicle Strikes on Threatened Species of animals or on animals that are part of a TEC	Actions to minimize mortality of wildlife involved in vehicle strikes: ■ Reduced vehicle speeds and signage to be installed within the solar farm. ■ Protocol detailing actions to be undertaken in the event of a vehicle strike. ■ Identification of a wildlife veterinary and/or wildlife carer group and agreement for injured wildlife to be taken care of or being humanely euthanized.	■ GAIA has overall responsibility to ensure meeting that they are meeting environmental commitments.	■ CEMP to be prepared and approved prior to commencement of works. ■ Reporting, evaluation and auditing as per the CEMP.	CEMP
	■ Avoid Night Works. ■ Direct lights away from retained native vegetation.	■ GAIA has overall responsibility to ensure meeting that they are meeting environmental commitments.	■ CEMP to be prepared and approved prior to commencement of works. ■ Reporting, evaluation and auditing as per the CEMP.	CEMP

Impact	Mitigation Measure	Responsibility	Timing	Reporting
Invasive Species	■ CEMP will include a Management protocol for declared priority weeds under the Biosecurity Act 2015 during and after construction. ■ Hygiene protocols to prevent the spread of weeds or pathogens between infected areas and uninfected areas. ■ Monitoring and management protocol for invasive feral/pest species, including cats, foxes and cane tods.	■ GAIA has overall responsibility to ensure meeting that they are meeting environmental commitments.	■ CEMP to be prepared and approved prior to commencement of works. ■ Reporting, evaluation and auditing as per the CEMP.	CEMP

8. SERIOUS AND IRREVERSIBLE IMPACTS (SAII)

A Serious and Irreversible Impact (SAII) is listed under the BC Act as an impact that is likely to contribute significantly to the risk of extinction of a threatened entity.

In accordance with the BAM, species and ecological communities with a 'very high' biodiversity risk weighting will be a potential serious and irreversible impact (SAII). Whenever potential SAII are identified for a Development Site, those SAII need to be address as per Section 10.2 of the BAM (OEH 2017a).

The following guidelines were consulted to identify potential SAII:

- OEH (2017b) *Guidance to assist a decision-maker to determine a serious and irreversible impact*.
- OEH (2018b) '*Species Credit' threatened bats and their habitats guide*.

8.1 Potential Serious and Irreversible Impact Entities

Based on candidate ecosystem credit species, species credit species and results of field surveys, the potential SAII for the Development Site are listed in Table 8.1 below.

Table 8.1 Potential SAII within the Development Site

Scientific Name Common Name	Justification as potential SAII	Corresponding habitat constraint	Is SAII present?
Miniopterus schreibersii subsp. oceanensis Eastern Bentwing Bat	The species is dependent on non-responding attribute (breeding habitat only) (OEH 2017b)	Caves are the primary breeding habitat for the Eastern Bentwing Bat. Breeding habitat is absent at the Development Site.	No
Vespadelus troughtoni Eastern Cave Bat	Breeding habitat is classified as SAII (OEH 2018b)	Breeding habitat for the species is caves, overhangs crevices, cliffs and escarpments, or old mines or tunnels, old buildings and sheds within the potential habitat.	No

8.1.1 Threatened Ecological Communities

No potential SAII for threatened ecological communities were identified for the Development Site.

8.1.2 Threatened Species

Two potential SAII were identified, the Eastern Bentwing Bat and the Eastern Cave Bat, due to their breeding habitat being identified as such. The echolocation calls of these species were recorded within the assessment area. However, breeding habitat for these microbat species, i.e. caves, overhangs crevices, cliffs or escarpments, are not present within the Development Site. It is concluded that due to the lack of suitable breeding habitat, the species would use foraging resources within the Development Site only. Therefore, these SAII are not present within the Development Site.

8.1.3 Additional Potential Entities

No other potential threatened entities, either TECs or species, were identified as having potential to qualify as SAII within the Development Site.

8.2 Assessment of SAII

SAIIs are not present within the Development Site.

9. REQUIREMENT TO OFFSET

This chapter provides an assessment of the impacts requiring offsetting in accordance with Section 10 of the BAM (OEH 2017a).

9.1 Impacts Requiring an Offset

9.1.1 Impacts on Native Vegetation – Ecosystem Credits

Impacts to native vegetation requiring offsets include:

- Direct impacts on PCT 516 – Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion
- Direct impacts on PCT 594 – Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion
- Direct impacts on PCT 596 – Tumbledown Red Gum - White Cypress Pine - Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion

The changes in vegetation integrity scores as a result of clearing for the solar array, laydown areas and access roads are documented for each vegetation zone in Table 6.3. This is based the estimated clearing of 40% of the development footprint, with only trees and shrubs will be removed on the remaining 60% of the footprint area. Groundcover under the solar arrays (albeit shaded) will continue to be available for grazing (sheep).

A total of 1,170 ecosystem credits are required to offset impacts of the proposed development. The impacts on the vegetation zones within each of the three PCTs is shown in Table 9.1.

Table 9.1 Summary of ecosystem credits

Vegetation Zone Number	Vegetation Zone Name	Area (ha)	Vegetation Integrity Score	Future Vegetation Integrity Score	Change in Vegetation Integrity Score	Credits Required
PCT 594 – Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion						
1	594_Moderate	18.62	61.3	3	-58.3	475
2	594_Low	7.02	33.3	2.9	-30.4	93
11	*594_Disturbed Grassland ^{A}*	*46.09*	*17.6*	*4.2*	*-13.4*	*269**
Total Ecosystem Credits required to offset impacts on PCT 594						837
PCT 596 – Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion						
3	596_Moderate	11.40	58.7	3.5	-55.2	236
4	596_Low	0.39	38.2	0.4	-37.8	6
5	596_Very Low	0.30	23.6	2.1	-21.5	2

Vegetation Zone Number	Vegetation Zone Name	Area (ha)	Vegetation Integrity Score	Future Vegetation Integrity Score	Change in Vegetation Integrity Score	Credits Required
Total Ecosystem Credits required to offset impacts on PCT 596						244
PCT 516 – Grey Box grassy woodland or open forest of the Nandewar Bioregion of New England Tableland Bioregion						
7	516_Moderate	0.57	23.4	0	-23.4	7
8	516_Very Low	5.76	20.7	2.9	-17.8	51
9	516_Derived_Moderate	3.46	24.7	6.6	-18.1	31
Total Ecosystem Credits required to offset impacts on PCT 516						89

A – Vegetation Zone 11 (594_Disturbed Grassland) is cleared land is mapped as cleared land on Figure 4.2 and based on the field results this entire area is heavily grazed and of low vegetation integrity.

* *ERM recommends that this zone should be removed from the offset obligation (which would reduce the PCT 594 credit requirement from 837 to 568).*

Important note: It is noted that based on extensive field survey vegetation zone 11 (PCT 594_Disturbed Grassland) is mapped as cleared land on Figure 4.2, but was assigned to the most likely PCT as per the BAM requirements. The Calculator returned an integrity score of 17.6, however based on the results of the field survey ERM does not consider that this integrity score accurately reflects the heavily grazed and highly disturbed nature of the vegetation zone and recommends that it should be removed from the offset obligation (which would reduce the PCT 594 credit requirement from 837 to 568 ecosystem credits). For the purposes of this BDAR, these credits have been included in the current assessment and should be the subject of further discussion with OEH to confirm if they can be removed from the final credit obligations.

9.1.2 Paddock Tree Credits

A total of 21 ecosystem credits are required to offset clearance of paddock trees in Class 2 (13 trees) and Class 3 (15 trees).

9.1.3 Impacts on Threatened Species – Species Credits

Impacts to habitat of Threatened Species requiring offsets include:

- Habitat for the Bristle-faced Free-tailed Bat in PCTs 516, 594 and 596, requiring 1,578 species credits
- Foraging habitat for Eastern Cave Bat in PCTs 516, 594 and 516, requiring 2,365 species credits.

A total of 3,943 species credits are required to offset loss of fauna habitat within the Development Site.

9.1.4 Offsets Required Under the EPBC Act

No offsets requirements under the EPBC Act had been identified within the Development Site.

9.2 Areas not requiring Offsets

Highly disturbed vegetation areas, such as the heavily grazed disturbed grasslands and low integrity derived grasslands are not required to be offset.

In line with the BAM (OEH 2017a, 218a), impacts in vegetation zones with low vegetation integrity scores do not require offsetting. These areas are shown in Table 9.2.

Table 9.2 Summary of impacts on vegetation not requiring offsets

Vegetation Zone Number	Vegetation Zone Name	Area (ha)	Vegetation Integrity Score	Future Vegetation Integrity Score	Change in Vegetation Integrity Score	Credits Required
PCT 596 – Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion						
6	596_Derived_Low	9.32	8	0	-8	0
12	596_Disturbed Grasslands	54.46	5.6	1.3	-4.3	0
PCT 516 – Grey Box grassy woodland or open forest of the Nandewar Bioregion of New England Tableland Bioregion						
10	516_Disturbed Grassland	8.71	15.8	1.6	-14.2	0

9.3 Summary of Offset Credits Required

The proposed development will incur loss of native vegetation and threatened fauna habitat requiring offsets for a total of 1,191 ecosystem credits and 6,317 species credits.

Note that this credit obligation may (with ongoing consultation with OEH) be reduced to 922 ecosystem credits based on the cleared nature of Vegetation Zone 11 (594_Disturbed Grassland).

9.4 Biodiversity Offset Framework

The following section outlines several methods which GAIA can use to compensate the projects impacts.

The development of the overall offset strategy for the project is yet to be achieved, though GAIA is committed to satisfying all offset requirements before any impacts due to the project occur.

In accordance with the Biodiversity Offset Framework, developers may use a single method or a combination of the following four methods to meet their offset requirements:

- Purchasing credits: Identifying if suitable credits are available on the market to meet offset requirements.
- Stewardship Site: Finding potential offset sites with the biodiversity values required to compensate for the project's impacts.
- Payment into the Biodiversity Conservation Trust
- Submit approval to the consent authority to apply variation rules. This excludes impacts on threatened species and TECs.

Given that impacts on habitat of threatened species will occur, variation rules are not applicable to the Bonshaw Solar Farm development. GAIA will use one or a combination of the first three options to meet offset requirements of its proposal.

The biodiversity credit report (like-for-like) detailing requirements for offsetting impacts in PCTs (i.e. 516, 594 and 596) and threatened fauna habitat (i.e. Bristle-faced Free-tailed Bat, Eastern Cave Bat and Masked Owl) is provided in Appendix K.

10. CONCLUSIONS

GAIA is proposing to develop a solar farm in disturbed land located in Lot 2 DP 1039185 (Project Boundary), Bonshaw within the Inverell LGA. The Development Site is located in the western portion of the Project Boundary and will occupy approximately 166.76 ha. The purpose of this BDAR was to address the requirements of the BAM and to address the biodiversity matters raised in the SEARs.

Based on the results of extensive field surveys, a total of 13 vegetation zones were identified within the Development Site pertaining to three plant community types (PCTs) with differing degrees of integrity. None of these PCT form part of any Threatened Ecological Community. The three PCTs are:

- PCT 516 – Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion
- PCT 594 – Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion
- PCT 596 – Tumbledown Red Gum - White Cypress Pine - Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion

An assessment of the potential impacts on the biodiversity values of the Subject Land has identified the following direct impacts to native vegetation requiring offset:

- Impacts on PCT 516 – Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion, requiring 89 ecosystem credits.
- Impacts on PCT 594 – Silver-leaved Ironbark – White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion ad Nandewar Bioregion, requiring 837 ecosystems credits
- Impacts on PCT 596 – Tumbledown Red Gum – White Cypress Pine – Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion, requiring 244 ecosystem credits
- Loss of 28 Paddock Trees, requiring 21 ecosystem credits.

A total of 1,191 ecosystem credits are required to offset the impacts of the project, noting that this credit obligation may (with ongoing consultation with OEH) be reduced to 922 ecosystem credits based on the cleared nature of Vegetation Zone 11 (594_Disturbed Grassland).

A total of eleven threatened fauna species were recorded in the Project Boundary. Threatened species included eight vulnerable microchiropteran bats (Little Pied Bat, Eastern Bent-wing Bat, Corben's Long-eared Bat, Yellow-bellied Sheath-tailed Bat, Eastern Cave Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Hoary Wattled Bat), one endangered microchiropteran bat (Bristle-faced Free-tailed bat), one vulnerable bird (Grey-crowned Babbler) and one migratory bird (Cicadabird). Out of the eight Vulnerable microchiropteran bats, six were definite call identifications and two (Greater Broad-nosed Bat and Hoary Wattled Bat) were potential calls. Impacts on fauna habitat generated the following species credits:

- Bristle-faced Free-tailed Bat, requiring a total of 1,578 species credits
- Eastern Cave Bat, requiring a total of 2,365 species credits.

The proposed Bonshaw Solar Farm development in its current footprint will be required to offset a total of 1,191 ecosystem credits and 3,943 species credits. Retirement of these credits will be carried out in accordance with the NSW Biodiversity Offsets Scheme.

11. REFERENCES

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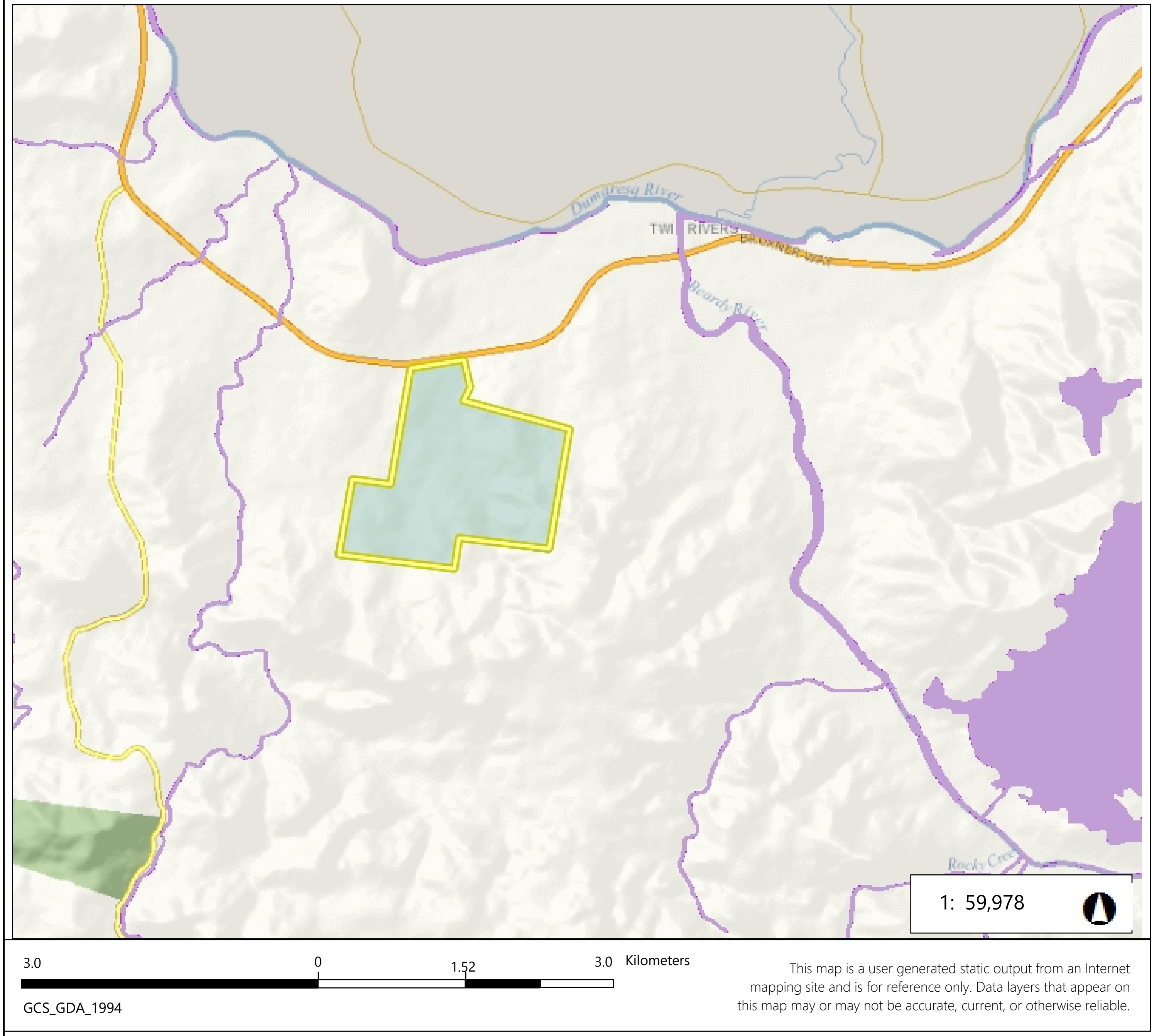
APPENDIX A BOSET REPORT

Biodiversity Offset Scheme (BOS) Entry Threshold Map



THIS MAP IS NOT TO BE USED FOR NAVIGATION

Legend

🟪 Biodiversity Values that have been mapped for more than 90 days

🟪 Biodiversity Values added within last 90 days

Notes

Biodiversity Values Map and Threshold Report

Results Summary

Date of Calculation	08/01/2019 10:12 AM	**BDAR Required***
Total Digitised Area	356.35 ha	
Minimum Lot Size Method	Lot size	
Minimum Lot Size	199.02 ha	
Area Clearing Threshold	1 ha	
Area clearing trigger Area of native vegetation cleared	Unknown #	Unknown #
Biodiversity values map trigger Impact on biodiversity values map(not including values added within the last 90 days)?	no	no

*If BDAR required has:

- at least one 'Yes': you have exceeded the BOS threshold. You are now required to submit a Biodiversity Development Assessment Report with your development application. Go to https://customer.lmbc.nsw.gov.au/assessment/AccreditedAssessor to access a list of assessors who are accredited to apply the Biodiversity Assessment Method and write a Biodiversity Development Assessment Report
- 'No': you have not exceeded the BOS threshold. You may still require a permit from local council. Review the development control plan and consult with council. You may still be required to assess whether the development is '"likely to significantly affect threatened species' as determined under the test in s. 7.3 of the Biodiversity Conservation Act 2016. You may still be required to review the area where no vegetation mapping is available.

Where the area of impact occurs on land with no vegetation mapping available, the tool cannot determine the area of native vegetation cleared and if this exceeds the Area Threshold. You will need to work out the area of native vegetation cleared - refer to the BOSET user guide for how to do this.

Disclaimer

This results summary and map can be used as guidance material only. This results summary and map is not guaranteed to be free from error or omission. The State of NSW and Office of Environment and Heritage and its employees disclaim liability for any act done on the information in the results summary or map and any consequences of such acts or omissions. It remains the responsibility of the proponent to ensure that their development application complies will all aspects of the *Biodiversity Conservation Act 2016.*

The mapping provided in this tool has been done with the best available mapping and knowledge of species habitat requirements. This map is valid for a period of 30 days from the date of calculation (above).

Acknowledgement

I as the applicant for this development, submit that I have correctly depicted the area that will be impacted or likely to be impacted as a result of the proposed development.

Signature__________________________ Date: 08/01/2019 10:12 AM

APPENDIX B NSW BIONET ATLAS RECORDS

Results of search of existing records of threatened species and Threatened Ecological Communities (TECs) in the NSW BioNet Atlas is summarised in Table B.1 below.

Table B.1 BioNet Atlas results

Family	Scientific Name	Common Name	NSW status	Comm. status	Records within 10km radius
Reptilia					
Gekkonidae	*Uvidicolus sphyrurus*	Border Thick-tailed Gecko	V	V	1
Aves					
Cacatuidae	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V		1
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V		2
Psittacidae	*Neophema pulchella*	Turquoise Parrot	V		6
Climacteridae	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)	V		2
Acanthizidae	*Chthonicola sagittata*	Speckled Warbler	V		2
Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	V		3
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V		1
Artamidae	*Artamus cyanopterus cyanopterus*	Dusky Woodswallow	V		1
Petroicidae	*Petroica boodang*	Scarlet Robin	V		1
Estrildidae	*Stagonopleura guttata*	Diamond Firetail	V		2
Mammalia					
Phascolarctidae	*Phascolarctos cinereus*	Koala	V	V	9
Petauridae	*Petaurus norfolcensis*	Squirrel Glider	V		1
Macropodidae	*Petrogale penicillata*	Brush-tailed Rock-wallaby	E	V	1
Vespertilionidae	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V		1

Family	Scientific Name	Common Name	NSW status	Comm. status	Records within 10km radius
Vespertilionidae	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V		1
Vespertilionidae	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V		2
Flora					
Araliaceae	*Astrotricha roddii*	Rodd's Star Hair	E	E	12
Asteraceae	*Rutidosis heterogama*	Heath Wrinklewort	V	V	1
Fabaceae (Faboideae)	*Swainsona sericea*	Silky Swainson-pea	V		1
Myrtaceae	*Eucalyptus caleyi subsp. ovendenii*	Ovenden's Ironbark	V	V	1
Myrtaceae	*Eucalyptus nicholii*	Narrow-leaved Black Peppermint	V	V	1

Notes: V = Vulnerable; E = Endangered

APPENDIX C MATTERS OF NATIONAL SIGNIFICANCE ASSESSMENT – PMST REPORT

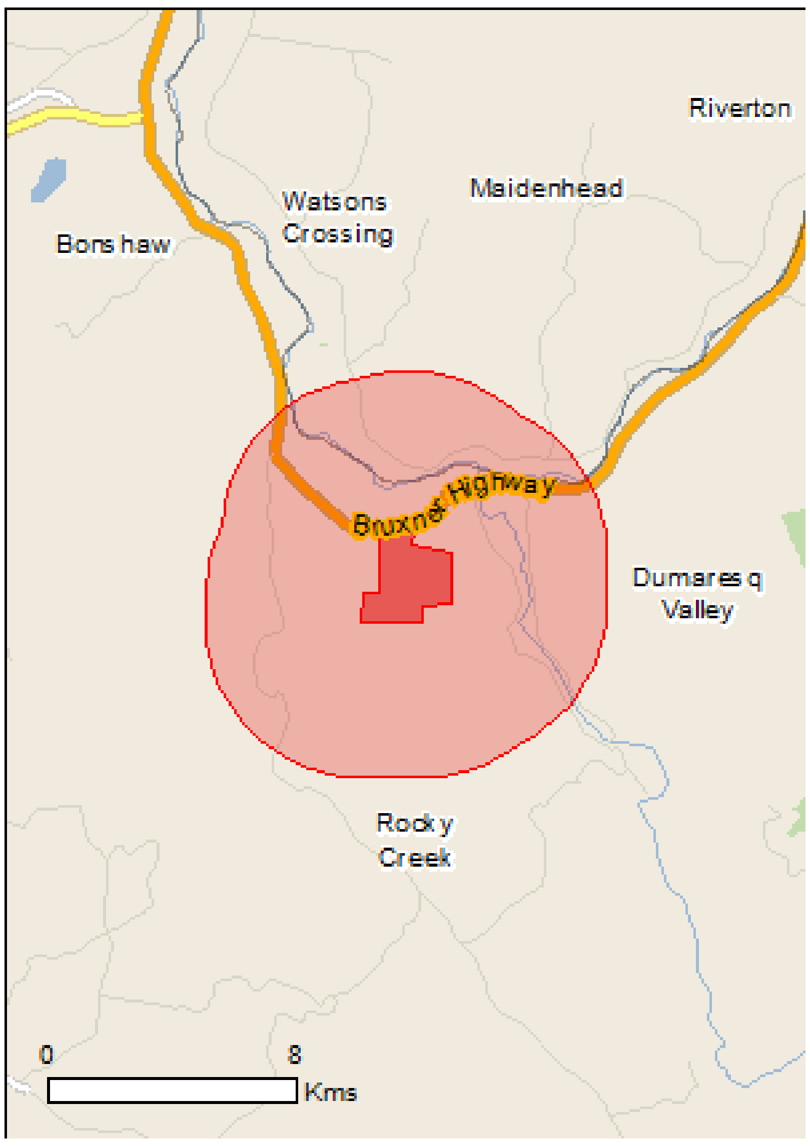
EPBC Act Protected Matters Report

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

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

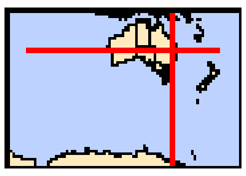
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 08/01/19 09:21:50



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 5.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	3
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	36
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	1
Regional Forest Agreements:	1
Invasive Species:	19
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Banrock station wetland complex	1100 - 1200km
Riverland	1100 - 1200km
The coorong, and lakes alexandrina and albert wetland	1300 - 1400km

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	Critically Endangered	Community likely to occur within area
New England Peppermint (Eucalyptus nova-anglica) Grassy Woodlands	Critically Endangered	Community may occur within area
Weeping Myall Woodlands	Endangered	Community may occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Fish		
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Mammals		
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area
Nyctophilus corbeni		
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat likely to occur within area
Petauroides volans		
Greater Glider [254]	Vulnerable	Species or species habitat may occur within area
Petrogale penicillata		
Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys novaehollandiae		
New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Plants		
Acacia pubifolia		
Velvet Wattle [19799]	Vulnerable	Species or species habitat may occur within area
Astrotricha roddii		
[56312]	Endangered	Species or species habitat known to occur within area
Boronia granitica		
Granite Boronia [18598]	Endangered	Species or species habitat may occur within area
Cadellia pentastylis		
Ooline [9828]	Vulnerable	Species or species habitat likely to occur within area
Callistemon pungens		
[55581]	Vulnerable	Species or species habitat likely to occur within area
Dichanthium setosum		
bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus caleyi subsp. ovendenii		
Ovenden's Ironbark [56193]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus mckieana		
McKie's Stringybark [20199]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus nicholii		
Narrow-leaved Peppermint, Narrow-leaved Black Peppermint [20992]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Homopholis belsonii Belson's Panic [2406]	Vulnerable	Species or species habitat may occur within area
Lepidium peregrinum Wandering Pepper-cress [14035]	Endangered	Species or species habitat may occur within area
Leucopogon confertus Torrington Beard-heath [14417]	Endangered	Species or species habitat may occur within area
Prasophyllum sp. Wybong (C.Phelps ORG 5269) a leek-orchid [81964]	Critically Endangered	Species or species habitat may occur within area
Rutidosis heterogama Heath Wrinklewort [13132]	Vulnerable	Species or species habitat known to occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
Tylophora linearis [55231]	Endangered	Species or species habitat may occur within area
Reptiles		
Delma torquata Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Uvidicolus sphyrurus Border Thick-tailed Gecko, Granite Belt Thick-tailed Gecko [84578]	Vulnerable	Species or species habitat known to occur within area
Wollumbinia belli Bell's Turtle, Western Sawshelled Turtle, Namoi River Turtle, Bell's Saw-shelled Turtle [86071]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species

[Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat likely to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Migratory Wetlands Species		

Name	Threatened	Type of Presence
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species

[Resource Information]

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

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat likely to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Crooked Creek	NSW

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
North East NSW RFA	New South Wales

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat may occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle,		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-29.190623 151.336471,-29.190324 151.336299,-29.190324 151.336299,-29.188525 151.345569,-29.190474 151.34677,-29.193471 151.346255,-29.195269 151.357242,-29.208156 151.357242,-29.208605 151.348659,-29.212651 151.349345,-29.212651 151.331493,-29.205459 151.331664,-29.205459 151.336642,-29.190623 151.336471

Acknowledgements

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

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

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

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

APPENDIX D LIKELIHOOD OF OCCURRENCE AND RISK ANALYSIS

MOVED TO SEPARATE DOCUMENT

In order to complement identification of likely threatened species likely to occur within the Development Site, the NSW BioNet and the PMST were undertaken. A likelihood of occurrence and risk assessments were undertaken for all species. Where results identify additional species to those generated in the OEH Calculator as “Ecosystem Species Credits” or “Species Credit Species”, those species were added in the surveys design.

Likelihood of Occurrence

Species identified in the NSW BioNet atlas and the PMST were collated into a table where an assessment of the likelihood of occurrence of that threatened biodiversity was undertaken. In making this determination, the following factors were considered:

- habitat quality within and adjacent to the Development Site as determined through review of regional vegetation mapping and the results of the September survey;
- breeding habitat/resources present – assists with identification of the importance of habitat to the species;
- dispersal ability - based on known ecology - whether the species have an ability to disperse to new areas of habitat following disturbance; and
- local records in similar habitat/distance/connectivity to the Development Site.

This allows for assessment of cryptic or seasonal species that are unlikely to be readily identified during brief site inspections and/or due to seasonal constraints. The likelihood of each species occurring was categorised as known, potential or unlikely to occur based on the definitions provided in Table D-1. Results of likelihood of occurrence is presented in Table D.3 for TECs and Table D.4 for threatened species.

Table D.1 Definitions of Likelihood of Occurrence

Category	Description
Known	■ the ecological community/species/matter has been recorded in the Development Site during field surveys; or ■ database records demonstrate that the ecological community/species has been known to occur in the Development Site within the last 10 year period.
Potential	■ the ecological community/species’ known distribution includes the Development Site, and suitable habitat is present within it, or, ■ database records demonstrate that the ecological community/species has been known to occur in the Development Site, however has not been recorded within the last 10 years, or ■ the species is a wide ranging flying species which may ‘fly-over’ the Development Site, regardless of the habitat types present and has been recorded within the 10 km locality surrounding the Development Site.
Unlikely	■ the ecological community/species has not been recorded within 10 km locality of the Development Site and suitable habitat does not occur within the Development Site, or ■ the Development Site is not within the TEC/species’ known distribution, or ■ sufficient field surveys have been conducted to conclude that the species is likely to be absent.

The following considerations were made in assessing habitat suitability and distribution:
Habitat quality within and adjacent to the Site.
Breeding habitat/resources present – assists with identification of the importance of habitat to the species.
The species’ ability to disperse to new areas of habitat following disturbance.
Local records in similar habitat/distance/connectivity to the Site.

Risk Assessment

A risk assessment was undertaken using the definitions of Species Sensitivity and Consequence to assign a relative risk ranking for each listed ecological value (Low, Medium, High or Very High, as shown in Table D.2). Impacts to ecological values with potential to occur that were assessed as having a Low risk was not further assessed. Results of risk assessment is presented in Table D.3 for TECs and Table D.4 for threatened species.

Impacts to ecological values with potential to occur that were assessed as having a Medium, High or Very High risk were further assessed in accordance with the requirements of the EPBC Act and BC Act, including the preparation of detailed Assessments of Significance (see Appendix E).

Species sensitivity rankings are based on the species conservation status under the EPBC Act, FM Act and BC Act. Where the conservation status differs between listings, the conservation status with higher sensitivity is used.

Table D.2 Risk Assessment Matrix

		Consequence			
		Negligible	Minor	Moderate	Major
Sensitivity	Ecological value not listed as threatened	Low	Low	Medium	High
	Ecological value listed as Vulnerable or Migratory	Low	Medium	Medium	High
	Ecological value listed as Endangered	Low	Medium	High	Very High
	Ecological value listed as Critically Endangered	Medium	High	Very High	Very High

Consequence Definitions

Negligible: No impacts or removal of ecological community. Effect on species is within the likely normal range of variation. No removal of specific breeding habitat features.

Minor: Indirect impacts to listed ecological community which may affect a small proportion of the ecological community. Effects a small proportion of a population and Project-related mortality of a small number of individuals may occur, but does not substantially affect other species dependent on it, or the populations of the species itself. No removal of specific breeding habitat features.

Moderate: Direct removal of a portion of a listed ecological community. Effects a sufficient proportion of a species population that it may bring about a substantial change in abundance and/or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.

Major: Direct removal of a listed ecological community. Effects an entire population or species at sufficient scale to cause a substantial decline in abundance and/or change in distribution beyond with natural recruitment (reproduction, immigration from unaffected areas) may not return that population or species, or any population or species dependent upon it, to its former level within several generations, or when there is no possibility of recovery.

Species sensitivity definitions

Species sensitivities refer to listed under either the EPBC Act or BC Act. Where listings differ, the higher sensitivity is used.

Table D.3 Threatened Ecological Communities: Likelihood of Occurrence and Risk Assessment

TEC name	EPBC Act	BC Act	Community Description	Likely of TEC Occurring in the Site	Potential Impacts	Mitigation Measures	Risk Rating
Natural Grasslands on Basalt and Fine-textured alluvial plains of northern New South Wales and southern Queensland Source: PMST	CE		The Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland are native grasslands typically composed of perennial native grasses. They are found on soils that are fine textured (often cracking clays) derived from either basalt or alluvium on flat to low slopes (< 1 degree). A tree canopy is usually absent, but when present, comprises ⩽10% projective foliage cover. The distribution of the ecological community is strongly reliant on soil type as it is associated with fine textured, often cracking clays derived from either basalt or quaternary alluvium. Temperate grasses and grassland forbs comprise the ground layer. Tussock grasses within this vegetation community can be dominated by species of the genera *Austrodanthonia*, *Austrostipa*, *Bothriochloa*, *Chloris*, *Enteropogon*, or *Themeda*. In the Darling Downs component of the community, Bluegrass (*Dichanthium sericeum*) tends to dominate, whereas the Plains Grass (*Austrostipa aristiglumis*) tend to dominate in the Liverpool Plains component. The herbaceous cover includes species within genera *Desmodium*, *Glycine*, *Lotus* and Rhynchosia. The shrub layer is generally a minimum component of the community, it can include Mimosa (*Acacia farnesiana*), *Pittosporum phylliraeoides*, *Pimelea* spp. and *Sclerolaena* spp. A tree canopy is typically absent. Where trees are present, they are of variable species composition and comprise less than 10% of projective crown cover. Tree species that may be present as scattered individuals include: *Acacia pendula* (Weeping Myall), *Eucalyptus albens* (White Box), *E. conica* (Fuzzy Box), *E. coolabah* (Coolabah), *E. melliodora* (Yellow Box), *E. populnea* (Poplar Box) or *E. tereticornis* (Forest Red Gum). This ecological community occurs from the Darling Downs in Queensland to Dubbo in NSW and incorporates the Liverpool and Moree Plains. This ecological community occurs within the Brigalow Belt South Bioregion and Border Rivers-Gwydir, Central West, Namoi, Condamine, Burnett Mary and Fitzroy Basin Natural Resource Management Regions. Patches of this vegetation community extend into the Nandewar, Sydney Basin and Darling Riverine Plains bioregions.	Unlikely The Development Site is located immediately south form the Darling Downs, Queensland. Cracking clays were observed in the southern portion of the Development Site, however, the site is highly disturbed and the characteristic species in the northern portion of the distribution of this TEC, i.e. Queensland Bluegrass (*Dichanthium sericeum*) were not recorded. Therefore, it is considered unlikely this CEEC occurs.	NA	NA	Low
New England Peppermint (*Eucalyptus nova-anglica*) Grassy Woodlands Source: PMST	CE	CE	The New England Peppermint (*Eucalyptus nova-anglica*) Grassy Woodlands ecological community occurs in northern NSW and southern Queensland, in the New England Tablelands, NSW North Coast and Nandewar IBRA Bioregions. The tree canopy is typically dominated (>50%) or co-dominated (>30%) by the tree species *Eucalyptus nova-anglica* (New England Peppermint). A range of other associated tree species may be present, and may be co-dominant in the ecological community, but do not dominate it by themselves, in particular *E. pauciflora* (Snow Gum) and *E. dalrympleana* subsp. *heptantha* (Mountain Gum). The understorey is usually made up of a dense, species-rich ground layer of grasses and herbs. Shrubs are typically sparse to absent. The main tree species in the community are New England Peppermint (*Eucalyptus nova-anglica*). Other tree species include Snow Gum (*E. pauciflora*), Black Sallee (*E. stellulata*), Mountain Gum (*E. dalrympleana subsp. heptantha*), Blakely's Red Gum (*E. blakelyi*) and Fuzzy Box (*E. conica*).	Unlikely No tree elements characteristic of the vegetation community were observed within the Development Site during surveys.	NA	NA	Low
Weeping Myall Woodlands	E		The Weeping Myall Woodlands ecological community occurs on the inland alluvial plains west of the Great Dividing Range in NSW and Queensland. It occurs in the Riverina, NSW South Western Slopes, Darling Riverine Plains, Brigalow Belt South, Brigalow Belt North, Murray-Darling Depression, Nandewar and Cobar	Unlikely No elements characteristic of the vegetation community were observed within the Development Site during surveys.	NA	NA	Low

TEC name	EPBC Act	BC Act	Community Description	Likely of TEC Occurring in the Site	Potential Impacts	Mitigation Measures	Risk Rating
Source: PMST			Peneplain IBRA Bioregions. The ecological community currently occurs in small pockets throughout this range. The Weeping Myall Woodlands occur in a range from open woodlands to woodlands, generally 4-12 m high, in which Weeping Myall (*Acacia pendula*) trees are the sole or dominant overstorey species. Weeping Myall trees often occur in monotypic stands, however other vegetation may also occur in the ecological community, though not as dominant species. These include: Western Rosewood (*Alectryon oleifolius subsp. elongatus*); Poplar Box (*Eucalyptus populnea*); or Black Box (*Eucalyptus largiflorens*). Grey Mistletoe (*Amyema quandang*) commonly occurs on the branches of Weeping Myall trees throughout the ecological community's range. Weeping Myall goes through regular cycles of senescence (aging and death) and regeneration. Weeping Myall trees are also susceptible to defoliation by Bag-shelter Moth (*Ochrogaster lunifer*) caterpillars and are often lopped for domestic stock fodder. Therefore, the ecological community can be dominated by Weeping Myall trees that are in a living, defoliated or dead state. The understorey of Weeping Myall Woodlands often includes an open layer of shrubs above an open ground layer of grasses and herbs, though the ecological community can exist naturally either as a shrubby or a grassy woodland.				
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland Source: PMST	CE	E	Box – Gum Grassy Woodlands and Derived Grasslands are characterised by a species-rich understorey of native tussock grasses, herbs and scattered shrubs, and the dominance, or prior dominance, of White Box, Yellow Box or Blakely's Red Gum trees. In the Nandewar Bioregion, Grey Box (*Eucalyptus microcarpa* or *E. moluccana*) may also be dominant or codominant. The tree-cover is generally discontinuous and consists of widely-spaced trees of medium height in which the canopies are clearly separated. Associated, and occasionally co-dominant, trees include, but are not restricted to: Grey Box (*Eucalyptus microcarpa*), Fuzzy Box (*E. conica*), Apple Box (*E. bridgesiana*), Red Box (*E. polyanthemos*), Red Stringybark (*E. macrorhyncha*), White Cypress Pine (*Callitris glaucophylla*), Black Cypress Pine (*C. enderlicheri*), Long-leaved Box (*E. gonicalyx*), New England Stringybark (*E. calignosa*), Brittle Gum (*E. mannifera*), Candlebark (*E. rubida*), Argyle Apple (*E. cinerea*), Kurrajong (*Brachychiton populneus*) and Drooping She-oak (*Allocasuarina verticillata*). This ecological community occurs in areas where rainfall is between 400 and 1200 mm per annum, on moderate to highly fertile soils at altitudes of 170 metres to 1200 metres. The White Box – Yellow Box – Blakely's Red Gum grassy woodlands that existed prior to European settlement now exists as remnants in three different states. The three states are: i) An overstorey of eucalypt trees exists, but there is no substantial native understorey. ii) A native understorey exists, but the trees have been cleared; and iii) Both a native understorey and an overstorey of eucalypts exist in conjunction. In order for an area to be included in the EPBC listed ecological community, a patch must have a predominantly native understorey. The size and life-form of understorey species are such that viable populations can exist in very small areas. Therefore, in order to be the listed ecological community, an understorey patch, in the absence of overstorey trees, must have a high level of native floral species diversity, but only needs to be 0.1 hectares or greater in size. A patch in which the perennial vegetation of the ground layer is dominated by native species, and which contains at least 12 native, non-grass understorey species (such as forbs, shrubs, ferns, grasses and sedges) is	Potential An area likely to conform to the Box-Gum community was recorded in the southern portion of the Subject Land. An individual tree, potentially identified as Blakely's Red Gum (*Eucalyptus blakely*), was observed during the September 2018 survey. The tree was later confirmed as *Eucalyptus dealbata* by ecologists Joanne Woodhouse and Tom Cotter. No elements of this vegetation community were found across the Development Site although it is likely to occur within the broader Project Boundary.	Negligible	Avoidance	Low

TEC name	EPBC Act	BC Act	Community Description	Likely of TEC Occurring in the Site	Potential Impacts	Mitigation Measures	Risk Rating
			considered to have a sufficiently high level of native diversity to be the listed ecological community. At least one of the understorey species should be an important species (e.g. grazing-sensitive, regionally significant or uncommon species; such as Kangaroo Grass or orchids) in order to indicate a reasonable condition.				🟩

Table D.4 Threatened Species: Likelihood of Occurrence and Risk Assessment

Scientific Name Common Name	BC Act	EPBC Act	Species and Habitat Information	Likelihood of species occurring in the Site	Potential Impacts	Mitigation Measures	Residual Risk Rating
Fauna							
Reptilia							
Delma torquata Adorned Delma, Collared Delma Source: PMST		V	Adorned Delma is the smallest of the legless lizards. The Collared Delma normally inhabits eucalypt dominated woodland and open forest where it is associated with suitable micro-habitats (exposed rocky outcrops). The ground cover is predominantly native grasses, such as Kangaroo Grass (*Themeda triandra*), Barbed-wire Grass (*Cymbopogon refractus*), Wiregrass (*Aristida* sp.) and *Lomandra*. The Collared Delma is known from the western suburbs of Brisbane, Queensland, and the following sites: Bunya Mountains, Blackdown Tableland National Park (NP), Bullyard Conservation Park, D'Aguilar Range NP, Expedition NP, Naumgna and Lockyer Forest Reserves, Western Creek near Millmerran and the Toowoomba Range. It occurs within the South East Queensland, Condamine, Burnett Mary and Fitzroy (Queensland) Natural Resource Management regions.	Unlikely No records of the species are known within a 10km radius of the Site. The species was not recorded during target reptile surveys within the rocky outcrops in December 2018.	NA	NA	Low
Furina dunmalli Dunmall's Snake		V	Dunmall's Snake preferred habitat is Brigalow forest and woodland with fallen timber and ground litter, growing on cracking clay soils and clay loam soils. It also occurs in eucalypt and *Callitris* woodland with fallen timber and ground litter. The species is nocturnal. Dunmall's Snake occurs in south-east interior of Queensland, including the Darling Downs, and is thought to potentially extend into inland north-eastern NSW. Most locality records are between 200 and 500 m elevation	Unlikely No records of the species are known within a 10km radius of the Site. The species was not recorded during target reptile surveys in December 2018.	NA	NA	Low
Uvidicolus sphyrurus Border Thick-tailed Gecko Source: BioNet, PMST	V	V	The Border Thick-tailed Gecko is a small lizard up to 10 cm long (average 7 cm). It often occurs on steep rocky or scree slopes, especially granite. Recent records from basalt and metasediment slopes and flats indicate its habitat selection is broader than formerly thought and may have extended into areas that were cleared for agriculture. Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter. Occupied sites often have a dense tree canopy that helps create a sparse understorey. These Geckos are active at night and shelter by day under rock slabs, in or under logs, and under the bark of standing trees. It is found only on the tablelands and slopes of northern NSW and southern Queensland, reaching south to Tamworth and west to Moree. Most common in the granite country of the New England Tablelands. Occurs at sites ranging from 500 to 1100 m elevation. Populations are mostly fragmented, with over 50 discrete sites currently known that are separated by at least 2 km.	Potential Habitat resources for the species are present within the Development Site. The only record within the 10km locality is at approximately 2.4km south from the site and was recorded over 10 years ago (in 1999) The species was not recorded during target reptile surveys within the rocky outcrops in December 2018.	Negligible A total of eleven rocky areas were recorded within the Subject Land. Five of the rocky outcrops have been avoided. Only two outcrops occur in the middle of the cleared paddocks and cannot be avoided by the development footprint. The remaining four may also be avoided during the detailed design and survey of the required riparian buffers and perimeter road.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation and habitat features to be retained within the adjacent habitat.	Low

Wollumbinia belli Bell's Turtle	E	V	Bell's Turtle occurs in shallow to deep pools in upper reaches or small tributaries of major rivers in granite country. Occupied pools are most commonly less than 3 m deep with rocky or sandy bottoms and patches of vegetation. Most typically uses narrow stretches of rivers 30 - 40 m wide. Most surrounding habitat has been converted to grazing land. Nests are dug out in riverbanks of sand or loam during late September to January. Eggs take 80 days to hatch and are thus vulnerable to nest predation for an extended period. Primarily a vegetarian, eating both aquatic plants and terrestrial leaves that fall into the watercourse. Also takes invertebrates ranging from insects to crayfish, other small animals and carrion. In NSW, currently found in four disjunct populations in the upper reaches of the Namoi, Gwydir and Border Rivers systems, on the escarpment of the North West Slopes.	Unlikely No deep pools occur within any of the unnamed creeks or their tributaries.	Negligible	NA	Low
Aves							
Anthochaera phrygia Regent Honeyeater Source: PMST	CE	CE	The Regent Honeyeater mainly inhabits temperate woodlands and open forests, particularly Box – Ironbark woodland and riparian forests of River Sheoak. The species inhabits woodlands that support a significantly high abundance and species richness of birds. These type of woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. The species can also be found in drier coastal woodlands and forests in some years. Non-breeding flocks of the species can be seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests. Although the species is a generalist forager, it feeds mainly on the nectar from a small number of eucalypts that produce high volumes of nectar (e.g. Mugga Ironbark, Yellow Box, White Box and Swamp Mahogahy).	Potential Limited foraging habitat is present within the woodland and riparian **corridor**. This woodland bird species forages in woodlands with significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. No habitat is available within the disturbed grasslands. The Regent Honeyeater has not been recorded within the Site.	Negligible. The second and third order watercourses will be avoided through detailed design. Riparian buffers will be applied to either side of the streams, measured from the edge of the high bank. The distances applied to this BDAR are 20m either side of the second order stream and 30m either side of the third order streams. This will significantly reduce the risk of the potential impacts.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation and habitat features to be retained within the adjacent habitat.	Low
Artamus cyanopterus cyanopterus Dusky Woodswallow	V		The Dusky Woodswallow primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland. The species forages on invertebrates, mainly insects, which are captured whilst hovering or sallying above the canopy or over water. It builds an open, cup-shape nest made of twigs, grass, fibrous rootlets and occasionally casuarina needles. Generally, nests are located on shrubs or low trees, living or dead, horizontal or upright forks in braches, spouts, hollow stumps or logs, behind loose bark or in a hollow in the top of a wooden fence post.	Possible. Potential foraging habitat is present in most woodland vegetation zones, excluding grasslands, cleared and disturbed land.. No records of the species exist for the Site and the nearest location is at approximately 4 km south-east where it was recorded in 1995.	Negligible The second and third order watercourses will be avoided through detailed design. Riparian buffers will be applied to either side of the streams, measured from the edge of the high bank. The distances applied to this BDAR are 20m either side of the second order stream and 30m either side of the third order streams. This will significantly reduce the risk of the potential impacts.	NA	Low
Calyptorhynchus lathami Glossy Black-Cockatoo	V		The Glossy Black-cockatoo inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak	Unlikely. Limited breeding habitat for the species is present within the	Negligible	Limit clearing through delineation of designated construction areas. This will help to protect	Low

Source: BioNet			(*Allocasuarina littoralis*) and Forest Sheoak (*A. torulosa*) are important foods. Inland populations feed on a wide range of sheoaks, including Drooping Sheoak, *Allocasuaraina diminuta*, and *A. gymnathera*. Belah is also utilised and may be a critical food source for some populations. In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, but also recorded in open woodlands dominated by Belah (*Casuarina cristata*). Feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species), shredding the cones with the massive bill.	Development Site. However, no suitable feeding habitat is present as its preferred feed tree species have not been recorded within the Site. It is unlikely the sepcies would breed in hollow-bearing trees at the site as the cost to travel long distances to feed will be too high. The nearest location is at approximately 3.6 km to the east, where one record from 1999 exists.		native vegetation to be retained within the Development Site and adjacent habitat.	
Climacteris picumnus victoriae Brown Treecreeper (eastern subspecies) Source: BioNet	V		The Brown Treecreeper (eastern subspecies) is found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains. It is considered resident of areas where it occurs and is usually observed in pairs or small groups of 8 to 12 birds. It forages on trunks and branches of trees and among fallen timber. Hollows in standing dead or live trees and stumps are essential for nesting.	Potential Potential foraging habitat is present in most woodland vegetation zones. The nearest record of the species dates back in 1995 and was located at approximately 2 km east from the Site.	Negligible The second and third order watercourses will be avoided through detailed design. Riparian buffers will be applied to either side of the streams, measured from the edge of the high bank. The distances applied to this BDAR are 20m either side of the second order stream and 30m either side of the third order streams. This will significantly reduce the risk of the potential impacts.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Chthonicola sagittata Speckled Warbler Source: BioNet	V		The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding. The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or at the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside.A clutch of 3-4 eggs is laid, between August and January, and both parents feed the nestlings. Speckled Warblers often join mixed species feeding flocks in winter, with other species such as Yellow-rumped, Buff-rumped, Brown and Striated Thornbills.	Potential Potential foraging habitat is present in most woodland vegetation zones. The nearest record of the species dates back in 1995 and was located at approximately 2 km east from the Site.	Negligible The second and third order watercourses will be avoided through detailed design. Riparian buffers will be applied to either side of the streams, measured from the edge of the high bank. The distances applied to this BDAR are 20m either side of the second order stream and 30m either side of the third order streams. This will significantly reduce the risk of the potential impacts.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low

Daphoenositta chrysoptera Varied Sittella Source: BioNet	V		The Varied Sittella Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland. It feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy. It builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years. Generation length is estimated to be 5 years. The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west.	Potential Potential foraging habitat is present in most woodland vegetation zones. The nearest record of the species dates back in 1995 and was located at approximately 4 km south from the Site.	Negligible The second and third order watercourses will be avoided through detailed design. Riparian buffers will be applied to either side of the streams, measured from the edge of the high bank. The distances applied to this BDAR are 20m either side of the second order stream and 30m either side of the third order streams. This will significantly reduce the risk of the potential impacts.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Erythrotriorchis radiatus Red Goshawk Source: PMST	CE	V	Red Goshawks inhabit open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers.	Unlikely Limited habitat for the species exists within the Development Site. Riparian corridor was dry at the time of surveys and highly fragmented. No existing records of the species within the 10 km locality exist. The species was not recorded during surveys.	Negligible	NA	Low
Geophaps scripta scripta Squatter Pigeon Source: PMST	CE	V	Squatter Pigeons are medium-sized ground-dwelling pigeons. They are found in grassy woodlands and plains, preferring sandy areas and usually close to water. Feed on the ground, on seeds of grasses, herbs and shrubs, as well as insects. Nest on the ground. The species is found from north Queensland to the North West Slopes of NSW and extending down to the Liverpool Plains and Dubbo. Today they are very rare in the southern parts of their range.	Potential Substandard foraging habitat is present within the Development Site. No existing records of the species within the 10 km locality exist. The species was not recorded during surveys.	Negligible	NA	Low
Glossopsitta pusilla Little Lorikeet Source: BioNet	V		The Little Lorikeet is a small parrot distributed widely across the coast and Great Divide regions. The species forages primarily in the canopy of open Eucalyptus forests and woodland. It also forages in Angophora, Melaeuca and other species including paddock, roadside remnants and urban trees. It feeds mainly on nectar and pollen, occasionally on native fruits.	Potential. Limited suitable foraging habitat for the species is present in Eucalypt trees within the remnant trees and vegetation. The nearest records of the species dates back in 1995 (two records) and were located at approximately 1 km east from the Site.	Negligible. Any clearing of Eucalypt trees has the potential to add to the incremental decline of potential habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat. Develop fauna clearance protocol that includes procedures to be followed should any injured fauna be encountere	Low
Grantiella picta Painted Honeyeater Source: PMST	V	V	The Painted Honeyeater inhabits Boree/ Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus *Amyema*. Insects and nectar from mistletoe or eucalypts are occasionally eaten. Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.	Potential Limited foraging resources for the species are available in Box and Ironbark trees across the Subject Land. No existing records of the species within the 10 km locality exist. The species was not recorded during surveys.	Negligible. Any clearing of Eucalypt trees has the potential to add to the incremental decline of potential habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low

Neophema pulchella Turquoise Parrot Source: BioNet	V		The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range (OEH 2019). The Turquoise Parrot lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. It prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed. It nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust (OEH 2019).	Potential Suitable habitat for the species includes woodlands and native grasslands. Roosting and breeding habitat for this woodland bird are hollow-bearing trees in woodlands. It forages in woodlands and native grasslands. The nearest record of the species dates back in 1995 and was located at approximately 1 km south-east from the Site.	Negligible The second and third order watercourses will be avoided through detailed design. Riparian buffers will be applied to either side of the streams, measured from the edge of the high bank. The distances applied to this BDAR are 20m either side of the second order stream and 30m either side of the third order streams. This will significantly reduce the risk of the potential impacts.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Petroica boodang Scarlet Robin Source: BioNet	V		The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Its habitat usually contains abundant logs and fallen timber: these are important components of its habitat. It breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 metres in altitude. It breeds between July and January. In autumn and winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees. It builds nests in the fork of branches, usually more than 2 metres above the ground.	Potential Limited suitable habitat for the species occurs in woodlands with fallen logs and timber in the Subject Land. The nearest record of the species dates back in 1995 and was located at approximately 4 km south-east from the Site.	Negligible The second and third order watercourses will be avoided through detailed design. Riparian buffers will be applied to either side of the streams, measured from the edge of the high bank. The distances applied to this BDAR are 20m either side of the second order stream and 30m either side of the third order streams. This will significantly reduce the risk of the potential impacts.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Pomatostomus temporalis temporalis Grey-crowned Babbler (eastern subspecies) Source: BioNet	V		The Grey-crowned Babbler 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. Flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas. It lives in family groups that consist of a breeding pair and young from previous breeding seasons. A group may consist of up to fifteen birds. All members of the family group remain close to each other when foraging. It is insectivorous and it forages on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. It builds nests that are used as dormitory and roosting and uses them all year round. It breeds between July and February. Territory ranges from one to 50 hectares (usually ten hectares) and are defended all year. Grey-crowned Babblers are communal breeders that form a family group, in which offspring from the previous season and other unrelated birds help to raise the	Known A breeding population of Grey-crowned have been recorded on site. The nearest BioNet record of the species dates back in 2010 and was located at approximately 500 m east from the Development Site.	Moderate A breeding population of Grey-crowned have been recorded on site. The movement of this species is largely confined to the riparian corridors as this species has limited flying capacity. These corridors (with a 20-30m buffer) have been avoided although nests will be removed within the development footprint..	Approved clearing limits to be clearly delineated with temporary fencing or similar prior to construction commencing. Removal of trees with nests will be included in the vegetation clearing protocol including any seasonal constraints to avoid impacting any juveniles or unfledged chicks. Removal of trees with nests will be supervised by an experienced fauna catcher or ecologist. A portion of felled trees will be salvaged as habitat for fauna and translocated in suitable areas in the remainder of the Project Boundary.	Medium

			current's year's brood. In some populations, breeding success is related to the number of helpers. Young birds staty with the family group for at least one year after fledging and may remain for two or more years acting as non-breeding helpers. As breeding spaces become available in the population, some helpers may disperse to establish their own breeding group. Population viability studies in Victoria suggests that a viable population is likely to contain more than ten family groups, while populations with less than ten family groups are likely to have high rate of extinction.				
Rostratula australis Australian Painted-snipe Source: PMST	E	E	The Australian Painted Snipe is small freshwater wader. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. The nest consists of a scrape in the ground, lined with grasses and leaves. Breeding is often in response to local conditions; generally occurs from September to December. Incubation and care of young is all undertaken by the male only. Forages nocturnally on mud-flats and in shallow water. Feeds on worms, molluscs, insects and some plant-matter.	Unlikely No preferred habitat is available. No existing records of the species within the 10 km locality exist. The species was not recorded during surveys.	NA	NA	Low
Stagonopleura guttata Diamond Firetail Source: BioNet	V		Diamond Firetails are found in open grassy woodland, heath and farmland or grassland with scattered trees. Diamond Firetails feed on the ground and generally eat ripe or partially ripe seeds and can be seen hopping around on the ground. They occasionally eat insects and their larvae. The Diamond Firetail builds a nest with green grass blades and stems and lines it with fine grasses and feathers. The nest can be found in trees and shrubs with dense foliage and has sometimes been known to build in the base of a hawk's nest.	Potential Potential roosting and breeding habitat for the species occurs in woodlands, foraging habitat for the species occurs across the entire Subject Land.. The nearest BioNet record of the species dates back in 1995 and was located at approximately 3 km south-east from the Site.	Negligible The second and third order watercourses will be avoided through detailed design. Riparian buffers will be applied to either side of the streams, measured from the edge of the high bank. The distances applied to this BDAR are 20m either side of the second order stream and 30m either side of the third order streams. This will significantly reduce the risk of the potential impacts.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Calidris ferruginea Curlew Sandpiper Source: PMST	E	CE, Mi	The Curlew Sandpiper is a migratory bird inhabiting coastal habitats and sometimes freshwater wetlands. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes inland.	Unlikely No preferred habitat is available. No existing records of the species within the 10 km locality exist. The species was not recorded during surveys.	NA	NA	Low
Mammals							
Dasyurus maculatus Spotted-tailed Quoll Source: PMST	V	E	The Spotted-tailed Quoll is 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. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares. Are known to traverse their home ranges along densely vegetated creeklines	Unlikely The high level of disturbance at the Development Site suggests no suitable habitat for the species is present. No known records of the species exists within the 10 km locality. The species was not recorded during surveys in	NA	NA	Low

				September and December 2018.			
Petaurus norfolcensis Squirrel Glider Source: BioNet	V		The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or *Acacia* midstorey. Live in family groups of a single adult male one or more adult females and offspring. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.	Unlikely. No suitable habitat for the species occurs within the Site. Only one record of the species exist within the 10km locality. It is located at approximately 3.5 km to the south from the Site and was recorded in 1997.	Negligible	NA	Low
Petauroides volans Greater Glider Source: PMST		V	The greater glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria (Wombat State Forest), with an elevational range from sea level to 1200 m above sea level. The greater glider is an arboreal nocturnal marsupial, largely restricted to eucalypt forests and woodlands. During the day it shelters in tree hollows, with a particular selection for large hollows in large, old trees. The greater glider is considered to be particularly sensitive to forest clearance.	Unlikely Limited substandard foraging habitat for the species occurs in remnant vegetation within the Development Site. No rsheltering habitat is present and the species has not been recorded within the 10km locality.	Negligible	NA	Low
Petrogale penicillata Brush-tailed Rock-wallaby Source: BioNet PMST	V		In NSW they occur from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit. Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night.	Unlikely. Limited habitat for the species occurs within the Site. Only one record of the species exist within the 10km locality. It is located at approximately 2.2 km to the south-west from the Site and was recorded in 1997.	Negligible	NA	Low
Phascolarctos cinereus Koala Source: BioNet, PMST	V	V	The Koala is an arboreal marsupial that inhabits eucalypt woodlands and forests. The species feed on the foliage of more than 70 species of eucalypt and 30 non-eucalypt species.	Potential Suitable feeding trees (e.g. E. albens) are present within the Subject Land. . No known records exists within the site. The nearest record is located at approximately 3 km south-east and is dated 1995.	Negligible. Any clearing of koala feed tree species has the potential to add to the incremental decline of potential habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Pseudomys novaehollandiae New Holland Mouse, Pookila Source: PMST		V	The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes It is a social animal, living predominantly in burrows shared with other individuals	Unlikely. Limited substandard woodland habitat for the species is present within the Development Site. No records of the species are known within the 10km locality.	Negligible	NA	Low

			Distribution is patchy in time and space, with peaks in abundance during early to mid stages of vegetation succession typically induced by fire.				
Pteropus poliocephalus Grey-headed Flying-fox Source: PMST	V	V	Grey-headed Flying-foxes are generally found within 200 km of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia. Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines. Also forage in cultivated gardens and fruit crops.	Potential Potential foraging habitat is present in canopy of Eucalypt trees. Grasslands and cleared land excluded as potential foraging habitat.. No records of the species exist within the 10km locality. The species was not recorded during surveys.	Negligible. Any clearing of Eucalypt trees has the potential to add to the incremental decline of potential habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Microchiropteran Bats							
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat Source: PMST	V	V	The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes. The species is found in well-timbered areas containing gullies. The species roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years.	Potential. Potential foraging/hunting habitat for cave dependant microchiropteran bats is present in the remnant trees and vegetation. No suitable roosting habitat is available and the microchiropteran bats	Negligible. Any clearing of native vegetation has the potential to add to the incremental decline of potential foraging habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat. Breeding habitat for these species is not present within the Development Site and avoidance measures for breeding habitat is not required.	Low
Falsistrellus tasmaniensis Eastern False Pipistrelle Source: BioNet	V		The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania (OEH 2019). The species prefers moist habitats, with trees taller than 20 m. It generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. It hunts beetles, moths, weevils and other flying insects above or just below the tree canopy. Hibernates in winter. Females are pregnant in late spring to early summer (OEH 2019). Only one record of the species exist within the 10km locality. It is located at approximately 3.2 km to the south-west from the Site and was recorded in 1997.	Known. Potential foraging/hunting and roosting habitat for hollow dependant microchiropteran bats is present in the remnant trees and vegetation.	Minor Any clearing of native vegetation has the potential to add to the incremental decline of potential foraging habitat available within the region. Removal of important habitat features e.g. 37 hollow bearing trees are to be removed	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat. Trees will be planted at a rate of 2:1 with two new trees planted for each HBT removed. This results in planting of 74 new trees within the riparian corridor. As naturally formed tree hollows will take many decades to develop, nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm	Medium
Miniopterus schreibersii oceanensis Eastern Bentwing-bat Source: BioNet	V		Eastern Bentwing-bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Hunt in forested areas, catching moths and other flying insects above the tree tops. Form discrete populations centred on a maternity cave that is used annually in spring and	Known. Potential foraging/hunting habitat for cave dependant microchiropteran bats is present in the remnant trees and vegetation.	Minor Any clearing of native vegetation has the potential to add to the incremental decline of potential foraging habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat. Breeding habitat for these species is not present within the Development Site and	Low

			summer for the birth and rearing of young. At other times of the year, populations disperse within about 300 km range of maternity caves. The nearest known record is located at approximately 150m north-west from the site and was recorded in 2006.	No suitable roosting habitat is available and the microchiropteran bats assessed are unlikely to be dependent on any of the resources available.	effects or degradation of any retained habitats.	avoidance measures for breeding habitat is not required.	
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat Source: PMST	V	V	Corben's Long-eared Bat inhabits a variety of vegetation types, including mallee, bulloke *Allocasuarina leuhmanni* and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. It roosts in tree hollows, crevices, and under loose bark. Slow flying agile bat, utilising the understorey to hunt non-flying prey - especially caterpillars and beetles - and will even hunt on the ground. Mating takes place in autumn with one or two young born in late spring to early summer. Corben's Long-eared Bat has not been recorded within the 10 km locality.	Known. Potential foraging/hunting and roosting habitat for hollow dependant microchiropteran bats is present in the remnant trees and vegetation.	Minor Any clearing of native vegetation has the potential to add to the incremental decline of potential foraging habitat available within the region. Removal of important habitat features e.g. 37 hollow bearing trees are to be removed	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat. Trees will be planted at a rate of 2:1 with two new trees planted for each HBT removed. This results in planting of 74 new trees within the riparian corridor. As naturally formed tree hollows will take many decades to develop, nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm	Medium
Scoteanax rueppellii Greater Broad-nosed Bat Source: BioNet	V		The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 m. Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species. Although this species usually roosts in tree hollows, it has also been found in buildings. Only two records of the species exist within the 10km locality. The nearest record is located at approximately 3.2 km to the south from the Site and was recorded in 1997.	Known. Potential foraging/hunting and roosting habitat for hollow dependant microchiropteran bats is present in the remnant trees and vegetation.	Minor Any clearing of native vegetation has the potential to add to the incremental decline of potential foraging habitat available within the region. Removal of important habitat features e.g. 37 hollow bearing trees are to be removed	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat. Trees will be planted at a rate of 2:1 with two new trees planted for each HBT removed. This results in planting of 74 new trees within the riparian corridor. As naturally formed tree hollows will take many decades to develop, nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm	Medium
Mormopterus eleryi *Bristle-faced Free-tailed Bat*	V		Distributed from the southern half of the Northern Territory to central Queensland and north-western NSW. In NSW, the species has been recently recorded from only three disjunct locations: thirteen individuals from Gundabooka National Park, south of Bourke; one individual from Dhinnia Dthinawan Nature Reserve (formerly Bebo State Forest), north of Warialda two individuals near Bonshaw. Knowledge of the ecology of the Hairy-nosed Freetail Bat is limited, however evidence suggests that the species depends on hollows and tree fissures for roosting sites. All other Australian species from the same family generally roost in tree hollows and fissures.	Known. Potential foraging/hunting and roosting habitat for hollow dependant microchiropteran bats is present in the remnant trees and vegetation.	Minor Any clearing of native vegetation has the potential to add to the incremental decline of potential foraging habitat available within the region. Removal of important habitat features e.g. 37 hollow bearing trees are to be removed	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat. Trees will be planted at a rate of 2:1 with two new trees planted for each HBT removed. This results in planting of 74 new trees within the riparian corridor. As naturally formed tree hollows will take many decades to develop, nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm	Medium

			Appears to be extremely rare throughout its range. Nationally, it has been recorded from only 15 locations.				
Fish							
Maccullochella peelii Murray Cod Source: PMST		V	The Murray Cod is a large freshwater fish endemic to the Murray-Darling Basin, from south east Queensland, through NSW, into Vitoria and South Australia. The species can grow to 100 kg in the wild. The species requires permanent streams and is highly dependent on instream woody structures for habitat, is highly territorial and very aggressive.	Unlikely No suitable habitat for the species is present within the Development Site.	Negligible	NA	Low
Flora							
Acacia pubifolia Velvet Wattle Source: PMST	E	V	Velvet Wattle is a shrub or small tree 3 - 8 m tall with golden yellow flowers and dark-grey bark. It occurs in NSW and Qld. In NSW it is known from two main populations, one north of Emmaville and the other near Warrabah National Park. The species generally grows in dry shrubby woodland on granite and metasediment soils.	Unlikely No suitable habitat for the species occurs within the Development Site. No known records of the species exist within the 10 km locality. The species was not recorded during surveys in September and December 2018.	Negligible	NA	Low
Astrotricha roddii Rodd's Star Hair Source: BioNet, PMST	E	E	Rodd's Star Hair is an upright, sparsely-branched shrub 1 - 3 m tall. Rodd's Star Hair usually grows in low dry woodland and shrublands on granite and acid volcanic outcrops, often in rock crevices. The species occurs in NSW in the Ashford area north of Inverell, including Kwiambal and Kings Plains National Parks, Severn River Nature Reserve and Severn River State Forest, and has also been recorded at one site in southern Queensland.	Potential Limited potential habitat for the species occurs within the Subject Land. A total of 12 records of the species exist within the 10 km locality. No records exist within the Development Site and the species was not recorded within the development footprint. The nearest record is located at approximately 4.3 km to the south and was recorded in 1999.	Negligible A total of eleven rocky areas were recorded within the Subject Land. Five of the rocky outcrops have been avoided. Only two outcrops occur in the middle of the cleared paddocks and cannot be avoided by the development footprint. The remaining four may also be avoided during the detailed design and survey of the required riparian buffers and perimeter road.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation and habitat features to be retained within the adjacent habitat.	Low
Boronia granitica Granite Boronia Source: PMST	V	E	Granite Boronia is a medium-sized shrub 0.6 - 2 m tall. It flowers from July to October. It grows on granitic soils amongst rock outcrops, often in rock crevices, and in forests and woodlands on granite scree and shallow soils. Important site characteristics include low precipitation and high levels of solar radiation. This semi-arid soil environment will have selected the more xerophytic species from the available regional assemblage of rainforest species. The largely barren substrate (e.g. granite) may help to control too frequent fire, thus allowing maturity and seed set. Granite Boronia occurs in scattered localities on the New England Tablelands and North West Slopes north from the Armidale area to the Stanthorpe district in southern Queensland. It can be locally common in appropriate habitat (e.g. Torrington).	Potential Suitable substrate for the species is present within the Subject Land. No known records of the species exist within the 10 km locality. The species was not recorded during surveys in September and December 2018.	Negligible A total of eleven rocky areas were recorded within the Subject Land. Five of the rocky outcrops have been avoided. Only two outcrops occur in the middle of the cleared paddocks and cannot be avoided by the development footprint. The remaining four may also be avoided during the detailed design and survey of the required riparian buffers and perimeter road.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation and habitat features to be retained within the adjacent habitat.	Low

Cadellia pentastylis Ooline Source: PMST	V	V	Ooline is a medium-sized spreading tree usually about 10 m tall, and rarely to 25 m. Appears to flower spasmodically, during a general flowering period of October to January. Dispersal of fruit and seed is probably by "passive fall" or by birds. Seeds showed a high rate of infertility at all sites, although they have been successfully germinated and established after heat application. 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. Has the capacity to resprout from rootstock and coppice vigorously from stumps, a feature which may be critical for the species survival in a fire-prone environment. Populations display a variety of age classes including large mature trees, suckering regrowth and seedlings. The total area occupied by Ooline is only about 1200 hectares, with remaining populations in NSW still threatened to various degrees by clearing for agriculture and grazing pressures.	Potential The development Site is located within known distribution of the species although it was not recorded on site during seasonal surveys. surveys. Noo known records of the species exist within the 10 km locality. The species was not recorded during surveys in September and December 2018.	Negligible. Any clearing of native vegetation has the potential to add to the incremental decline of potential habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Callistemon pungens Source: PMST		V	*Callistemon pungens* is a distinct shrub or small tree ranging from 2-5 m tall. The species inhabits a range from riparian areas dominated by *Casuarina cunninghamiana subsp. cunninghamiana* to woodland and rocky shrubland. Often in rocky watercourses, usually with sandy granite (occasionally basalt) creek beds. Flowers over spring and summer, mostly in November.	Unlikely No suitable habitat is present within the Development Site. No known records of the species exist within the 10 km locality. The species was not recorded during surveys in September and December 2018.	Negligible	NA	Low
Dichanthium setosum Bluegrass Source: PMST	V	V	Bluegrass is an upright grass less than 1 m tall. Flowering time is mostly in summer. Associated with heavy basaltic black soils and red-brown loams with clay subsoil. 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). It is open to question whether the species tolerates or is promoted by a certain amount of disturbance, or whether this is indicative of the threatening processes behind its depleted habitat. Associated species include *Eucalyptus albens*, *Eucalyptus melanophloia*, *Eucalyptus melliodora*, *Eucalyptus viminalis*, *Myoporum debile*, *Aristida ramosa*, *Themeda triandra*, *Poa sieberiana*, *Bothriochloa ambigua*, *Medicago minima*, *Leptorhynchos squamatus*, *Lomandra aff. longifolia*, *Ajuga australis*, *Calotis hispidula* and *Austrodanthonia*, *Dichopogon*, *Brachyscome*, *Vittadinia, Wahlenbergia* and *Psoralea* species. Bluegrass occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes	Potential. Suitable habitat elements for the species occur within the Development Site. No known records of the species exist within the 10 km locality. The species was not recorded during surveys in September and December 2018.	Negligible. Any clearing of native vegetation has the potential to add to the incremental decline of potential habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low

			of NSW, extending to northern Queensland. It occurs widely on private property, including in the Inverell, Guyra, Armidale and Glen Innes areas.				
Eucalyptus caleyi subsp. ovendenii Ovenden's Ironbark Source: BioNet, PMST	V	V	Ovenden's Ironbark grows in grassy woodland on dry, shallow soils of moderate fertility. Its preferred altitudes are 610 to 820 m, on granitic substrates. Ovenden's Ironbark occupies a higher geographical range than that of subspecies caleyi, occurring on the crests of broad high ridges and replacing subspecies caleyi inhabiting the lower slopes in the same general area. Associated species include *Eucalyptus melliodora*, *Eucalyptus dealbata*, *Eucalyptus albens*, *Eucalyptus melanophloia* and *Geijera parviflora*. Flowering occurs from July to September, with fruits having a distinctly square cross-section. Can be locally abundant within its grassy woodland habitat. Juveniles were present in about half the sampled sites within Torrington State Conservation Area, indicating good recruitment	Potential The species was not recorded within the Development Site during surveys in September and December 2018. Several species with which Ovenden's Ironbark is associated were recorded within the Development Site, including *Eucalyptus dealbata*, *Eucalyptus albens* and *Geijera parviflora*. Only one record of the species exist within the 10 km locality and at approximately 5.3 km to the south-west from the Development Site. The species was recorded in 1999.	Negligible. Any clearing of native vegetation has the potential to add to the incremental decline of potential habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Eucalyptus mckieana MicKie's Stringybark Source: PMST	V	V	MicKie's Stingybark is a medium sized tree about 25 m tall. The species flowers are white, with a flowering period of March to May. The species is remarkable for its very narrow and numerous sucker leaves, the narrowest of all the stringybarks and which persist to a height of 2 to 4 metres. *Eucalyptus mckieana* is found in grassy open forest or woodland on poor sandy loams, most commonly on gently sloping or flat sites. Associated species at Northern Tablelands sites include *Angophora floribunda*, *Eucalyptus amplifolia*, *Eucalyptus andrewsii*, *Eucalyptus bridgesiana*, *Eucalyptus youmanii*, *Eucalyptus nicholii*, *Eucalyptus blakelyi* and *Eucalyptus conica*, and at North Western Slopes sites *Eucalyptus andrewsii*, *Eucalyptus stannicola*, *Eucalyptus prava* and *Angophora floribunda*. Confined to the drier western side of the New England Tablelands of NSW, from Torrington to Bendemeer. Most populations occur on private property, but it does occur in Kings Plain National Park, Torrington State Conservation Area and Severn River Nature Reserve.	Unlikely. Very limited potential habitat is present. No known records of the species exist within the 10 km locality. The species was not recorded during surveys in September and December 2018.	Negligible	NA	Low
Eucalyptus nicholii Narrow-leaved Black Peppermint Source: BioNet, PMST	V	V	The Narrow-leaved Black Peppermint typically grows in dry grassy woodland, on shallow soils of slopes and ridges. Found primarily on infertile soils derived from granite or metasedimentary rock. Seedling recruitment is common, even in disturbed soils, if protected from grazing and fire. It tends to grow on lower slopes in the landscape. This species is sparsely distributed but widespread on the New England Tablelands from Nundle to north of Tenterfield, being most common in central portions of its range. Found largely on private property and roadsides, and occasionally in conservation reserves. Planted as urban trees, windbreaks and corridors.	Potential The species was not recorded during surveys in September and December 2018. Only one record of the species exist within the 10 km locality and at approximately 5.5 km to the south-west from the Development Site. The species was recorded in 2000.	Negligible. Any clearing of native vegetation has the potential to add to the incremental decline of potential habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low

Homopholis belsonii Belson's Panic Source: PMST		V	Belson's Panic is a perennial grass growing to 0.5m high. It is known to occur in dry woodland habitats on poor soils, such as those derived from basalt. It occurs on rocky hills supporting White Box (*Eucalyptus albens*) and in Wilga (*Geijera parviflora*) woodland; flat to gently undulating alluvial areas supporting Belah (*Casuarina cristata*) forest; and soils and plant communities of Poplar Box (*Eucalyptus populnea*) woodlands. It may also be associated with shadier areas of Brigalow (*Acacia harpophylla*), Myall (*A. melvillei*), and Weeping Myall (*A. pendula*) communities; in Mountain Coolibah (*Eucalyptus orgadophila*) communities; and on roadsides. It is generally found among fallen timber at the base of trees or shrubs, among branches and leaves of trees hanging to ground level or along the bottom of netting fences. It is known to occur within the southern Brigalow belt, Queensland and on the north-western slopes and plains of NSW. In NSW, this species occurs between Wee Waa, Goondiwindi and Glen Innes.	Potential Limited suitable habitat for the species occurs within the Development Site. No known records of the species exist within the 10 km locality. The species was not recorded during surveys in September and December 2018.	Negligible. Any clearing of native vegetation has the potential to add to the incremental decline of potential habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Lepidium peregrinum Wandering Pepper-cress Source: PMST		E	The Wandering Pepper-cress is a spreading soft-stemmed perennial herb to sub-shrub 10 - 80 cm tall but sometimes ascending to 2 m in surrounding vegetation. Flowers from January to April. The largest population of Wandering Pepper Cress occurs in an open riparian forest on the banks of the Tenterfield creek at Clifton. Sandy alluvium is the main soil type at the site. Associated species at the Clifton site are dominated by *Eucalyptus camaldulensis* and *Casuarina cunninghamiana*, with a variably dense shrubby understorey of *Hymenanthera dentata*, *Bursaria spinosa*, Acacia fimbriata, Acacia floribunda, Callistemon viminalis and *Leptospermum brachyandrum*. *Lepidium peregrinum* was most abundant in the tussock grassland fringe of the riparian open forest, comprising *Poa* species, *Lomandra longifolia* and *Paspalum dilatatum*. After 2001, the species was found near Tenterfield and south-eastern Queensland.	Unlikely No suitable habitat for the species is present. No known records of the species exist within the 10 km locality. The species was not recorded during surveys in September and December 2018.	Negligible	NA	Low
Leucopogon confertus Torrington Beard-heath Source: PMST		E	*Leucopogon confertus* is known from only one collection along Silent Grove Road, near Torrington, in the NSW Northern Tablelands. It is possible that the species is extinct. Little is known of the habitat of *L. confertus*, but it may occur in open forest or woodland in rocky granite areas. This species occurs within the Border Rivers–Gwydir (NSW) Natural Resource Management Region. The distribution of this species overlaps with the "White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland".	Potential Limited potential habitat is present within the Subject Land. No known records of the species exist within the 10 km locality. The species was not recorded during surveys in September and December 2018.	Negligible	NA	Low
Prasophyllum sp. Wybong (C.Phelps ORG 5269) A leek Orchid Source: PMST		CE	*Prasophyllum* sp. Wybong (C. Phelps ORG 5269) is a terrestrial orchid that grows to approximately 30 cm high. A perennial orchid, appearing as a single leaf over winter and spring. Flowers in spring and dies back to a dormant tuber over summer and autumn. Known to occur in open eucalypt woodland and grassland.	Potential Suitable habitat for the species is present within the Development Site. No known records of the species exist within the 10 km locality. The species was not	Negligible	NA	Low

			Endemic to NSW, it is known from near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell, Tenterfield, Currabubula and the Pilliga area. Most populations are small, although the Wybong population contains by far the largest number of individuals.	recorded during surveys in September and December 2018.			
Rutidosis heterogama Heath Wrinklewort Source: BioNet, PMST	V	V	The Heath Wrinklewort is a small perennial herb to 30 cm tall. It grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides. It flowers mainly in Autumn. The species has been recorded from near Cessnock to Kurri Kurri with an outlying occurence at Howes Valley. On the Central Coast it is located north from Wyong to Newcastle. There are north coast populations between Wooli and Evans Head in Yuraygir and Bundjalung National Parks. It also occurs on the New England Tablelands from Torrington and Ashford south to Wandsworth south-west of Glen Innes.	Potential Limited potential habitat for the species might occur within the Subject Land. Surveys were undertaken outside the flowering period for the species. Only one record of the species exist within the 10 km locality and at approximately 5.4 km to the south from the Development Site. The species was recorded in 1999.	Negligible. Any clearing of native vegetation has the potential to add to the incremental decline of potential habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Swainsona sericea Silky Swainson-pea Source: BioNet	V		The Silky Swainson-pea is a prostrate or erect perennial, growing to 10 cm tall. The species flowers in spring and produces hairy pods. It is found in Natural Temperate Grassland and Snow Gum *Eucalyptus pauciflora* Woodland on the Monaro. It is also found in Box-Gum Woodland in the Southern Tablelands and South West Slopes. It is sometimes found in association with cypress-pines *Callitris* spp. Habitat on plains unknown. Regenerates from seed after fire.	Potential. Cypress pines, Whtie Cypress Pine (*Callitris glaucophylla*), was recorded within the Development Site. The Development Site is highly disturbed due to historical land use and current land use for grazing. Therefore, it is considered the species has a very low potential to occur within the Development Site. The species was not recorded during surveys in Spring and Summer. Only one record of the species exist within the 10 km locality and at approximately 3.5 km to the south-west from the Development Site. The species was recorded in 2003.	Negligible. Any clearing of native vegetation has the potential to add to the incremental decline of potential habitat available within the region. Future development is unlikely to exacerbate the existing degree of edge effects or degradation of any retained habitats.	Limit clearing through delineation of designated construction areas. This will help to protect native vegetation to be retained within the Development Site and adjacent habitat.	Low
Thesium australe Austral Toadflax, Toadflax Source: PMST	V	V	The Austral Toadflax is a small, straggling herb to 40 cm tall. It is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Although originally described from material collected in the SW Sydney area, populations have not been seen in a long time. It may persist in some areas in the broader region. It occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. It is often found in association with Kangaroo Grass (*Themeda australis*). The species is a root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass.	Potential Limited suitable habitat for the species is present within the Development Site. No records of the species exist within the 10 km locality and the species was not recorded during the September and December 2018 surveys.	Negligible	NA	Low

Tylophora linearis Source: PMST	V	E	*Tylophora linearis* is a slender, almost hairless twiner with a clear sap. It grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa*, *Eucalyptus sideroxylon*, *Eucalyptus albens*, *Callitris endlicheri*, *Callitris glaucophylla* and *Allocasuarina luehmannii*. Also grows in association with *Acacia hakeoides*, *Acacia lineata*, *Melaleuca uncinata*, *Myoporum* species and *Casuarina* species. It flowers in spring, with flowers recorded in November or May with fruiting probably 2 to 3 months later.	Potential Limited suitable habitat for the species is present within the Development Site. No records of the species exist within the 10 km locality and the species was not recorded during the September and December 2018 surveys.	Negligible	NA	Low

APPENDIX E TEST OF SIGNIFICANCE AND SIGNIFICANT IMPACT ASSESSMENT

Test of Significance

The following Test of Significance (ToS) have been prepared in accordance with Section 7.3 of the BC Act and OEH (2018) *Threatened Species Test of Significance Guidelines*.

Grey-crowned Babbler (Pomatostomus temporalis) – Vulnerable

Species Overview

The Grey-crowned Babbler is a bird listed as vulnerable under the BC Act.

The Grey-crowned Babbler 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. Its flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas. It lives in family groups that consist of a breeding pair and young from previous breeding seasons. A group may consist of up to fifteen birds. All members of the family group remain close to each other when foraging. It is insectivorous and it forages on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. It builds nests that are used as dormitory and roosting and uses them all year round. It breeds between July and February. Territory ranges from one to 50 hectares (usually ten hectares) and are defended all year.

Grey-crowned Babblers are obligate communal breeders that form a family group, in which offspring from the previous season and other unrelated birds help to raise the current's year's brood. Young birds stay with the family group for at least one year after fledging and may remain for two or more years acting as non-breeding helpers. As breeding spaces become available in the population, some helpers may disperse to establish their own breeding group. In some populations, breeding success is related to the number of helpers. Population viability studies in Victoria suggests that a viable population is likely to contain more than ten family groups, while populations with less than ten family groups are likely to have high rate of extinction. In NSW, the species breeds between July and February (OEH 2019).

It has been suggested that cooperative breeder species, such as the Grey-crowned Babbler, are more sensitive to habitat fragmentation and loss (including loss due to fire) as availability of resources for breeding decreases (Fischer 2011). Habitat fragmentation and predation by introduced species being the major threats to the species. The species is capable to survive in disturbed landscapes, such as urban areas, where proportion of ground cover and leaf litter provides sufficient food (Lambert and Ford 2016, Stevens *et. al*. 2015).

Results of the NSW BioNet atlas indicated that a total of three records of the Grey-crowned Babbler exists within the 10 km locality. None of those known (i.e. BioNet) records are within the Development Site. The nearest BioNet record of the species dates back in 2010 and was located at approximately 500 m east from the Development Site.

The Grey-crowned Babbler was observed during surveys in September and December 2018 and heard during the March 2019 survey. In December 2018, the Grey-crowned Babbler was recorded in 20 points within the Development Site and a total of 17 bird nests likely to belong to the species were observed (see *Figure 5.2*). The records included six individuals observed, 21 calls heard with an additional two potential calls heard at distance. Also, a pair was observed adding twigs to a nest located on the lower branches of a Silver-leaved Ironbark (*Eucalyptus melanophloia*).

The Grey-crowned Babbler was observed in the following vegetation types:

- 594_Moderate (Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion). A total of 18.78 ha is present across the Development Site;
- 596_Moderate (Tumbledown Red Gum - White Cypress Pine - Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion). A total of 11.40 ha are present across the Development Site;
- 516_Very Low (Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion), a total of 5.72 ha are present across the Development Site; and
- 516_Disturbed Grasslands (Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tablelands Bioregion). A total 8.71 ha are present within the Development Site.

Test of Significance	
(a)	*in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*
	The Grey-crowned Babbler individuals observed within the Development Site are likely to be part of a single family group utilising the grassy woodlands and derived grasslands. Based on published information, the home range of a local population can range from one to 50ha (usually 10 ha). It is likely the family group range extends beyond the development footprint, as two potential Grey-crowned Babbler nests were recorded to the north-east from the Development Site. The movement of this species is expected to be largely confined to the woodland habitats as this species has limited flying capacity. The riparian corridors (with a 20-30m buffer) have been avoided although nests will be removed within the development footprint and any clearing of native vegetation has the potential to add to the incremental decline of potential habitat available within the region. Removal 8 nests (47 % of the 17 nests recorded on site) will reduce the availability of roosting dormitories for the species, and will likely reduce available nesting sites for current breeding adults and for young individuals sexually mature seeking to establish breeding nests. Removal of trees with nests will be included in the vegetation clearing protocol including any seasonal constraints to avoid impacting any juveniles or unfledged chicks. The vegetation clearance protocol should also consider that nests are salvaged and translocated to a suitable location within the riparian corridor where possible. A portion of felled trees will be salvaged as foraging habitat for fauna and translocated to suitable areas in the remainder of the Project Boundary. Tree replacement is also proposed as a mitigation measure for loss of hollow bearing trees. Replacement of trees at a rate of 2:1 (i.e. two trees will be planted to replace each hollow bearing tree removed). This results in planting of 74 new trees within the riparian corridor. In the event that a newly-planted tree dies during the lifespan of the solar farm, the client has the responsibility to replace it in order to achieve a 100% recruitment of 74 trees. This is expected to improve the current fragmented condition of the riparian corridor and assist movement of the Grey-crowned Babbler along creek-lines outside of the Development Site and beyond the solar panel fields. Monitoring of the revegetation works would also include monitoring of the local Babbler population including population numbers and evidence on ongoing breeding (active nests). Based on the application of these mitigation measures the proposed solar farm is unlikely to result in an adverse effect on the life cycle of the species such that the local population might be placed at risk of extinction.
(b)	*in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:*
	‘(i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
	Not applicable
	‘(ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.
	Not applicable

Test of Significance	
(c)	*in relation to the habitat of a threatened species or ecological community:*
	(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and
	The movement of this species is largely confined to the woodland habitats and riparian corridors as this species has limited flying capacity. Habitat to be removed includes 46.06 ha of woodland zones and 12.78 ha of Derived Native Grasslands. This constitutes 34.1% of the Development Site. The riparian corridors (with a 20-30m buffer) have been avoided although 4 nests (23.5% of the 17 nests recorded on site) will be removed within the development footprint and any clearing of native vegetation has the potential to add to the incremental decline of potential habitat available within the region. No vegetation removal will occur outside of the Development Site and the remainder of the Property Boundary will not be modified as result of the current proposal.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
	The removal of native vegetation has the potential to result in fragmentation of fauna habitat, with resultant effects on fauna species movement, reproduction and gene flow. The impact of this vegetation clearance in an already highly modified landscape is anticipated to be negligible for species such as the Grey-crowned Babbler given that no significant fauna movement corridors currently exist within the development site (excluding the riparian corridor). The movement of this species is largely confined to the woodland habitats and riparian corridors as this species has limited flying capacity. The riparian corridors (with a 20-30m buffer) have been avoided and the proposed replacement tree planting is expected to improve the current fragmented condition of the riparian corridor and assist movement of the Grey-crowned Babbler along creek-lines outside of the Development Site and beyond the solar panel fields. Monitoring of the plantings would also include monitoring of the local Babbler population including population numbers and evidence on ongoing breeding (active nests). It is considered that the development of this site will not further isolate or fragment any known habitat linkages for the local population of Grey-crowned Babbler.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality
	The Development Site has been selected as being a suitable site for a solar plant based on its mostly cleared landscape with minimal vegetation removal required. Habitat to be removed includes 46.06 ha of woodland zones and 12.78 ha of Derived Native Grasslands (34.1% of the Development Site). Although localised and short term impacts may be observed, the local population of Babbler would not be dependent on this habitat for their long term survival, particularly given the retention (and enhancement) of the riparian corridors which will assist movement of the Grey-crowned Babbler along creek-lines outside of the Development Site and beyond the solar panel fields.
(d)	*whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)*
	The proposed development is not located within areas listed as Critical Habitat Declarations in the Register of Declared Areas of Outstanding Biodiversity Value in NSW.

Test of Significance

(e) *whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key of a key threatening process.*

The proposed development of this site is likely to include the following key threatening processes (KTP):

- Infestation of habitat by invasive weed exotic perennial grasses.
- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners.
- Nest predation by species such as ravens and butcherbirds in the fragmented landscape.

Mitigation measures such as weed management, monitoring and control of invasive and nuisance species will be required during the construction and operational phase of the proposed solar farm development..

Conclusion

Although localised and short term impacts may be observed, the local population of the Grey-crowned Babbler would not be dependent on development site for their long term survival, particularly given the retention (and enhancement) of the riparian corridors which will assist movement of the Grey-crowned Babbler along creek-lines outside of the Development Site and beyond the solar panel fields.

Loss of habitat for the Grey-crowned Babbler within the Development Site will require offsetting as per the BC Act. The possibility to offset the direct impact on habitat of the Grey-crowned Babbler by active management and/or enhancement of retained areas of habitat may be considered a viable option in consultation with OEH.

It is considered that with the implementation of mitigation measures, the proposed solar farm development will not result in any long term significant effect on the population.

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Bristle-faced Free-tailed Bat (Mormopterus eleryi) – Endangered

Species Overview

The Bristle-faced Free-tailed Bat or Hairy-nosed Freetail Bat (*Mormopterus eleryi* Reardon and McKenzie, 2008) (Reardon et. al. 2008) or *Mormopterus (Setirostris) eleryi* (Reardon et. al. 2014) is a microchiropteran bat species listed as endangered under the BC Act. The species was collected and referred to as *Mormopterus* 'Species 6' (e.g. Churchill 1988, Adams *et. al*. 1988) in publications prior to its formal description. The species is identified as data deficient in the action plan for Australian Bats (Duncan *et. al.* 1999).

The Bristle-faced Free-tailed Bat is distributed from the southern half of the Northern Territory to central Queensland and north-western NSW. The species appears to be extremely rare throughout its range. Nationally, it has been recorded from only 15 locations. In NSW, the species has been recently recorded from only three disjunct locations (NSW SC 2004, Pennay *et. al*. 2011, OEH 2019): thirteen individuals were recorded on 21 November 1998 at Yanda Creek in Gundabooka National Park, south of Bourke (Ellis 2001, Pennay 2006 in Scotts 2012); one individual was recorded in 2001 from Dhinnia Dthinawan Nature Reserve (formerly Bebo State Forest) (Pennay 2002); two individuals at and near Maroomba State Conservation Area (near Bonshaw) (Arden 2004 in Scotts 2012) and one individual captured on 25th March 2010 at the McIntyre River in Kwiambal National Park (Scotts 2012), Kwiambal National park and Maroomba State Conservation Area are located at approximately 37km south-west and 27km north-west from the proposed Bonshaw solar farm.

Knowledge of the ecology of the Bristle-faced Free-tailed Bat is limited, however evidence suggests that the species depends on hollows and tree fissures for roosting sites (NSW SC 2004, OEH 2019). All other Australian species from the family Molossidae, which includes the genus *Mormopterus*, generally roost in tree hollows and fissures (NSW SC 2004, OEH 2019) and Ellis (2001) recorded the species along with other six species known to roost in three hollows. Ellis and Wilson (1992) indicate that species within genus *Mormopterus* are aerial insectivorous with very high flight speed and limited manoeuvrability. They forage typically well-above the canopy and only coming low in relatively open areas. Three species within the genus *Mormopterus*, *M. nofolkensis*, *M. planiceps* and *Mormopterus* sp 1 were classified as an assemblage of vegetation dependent bats that generally fly over the canopy of any vegetation type when feeding; and which are dependent on hollows, usually in larger trees, for roosting and breeding (Ellis 2006).

At Yanda Creek (Gundabooka National Park), three individuals of the species were captured in a harp trap set under a *Eucalypt* tree on the margins of a dry creek (Ellis 2001), a similar habitat where the species' calls were recorded in the Bonshaw Solar Farm's assessment area. The habitat where the species was recorded by Ellis (2001) was a River Red Gum (*Eucalyptus camadulensis*) and Poplar Box (*E. populnea*) lined watercourse set in Poplar Box woodlands with areas of Mulga (*Acacia aneura*) shrublands in the vicinity. The species has also being regarded as using tree hollows for roosting with a "significant bias" for foraging and roost at locations along riparian habitats (Pennay 2006 in Scotts 2012). At Kwiamba National Park (Scotts 2012), the species was captured on a forested terrace adjacent to the McIntyre River where vegetation comprised a mixed over storey of Blakely's Red Gum (*Eucalyptus blakelyi*), Silver-leaved Ironbark (*E. melanophloia*) and Rough-barked Apple (*Angophora floribunda*). The mid-storey was generally sparse but with patch thickets of tea tree (*Leptospermum brevipes*) and White Cypress Pine (*Callitris glaucophylla*). A grassy understorey dominated the more open areas.

Lactating females had been recorded in November (Ellis 2001).

The calls of the Bristle-faced Free-tailed Bat were recorded in five of the eight SongMeters located within the assessment area. The records were analysed by Mr. Greg Ford (Balance!, see call report in Appendix I). Mr Ford is one of the most experience bat call analysis experts in Australia. Following consultation with OEH, Mr Greg Ford was requested to re-analyze the bat calls to ensure the records of the Bristle-faced Free-tailed Bat were confident. Regarding the Bristle-faced Free-tailed Bat, he noted that the calls of the species are similar to the non-listed Inland Broad-nosed Bat (*Scotorepens greyii*) but that the species can be differentiated based on their feeding buzzes (Ford 2018). A total of 53 definite calls of the species were recorded from S4 (11 definite calls) S2 (5 definite calls), S5 (25 definite calls), S6 (one definite call) and S7 (12 definite calls) (see *Figure 5.2*). The locations with the highest number of calls were S5 (25 calls), S7 (12 calls) and S4 (11 calls).

Species Overview

These locations were near creek lines (S5 adjacent to a second order creek line with water, whereas S4 and S7 are located at/near a dry first order creek line).

Based record of the Bristle-faced Free-tailed Bat in the assessment area is considered to be a genuine record of this rare microbat species.

The Bristle-faced Free-tail Bat was recorded in the following vegetation types:

- 594_Moderate (Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion). A total of 18.78 ha of this vegetation zone is present within the Development Site.
- 594_Low (Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion). A total of 7.02 ha of this vegetation zone is present within the Development Site.
- 594_Disturbed Grassland is cleared land allocated as PCT 594 (Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion) for assessment purposes. A total of 45.95 ha of this vegetation zone is present within the Development Site.

Test of Significance

(a)	*in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*
	Little is known about the species and it has been assumed that similar to other species within the genus *Mormopterus*, it relies on tree hollows for roosting and maternity sites. It appears that the species is rare in NSW and no information is currently available regarding its habitat range, reproduction period and social activities although many of the existing records are along riparian habitats. This is also consistent with the results of the surveys within the Project Boundary, within a higher number of calls recorded near creek lines and water bodies. Within the Project Boundary, the riparian corridors (with a 20-30m buffer) have been avoided. A total of 60 hollow bearing trees were recorded across the assessment area, including 37 HBT within the development footprint. Any clearing of native vegetation has the potential to add to the incremental decline of potential habitat available within the region and the removal of trees will be included in the vegetation clearing protocol including any seasonal constraints and monitoring of the hollows prior to removal to avoid impacting any breeding females or juveniles. If this species is confirmed utisiling any of the hollow bearing trees, the trees will be left undisturbed until further advice is sought from OEH and a suitably recognised bat expert. Tree replacement is also proposed as a mitigation measure for loss of hollow bearing trees. Replacement of trees at a rate of 2:1 (i.e. two trees will be planted to replace each hollow bearing tree removed). This results in planting of 74 new trees within the riparian corridor. In the event that a newly-planted tree dies during the lifespan of the solar farm, the client has the responsibility to replace it in order to achieve a 100% recruitment of 74 trees. This is expected to improve the current fragmented condition of the riparian corridor. As naturally formed tree hollows will take many decades to develop, nest-boxes suitable for hollow dependent microbats will be installed prior to HBT clearance and will be monitored during the lifespan of the solar farm Based on the recommended avoidance and mitigation measures outlined above, including the monitoring of the hollows prior to removal and consultation with OEH in the event that the species is confirmed utilising any of the hollows, it is unlikely that activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Species Overview	
(b)	*in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:*
	'(i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
	Not applicable
	'(ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.
	Not applicable
(c)	*in relation to the habitat of a threatened species or ecological community:*
	(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and
	The Development Site is located in a highly disturbed environment that has undergone extensive clearing. Approximately 37 hollow-bearing trees (HBTs) will be removed across the Development Site, including at least three HBTs along first order streams. No trees will be removed along the second and third order creeklines, where echolocation calls of the Bristle-faced Free-tailed Bat is more frequently recorded. Also, it is estimated that a larger number of trees, particularly rough bark *Eucalyptus* and *Callitris* are available in vegetation to be retained within the Project Boundary and wider locality. Therefore the removal of approximately 37 trees will represent a small portion of trees available as breeding and roosting habitat for the Bristle-faced Free-tailed Bat. Loss of approximately 37 HBTs represent net-loss of suitable habitat for the Bristle-faced Free-tailed Bat and other hollow dependent fauna. However, on a landscape scale, loss of approximately 37 HBTs within a mostly cleared area is not considered significant when considering currently available tree resources elsewhere in the Project Boundary and broader locality.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
	The removal of native vegetation has the potential to result in fragmentation of fauna habitat, with resultant effects on fauna species movement, reproduction and gene flow. The impact of this vegetation clearance in an already highly modified landscape is anticipated to be negligible given that no significant fauna movement corridors currently exist within the development site (excluding the riparian corridor which will be avoided). As part of mitigation measures to compensate for loss of trees and vegetation, replacement of trees will be planted along the second and third order streams within the Project Boundary. This will increase the vegetation density along the creek-lines and enhance its value as a linking corridor with remnant vegetation fragments and paddock trees beyond the Development Site. This will also enhance corridors for mobile fauna such as the Bristle-faced Free-tailed Bat and other microbats recorded within the Project Boundary. Therefore, it is considered that the development of this site will not further isolate or fragment the existing landscape.

Species Overview

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality

The Development Site has been selected as being a suitable site for a solar plant based on its mostly cleared landscape with minimal vegetation removal required. It appears that the species is rare in NSW and no information is currently available regarding its habitat range, reproduction period and social activities although many of the existing records are along riparian habitats. This is also consistent with the results of the surveys within the Project Boundary, within a higher number of calls recorded near creek lines and water bodies. Within the Project Boundary, the riparian corridors (with a 20-30m buffer) have been avoided.

The importance of hollow bearing for this species within NSW is also not known however for the purposes of this assessment they have been assumed to be used for roosting and breeding. A total of 60 hollow bearing trees were recorded across the assessment area, including 37 HBT within the development footprint. Any clearing of native vegetation has the potential to add to the incremental decline of potential habitat available within the region and the removal of trees will be included in the vegetation clearing protocol including any seasonal constraints and monitoring of the hollows prior to removal to avoid impacting any breeding females or juveniles. If this species is confirmed utisiling any of the hollow bearing trees, the trees will be left undisturbed until further advice is sought from OEH and a suitably recognised bat expert.

Based on the recommended avoidance and mitigation measures outlined within this assessment, including the monitoring of the hollows prior to removal and consultation with OEH in the event that the species is confirmed utilising any of the hollows, the proposal is unlikely to remove any key habitats that will impact on the long-term survival of the local population.

(d) *whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)*

The proposed development is not located within areas listed as Critical Habitat Declarations in the Register of Declared Areas of Outstanding Biodiversity Value in NSW.

(e) *whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key of a key threatening process.*

Future development of this site is likely to include the following KTP:

- Clearing and removal of hollow bearing trees as a consequence of firewood collection and agricultural and forestry practices. The proposal will remove HBT to give way to installation of solar panels.
- Loss of habitat is exacerbated by its apparent low population numbers.
- Lack of understanding about the species' ecology, distribution and habitat preferences.
- Loss and degradation of foraging and roosting habitat, including changes in vegetation structure due to weed invasion.
- Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individual's fat stores.

The following mitigation measures will be implemented to minimise the potential of the above listed threats having negative effects on the species:

- A weed management plan will be required to be implemented during the construction and operation phases of the solar farm.
- Chemical use, such as pesticides and herbicides, will be controlled (or avoided) to prevent reduction of insect populations, a feeding resource for the species. This will also eliminate the possibility of trophic induced toxicity due to bioaccumulation in the bat species.

Species Overview

- Loss of hollow-bearing trees will be mitigated by replacement of nest boxes (short term mitigation measure) and replacement of trees suitable to develop hollows at their mature stage. It is noted that mature trees (i.e. with more than 80cm DBH) were rare at the site. It has been proposed that periods of time in the range of 180 to 238 years (e.g. soft bark Eucalypt spp.) or up to 324 years (e.g. ironbarks) are required for hollows suitable for fauna (e.g. bats) to form naturally on trees (e.g. Parnaby *et. al.* 2011). The development footprint area contains mature trees, but not old growth (i.e. trees with DBH greater than 100cm (DEC 2004)). Therefore, replanting trees suitable to naturally develop hollows, e.g. *Eucalypt* spp., has the potential to replace tree hollows in the long-term and provide natural habitat for hollow-dependent species, such as the Bristle-faced Free-tailed Bat. Evidence suggest that lineal planting and remnants are suitable habitat for bats in disturbed landscapes (Lentini *et. al.* 2012).

Conclusion

The conservation value of locations where the Bristle-faced Free-tailed Bat had been recorded is unknown due to the lack of knowledge on the biology and ecological requirements for the species. It is known that the species is rare and, based on the ecology of other species within the same genus, it has been assumed the Bristle-faced Free-tailed Bat to be tree hollow dependent. The pattern of the species being more frequently recorded along creek-lines than in other habitats in the landscape has emerged and the riparian corridors (with a 20-30m buffer) have been avoided.

Based on the recommended avoidance and mitigation measures outlined above, including the monitoring of the hollows prior to removal and consultation with OEH in the event that the species is confirmed utilising any of the hollows, it is unlikely that activity is likely to have an adverse effect on the life cycle of the species such that the local population of the species is likely to be placed at risk of extinction although it is noted that any clearing of native vegetation, including paddock trees has the potential to add to the incremental decline of potential habitat available within the region and will require offsetting in accordance with the offset scheme under the BC Act. The possibility to offset the impact on site by active management and/or enhancing retained areas of habitat might be considered as a viable option in consultation with OEH.

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Eastern Cave Bat (Vespadelus troughtoni) – Vulnerable

Species Overview

The Eastern Cave Bat (*Vespadelus troughtoni*) is a microchiropteran bat species listed as vulnerable under the BC Act.

The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT (OEH 2019).

The profile for the species (OEH 2019) indicates the following with regards to the habitat and ecology of the species:

- Very little is known about the biology of this uncommon species.
- A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals.
- Occasionally found along cliff-lines in wet eucalypt forest and rainforest.
- Little is understood of its feeding or breeding requirements or behaviour.

The Eastern Cave Bat was recorded in the following vegetation types:

- 594_Moderate (Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion). A total of 18.78 ha of this vegetation zone is present within the Development Site.
- 594_Low (Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion). A total of 7.02 ha of this vegetation zone is present within the Development Site.
- 594_Disturbed Grassland is cleared land allocated as PCT 594 (Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion) for assessment purposes. A total of 45.95 ha of this vegetation zone is present within the Development Site.

In accordance with the TBDC, the Eastern Cave Bat is also found in the other two PCTs recorded at the Development Site, i.e. PCT 516 and 596.

Test of Significance

(a)	*in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*
	There is not suitable roosting or breeding habitat for the Eastern Cave Bat within the Development Site. The species is known to occur in the three PCTs recorded at the Development Site (i.e. PCT 594, 596 and 516) and is likely that foraging resources for the species are present therein. Clearing within the Development Site will likely reduce potential foraging resources for the species. However, it is considered this is unlikely that activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Species Overview	
(b)	*in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:*
	'(i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
	Not applicable
	'(ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.
	Not applicable
(c)	*in relation to the habitat of a threatened species or ecological community:*
	(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and
	The Development Site is located in a highly disturbed environment that has undergone extensive clearing. Approximately 44.06ha of woodland and 12.78ha of derived grasslands will be cleared within this disturbed environment. None of the vegetation to be cleared or the land where this will occur includes suitable roosting or breeding habitat for the Eastern Cave Bat. Therefore, the project will result in loss of a total of 56.84ha of potential foraging habitat. However, on a landscape scale, loss of 56.84ha within a mostly cleared area is not considered significant when considering currently available vegetated resources elsewhere in the Project Boundary and broader locality.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
	The removal of native vegetation has the potential to result in fragmentation of fauna habitat, with resultant effects on fauna species movement, reproduction and gene flow. The impact of this vegetation clearance in an already highly modified landscape is anticipated to be negligible given that no significant fauna movement corridors currently exist within the development site (excluding the riparian corridor which will be avoided). As part of mitigation measures to compensate for loss of trees and vegetation, replacement of trees will be planted along the second and third order streams within the Project Boundary. This will increase the vegetation density along the creek-lines and enhance its value as a linking corridor with remnant vegetation fragments and paddock trees beyond the Development Site. This will also enhance corridors for mobile fauna such as the Eastern Cave Bat and other microbats recorded within the Project Boundary. Therefore, it is considered that the development of this site will not further isolate or fragment the existing landscape.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality

Species Overview	
	The Development Site has been selected as being a suitable site for a solar plant based on its mostly cleared landscape with minimal vegetation removal required. The Development Site does not contain suitable roosting or breeding habitat for the Eastern Cave Bat, only potential foraging habitat is present therein. When considered at a larger spatial scale, loss of 56.84ha of potential foraging ground in a disturbed land is not significant as more foraging habitat and at better condition is present in the broader locality. Therefore, the proposal is unlikely to remove any key habitats that will impact on the long-term survival of the local population.
(d)	*whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)*
	The proposed development is not located within areas listed as Critical Habitat Declarations in the Register of Declared Areas of Outstanding Biodiversity Value in NSW.
(e)	*whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key of a key threatening process.*
	Future development of this site is likely to trigger the following KTP: ■ Pesticides and herbicides may reduce the availability of insects, or result in the accumulation of toxic residues in individual’s fat stores. ■ Probable predation by cats and foxes The following mitigation measures will be implemented to minimise the potential of the above listed threats having negative effects on the species: ■ Chemical use, such as pesticides and herbicides, will be controlled (or avoided) to prevent reduction of insect populations, a feeding resource for the species. This will also eliminate the possibility of trophic induced toxicity due to bioaccumulation in the bat species. ■ Monitoring and management of invasive pest species. This will minimize the possibility of predation on native species, such as microbats.
Conclusion	
	There is no suitable roosting and breeding habitat for the Eastern Cave Bat within the Development Site. The Development Site contains vegetation with potential foraging resources for the species. Given that little is known about the feeding behaviour of the Eastern Cave Bat, the conservation value of locations where the species had been recorded is unknown. Given that microchiropteran bats are considered to be insectivorous, use of pesticides and herbicides at the site will be avoided to prevent indirect impacts on insect populations and bioaccumulation on predators, such as the Eastern Cave Bat. Based on the recommended avoidance and mitigation measures outlined above, including the monitoring of the invasive pest species and avoidance in use of herbicides and pesticides, it is unlikely that activity is likely to have an adverse effect on the life cycle of the species such that the local population of the species is likely to be placed at risk of extinction. Although it is noted that any clearing of native vegetation, including paddock trees has the potential to add to the incremental decline of potential habitat available within the region and will require offsetting in accordance with the offset scheme under the BC Act. The possibility to offset the impact on site by active management and/or enhancing retained areas of habitat might be considered as a viable option in consultation with OEH.

Species Overview	
References	
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Significant Impact Assessment

The following Significant Impact Assessment (SIA) have been prepared in accordance with DoE (2013) *Matters of National Environmental Significance. Significant Impact Guidelines 1.1 under the Environment Protection and Biodiversity Conservation Act 1999*.

Cicadabird (Coracina tenuirostris) – EPBC Act status: Marine

Species Overview

The Cicadabird (*Coracina tenuirostris*) is listed as Marine under the EPBC Act (DoEE 2019), whereas the subspecies Melville Cicadabird (*Coracina tenuirostris melvillensis*) is listed as Migratory. Given that Significant Impact Criteria for marine species is not provided in DoE (2013), the SIA for Cicadabird has been based on criteria for migratory species. The Cicadabird is listed as least concern (ALA 2019, BirdLife International 2017).

The Common Cicadabird (*Edolisoma tenuirostre* synonym *Coracina tenuirostris*) is a full migrant bird species found in Australia, Indonesia, New Guinea and the Solomon Islands (BirdLife International 2017, Wikipedia 2019). In Australia, the Cicadabird inhabits the northernmost part of the NT and WA. It also inhabits the eastern coast of Queensland, New South Wales and Victoria (see Screen Shot below). The species is considered native to the Northern Territory (ALA 2019).

Screen shot 1 Distribution of Cicadabird (source BirLife International 2017)

The natural habitat of the Cicadabird are temperate forests and subtropical or tropical moist lowland forests (Wikipedia 2019). The species is found in several habitats, including forest, artificial/terrestrial, savannah and shrubland. Of those habitats, temperate forests and subtropical/tropical moist lowland forests are habitats of major importance (BirdLife International 2017).

The Cicadabird's generation length is 4.6 years (BirdLife International 2017). The Cicadabrid is considered part of the frugivorous and insectivorous group of birds which has been observed breeding in February and December (Lavery 1985).

One individual of the Cicadabird was recorded in PCT 594 – Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion moderate condition adjacent to Disturbed Land.

Significant Impact Assessment – Significant Impact Criteria for Migratory Species

(a)	*An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.*

Species Overview

The sole individual of the Cicadabird was recorded in a moderate condition forest within the Development Site. The Cicadabird has a wide distribution along the eastern coast of Australia and it is of least concern. Regarding the habitat where the species was recorded, the Development Site has undergone a long history of disturbance due to clearing, agriculture and grazing practices, including the vegetation where the species was recorded. The disturbed nature of the site along with the fact that only one individual of the Cicadabird was observed suggests that the species would not be a frequent visitor, or be dependant on any of the resources available. Therefore, it is not considered that the proposed development will substantially modify, destroy or isolate an area of important habitat for the Cicadabird.

(b) *An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or*

Information regarding invasive species harmful to the Cicadabird are not readily available (DoEE 2019). It has been assumed that predatory species feeding on birds (e.g. European Red Fox, Cats and Dogs) or species with aggressive behaviour (e.g. Noisy Miner) have potential to have negative effects on individuals and/or population of birds, such as the Cicadabird.

It is not considered that the proposal will result in the establishment of invasive species. Therefore, it is not expected that significant negative effects on the Cicadabird due to interactions with invasive species will result from the proposed solar farm.

(c) *An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.*

Very little is known about the breeding, feeding, migratory and resting behaviour of the Cicadabird. Given its widespread distribution in eastern Australia, it is considered sufficient feeding and breeding resources for the species occur.

Due to the Development Site being in a disturbed condition, it is not considered that critical feeding or breeding resources for the species are found. Therefore, it is not considered that the proposed solar farm will result in a significant impact on feeding or breeding resources for the species, nor will it result in disrupting its lifecycle or migratory behaviour.

Conclusion

The Cicadabird is widespread in eastern Australia and is a species of least concern. In spite of little knowledge about the species' feeding, breeding, roosting and migratory behaviour being available, the species continues to persist along the eastern coast of Australia, suggesting sufficient resources are present.

The Development Site is a disturbed environment with cleared and disturbed vegetation. Remnant vegetation patches are disturbed (moderate to very low condition) and are not considered to represent critical habitat for the species. Therefore, it is considered that the proposed solar farm will not result in significant impacts on the species and that a referral to the Commonwealth is not deemed necessary as significant impacts to migratory/marine Matters of National Significance will not occur.

Species Overview

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Assessment of Signifcance

The following Assessment of Significance (AoS) have been prepared in accordance with DPI (2008) *Threatened Species Assessment Guidelines*. The DPI (2008) guideline, provide a series of criteria to assess whether a proposed development is likely to have significant effects on aquatic threatened species listed under the FM Act. An AoS has been prepared for three aquatic threatened species whose indicative distributional maps suggest they were likely to occur in creeks within the Development Site. The species are:

- Southern Purple Spotted Gudgeon (Endangered Species)
- Eel Tailed Catfish (Endangered Population)
- Olive Perchlet (Endangered Population)

Southern Purple Spotted Gudgeon, Eel Tailed Catfish & Olive Perchlet

Species Overview

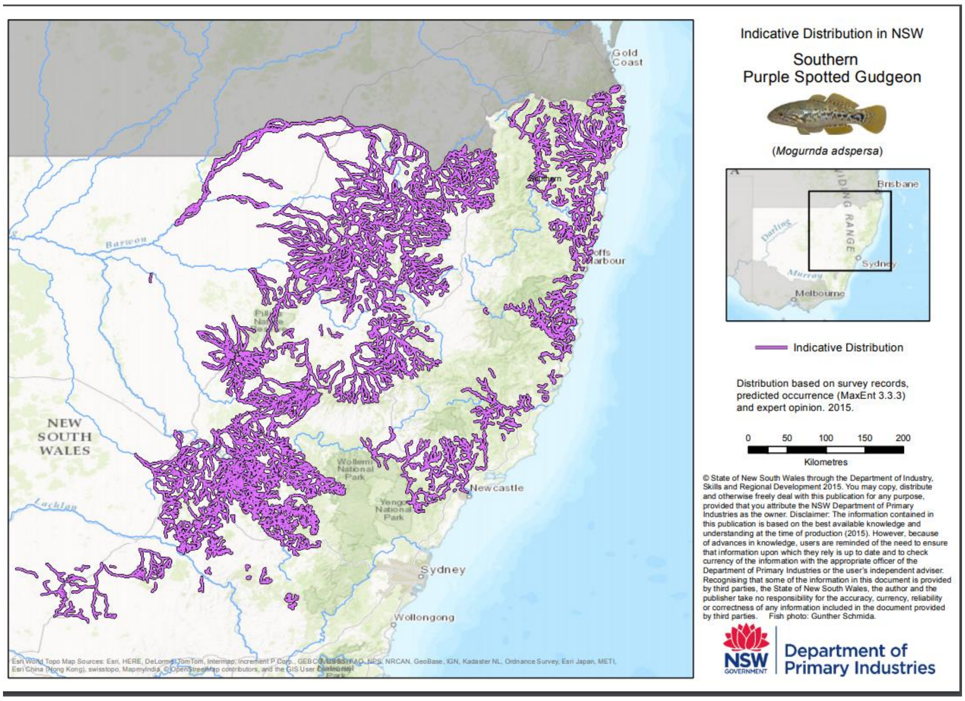
Southern Purple Spotted Gudgeon (*Mogunda adspersa*) – Endangered Species

The Southern Purple Spotted Gudgeon occur in inland drainages of the Murray-Darling basin as well as coastal drainages of northern NSW and Queensland. The western population of the Southern Purple Spotted Gudgeon was previously widespread in the Murray, Murrumbidgee and Lachlan River systems and tributaries of the Darling, but has experienced a significant decline in recent times. Southern Purple Spotted Gudgeons are now extremely rare in inland NSW, having been recorded from this area only once since 1983 (DPI 2019).

The Southern Purple Spotted Gudgeon generally grow to 15 cm in length. The species is found in slow moving or still waters of rivers, creeks and billabongs, often amongst weeds, rocks and snags. They feed mainly on insect larvae, but also consume worms, tadpoles, small fish and some plant matter. Female *Mogurnda*

Species Overview

adspersa may lay several batches of eggs per season (30-1,300 per batch). The eggs are deposited in clusters on solid objects such as rocks, wood or broad-leafed plants. The male guards and fans the eggs until hatching (3-8 days). The species is part of the Endangered Aquatic Ecological Community in the Natural Drainage System of the Lower Murray River Catchment, the Endangered Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River and the Endangered Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Lachlan River (FSC 2008a).



Distribution based on survey records, predicted occurrence (MaxEnt 3.3.3) and expert opinion. 2015.

Fish photo: Gunther Schmida.

Esri World Topo Map Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

DPI (2019) Indicative Distribution Map for the Southern Purple Spotted Gudgeon

A close review of DPI's indicative distribution map for the Southern Purple Spotted Gudgeon (see Figure 5.4) indicates that none of the creeks within the Project Boundary are mapped as habitat for the species.

Eel Tailed Catfish (*Tandanus tandanus*) – Endangered Population

The Murray-Darling Basin (MDB) population of Eel Tailed Catfish is listed as an Endangered population under the FM Act.

Eel Tailed Catfish is an Australian endemic fish species (DPI 2015). It is naturally distributed throughout the Murray-Darling Basin and in the Eastern drainages NSW north of Newcastle. Eel Tailed Catfish numbers in the Murray-Darling Basin have declined due to a range of impacts including invasive species, habitat degradation, cold water pollution and fishing pressures and are now virtually absent from the Murray, Murrumbidgee and Lachlan catchments (DPI 2019).

Eel Tailed Catfish is a medium-sized fish with a large head and a compressed rear portion of the body. It has a relatively long life span, living for at least 8 years (DPI 2015).It can grow up to 900mm in length and 7kg, however fish over 2kg are exceptional (DPI 2015, 2019). Colour ranges from grey to brown dorsally or laterally, usually mottled with dark brown to black blotchings with a whitish underbelly. Larger fish have less mottlings and can be greener in colour fading to white below (DPI 2019). Catfish are predominantly opportunistic carnivores, feeding mainly on small fish, freshwater prawns, yabbies, zooplankton and insects.

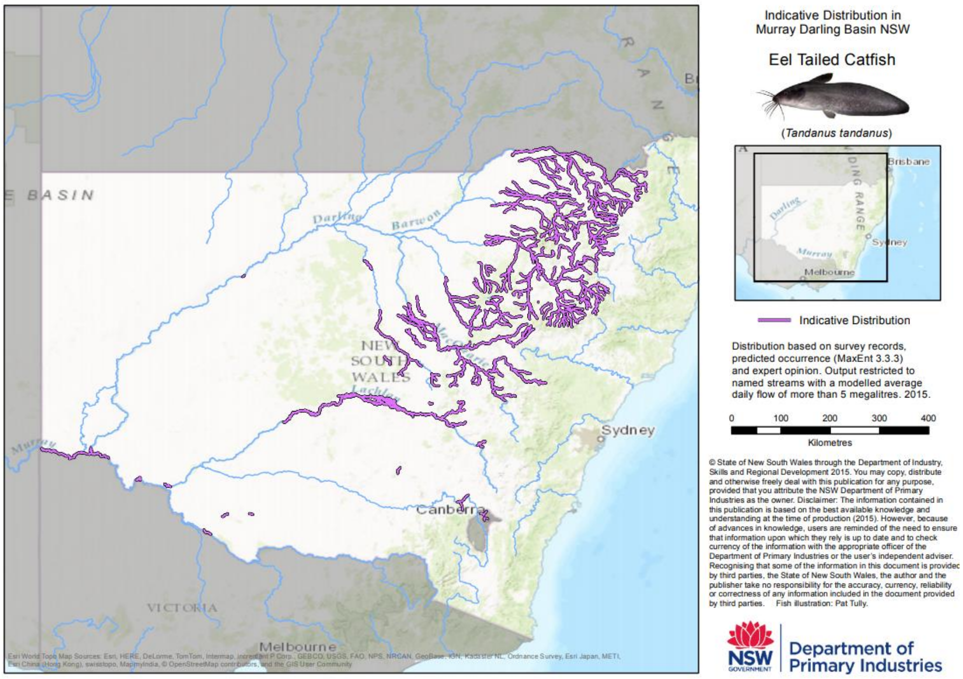
Individuals are sexually mature at 3-5 years of age and spawn in spring/summer when water temperatures are 20-24ºC (DPI 2015). Eel Tailed Catfish builds a nest in areas of still water to breed, and their reproduction is not temperature reliant. Males construct and defend a nest up to 2 metres in diameter, made from pebbles and gravel.

Species Overview

Eel Tailed Catfish is a non-migratory, benthic (bottom dwelling) species. It is relatively sedentary and adults typically only move within a 5 km range. Individuals are more active at night compared with during the day (DPI 2015, 2019). The species lives in a wide range of habitats including rivers, creeks, lakes, billabongs and lagoons, and although it inhabits flowing streams, prefers sluggish or still waters. It can be found in clear to turbid waters, and over substrates ranging from mud to gravel and rock. It is rare in natural riverine habitats but can be found in farm dams through-out inland NSW and southern Queensland (FSC 2008b). The species is relatively inactive and do not migrate for spawning, unlike other inland species such as Golden Perch or Murray Cod (DPI 2015, 2019).

Duncan et. al. (2017) indicated that Eel Tailed Catfish populations were most likely to be present in reaches of the MDB if there is a high cover of Cobble/Gravel, submerged macrophytes and low daily flow. Catfish are thought to prefer slow-moving or still waters and are found in greater abundance in lakes and backwaters. Breeding is more likely to occur at sites with a high abundance of Bedrock/Boulders, Riffle/Rapids, Emergent Macrophytes and low Daily Flow. They also note that in reaches of tributaries of the MDB where the species is currently extinct, it is unlikely that the species would naturally re-colonize and establish itself due to it being a not highly migratory species. Catfish have a relatively high minimum spawning temperature threshold relative to other native fishes in the MDB. Thermal pollution may partly explain their disappearance from some rivers in the MDB subject to cold-water releases from large impoundments.

The indicative distributional map for the species indicates the Project Boundary is within the portion of the Murray-Darling Basin where the species had been recorded (see DPI's image below). A zoom into the Project Boundary (see Figure 5.4) shows that the creeks within the Project Boundary are not mapped as habitat for the Eel Tailed Catfish. Duncan et. al. (2017) indicated that the species has disappeared from the Dumaresq River.



DPI (2019) Indicative Distribution Map for the Eel Tailed Catfish

Olive Perchlet (*Ambassis agassizii*) – Endangered Population

The Western Population of the Olive Perchlet in the Murray-Darling Basin (MDB) is listed as an Endangered population under the FM Act.

Species Overview

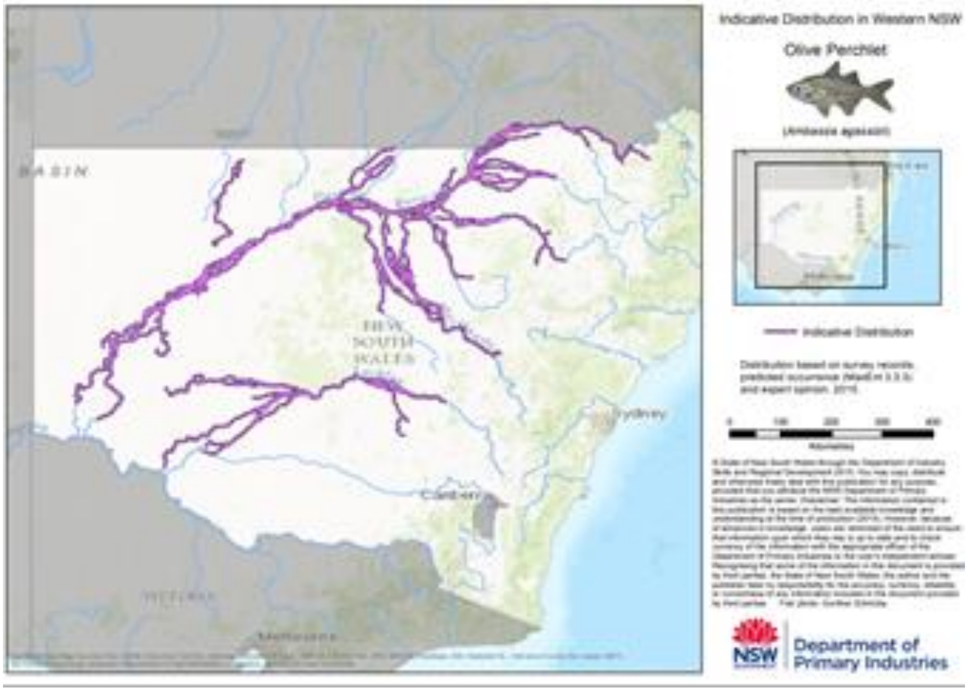
Olive Perchlets are a small native fish that occur in both eastern (coastal) and western (Murray-Darling) drainages, but these populations may be genetically distinct. The western population of the Olive Perchlet was once widespread throughout the Murray-Darling system of South Australia, Victoria, western New South Wales and southern Queensland. This population has suffered a serious decline and is now found only at a few sites in the Darling River drainage (DPI 2019).

Olive Perchlets have an oval shaped body with a moderately large mouth, very large eyes and a forked tail. They are usually semi-transparent, with dark-edged scales forming a distinct pattern. The fins are generally clear, although there is often a broad, blackish band along the edges of the pelvic and anal fins. Olive Perchlet can grow to about 7080 mm but are more commonly less than 40 mm (DPI 2013, 2019).

Males and females reach sexual maturity at one year of age, and live for 2-4 years. Spawning occurs between October and December when the water temperature reaches 23°C. Females lay 200-700 eggs which attach to aquatic plants and rocks on the streambed. The eggs are scattered among vegetation. Both sexes reach maturity in one year, with some males surviving and breeding for two years and some females breeding in their third year (DPI 2009).

Olive Perchlet inhabit rivers, creeks, ponds and swamps. They are usually found in slow-flowing or still waters. They are usually found in sheltered areas such as overhanging vegetation, aquatic macrophyte beds, logs, dead branches and boulders during the day, and disperse to feed during the night. Olive Perchlet feed on a range of zooplankton and aquatic and terrestrial insects (DPI 2013, 2019).

The indicative distributional map for the species in the Murray-Darling Basin indicates the Project Boundary is within the portion of the Murray-Darling Basin where the species had been recorded (see DPI's image below (DPI 2019)). The current distribution of the species in the MDB has decreased (DPI 2013). A zoom into the Project Boundary (see Figure 5.4) shows that the creeks within the Project Boundary are not mapped as habitat for the Olive Perchlet.



DPI (2019) Indicative Distribution Map for the Olive Perchlet

Species Overview **Assessment of Significance**	
(a)	*In the case of threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*
	The six first order creeks to be lost as part of the proposed development are currently dry, as such, they do not represent suitable habitat for any of these aquatic fish species. The third, second and first order creeks within the Project Boundary to be retained were also dry at the time of surveys and are isolated from the broader riparian system due to the presence of Bruxner Way. During period of heavy rain and increase surface flow, the possibility exists for aquatic fauna, such as fish, to occasionally occupy these creeks in association with flooding events whereby they can be carried into the creeks by the flow and remained ‘trapped’ as waters recede. When such flood-induced occasional use of the creeks might occur, it is unlikely those individuals would establish a local population due to the lack of connectivity with the broader riparian system and ephemerality of the creeks. The proposed development is unlikely to result in any impacts to any local population of these aquatic species nor it is predicted that the project or activities associated with it will put the species at risk of extinction.
(b)	*in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.*
	None of the creeks within the Subject Land provide habitat for any of the species assessed and the proposed development is unlikely to result in any impacts to any local population of these species or have any effect on the life cycle of any local population.
(c)	*in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:* *(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or* *(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.*
	NA
(d)	*in relation to the habitat of a threatened species, population or ecological community:* *(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and* *(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and* *(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*
	None of the creeks within the Subject Land provide habitat for any of the species assessed and the proposed development is unlikely to result in any impacts or remove any habitat critical to the survival of any local population of these species.

Species Overview	
(e)	*whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*
	No critical habitat for the three threatened fish species is present at the Development Site.
(f)	*whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*
	Southern Purple Spotted Gudgeon No recovery plan or threat abatement plan is available for the Southern Purple Spotted Gudgeon. The final determination for the species indicates that threatening processes associated with the decline of the species are: ■ predation by introduced fish such as gambusia and redfin perch, ■ habitat loss, ■ rapid fluctuations in water levels (due to water regulation) that have deleterious effects on successful reproduction and recruitment. A Priorities Action Statement for the species is available in DPI (2019). The proposed development do not contravene any of the provided actions for recovery of the Southern Purple Spotted Gudgeon. **Eel Tailed Catfish:** No recovery plan or threat abatement plan is available for the Eel Tailed Catfish. The final determination for the species and its PrimaFace (DPI 2015) indicates that threatening processes associated with the decline of the species are uncertain, but that probably include: ■ Historic commercial fishing; ■ Loss of habitat (lakes, billabongs, lagoons) through river regulation; ■ Interactions with introduced species, such as carp (*Cyprinus carpio*) and Redfin Perch (*Perca fluviatilis*); ■ Loss of habitat and spawning sites through siltation; ■ Reduced success of spawning and recruitment; ■ Loss of habitat due to alterations to flow patterns and flooding regimes; ■ Reduced habitat and loss of temperature spawning cues due to cold-water discharge from the base of large dams and high-level weirs; ■ Loss of aquatic plants; ■ Chemical pollution, including agricultural pesticides. A Priorities Action Statement for the species is available in DPI (2019). The proposed development do not contravene any of the provided actions for recovery of the Eel Tailed Catfish. **Olive Perchlet:** No recovery plan or threat abatement plan is available for the Olive Perchlet. The final determination for the species and its PrimaFace (DPI 2013) indicates that threatening processes associated with the decline of the species may include: ■ Predation by introduced fish such as Mosquitofish (*Gambusia holbrooki*) and Redfin perch (*Perca fluviatilis*).

Species Overview	
	- Habitat degradation and loss, including the removal of vegetation, logs and snags. - Rapid fluctuations in water levels (due to river regulation) that have deleterious effects on successful reproduction and recruitment. - Cold water pollution from impoundment water release restricting spawning. - Loss of instream aquatic vegetation through the impacts of river regulation and carp (*Cyprinus carpio*). A Priorities Action Statement for the species is available in DPI (2019). The proposed development do not contravene any of the provided actions for recovery of the Western Population of the Olive Perchlet.
Conclusion	
	None of the creeks within the Subject Land provide habitat for any of the species assessed and the proposed development is unlikely to result in any impacts or remove any habitat critical to the survival of any local population of these species.

Species Overview

References

DPI (2013) **PrimeFact: Olive Perchlet (western population) – *Ambassis agassizii*.** NSW Department of Primary Industries, Port Stephens.

DPI (2015) **PrimeFact: Eel-tailed Catfish population in the Murray-Darling Basin, *Tandanus tandanus***. NSW Department of Primary Industries, Port Stephens.

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FSC (2009) Recommendation Ambassis agassizii – (Olive Perchlet). Recommendation by the Fisheries Scientific Committee under the NSW Fisheries Management Act 1994 (Ref. No. RF17, File No. FSC 01/09).

Rourke M. and Gilligan D. (2010) **Population genetic structure of freshwater catfish (*Tandanus tandanus*) in the Murray-Darling Basin and coastal catchments of New South Wales: Implications for future re-stocking programs**. Industry & Investment NSW, Narrandera Fisheries Centre, Narrandera NSW.

APPENDIX F SURVEY METHODS AND EFFORT

Survey Method and Effort

Flora and fauna surveys were undertaken within the Development Site at locations shown in *Figure 5.1*. Environmental conditions are presented in Table F.1 below. Weather conditions are as per the Bureau of Meteorology's Applethorpe (Station 041175).

Fauna survey methods and effort are presented in Table F.1.

Targeted flora surveys methods and effort are presented in Table F.3.

Table F.1 Weather during Surveys

Date	Min Temp	Max Temp	Rainfall (mm)	Other
10/09/2018	3.1	22.6	0	
11/09/2018	6.0	20.3	0	
12/09/2018	5.1	21.7	0	
13/09/2018	5.1	24.2	0	
14/09/2018	5.2	25.4	0	
10/12/2018	14.0	30.7	0	
11/12/2018	16.0	27.4	0	
12/12/2018	14.2	30.3	0	
13/12/2018	14.2	29.2	0.2	
14/12/2018	17.0	27.7	26	
25/03/2019	19.6	29.9	0	
26/03/2019	19.1	24.1	0	
27/03/2019	14.6	17.8	1.2	
28/03/2019	14.0	21.7	1.2	

Table F.2 Summary of Fauna Survey Effort

Bird Surveys

Survey method: A 20 minute point survey was undertaken by one or two ecologists. Survey consisted of listening bird calling, observing birds activity using binoculars. Bird surveys are in general agreement with guidelines such as DEWHA (2010) *Survey guidelines for Australia's threatened birds*. *Guidelines for detecting birds listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999*.

Date	Survey ID	Start Time	Finish Time	Ecologists	Effort (man hours)	Notes
12/09/2018	B0	10:35	11.00	JW	0.40	Diurnal
10/12/2018	B1	19:22	19:42	TC, ACM	0.67	Dusk
11/12/2018	B2	19:25	17:45	TC, ACM	0.67	Dusk
12/12/2018	B3	18:27	18:27	TC, ACM	0.67	Dusk
13/12/2018	B4	10:48	11:08	TC, ACM	0.67	Diurnal
13/12/2018	B5	18:22	18:42	TC	0.33	Dusk
14/12/2018	B6	6:08	6:28	TC	0.33	Dawn
14/12/2018	B7	6:57	7:17	TC	0.33	Dawn
				Total Survey Effort	4.07	

Ecologists: ACM – Adriana Corona Mothe; JW – Joanne Woodhouse; TC – Thomas Cotter

Frog Surveys

Survey method: Frog surveys were undertaken using playback of the call of Tusked Frog (*Adelotus brevis*) using a mobile phone and a speaker. Two or three cycles of two minutes playing the call recording followed by two minutes listening for any response.

Date	Survey ID	Start Time	Finish Time	Ecologists	No Playback events	Playback Duration
12/12/2018	F1	22:15	22:23	TC, ACM	2	2 min call, 2 min listen
13/12/2018	F2	18:58	19:10	TC, ACM	3	2 min call, 2 min listen
14/12/2018	F3	7:30	7:38	TC, ACM	2	2 min call, 2 min listen
				Total effort (no call playback events)	7	Survey undertaken at suitable habitat for the targeted species.

Ecologists: ACM – Adriana Corona Mothe; TC – Thomas Cotter

Reptile Surveys

A total of seven reptile surveys were undertaken within rocky areas.

Reptile surveys were design to target the following:

- General reptile habitats
- Targeting habitat for the Zigzag Velvet Gecko (*Amalosia rhombifer*) in gum trees (e.g. *Eucalyptus blakelyi*) and Whyte Cypress Pine (*Callitris glaucophyla*).
- Targeting habitat for the Border Thick-tailed Gecko (*Uvidicolus sphyrurus*) in rocky habitats, coarse woody debris and leaf litter.
- Targeting habitat for the Pale Headed Snake (*Hoplocephalus bitorquatus*) treed areas, riparian areas and coarse woody debris.

Survey Method: Two ecologist undertook nocturnal spotlight surveys. Searches included turning rocks, searching underneath leaf litter piles and under logs. Spotlighting also targeted tree trunks. No recommended survey effort for the targeted species is readily available, therefore, survey effort was determined based on standard practice for reptiles, habitat availability at the Development site, species profiles and advice for similar species (e.g. gekos) as per DEWHA (2011) *Survey guidelines for Australia's threatened reptiles*.

Date	Survey ID	Start Time	Finish Time	Ecologists	Effort (Man hours)	Notes
10/12/2018	R1	20:21	20:41	TC, ACM	0.67	Rocky Area. Leaf litter, log, rock, granite. Eastern facing
10/12/2018	R2	19:57	10:17	TC, ACM	0.67	Rocky Area. Leaf litter (3cm depth), log and rock turn, granite, eastern slope
11/12/2018	R3	20:50	21:10	TC, ACM	0.67	Rocky Area. Leaf litter (2cm depth), east facing
11/12/2018	R4	21:26	21:46	TC, ACM	0.67	Rocky Area. Leaf litter (2cm depth), west facing
11/12/2018	R5	21:58	22:09	TC, ACM	0.33	Rocky Area
11/12/2018	R6	21:00	21:34	TC, ACM	1.13	Rocky Area
12/12/2018	R7	20:34	20:54	TC, ACM	0.67	Rocky Area
12/12/2018	R8	20:02	20:22	TC, ACM	0.67	Rocky Area
				Total Survey Effort	5.48	Survey effort for reptiles at the Development Site is considered sufficient given the extent of suitable habitat .

Ecologists: ACM – Adriana Corona Mothe; TC – Thomas Cotter

Camera Traps

A total of eight camera traps were installed across the Project Boundary. Camera traps used included:

- Four pocket camera SG565F-8M.
- Four UV565 cameras.

Survey method: Camera traps were set up targeting arboreal fauna, particularly that using tree hollows, such as Squirrel Glider (*Petaurus norfolcensis*). Camera traps were set up to record fauna during three or four nights. The cameras were timed to record fauna activity one hour before dusk to hour after dawn. Analysis of photographic records were undertaken by ERM's ecologists.

Unit ID	Date Set up	Date Removed	Recording Start Time	Recording Finish Time	Effort (Trap Nights)	Notes
C1	10/12/2018	14/12/2018	18:00 hrs	6:00 hrs	4	Camera set up on an ironbark. Directed at a hollow in adjacent *Angophora floribunda*. Lure used: honey water spray
C2	10/12/2018	14/12/2018	18:00 hrs	6:00 hrs	4	Camera set up on a *Eucalyptus albens* at 2m height. Directed at an adjacent *E. albens*.
C3	10/12/2018	14/12/2018	18:00 hrs	6:00 hrs	4	Camera set up on a *Callitris glaucophylla* and at 1,5m high. Directed towards a *Eucalyptus blakelyi* which had some arboreal mammal scratch marks.
C4	10/12/2018	14/12/2018	18:00 hrs	6:00 hrs	4	Camera set up on a *Hakea* sp. at 1.5m high. Directed towards a *Eucalyptus melanophloia* with hollow.
C5	11/12/2018	14/12/2018	18:00 hrs	6:00 hrs	3	Camera set up on a *Eucalyptus melanophloia* and at 2 m high. Directed towards adjacent *Eucalyptus melanophloia*'s trunk located at the edge of a drainage feature with water present.
C6	11/12/2018	14/12/2018	18:00 hrs	6:00 hrs	3	Camera set up on a *Dododanea* sp. and a 1.5 m high. Directed towards *Eucalyptus melanophloia* with hollows. Lure used: honey water spray.
C7	11/12/2018	14/12/2018	18:00 hrs	6:00 hrs	3	Camera set up on a *Callitris glaucophylla* and at 1.75m high. Directed towards adjacent a *Corymbia dolichocarpa* with hollow. Lure used: honey water spray.
C8	11/12/2018	14/12/2018	18:00 hrs	6:00 hrs	3	Camera set up on a stag at 1.5m high. Directed towards *Eucalyptus dealbata* trunk with hollows and scratch marks. Lure used: honey water spray.
				Total trap nights	28	Given that the Development Site has undergone intensive disturbance due to its historical and current land use, an intense level of survey (e.g. 14 night traps and using approximately 10 cameras per hectare (DSEWPC (2011) *Survey guidelines for Australia's threatened mammals*)) was not considered necessary. We targeted the most likely habitats were arboreal species might occur.

SongMeters

Eight SongMeter model SM2+ (Wildlife Acoustics Inc.) were used. A total of 28 trap nights were recorded using eight instruments during three to four nights.
The microchiropteran bat recordings were submitted for analyses by recognised bat call analysis expert, Mr Greg Ford (Balance! Environmental). The report is provided in Appendix I.

Unit ID	Date Set up	Date Removed	Recording Start Time	Recording Finish Time	Effort (Trap Nights)	Notes
S1	10/12/2018	14/12/2018	18:00 hrs	6:00 hrs	4	Unit set up on an *E. albens*' stag, adjacent dam with water.
S2	10/12/2018	14/12/2018	18:00 hrs	6:00 hrs	4	Unit set up on an *E albens* at 2 m high and directed to adjacent dam.
S3	10/12/2018	14/12/2018	18:00 hrs	6:00 hrs	4	Unit set up on an *Angophora floribunda*, at 1.5m high and along dry drainage feature.
S4	10/12/2018	14/12/2018	18:00 hrs	6:00 hrs	4	Unit set up on an *E. melanophloia*, at 1.5 m high and along dry drainage feature.
S5	11/12/2018	14/12/2018	18:00 hrs	6:00 hrs	3	Unit set up on an *A. floribunda*, at 2m high, facing drainage feature with water immediately adjacent. Lure used: honey water spray.
S6	11/12/2018	14/12/2018	18:00 hrs	6:00 hrs	3	Unit set up on an *E. melanophloia* with hollows, at 1.75m high and adjacent to a dry drainage feature.
S7	11/12/2018	14/12/2018	18:00 hrs	6:00 hrs	3	Unit set up on a *C. glaucophylla*, at 2m high, directed towards *C. glaucophylla* regrowth
S8	11/12/2018	14/12/2018	18:00 hrs	6:00 hrs	3	Unit set up on a stag, at 1.75m high, directed towards cleared land adjacent *Eucalyptus dealbata* with hollows.
				Total	28	A total of 28 trap nights were undertaken at the Assessment Area, including the Development Site (approx. 166.77 ha). In accordance with the OEH (2016*) 'Species credit' threatened bats and their habitats. NSW survey guide for the Biodiversity Assessment Method*. A minimum of 16 bat nights are required for a default 50ha site. For Subject Lands larger than 50 ha, survey effort is to be scaled up. Based on the highly disturbed and heavily modified nature of the Subject Land and the identification of 46.06 ha of Woodland Vegetation and 12.75 ha Derived Native Grasslands, this survey effort is considered appropriate. SongMeters were installed along riparian areas and areas most likely used by microchiropteran bats as potential flyways.

Ecologists: JW = Joanne Woodhouse; TC = Thomas Cotter; ACM = Adriana Corona Mothe.

Targeted flora survey method

Candidate flora species requiring survey were identified early on during Stage 1 of the project. Table F.3 shows the candidate species identified along with their flowering periods and habitats. Survey method consisted of the following:

- Random meander transects (RMT) were undertaken across the Development Site to undertake vegetation ground-truthing. Along RMT, where suitable habitat for a candidate flora species was identified, the corresponding species was searched for. This was undertaken during the spring and summer survey field trips.
- As part of vegetation mapping, habitat observations and vegetation community observation were undertaken at over 150 locations across the Development Site. At each of these locations, candidate species were searched for if suitable habitat was present.
- At BAM plot locations, candidate flora species were looked for within the BAM plot area. A total of 42 BAM plots were undertaken.

Table F.3 Candidate flora species identified during survey design

Common Name (Scientific Name)	BC Act	EPBC Act	Habitat Targeted	Stratum Targeted	Flowering Period	Survey period		
						Spring (September 2018)	Summer (December 2018)	Autumn (March 2019)
Scant Pomaderris (*Pomaderris queenslandica*)	E	-	Vegetated areas, particularly where gum trees (*Eucalyptus*) are present	Shrub	Spring - Summer	x	x	
Silky Swainson-pea (*Swainsona sericea)*	V	-	Grassland, Woodlands with *Eucalyptus* spp. and *Callitris* spp.	Groundcover	Spring	x		
Austral Toadflax (*Thesium australe)*	V	V	Grassland, Grassy Woodlands, areas with Kangaroo Grass (*Themeda australis*)	Groundcover	Spring	x		
Bluegrass *(Dichanthium setosum)*	V	V	Grassland, Grassy Woodlands	Groundcover	Summer		x	
Finger Panic Grass *(Digitaria porrecta)*	E	-	Grassland, Grassy Woodlands, areas with *Eucalyptus albens*	Groundcover	Summer		x	
Rodd's Star Hair (*Astrotricha roddii)*	E	E	Woodlands	Shrub	October to February	x	x	
Heath Wrinklewort (*Rutidosis heterogama)*	V	V	Open Forests, disturbed areas	Groundcover	Mainly Autumn			X
Ovenden's Ironbark (*Eucalyptus caleyi subsp. ovendenii)*	V	V	Grassy Woodlands, paddock trees	Canopy	July to September	x		
Narrow-leaved Black Peppermint (*Eucalyptus nicholii*)	V	V	Grassy Woodlands, paddock trees	Canopy	Autumn	*	*	X

*Notes: * Tree identification based on trunk and leave characteristics*

APPENDIX G BAM PLOTS DATA AND PHOTOGRAPHS

BAM Plot field data sheets

A total of 42 BAM Plots were undertaken as part of this study. Field data sheets used included:

- Hard Copy: Field data sheet printed in paper were used to collect data in a total of 33 BAM plots (i.e. plot P1 to P5 and P15 to P42). This section presents scanned field data sheets of those BAM plots.
- Electronic: Electronic field data sheets was created in Survey 123 (ArcGIS). A tablet was used in the field to collect data for nine BAM plots (i.e. plots P6 to P14). Data for BAM plots collected with electronic data sheet are presented in tabular form in this Appendix.

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 11 Sept 18 **Recorders:** Jo + Adriana **Plot ID:** 1

Project No: ________ **Project Name:** Bonshaw Solar **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56.	**IBRA region:**	Nandewar		
Datum:		**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):	Silver Ironbark White cypress		**EEC:**		Confidence H M L

BAM Nested Plots Requirement

[illegible]

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	A75			86 E.	✓	✓
50 m	A76.					

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	LP1	LP2	LP3	LP4		
	Photo						
Litter Cover (%)		5	35	70.	80	20	
Bare Ground (%)		85	50	20	15.	70	
Cryptogam Cover (%)		2	5	5			
Rock Cover (%)		8	5	5	5	10.	

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type		Landform Element		Landform Pattern		Microrelief	
Lithology		Soil Surface Texture		Soil Colour		Soil Depth	
Slope		Aspect		Site Drainage		Distance to nearest water and type	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)			
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)			
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 11/9/18 **Recorders:** Jo + Adriana **Plot ID:** 1

Project No: ____ **Project Name:** Bonshaw solar **Zone ID:** ____

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80⁺ cm				
50 - 79 cm	1		1	
30 - 49 cm		1		
20 - 29 cm		卌 1 = 6		1
10 - 19 cm		20 + 10 = 30		
5 - 9 cm		40		
<5 cm [b]		callistris ✓	n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	120 540 540 230 366 270 120 = 2186			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm
Callitris / stag	23	H1			1	–
silver ironbark	59	H2			10	–
stag	38	H3			6	

○ dry out

400 m² plot: Sheet 1 of _	Survey Name	Plot Identifier	Recorders ACM / JW
Date 11 09 2018	Bonshaw	Plot 1	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Callitris sp (Cipress) Callitris glaucophylla (White Cypress Pine)	N	30	2 + 28		
	Iron bark (Eucalyptus melanophloia (Silver-leaved Ironbark)	N	15	1		
	S1 → Asteraceae sp. 1 10; •••• 10, • • ; 30; 20; 30 ; 5; / ⁄⁄⁄⁄	*	0.5	> 1000		
	S2 ① [Urtica urens (Small Nettle)*] • 10; 20; 10; ⁄⁄⁄⁄ Sida corrugata (Native)	~~*~~ N	0.1	185		
	Grass 1 Themeda triandra (Kangaroo Grass) (• •) 10, 10 (• •) ; 50	N	0.2	410		
	Clove 1 – Oxalis perennans // ; 10 ; 50	N	0.1	62		
	W1 – Actinotus sp. 1 ••••••••••••••• ; 5 ; // ; 20 ; 30	N	0.2	2000		
	N1 – ~~Trifolium sp Einadia nutans~~ Trifolium sp. 1 ; 20 ; 4	* ~~N~~	0.1	24		
	Opuntia? Opuntia aurantiaca (Tiger Pear) // ⁄⁄⁄⁄ ⁄⁄⁄⁄ ⁄⁄⁄⁄	*	0.1	17		
	W2 · Hypochaeris radicata (Flatweed) 10 • //	*	0.1	112		
	Grass 2 ~~Sporobolus sp~~ Tripogon loliiformis •• ; 53 ; / ⁄⁄⁄⁄	N	0.1	300		
	N2 Pimelea nova-anglica /	N	0.1	1		
	③ Clove 2 → Trifolium sp. 2 • ; 20 ; //	*	0.1	122		
	W3 – Solanum sp. 1 10 ; //	*	0.1	12		
	Grass 3 Panicum sp. /	*	0.1	1		
	W4 Geranium molle (Cranesbill Geranium) /	*	0.1	1		
	Ⓐ N3 Callitris glaucophyla (regeneration mostly eaten) //	N	0.1	2		
	W5 – Gamochaeta sp. 1 20	~~*~~ E	0.1	20		
	N4 – Einadia nutans /	N	0.1	1		
	① Urtica urens (Small Nettle)	*	0.1	145		
	Sclerolaena birchii	N	—	X		

+Ⓐ

Yellow flower

+③

black dots [illegible]

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

• ≃ 100

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 11/09/18 **Recorders:** Jo, Adriana **Plot ID:** 2

Project No: ________ **Project Name:** Bonshaw Solar **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56.	**IBRA region:**	Nandewar		
Datum:		**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):	Grey Box Grassy Woodland or open fors		**EEC:**		Confidence H M L

BAM Nested Plots Requirement

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	787	151.33768°	29.20992	344°N	✓	✓
50 m	788	151.33763°	29.20946	—	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	LP1	LP2	WP 10	11	13.	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		100.	80.	65.	70.	60.	
Bare Ground (%)							
Cryptogam Cover (%)							
Rock Cover (%)							

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type		**Landform Element**		**Landform Pattern**		**Microrelief**	
Lithology		**Soil Surface Texture**		**Soil Colour**		**Soil Depth**	
Slope		**Aspect**		**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)			
Cultivation (incl. pasture) ✓			
Soil Erosion ✓			
Firewood | CWD removal			
Grazing (identify native/stock) ✓			
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1= light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 11/09/18 **Recorders:** Jo + Adriana **Plot ID:** 2

Project No: ________ **Project Name:** Bonshaw Solar. **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm	/		/	
50 - 79 cm	//		/	
30 - 49 cm				
20 - 29 cm	//	//		
10 - 19 cm		/		
5 - 9 cm		8		
<5 cm [b]		40	n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	350 - 520 810 400 70 . 1080 140 . 990 610 . =5670			

total = 4970 = 49.7

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

>1 m dbh >20 cm
WP 15 Hollow

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm
Grey Box	140	16			////	/
Grey Box		17			卌 /	

Field Data Sheet created by Dr Adriana Corona Mothe

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date: 10 09 2018	0470861-Bonshaw	2	ACM, JW

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
T	Grey Box Eucalyptus microcarpa	N	30	12		
T	Ironbark → Eucalyptus melanophila (Silver-leaved Ironbark)	N	20	1		
	Small Tree 1 Ficus sp. 1	N	0.3	7		
	Small Tree 2 Notelaea longifolia	N	30	47		
	Small Tree 3 Notelaea microcarpa	N	0.1	1		
	N1, small shrub up to 80cm tall Pittosporum spinescens / ||||	N	0.1	6		
	Grass 1 Tripogon longiformis • 10 10; |||	N	0.1	123		
	Clove 1 yellow flower Oxalis perennans •; 5; 10; |||	N	0.1	119		
	Grass 2 Sporobolus elongatus ||	N	0.1	2		
	W1 Asteraceae sp. 1 • 10	*	0.1	110		
	W2 5 Asteraceae sp. 2 10; 20	*	0.1	30		
	N2 Euphorbia sp. 1 / |||| ||||	*	0.1	21		
	N3 Pimelea neo-anglica ||||	N	0.1	4		
	N4 Melichrus sp. 1 /	N	0.1	1		
	Cypress 1 → Callitris glaucophylla (White Cypress Pine) |||	N	0.1	3		
	Grass 3 Schoenus sp. 1 60; ||	N	0.1	62		
	Clove 2 Trifolium sp. 1 ||	*	0.1	2		
	N5 white central vein Vine Parsonsia sp. 1 •; 12, |; 10	N	0.1	124		
	Opuntia (same as plot 1) Opuntia aurantiaca /	E	0.1	1		
	V1 Hardenbergia violaceae /	N	0.1	1		
	V2 ® <1cm Pandorea pandorana 10® + /	N	0.1	11		
	N6 rhizome Dichondra sp. A |||	N	0.1	3		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:** 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

• = 100

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 11/9/18 **Recorders:** Jo + Adriana **Plot ID:** 3

Project No: ____ **Project Name:** Bonshaw Solar **Zone ID:** ____

Desktop Information Requirements for BAM Plot survey

Zone:		**IBRA region:**	Nandewar		
Datum:		**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):	? Rough-barked Apple - White Cypress Pine - Blakely's Red Gum woodland		**EEC:**		Confidence H M L

BAM Nested Plots Requirement

4 monitors.

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	790	151.34035°	29.21024°	24° NE	✓	✓
50 m						

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	19	20	21	22	23	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		65	30	20	10	90	
Bare Ground (%)		15	20	40	50	5	
Cryptogam Cover (%)							
Rock Cover (%)		20	~~40~~ 50	40	40	5	

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type		**Landform Element**		**Landform Pattern**		**Microrelief**	
Lithology		**Soil Surface Texture**		**Soil Colour**		**Soil Depth**	
Slope		**Aspect**		**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)			
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)			
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1= light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: ______________ **Recorders:** ______________________________ **Plot ID:** 3

Project No: __________ **Project Name:** ___________________________ **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm	1		1	
30 - 49 cm	1			
20 - 29 cm		1		
10 - 19 cm		1		
5 - 9 cm		1		
<5 cm [b]	1	40	n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	530 150 400 910 620 330 160 610 = 3710			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm
Ironbark (crebra?)	65	24			1	11

Field Data Sheet created by Dr Adriana Corona Mothe

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 10 09 2018	0470861- Bonshaw	3	ACM / JW

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Ironbark (E. crebra)	N	25	1	Canopy	
	Red Gum (E. blakely ?) → 5-08-2019 Tom Cotter confirmed the plant ID as E. ~~d~~ dealbata	N	20	2	Canopy	
Ⓐ	Callitris glaucophylla ~~sp~~ (from < 20cm to Small trees)	N	0.2	1+ 43	< 50cm Ground -	
	① [N2 - Pimelea microcephala] → r ///		0.1	3	Small Shrub	
	Grass 1 → Poa sp. 1 10 ; >500	*	0.1	600	Ground	
	Fern 1 // ~~////~~ ~~////~~		0.1	22	Ground	
	Opuntia (sau) Opuntia aurantiaca //	*	0.1	2	Ground	
	[N1 Ozothamnus cassinioides] 50; ///		0.1	173	Ground - Shrub	
	Grass 2 Eragrostis sp. 1 10	*	0.1	10	ground	
	W 1 Senecio sp. 1 / ~~////~~	*	0.1	6	ground	
	Clove 2 (as plot 2) Trifolium sp. 1 /; 5	*	0.1	6	ground	
	Clove 1 (velvety on) Sclerolaena birchii 8; ~~////~~ 10; ~~////~~	N	0.1	28	ground	
	W2 Urtica urens 10; // ~~////~~ ~~////~~	*	0.1	32	ground	
	N3 = Ⓐ but grazed to ground /	N	0.1	1	ground	
	Clove 3 (= Clove 1 Plot 1) Oxalis perennans ///; 5	N	0.1	8	ground	
	W3 Plantago sp 1 /	*	0.1	1	ground	
	W4 Goodenia sp. 1 // ~~////~~	N	0.1	7	ground	
	W as in Plot 1 Asteraceae sp. 1 /	*	0.1	1	ground	

1 <10cm ø

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Overall - bare ground
Soil + Silty-gravelly shale fragments
Ant ? holes
rabbit
Most shrub-small trees chewed

791 @ 50m

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

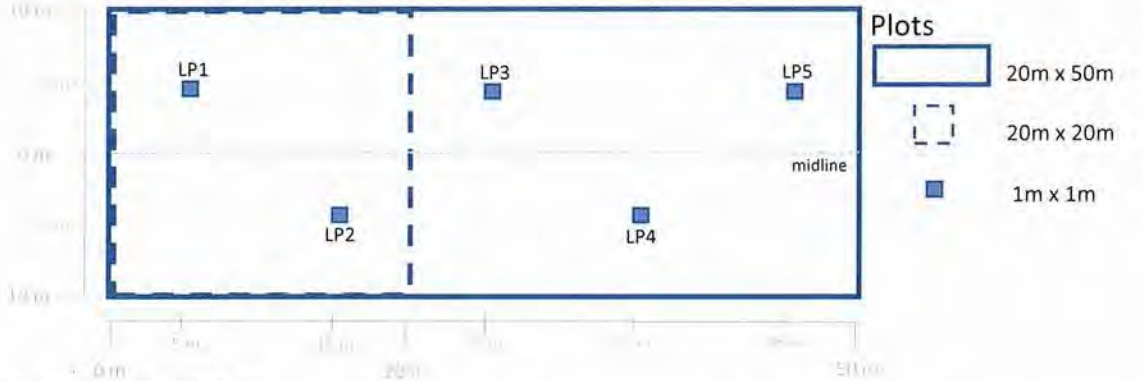
Date: 12-09-2018 **Recorders:** ACN / JW **Plot ID:** 4

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:		**IBRA region:**	Nandewar		
Datum:		**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):	Cleared - Non-native		**EEC:**		Confidence H M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
5 0 m	796	0338834	6768241	—	✓	✓
~~5~~0 m 0	~~796~~ 797	0338827	6768189	1° N	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	798	799	800	801	802	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		15	2	0	85	80	
Bare Ground (%)		60	95	~~8~~90	5	10	
Cryptogam Cover (%)		5	5	5	0	0	
Rock Cover (%)		0	2	0	0	0	

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type		**Landform Element**		**Landform Pattern**		**Microrelief**	flat
Lithology		**Soil Surface Texture**		**Soil Colour**	light orange	**Soil Depth**	
Slope	gentl <15° downslope to N	**Aspect**	N	**Site Drainage**		**Distance to nearest water and type**	Creek to East

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)			
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)			
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1= light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 12-09-2018 **Recorders:** ACM / JW **Plot ID:** 4

Project No: ____ **Project Name:** 0470861 **Zone ID:** ____

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80⁺ cm	–			
50 - 79 cm	–			
30 - 49 cm	–			
20 - 29 cm	–			
10 - 19 cm	–			
5 - 9 cm	–			
<5 cm [b]	–		n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	2; 1; 2, 2; 3 = 10			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 12 09 2018	0470861- Bonshaw	4	ACM, JW

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Kangaroo Grass Themeda triandra • 50 • //	N	0.1	200		
	Oxalis perennans /// 5, 10	N	0.1	37		
	Kidney weed (4-1) Dichondra repens ; 10; 5, ////	N	0.1	20		
	Rock Fern Cheilantes sieberi ; 10; • //// ; 20; ////	N	0.1	240		
	W1 (Mint like) stingy → Urtica urens 20; // ////	*	0.1	27		
	Grass 1 * Dichanthium setosum (Bluegrass) • • • ////	N	0.2	305		
	Trifolium sp1 //	*	0.1	3		
	Opuntia aurantiaca ///	*	0.1	4		
	N1 → Ericaceae (N≠), Pimelea neo-anglica 9; ////	N	0.1	17		
	W2 purple cakes Goodenia sp.1 //	N	0.1	2		
	Cactaceae ( ) Sclerolaena birchii 2; 14	N	0.1	16		
	Cactus tr Opuntia tomentosa /	*		X		
	W3 Wahlembergia graniticola ///	N	0.1	3		
	W4 Senecio sp.1 /	*	0.1	1		
	Callitris sp1 (< 7cm grazed) /	N	0.1	1		
	Grass 2 Sporobolus elongatus (Slender Rat's Tail Grass) ////	N	0.1	5		
	W5 Euphorbia dallachyana /	N	0.1	1		
	Pea flower Bossiaea scortechinii ///	N	0.1	3		
	Cyperaceae → Schoenus sp. 1 /	N	0.1	1		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, …, 1, 2, 3, …, 10, 15, 20, 25, …100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, …, 10, 20, 30, … 100, 200, …, 1000, …

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 12-09-2018 **Recorders:** ACM / JW **Plot ID:** 5

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:		**IBRA region:**	Nandewar		
Datum:		**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):			**EEC:**		Confidence H M L

BAM Nested Plots Requirement

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	804	0339451	6768659	239° SW	✓	✓
50 m	803	0339402	6768675	201° S	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	29	30	31	32	33	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		82	90	85	20	98	
Bare Ground (%)		3	6	15	6	2	
Cryptogam Cover (%)							
Rock Cover (%)		15	4	–	74	–	

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type		**Landform Element**		**Landform Pattern**		**Microrelief**	
Lithology		**Soil Surface Texture**		**Soil Colour**		**Soil Depth**	
Slope		**Aspect**		**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)			
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)			
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: ______________ **Recorders:** ______________________________ **Plot ID:** 5

Project No: __________ **Project Name:** ______________________________ **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm	I			
30 - 49 cm	IIII		I	
20 - 29 cm	卌 卌 卌 II		I	
10 - 19 cm	III			
5 - 9 cm	I	I		
<5 cm [b]	✓	✓	n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	810. 690 900 220 310 420 = 3,350 cm = 33.5m			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm
red/ Grey Gum ?	38	34			II	
red/ Grey Gum ?	20.	35			I	
as above. ?	23	36			I	
as above ?	54	37			II	I

Field Data Sheet created by Dr Adriana Corona Mothe

400 m^2 plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 12-09-2018	0470961- Banshriki	S	ACM I JW

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Gum 1 (Eucalyptus dealbata ? ~~sample~~) ① Juvenile < 30cm height → E prava	N	20	18① + 6		
	Gum 2 [Corymbia sp.] E. dealbata	N	15	2		
	Callistes sp. 1 (Cypress grazed down to <20cm) Callitris glaucophylla	N	0.2	166		
	N1 Pimelea neo-anglica //	N	0.1	2		
	Opuntia tomentosa ~~aurantiaca~~ ////	*	0.1	4		
	Grass 1 (perennial) Sporobolus elongatus ; 12	*N	0.1	12		
	Kidney weed ① (in plots) Dichondra repens 200; 20; //	N	0.1	222		
	Rock Fern Cheilanthes sieberi • ;7 ;2;10, //; 3; 6	N	0.1	133		
	N2 Goodenia sp. ///	N	0.1	3		
	Oxalis perennans //	N	0.1	2		
	Grass 2 Tripogon loliiformis fine clumps >1,000 //////	N	0.1	1000		
	W1 Bossiaea sp. ;4	N	0.1	4		
	W2 Undetermined 2	*	0.1	2		
	Vine 1 Pandorea pandorana /	N	0.1	1		
	Shrub 1 Dodonaea viscosa subsp. spatulata /	N	0.1	1		
	Rostellularia adscendens	N	X	X		
	Corymbya sp.		X			

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Rock section

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

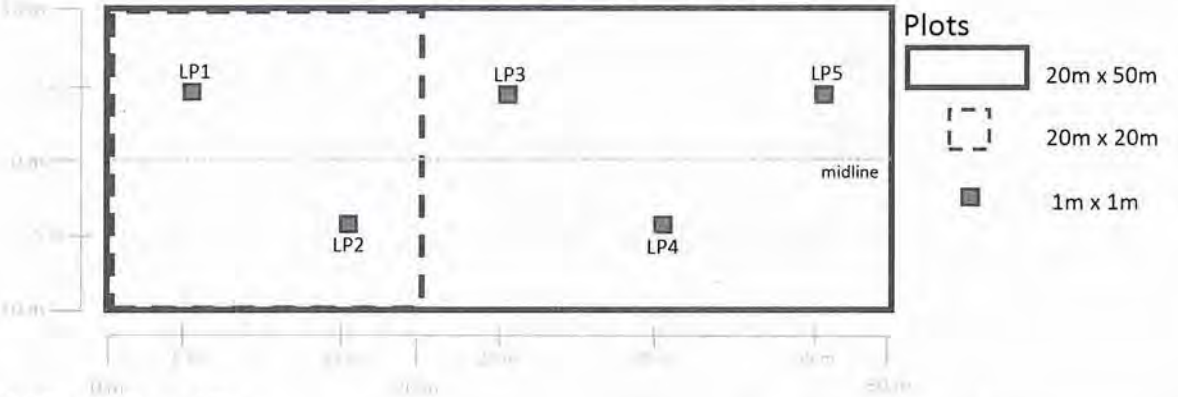
Date: 25-March-2019 **Recorders:** ACM, TZ **Plot ID:** 15

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):				**EEC:**	Confidence H M L

BAM Nested Plots Requirement



20x50 ✓

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1458	0338451	6767511	193° SE	✓	✓
50 m	1464	0338482	6767479	285° W	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1459	1460	1461	1462	1463	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		60	30	80	80	95	69
Bare Ground (%)		35	70	18	20	5	29.6
Cryptogam Cover (%)		2	0	1	2	2	1.4
Rock Cover (%)		5	0	2	0	0	1.4

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Slope	**Landform Element**	Hillslope	**Landform Pattern**	Low Hill - Flat	**Microrelief**	
Lithology		**Soil Surface Texture**	Mostly leaf litter	**Soil Colour**	light brown	**Soil Depth**	-
Slope		**Aspect**		**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	2	O	Stums present
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)			
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (> 10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 25-03-2019 **Recorders:** ACM, TZ **Plot ID:** 15

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ____

Plot 20m x 50m: Tree Classes [a]

DBH Class#	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80+ cm	|| =2		|| =2	
50 - 79 cm	卌 | =6		卌 =5	
30 - 49 cm		||| =3		
20 - 29 cm		卌 | =6	|	
10 - 19 cm		6, 卌, 5, 4, 4, || =26	卌	
5 - 9 cm		11, 8, 6 =25	#	
<5 cm [b]		7, 38, 6, 18, 20 =89	n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	3, 2, 3, 1, 4; 9, 7, 3, 4, 9, 10, 5, 6 =66			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm
Silver-leaved Ironbark	83	1465	0338478	6767484	2 hollows 15cm	
"	49.5	1466	0338477	6767487	1	
"	82	1467	0338461	6767487	4 x <10cm / 1 x 15cm	
"	52	1468	0338454	6767514	1 x 10cm	
"	51	1469	0338459	6767506	1 x <10cm	
E. albens	72	1470	0338465	6767503	1	1
E. albens	54	1471	0338478	6767491	1	

400 m² plot: Sheet _ of _		Survey Name	Plot Identifier	Recorders
Date	25/3/2019	Bonshaw	15	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Eucalyptus melanophloia		20	3	T	
	Eucalyptus albens		5	1	T	
	Callitris glaucophylla		15		S	
	Pimelia stricta		0.1	21		
	Chloris truncata		0.1	10		
	Aristida ramosa		0.1	10		
	Corrinia sp.		0.1	5		
	Cymbopogon refractus		0.2	10		
	Cyperus gracilis		0.1	50		
	Opuntia auracantiaca		0.1	4		
	Digitaria diffusa		0.1	20		
	Austrostipa scabra		0.2	100		
	Einadia nutans		0.1	10		
	Cheilanthes sieberi		0.1	7		
	Rastellularia adscendens		0.1	100		
	Sida corrugata		0.1	50		
	Vittadinia sulcata		0.1	1		
	Notelaea microcarpa		0.1	6		
	Glycine clandestina		0.1	26		
	Boerhavia dominii		0.1	1		
	Enneapogon gracilis		0.3	600		
	Sclerolaena birchii		0.1	1		
	Entolasia stricta		0.2	50		
	Dichondra sp. A		0.1	3		
	Solanum ferocissimum		0.1	1		
	Pandorea pandorana		0.1	1		
	Bothriochloa decipiens		0.1	7		
	Aristida leptopoda		0.1	5		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code if 'top 3'.**

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Total gram cov 1%
g/c live 1.5%

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 25-03-2019 **Recorders:** ACM, TZ **Plot ID:** 16

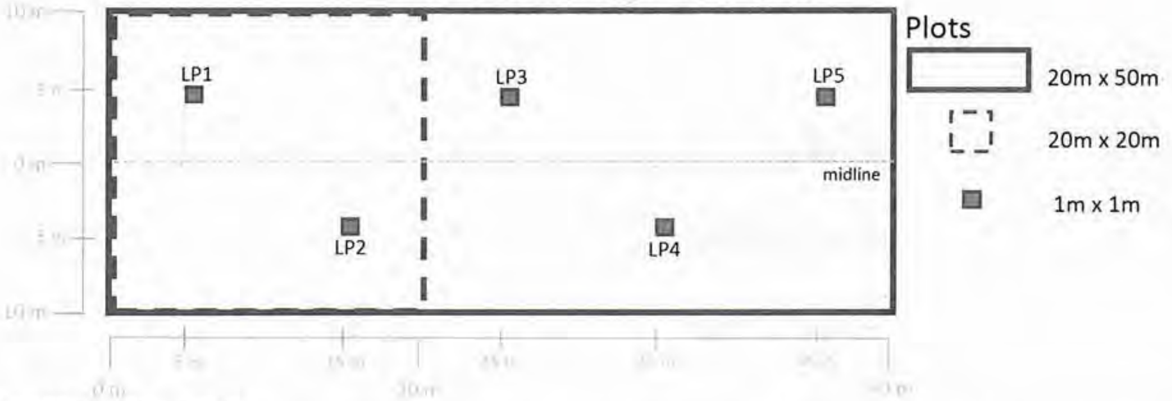
Project No: 0470861 **Project Name:** Rombaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):		594		**EEC:**	Confidence [✓ H] M L

BAM Nested Plots Requirement

50 x 20m ✓



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1472	0338659	676 7564	255° W	✓	✓
50 m	1473	0338619	6767 587	118° SE	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute		1	2	3	4	5	Average
	LP	1	2	3	4	5	
	WP	1477	1478	1479	1480	1481	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		80	90	85	10	1	53.2
Bare Ground (%)		20	5	5	90	98	43.6
Cryptogam Cover (%)		1	0	5	0	0	1.2
Rock Cover (%)		2	5	10	0	1	3.6

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Crest	**Landform Element**	Hillcrest	**Landform Pattern**	Hill	**Microrelief**	Open woodland
Lithology	Sandy-clay with pebbles, rocks	**Soil Surface Texture**		**Soil Colour**	light orange-brown	**Soil Depth**	–
Slope	⋀ crest	**Aspect**		**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R - O	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (> 10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 25-03-2019 **Recorders:** ACM, TZ **Plot ID:** 16

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80⁺ cm				
50 - 79 cm	/ = 1		/ = 1	
30 - 49 cm	𝍸 = 5		// = 2	
20 - 29 cm	~~[illegible]~~ // = 2	𝍸 ///,5, = 13		
10 - 19 cm	~~[illegible]~~	10,4,3 𝍸 𝍸 / = 28		
5 - 9 cm		2,2,/ = 5		
<5 cm [b]		// = 2	n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	1, 10, 4, 1, 7, 6, 3, 13; 4; 15; 3, = 70			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

Rocky crest

Holes → wombat ??

E dealbata (Tumbledown Red Gum)

E albens / moluccana
E: red smooth bark
Silver-leaved Ironbark

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm
Silver-leaved Ironbark	43	1474	038626	6767587	1	
Eucalyptus dealbata (smooth-[illegible])	44	1473	0338640	6767582	1	1
E. dealbata	58	1476	0338636	6767572	2	1

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 25/3/19	Bonshaw	16	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Eucalyptus dealbata		15		T	
	Eucalyptus melanophloia		3		T	
	Eucalyptus albens		3	1	T	
	Callitris glaucophylla		20		T	
	Hypericum sp.		0.1	20		
	Ozothamnus cassinoides		0.2	200		
	Cymbopogon refractus		0.1	15		
	Aristida ramosa		0.3	20		
	Dichondra sp. A		0.3	400		
	Rostellularia adscendens		0.3	200		
	Glycine clandestina		0.3	200		
	Sida corrugata		0.2	200		
	Boerhavia dominii		0.1	40		
	Cyperus gracilis		0.1	40		
	Opuntia auracantiaca		0.1	100		
	Enneapogon gracilis		0.3	200		
	Pimelia stricta		0.2	80		
	Parsonsia eucalyptifolia		0.1	10		
	Vittadinia sulcata		0.1	5		
	Solegyne bellioides		0.1	40		
	Cheilanthes sieberi		0.1	20		
	Carrisa sp.		0.1	1		

outside plot

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

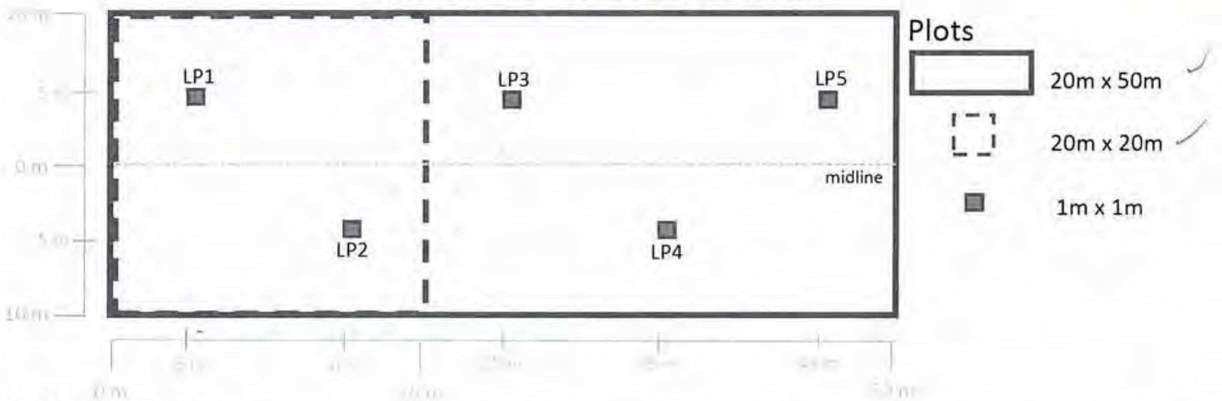
Date: 25-03-2019 **Recorders:** ACM, TZ **Plot ID:** 17

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar North Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):	594 – Low (logged)		**EEC:**	X	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1485	0338763	6767760	270°W	✓	✓
50 m	1486	0338720	6767 787	124°SE	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1487	1488	1489	1490	1491	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		50	20	30	10	40	30
Bare Ground (%)		30	80	68	50	50	55.6
Cryptogam Cover (%)		25	0	0	0	5	2
Rock Cover (%)		20	0	2	40	10	14.4

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Slope	**Landform Element**	Low Hill	**Landform Pattern**	Hillslope	**Microrelief**	grassy open
Lithology		**Soil Surface Texture**		**Soil Colour**	light orange brown	**Soil Depth**	–
Slope	<20%	**Aspect**	NW	**Site Drainage**	NW towards creek	**Distance to nearest water and type**	~5m

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	R	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	2	R - O	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Brunoniella – little blue flower

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 25-03-2019 **Recorders:** ACM, TZ **Plot ID:** 17

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm		1		
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	3, 2, 3, 1, 3, =12			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Fall off trees = (logs) = 2, 6 1, 2, 2, 5, 3, 2, 2, 1;
→ Not touching ground. Branches are supporting main trunk

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 25/3/19	Bonshaw	17	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Evolvulus alsinoides		0.1	20		
	Callitris glaucophylla		0.1	30	S	
	Boerhavia dominii		<0.1	60		
	Vittadinia sulcata		0.1	20		
	Solanum ferocissimum		0.1	5		
	Dichondra sp. A		0.2	100		
	Sida corrugata		0.5	600		
	Glycine clandestina		0.2	70		
	Solegyne bellioides		0.1	30		
	? Hypericum sp.		0.1	40		
	Aristida ramosa		5	50		
	Oxalis perennans		0.1	16		
	Xanthium spinosum		0.1	1		
	Cheilanthes sieberi		0.1	5		
	Calotis lappulacea		0.1	5		
	Enneapogon gracilis		5	200		
	Opuntia aurantiaca		0.1	20		
	Chamaesyce drummondii		0.1	20		
	Cyperus gracilis		0.1	20		
	Pimelia stricta		0.1	5		
	Bothriochloa macra		5	50		
	Rostellularia adscendens		0.1	30		
	Heliotropium amplexicaule		0.1	1		
	Scleria mackaviensis		0.1	2		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

grasses total 15%

total cover 20%

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

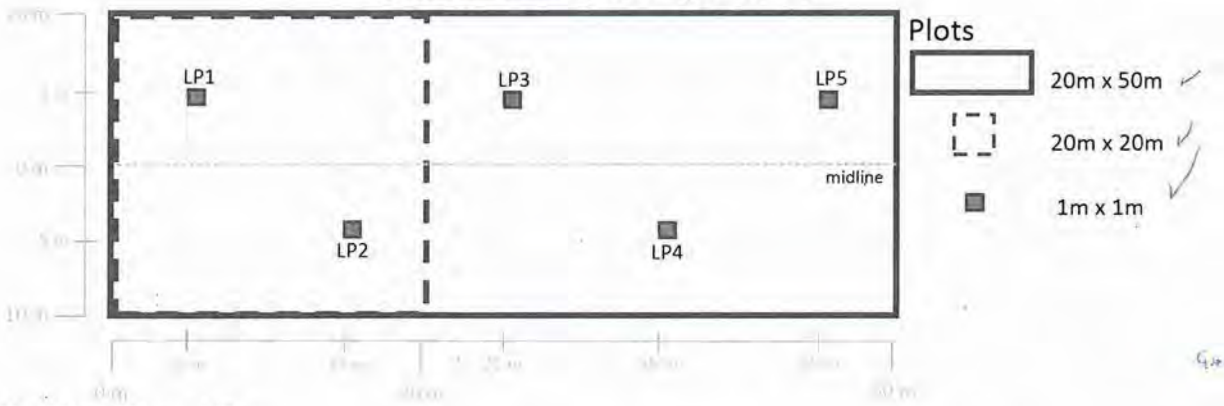
Date: 25-08-2019 **Recorders:** ACM, TZ **Plot ID:** 18

Project No: 047086l **Project Name:** Barraba Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:		Grassland			Confidence H M L
Plant Community Type (PCT):		594 - DNG	**EEC:**		Confidence [✓ H] M L

BAM Nested Plots Requirement



Greycrowned Babbler - call heard

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1492	033 83 77	67 67 858	53° NE	✓	✓
50 m	1493	033 84 22	67 67 888	229° SW	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1494	1496	1947	1948	1949	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		75	60	40	40	30	49
Bare Ground (%)		25	39	60	60	70	50.8
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		0	1	0	0	0	0.2

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	flat	**Landform Element**	flat	**Landform Pattern**		**Microrelief**	grassland
Lithology		**Soil Surface Texture**		**Soil Colour**	light - brown	**Soil Depth**	—
Slope	flat	**Aspect**	NE	**Site Drainage**	SW	**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	2	R-O	
Fire damage			
Storm damage			
Weediness	1	R-O	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 25-03-2019 **Recorders:** ACM, TZ **Plot ID:** 18

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	12, 1, 3, 15, 1, 2, 1 = 35			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

400 m² plot: Sheet _ of _		Survey Name	Plot Identifier	Recorders
Date	25/3/2019	Bonshaw	18	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Aristida ramosa		5	120		
	Cheilanthes sieberi		0.2	500		
	Dichondra sp. A		0.1	200		
	Glycine clandestine		0.2	500		
	Hypericum sp		0.1	30		
	Sida corrugata		0.1	30		
	Oxalis perennans		0.1	100		
	Sclerolaena birchii		0.1	200		
	Vittadinia sulcata		0.1	70		
	Cyperus gracilis		0.1	70		
	Einadia nutans		0.2	200		
	Solegyne bellioides		0.1	15		
	Solanum ferocissimum		0.1	10		
	Bothriochloa macra		1.5	200		
	Pimelia stricta		0.1	2		
	Cymbopogon refractus		0.1	3		
	Paspalidium distans		0.1	2		
	unidentifiable grasses		25%			
	Bothriochloa biloba		0.1	3		
	Panicum simile		0.1	2		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

total grass cover 30%

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

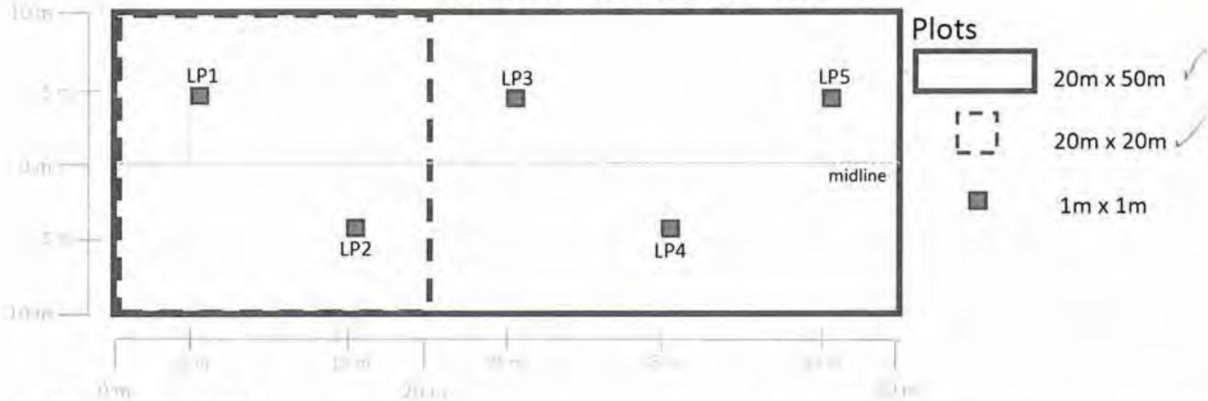
Date: 25·03·2019 **Recorders:** ACM, TZ **Plot ID:** 19

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):		DNG	**EEC:**	X	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1500	033 83 20	67 68 072	155° SE	✓	✓
50 m	1501	033 83 59	67 68 031	258° W		

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1502	1503	1504	1505	1506	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		30	15	40	80	40	41
Bare Ground (%)		65	85	58	20	60	57.6
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		0	0	2	0	0	0.4

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Flat	**Landform Element**		**Landform Pattern**		**Microrelief**	
Lithology		**Soil Surface Texture**		**Soil Colour**		**Soil Depth**	
Slope	flat	**Aspect**	SE	**Site Drainage**		**Distance to nearest water and type**	70m

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	R - O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 25-03-2019 **Recorders:** ACM, TZ **Plot ID:** 19

Project No: 047086l **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80⁺ cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	1.5; 1; 2 = 4.5m			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

Field Data Sheet created by Dr Adriana Corona Mothe

400 m² plot: Sheet _ of _		Survey Name	Plot Identifier	Recorders
Date	25/3/19	Bonshaw	19	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Sclerolaena birchii		20	6000		
	Aristida ramosa		4	300		
	Xanthium spinulosum		0.1	2		
	Maireana microphylla		0.2	4		
	Einadia nutans		<0.1	100		
	Dichondra sp. A		<0.1	5		
	Bothriochloa [illegible] decipiens		<1	100		
	Glycine clandestina		0.2	100		
	Chamaesyce drummondii		<0.1	15		
	Cheilanthes sieberi		<0.1	8		
	Boerhavia dominii		<0.1	1		
	Gomphrena celosoides		<0.1	1		
	Rumex brownii		<0.1	1		
	Carthamus lanatus		<0.1	1		
	unidentified grasses		5			

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code if 'top 3'.**

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); *Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

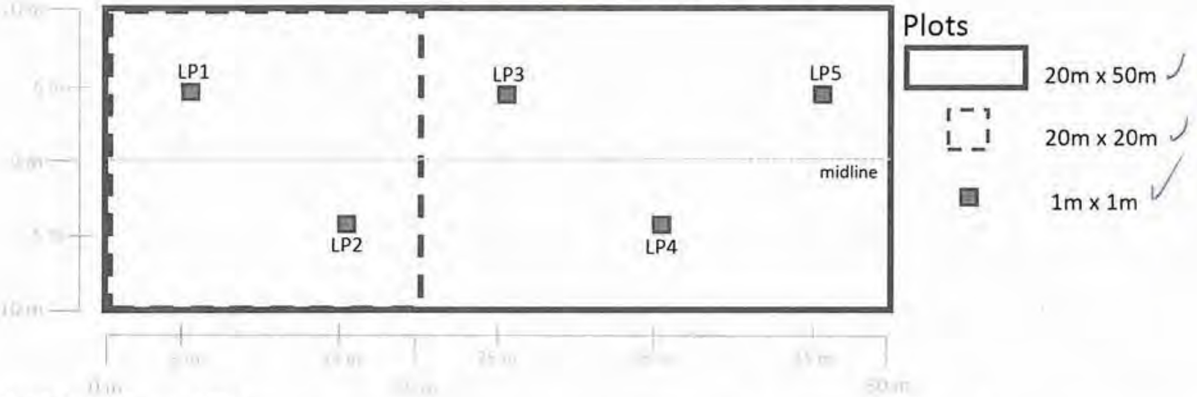
Date: 26-03-2019 **Recorders:** ACM, TZ **Plot ID:** 20

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:		Cleared			Confidence H M L
Plant Community Type (PCT):		Cleared Land	**EEC:**	X	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1507	33 7983	67 67 855	321° NW	✓	✓
50 m	1508	33 8003	67 67 809	330° NW	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1509	1510	1511	1512	1513	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		40	25	50	70	26	31
Bare Ground (%)		60	75	50	80	80	69
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		0	0	0	1	0	0.2

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Flat	**Landform Element**	Plain	**Landform Pattern**	Flood plain	**Microrelief**	>> bare soils Sparse ground ind
Lithology	Rich organic Soils	**Soil Surface Texture**		**Soil Colour**	Dark brown	**Soil Depth**	
Slope	Flat	**Aspect**	NW	**Site Drainage**	–	**Distance to nearest water and type**	–

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	R-O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)			
Fire damage			
Storm damage			
Weediness	1	R-O	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 26-03-2019 **Recorders:** ACM, TZ **Plot ID:** 20

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class#	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80+ cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)				

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

2

400 m^2 plot: Sheet _ of _		Survey Name	Plot Identifier	Recorders
Date	26/3/19	Bonshaw	20	TZ

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Aristida leptopoda		0.2	13		
	Bothriochloa decipiens		0.2	13		
	Rumex brownii		<0.1	5		
	Rhynchosia minima		<0.1	10		
	Maireana microphylla		<0.1	1		
	Xanthium spinosum		<0.1	4		
	Notelaed microphylla		<0.1	1		
	Paspalidium distans		<0.1	1		
	Tribulus terrestris		<0.1	1		
	Convulvulus erubescens		<0.1	1		
	Als. Neptunia + Boerhavia					
	avena					

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Black soil ~50% grass cover, but dead, not bare soil
0-4% green cover

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

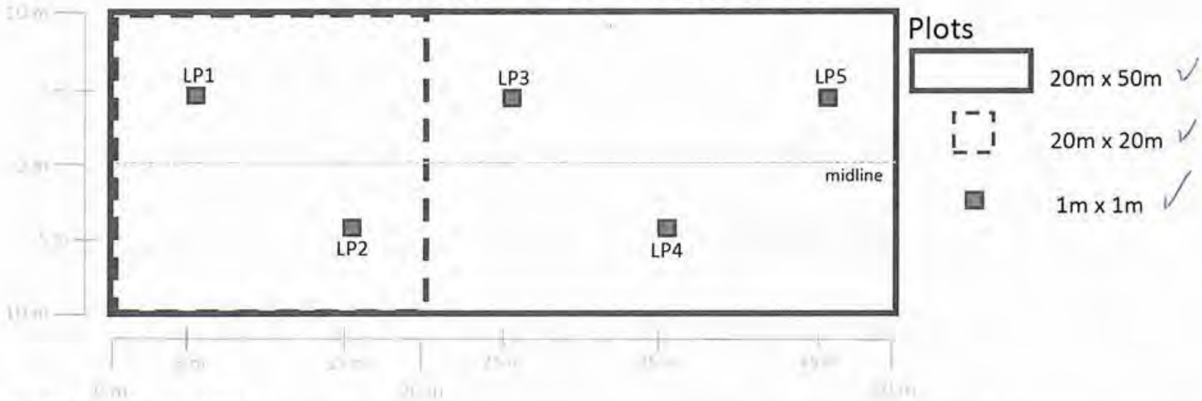
Date: 26-03-2019 **Recorders:** ACM, TZ **Plot ID:** 21

Project No: D47084 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):		594 - Low		**EEC:** X	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1514	337855	6767956	321° NW	✓	✓
50 m	1520	337827	6767947	144° SE	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1515	1516	1517	1518	1519	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		60	35	50	30	5	36
Bare Ground (%)		39	35	70	50	95	46
Cryptogam Cover (%)		20	30	30	30	60	34
Rock Cover (%)		1	1	0	10	0	2.4

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Flat	**Landform Element**	Plain	**Landform Pattern**	Plain	**Microrelief**	open woodland
Lithology		**Soil Surface Texture**		**Soil Colour**	Brown	**Soil Depth**	—
Slope	Level	**Aspect**	NW	**Site Drainage**	–	**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	2	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	2	R-O	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 26-03-2019 **Recorders:** ACM, TZ **Plot ID:** P21

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm		/ = 1		
10 - 19 cm		𝍸 𝍸 𝍸 // = 17		
5 - 9 cm		6, 2, 𝍸 𝍸 // = 20		
<5 cm [b]		4, //, 6; 2, 3 = 17	n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	8; 2; 1, 1, 14, 6; 3, 4, 1, = 40			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

Only Callitrus glauca

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

400 m² plot: Sheet _ of _		Survey Name	Plot Identifier	Recorders
Date	26/3/19	Bonshaw	21	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Bothriochloa decipiens		0.5	15		
	Enneapogon gracile		2.0	300		
	Sida corrugata		0.2	100		
	Boerhavia dominii		0.1	80		
	Einadia nutans		<0.1	20		
	Portulacca bicolor		<0.1	20		
	Opuntia aurantiaca		<0.1	2		
	Dichondra sp. A		<0.1	20		
	Cupressus semiglauca shrubs		3	15		
	Rumex brownii		<0.1	8		
	Pimelia stricta		<0.1	4		
	Glycine clandestina		0.1	30		
	Portulaca oleracea		<0.1	5		
	Tribulus terrestris		<0.1	4		
	Vittadinia sulcata		<0.1	8		
	Sclerolaena birchii		<.01	4		
	Convolvulus erubescens		<0.1	3		
	Rostellularia adscendens		<0.1	4		
	Aristida ramosa		3	200		
	Oxalis perennans		<0.1	4		
	Cymbopogon refractus		<0.1	2		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:** 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

total ~~green~~ cover green + dead 35 (and Cupressus)

green 10

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

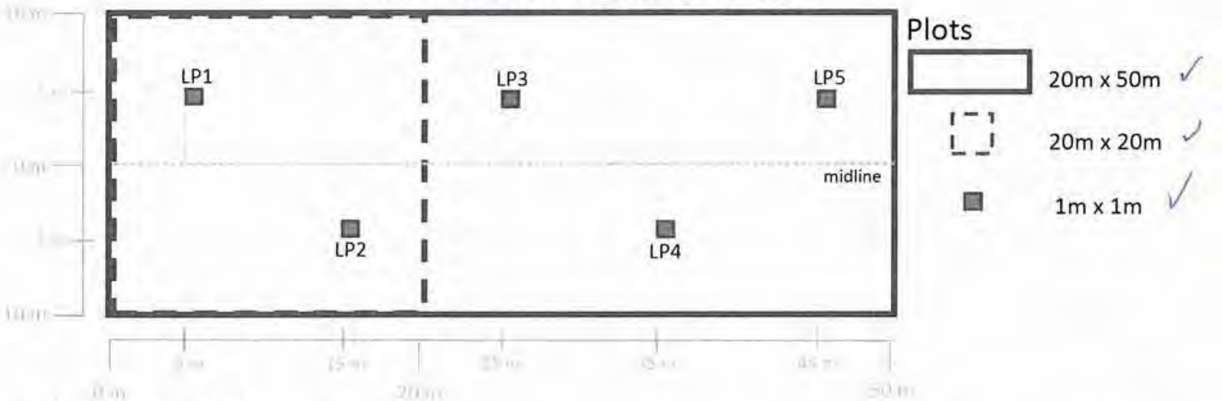
Date: 26-03-2019 **Recorders:** ACM, TZ **Plot ID:** 22

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar			
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex			
Likely Vegetation Class:						Confidence H M L
Plant Community Type (PCT):		594_Low		**EEC:**	x	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1522	338024	6768238	248° NW	✓	✓
50 m	1523	337991	67 68277	134° SE	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1524	1525	1526	1527	1528	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		60	70	25	15	20	38
Bare Ground (%)		40	30	75	85	80	62
Cryptogam Cover (%)		10	15	20	30	30	21
Rock Cover (%)		0	0	0	0	20	4

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Crest	**Landform Element**	I Flat	**Landform Pattern**	Low Hill	**Microrelief**	soil w/ pebbles
Lithology	Silty-clayed soils	**Soil Surface Texture**		**Soil Colour**	light orange-brown	**Soil Depth**	–
Slope	Very gently inclined	**Aspect**	NW	**Site Drainage**		**Distance to nearest water and type**	–

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	N-O	
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 26-03-2019 **Recorders:** ACM, TZ **Plot ID:** 22

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm		3		
5 - 9 cm		/// =3		
<5 cm [b]		/// =3	n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	11, 2, 8, 2 = 23			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 26/7/19	Bonshaw	22	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Cuuressun semiglauca climbr		<0.1	2		
	Rostellularia adscendens		<0.1	8		
	Chamaesyce drummondii		<0.1	8		
	Glycine clandestine		0.2	50		
	Sida corrusa		<0.1	50		
	Aristida ramosa		1			
	Enneapogon gracilis		1			
	Cymbopogon refractus		<0.1	3		
	Sclerolaena birchii		<0.1	40		
	Oxalis perennans		<0.1	16		
	Pimelia stricta		<0.1	20		
	Calotis lappulacea		<0.1	1		
	Boerhavia dominii		<0.1	12		
	Portulaca bicolor		<0.1	50		
	Portulaca oleracea		<0.1	2		
	Heliotropium amplexicaule		<0.1	2		
	Convulvulus alsinoides		<0.1	8		
	Desmodium varians		<0.1	3		
	Opuntia ~~stricta~~ tomentosa		<0.1	2		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

total plant cover 10% of which 8% is clean

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

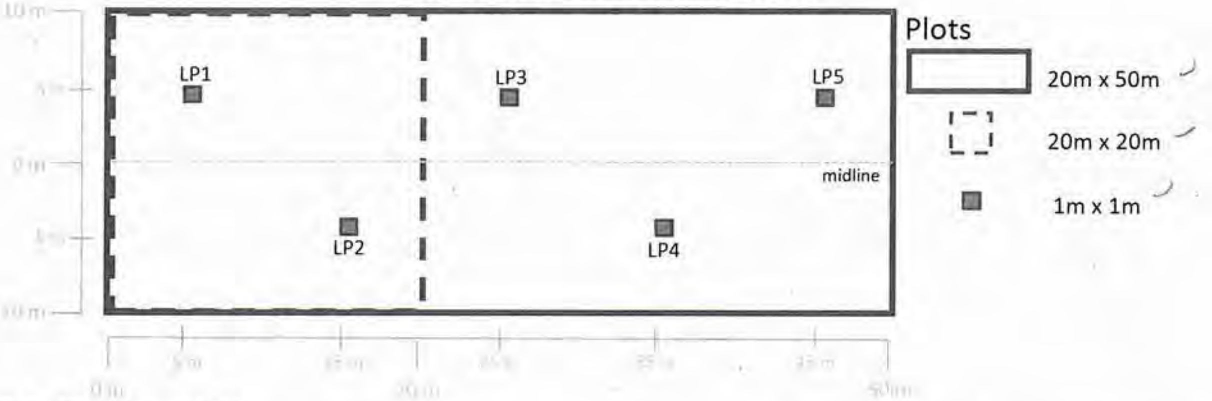
Date: 26 - 03 - 2019 **Recorders:** ACM, TZ **Plot ID:** 23

Project No: 0470861 **Project Name:** Barohaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):			**EEC:**		Confidence H M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1531	0338490	6768126	159° S	✓	✓
50 m	1532	0338504	6768075	331° NW	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1533	1534	1535	1536	1537	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		90	30	80	70	80	70
Bare Ground (%)		10	70	20	30	20	30
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		0	0	0	0	0	0

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Slope	**Landform Element**	Hill slope	**Landform Pattern**	Low Hill	**Microrelief**	grassland
Lithology	-	**Soil Surface Texture**		**Soil Colour**	light - orange - brown	**Soil Depth**	-
Slope	Gentle inclined hill	**Aspect**		**Site Drainage**	downslope runoff	**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R	
Fire damage			
Storm damage			
Weediness	1	R-O	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 26-03-2019 **Recorders:** ACM TZ **Plot ID:** 23

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class#	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80+ cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm		/ = 1		
10 - 19 cm		// = 2		
5 - 9 cm		/ = 1		
<5 cm [b]		/ = 1	n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	2,1,1 = 4			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

80
~~62~~

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 26/2/16	Bonshaw	23	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Cyperus glaucophila shrubs		0.2	2		
	Pimelea stricta		<0.1	3		
	Aristida ramosa		1	~~[illegible]~~		
	Cymbopogon refractus		0.3	40		
	Sida corrugata		0.1	100		
	Cassinia		<0.1	1		
	Heliotropium		<0.1	28		
	[illegible]					
	Glycine		<0.1	12		
	Sida ~~[illegible]~~		<0.1	2		
	Dichondra sp A		<0.1	6		
	Bothriochloa decipiens		1	1		
	Cheilanthes		<0.1	7		
	Panicum		<0.1	2		
	Boerhavia		<0.1	6		
	unidentifiable grasses		20			
	no samples					

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code if 'top 3'.**

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:** 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Total veg cover 25 ~~[illegible]~~ %
~~[illegible]~~ ~~dead~~ alive 23 %

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

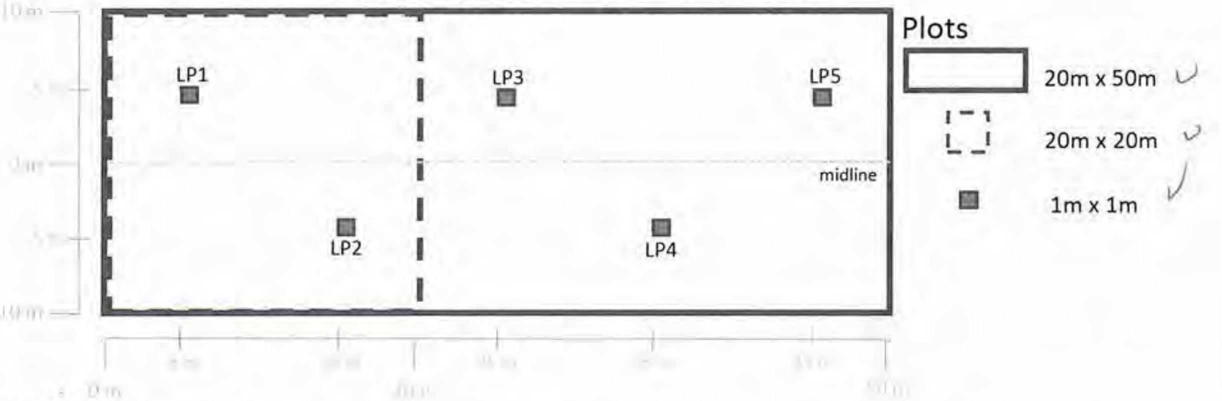
Date: 26-03-2019 **Recorders:** ACM, TZ **Plot ID:** 24

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:		grass			Confidence H M L
Plant Community Type (PCT):		596 - DNG - Low	**EEC:**		Confidence H M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1538	33 88 00	67 68 481	170° S	✓	✓
50 m	1539	33 88 13	67 68 430	332° NW		

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1540	1541	1542	1543	1544	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		60	80	80	85	60	73
Bare Ground (%)		40	10	20	15	40	25
Cryptogam Cover (%)		5	30	5	10	5	11
Rock Cover (%)		0	1	0	0	0	0.2

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Flat	**Landform Element**	Plain	**Landform Pattern**	Plain	**Microrelief**	grassy area
Lithology	silt-clay	**Soil Surface Texture**		**Soil Colour**	light orange-brown	**Soil Depth**	–
Slope	Level	**Aspect**		**Site Drainage**	–	**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R	
Fire damage			
Storm damage			
Weediness	2	R-O	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 26-03-2019 **Recorders:** ACM, TZ **Plot ID:** 24

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80⁺ cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	7, 1; 2; 5, 6; = 21			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

40
36
16
92

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 26/3/2019	Bonshaw	24	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Aristida ramosa		<0.1	1		
	Bothriochloa decipiens		1.5	500		
	Eragrostis brownii		<0.1	3		
	Cymbopogon refractus		0.2	4		
	Panicum simile		<0.1	3		
	Dichondra sp. A		0.5	200	— lots of dead	
	Vittadinia sulcata		<0.1	2	matter of these	
	Glycine clandestina		<0.1	16	species also	
	Sida corrugata		0.1	30		
	Cheilanthes sieberi		<0.1	5		
	Solenogyne gracilis		<0.1	12		
	Pimelea stricta		<0.1	3		
	unidentifiable grasses		25			

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code if 'top 3'.**

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

total veg cover 30%
dead 50%
bare 20%

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

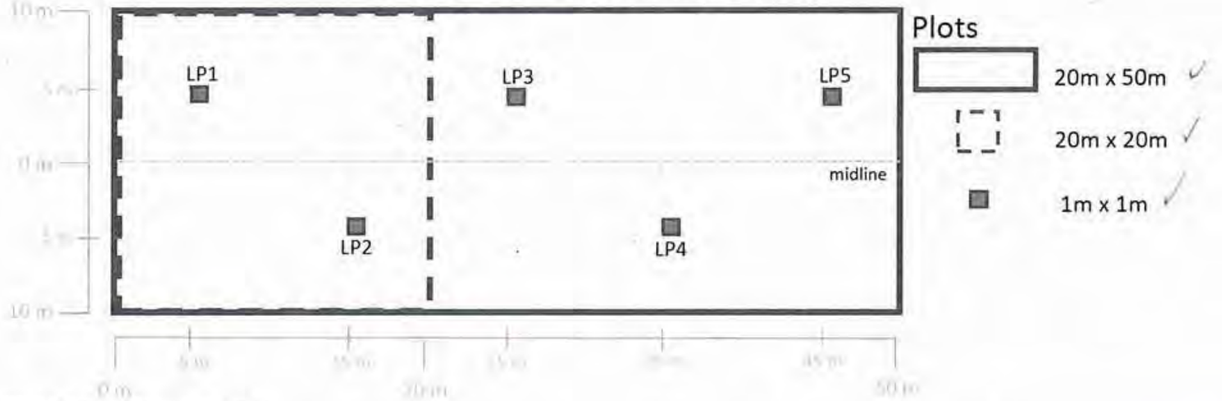
Date: 26-03-2019 **Recorders:** ACM, TZ **Plot ID:** 25

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ____

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					**Confidence** **H M L**
Plant Community Type (PCT):				**EEC:**	**Confidence** **H M L**

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1545	338687	6768607	257° W	✓	✓
50 m	1551	338635	6768598	67° NE	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1546	1547	1548	1549	1550	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		90	70	90	60	60	74
Bare Ground (%)		10	30	10	40	40	26
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		0	0	0	0	0	0

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

grazing paddock - fenced

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Flat	**Landform Element**	Plain	**Landform Pattern**	Plain	**Microrelief**	grassland
Lithology	silt-clay	**Soil Surface Texture**		**Soil Colour**	light orange-brown	**Soil Depth**	—
Slope	level	**Aspect**	W	**Site Drainage**	—	**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	2	R-O	
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 26-03-2019 **Recorders:** ACM, TZ **Plot ID:** 25

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	8, 3 = 11			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

Field Data Sheet created by Dr Adriana Corona Mothe

-This document has not been endorsed or approved by Office of Environment and Heritage or Muddy Boots Environmental Training-

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 26/2/2019	Bonshaw	25	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Bothriochloa decipiens		0.5	300		
	Aristida leptopoda		<0.1	3		
	Boerhavia		<0.1	3		
	Eragrostis		<0.1	2		
	Aristida racemosa		0.5	7		
	Dichondra sp A		0.1	200		
	Vittadinia sulcata		<0.1	1		
	Heliotropium		<0.1	3		
	Sclerolaena		<0.1	12		
	Glycine		<0.1	26		
	Opuntia tomentosa		0.1	1		
	Cymbopogon refractus		0.1	15		
	Cheilanthes		<0.1	2		
	Rumex		<0.1	2		
	unidentifiable grasses		25			

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

total veg cover 25%
dead 50 ~~75~~ %
bare 10-25%

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

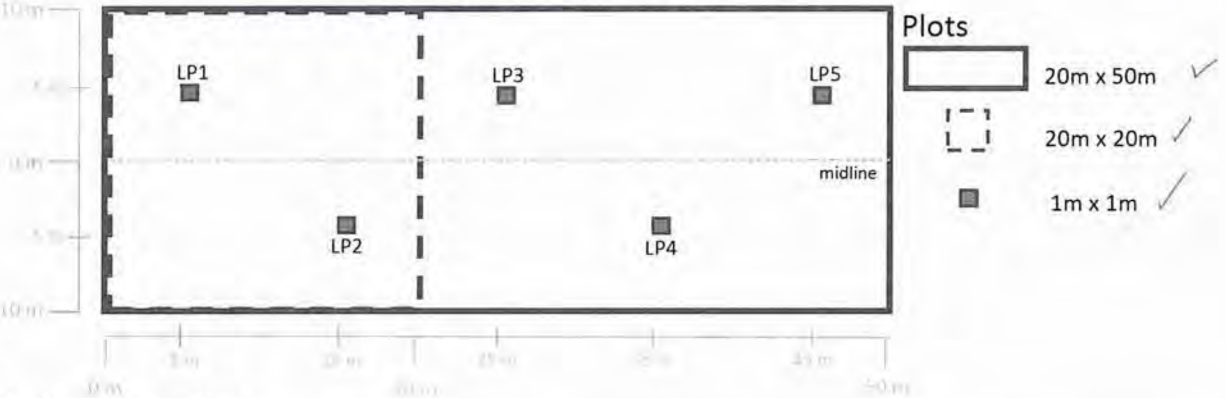
Date: 26-03-2019 **Recorders:** ACM, TZ **Plot ID:** 26

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):			**EEC:**	X	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1552	339225	6768 408	255° W	✓	✓
50 m	1558	339177	6768 412	87° E	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute		1	2	3	4	5	Average
	LP	1	2	3	4	5	
	WP	1553	1554	1555	1556	1557	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		25	20	15	30	40	26
Bare Ground (%)		75	80	84	70	60	73.8
Cryptogam Cover (%)		10	5	0	2	2	3.8
Rock Cover (%)		6	1	1	0	0	0.4

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Slope	**Landform Element**	Hill slope	**Landform Pattern**	Low Hill	**Microrelief**	grass -chord
Lithology	silty-clay	**Soil Surface Texture**		**Soil Colour**	light orange-brown	**Soil Depth**	-
Slope	Gently inclined	**Aspect**	W	**Site Drainage**		**Distance to nearest water and type**	-

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal	3	R-O	
Grazing (identify native/stock)			
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (> 10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 26-03-17 **Recorders:** ACM, TZ **Plot ID:** 26

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80⁺ cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm	𝍸 = 5			
5 - 9 cm				
<5 cm [b]	/ = 1	|| = 2	n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	3, 2, 3, 1, 3, 2, 1, 1, 3, 2 = 21			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

Field Data Sheet created by Dr Adriana Corona Mothe

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 26/3/2019	Bonshaw	26	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Cupressus semiglauca		0.1	11		
	Aristida jerichoensis		0.5	150		
	Enneapogon gracilis		1.0	700		
	Convolvulus alsinoides		<0.1	8		
	Boerhavia dominii		0.1	80		
	Sida corrugata		0.1	300		
	Pimelea stricta		<0.1	10		
	Cymbopogon refractus		0.1	10		
	Dichondra sp A		0.1	90		
–	[illegible]		<0.1	7		
	Hypericum		<0.1	8		
	Bothriochloa decipiens		2.0	200		
	Eragrostis brownii		<0.1	1		
	Chamaesyce drummondii		<0.1	3		
	Panicum simile		<0.1	1		
	Chloris truncata		<0.1	1		
	Eucalyptus dealbata (shrub)		0.1	1		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code if 'top 3'.**

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

total cover	5-10%
dead	10-25
rock	10
soil	50-75

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

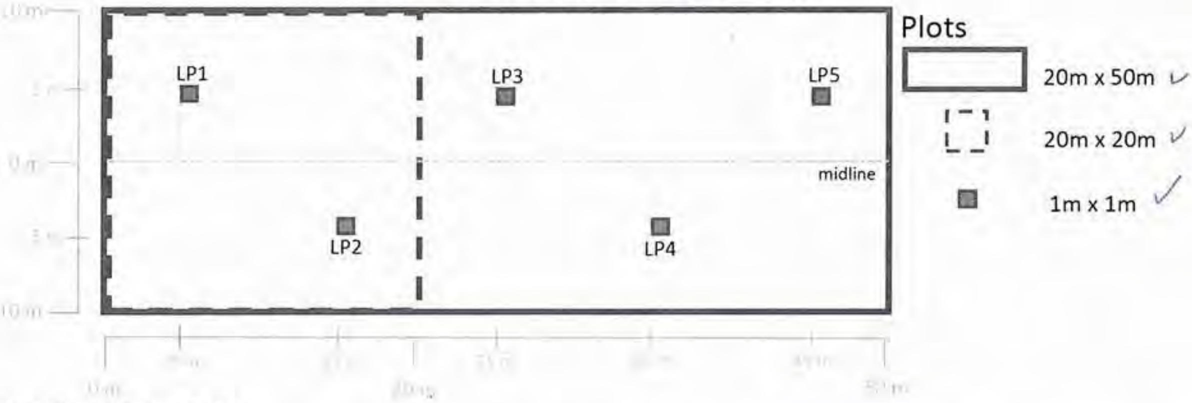
Date: 27-03-2019 **Recorders:** ACM TZ **Plot ID:** 27

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:	Grassland (1				Confidence H M L
Plant Community Type (PCT):	DNG		**EEC:**	X	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1560	33 83 44	67 68 782	184°S	✓	✓
50 m	1561	33 83 28	67 68 734	3°N	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1562	1563	1564	1565	1566	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		70	60	50	70	80	66
Bare Ground (%)		30	40	40	25	20	31
Cryptogam Cover (%)		5	5	5	0	10	5
Rock Cover (%)		1	0	0	0	0	0.2

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Slope	**Landform Element**	Very Low Hill	**Landform Pattern**	Low Hill	**Microrelief**	grassland
Lithology	Clayed soils	**Soil Surface Texture**		**Soil Colour**	light orange-brown	**Soil Depth**	
Slope	Very gently to W	**Aspect**	W	**Site Drainage**	–	**Distance to nearest water and type**	–

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R-O	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 27

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)				

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

40
15
30
20
105

400 m² plot: Sheet _ of _		Survey Name	Plot Identifier	Recorders
Date	21/3/11		27	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Aristida ramosa		60	900		
	Bothriochloa (decipiens)		2	40		
	Sclerolaena birchii		0.1	60		
	Heliotropium amplexicaule		0.1	100		
	Boerhavia dominii		<0.1	5		
	Cheilanthes sieberi		<0.1	30		
	Einadia nutans		<0.1	50		
	Juncus usitatus		<0.1	8		
	Dichondra repens		<0.1	8		
	Sida corrugata		<0.1	4		
	Glycine [illegible]		<0.1	40		
	Dichondra sp. A		0.1	30		
	Eragrostis brownii		<0.1	15		
	Rumex brownii		<0.1	5		
	unidentifiable grasses/sedges		30			
	<(C. appressa?					
	Einadia hastata		<0.1	3		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code if 'top 3'.**

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Total veg cover 50%
Bare 30%
[illegible] 20%

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 27-03-2014 **Recorders:** ACM, TZ **Plot ID:** 28

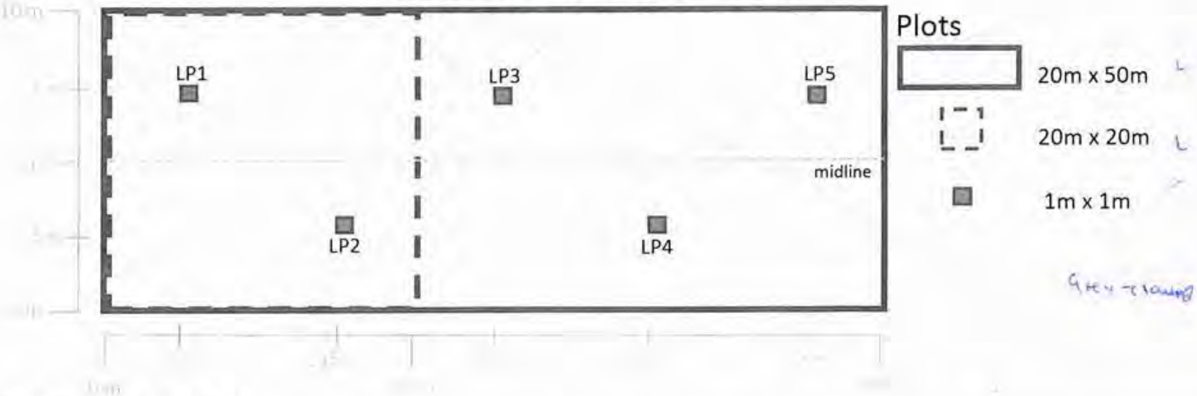
Project No: 047084 **Project Name:** Bonshaw Solar Farm **Zone ID:** ____

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	NNC		
Likely Vegetation Class:	DNG				Confidence H M L
Plant Community Type (PCT):	516 - DNG - Mod		**EEC:**	×	Confidence [✓ H] M L

BAM Nested Plots Requirement

Raining



Grey-crowned babbler - calling

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1569	33 86 58	67 68 836	180° S	✓	✓
50 m	1570	338643	67 68 787	350° N	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1571	1572	1573	1574	1575	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		20	50	25	30	40	33
Bare Ground (%)		80	40	75	70	60	65
Cryptogam Cover (%)		0	5	0	0	0	1
Rock Cover (%)		1	0	0	0	0	0.2

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Slope	**Landform Element**		**Landform Pattern**		**Microrelief**	
Lithology		**Soil Surface Texture**		**Soil Colour**		**Soil Depth**	
Slope		**Aspect**		**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R-O	
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 28

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80⁺ cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)				

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

Field Data Sheet created by Dr Adriana Corona Mothe

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 27/3/2019		28	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Aristida racemosa		25	500		
	Heliotropium amplexicaule		0.5	2200		
	Dichondra sp. A		0.1	7		
	Einadia nutans		0.1	100		
	[illegible] Calotis lapulla		<0.1	14		
	Sclerolaena birchii		0.3	130		
	Tribulus terrestris		0.1	20		
	[illegible]		0.1	20		
	Maireana microphylla		<0.1	2		
	[illegible]		[illegible]			
	Oxalis perennans		<0.1	3		
	Rumex brownii		<0.1			
	unidentifiable grass		10			
	Boerhavia dominii		<1	3		
	T					

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 29

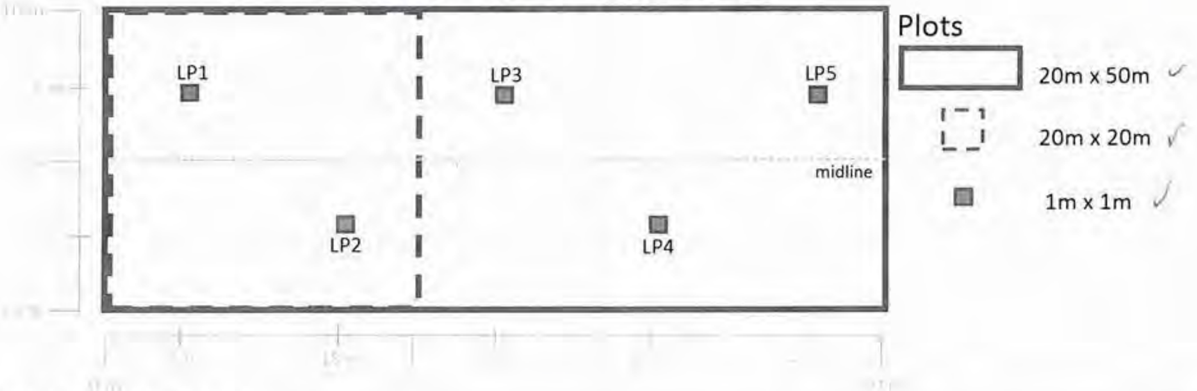
Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ____

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	UTM94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:		Grassland - Cleared land			Confidence H M L
Plant Community Type (PCT):		546 - DNG - Low	**EEC:**	✗	Confidence [✓ H] M L

Raining

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1576	33 90 52	67 68 750	178°S	✓	✓
50 m	1577	33 9047	67 68 699	347°N	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1578	1579	1580	1581	1582	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		80	80	60	65	75	72
Bare Ground (%)		10	20	10	10	25	15
Cryptogam Cover (%)		15	10	20	10	5	12
Rock Cover (%)		10	1	30	25	1	13.4

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Slope	**Landform Element**	Hill Slope	**Landform Pattern**	Low Hill	**Microrelief**	grassy
Lithology	Silty-clay	**Soil Surface Texture**		**Soil Colour**	light - orange brown	**Soil Depth**	-
Slope	Very gentle slope	**Aspect**	247° W	**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R - 6	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (> 10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: ____________ **Recorders:** AIM **Plot ID:** 29

Project No: ____________ **Project Name:** Bonshaw **Zone ID:** ____________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80+ cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]	/		n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	4, 1, 2, 4, 5, 3, 5, 7, 8, 1, 2, 1 =43			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

-This document has not been endorsed or approved by Office of Environment and Heritage or Muddy Boots Environmental Training-

400 m² plot: Sheet _ of _		Survey Name	Plot Identifier	Recorders
Date	27/3/14		29	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Aristida ramosa		0.5	20		
	Enneapogon gracilis		5	200		
	Dichondra sp. A		0.3	100		
	Boerhavia dominii		0.1	20		
	Vittadinia sulcata		0.1	4		
	[illegible]		[illegible]	[illegible]		
	Sida corrugata		[illegible]	[illegible]		
	[illegible] "		0.1	200		
	Chamaesyce drummondi		0.1	5		
	Rumex brownii		0.3	20		
	Cheilanthes sieberi		<0.1	10		
	Pimelea stricta		0.5	10		
	Cupressus semiglauca		<0.1	1		
	Panicum simile		0.1	30		
	Bothriochloa decipiens		10	1000		
	Calotis [illegible]		<0.1	15		
	Convolvulus alsinoides		<0.1	4		
	Eragrostis brownii		<0.1	6		
	Cymbopogon refractus		0.5	15		
	Chloris truncata		<0.1	1		
	Eucalyptus dealbata shrub		0.2	1		
	unidentifiable grasses/sedges		1.5			

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: .1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

total veg 25%
dead 25%

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 30

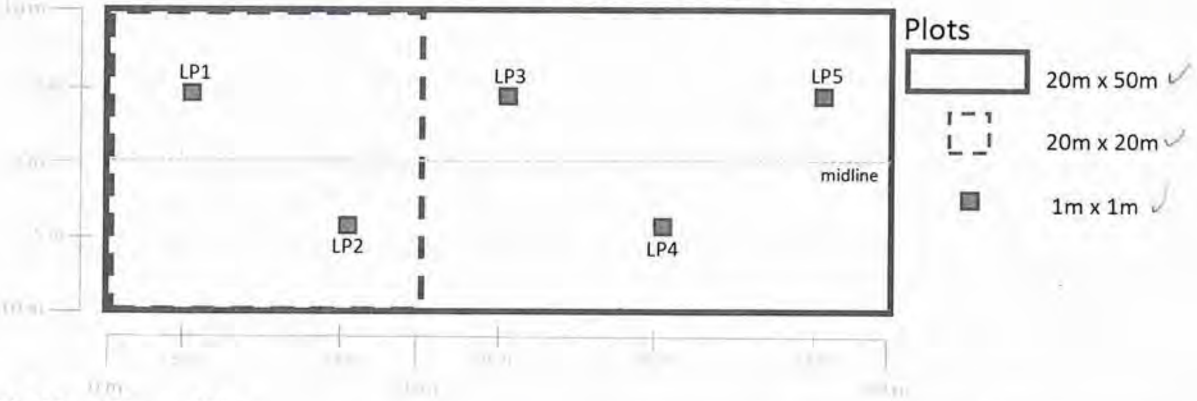
Project No: 0470861 **Project Name:** Ramshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):		Cleared Land	**EEC:**	No	Confidence [✓ H] M L

BAM Nested Plots Requirement

Wet - rain



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1583	33 8535	67 69 002	25° NE	✓	✓
50 m	1584	33 8565	67 69 043	211° SW	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1585	1586	1587	1588	1589	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		20	40	60	30	75	45
Bare Ground (%)		80	60	40	70	25	55
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		0	0	0	0	0	0

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Flat	**Landform Element**	flat plain	**Landform Pattern**	Plain	**Microrelief**	grassy decayed
Lithology	silty-clay	**Soil Surface Texture**		**Soil Colour**	light orange-brown	**Soil Depth**	—
Slope	Level	**Aspect**	—	**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R - O	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: ______________ **Recorders:** ______________________________ **Plot ID:** 30

Project No: __________ **Project Name:** ______________________________ **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	—			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 27/3/19	Bunshew	30	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Aristida ramosa		0.5	20		
	Maireana microphylla		0.1	20		
	Sclerolaena birchii		0.2	100		
	Einadia nutans		0.1	20		
	Heliotropium amplexicaule		0.2	400		
	Glinus		0.1	50		
	Sida corrugata		<0.1	50		
	Dichondra sp. A		<0.1	20		
	Boerhavia dominii		0.1	90		
	Tribulus terrestris		0.1	60		
	Vittadinia sulcata		<0.1	40		
	Chloris truncata		<0.1	5		
	Convolvulus erubescens		<0.1	30		
	Neptunia gracilis		<0.1	1		
	Rumex brownii		<0.1	7		
	Bothriochloa decipiens		0.5	200		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Litter 5%
dead 3%
[illegible] 65%

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

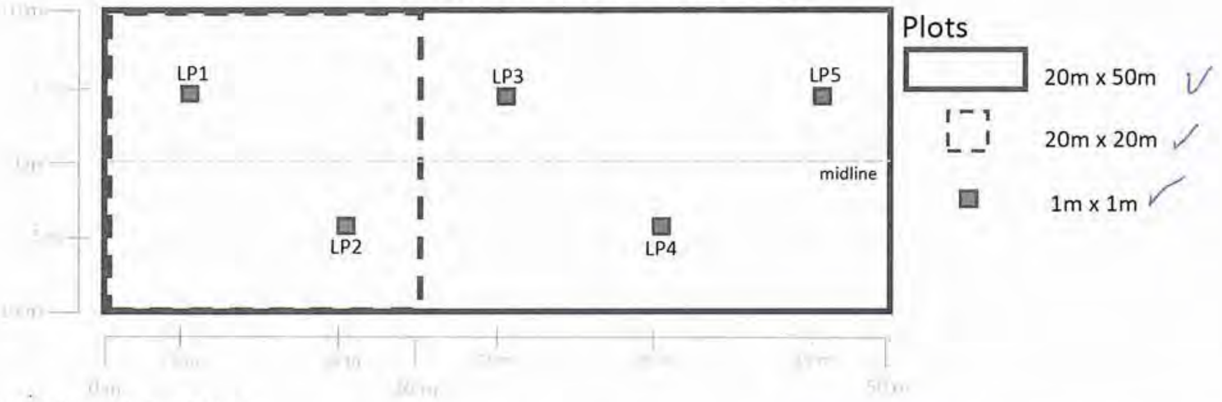
Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 31

Project No: 047 0861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	53	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):		596_ Low	**EEC:**	X	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1592	338402	67 69 323	191°S	✓	✓
50 m	1593	33 8380	67 69 277	11°N	✓	✓

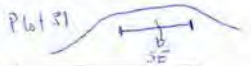
*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	**LP**	**1**	**2**	**3**	**4**	**5**	**Average**
	WP	1594	1595	1596	1598	1599	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		20	30	56	10	80	38
Bare Ground (%)		65	50	35	10	10	34
Cryptogam Cover (%)		5	10	2	60	5	16.4
Rock Cover (%)		15	20	15	80	10	28

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;



Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Slope	**Landform Element**	Hill Crest	**Landform Pattern**	Low Hill	**Microrelief**	boulder field
Lithology	Silty-clayed soil	**Soil Surface Texture**	—	**Soil Colour**		**Soil Depth**	
Slope	Gentle Inclined	**Aspect**	120° SE	**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R–O	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 31

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80⁺ cm				
50 - 79 cm	/		/	
30 - 49 cm				
20 - 29 cm		/		
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	2,1			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm
Silver-leaved Ironbark	54	1597			<5 cm Ø	

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400 m^2 plot: Sheet _ of _		Survey Name	Plot Identifier	Recorders
Date	27/3/10	Bonshaw	31	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Notelaea microcarpa 3-4 m		3	1		
	Opuntia tomentosa (2 m)		1.5	1		
	Maireana microphylla		0.2	6		
	Aristida ramosa		0.2	25		
	Enneapogon nutans		0.1	200		
	Chamaesyce drummondii		0.1	80		
	Opuntia aurantiaca		0.1	3		
	Sida corrugata		0.1	200		
	Sclerolaena birchii		<0.1	40		
	Boerhavia dominii		<0.1	20		
	Heliotropium amplexicaule		<0.1	[illegible]		
	Vittadinia sulcata		<0.1	3		
	Portulacca oleracea		<0.1	2		
	Dichondra sp. A		<0.1	8		
	Solanum		<0.1	1		
	[illegible] bicolor		<0.1	4		
	unidentifiable grasses / sedges		[illegible]			
	Bothriochloa decipiens		1	100		
	[illegible] geniculata (seedlings)		<0.1	6		
	Cheilanthes sieberi		<0.1	8		
	Enneapogon gracilis		0.1	20		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Total veg cover (ground) 10
dead 20
bare 30
rock 30

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 27-03-2019 **Recorders:** ALM, TZ **Plot ID:** 32

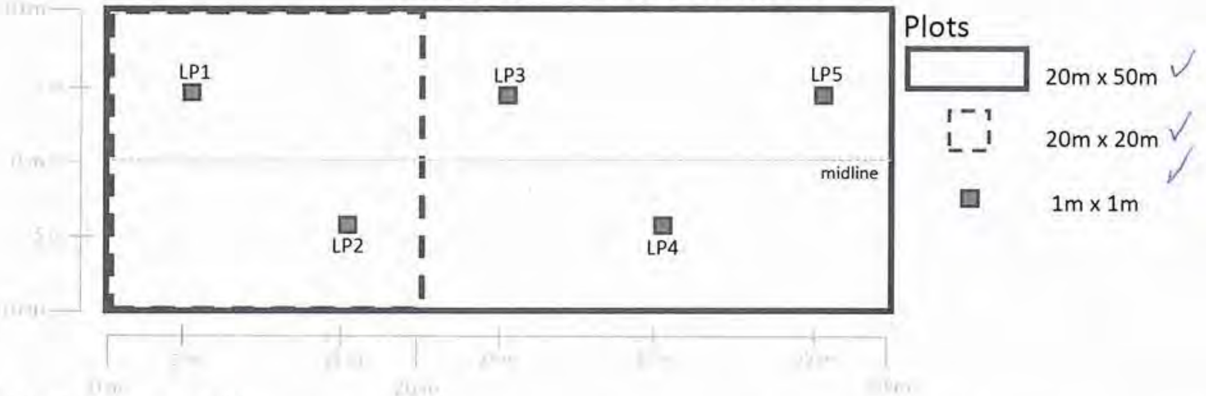
Project No: 047084 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Grey-crowned Babbler calling in tree

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:		grassy - cleared land			Confidence H M L
Plant Community Type (PCT):		516 - DNG - Mod	**EEC:**	X	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1600	33 85 18	67 69 371	173°S	✓	✓
50 m	1601	338517	67 69 320	350°N	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1602	1603	1604	1605	1606	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		70	85	90	75	80	76
Bare Ground (%)		30	15	10	25	20	20
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		0	0	0	0	0	0

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	flat	**Landform Element**	Hill base	**Landform Pattern**	Flat	**Microrelief**	grassy
Lithology	cleared soils	**Soil Surface Texture**		**Soil Colour**		**Soil Depth**	–
Slope	Level	**Aspect**	–	**Site Drainage**	–	**Distance to nearest water and type**	< ~~70m~~ 5m adjacent to creek line dry

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R - O	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 32

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)				

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

80
32
112

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 27/3/19		32	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Aristida ramosa		40	1200		
	Maireana microphylla		0.1	1		
	Sida corrugata		<0.1	16		
	Dorichondra white backed		<0.1	6		
	Glycine		<0.1	17		
	Heliotropium		<0.1	4		
	Sclerolaena birchii		<0.1	5		
	Lomandra [illegible]		0.1	40		
	Cheilanthes		<0.1	12		
	Rumex		<0.1	8		
	Bothriochloa decipiens		<0.1	8		
	Eulalia		<0.1	1		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

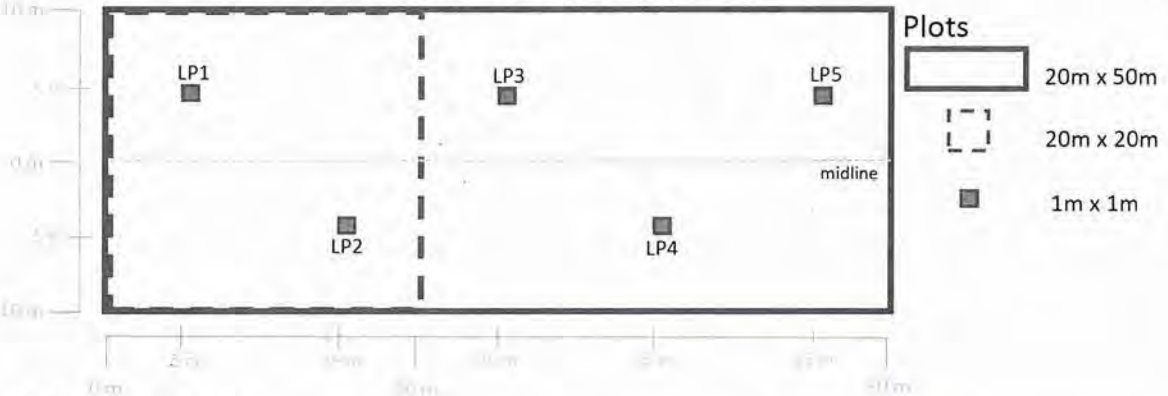
Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 33

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:		Cleared → grassy			Confidence H M L
Plant Community Type (PCT):		516 - DNG - Low	**EEC:**	X	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1607	33 83 61	67 69 671	326° NW	✓	✓
50 m	1613	33 83 58	67 69 722	273° W	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1608	1609	1610	1611	1612	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		15	10	5	5	2	7.4
Bare Ground (%)		80	65	90	85	97	83.4
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		5	25	5	10	1	9.2

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional) cracking - surface

Morphological Type	~~Plain~~ Flat	**Landform Element**	Plain	**Landform Pattern**	Plain	**Microrelief**	
Lithology	silty - topsoil	**Soil Surface Texture**		**Soil Colour**	dark brown	**Soil Depth**	
Slope	Leveled	**Aspect**		**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R-O	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (> 10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 33

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)				

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

20
64

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 27/3/19	Bonshaw	33	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Carthamus		<0.1	18		
	exotic grass, mostly dead		0.5	[illegible]	[illegible]	[illegible]
	Heliotropium		<0.1	65		
	Convolvulus erubescens		<.	3		
	Chamaesyce		< ″	6		
	Aristida ramosa		< ″	3		
	Bothriochloa decipiens		< ″	35		
	Neptunia		< ″	3		
	Sclerolaena birchii		< ″	4		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

total veg cover green 0.5
dead 40
rocks 20
soil 40

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

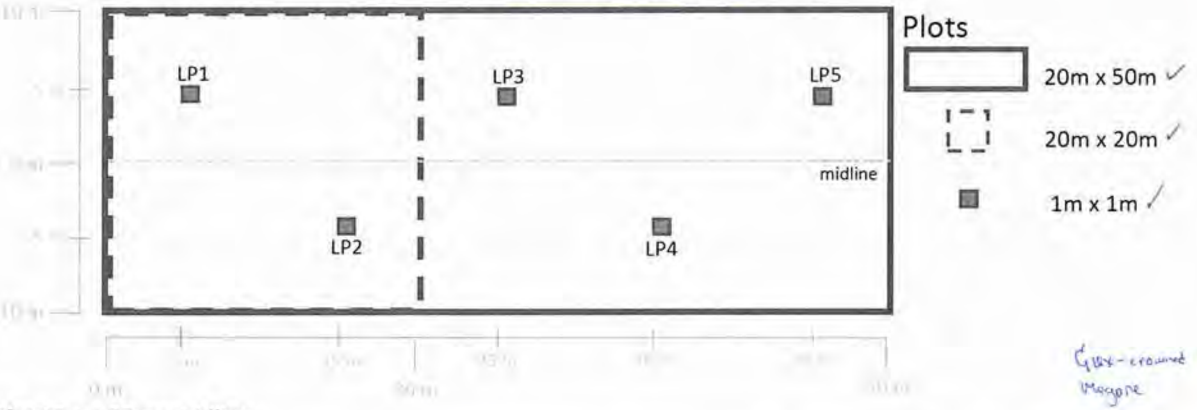
Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 34

Project No: 047086l **Project Name:** Barshaw Solar Farm **Zone ID:** ____

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:		Cleared Land			Confidence H M L
Plant Community Type (PCT):		N/A	**EEC:**	X	Confidence [✓ H] M L

BAM Nested Plots Requirement



Grey-crowned Babbler call @ distance
Magpie

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1614	33 8569	67 69 788	275°W	✓	✓
50 m	1620	33 8592	67 69 743	310° NW	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1615	1616	1617	1618	1619	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		40	50	5	25	10	
Bare Ground (%)		60	50	95	75	90	
Cryptogam Cover (%)		0	0	0	0	0	
Rock Cover (%)		0	0	0	1	0	

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Flat	**Landform Element**	Plain	**Landform Pattern**	Plain	**Microrelief**	Grazed land
Lithology	silty-clayed soil	**Soil Surface Texture**		**Soil Colour**	light-orange brown	**Soil Depth**	–
Slope	Leveled	**Aspect**	—	**Site Drainage**	–	**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)	3	O	
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	O	
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: ____________ **Recorders:** ______________________ **Plot ID:** 34

Project No: __________ **Project Name:** ______________________ **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80⁺ cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)				

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 27/3/19		34	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Sclerolaena birchii		0.3	200		
	Bothriochloa decipiens		0.2	100		
	exotic grass like		1	80		
	" dead		20	300		
	Gomphrena celosioides		0.2	150		
	Heliotropium		0.2	200		
	Chamaesyce		0.2	60		
	Einadia nutans		0.1	100		
	Convolvulus erubescens		0.2	200		
			0.1	100		
	[illegible]		<0.1	20		
	Eragrostis brownii		<0.1	2		
	Carthamus		<0.1	7		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

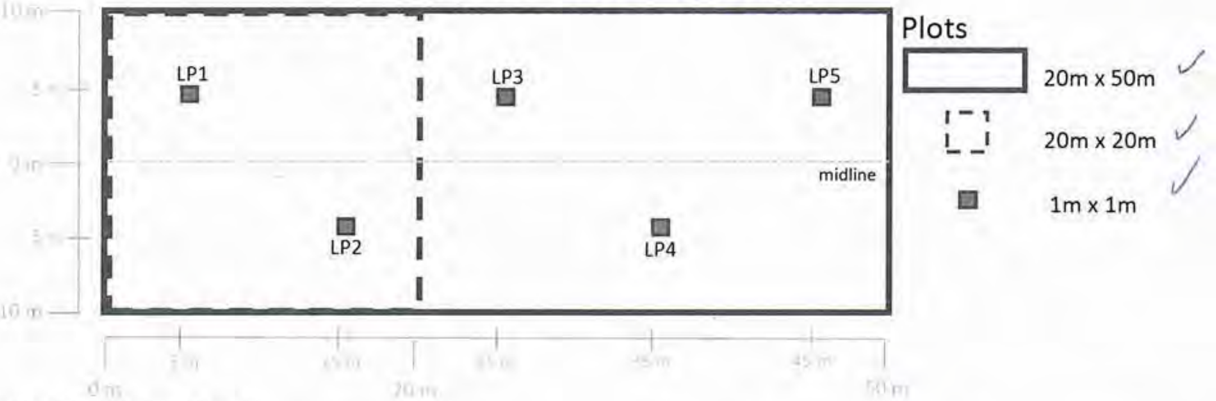
Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 35

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:		DNG			Confidence H M L
Plant Community Type (PCT):		516 - DNG - Low	**EEC:**	X	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1621	33 86 71	67 69 805	262° W	✓	✓
50 m	1627	33 86 67	67 69 756	366° N	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1622	1623	1624	1625	1626	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		10	85	20	5	1	24.2
Bare Ground (%)		90	15	80	95	99	75.8
Cryptogam Cover (%)		0	2	0	0	0	0.4
Rock Cover (%)		0	0	0	0	0	0

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	flat	**Landform Element**	Plain	**Landform Pattern**	Plain	**Microrelief**	
Lithology	Clayed soil	**Soil Surface Texture**	–	**Soil Colour**	light-orange-brown	**Soil Depth**	
Slope	Leveled	**Aspect**	—	**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R-O	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 27-03-2019 **Recorders:** ACM, TZ **Plot ID:** 35

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80⁺ cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	—			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, *Corymbia*, *Angophora*, *Lophostemon* and *Syncarpia*)

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 27/3/19	Bonshaw	35	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Sclerolaena birchii		2.0	150		
	Portulaca oleracea		<0.1	18		
	Einadia nutans		<0.1	10		
	Maireana microphylla	3.5	[illegible]	18		
	Bothriochloa decipiens		0.8	200		
	Rumex		<0.1	10		
	Convolvulus erubescens		<0.1	6		
	Sida corrugata		<0.1	29		
	Enneapogon		0.5	50		
	Chloris truncata		<0.1	2		
	Aristida ramosa		2	29		
	Lomandra [illegible]		0.1	25		
	unidentifiable grass (?) [illegible]		8			
	dead		25			
	Eragrostis		<0.1	3		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code if 'top 3'.**

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

total veg life	10
dead	50
bare	30
rock	20

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

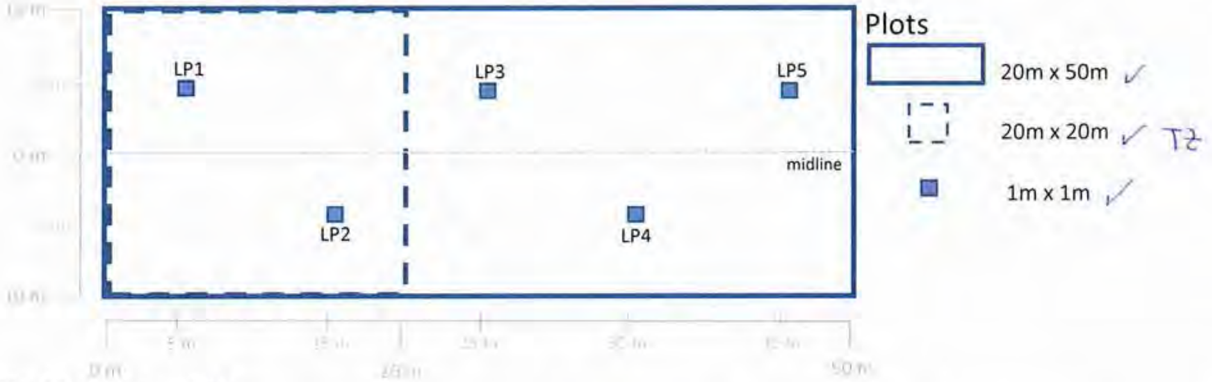
Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 36

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):				**EEC:**	Confidence H M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1629	339043	6768195	315° W	✓	✓
50 m	1630	339015	6768237	147°SE	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1631	1632	1633	1634	1635	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		65	68	30	25	45	46.6
Bare Ground (%)		45	30	70	75	50	54
Cryptogam Cover (%)		15	0	5	0	5	5
Rock Cover (%)		0	2	0	0	~~2~~ 5	1.4

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Slope	**Landform Element**	Hillside	**Landform Pattern**	Low Hill	**Microrelief**	grassy area
Lithology	Clayed soils	**Soil Surface Texture**	-	**Soil Colour**	light orange-brown	**Soil Depth**	
Slope	Gently inclined	**Aspect**	W	**Site Drainage**	W, SW to creek	**Distance to nearest water and type**	≤10m S

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R-O	
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 36

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	2, 7, 1, 1, 9, 2 = 22			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 28/3/19	Bonshaw	36	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Bothriochloa decipiens		7.5	600		
	Aristida ramosa + ?		0.2	15		
	Enneapogon gracilis		1.0	600		
	Sida corrugata		0.1	90		
	Cymbopogon refractus		0.1	30		
	Dichondra sp. A		0.1	100		
	Rumex brownii		<0.1	8		
	[illegible]		<0.1	90		
	Eragrostis brownii		0.1	24		
	Panicum simile		0.2	50		
	Cupressus glaucophylla		<0.1	4		
	Boerhavia dominii		<0.1	14		
	Heliotropium amplexicaule		<0.1	4		
	Pimelea stricta		<0.1	1		
	Unidentifiable grasses		7			
			<0.1	1		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code if 'top 3'.**

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:** 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

total veg	10
dead	40
rock	20
bare	30

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 37

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):			**EEC:**		Confidence H M L

BAM Nested Plots Requirement

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1636	338564	6768372	177°S	✓	✓
50 m	1637	338579	6768321	327°NW	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1638	1639	1640	1641	1642	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		70	90	80	60	60	72
Bare Ground (%)		30	10	20	40	40	28
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		0	0	0	0	0	0

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	≈ Flat	**Landform Element**	Plain	**Landform Pattern**	Plain	**Microrelief**	grassy land
Lithology	Clayed soils	**Soil Surface Texture**	–	**Soil Colour**	light orange-brown	**Soil Depth**	
Slope	Very gently inclined	**Aspect**	NW	**Site Drainage**	W to creek line	**Distance to nearest water and type**	~50m W

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	stumps of felled trees present
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R-O	
Fire damage			
Storm damage			
Weediness	1	n	
Other			

Severity: 0 = no evidence; 1= light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 37

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80+ cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm		/		
5 - 9 cm				
<5 cm [b]		/	n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	16, 7, 1, 1, 2, 4, 11, 7, 1, 1, 9, 4, =64			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

Field Data Sheet created by Dr Adriana Corona Mothe

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 28/3/14	Bonshaw	37	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Sida corrugata		<0.1	50		
	Glycine (.)		<0.1	20		
	Enneapogon gracilis		<0.1	4		
	Cymbopogon refractus		0.1	20		
	Panicum simile		0.1	11		
	Bothriochloa decipiens		3	700		
	Eragrostis brownii		0.1	11		
	Cheilanthes sieberi		<0.1	3		
	Heliotropium amplexicaule		<0.1	3		
	Dichondra sp. A		<0.1	7		
	Convolvulus alsinoides		<0.1	3		
	Rumex brownii		<0.1	8		
			<0.1	8		
	Chamaesyce drummondi		<0.1	5		
	Juncus usitatus		0.1	6		
	Solenogyne bellioides		<0.1	7		
	unidentifiable grasses		5			
	Aristida ramosa		1	20		
	Oxalis perennans		<0.1	1		
	Pimelea stricta		<0.1	1		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

live veg 5-10
dead incl trunk 90
rock 0.1
soil 30

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

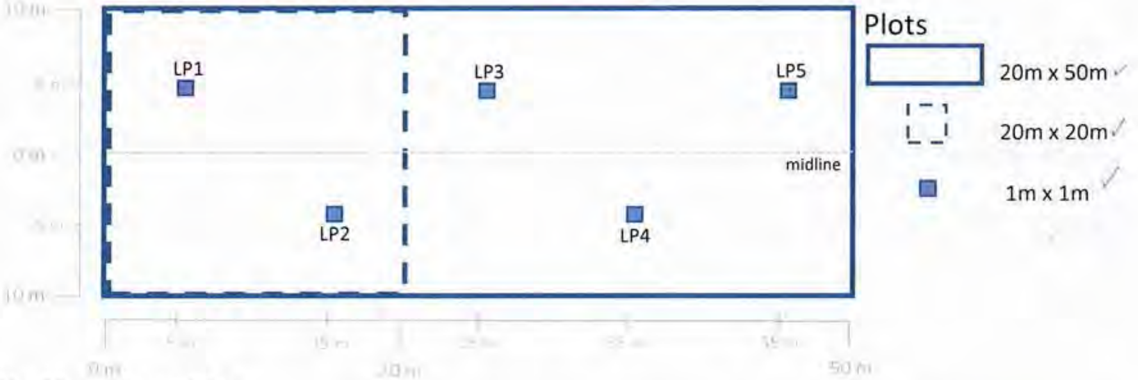
Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 38

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** 38

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:		Open woodland			Confidence [✓ H] M L
Plant Community Type (PCT):		516 mod-low	**EEC:**	×	Confidence [✓ H] M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1643	33 8685	67 68 653	235°SW	✓	✓
50 m	1644	33 8640	67 68 645	80°E	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1645	1646	1647	1648	1649	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		98	95	60	45	20	63.6
Bare Ground (%)		2	5	40	55	80	36.4
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		0	0	0	0	0	0

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Flat	**Landform Element**	Plain	**Landform Pattern**	Plain	**Microrelief**	woodland
Lithology	Sand-silt	**Soil Surface Texture**		**Soil Colour**	dark brown	**Soil Depth**	
Slope	Leveled	**Aspect**	—	**Site Drainage**	-	**Distance to nearest water and type**	~ 30m W

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	stumps (cut) present
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R	Cattle & sheep
Fire damage			
Storm damage			
Weediness	1	R	
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 38

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm	𝍸 || = 7			
20 - 29 cm	𝍸 𝍸 𝍸 𝍸 |||| = 24			
10 - 19 cm	𝍸 𝍸 | = 11			
5 - 9 cm	|| = 2			
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	1, 4, 1, 12, 13, 8, 3, = 42			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

E. albens

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 28/3/14	Borshaw	38	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Sclerolaena birchii		<0·1	12		
	Aristida ramosa		<0·1	20		
	Eucalyptus albens		50%		T	
	Maireana microphylla		<0·1	2		
	unidentifiable grasses		0.5			
	Opuntia aurantiaca		<0·1	3		
	Pimelia stricta		<0·1	1		
	Eragrostis brownii		<0·1	2		
	Rostellularia adscendens		<0·1	3		
	Austrostipa scabra		<0·1	4		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

total veg 0.5 ground cover + 0.5% E. albens !

dead / litter 75

bare 25

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** ____

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** 39

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):			**EEC:**		Confidence H M L

BAM Nested Plots Requirement

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1650	33 86 76	67 68 698	56° NE	✓	✓
50 m	1656	~~67 68~~ ~~698~~ 338720	67 68 719	225° SW	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1651	1652	1653	1654	1655	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		95	98	80	55	80	
Bare Ground (%)		5	2	15	40	20	
Cryptogam Cover (%)		0	0	0	0	0	
Rock Cover (%)		0	0	5	5	0	

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Flat	**Landform Element**	Plain	**Landform Pattern**	Plain	**Microrelief**	
Lithology	Clayed soil	**Soil Surface Texture**	-	**Soil Colour**	light orange-brown	**Soil Depth**	—
Slope	Leveled	**Aspect**	—	**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R-O	
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1= light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** ________

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** 39

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80[+] cm				
50 - 79 cm				
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	—			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

only a small section of ≤ 10 cm ∅

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm

40
32
72

-This document has not been endorsed or approved by Office of Environment and Heritage or Muddy Boots Environmental Training-

400 m^2 plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 28/3/19		39	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Aristida ramosa		1.5	100		
	Sida corrugata		0.1	200		
	Sclerolaena birchii		0.3	200		
	Solenogyne bellioides		<0.1	40		
	Dichondra sp. A		0.2	90		
	Einadia nutans		<0.1	6		
	Maireana microphylla		0.1	1		
	unidentified grasses / sedges		5			
	Bothriochloa decipiens		0.2	200		
	Opuntia aurantiaca		<0.1	2		
	Austrostipa scabra		0.1	4		

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Total Veg 5
Dead 75
bare 20

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

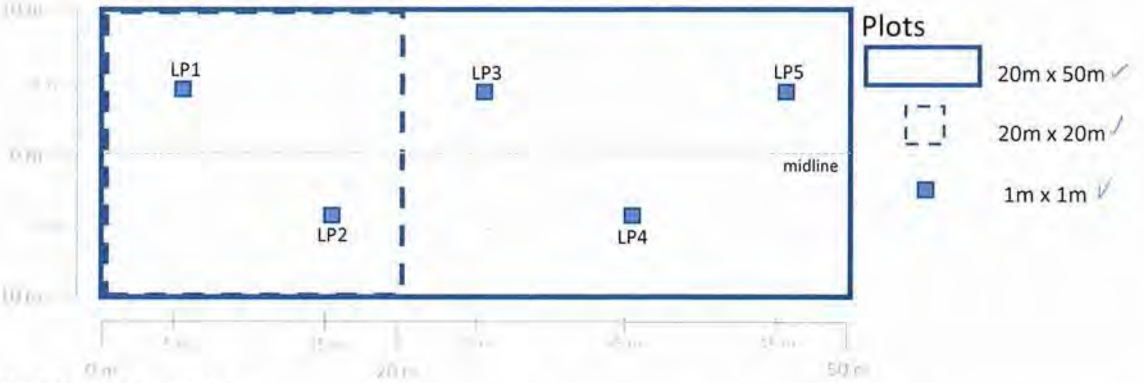
Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 40

Project No: 0470861 **Project Name:** Brinshaw Solar Farm **Zone ID:** ________

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):			**EEC:**		Confidence H M L

BAM Nested Plots Requirement



Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1657	33 9305	67 68 405	40° NE	✓	✓
50 m	1663	33 9350	67 68 429	208° SW	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1658	1659	1660	1661	1662	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		30	30	25	20	40	29
Bare Ground (%)		55	65	70	70	60	64
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		5	5	5	10	0	5

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	Slope ~~Ridge~~ Crest	**Landform Element**	Hillslope	**Landform Pattern**	Hill	**Microrelief**	rocky [illegible]
Lithology	Silty-clay	**Soil Surface Texture**	-	**Soil Colour**	light orange brown	**Soil Depth**	-
Slope	Steep	**Aspect**	315° NW	**Site Drainage**	downslope	**Distance to nearest water and type**	± 50 m NW

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R-O	
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1= light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 40

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class[#]	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80⁺ cm				
50 - 79 cm	///		/	
30 - 49 cm	//		/	
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	14, 4, 3, 2, = 23			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm
Silver-leaved Ironbark	56	1664	33 93 35	67 68 429	< 10 cm ø	
"	45	1663	33 93 14	67 68 405	< 10 cm ø	

Field Data Sheet created by Dr Adriana Corona Mothe

400 m² plot: Sheet _ of _		Survey Name	Plot Identifier	Recorders
Date	28/3/19	Bonshaw	40	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
	Cymbopogon refractus		0.1	10		
	Enneapogon gracilis		0.2	50		
	Aristida ramosa		0.3	100		
	Opuntia aurantiacum		0.2	30		
	Aristida leptopoda		<0.1	5		
	Sida corrugata		0.1	100		
	Dichondra sp A		0.1	40		
	Rostellularia		<0.1	3		
	Glycine		<0.1	20		
	Chamaesyce drummondii		<0.1	3		
	Parsonsia eucalyptifolia		<0.1	400		
	Bothriochloa decipiens		0.1	50		
	Hypericum		<0.1	8		
	Pimelea stricta		<0.1	4		
	Eucalyptus melanophloia		25%		T	
	Ozothamnus cassinioides		<0.1	1		
		?				
	Melichrus urceolatus		<0.1	1		
	Unidentifiable grasses		5			
	just outside plot: Tree orchid					
	Also Notelaea micro					

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code** if 'top 3'.

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

G/C Total veg 6
dead 60
soil 32
rock 3

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 9

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** 41

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):			**EEC:**		Confidence H M L

BAM Nested Plots Requirement

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1667	33 83 92	67 68 534	259° W	✓	✓
50 m	1673	33 83 41	67 68 541	82° E	✓	✓

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1668	1669	1670	1671	1672	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		95	10	5	1	5	23.2
Bare Ground (%)		5	90	5	99	95	58.8
Cryptogam Cover (%)		0	0	60	0	0	12
Rock Cover (%)		0	0	90	0	0	18

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

lots of sheep's & cow's stools

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	crest	**Landform Element**	Hill crest	**Landform Pattern**	Hill crest	**Microrelief**	rocky bould
Lithology	Clayey soils	**Soil Surface Texture**	-	**Soil Colour**	light orange-brown	**Soil Depth**	—
Slope	Very gently inclined	**Aspect**	340° N	**Site Drainage**	-	**Distance to nearest water and type**	—

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R-O	
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1 = light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 41

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ________

Plot 20m x 50m: Tree Classes [a]

DBH Class#	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80+ cm				
50 - 79 cm	/		|	
30 - 49 cm				
20 - 29 cm		X//|		
10 - 19 cm	/	/		
5 - 9 cm		|		
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	3, 2, =5			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

Callitris glaucophylla

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm
Stag - Euc	53	1674	338350	6768546		2

16
56

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400 m² plot: Sheet _ of _	Survey Name	Plot Identifier	Recorders
Date 28/3/14	Bonshaw	41	

GF Code	*Top 3 native species in each growth form group: Full species name mandatory* *All other native and exotic species: Full species name where practicable*	N, E or HTE	Cover	Abund	stratum	voucher
	Cupressus semiglauca 5-7m tall		10	73	T	
	Austrostipa scabra		0.1	40		
	Maireana microphylla		0.3	7		
	Sclerolaena birchii		0.2	100		
	Sida corrugata		<0.1	50		
	Cheilanthes sieberi		<0.1	20		
	Glycine		<0.1	8		
	Oxalis perennans		<0.1	15		
	Einadia nutans		<0.1	15		
	Gomphrena		<0.1	2		
	Boerhavia dominii		<0.1	30		
	Opuntia aurantiaca		<0.1	3		
	Cynodon dactylon		20			
	Aristida ramosa		0.4	30		
	Lots of sheep + cow dung. They like					
	to congregate here					
	Appears to have been oversown with					
	Couch					

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code if 'top 3'.**

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:*** *0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

g/c veg 20
dead / manure 40
rock 25%
soil 15

BAM Plot - Field Survey Form

Sheet A Page 1 of ____

Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 42

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** 42

Desktop Information Requirements for BAM Plot survey

Zone:	56	**IBRA region:**	Nandewar		
Datum:	94	**IBRA sub-region:**	Nandewar Northern Complex		
Likely Vegetation Class:					Confidence H M L
Plant Community Type (PCT):			**EEC:**		Confidence H M L

BAM Nested Plots Requirement

Plot 20m x 50m - midline

Point on midline	Way Point	Easting	Northing	Orientation*	Photo - Horizontal	Photo - Vertical
0 m	1675	33 85 33	67 68 664	18°N	✓	✓
50 m	1681	33 85 34	67 68 715	164°S		

*Magnetig bearing obtained with compas along the midline

BAM Attribute (1m x 1m plots)

Attribute	LP	1	2	3	4	5	Average
	WP	1676	1677	1678	1679	1680	
	Photo	✓	✓	✓	✓	✓	
Litter Cover (%)		40	30	5	90	60	55
Bare Ground (%)		10	70	95	10	40	45
Cryptogam Cover (%)		0	0	0	0	0	0
Rock Cover (%)		0	0	0	0	0	0

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1m x 1m plots centered at 5, 15, 25, 35 and 45m along the midline of the 20m x 50m plot.

LP = Litter Plot (1m x 1m plot); WP =Waypoint;

Physiography + site features that may help in determinng PCT and Management Zone (optional)

Morphological Type	± flat	**Landform Element**	Plain	**Landform Pattern**	Plain	**Microrelief**	grass
Lithology	Clayey soils	**Soil Surface Texture**	-	**Soil Colour**	orange, brown	**Soil Depth**	
Slope	Very Gently inclined	**Aspect**	N	**Site Drainage**		**Distance to nearest water and type**	

Plot Disturbance	Severity Code	Age Code	Observational Evidence
Clearing (incl. logging)	3	O	
Cultivation (incl. pasture)			
Soil Erosion			
Firewood | CWD removal			
Grazing (identify native/stock)	3	R-O	
Fire damage			
Storm damage			
Weediness			
Other			

Severity: 0 = no evidence; 1= light; 2 = moderate; 3 = severe

Age: R = recent (<3 yrs); NR = not recent (3 - 10 yr); O = old (>10 yrs)

Field Data Sheet created by Dr Adriana Corona Mothe

BAM Plot - Field Survey Form

Sheet B Page 2 of ____

Date: 28-03-2019 **Recorders:** ACM, TZ **Plot ID:** 42

Project No: 0470861 **Project Name:** Bonshaw Solar Farm **Zone ID:** ~~42~~

Plot 20m x 50m: Tree Classes [a]

DBH Class#	Tree Stems Count #		Stems with Hollows	
	Euc*	Non-Euc^	Euc*	Non-Euc^
80+ cm	1		1	
50 - 79 cm	[illegible]			
30 - 49 cm				
20 - 29 cm				
10 - 19 cm				
5 - 9 cm				
<5 cm [b]			n/a	n/a
Length of logs (m): (≥10 cm diameter, >50cm in length)	—			

a - Presence/Absence of trees in each class; b -regeneration is size class <5 cm; # Living trees only;

* Euc - Record of living native eucalypt trees (includes all species of Eucalyptus, [redacted]

^ Non-Euc - Record of living native non eucalypt trees

Count apply when the number of tree stems within a size class is ≤10. Estimates can be used when >10 (eg 10, 200, 30, ..., 100, 200, 300). For a multi-stemmed tree, only the largest living stem is included in the count/estimate. Tree Stems must be living.

BAM Attributes: Tree DBH & Hollows (Plot 20m x 50m)

Species Name	DBH (cm)	WP	Easting	Northing	Hollow <20 cm	Hollow >20 cm
Silver-leaved Iron	81	1682	338539	6768671	3x <10cm	

Field Data Sheet created by Dr Adriana Corona Mothe

40
36
16
92

400 m² plot: Sheet _ of _		Survey Name	Plot Identifier	Recorders
Date	28/3/19	Bonshaw	42	

GF Code	Top 3 native species in each growth form group: Full species name mandatory All other native and exotic species: Full species name where practicable	N, E or HTE	Cover	Abund	stratum	voucher
–	Glyin		<0.1	30		
	Sida corrugata		0.1	40		
	Einadia nutans		<0.1	20		
	Eucalyptus melanophloia tree		20	1		
	Maireana microphylla		0.1	2		
	~~Aristida ramosa~~		3	300		
	Heliotropis amplexicaula		<0.1	13		
	Dichondra sp A		<0.1	3		
	Pimelea stricta		<0.1	1		
	Rostellularia adscendens		<0.1	15		
	Boerhavia dominii		<0.1	16		
	Opuntia aurantiaca		<0.1	2		
	Sclerolaena birchii		0.1	40		
	Tribulus terrestris		<0.1	60		
	Portulaca oleracea		<0.1	3		
	Vittadinia sulcata		<0.1	1		
	unidentifiable grasses		4			

GF Code: see Growth Form definitions in Appendix 1 **N:** native, **E:** exotic, **HTE:** high threat exotic **GF – circle code if 'top 3'.**

Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover); ***Note:** 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m*

Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

g/c total veg 7
dead 52
rock 0.1
soil 40

+ tree trunk 0.2%

BAM Plot Data

Table G.1 - Summary of BAM Plot Data

					Composition						Structure						Function										
					Native Richness (count no spp)						Cover (Sum cover of spp in each growth form group)						Large Tree (P/A)	HBT	Litter Cover	Logs	Tree DBH (Tree stems - native species only) (P/A)						HTE
Plot	**Zone**	**Easting**	**Northing**	**Bearing**	**Trees**	**Shrubs**	**Grasses**	**Forbs**	**Ferns**	**Other**	**Trees**	**Shrubs**	**Grasses**	**Forbs**	**Ferns**	**Other**	**>80 cm DBH**	**(P/A)**	**(average)**	**(m)**	**5-9cm DBH**	**10-19cm DBH**	**20-29cm DBH**	**30-49cm DBH**	**50-79cm DBH**	**<5cm DBH**	**(number)**
1	56	337831	6767626	86 E	2	1	1	4	0	0	45.0	0.1	0.2	0.5	0.0	0.0	0	1	42	21.86	1	1	1	1	1	1	1
2	56	338406	6767613	344 N	6	3	3	2	0	3	80.5	0.3	0.3	0.2	0.0	0.3	1	1	75	49.7	1	1	1	0	1	1	1
3	56	338667	6767581	24 NE	3	3	0	2	1	0	45.2	0.4	0.0	0.2	0.1	0.0	0	1	43	37.1	1	1	1	1	1	1	1
4	56	338827	6768189	1 N	1	4	4	4	1	0	0.1	0.4	0.5	0.4	0.1	0.0	0	0	36.4	10	0	0	0	0	0	0	2
5	56	339451	6768659	239 W	3	3	2	3	1	1	35.2	0.3	0.2	0.3	0.1	0.1	0	1	75	33.5	1	1	1	1	1	1	1
6	56	339229	6768505	196 S	0	2	3	7	0	1	0.0	5.1	25.5	0.7	0.0	0.1	0	1	60	0	0	0	0	0	0	0	1
7	56	339300	6768650	236 SW	2	3	3	10	0	3	72.0	0.3	17.1	1.0	0.0	0.3	0	0	50	53	1	1	1	1	0	1	1
8	56	338603	6768514	252 W	4	6	7	7	0	1	68.5	1.9	5.6	2.0	0.0	0.1	0	1	57	54	1	1	1	1	0	1	1
9	56	338079	6768264	294 NW	1	3	9	10	1	1	35.1	0.3	2.7	1.0	0.1	0.1	0	1	24	16	1	1	1	1	0	1	1
10	56	338759	6768130	162 S	3	4	6	9	1	3	43.0	0.4	15.5	0.9	0.1	0.3	0	1	65	80	1	1	1	1	0	1	0
11	56	338572	6767919	247 SW	3	3	6	10	1	2	38.0	0.3	1.0	1.0	0.1	0.3	0	1	50	32	1	1	0	0	1	1	0
12	56	338521	6767776	207 SW	2	4	6	8	0	1	47.3	0.4	0.7	0.8	0.0	0.1	0	0	36	21	1	1	1	1	0	1	1
13	56	338198	6768336	81 E	0	2	4	5	0	1	0.0	0.2	0.9	0.5	0.0	5.0	0	0	7.4	0	0	0	0	0	0	0	1
14	56	338663	6768348	260 W	0	3	11	14	1	1	0.0	0.3	1.3	2.3	0.3	0.1	0	0	35	6	0	0	0	0	0	0	1
15	56	338451	6767511	143 SE	4	3	9	6	1	3	40.1	0.3	1.3	0.6	0.1	0.3	1	1	69	66	1	1	1	1	1	1	1
16	56	338659	6767569	255 W	4	2	4	6	1	3	41.0	0.4	0.8	1.1	0.1	0.5	0	1	53.2	70	1	1	1	1	1	1	1
17	56	338763	6767760	270 W	1	3	4	10	1	1	0.1	0.3	15.1	1.5	0.1	0.2	0	0	30	12	0	1	0	0	0	0	3
18	56	338377	6767858	53 NE	0	2	6	6	1	1	0.0	0.2	6.9	0.7	0.2	0.2	0	0	49	35	0	0	0	0	0	0	0
19	56	338320	6768072	155 SE	0	2	2	5	1	1	0.0	20.2	5.0	0.5	0.1	0.2	0	0	41	4.5	0	0	0	0	0	0	2
20	56	337983	6767855	321 NW	1	1	3	1	0	2	0.1	0.1	0.5	0.1	0.0	0.2	0	0	31	0	0	0	0	0	0	0	1
21	56	337855	6767956	321 NW	1	2	4	10	0	1	3.0	0.2	5.6	1.1	0.0	0.1	0	0	36	40	1	1	1	0	0	1	1
22	56	338024	6768238	298 NW	1	2	3	9	0	2	0.1	0.2	2.1	0.9	0.0	0.3	0	0	38	23	1	0	0	0	0	1	2
23	56	338490	6768126	159 S	1	2	4	4	1	1	0.2	0.2	2.4	0.4	0.1	0.1	0	0	26	4	1	1	1	0	0	1	1
24	56	338800	6768481	170 S	0	1	5	4	1	1	0.0	0.1	2.0	0.8	0.1	0.1	0	0	73	21	0	0	0	0	0	0	0
25	56	338687	6768607	257 W	0	0	5	5	1	1	0.0	0.0	1.3	0.5	0.1	0.1	0	0	74	11	0	0	0	0	0	0	2
26	56	339225	6768408	255 W	2	1	7	5	0	1	0.2	0.1	3.9	0.5	0.0	0.1	0	0	26	21	0	1	0	0	0	1	0
27	56	338344	6768782	184 S	0	1	3	5	1	1	0.0	0.1	40.4	0.5	0.1	0.1	0	0	66	0	0	0	0	0	0	0	1
28	56	338658	6768836	183 S	0	2	1	6	0	1	0.0	0.4	25.0	0.6	0.0	0.1	0	0	33	0	0	0	0	0	0	0	1
29	56	339052	6768750	178 S	2	1	7	8	1	1	0.2	0.1	16.3	8.0	0.1	0.1	0	0	72	43	0	0	0	0	0	1	0
30	56	338535	6769002	25 NW	0	2	3	7	0	3	0.0	0.3	1.1	0.7	0.0	0.3	0	0	45	0	0	0	0	0	0	0	0
31	56	338402	6769323	191 S	2	3	3	8	1	0	3.1	0.4	1.3	0.8	0.1	0.0	0	1	38	2	0	0	1	0	1	0	2
32	56	338518	6769371	173 S	0	2	4	2	1	1	0.0	0.2	40.3	0.2	0.1	0.1	0	0	76	0	0	0	0	0	0	0	1
33	56	338361	6769671	326 NW	0	1	2	2	0	1	0.0	0.1	0.2	0.2	0.0	0.1	0	0	7.4	0	0	0	0	0	0	0	2
34	56	338569	6769788	275 W	0	1	2	4	0	1	0.0	0.3	0.3	0.5	0.0	0.2	0	0	26	0	0	0	0	0	0	0	2
35	56	338671	6769805	262 W	0	2	6	4	0	1	0.0	5.0	3.0	0.4	0.0	0.1	0	0	24.2	0	0	0	0	0	0	0	0
36	56	339043	6768195	315 W	1	1	6	4	0	1	0.1	0.1	3.1	0.4	0.0	0.1	0	0	46.6	22	0	0	0	0	0	0	1
37	56	338564	6768372	177 S	0	1	6	7	1	1	0.0	0.1	4.4	0.7	0.1	0.1	0	0	72	64	0	1	0	0	0	1	1
38	56	338685	6768653	235 SW	1	3	2	1	0	0	50.0	0.3	0.2	0.1	0.0	0.0	0	0	63.6	42	0	1	1	1	1	0	1
39	56	338676	6768698	56 NE	0	2	3	4	0	0	0.0	0.4	1.8	0.5	0.0	0.0	0	0	81.6	0	0	0	0	0	0	0	1
40	56	339305	6768405	40 NE	1	3	5	4	0	2	25.0	0.3	0.8	0.4	0.0	0.2	0	1	29	23	0	0	0	1	1	0	1
41	56	338392	6768534	259 W	1	2	3	4	1	1	10.0	0.5	20.5	0.4	0.1	0.1	0	1	23.2	5	1	1	1	0	1	0	1
42	56	338533	6768664	18 N	1	3	1	7	0	1	20.0	0.3	3.0	0.7	0.0	0.1	1	1	55	0	0	0	0	0	0	0	2

Notes:

x = present
HTE = High Threat Exotic
HBT = Hollow-bearing Tree

P/A = Presence / Absence
1 = Present; 0 = Absent

DBH = Diameter at Breast Heght;
Logs = Length of logs with more than 10cm diameter

BAM Plot photographs

Plot 1: horizontal view from 0m midline (11 Sep 2018)

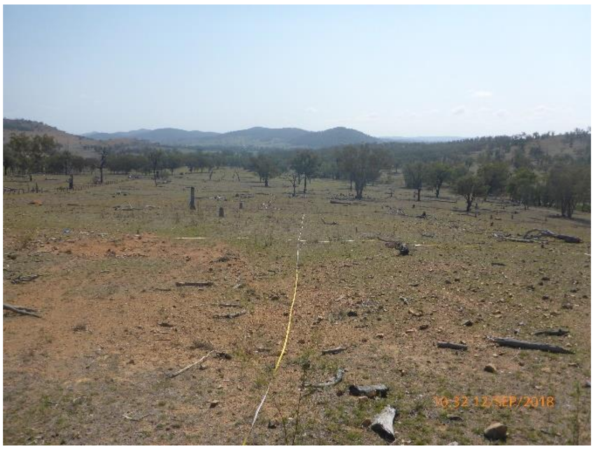
Plot 1: vertical view from 0m midline (11 Sep 2018)

Plot 2: horizontal view from 0m midline (11 Sep 2018)

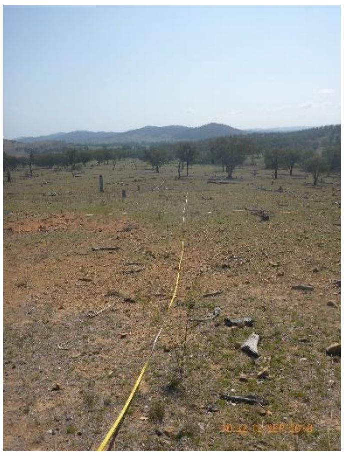
Plot 2: vertical view from 0m midline (11 Sep 2018)

Plot 3: horizontal view from 0m midline (11 Sep 2018)

Plot 3: vertical view from 0m midline (11 Sep 2018)



Plot 4: horizontal view form 0m midline (12 Sep 2018)



Plot 4: vertical view from 0m midline (12 Sep 2018)

Plot 5: horizontal view from 0m midline (12 Sep 2018)

Plot 5: vertical view from 0m midline (12 Sep 2018)

Plot 6: horizontal view from 0m midline (11 Dec 2018)

Plot 6: vertical view form 0m midline (11 Dec 2018)

Plot 7: horizontal view from 0m midline (12 Dec 2018)

Plot 7: vertical view from 0m midline (12 Dec 2018)

Plot 8: horizontal view from 0m midline (13 Dec 2018)

Plot 8: vertical view from 0m midline (13 Dec 2018)

Plot 9: horizontal view from 0m midline (13 Dec 2018)

Plot 9: vertical view from 0m midline (13 Dec 2018)

Plot 10: horizontal view from 0m midline (13 Dec 2018)

Plot 10: vertical view from 0m midline (13 Dec 2018)

Plot 11: horizontal view from 0m midline (13 Dec 2018)

Plot 11: vertical view from 0m midline (13 Dec 2018)

Plot 12: horizontal view from 0m midline (13 Dec 2018)

Plot 12: vertical view from 0m midline (13 Dec 2018)

Plot 13: horizontal view from 0m midline (14 Dec 2018)

Plot 13: vertical view from 0m midline (14 Dec 2018)

Plot 14: horizontal view from 0m midline (14 Dec 2018)

Plot 14: vertical view from 0m midline (14 Dec 2018)

Plot 15: horizontal view from 0m midline (25 Mar 2019)

Plot 15: vertical view from 0m midline (25 Mar 2019)

Plot 16: horizontal view from 0m midline (25 Mar 2019)

Plot 16: vertical view from 0m midline (25 Mar 2019)

Plot 17: horizontal view from 0m midline (25 Mar 2019)

Plot 17: vertical view from 0m midline (25 Mar 2019)

Plot 18: horizontal view from 0m midline (25 Mar 2019)

Plot 18: vertical view from 0m midline (25 Mar 2019)

Plot 19: horizontal view from 0m midline (25 Mar 2019)

Plot 19: vertical view from 0m midline (25 Mar 2019)

Plot 20: horizontal view from 0m midline (26 Mar 2019)

Plot 20:horizontal view from 0m midline (26 Mar 2019)

Plot 21: horizontal view from 0m midline (26 Mar 2019)

Plot 21: horizontal view from 0m midline (26 Mar 2019)

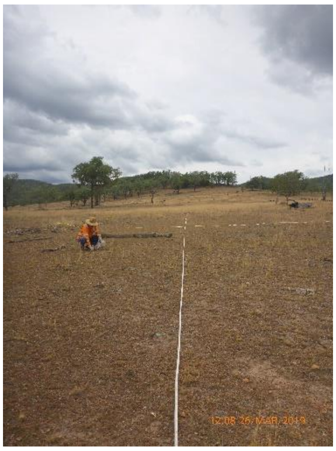
Plot 22: horizontal view from 0m midline (26 Mar 2019)

Plot 22: horizontal view from 0m midline (26 Mar 2019)

Plot 23: horizontal view from 0m midline (26 Mar 2019)

Plot 23: horizontal view from 0m midline (26 Mar 2019)

Plot 24: horizontal view from 0m midline (26 Mar 2019)



Plot 24: horizontal view from 0m midline (26 Mar 2019)

Plot 25: horizontal view from 0m midline (26 Mar 2019)

Plot 25: horizontal view from 0m midline (26 Mar 2019)

Plot 26: horizontal view from 0m midline (26 Mar 2019)

Plot 26: horizontal view from 0m midline (26 Mar 2019)

Plot 27: horizontal view from 0m midline (27 Mar 2019)

Plot 27: horizontal view from 0m midline (27 Mar 2019)

Plot 28: horizontal view from 0m midline (27 Mar 2019)

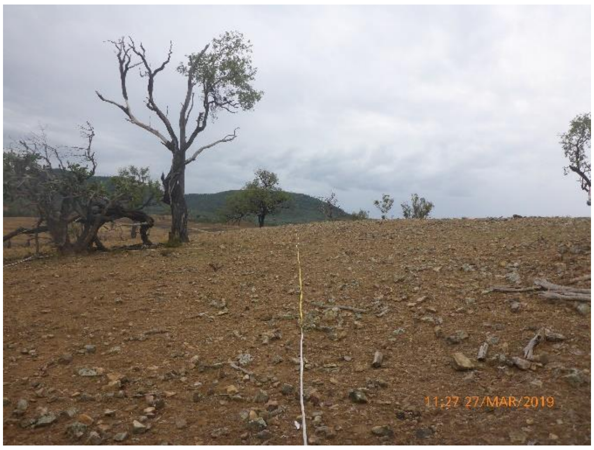
Plot 28: horizontal view from 0m midline (27 Mar 2019)

Plot 29: horizontal view from 0m midline (27 Mar 2019)

Plot 29: horizontal view from 0m midline (27 Mar 2019)

Plot 30: horizontal view from 0m midline (27 Mar 2019)

Plot 30: horizontal view from 0m midline (27 Mar 2019)



Plot 31: horizontal view from 0m midline (27 Mar 2019)

Plot 31: horizontal view from 0m midline (27 Mar 2019)

Plot 32: horizontal view from 0m midline (27 Mar 2019)

Plot 32: horizontal view from 0m midline (27 Mar 2019)

Plot 33: horizontal view from 0m midline (27 Mar 2019)

Plot 33: horizontal view from 0m midline (27 Mar 2019)

Plot 34: horizontal view from 0m midline (27 Mar 2019)

Plot 34: horizontal view from 0m midline (27 Mar 2019)

Plot 35: horizontal view from 0m midline (27 Mar 2019)

Plot 35: horizontal view from 0m midline (27 Mar 2019)

Plot 36: horizontal view from 0m midline (28 Mar 2019)

Plot 36: horizontal view from 0m midline (28 Mar 2019)

Plot 37: horizontal view from 0m midline (28 Mar 2019)

Plot 37: horizontal view from 0m midline (28 Mar 2019)

Plot 38: horizontal view from 0m midline (28 Mar 2019)

Plot 38: horizontal view from 0m midline (28 Mar 2019)


12:03 28/MAR/2019


12:03 28/MAR/2019

Plot 39: horizontal view from 0m midline (28 Mar 2019) Plot 39: horizontal view from 0m midline (28 Mar 2019)


12:04 28/MAR/2019


12:04 28/MAR/2019

Plot 40: horizontal view from 0m midline (28 Mar 2019) Plot 40: horizontal view from 0m midline (28 Mar 2019)

Plot 41: horizontal view from 0m midline (28 Mar 2019)

Plot 41: horizontal view from 0m midline (28 Mar 2019)

Plot 42: horizontal view from 0m midline (28 Mar 2019)

Plot 42: horizontal view from 0m midline (28 Mar 2019)

APPENDIX H FLORA AND FAUNA SPECIES LISTS

Table H.1 Bird Species Records

Family	Common Name	Scientific Name	BC Act	EPBC Act	B1	B2	B3	B4	B5	B6	B7	Incidentals
Acanthizidae	Weebill	*Smicrornis brevirostris*				1	2					I
Acanthizidae	White-throated Gerygone	*Gerygone albogularis*										II
Acanthizidae	Yellow-rumped thornbill	*Acanthiza chrysorrhoa*										I
Accipitridae	Whistling Kite	*Haliastur sphenurus*										I
Aegothelidae	Australian Owlet-nightjar	*Aegotheles cristatus*										I
Anatidae	Pacific Black-duck	*Anas superciliosa*								10		I
Artamidae	Australian Magpie	*Cracticus tibicen*			2	1		1		2	3	I
Artamidae	Grey Butcherbird	*Cracticus torquatus*			1	1	1	1			1	I
Artamidae	Pied Butcherbird	*Pied Butcherbird*								1		I
Artamidae	Pied Currawong	*Strepera graculina*			1		1	1				I
Cacatuidae	Galah	*Eolophus roseicapillus*						1		5	4	I
Cacatuidae	Little Corella	*Cacatua sanguinea*								30		
Cacatuidae	Sulphur-crested Coockatoo	*Cacatua galerita*								6		I
Campephagidae	Cicadabird	*Coracina tenuirostris*		Ma		1						I
Campephagidae	Black-faced cuckooshrike	*Coracina novaehollandiae*										I
Campephagidae	White-winged Triller	*Lalage sueurii*										I
Charadriidae	Masked Lapwing	*Vanellus miles*										I
Columbidae	Crested Pigeon	*Ocyphaps lophotes*			2	2	1	1		1		I
Columbidae	Common bronzewing	*Phaps chalcoptera*										I

Family	Common Name	Scientific Name	BC Act	EPBC Act	B1	B2	B3	B4	B5	B6	B7	Incidentals
Columbidae	Peaceful Dove	*Geopelia striata*										II
Corcoracidae	Apostlebird	*Struthidea cinerea*			6	2				3	2	I
Corcoracidae	White-winged Chough	*Corcorax melanorhamphos*			4							I
Corvidae	Australian Raven	*Corvus coronoides*			2							I
Corvidae	Torresian Crow	*Corvus orru*				3		1				I
Cuculidae	Channel-billed Cockoo	*Scythrops novaehollandiae*								1		I
Cuculidae	Eastern Koel	*Eudynamys orientalis*			1						1	
Estrildidae	Double-barred Finch	*Taeniopygia bichenovii*										I
Falconidae	Nankeen Kestrel	*Falco cenghroides*										I
Meliphagidae	Blue-faced Honeyeater	*Entomyzon cyanotis*						1				
Meliphagidae	Lewin's Honeyeaater	*Meliphaga lewinii*					1				1	
Meliphagidae	Little Friabird	*Philemon citreogularis*			2	3	1		1		3	I
Meliphagidae	Noisy Miner	*Manorina melanocephala*			5	4	4	11		2	4	I
Meliphagidae	Striped Honeyeater	*Plectorhyncha lanceolata*					1					I
Meliphagidae	Brown Honeyeater	*Lichmera indistincta*										I
Monarchidae	Magpie-lark	*Grallina cyanoleuca*			2	2		1		9	1	I
Motacillidae	Australasian Pipit	*Anthus novaeseelandiae*						1			1	I
Nectariniidae	Mistletoebird	*Dicaeum hirundinaceum*										I
Oriolidae	Olive-backed Oriole	*Oriolus sagitattus*										I
Pachycephalidae	Rufus Whistler	*Pachycephala rufiventris*										I
Pardalotidae	Striated Pardalote	*Pardalotus striatus*			1			1		2	1	I
Pomatostomidae	Grey-crowned Babbler	*Pomatostomus temporalis*	V*							1	4	

Family	Common Name	Scientific Name	BC Act	EPBC Act	B1	B2	B3	B4	B5	B6	B7	Incidentals
Psittacidae	Pale-headed Rosella	*Platycercus adscitus*			1	5					1	I
Psittacidae	Red-rumped Parrot	*Psephotus haematonotus*				10	4	1	1			I
Psittacidae	Red-winged Parrot	*Aprosmictus erythropterus*				6	1					
Psittacidae	Eastern Rosella	*Platycercus eximius*										I
Rhipiduridae	Willie Wagtail	*Rhipidura leucophrys*			1	1		1			2	I

Notes: # = number of individuals; I - one record; II = two records;

Table H.2 Reptile species records

Family	Common Name	Scientific Name	BC Act	EPBC Act	R1	R2	R3	R4	R5	R6	R7	R8	Incidentals
Varanidae	Monitor Lizard	*Varanus varius*											I
Gekkonidae	Bynoe's Gecko	*Heteronotia binoei*											I
Scincidae	Tree-base Litter-skink, Rainbow Skink	*Lygisaurus foliorum*											I
Gekkonidae	A Gecko	Gehyra sp.						1					
	Small brown gecko												I
	Skink												I
	Turtle												I

Table H.3 Mammal species records

Family	Common Name	Scientific Name	BC Act	EPBC Act	Incidentals
Bovidae	European Cattle	*Bos taurus*			x
Bovidae	Sheep	*Ovis aries*			x
Canidae	Dog	*Canis lupus familiaris*			x
Leporidae	European Rabbit	*Oryctolagus cuniculus*			scat, x
Macropodidae	Common wallaroo	*Macropus robustus*			x
Macropodidae	Eastern Grey Kangaroo	*Macropus giganteus*			x
Peramelidae	Northern Brown Bandicoot	*Isoodon macrourus*			x
Phalangeridae	Common brushtail possum	*Trichosurus vulpecula*			x

Table H.4 Amphibian species list

Family	Common Name	Scientific Name	F1	F2	F3	Incidentals
Hyalidae	Desert Tree Frog	*Litoria rubella*	C			
Hylidae	Broad-palmed Frog	*Litoria latopalmata*				O
Hylidae	Peron's Tree Frog	*Litoria peronii*				O

Notes: C = heard calling; O = observed;

Table H.5 Microchiropteran Bat Species List

Family	Common Name	Scientific Name	BC Act	EPBC Act	S2	S3	S4	S5	S6	S7	S8
Molossidae	*Austronomus australis*	White-striped Freetail-bat	-		D	D	D	D	D	D	D
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat			D	D	D	D	D	D	D
Vespertilionidae	*Chalinolobus morio*	Chocolate Wattled Bat			D	D	D	D	D	D	D
Vespertilionidae	*Chalinolobus picatus*	Little Pied Bat	V		D	D	D	D	P	D	D
Miniopteridae	*Miniopterus schreibersii oceanensis* *	Eastern Bent-winged Bat	V		D	D	D	D	D	D	D
Molossidae	*Ozimops planiceps / O. petersi*	South-eastern Free-tailed Bat / Inland Free-tailed Bat	-	-	P	P	P	P	P	P	P
Molossidae	*Ozimops ridei*	Ride's Free-tailed Bat			D	D	D	D	D	D	D
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheath-tailed Bat	V		D	D	D	D	D	D	D
Vespertilionidae	*Scotorepens balstoni*	Inland Broad-nosed Bat			D	D	D	D	D	D	P
Vespertilionidae	*Scotorepens greyii*	Little Broadnosed Bat			17	15	46	210	26	10	27
Molossidae	*Mormopterus eleryi* **	Bristle-faced Free-tailed Bat	E		5		11	25	1	12	
Vespertilionidae	*Vespadelus troughtoni*	Eastern Cave Bat	V		P	P	P	P	P	P	P
Vespertilionidae	*Vespadelus vulturnus*	Little Forest Bat			D	D	D	D	D	D	D
Nyctophilus species - group formed by the three species below					D	D	D	D	D	D	
Vespertilionidae	*Nyctophilus corbeni*	Corben's Long-eared Bat	V	V							
Vespertilionidae	*Nyctophilus geoffroyi*	Lesser Long-eared Bat									
Vespertilionidae	*Nyctophilus gouldi*	Gould's Long-eared Bat									
Vespertilionidae/ Molosidae	*Scotorepens greyii* or *Chalinolobus nigrogriseus*^{V}	Little Broad-nosed Bat or Hoary Wattled Bat	V		P	P	P	P	P	P	P

Family	**Common Name**	**Scientific Name**	**BC Act**	**EPBC Act**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**
Vestertilionidae /	*Scotorepens greyii* or *Falsistrellus tasmaniensis*[V]	Little Broad-nosed Bat or Eastern False Pipistrelle	V		P	P	P	P	P	P	

*D = Definite call identification, i.e. at least one call attributed unequivocally to the species; P = Possible call identification, i.e. calls like those of the species were recorded, but were not reliably identified; V = Vulnerable; * reported as Miniopterus orianae oceanensis by Balance! Environmental (see Appendix I); ** reported as Setirostris eleryi by Balance! Environmental (see Appendix I)*

Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	I	Plot 1		Plot 2		Plot 3		Plot 4		Plot 5		Plot 6	
						C	A	C	A	C	A	C	A	C	A	C	A
Acanthaceae	*Rostellularia adscendens*	-	N	FG										X	X		
Amaranthaceae	*Alternanthera sp. A* Flora of New South Wales (M.Gray 5187) J. Palmer	-	N	FG												0.1	4
Amaranthaceae	*Gomphrena celosioides*	Gomphrena Weed	E	N/A													
Apiaceae	*Actinotus sp. 1*	-	N	FG		0.2	2000										
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery	E	N/A													
Apocynaceae	*Carissa ovata* (i.e. *Carissa spinarum*)	-	N	OG													X
Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton B	E	N/A													
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo	N	OG	X												
Apocynaceae	*Parsonsia sp. 1*	-	N	OG				0.1	124								
Asteraceae	*Asteraceae*	-	N	FG													
Asteraceae	*Asteraceae sp. 1*	-	E	N/A		0.5	1000	0.1	110	0.1	1						
Asteraceae	*Asteraceae sp. 2*	-	E	N/A				0.1	30								
Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy	N	FG													
Asteraceae	*Carthamus lanatus*	Saffron Thistle	HTE	N/A													
Asteraceae	*Cassinia arcuata*	Siffon Bush	N	SG													
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting, Ye	N	FG													
Asteraceae	*Cirsium vulgare*	Spear Thistle	E	N/A													
Asteraceae	*Gamochaeta sp. 1*	a Cudweed	E	N/A		0.1	20										
Asteraceae	*Glossocardia bidens*	Cobbler's Tack	N	FG													
Asteraceae	*Hypochaeris glabra*	Smooth Catsear	E	N/A													
Asteraceae	*Hypochaeris radicata*	Flatweed	E	N/A		0.1	112										
Asteraceae	*Lactuca serriola*	Prickly Lettuce	E	N/A													
Asteraceae	*Leiocarpa brevicompta*	Flat Billy-buttons	N	FG	X												
Asteraceae	*Ozothamnus cassinioides*	-	N	SG						0.2	173						
Asteraceae	*Senecio sp. 1*	a Fireweed	E	N/A						0.1	6	0.1	1				
Asteraceae	*Solenogyne bellioides*	-	N	FG													
Asteraceae	*Vittadinia cuneata var. cuneata*	-	N	FG													
Asteraceae	*Vittadinia sp.*	-	N	FG												0.1	8
Asteraceae	*Vittadinia sulcata*	-	N	FG													
Asteraceae	*Xanthium spinosum*	Bathurst Burr	HTE	N/A													
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	N	OG				0.1	11					0.1	1		
Boraginaceae	*Heliotropium amplexicaule*	Blue Heliotrope	HTE	N/A													
Cactaceae	*Opuntia aurantiaca*	Tiger Pear	HTE	N/A	X	0.1	17	0.1	1	0.1	2	0.1	4			0.1	1
Cactaceae	*Opuntia tomentosa*	Velvet Tree Pear	HTE	N/A	X							-	X	0.1	4		
Campanulaceae	*Wahlenbergia graniticola*	Granite Bluebell	N	FG								0.1	3				
Campanulaceae	*Wahlenbergia sp.*	-	N	FG	X											0.1	44
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	N	FG													
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	N	FG		0.1	1										
Chenopodiaceae	*Maireana microphylla*	Small-leaf Bluebush	N	SG													
Chenopodiaceae	*Sclerolaena birchii*	Galvanized Burr	N	SG	X	-	X			0.1	28	0.1	16			0.1	1
Convolvulaceae	*Convolvulus erubescens*	Blushing Bindweed	N	OG													
Convolvulaceae	*Dichondra repens*	Kidney Weed	N	FG								0.1	20	0.1	222		
Convolvulaceae	*Dichondra sp. A* Sensu Harden (1992)	-	N	FG	X			0.1	3								
Convolvulaceae	*Evolvulus alsinoides*	Dwarf Monring Glory	N	FG	X												
Cupressaceae	*Callitris endlicheri*	Black Cypress Pine	N	TG	X												
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine	N	TG	X	30	30	0.1	3	0.2	44	0.1	1	0.2	166		
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge	N	GG													

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Family	Scientific Name	Common Name	N, E or THE	Growth Form	I	Plot 1		Plot 2		Plot 3		Plot 4		Plot 5		Plot 6	
						C	A	C	A	C	A	C	A	C	A	C	A
Cyperaceae	*Schoenus sp. 1*	a Bog-rush	N	GG				0.1	62			0.1	1				
Ericaceae (Epacridoideae)	*Melichrus urceolatus*	Urn-heath	N	SG				0.1	1								
Euphorbiaceae	*Euphorbia dallachyana*	Mat Spurge	N	SG								0.1	1				
Euphorbiaceae	*Euphorbia drummondii*	Mat Spurge	N	FG													
Euphorbiaceae	*Euphorbia sp.*	-	N	FG													
Euphorbiaceae	*Euphorbia sp. 1*	-	E	N/A				0.1	21								
Fabaceae (Faboideae)	*Bossiaea scortechinii*	-	N	SG								0.1	3				
Fabaceae (Faboideae)	*Bossiaea sp.*	-	N	SG										0.1	4		
Fabaceae (Faboideae)	*Desmodium sp.*	-	N	FG												0.1	40
Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	N	OG												0.1	378
Fabaceae (Faboideae)	*Glycine clandestina*	-	N	OG													
Fabaceae (Faboideae)	*Hardenbergia violaceae*	Purple Coral Pea	N	OG				0.1	1								
Fabaceae (Faboideae)	*Rhynchosia minima*	-	N	OG													
Fabaceae (Faboideae)	*Trifolium sp. 1*	a Clover	E	N/A		0.1	24	0.1	2	0.1	6	0.1	3				
Fabaceae (Faboideae)	*Trifolium sp. 2*	a Clover	E	N/A		0.1	122										
Fabaceae (Faboideae)	*Zornia dyctiocarpa*	Zornia	N	FG													
Fabaceae (Mimosoideae)	*Acacia decora*	Western Silver Wattle, S	N	SG	X												
Fabaceae (Mimosoideae)	*Neptunia gracilis*	Native Senstitive Plant	N	FG													
Geraniaceae	*Geranium molle*	Cranesbill Geranium	E	N/A		0.1	1										
Goodeniaceae	*Goodenia sp. 1*	-	N	FG						0.1	7	0.1	2	0.1	3		
Haloragaceae	*Haloragis sp.*	-	N	FG													
Hypericaceae	*Hypericum sp.*	-	E	N/A													
Juncaceae	*Juncus sp.*	a Rush	E	N/A												0.1	5
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush	N	GG													
Loranthaceae	*Amyema miquelii*	-	N	OG													
Malvaceae	*Sida corrugata*	Corrugated Sida	N	FG		0.1	1										
Moraceae	*Ficus sp. 1*	a Fig	N	TG				0.3	7								
Myrtaceae	*Angophora floribunda*	Rough-barked Apple	N	TG	X												
Myrtaceae	*Corymbia dolichocarpa*	Long-fruited Bloodwood	N	TG	X												
Myrtaceae	*Corymbia sp.*	-	N	TG										X			
Myrtaceae	*Eucalyptus albens*	White Box	N	TG	X			30	1								
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	N	TG	X												
Myrtaceae	*Eucalyptus dealbata*	Tumbledown Red Gum	N	TG						20	3			15	2		
Myrtaceae	*Eucalyptus melanophloia*	Silver-leaved Ironbark	N	TG	X	15	1	20	1	25	1						
Myrtaceae	*Eucalyptus melliodora*	Yellow Box	N	TG	X												
Myrtaceae	*Eucalyptus prava*	Orange Gum	N	TG	X									20	18		
Nyctaginaceae	*Boerhavia dominii*	Tarvine	N	FG												0.1	5
Oleaceae	*Notelaea longifolia*	Large-leaved Olive	N	TG				30	47								
Oleaceae	*Notelaea microcarpa*	Native Olive	N	TG				0.1	1								
Oleaceae	*Notelaea sp.*	an olive	N	SG													
Oxalidaceae	*Oxalis perennans*	-	N	FG		0.1	62	0.1	119	0.1	8	0.1	37	0.1	2		
Phyllanthaceae	*Breynia sp.*	-	N	SG													
Phyllanthaceae	*Phyllanthus virgatus*	-	N	FG													
Pittosporaceae	*Pittosporum spinescens*	Wallaby Apple	N	SG				0.1	6								
Plantaginaceae	*Plantago debilis*	-	N	FG												0.1	27
Plantaginaceae	*Plantago sp. 1*	a Plantain	E	N/A						0.1	1						
Poaceae	*Aristida leptopoda*	White Speargrass	N	GG													
Poaceae	*Aristida ramosa*	Purple Wiregrass	N	GG	X											25	633

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						C	A	C	A	C	A	C	A	C	A	C	A
Poaceae	*Austrostipa scabra subsp. scabra*	Speargrass	N	GG												0.3	336
Poaceae	*Austrostipa verticillata*	Slender Bamboo Grass	N	GG	X												
Poaceae	*Bothriochloa biloba*	-	N	GG													
Poaceae	*Bothriochloa decipiens*	Red Grass, Redleg Grass	N	GG								0.2	305				
Poaceae	*Chloris truncata*	Windmill Grass	N	GG													
Poaceae	*Chloris ventricosa*	Plump Windmill Grass	N	GG													
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	N	GG	X												
Poaceae	*Cynodon dactylon*	Couch, Bermudagrass	N	GG	X												
Poaceae	*Digitaria brownii*	Cotton Panic Grass	N	GG													
Poaceae	*Digitaria diffusa*	Open Summer-grass	N	GG													
Poaceae	*Enneapogon gracilis*	Slender Bottle-washers	N	GG													
Poaceae	*Entolasia stricta*	Wiry Panic	N	GG													
Poaceae	*Eragrostis brownii*	Brown's Lovegrass	N	GG													
Poaceae	*Eragrostis leptostachya*	Paddock Lovegrass	N	GG												0.2	476
Poaceae	*Eragrostis sp.*	-	N	GG						0.1	10						
Poaceae	*Eragrostis sp. 1*	-	E	N/A						0.1	10						
Poaceae	*Eulalia aurea*	Sliky Browntop	N	GG													
Poaceae	*Heteropogon contortus*	Bunch Speargrass	N	GG													
Poaceae	*Panicum simile*	Two Colour Panic	N	GG													
Poaceae	*Panicum sp. 1*	a Panic Grass	E	N/A		0.1	1										
Poaceae	*Paspalidium distans*	-	N	GG													
Poaceae	*Poa sp. 1*	-	E	N/A						0.1	600						
Poaceae	*Sporobolus creber*	Western Rat-tail Grass	N	GG													
Poaceae	*Sporobolus elongatus*	Slender Rat's Tail Grass	N	GG				0.1	2			0.1	5	0.1	12		
Poaceae	*Sporobolus sp.*	-	E	N/A													
Poaceae	*Themeda triandra*	Kangaroo Grass	N	GG		0.2	470					0.1	200				
Poaceae	*Tripogon loliiformis*	Fiveminute Grass	N	GG		0.1	400	0.1	123					0.1	1000		
Poaceae	*Urochloa panicoides*	Urochloa Grass, Liversee	E	N/A													
Polygonaceae	*Rumex brownii*	Swamp Dock	N	FG												0.1	16
Polygonaceae	*Rumex sp.*	-	N	FG	X												
Portulacaceae	*Portulaca bicolor*	-	N	FG													
Portulacaceae	*Portulaca oleracea*	Pigweed	N	FG													
Proteaceae	*Hakea laevipes*	-	N	SG													
Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern	N	EG	X					0.1	22						
Pteridaceae	*Cheilanthes sieberi*	-	N	EG								0.1	240	0.1	133		
Rutaceae	*Geijera parviflora*	Wilga	N	SG	X			30	47								
Sapindaceae	*Dodonaea viscosa subsp. spatulata*	-	N	SG	X									0.1	1		
Solanaceae	*Solanum ferocissimum*	Spiny Potato Bush	N	SG													
Solanaceae	*Solanum sp.*	-	N	FG													
Solanaceae	*Solanum sp. 1*	-	E	N/A		0.1	12										
Solanaceae	*Solanum sturtianum*	Thargomindah Nightsha	N	SG													
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia	N	FG													
Thymelaeaceae	*Pimelea neo-anglica*	Poison Pimelea	N	SG		0.1	1	0.1	4	0.1	3	0.1	17	0.1	2	5	15
Thymelaeaceae	*Pimelea stricta*	-	N	SG	X												
Urticaceae	*Urtica urens*	Small Nettle	E	N/A		0.1	145			0.1	32	0.1	27				
Verbenaceae	*Glandularia aristigera*	Mayne's Pest	E	N/A	X												
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Johnson's Grass Tree	N	OG													
Zygophyllaceae	*Tribulus terrestris*	Caltrop	E	N/A													

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						C	A	C	A	C	A	C	A	C	A	C	A
Unknown	Undetermined exotic	-	E	N/A										0.1	2		
Unknown	Unidentified Forb B	-	N	FG													
Rubiaceae	Rubiaceae	-	N	SG													
Unknown	Unidentified Forb A	-	N	FG													
Unknown	Unidentified Forb C	-	N	FG													
Unidentified	unidentified species	-	-	-													

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Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 7		Plot 8		Plot 9		Plot 10		Plot 11		Plot 12	
					C	A	C	A	C	A	C	A	C	A	C	A
Acanthaceae	*Rostellularia adscendens*	-	N	FG	0.1	8			0.1	20			0.1	12	0.1	8
Amaranthaceae	*Alternanthera sp. A* Flora of New South Wales (M.Gray 5187) J. Palmer	-	N	FG												
Amaranthaceae	*Gomphrena celosioides*	Gomphrena Weed	E	N/A												
Apiaceae	*Actinotus sp. 1*	-	N	FG												
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery	E	N/A												
Apocynaceae	*Carissa ovata* (i.e. *Carissa spinarum*)	-	N	OG												
Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton B	E	N/A												
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo	N	OG	0.1	2										
Apocynaceae	*Parsonsia sp. 1*	-	N	OG												
Asteraceae	*Asteraceae*	-	N	FG											0.1	8
Asteraceae	*Asteraceae sp. 1*	-	E	N/A												
Asteraceae	*Asteraceae sp. 2*	-	E	N/A												
Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy	N	FG	0.1	2			0.1	2			0.1	4	0.1	12
Asteraceae	*Carthamus lanatus*	Saffron Thistle	HTE	N/A												
Asteraceae	*Cassinia arcuata*	Siffon Bush	N	SG			1	7	0.1	1	0.1	1			0.1	6
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting, Ye	N	FG							0.1	14	0.1	7		
Asteraceae	*Cirsium vulgare*	Spear Thistle	E	N/A												
Asteraceae	*Gamochaeta sp. 1*	a Cudweed	E	N/A												
Asteraceae	*Glossocardia bidens*	Cobbler's Tack	N	FG							0.1	2				
Asteraceae	*Hypochaeris glabra*	Smooth Catsear	E	N/A					0.1	2						
Asteraceae	*Hypochaeris radicata*	Flatweed	E	N/A												
Asteraceae	*Lactuca serriola*	Prickly Lettuce	E	N/A					0.1	2						
Asteraceae	*Leiocarpa brevicompta*	Flat Billy-buttons	N	FG												
Asteraceae	*Ozothamnus cassinioides*	-	N	SG												
Asteraceae	*Senecio sp. 1*	a Fireweed	E	N/A												
Asteraceae	*Solenogyne bellioides*	-	N	FG												
Asteraceae	*Vittadinia cuneata var. cuneata*	-	N	FG			0.1	2	0.1	1	0.1	2				
Asteraceae	*Vittadinia sp.*	-	N	FG									0.1	3	0.1	3
Asteraceae	*Vittadinia sulcata*	-	N	FG												
Asteraceae	*Xanthium spinosum*	Bathurst Burr	HTE	N/A												
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	N	OG	0.1	4					0.1	1				
Boraginaceae	*Heliotropium amplexicaule*	Blue Heliotrope	HTE	N/A												
Cactaceae	*Opuntia aurantiaca*	Tiger Pear	HTE	N/A	0.1	19	0.1	3	0.1	4					0.1	1
Cactaceae	*Opuntia tomentosa*	Velvet Tree Pear	HTE	N/A												
Campanulaceae	*Wahlenbergia graniticola*	Granite Bluebell	N	FG												
Campanulaceae	*Wahlenbergia sp.*	-	N	FG	0.1	27			0.1	52	0.1	14	0.1	8	0.1	2
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	N	FG			1	216					0.1	9		
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	N	FG												
Chenopodiaceae	*Maireana microphylla*	Small-leaf Bluebush	N	SG												
Chenopodiaceae	*Sclerolaena birchii*	Galvanized Burr	N	SG									0.1	1		
Convolvulaceae	*Convolvulus erubescens*	Blushing Bindweed	N	OG												
Convolvulaceae	*Dichondra repens*	Kidney Weed	N	FG												
Convolvulaceae	*Dichondra sp. A* Sensu Harden (1992)	-	N	FG	0.1	200			0.1	4	0.1	73	0.1	30	0.1	1
Convolvulaceae	*Evolvulus alsinoides*	Dwarf Monring Glory	N	FG	0.1	1	0.1	1								
Cupressaceae	*Callitris endlicheri*	Black Cypress Pine	N	TG			10.6	22								
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine	N	TG	41	21	27.1	40	35.1	247	3.5	41	0.7	18	0.1	6
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge	N	GG			0.1	40	0.1	3	15	1040	0.3	320	0.1	23

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					C	A	C	A	C	A	C	A	C	A	C	A
Cyperaceae	*Schoenus sp. 1*	a Bog-rush	N	GG												
Ericaceae (Epacridoideae)	*Melichrus urceolatus*	Urn-heath	N	SG			0.5	9			0.1	1				
Euphorbiaceae	*Euphorbia dallachyana*	Mat Spurge	N	SG												
Euphorbiaceae	*Euphorbia drummondii*	Mat Spurge	N	FG												
Euphorbiaceae	*Euphorbia sp.*	-	N	FG					0.1	1	0.1	6				
Euphorbiaceae	*Euphorbia sp. 1*	-	E	N/A												
Fabaceae (Faboideae)	*Bossiaea scortechinii*	-	N	SG												
Fabaceae (Faboideae)	*Bossiaea sp.*	-	N	SG												
Fabaceae (Faboideae)	*Desmodium sp.*	-	N	FG					0.1	31	0.1	6	0.1	2	0.1	32
Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	N	OG	0.1	86			0.1	2	0.1	20	0.2	21	0.1	2
Fabaceae (Faboideae)	*Glycine clandestina*	-	N	OG												
Fabaceae (Faboideae)	*Hardenbergia violaceae*	Purple Coral Pea	N	OG												
Fabaceae (Faboideae)	*Rhynchosia minima*	-	N	OG												
Fabaceae (Faboideae)	*Trifolium sp. 1*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Trifolium sp. 2*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Zornia dyctiocarpa*	Zornia	N	FG			0.1	2								
Fabaceae (Mimosoideae)	*Acacia decora*	Western Silver Wattle, S	N	SG												
Fabaceae (Mimosoideae)	*Neptunia gracilis*	Native Senstitive Plant	N	FG												
Geraniaceae	*Geranium molle*	Cranesbill Geranium	E	N/A												
Goodeniaceae	*Goodenia sp. 1*	-	N	FG												
Haloragaceae	*Haloragis sp.*	-	N	FG												
Hypericaceae	*Hypericum sp.*	-	E	N/A			0.1	15	0.1	2						
Juncaceae	*Juncus sp.*	a Rush	E	N/A												
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush	N	GG												
Loranthaceae	*Amyema miquelii*	-	N	OG							0.1	10	0.1	3		
Malvaceae	*Sida corrugata*	Corrugated Sida	N	FG	0.1	4	0.5	80			0.1	4	0.1	12		
Moraceae	*Ficus sp. 1*	a Fig	N	TG												
Myrtaceae	*Angophora floribunda*	Rough-barked Apple	N	TG												
Myrtaceae	*Corymbia dolichocarpa*	Long-fruited Bloodwood	N	TG												
Myrtaceae	*Corymbia sp.*	-	N	TG												
Myrtaceae	*Eucalyptus albens*	White Box	N	TG												
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	N	TG												
Myrtaceae	*Eucalyptus dealbata*	Tumbledown Red Gum	N	TG			30.6	8			36.5	89	37.2	57	0.1	6
Myrtaceae	*Eucalyptus melanophloia*	Silver-leaved Ironbark	N	TG	31	8	0.2	2			3	2	0.1	2		
Myrtaceae	*Eucalyptus melliodora*	Yellow Box	N	TG												
Myrtaceae	*Eucalyptus prava*	Orange Gum	N	TG												
Nyctaginaceae	*Boerhavia dominii*	Tarvine	N	FG	0.1	3			0.1	5	0.1	5	0.1	6		
Oleaceae	*Notelaea longifolia*	Large-leaved Olive	N	TG												
Oleaceae	*Notelaea microcarpa*	Native Olive	N	TG												
Oleaceae	*Notelaea sp.*	an olive	N	SG	0.1	2	0.1	2	0.1	11						
Oxalidaceae	*Oxalis perennans*	-	N	FG			0.1	1	0.1	12	0.1	6				
Phyllanthaceae	*Breynia sp.*	-	N	SG			0.1	1								
Phyllanthaceae	*Phyllanthus virgatus*	-	N	FG					0.1	37						
Pittosporaceae	*Pittosporum spinescens*	Wallaby Apple	N	SG												
Plantaginaceae	*Plantago debilis*	-	N	FG	0.1	4	0.1	5							0.1	24
Plantaginaceae	*Plantago sp. 1*	a Plantain	E	N/A												
Poaceae	*Aristida leptopoda*	White Speargrass	N	GG												
Poaceae	*Aristida ramosa*	Purple Wiregrass	N	GG	0.1	4			1	124	0.1	1	0.1	9	0.1	13

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 7		Plot 8		Plot 9		Plot 10		Plot 11		Plot 12	
					C	A	C	A	C	A	C	A	C	A	C	A
Poaceae	*Austrostipa scabra subsp. scabra*	Speargrass	N	GG	2	200	5	309	0.1	70	0.1	92	0.3	354		
Poaceae	*Austrostipa verticillata*	Slender Bamboo Grass	N	GG												
Poaceae	*Bothriochloa biloba*	-	N	GG			0.1	1								
Poaceae	*Bothriochloa decipiens*	Red Grass, Redleg Grass	N	GG					0.1	2					2.2	16
Poaceae	*Chloris truncata*	Windmill Grass	N	GG												
Poaceae	*Chloris ventricosa*	Plump Windmill Grass	N	GG												
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	N	GG			0.1	56	0.1	11	0.1	7	0.1	9	0.2	120
Poaceae	*Cynodon dactylon*	Couch, Bermudagrass	N	GG												
Poaceae	*Digitaria brownii*	Cotton Panic Grass	N	GG					0.1	1						
Poaceae	*Digitaria diffusa*	Open Summer-grass	N	GG			0.1	3								
Poaceae	*Enneapogon gracilis*	Slender Bottle-washers	N	GG	15	1400	0.1	16	1	251	0.1	9	0.1	1	45.1	20
Poaceae	*Entolasia stricta*	Wiry Panic	N	GG												
Poaceae	*Eragrostis brownii*	Brown's Lovegrass	N	GG												
Poaceae	*Eragrostis leptostachya*	Paddock Lovegrass	N	GG												
Poaceae	*Eragrostis sp.*	-	N	GG												
Poaceae	*Eragrostis sp. 1*	-	E	N/A												
Poaceae	*Eulalia aurea*	Sliky Browntop	N	GG												
Poaceae	*Heteropogon contortus*	Bunch Speargrass	N	GG					0.1	5						
Poaceae	*Panicum simile*	Two Colour Panic	N	GG												
Poaceae	*Panicum sp. 1*	a Panic Grass	E	N/A												
Poaceae	*Paspalidium distans*	-	N	GG												
Poaceae	*Poa sp. 1*	-	E	N/A												
Poaceae	*Sporobolus creber*	Western Rat-tail Grass	N	GG			0.1	6	0.1	8	0.1	4	0.1	19	0.1	11
Poaceae	*Sporobolus elongatus*	Slender Rat's Tail Grass	N	GG												
Poaceae	*Sporobolus sp.*	-	E	N/A					0.1	2						
Poaceae	*Themeda triandra*	Kangaroo Grass	N	GG												
Poaceae	*Tripogon loliiformis*	Fiveminute Grass	N	GG												
Poaceae	*Urochloa panicoides*	Urochloa Grass, Liversee	E	N/A					0.1	9						
Polygonaceae	*Rumex brownii*	Swamp Dock	N	FG												
Polygonaceae	*Rumex sp.*	-	N	FG												
Portulacaceae	*Portulaca bicolor*	-	N	FG												
Portulacaceae	*Portulaca oleracea*	Pigweed	N	FG												
Proteaceae	*Hakea laevipes*	-	N	SG											0.1	4
Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern	N	EG					0.1	1	0.1	1	0.1	1		
Pteridaceae	*Cheilanthes sieberi*	-	N	EG												
Rutaceae	*Geijera parviflora*	Wilga	N	SG												
Sapindaceae	*Dodonaea viscosa subsp. spatulata*	-	N	SG												
Solanaceae	*Solanum ferocissimum*	Spiny Potato Bush	N	SG												
Solanaceae	*Solanum sp.*	-	N	FG	0.1	1										
Solanaceae	*Solanum sp. 1*	-	E	N/A												
Solanaceae	*Solanum sturtianum*	Thargomindah Nightsha	N	SG			0.1	3			0.1	3	0.1	22	0.1	6
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia	N	FG											0.1	5
Thymelaeaceae	*Pimelea neo-anglica*	Poison Pimelea	N	SG	0.1	22	0.1	2	0.1	1	0.1	7	0.1	4	0.1	4
Thymelaeaceae	*Pimelea stricta*	-	N	SG												
Urticaceae	*Urtica urens*	Small Nettle	E	N/A												
Verbenaceae	*Glandularia aristigera*	Mayne's Pest	E	N/A												
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Johnson's Grass Tree	N	OG			0.1	1								
Zygophyllaceae	*Tribulus terrestris*	Caltrop	E	N/A												

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 7		Plot 8		Plot 9		Plot 10		Plot 11		Plot 12	
					C	A	C	A	C	A	C	A	C	A	C	A
Unknown	Undetermined exotic	-	E	N/A												
Unknown	Unidentified Forb B	-	N	FG	0.1	12					0.1	3				
Rubiaceae	Rubiaceae	-	N	SG	0.1	2					0.1	1				
Unknown	Unidentified Forb A	-	N	FG												
Unknown	Unidentified Forb C	-	N	FG												
Unidentified	unidentified species	-	-	-												

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 13		Plot 14		Plot 15		Plot 16		Plot 17		Plot 18	
					C	A	C	A	C	A	C	A	C	A	C	A
Acanthaceae	*Rostellularia adscendens*	-	N	FG					0.1	100	0.3	200	0.1	30		
Amaranthaceae	*Alternanthera sp. A* Flora of New South Wales (M.Gray 5187) J. Palmer	-	N	FG			0.1	4								
Amaranthaceae	*Gomphrena celosioides*	Gomphrena Weed	E	N/A												
Apiaceae	*Actinotus sp. 1*	-	N	FG												
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery	E	N/A	0.1	1	0.1	2								
Apocynaceae	*Carissa ovata* (i.e. *Carissa spinarum*)	-	N	OG					0.1	5	0.1	1				
Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton B	E	N/A	0.1	8										
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo	N	OG							0.1	10				
Apocynaceae	*Parsonsia sp. 1*	-	N	OG												
Asteraceae	*Asteraceae*	-	N	FG												
Asteraceae	*Asteraceae sp. 1*	-	E	N/A												
Asteraceae	*Asteraceae sp. 2*	-	E	N/A												
Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy	N	FG			0.1	5					0.1	5		
Asteraceae	*Carthamus lanatus*	Saffron Thistle	HTE	N/A												
Asteraceae	*Cassinia arcuata*	Siffon Bush	N	SG												
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting, Ye	N	FG			0.1	20								
Asteraceae	*Cirsium vulgare*	Spear Thistle	E	N/A	0.1	23										
Asteraceae	*Gamochaeta sp. 1*	a Cudweed	E	N/A												
Asteraceae	*Glossocardia bidens*	Cobbler's Tack	N	FG												
Asteraceae	*Hypochaeris glabra*	Smooth Catsear	E	N/A												
Asteraceae	*Hypochaeris radicata*	Flatweed	E	N/A												
Asteraceae	*Lactuca serriola*	Prickly Lettuce	E	N/A												
Asteraceae	*Leiocarpa brevicompta*	Flat Billy-buttons	N	FG												
Asteraceae	*Ozothamnus cassinioides*	-	N	SG							0.2	200				
Asteraceae	*Senecio sp. 1*	a Fireweed	E	N/A												
Asteraceae	*Solenogyne bellioides*	-	N	FG							0.1	40	0.1	30	0.1	15
Asteraceae	*Vittadinia cuneata var. cuneata*	-	N	FG			0.1	8								
Asteraceae	*Vittadinia sp.*	-	N	FG			0.1	3								
Asteraceae	*Vittadinia sulcata*	-	N	FG					0.1	1	0.1	5	0.1	20	0.1	70
Asteraceae	*Xanthium spinosum*	Bathurst Burr	HTE	N/A									0.1	1		
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	N	OG					0.1	1						
Boraginaceae	*Heliotropium amplexicaule*	Blue Heliotrope	HTE	N/A			0.1	10					0.1	1		
Cactaceae	*Opuntia aurantiaca*	Tiger Pear	HTE	N/A	0.1	1			0.1	4	0.1	100	0.1	20		
Cactaceae	*Opuntia tomentosa*	Velvet Tree Pear	HTE	N/A												
Campanulaceae	*Wahlenbergia graniticola*	Granite Bluebell	N	FG												
Campanulaceae	*Wahlenbergia sp.*	-	N	FG			0.1	76								
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	N	FG												
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	N	FG					0.1	10					0.2	200
Chenopodiaceae	*Maireana microphylla*	Small-leaf Bluebush	N	SG												
Chenopodiaceae	*Sclerolaena birchii*	Galvanized Burr	N	SG			0.1	3	0.1	1			0.1	2	0.1	200
Convolvulaceae	*Convolvulus erubescens*	Blushing Bindweed	N	OG												
Convolvulaceae	*Dichondra repens*	Kidney Weed	N	FG												
Convolvulaceae	*Dichondra sp. A* Sensu Harden (1992)	-	N	FG			1	206	0.1	3	0.3	400	0.2	100	0.1	200
Convolvulaceae	*Evolvulus alsinoides*	Dwarf Monring Glory	N	FG	0.1	2	0.1	2					0.1	20		
Cupressaceae	*Callitris endlicheri*	Black Cypress Pine	N	TG												
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine	N	TG					15		20		0.1	30		
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge	N	GG			0.1	26	0.1	50	0.1	40	0.1	20	0.1	70

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Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 13		Plot 14		Plot 15		Plot 16		Plot 17		Plot 18	
					C	A	C	A	C	A	C	A	C	A	C	A
Cyperaceae	*Schoenus sp. 1*	a Bog-rush	N	GG												
Ericaceae (Epacridoideae)	*Melichrus urceolatus*	Urn-heath	N	SG												
Euphorbiaceae	*Euphorbia dallachyana*	Mat Spurge	N	SG												
Euphorbiaceae	*Euphorbia drummondii*	Mat Spurge	N	FG									0.1	20		
Euphorbiaceae	*Euphorbia sp.*	-	N	FG												
Euphorbiaceae	*Euphorbia sp. 1*	-	E	N/A												
Fabaceae (Faboideae)	*Bossiaea scortechinii*	-	N	SG												
Fabaceae (Faboideae)	*Bossiaea sp.*	-	N	SG												
Fabaceae (Faboideae)	*Desmodium sp.*	-	N	FG	0.1	1										
Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	N	OG	5	6	0.1	16								
Fabaceae (Faboideae)	*Glycine clandestina*	-	N	OG					0.1	26	0.3	200	0.2	70	0.2	500
Fabaceae (Faboideae)	*Hardenbergia violaceae*	Purple Coral Pea	N	OG												
Fabaceae (Faboideae)	*Rhynchosia minima*	-	N	OG												
Fabaceae (Faboideae)	*Trifolium sp. 1*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Trifolium sp. 2*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Zornia dyctiocarpa*	Zornia	N	FG												
Fabaceae (Mimosoideae)	*Acacia decora*	Western Silver Wattle, S	N	SG												
Fabaceae (Mimosoideae)	*Neptunia gracilis*	Native Senstitive Plant	N	FG	0.1	19										
Geraniaceae	*Geranium molle*	Cranesbill Geranium	E	N/A												
Goodeniaceae	*Goodenia sp. 1*	-	N	FG												
Haloragaceae	*Haloragis sp.*	-	N	FG			0.1	68								
Hypericaceae	*Hypericum sp.*	-	E	N/A							0.1	20	0.1	40	0.1	30
Juncaceae	*Juncus sp.*	a Rush	E	N/A												
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush	N	GG												
Loranthaceae	*Amyema miquelii*	-	N	OG												
Malvaceae	*Sida corrugata*	Corrugated Sida	N	FG			0.1	133	0.1	50	0.2	200	0.5	600	0.1	30
Moraceae	*Ficus sp. 1*	a Fig	N	TG												
Myrtaceae	*Angophora floribunda*	Rough-barked Apple	N	TG												
Myrtaceae	*Corymbia dolichocarpa*	Long-fruited Bloodwood	N	TG												
Myrtaceae	*Corymbia sp.*	-	N	TG												
Myrtaceae	*Eucalyptus albens*	White Box	N	TG					5	1	3	1				
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	N	TG												
Myrtaceae	*Eucalyptus dealbata*	Tumbledown Red Gum	N	TG							15					
Myrtaceae	*Eucalyptus melanophloia*	Silver-leaved Ironbark	N	TG					20	3	3	0				
Myrtaceae	*Eucalyptus melliodora*	Yellow Box	N	TG												
Myrtaceae	*Eucalyptus prava*	Orange Gum	N	TG												
Nyctaginaceae	*Boerhavia dominii*	Tarvine	N	FG	0.1	26	0.1	4	0.1	1	0.1	40	0.1	60		
Oleaceae	*Notelaea longifolia*	Large-leaved Olive	N	TG												
Oleaceae	*Notelaea microcarpa*	Native Olive	N	TG					0.1	6						
Oleaceae	*Notelaea sp.*	an olive	N	SG												
Oxalidaceae	*Oxalis perennans*	-	N	FG									0.1	16	0.1	100
Phyllanthaceae	*Breynia sp.*	-	N	SG												
Phyllanthaceae	*Phyllanthus virgatus*	-	N	FG	0.1	6										
Pittosporaceae	*Pittosporum spinescens*	Wallaby Apple	N	SG												
Plantaginaceae	*Plantago debilis*	-	N	FG												
Plantaginaceae	*Plantago sp. 1*	a Plantain	E	N/A												
Poaceae	*Aristida leptopoda*	White Speargrass	N	GG	0.2	316			0.1	5						
Poaceae	*Aristida ramosa*	Purple Wiregrass	N	GG	0.1	3	0.1	11	0.1	10	0.3	20	5	50	5	120

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Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 13		Plot 14		Plot 15		Plot 16		Plot 17		Plot 18	
					C	A	C	A	C	A	C	A	C	A	C	A
Poaceae	*Austrostipa scabra subsp. scabra*	Speargrass	N	GG			0.1	72								
Poaceae	*Austrostipa verticillata*	Slender Bamboo Grass	N	GG												
Poaceae	*Bothriochloa biloba*	-	N	GG	0.5	635									0.1	3
Poaceae	*Bothriochloa decipiens*	Red Grass, Redleg Grass	N	GG	0.1	8	0.3	60	0.1	7			5	50	1.5	200
Poaceae	*Chloris truncata*	Windmill Grass	N	GG			0.1	6	0.1	10	0.1	15				
Poaceae	*Chloris ventricosa*	Plump Windmill Grass	N	GG			0.1	1								
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	N	GG			0.1	23	0.2	10						
Poaceae	*Cynodon dactylon*	Couch, Bermudagrass	N	GG												
Poaceae	*Digitaria brownii*	Cotton Panic Grass	N	GG												
Poaceae	*Digitaria diffusa*	Open Summer-grass	N	GG					0.1	20						
Poaceae	*Enneapogon gracilis*	Slender Bottle-washers	N	GG			0.1	15	0.3	600	0.3	200	5	200		
Poaceae	*Entolasia stricta*	Wiry Panic	N	GG					0.2	50						
Poaceae	*Eragrostis brownii*	Brown's Lovegrass	N	GG			0.1	2								
Poaceae	*Eragrostis leptostachya*	Paddock Lovegrass	N	GG												
Poaceae	*Eragrostis sp.*	-	N	GG			0.1	8								
Poaceae	*Eragrostis sp. 1*	-	E	N/A												
Poaceae	*Eulalia aurea*	Sliky Browntop	N	GG												
Poaceae	*Heteropogon contortus*	Bunch Speargrass	N	GG												
Poaceae	*Panicum simile*	Two Colour Panic	N	GG											0.1	2
Poaceae	*Panicum sp. 1*	a Panic Grass	E	N/A												
Poaceae	*Paspalidium distans*	-	N	GG											0.1	2
Poaceae	*Poa sp. 1*	-	E	N/A												
Poaceae	*Sporobolus creber*	Western Rat-tail Grass	N	GG			0.1	19								
Poaceae	*Sporobolus elongatus*	Slender Rat's Tail Grass	N	GG												
Poaceae	*Sporobolus sp.*	-	E	N/A												
Poaceae	*Themeda triandra*	Kangaroo Grass	N	GG												
Poaceae	*Tripogon loliiformis*	Fiveminute Grass	N	GG												
Poaceae	*Urochloa panicoides*	Urochloa Grass, Liversee	E	N/A	0.1	21										
Polygonaceae	*Rumex brownii*	Swamp Dock	N	FG			0.1	15								
Polygonaceae	*Rumex sp.*	-	N	FG												
Portulacaceae	*Portulaca bicolor*	-	N	FG												
Portulacaceae	*Portulaca oleracea*	Pigweed	N	FG												
Proteaceae	*Hakea laevipes*	-	N	SG												
Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern	N	EG			0.3	290								
Pteridaceae	*Cheilanthes sieberi*	-	N	EG					0.1	7	0.1	20	0.1	5	0.2	500
Rutaceae	*Geijera parviflora*	Wilga	N	SG												
Sapindaceae	*Dodonaea viscosa subsp. spatulata*	-	N	SG												
Solanaceae	*Solanum ferocissimum*	Spiny Potato Bush	N	SG					0.1	1			0.1	5	0.1	10
Solanaceae	*Solanum sp.*	-	N	FG												
Solanaceae	*Solanum sp. 1*	-	E	N/A												
Solanaceae	*Solanum sturtianum*	Thargomindah Nightsha	N	SG	0.1	4	0.1	23								
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia	N	FG												
Thymelaeaceae	*Pimelea neo-anglica*	Poison Pimelea	N	SG	0.1	15	0.1	8								
Thymelaeaceae	*Pimelea stricta*	-	N	SG					0.1	21	0.2	80	0.1	5		
Urticaceae	*Urtica urens*	Small Nettle	E	N/A												
Verbenaceae	*Glandularia aristigera*	Mayne's Pest	E	N/A												
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Johnson's Grass Tree	N	OG												
Zygophyllaceae	*Tribulus terrestris*	Caltrop	E	N/A												

BAM Growth Form Group Code: SG - Shrub (SG); FG - Form (FG); OG - Other (OG); *GG - Grass grasslike (GG); EG - Fern (EG); TG - Tree (TG)*
I - incidental observation; C = Cover (%); A = Abundance

Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 13		Plot 14		Plot 15		Plot 16		Plot 17		Plot 18	
					C	A	C	A	C	A	C	A	C	A	C	A
Unknown	Undetermined exotic	-	E	N/A												
Unknown	Unidentified Forb B	-	N	FG												
Rubiaceae	Rubiaceae	-	N	SG												
Unknown	Unidentified Forb A	-	N	FG			0.1	9								
Unknown	Unidentified Forb C	-	N	FG			0.1	1								
Unidentified	unidentified species	-	-	-											25	

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I - incidental observation; C = Cover (%); A = Abundance

Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 19		Plot 20		Plot 21		Plot 22		Plot 23		Plot 24	
					C	A	C	A	C	A	C	A	C	A	C	A
Acanthaceae	*Rostellularia adscendens*	-	N	FG					0.1	4	0.1	8				
Amaranthaceae	*Alternanthera sp. A* Flora of New South Wales (M.Gray 5187) J. Palmer	-	N	FG												
Amaranthaceae	*Gomphrena celosioides*	Gomphrena Weed	E	N/A	0.1	1										
Apiaceae	*Actinotus sp. 1*	-	N	FG												
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery	E	N/A												
Apocynaceae	*Carissa ovata* (i.e. *Carissa spinarum*)	-	N	OG												
Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton B	E	N/A												
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo	N	OG												
Apocynaceae	*Parsonsia sp. 1*	-	N	OG												
Asteraceae	*Asteraceae*	-	N	FG												
Asteraceae	*Asteraceae sp. 1*	-	E	N/A												
Asteraceae	*Asteraceae sp. 2*	-	E	N/A												
Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy	N	FG							0.1	1				
Asteraceae	*Carthamus lanatus*	Saffron Thistle	HTE	N/A	0.1	1										
Asteraceae	*Cassinia arcuata*	Siffon Bush	N	SG												
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting, Ye	N	FG												
Asteraceae	*Cirsium vulgare*	Spear Thistle	E	N/A												
Asteraceae	*Gamochaeta sp. 1*	a Cudweed	E	N/A												
Asteraceae	*Glossocardia bidens*	Cobbler's Tack	N	FG												
Asteraceae	*Hypochaeris glabra*	Smooth Catsear	E	N/A												
Asteraceae	*Hypochaeris radicata*	Flatweed	E	N/A												
Asteraceae	*Lactuca serriola*	Prickly Lettuce	E	N/A												
Asteraceae	*Leiocarpa brevicompta*	Flat Billy-buttons	N	FG												
Asteraceae	*Ozothamnus cassinioides*	-	N	SG									0.1	1		
Asteraceae	*Senecio sp. 1*	a Fireweed	E	N/A												
Asteraceae	*Solenogyne bellioides*	-	N	FG									0.1	2	0.1	12
Asteraceae	*Vittadinia cuneata var. cuneata*	-	N	FG												
Asteraceae	*Vittadinia sp.*	-	N	FG												
Asteraceae	*Vittadinia sulcata*	-	N	FG					0.1	8					0.1	2
Asteraceae	*Xanthium spinosum*	Bathurst Burr	HTE	N/A	0.1	2	0.1	4								
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	N	OG												
Boraginaceae	*Heliotropium amplexicaule*	Blue Heliotrope	HTE	N/A							0.1	2	0.1	18		
Cactaceae	*Opuntia aurantiaca*	Tiger Pear	HTE	N/A					0.1	2	0.1	2				
Cactaceae	*Opuntia tomentosa*	Velvet Tree Pear	HTE	N/A												
Campanulaceae	*Wahlenbergia graniticola*	Granite Bluebell	N	FG												
Campanulaceae	*Wahlenbergia sp.*	-	N	FG												
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	N	FG												
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	N	FG	0.1	100			0.1	20						
Chenopodiaceae	*Maireana microphylla*	Small-leaf Bluebush	N	SG	0.2	4	0.1	1								
Chenopodiaceae	*Sclerolaena birchii*	Galvanized Burr	N	SG	20	600			0.1	4	0.1	40				
Convolvulaceae	*Convolvulus erubescens*	Blushing Bindweed	N	OG			0.1	1								
Convolvulaceae	*Dichondra repens*	Kidney Weed	N	FG												
Convolvulaceae	*Dichondra sp. A* Sensu Harden (1992)	-	N	FG	0.1	5			0.1	20			0.1	9	0.5	200
Convolvulaceae	*Evolvulus alsinoides*	Dwarf Monring Glory	N	FG					0.1	3	0.1	8				
Cupressaceae	*Callitris endlicheri*	Black Cypress Pine	N	TG												
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine	N	TG					3	15	0.1	2	0.2	2		
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge	N	GG												

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 19		Plot 20		Plot 21		Plot 22		Plot 23		Plot 24	
					C	A	C	A	C	A	C	A	C	A	C	A
Cyperaceae	*Schoenus sp. 1*	a Bog-rush	N	GG												
Ericaceae (Epacridoideae)	*Melichrus urceolatus*	Urn-heath	N	SG												
Euphorbiaceae	*Euphorbia dallachyana*	Mat Spurge	N	SG												
Euphorbiaceae	*Euphorbia drummondii*	Mat Spurge	N	FG	0.1	15					0.1	8				
Euphorbiaceae	*Euphorbia sp.*	-	N	FG												
Euphorbiaceae	*Euphorbia sp. 1*	-	E	N/A												
Fabaceae (Faboideae)	*Bossiaea scortechinii*	-	N	SG												
Fabaceae (Faboideae)	*Bossiaea sp.*	-	N	SG												
Fabaceae (Faboideae)	*Desmodium sp.*	-	N	FG												
Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	N	OG							0.1	3				
Fabaceae (Faboideae)	*Glycine clandestina*	-	N	OG	0.2	100			0.1	30	0.2	50	0.1	12	0.1	16
Fabaceae (Faboideae)	*Hardenbergia violaceae*	Purple Coral Pea	N	OG												
Fabaceae (Faboideae)	*Rhynchosia minima*	-	N	OG			0.1	10								
Fabaceae (Faboideae)	*Trifolium sp. 1*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Trifolium sp. 2*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Zornia dyctiocarpa*	Zornia	N	FG												
Fabaceae (Mimosoideae)	*Acacia decora*	Western Silver Wattle, S	N	SG												
Fabaceae (Mimosoideae)	*Neptunia gracilis*	Native Senstitive Plant	N	FG												
Geraniaceae	*Geranium molle*	Cranesbill Geranium	E	N/A												
Goodeniaceae	*Goodenia sp. 1*	-	N	FG												
Haloragaceae	*Haloragis sp.*	-	N	FG												
Hypericaceae	*Hypericum sp.*	-	E	N/A												
Juncaceae	*Juncus sp.*	a Rush	E	N/A												
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush	N	GG												
Loranthaceae	*Amyema miquelii*	-	N	OG												
Malvaceae	*Sida corrugata*	Corrugated Sida	N	FG					0.2	100	0.1	50	0.1	200	0.1	30
Moraceae	*Ficus sp. 1*	a Fig	N	TG												
Myrtaceae	*Angophora floribunda*	Rough-barked Apple	N	TG												
Myrtaceae	*Corymbia dolichocarpa*	Long-fruited Bloodwood	N	TG												
Myrtaceae	*Corymbia sp.*	-	N	TG												
Myrtaceae	*Eucalyptus albens*	White Box	N	TG												
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	N	TG												
Myrtaceae	*Eucalyptus dealbata*	Tumbledown Red Gum	N	TG												
Myrtaceae	*Eucalyptus melanophloia*	Silver-leaved Ironbark	N	TG												
Myrtaceae	*Eucalyptus melliodora*	Yellow Box	N	TG												
Myrtaceae	*Eucalyptus prava*	Orange Gum	N	TG												
Nyctaginaceae	*Boerhavia dominii*	Tarvine	N	FG	0.1	1			0.1	80	0.1	12	0.1	6		
Oleaceae	*Notelaea longifolia*	Large-leaved Olive	N	TG												
Oleaceae	*Notelaea microcarpa*	Native Olive	N	TG			0.1	1								
Oleaceae	*Notelaea sp.*	an olive	N	SG												
Oxalidaceae	*Oxalis perennans*	-	N	FG					0.1	4	0.1	16				
Phyllanthaceae	*Breynia sp.*	-	N	SG												
Phyllanthaceae	*Phyllanthus virgatus*	-	N	FG												
Pittosporaceae	*Pittosporum spinescens*	Wallaby Apple	N	SG												
Plantaginaceae	*Plantago debilis*	-	N	FG												
Plantaginaceae	*Plantago sp. 1*	a Plantain	E	N/A												
Poaceae	*Aristida leptopoda*	White Speargrass	N	GG			0.2	13								
Poaceae	*Aristida ramosa*	Purple Wiregrass	N	GG	4	300			3	200	1	25	1	40	0.1	1

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 19		Plot 20		Plot 21		Plot 22		Plot 23		Plot 24	
					C	A	C	A	C	A	C	A	C	A	C	A
Poaceae	*Austrostipa scabra subsp. scabra*	Speargrass	N	GG												
Poaceae	*Austrostipa verticillata*	Slender Bamboo Grass	N	GG												
Poaceae	*Bothriochloa biloba*	-	N	GG			0.2	13								
Poaceae	*Bothriochloa decipiens*	Red Grass, Redleg Grass	N	GG	1	100			0.5	15			1	200	1.5	500
Poaceae	*Chloris truncata*	Windmill Grass	N	GG												
Poaceae	*Chloris ventricosa*	Plump Windmill Grass	N	GG												
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	N	GG					0.1	2	0.1	3	0.3	40	0.2	4
Poaceae	*Cynodon dactylon*	Couch, Bermudagrass	N	GG												
Poaceae	*Digitaria brownii*	Cotton Panic Grass	N	GG												
Poaceae	*Digitaria diffusa*	Open Summer-grass	N	GG												
Poaceae	*Enneapogon gracilis*	Slender Bottle-washers	N	GG					2	300	1	100				
Poaceae	*Entolasia stricta*	Wiry Panic	N	GG												
Poaceae	*Eragrostis brownii*	Brown's Lovegrass	N	GG											0.1	3
Poaceae	*Eragrostis leptostachya*	Paddock Lovegrass	N	GG												
Poaceae	*Eragrostis sp.*	-	N	GG												
Poaceae	*Eragrostis sp. 1*	-	E	N/A												
Poaceae	*Eulalia aurea*	Sliky Browntop	N	GG												
Poaceae	*Heteropogon contortus*	Bunch Speargrass	N	GG												
Poaceae	*Panicum simile*	Two Colour Panic	N	GG									0.1	2	0.1	3
Poaceae	*Panicum sp. 1*	a Panic Grass	E	N/A												
Poaceae	*Paspalidium distans*	-	N	GG			0.1	1								
Poaceae	*Poa sp. 1*	-	E	N/A												
Poaceae	*Sporobolus creber*	Western Rat-tail Grass	N	GG												
Poaceae	*Sporobolus elongatus*	Slender Rat's Tail Grass	N	GG												
Poaceae	*Sporobolus sp.*	-	E	N/A												
Poaceae	*Themeda triandra*	Kangaroo Grass	N	GG												
Poaceae	*Tripogon loliiformis*	Fiveminute Grass	N	GG												
Poaceae	*Urochloa panicoides*	Urochloa Grass, Liversee	E	N/A												
Polygonaceae	*Rumex brownii*	Swamp Dock	N	FG	0.1	1	0.1	5	0.1	8						
Polygonaceae	*Rumex sp.*	-	N	FG												
Portulacaceae	*Portulaca bicolor*	-	N	FG					0.1	20	0.1	50				
Portulacaceae	*Portulaca oleracea*	Pigweed	N	FG					0.1	5	0.1	2				
Proteaceae	*Hakea laevipes*	-	N	SG												
Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern	N	EG												
Pteridaceae	*Cheilanthes sieberi*	-	N	EG	0.1	8							0.1	7	0.1	5
Rutaceae	*Geijera parviflora*	Wilga	N	SG												
Sapindaceae	*Dodonaea viscosa subsp. spatulata*	-	N	SG												
Solanaceae	*Solanum ferocissimum*	Spiny Potato Bush	N	SG												
Solanaceae	*Solanum sp.*	-	N	FG												
Solanaceae	*Solanum sp. 1*	-	E	N/A												
Solanaceae	*Solanum sturtianum*	Thargomindah Nightsha	N	SG												
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia	N	FG												
Thymelaeaceae	*Pimelea neo-anglica*	Poison Pimelea	N	SG												
Thymelaeaceae	*Pimelea stricta*	-	N	SG					0.1	4	0.1	20	0.1	3	0.1	3
Urticaceae	*Urtica urens*	Small Nettle	E	N/A												
Verbenaceae	*Glandularia aristigera*	Mayne's Pest	E	N/A												
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Johnson's Grass Tree	N	OG												
Zygophyllaceae	*Tribulus terrestris*	Caltrop	E	N/A			0.1	1	0.1	4						

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 19		Plot 20		Plot 21		Plot 22		Plot 23		Plot 24	
					C	A	C	A	C	A	C	A	C	A	C	A
Unknown	Undetermined exotic	-	E	N/A												
Unknown	Unidentified Forb B	-	N	FG												
Rubiaceae	Rubiaceae	-	N	SG												
Unknown	Unidentified Forb A	-	N	FG												
Unknown	Unidentified Forb C	-	N	FG												
Unidentified	unidentified species	-	-	-	5								20		25	

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 25		Plot 26		Plot 27		Plot 28		Plot 29		Plot 30	
					C	A	C	A	C	A	C	A	C	A	C	A
Acanthaceae	*Rostellularia adscendens*	-	N	FG												
Amaranthaceae	*Alternanthera sp. A* Flora of New South Wales (M.Gray 5187) J. Palmer	-	N	FG												
Amaranthaceae	*Gomphrena celosioides*	Gomphrena Weed	E	N/A												
Apiaceae	*Actinotus sp. 1*	-	N	FG												
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery	E	N/A												
Apocynaceae	*Carissa ovata* (i.e. *Carissa spinarum*)	-	N	OG												
Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton B	E	N/A												
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo	N	OG												
Apocynaceae	*Parsonsia sp. 1*	-	N	OG												
Asteraceae	*Asteraceae*	-	N	FG												
Asteraceae	*Asteraceae sp. 1*	-	E	N/A												
Asteraceae	*Asteraceae sp. 2*	-	E	N/A												
Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy	N	FG							0.1	14				
Asteraceae	*Carthamus lanatus*	Saffron Thistle	HTE	N/A												
Asteraceae	*Cassinia arcuata*	Siffon Bush	N	SG												
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting, Ye	N	FG												
Asteraceae	*Cirsium vulgare*	Spear Thistle	E	N/A												
Asteraceae	*Gamochaeta sp. 1*	a Cudweed	E	N/A												
Asteraceae	*Glossocardia bidens*	Cobbler's Tack	N	FG												
Asteraceae	*Hypochaeris glabra*	Smooth Catsear	E	N/A												
Asteraceae	*Hypochaeris radicata*	Flatweed	E	N/A												
Asteraceae	*Lactuca serriola*	Prickly Lettuce	E	N/A												
Asteraceae	*Leiocarpa brevicompta*	Flat Billy-buttons	N	FG												
Asteraceae	*Ozothamnus cassinioides*	-	N	SG												
Asteraceae	*Senecio sp. 1*	a Fireweed	E	N/A												
Asteraceae	*Solenogyne bellioides*	-	N	FG	0.1	16										
Asteraceae	*Vittadinia cuneata var. cuneata*	-	N	FG												
Asteraceae	*Vittadinia sp.*	-	N	FG												
Asteraceae	*Vittadinia sulcata*	-	N	FG	0.1	1									0.1	40
Asteraceae	*Xanthium spinosum*	Bathurst Burr	HTE	N/A												
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	N	OG											0.1	400
Boraginaceae	*Heliotropium amplexicaule*	Blue Heliotrope	HTE	N/A	0.1	3			0.1	100	0.5	2200				
Cactaceae	*Opuntia aurantiaca*	Tiger Pear	HTE	N/A												
Cactaceae	*Opuntia tomentosa*	Velvet Tree Pear	HTE	N/A	0.1	1										
Campanulaceae	*Wahlenbergia graniticola*	Granite Bluebell	N	FG												
Campanulaceae	*Wahlenbergia sp.*	-	N	FG												
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	N	FG												
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	N	FG					0.1	50	0.1	100			0.1	90
Chenopodiaceae	*Maireana microphylla*	Small-leaf Bluebush	N	SG							0.1	2			0.1	2
Chenopodiaceae	*Sclerolaena birchii*	Galvanized Burr	N	SG					0.1	60	0.3	100			0.2	100
Convolvulaceae	*Convolvulus erubescens*	Blushing Bindweed	N	OG											0.1	30
Convolvulaceae	*Dichondra repens*	Kidney Weed	N	FG												
Convolvulaceae	*Dichondra sp. A* Sensu Harden (1992)	-	N	FG	0.1	200	0.1	90	0.1	30	0.1	7			0.1	20
Convolvulaceae	*Evolvulus alsinoides*	Dwarf Monring Glory	N	FG			0.1	8								
Cupressaceae	*Callitris endlicheri*	Black Cypress Pine	N	TG												
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine	N	TG			0.1	11								
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge	N	GG												

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 25		Plot 26		Plot 27		Plot 28		Plot 29		Plot 30	
					C	A	C	A	C	A	C	A	C	A	C	A
Cyperaceae	*Schoenus sp. 1*	a Bog-rush	N	GG												
Ericaceae (Epacridoideae)	*Melichrus urceolatus*	Urn-heath	N	SG												
Euphorbiaceae	*Euphorbia dallachyana*	Mat Spurge	N	SG												
Euphorbiaceae	*Euphorbia drummondii*	Mat Spurge	N	FG			0.1	3								
Euphorbiaceae	*Euphorbia sp.*	-	N	FG												
Euphorbiaceae	*Euphorbia sp. 1*	-	E	N/A												
Fabaceae (Faboideae)	*Bossiaea scortechinii*	-	N	SG												
Fabaceae (Faboideae)	*Bossiaea sp.*	-	N	SG												
Fabaceae (Faboideae)	*Desmodium sp.*	-	N	FG												
Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	N	OG												
Fabaceae (Faboideae)	*Glycine clandestina*	-	N	OG	0.1	20	0.1	7	0.1	40	0.1	20			0.1	50
Fabaceae (Faboideae)	*Hardenbergia violaceae*	Purple Coral Pea	N	OG												
Fabaceae (Faboideae)	*Rhynchosia minima*	-	N	OG												
Fabaceae (Faboideae)	*Trifolium sp. 1*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Trifolium sp. 2*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Zornia dyctiocarpa*	Zornia	N	FG												
Fabaceae (Mimosoideae)	*Acacia decora*	Western Silver Wattle, S	N	SG												
Fabaceae (Mimosoideae)	*Neptunia gracilis*	Native Senstitive Plant	N	FG											0.1	1
Geraniaceae	*Geranium molle*	Cranesbill Geranium	E	N/A												
Goodeniaceae	*Goodenia sp. 1*	-	N	FG												
Haloragaceae	*Haloragis sp.*	-	N	FG												
Hypericaceae	*Hypericum sp.*	-	E	N/A			0.1	8								
Juncaceae	*Juncus sp.*	a Rush	E	N/A					0.1	8						
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush	N	GG												
Loranthaceae	*Amyema miquelii*	-	N	OG												
Malvaceae	*Sida corrugata*	Corrugated Sida	N	FG			0.1	300	0.1	4					0.1	40
Moraceae	*Ficus sp. 1*	a Fig	N	TG												
Myrtaceae	*Angophora floribunda*	Rough-barked Apple	N	TG												
Myrtaceae	*Corymbia dolichocarpa*	Long-fruited Bloodwoo	N	TG												
Myrtaceae	*Corymbia sp.*	-	N	TG												
Myrtaceae	*Eucalyptus albens*	White Box	N	TG												
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	N	TG												
Myrtaceae	*Eucalyptus dealbata*	Tumbledown Red Gum	N	TG			0.1	1								
Myrtaceae	*Eucalyptus melanophloia*	Silver-leaved Ironbark	N	TG												
Myrtaceae	*Eucalyptus melliodora*	Yellow Box	N	TG												
Myrtaceae	*Eucalyptus prava*	Orange Gum	N	TG												
Nyctaginaceae	*Boerhavia dominii*	Tarvine	N	FG	0.1	3	0.1	80	0.1	3	0.1	3	0.1	28	0.1	90
Oleaceae	*Notelaea longifolia*	Large-leaved Olive	N	TG												
Oleaceae	*Notelaea microcarpa*	Native Olive	N	TG												
Oleaceae	*Notelaea sp.*	an olive	N	SG												
Oxalidaceae	*Oxalis perennans*	-	N	FG							0.1	3				
Phyllanthaceae	*Breynia sp.*	-	N	SG												
Phyllanthaceae	*Phyllanthus virgatus*	-	N	FG												
Pittosporaceae	*Pittosporum spinescens*	Wallaby Apple	N	SG												
Plantaginaceae	*Plantago debilis*	-	N	FG												
Plantaginaceae	*Plantago sp. 1*	a Plantain	E	N/A												
Poaceae	*Aristida leptopoda*	White Speargrass	N	GG	0.1	3										
Poaceae	*Aristida ramosa*	Purple Wiregrass	N	GG	0.5	7	0.5	150	40	900	25	500	0.5	20	0.5	20

BAM Growth Form Group Code: SG - Shrub (SG); FG - Form (FG); OG - Other (OG); *GG - Grass grasslike (GG); EG - Fern (EG); TG - Tree (TG)*
I - incidental observation; C = Cover (%); A = Abundance

Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 25		Plot 26		Plot 27		Plot 28		Plot 29		Plot 30	
					C	A	C	A	C	A	C	A	C	A	C	A
Poaceae	*Austrostipa scabra subsp. scabra*	Speargrass	N	GG												
Poaceae	*Austrostipa verticillata*	Slender Bamboo Grass	N	GG												
Poaceae	*Bothriochloa biloba*	-	N	GG												
Poaceae	*Bothriochloa decipiens*	Red Grass, Redleg Grass	N	GG	0.5	300	2	200	0.3	40			10	1000	0.5	200
Poaceae	*Chloris truncata*	Windmill Grass	N	GG			0.1	1					0.1	1	0.1	3
Poaceae	*Chloris ventricosa*	Plump Windmill Grass	N	GG												
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	N	GG	0.1	15	0.1	10					0.5	16		
Poaceae	*Cynodon dactylon*	Couch, Bermudagrass	N	GG												
Poaceae	*Digitaria brownii*	Cotton Panic Grass	N	GG												
Poaceae	*Digitaria diffusa*	Open Summer-grass	N	GG												
Poaceae	*Enneapogon gracilis*	Slender Bottle-washers	N	GG			1	100					5	200		
Poaceae	*Entolasia stricta*	Wiry Panic	N	GG												
Poaceae	*Eragrostis brownii*	Brown's Lovegrass	N	GG	0.1	2	0.1	1	0.1	15			0.1	6		
Poaceae	*Eragrostis leptostachya*	Paddock Lovegrass	N	GG												
Poaceae	*Eragrostis sp.*	-	N	GG												
Poaceae	*Eragrostis sp. 1*	-	E	N/A												
Poaceae	*Eulalia aurea*	Sliky Browntop	N	GG												
Poaceae	*Heteropogon contortus*	Bunch Speargrass	N	GG												
Poaceae	*Panicum simile*	Two Colour Panic	N	GG			0.1	1					0.1	30		
Poaceae	*Panicum sp. 1*	a Panic Grass	E	N/A												
Poaceae	*Paspalidium distans*	-	N	GG												
Poaceae	*Poa sp. 1*	-	E	N/A												
Poaceae	*Sporobolus creber*	Western Rat-tail Grass	N	GG												
Poaceae	*Sporobolus elongatus*	Slender Rat's Tail Grass	N	GG												
Poaceae	*Sporobolus sp.*	-	E	N/A												
Poaceae	*Themeda triandra*	Kangaroo Grass	N	GG												
Poaceae	*Tripogon loliiformis*	Fiveminute Grass	N	GG												
Poaceae	*Urochloa panicoides*	Urochloa Grass, Liversee	E	N/A												
Polygonaceae	*Rumex brownii*	Swamp Dock	N	FG	0.1	2			0.1	5	0.1	3	0.1	20	0.1	7
Polygonaceae	*Rumex sp.*	-	N	FG												
Portulacaceae	*Portulaca bicolor*	-	N	FG												
Portulacaceae	*Portulaca oleracea*	Pigweed	N	FG												
Proteaceae	*Hakea laevipes*	-	N	SG												
Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern	N	EG												
Pteridaceae	*Cheilanthes sieberi*	-	N	EG	0.1	2			0.1	30			0.1	14		
Rutaceae	*Geijera parviflora*	Wilga	N	SG												
Sapindaceae	*Dodonaea viscosa subsp. spatulata*	-	N	SG												
Solanaceae	*Solanum ferocissimum*	Spiny Potato Bush	N	SG												
Solanaceae	*Solanum sp.*	-	N	FG												
Solanaceae	*Solanum sp. 1*	-	E	N/A												
Solanaceae	*Solanum sturtianum*	Thargomindah Nightsha	N	SG												
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia	N	FG												
Thymelaeaceae	*Pimelea neo-anglica*	Poison Pimelea	N	SG												
Thymelaeaceae	*Pimelea stricta*	-	N	SG			0.1	10					0.1	10		
Urticaceae	*Urtica urens*	Small Nettle	E	N/A												
Verbenaceae	*Glandularia aristigera*	Mayne's Pest	E	N/A												
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Johnson's Grass Tree	N	OG												
Zygophyllaceae	*Tribulus terrestris*	Caltrop	E	N/A							0.1	20			0.1	60

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 25		Plot 26		Plot 27		Plot 28		Plot 29		Plot 30	
					C	A	C	A	C	A	C	A	C	A	C	A
Unknown	Undetermined exotic	-	E	N/A												
Unknown	Unidentified Forb B	-	N	FG												
Rubiaceae	Rubiaceae	-	N	SG												
Unknown	Unidentified Forb A	-	N	FG												
Unknown	Unidentified Forb C	-	N	FG												
Unidentified	unidentified species	-	-	-	25				30		10		15			

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 31		Plot 32		Plot 33		Plot 34		Plot 35		Plot 36	
					C	A	C	A	C	A	C	A	C	A	C	A
Acanthaceae	*Rostellularia adscendens*	-	N	FG												
Amaranthaceae	*Alternanthera sp. A* Flora of New South Wales (M.Gray 5187) J. Palmer	-	N	FG												
Amaranthaceae	*Gomphrena celosioides*	Gomphrena Weed	E	N/A							0.2	150				
Apiaceae	*Actinotus sp. 1*	-	N	FG												
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery	E	N/A												
Apocynaceae	*Carissa ovata* (i.e. *Carissa spinarum*)	-	N	OG												
Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton B	E	N/A												
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo	N	OG												
Apocynaceae	*Parsonsia sp. 1*	-	N	OG												
Asteraceae	*Asteraceae*	-	N	FG												
Asteraceae	*Asteraceae sp. 1*	-	E	N/A												
Asteraceae	*Asteraceae sp. 2*	-	E	N/A												
Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy	N	FG												
Asteraceae	*Carthamus lanatus*	Saffron Thistle	HTE	N/A					0.1	10	0.1	7				
Asteraceae	*Cassinia arcuata*	Siffon Bush	N	SG												
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting, Ye	N	FG												
Asteraceae	*Cirsium vulgare*	Spear Thistle	E	N/A												
Asteraceae	*Gamochaeta sp. 1*	a Cudweed	E	N/A												
Asteraceae	*Glossocardia bidens*	Cobbler's Tack	N	FG												
Asteraceae	*Hypochaeris glabra*	Smooth Catsear	E	N/A												
Asteraceae	*Hypochaeris radicata*	Flatweed	E	N/A												
Asteraceae	*Lactuca serriola*	Prickly Lettuce	E	N/A												
Asteraceae	*Leiocarpa brevicompta*	Flat Billy-buttons	N	FG												
Asteraceae	*Ozothamnus cassinioides*	-	N	SG												
Asteraceae	*Senecio sp. 1*	a Fireweed	E	N/A												
Asteraceae	*Solenogyne bellioides*	-	N	FG												
Asteraceae	*Vittadinia cuneata var. cuneata*	-	N	FG												
Asteraceae	*Vittadinia sp.*	-	N	FG												
Asteraceae	*Vittadinia sulcata*	-	N	FG	0.1	3										
Asteraceae	*Xanthium spinosum*	Bathurst Burr	HTE	N/A												
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	N	OG												
Boraginaceae	*Heliotropium amplexicaule*	Blue Heliotrope	HTE	N/A			0.1	4	0.1	65	0.2	200			0.1	4
Cactaceae	*Opuntia aurantiaca*	Tiger Pear	HTE	N/A	0.1	3										
Cactaceae	*Opuntia tomentosa*	Velvet Tree Pear	HTE	N/A	1.5	1										
Campanulaceae	*Wahlenbergia graniticola*	Granite Bluebell	N	FG												
Campanulaceae	*Wahlenbergia sp.*	-	N	FG												
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	N	FG												
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	N	FG	0.1	300					0.1	100	0.1	10		
Chenopodiaceae	*Maireana microphylla*	Small-leaf Bluebush	N	SG	0.2	4	0.1	1					3	18		
Chenopodiaceae	*Sclerolaena birchii*	Galvanized Burr	N	SG	0.1	40	0.1	5	0.1	4	0.3	200	2	150		
Convolvulaceae	*Convolvulus erubescens*	Blushing Bindweed	N	OG					0.1	3	0.2	200	0.1	6		
Convolvulaceae	*Dichondra repens*	Kidney Weed	N	FG												
Convolvulaceae	*Dichondra sp. A* Sensu Harden (1992)	-	N	FG	0.1	8	0.1	6			0.1	100			0.1	100
Convolvulaceae	*Evolvulus alsinoides*	Dwarf Monring Glory	N	FG												
Cupressaceae	*Callitris endlicheri*	Black Cypress Pine	N	TG												
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine	N	TG	0.1	6									0.1	4
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge	N	GG												

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 31		Plot 32		Plot 33		Plot 34		Plot 35		Plot 36	
					C	A	C	A	C	A	C	A	C	A	C	A
Cyperaceae	*Schoenus sp. 1*	a Bog-rush	N	GG												
Ericaceae (Epacridoideae)	*Melichrus urceolatus*	Urn-heath	N	SG												
Euphorbiaceae	*Euphorbia dallachyana*	Mat Spurge	N	SG												
Euphorbiaceae	*Euphorbia drummondii*	Mat Spurge	N	FG	0.1	80			0.1	6	0.2	60				
Euphorbiaceae	*Euphorbia sp.*	-	N	FG												
Euphorbiaceae	*Euphorbia sp. 1*	-	E	N/A												
Fabaceae (Faboideae)	*Bossiaea scortechinii*	-	N	SG												
Fabaceae (Faboideae)	*Bossiaea sp.*	-	N	SG												
Fabaceae (Faboideae)	*Desmodium sp.*	-	N	FG												
Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	N	OG												
Fabaceae (Faboideae)	*Glycine clandestina*	-	N	OG			0.1	17							0.1	70
Fabaceae (Faboideae)	*Hardenbergia violaceae*	Purple Coral Pea	N	OG												
Fabaceae (Faboideae)	*Rhynchosia minima*	-	N	OG												
Fabaceae (Faboideae)	*Trifolium sp. 1*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Trifolium sp. 2*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Zornia dyctiocarpa*	Zornia	N	FG												
Fabaceae (Mimosoideae)	*Acacia decora*	Western Silver Wattle, S	N	SG												
Fabaceae (Mimosoideae)	*Neptunia gracilis*	Native Senstitive Plant	N	FG					0.1	3	0.1	20				
Geraniaceae	*Geranium molle*	Cranesbill Geranium	E	N/A												
Goodeniaceae	*Goodenia sp. 1*	-	N	FG												
Haloragaceae	*Haloragis sp.*	-	N	FG												
Hypericaceae	*Hypericum sp.*	-	E	N/A												
Juncaceae	*Juncus sp.*	a Rush	E	N/A												
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush	N	GG			0.1	40					0.1	25		
Loranthaceae	*Amyema miquelii*	-	N	OG												
Malvaceae	*Sida corrugata*	Corrugated Sida	N	FG	0.1	200	0.1	16					0.1	29	0.1	90
Moraceae	*Ficus sp. 1*	a Fig	N	TG												
Myrtaceae	*Angophora floribunda*	Rough-barked Apple	N	TG												
Myrtaceae	*Corymbia dolichocarpa*	Long-fruited Bloodwood	N	TG												
Myrtaceae	*Corymbia sp.*	-	N	TG												
Myrtaceae	*Eucalyptus albens*	White Box	N	TG												
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	N	TG												
Myrtaceae	*Eucalyptus dealbata*	Tumbledown Red Gum	N	TG												
Myrtaceae	*Eucalyptus melanophloia*	Silver-leaved Ironbark	N	TG												
Myrtaceae	*Eucalyptus melliodora*	Yellow Box	N	TG												
Myrtaceae	*Eucalyptus prava*	Orange Gum	N	TG												
Nyctaginaceae	*Boerhavia dominii*	Tarvine	N	FG	0.1	30									0.1	14
Oleaceae	*Notelaea longifolia*	Large-leaved Olive	N	TG												
Oleaceae	*Notelaea microcarpa*	Native Olive	N	TG	3	1										
Oleaceae	*Notelaea sp.*	an olive	N	SG												
Oxalidaceae	*Oxalis perennans*	-	N	FG												
Phyllanthaceae	*Breynia sp.*	-	N	SG												
Phyllanthaceae	*Phyllanthus virgatus*	-	N	FG												
Pittosporaceae	*Pittosporum spinescens*	Wallaby Apple	N	SG												
Plantaginaceae	*Plantago debilis*	-	N	FG												
Plantaginaceae	*Plantago sp. 1*	a Plantain	E	N/A												
Poaceae	*Aristida leptopoda*	White Speargrass	N	GG												
Poaceae	*Aristida ramosa*	Purple Wiregrass	N	GG	0.2	25	40	1200	0.1	3			2	29	0.2	15

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 31		Plot 32		Plot 33		Plot 34		Plot 35		Plot 36	
					C	A	C	A	C	A	C	A	C	A	C	A
Poaceae	*Austrostipa scabra subsp. scabra*	Speargrass	N	GG												
Poaceae	*Austrostipa verticillata*	Slender Bamboo Grass	N	GG												
Poaceae	*Bothriochloa biloba*	-	N	GG												
Poaceae	*Bothriochloa decipiens*	Red Grass, Redleg Grass	N	GG	1	100	0.1	1	0.1	35	0.2	100	0.2	200	1.5	600
Poaceae	*Chloris truncata*	Windmill Grass	N	GG									0.1	2		
Poaceae	*Chloris ventricosa*	Plump Windmill Grass	N	GG												
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	N	GG											0.1	30
Poaceae	*Cynodon dactylon*	Couch, Bermudagrass	N	GG												
Poaceae	*Digitaria brownii*	Cotton Panic Grass	N	GG												
Poaceae	*Digitaria diffusa*	Open Summer-grass	N	GG												
Poaceae	*Enneapogon gracilis*	Slender Bottle-washers	N	GG	0.1	20							0.5	50	1	600
Poaceae	*Entolasia stricta*	Wiry Panic	N	GG												
Poaceae	*Eragrostis brownii*	Brown's Lovegrass	N	GG							0.1	2	0.1	3	0.1	24
Poaceae	*Eragrostis leptostachya*	Paddock Lovegrass	N	GG												
Poaceae	*Eragrostis sp.*	-	N	GG												
Poaceae	*Eragrostis sp. 1*	-	E	N/A												
Poaceae	*Eulalia aurea*	Sliky Browntop	N	GG			0.1	1								
Poaceae	*Heteropogon contortus*	Bunch Speargrass	N	GG												
Poaceae	*Panicum simile*	Two Colour Panic	N	GG											0.2	50
Poaceae	*Panicum sp. 1*	a Panic Grass	E	N/A												
Poaceae	*Paspalidium distans*	-	N	GG												
Poaceae	*Poa sp. 1*	-	E	N/A												
Poaceae	*Sporobolus creber*	Western Rat-tail Grass	N	GG												
Poaceae	*Sporobolus elongatus*	Slender Rat's Tail Grass	N	GG												
Poaceae	*Sporobolus sp.*	-	E	N/A												
Poaceae	*Themeda triandra*	Kangaroo Grass	N	GG												
Poaceae	*Tripogon loliiformis*	Fiveminute Grass	N	GG												
Poaceae	*Urochloa panicoides*	Urochloa Grass, Liversee	E	N/A												
Polygonaceae	*Rumex brownii*	Swamp Dock	N	FG									0.1	10	0.1	8
Polygonaceae	*Rumex sp.*	-	N	FG												
Portulacaceae	*Portulaca bicolor*	-	N	FG	0.1	4										
Portulacaceae	*Portulaca oleracea*	Pigweed	N	FG	0.1	2							0.1	18		
Proteaceae	*Hakea laevipes*	-	N	SG												
Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern	N	EG												
Pteridaceae	*Cheilanthes sieberi*	-	N	EG	0.1	8	0.1	12								
Rutaceae	*Geijera parviflora*	Wilga	N	SG												
Sapindaceae	*Dodonaea viscosa subsp. spatulata*	-	N	SG												
Solanaceae	*Solanum ferocissimum*	Spiny Potato Bush	N	SG	0.1	1										
Solanaceae	*Solanum sp.*	-	N	FG												
Solanaceae	*Solanum sp. 1*	-	E	N/A												
Solanaceae	*Solanum sturtianum*	Thargomindah Nightsha	N	SG												
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia	N	FG												
Thymelaeaceae	*Pimelea neo-anglica*	Poison Pimelea	N	SG												
Thymelaeaceae	*Pimelea stricta*	-	N	SG											0.1	1
Urticaceae	*Urtica urens*	Small Nettle	E	N/A												
Verbenaceae	*Glandularia aristigera*	Mayne's Pest	E	N/A												
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Johnson's Grass Tree	N	OG												
Zygophyllaceae	*Tribulus terrestris*	Caltrop	E	N/A												

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 31		Plot 32		Plot 33		Plot 34		Plot 35		Plot 36	
					C	A	C	A	C	A	C	A	C	A	C	A
Unknown	Undetermined exotic	-	E	N/A												
Unknown	Unidentified Forb B	-	N	FG												
Rubiaceae	Rubiaceae	-	N	SG												
Unknown	Unidentified Forb A	-	N	FG												
Unknown	Unidentified Forb C	-	N	FG												
Unidentified	unidentified species	-	-	-	9				0.5	900	1	80	1		7	

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Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 37		Plot 38		Plot 39		Plot 40		Plot 41		Plot 42	
					C	A	C	A	C	A	C	A	C	A	C	A
Acanthaceae	*Rostellularia adscendens*	-	N	FG			0.1	3								
Amaranthaceae	*Alternanthera sp. A* Flora of New South Wales (M.Gray 5187) J. Palmer	-	N	FG												
Amaranthaceae	*Gomphrena celosioides*	Gomphrena Weed	E	N/A												
Apiaceae	*Actinotus sp. 1*	-	N	FG												
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery	E	N/A												
Apocynaceae	*Carissa ovata* (i.e. *Carissa spinarum*)	-	N	OG												
Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton B	E	N/A												
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo	N	OG												
Apocynaceae	*Parsonsia sp. 1*	-	N	OG												
Asteraceae	*Asteraceae*	-	N	FG												
Asteraceae	*Asteraceae sp. 1*	-	E	N/A												
Asteraceae	*Asteraceae sp. 2*	-	E	N/A												
Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy	N	FG												
Asteraceae	*Carthamus lanatus*	Saffron Thistle	HTE	N/A												
Asteraceae	*Cassinia arcuata*	Siffon Bush	N	SG												
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting, Ye	N	FG												
Asteraceae	*Cirsium vulgare*	Spear Thistle	E	N/A												
Asteraceae	*Gamochaeta sp. 1*	a Cudweed	E	N/A												
Asteraceae	*Glossocardia bidens*	Cobbler's Tack	N	FG												
Asteraceae	*Hypochaeris glabra*	Smooth Catsear	E	N/A												
Asteraceae	*Hypochaeris radicata*	Flatweed	E	N/A												
Asteraceae	*Lactuca serriola*	Prickly Lettuce	E	N/A												
Asteraceae	*Leiocarpa brevicompta*	Flat Billy-buttons	N	FG												
Asteraceae	*Ozothamnus cassinioides*	-	N	SG												
Asteraceae	*Senecio sp. 1*	a Fireweed	E	N/A												
Asteraceae	*Solenogyne bellioides*	-	N	FG					0.1	40						
Asteraceae	*Vittadinia cuneata var. cuneata*	-	N	FG												
Asteraceae	*Vittadinia sp.*	-	N	FG												
Asteraceae	*Vittadinia sulcata*	-	N	FG												
Asteraceae	*Xanthium spinosum*	Bathurst Burr	HTE	N/A												
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	N	OG												
Boraginaceae	*Heliotropium amplexicaule*	Blue Heliotrope	HTE	N/A												
Cactaceae	*Opuntia aurantiaca*	Tiger Pear	HTE	N/A			0.1	3	0.1	2						
Cactaceae	*Opuntia tomentosa*	Velvet Tree Pear	HTE	N/A												
Campanulaceae	*Wahlenbergia graniticola*	Granite Bluebell	N	FG												
Campanulaceae	*Wahlenbergia sp.*	-	N	FG												
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	N	FG												
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	N	FG					0.1	6						
Chenopodiaceae	*Maireana microphylla*	Small-leaf Bluebush	N	SG			0.1	2	0.1	1			0.3	7		
Chenopodiaceae	*Sclerolaena birchii*	Galvanized Burr	N	SG			0.1	12	0.3	200			0.2	100		
Convolvulaceae	*Convolvulus erubescens*	Blushing Bindweed	N	OG												
Convolvulaceae	*Dichondra repens*	Kidney Weed	N	FG												
Convolvulaceae	*Dichondra sp. A* Sensu Harden (1992)	-	N	FG					0.2	90						
Convolvulaceae	*Evolvulus alsinoides*	Dwarf Monring Glory	N	FG												
Cupressaceae	*Callitris endlicheri*	Black Cypress Pine	N	TG												
Cupressaceae	*Callitris glaucophylla*	White Cypress Pine	N	TG									10	13		
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge	N	GG	0.1	3										

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I - incidental observation; C = Cover (%); A = Abundance

Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 37		Plot 38		Plot 39		Plot 40		Plot 41		Plot 42	
					C	A	C	A	C	A	C	A	C	A	C	A
Cyperaceae	*Schoenus sp. 1*	a Bog-rush	N	GG												
Ericaceae (Epacridoideae)	*Melichrus urceolatus*	Urn-heath	N	SG												
Euphorbiaceae	*Euphorbia dallachyana*	Mat Spurge	N	SG												
Euphorbiaceae	*Euphorbia drummondii*	Mat Spurge	N	FG							0.1	3				
Euphorbiaceae	*Euphorbia sp.*	-	N	FG												
Euphorbiaceae	*Euphorbia sp. 1*	-	E	N/A												
Fabaceae (Faboideae)	*Bossiaea scortechinii*	-	N	SG												
Fabaceae (Faboideae)	*Bossiaea sp.*	-	N	SG												
Fabaceae (Faboideae)	*Desmodium sp.*	-	N	FG												
Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil	N	OG												
Fabaceae (Faboideae)	*Glycine clandestina*	-	N	OG							0.1	20	0.1	8		
Fabaceae (Faboideae)	*Hardenbergia violaceae*	Purple Coral Pea	N	OG												
Fabaceae (Faboideae)	*Rhynchosia minima*	-	N	OG												
Fabaceae (Faboideae)	*Trifolium sp. 1*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Trifolium sp. 2*	a Clover	E	N/A												
Fabaceae (Faboideae)	*Zornia dyctiocarpa*	Zornia	N	FG												
Fabaceae (Mimosoideae)	*Acacia decora*	Western Silver Wattle, S	N	SG												
Fabaceae (Mimosoideae)	*Neptunia gracilis*	Native Senstitive Plant	N	FG												
Geraniaceae	*Geranium molle*	Cranesbill Geranium	E	N/A												
Goodeniaceae	*Goodenia sp. 1*	-	N	FG												
Haloragaceae	*Haloragis sp.*	-	N	FG												
Hypericaceae	*Hypericum sp.*	-	E	N/A							0.1	8				
Juncaceae	*Juncus sp.*	a Rush	E	N/A	0.1	6										
Lomandraceae	*Lomandra filiformis*	Wattle Mat-rush	N	GG												
Loranthaceae	*Amyema miquelii*	-	N	OG												
Malvaceae	*Sida corrugata*	Corrugated Sida	N	FG	0.1	50			0.1	200	0.1	100	0.1	50	0.1	40
Moraceae	*Ficus sp. 1*	a Fig	N	TG												
Myrtaceae	*Angophora floribunda*	Rough-barked Apple	N	TG												
Myrtaceae	*Corymbia dolichocarpa*	Long-fruited Bloodwood	N	TG												
Myrtaceae	*Corymbia sp.*	-	N	TG												
Myrtaceae	*Eucalyptus albens*	White Box	N	TG			50									
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	N	TG												
Myrtaceae	*Eucalyptus dealbata*	Tumbledown Red Gum	N	TG												
Myrtaceae	*Eucalyptus melanophloia*	Silver-leaved Ironbark	N	TG							25				20	1
Myrtaceae	*Eucalyptus melliodora*	Yellow Box	N	TG												
Myrtaceae	*Eucalyptus prava*	Orange Gum	N	TG												
Nyctaginaceae	*Boerhavia dominii*	Tarvine	N	FG									0.1	30	0.1	16
Oleaceae	*Notelaea longifolia*	Large-leaved Olive	N	TG												
Oleaceae	*Notelaea microcarpa*	Native Olive	N	TG												
Oleaceae	*Notelaea sp.*	an olive	N	SG												
Oxalidaceae	*Oxalis perennans*	-	N	FG	0.1	1							0.1	15		
Phyllanthaceae	*Breynia sp.*	-	N	SG												
Phyllanthaceae	*Phyllanthus virgatus*	-	N	FG												
Pittosporaceae	*Pittosporum spinescens*	Wallaby Apple	N	SG												
Plantaginaceae	*Plantago debilis*	-	N	FG												
Plantaginaceae	*Plantago sp. 1*	a Plantain	E	N/A												
Poaceae	*Aristida leptopoda*	White Speargrass	N	GG							0.1	5				
Poaceae	*Aristida ramosa*	Purple Wiregrass	N	GG	1	20	0.1	20	1.5	100	0.3	100	0.4	30	3	300

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I - incidental observation; C = Cover (%); A = Abundance

Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 37		Plot 38		Plot 39		Plot 40		Plot 41		Plot 42	
					C	A	C	A	C	A	C	A	C	A	C	A
Poaceae	*Austrostipa scabra subsp. scabra*	Speargrass	N	GG					0.1	4			0.1	40		
Poaceae	*Austrostipa verticillata*	Slender Bamboo Grass	N	GG												
Poaceae	*Bothriochloa biloba*	-	N	GG												
Poaceae	*Bothriochloa decipiens*	Red Grass, Redleg Grass	N	GG	3	700			0.2	200	0.1	50				
Poaceae	*Chloris truncata*	Windmill Grass	N	GG												
Poaceae	*Chloris ventricosa*	Plump Windmill Grass	N	GG												
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	N	GG	0.1	20					0.1	10				
Poaceae	*Cynodon dactylon*	Couch, Bermudagrass	N	GG									20	1		
Poaceae	*Digitaria brownii*	Cotton Panic Grass	N	GG												
Poaceae	*Digitaria diffusa*	Open Summer-grass	N	GG												
Poaceae	*Enneapogon gracilis*	Slender Bottle-washers	N	GG	0.1	4					0.2	50				
Poaceae	*Entolasia stricta*	Wiry Panic	N	GG												
Poaceae	*Eragrostis brownii*	Brown's Lovegrass	N	GG	0.1	11	0.1	2								
Poaceae	*Eragrostis leptostachya*	Paddock Lovegrass	N	GG												
Poaceae	*Eragrostis sp.*	-	N	GG												
Poaceae	*Eragrostis sp. 1*	-	E	N/A												
Poaceae	*Eulalia aurea*	Sliky Browntop	N	GG												
Poaceae	*Heteropogon contortus*	Bunch Speargrass	N	GG												
Poaceae	*Panicum simile*	Two Colour Panic	N	GG	0.1	11										
Poaceae	*Panicum sp. 1*	a Panic Grass	E	N/A												
Poaceae	*Paspalidium distans*	-	N	GG												
Poaceae	*Poa sp. 1*	-	E	N/A												
Poaceae	*Sporobolus creber*	Western Rat-tail Grass	N	GG												
Poaceae	*Sporobolus elongatus*	Slender Rat's Tail Grass	N	GG												
Poaceae	*Sporobolus sp.*	-	E	N/A												
Poaceae	*Themeda triandra*	Kangaroo Grass	N	GG												
Poaceae	*Tripogon loliiformis*	Fiveminute Grass	N	GG												
Poaceae	*Urochloa panicoides*	Urochloa Grass, Liversee	E	N/A												
Polygonaceae	*Rumex brownii*	Swamp Dock	N	FG	0.1	8										
Polygonaceae	*Rumex sp.*	-	N	FG												
Portulacaceae	*Portulaca bicolor*	-	N	FG												
Portulacaceae	*Portulaca oleracea*	Pigweed	N	FG											0.1	3
Proteaceae	*Hakea laevipes*	-	N	SG												
Pteridaceae	*Cheilanthes distans*	Bristly Cloak Fern	N	EG												
Pteridaceae	*Cheilanthes sieberi*	-	N	EG									0.1	20		
Rutaceae	*Geijera parviflora*	Wilga	N	SG												
Sapindaceae	*Dodonaea viscosa subsp. spatulata*	-	N	SG												
Solanaceae	*Solanum ferocissimum*	Spiny Potato Bush	N	SG												
Solanaceae	*Solanum sp.*	-	N	FG												
Solanaceae	*Solanum sp. 1*	-	E	N/A												
Solanaceae	*Solanum sturtianum*	Thargomindah Nightsha	N	SG												
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia	N	FG												
Thymelaeaceae	*Pimelea neo-anglica*	Poison Pimelea	N	SG												
Thymelaeaceae	*Pimelea stricta*	-	N	SG	0.1	1	0.1	3			0.1	4			0.1	1
Urticaceae	*Urtica urens*	Small Nettle	E	N/A												
Verbenaceae	*Glandularia aristigera*	Mayne's Pest	E	N/A												
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Johnson's Grass Tree	N	OG												
Zygophyllaceae	*Tribulus terrestris*	Caltrop	E	N/A											0.1	60

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I - incidental observation; C = Cover (%); A = Abundance

Table H.1 Flora Species List

Family	Scientific Name	Common Name	N, E or THE	Growth Form	Plot 37		Plot 38		Plot 39		Plot 40		Plot 41		Plot 42	
					C	A	C	A	C	A	C	A	C	A	C	A
Unknown	Undetermined exotic	-	E	N/A												
Unknown	Unidentified Forb B	-	N	FG												
Rubiaceae	Rubiaceae	-	N	SG												
Unknown	Unidentified Forb A	-	N	FG												
Unknown	Unidentified Forb C	-	N	FG												
Unidentified	unidentified species	-	-	-	5		0.5		5		5				4	

BAM Growth Form Group Code: SG - Shrub (SG); FG - Form (FG); OG - Other (OG); *GG - Grass grasslike (GG); EG - Fern (EG); TG - Tree (TG)*
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Table H.7 Summary of Hollow Bearing Trees Observations

No	Latitude	Longitud	Scientific Name	Common Name	Type	DBH	No Hollows	Size (cm)	Notes
1	-29.1927	151.3394	*Eucalyptus albens*	White Box	T	-	1	15	-
2	-29.194	151.3394	*Eucalyptus dealbata*	Tumbledown Red Gum	S	-	1	20	-
3	-29.1943	151.3403	*Eucalyptus albens*	White Box	T	-	1	5	-
4	-29.1952	151.3413	*Angophora floribunda*	Rough-barked Apple	T	-	1	45	-
5	-29.1942	151.3419	*Angophora floribunda*	Rough-barked Apple	T	-	1	15	-
6	-29.1968	151.3438	*Eucalyptus albens*	White Box	T	-	1	30	-
7	-29.1972	151.3441	-	-	S	-	1	40	-
8	-29.1973	151.3444	-	-	S	-	1	40	-
9	-29.197	151.3446	-	-	S	-	1	-	Large top opening
10	-29.1982	151.3432	*Eucalyptus melanophloia*	Silver-leaved Ironbark	S	-	1	10	-
11	-29.2062	151.345	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	25	-
12	-29.2053	151.3453	-	-	S	-	1	25	-
13	-29.2098	151.3414	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	10	-
14	-29.2098	151.3415	-	-	S	-	1	35	-
15	-29.2056	151.3366	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	5	-
16	-29.2084	151.3373	-	-	S	-	1	10	-
17	-29.2095	151.3375	*Eucalyptus albens*	White Box	T	-	1	5	-
18	-29.2097	151.3378	*Eucalyptus albens*	White Box	T	-	1	10	-
19	-29.21	151.3331	*Corymbia dolichocarpa*	Long-fruited Bloodwood	T	-	1	20	-
20	-29.2095	151.3336	-	-	S	-	1	10	-
21	-29.2094	151.3335	-	-	S	-	1	5	-
22	-29.2093	151.3301	-	-	S	-	1	-	Split at base to 1.75m
23	-29.2086	151.3311	-	-	S	-	1	10	-
24	-29.2058	151.3318	-	-	S	-	1	5	-
25	-29.2014	151.3478	-	-	S	-	1	35	-
26	-29.2022	151.3479	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	35	-
27	-29.2018	151.3485	*Eucalyptus dealbata*	Tumbledown Red Gum	T	-	1	20	-
28	-29.2019	151.3485	*Eucalyptus dealbata*	Tumbledown Red Gum	T	-	1	25	-
29	-29.2019	151.3454	-	-	S	-	1	25	-
30	-29.2068	151.3424	*Eucalyptus albens*	White Box	S	-	1	40	-
31	-29.2073	151.3423	*Eucalyptus albens*	White Box	S	-	1	15	-
32	-29.205	151.3368	-	-	S	-	1	15	-

No	Latitude	Longitud	Scientific Name	Common Name	Type	DBH	No Hollows	Size (cm)	Notes
33	-29.1968	151.3401	*Eucalyptus albens*	White Box	T	-	1	15	-
34	-29.2095	151.3319	*Corymbia dolichocarpa*	Long-fruited Bloodwood	T	-	1	20	-
35	-29.194	151.3377	*Eucalyptus albens*	White Box	T	-	3	20	Largest hollow 20cm D
36	-29.194	151.3381	*Eucalyptus albens*	White Box	T	-	1	10	-
37	-29.1961	151.3387	*Eucalyptus albens*	White Box	S	-	1	30	-
38	-29.1977	151.3399	-	-	S	-	1	5	-
39	-29.1983	151.3399	*Eucalyptus albens*	White Box	S	80	1	30	-
40	-29.2005	151.3376	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	20	-
41	-29.2029	151.3369	*Eucalyptus albens*	White Box	T, S	-	1	10	-
42	-29.2022	151.336	*Eucalyptus albens*	White Box	T	-	1	15	-
43	-29.201	151.3385	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	10	-
44	-29.2022	151.3378	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T, S*	-	1	<10	-
45	-29.2095	151.332	*Eucalyptus albens*	White Box	T	-	1	30	-
46	-29.2018	151.3426	-	-	S	-	1	15	-
47	-29.2011	151.3451	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	15	-
48	-29.2016	151.3383	-	-	S	-	1	15	-
49	-29.2056	151.3399	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	40	Hollow at approx 6m above ground level
50	-29.2068	151.3395	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	7	-
51	-29.2087	151.3384	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	10	-
52	-29.2107	151.3358	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	10	-
53	-29.21	151.3415	*Corymbia dolichocarpa*	Long-fruited Bloodwood	T	-	1	30	-
54	-29.2077	151.3418	Eucalyptus melanophloia	Silver-leaved Ironbark	T	-	1	20	-
55	-29.2074	151.3411	-	-	T	-	1	15	-
56	-29.2071	151.3409	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	35	-
57	-29.2062	151.3415	-	-	T	-	1	10	-
58	-29.2063	151.3446	*Eucalyptus dealbata*	Tumbledown Red Gum	T	-	1	15	-
59	-29.2	151.344	*Eucalyptus melanophloia*	Silver-leaved Ironbark	T	-	1	15	-
60	-29.1996	151.3393	*Eucalyptus albens*	White Box	T	-	1	40	-

APPENDIX I MICROCHIROPTERAN BAT CALL REPORT

Microbat Call Identification Report

Prepared for ("Client"):	ERM
Survey location/project name:	Bonshaw area (NSW)
Survey dates:	10-14 December 2018
Client project reference:	0470861
Job no.:	ERM-1901
Report date:	22 February 2019

DISCLAIMER:

Methods

Data received

Balance! Environmental received 8351 full-spectrum (WAV format) audio files, recorded using Song Meter SM2BAT detectors at seven sites (S2-S8) over four consecutive nights (10-13 December 2018). A file note included with the submitted data indicated that another site ("S1") was sampled but no data was obtained.

Call identification

Data were analysed in *Kaleidoscope Pro* (Version 5.1.7; Wildlife Acoustics, Maynard MA, USA). The first-pass analysis utilised the "Cluster Analysis" function, to scan all WAV files and automatically group recognised bat calls into clusters with similar call characteristics (based on zero-crossing analysis). Clusters were then assigned species identifications by manually reviewing call spectrograms and derived metrics and comparing them with those of regionally-relevant reference calls and/or with published call descriptions (Reinhold et al. 2001; Pennay *et al.* 2004). Consideration was also given to the probability of species' occurrence based on published distribution information (e.g. Churchill 2008; van Dyck *et al.* 2013) and on-line database records (e.g. http://www.ala.org.au).

Species identification was based largely on search-phase call sequences; however, where good-quality foraging sequences were available (*i.e.* a call sequence with contiguous search-phase, attack-phase and feeding-buzz components), those calls were used to provide additional evidence of some species' presence. The feeding buzzes of *Miniopterus* species (bent-winged bats) and some Molossids (free-tailed bats) are quite distinctive, compared with those of Vespertilionids (vesper bats) with which they often share search-phase characteristics (Corben 2010).

Reporting standard

The format and content of this report follows Australasian Bat Society standards for the interpretation and reporting of bat call data (Reardon 2003), available on-line at http://www.ausbats.org.au/.

Species nomenclature follows Jackson & Groves (2015), which uses several new genus/species names compared with common field guides (*e.g.* Churchill 2008; Van Dyck *et al.* 2013). New names used in this report include:

> *Ozimops ridei* (Ride's Free-tailed Bat) – formerly *Mormopterus ridei* and *M.* 'species 2';
>
> *O. petersi* (Inland Free-tailed Bat) – formerly *M. petersi* and *M.* 'species 3';
>
> *O. planiceps* (Southern free-tailed Bat) – formerly *M. planiceps* and *M.* 'species 4';
>
> *Setirostris eleryi* (Bristle-faced Free-tailed Bat) – formerly *M. eleryi* and *M.* 'species 6'; and
>
> *Miniopterus orianae* (Large or Eastern Bent-winged Bat) – formerly *M. schreibersii.*

Results & Discussion

Cluster analysis output

The Cluster Analysis recognised 7705 bat calls and grouped them into 54 clusters; however, many clusters contained slight variants of the same species' calls. Three-quarters of the recognised calls were positively identified, with the other 25% unable to be allocated reliably to a single species. These were assigned to "unresolved species" groups. A breakdown of the numbers of calls attributed to species or unresolved groups for each site is provided at **Appendix 1**.

Species recorded

At least 12 and up to 16 species were recorded during the Bonshaw survey (see **Table 1**). Eleven call types were positively identified to individual species, while one call type was attributed to the genus *Nyctophilus*, within which species cannot be reliably differentiated using call characteristics. Three *Nyctophilus* species potentially occur in the study area: *N. corbeni; N. geoffroyi;* and *N. gouldi*. Half (3907) of the total recorded calls were reliably attributed to just three species: *Miniopterus orianae oceanensis* (Eastern Bent-winged Bat); *Ozimops ridei* (Eastern Free-tailed Bat); and *Saccolaimus flaviventris* (Yellow-bellied Sheath-tailed Bat).

Several call types that potentially represented multiple species were allocated to "unresolved" species groups. Where calls were allocated to one these "unresolved" groups, all group members are listed as "possibly present" in **Table 1** unless other, more typical calls form one or more members were also observed for the relevant site. Three of the "unresolved" species groups included species that were not otherwise found in the positively-identified call data. These include:

- *Ozimops ridei / O. petersi / O. planiceps*
    - *O. ridei* was positively identified where calls had typical *Ozimops* pulse-shape characteristics (predominantly flat search-phase pulses) and characteristic frequency (Fc) of 30-35 kHz
    - Calls allocated to this "unresolved" group had similar pulse shapes but Fc27-30 kHz
    - It is likely these were all low-frequency variants of *O. ridei*, but it is possible that *O. planiceps* and (remotely possible) *O. petersi* also occur in the study area
- *Vespadelus vulturnus / V. troughtoni*
    - *V. vulturnus* positively identified from numerous calls having typical steep, curvilinear pulses with hooked bodies (up-swept tail) and Fc~46-48 kHz
    - A number of calls with the same typical *Vespadelus* pulse-shape had Fc~48-50 kHz may have been form either of these species
- *Vespadelus* spp. */ Chalinolobus morio*
    - Calls were similar to above group but had mixed pulse shape and duration, varying from the shorter, hooked *Vespadelus* pulse-shape to longer, flatter pulse bodies with no tail or down-swept tail more typical of *C. morio*
    - *C. morio* calls were reliably identified only where all pulses showed consistent shape with flatter characteristic section and obvious down-swept tail

Sample spectrograms of all call-types are shown at Appendix 1.

Threatened species

Several of the identified species are listed as threatened under State and Commonwealth nature conservation legislation (Environment Protection and Biodiversity Conservation Act 1999 [EPBC Act] – Cwlth; Biodiversity Conservation Act 2016 [BCA] – New South Wales; Nature Conservation Act 1992 [NCA] – Queensland). These include:

- *Chalinolobus picatus* (Little Pied Bat) – Vulnerable, BCA
- *Nyctophilus corbeni* (Corben's Long-eared Bat) – Vulnerable, EPBC, BCA, NCA
    - Note that this species was not positively identified, but may have been responsible for some of the calls allocated to the *Nyctophilus* genus
- *Vespadelus troughtoni* (Eastern Cave Bat) – Vulnerable, BCA
    - Note that this species was not positively identified but may have been responsible for some of the unresolved calls allocated to two multi-species groups (see previous section)
- *Miniopterus orianae oceanensis* (Eastern Bent-winged Bat) – Vulnerable, BCA
- *Setirostris eleryi* (Bristle-faced Free-tailed Bat) – Endangered, BCA
- *Saccolaimus flaviventris* (Yellow-bellied Sheath-tailed Bat) – Vulnerable, BCA

Table 1. Microbat species recorded during the ERM Bonshaw survey, 10-14 December 2018.

♦ = 'definite' - at least one call was attributed unequivocally to the species
☐ = 'possible' - calls like those of the species were recorded, but were not reliably identified

Site code:	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**
Chalinolobus gouldii	♦	♦	♦	♦	♦	♦	♦
Chalinolobus morio	♦	♦	♦	♦	♦	♦	♦
Chalinolobus picatus	♦	♦	♦	♦	☐	♦	♦
Nyctophilus species	♦	♦	♦	♦	♦	♦	
Scotorepens balstoni	♦	♦	♦	♦	♦	♦	☐
Scotorepens greyii	♦	♦	♦	♦	♦	♦	♦
Vespadelus vulturnus	♦	♦	♦	♦	♦	♦	♦
Vespadelus troughtoni	☐	☐	☐	☐	☐	☐	☐
Miniopterus orianae oceanensis	♦	♦	♦	♦	♦	♦	♦
Austronomus australis	♦	♦	♦	♦	♦	♦	♦
Ozimops ridei	♦	♦	♦	♦	♦	♦	♦
Ozimops planiceps / O. petersi	☐	☐	☐	☐	☐	☐	☐
Setirostris eleryi	♦	♦	♦	♦	♦	♦	♦
Saccolaimus flaviventris	♦	♦	♦	♦	♦	♦	♦

References

Churchill, S. (2008). *Australian Bats*. Jacana Books, Allen & Unwin; Sydney.

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van Dyck, S., Gynther, I. and Baker, A. (ed.) (2013). *Field Companion to the Mammals of Australia*. New Holland; Sydney.

Glossary

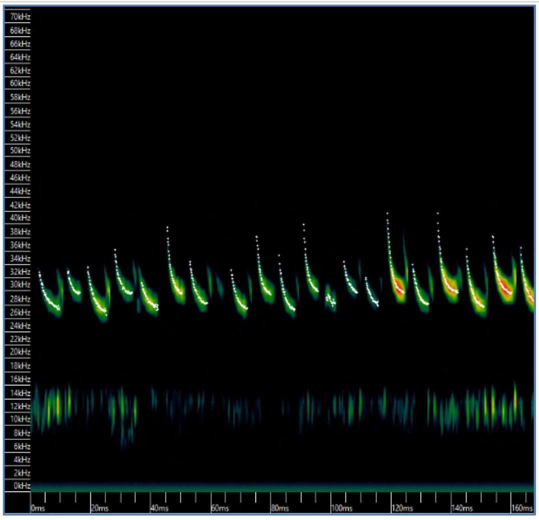
Technical terms used in this report are described in the following table.

Approach phase	The part of a bat *call* emitted as the bat starts to home in on a detected prey item; a transitional series of *pulses* between the *search phase* and *feeding buzz*, that become progressively steeper and shorter in duration.
Call	Refers to a single bat call, made up of a series of individual sound *pulses* in one or more *phases* (*search, approach, feeding buzz*).
CF (=Constant Frequency)	A type of *pulse* in which the dominant component consists of a more-or-less 'pure tone' of sound at a Constant Frequency; with *shape* appearing flat on the sonogram. Often also contains a brief *FM* component at the beginning and/or end of the CF component (*viz.* FM-CF-FM).
Characteristic frequency (Fc)	The frequency of the flattest part of a *pulse*; usually the lowest frequency reached in the *qCF* component of a pulse. This is often the primary diagnostic feature for species identification.
Duration	The time period from the beginning of a *pulse* to the end of the pulse.
Feeding buzz	The terminal part of a *call*, following the *approach phase*, emitted as the bat catches a prey item; a distinctive, rapid series of very steep, very short-duration pulses.
FM (=Frequency Modulated)	A type of *pulse* in which there is substantial change in frequency from beginning to end; *shape* ranges from almost vertical and linear through varying degrees of curvature.
FC range	Refers to the range of frequencies occupied by the *characteristic frequency* section of *pulses* within a call or set of calls.
Frequency sweep or "band-width"	The range of frequencies through which a *pulse* sweeps from beginning to end; Maximum frequency (Fmax) – minimum frequency (Fmin).
Knee	The transitional part of a *pulse* between the initial (usually steeper) frequency sweep and the *characteristic frequency* section (usually flatter); time to knee (Tk) and frequency of knee (Fk) can be diagnostic for some species.
Pulse	An individual pulse of sound within a bat *call*; the *shape*, *duration* and *characteristic frequency* of a pulse are the key diagnostic features used to differentiate species.
Pulse body	The part of the *pulse* between the *knee* and *tail* and containing the *characteristic frequency* section.
Pulse shape	The general appearance of a *pulse* on the sonogram, described using relative terms related to features such as slope and degree of curvature. See also *CF, qCF* and *FM*.
qCF (=quasi Constant Frequency)	A type of *pulse* in which there is very little change in frequency from beginning to end; *shape* appears to be almost flat. Some pulses also contain an *FM* component at the beginning and/or end of the qCF component (*viz.* FM-qCF).
Search phase	The part of a bat *call* generally required for reliable species diagnosis. A consistent series of *pulses* emitted by a bat that is searching for prey or and/or navigating through its habitat. Search phase pulses generally have longer duration, flatter slope and more consistent shape than *approach phase* and *feeding buzz* pulses.
Sequence	Literally, a sequence of *pulses* that may be from one or more bats; but generally refers to a *call* or part (e.g. *phase*) of a call.
Tail	The final component of a *pulse*, following the *characteristic frequency* section; may consist of a short or long sweep of frequencies either upward or downward from the Fc; or may be absent.

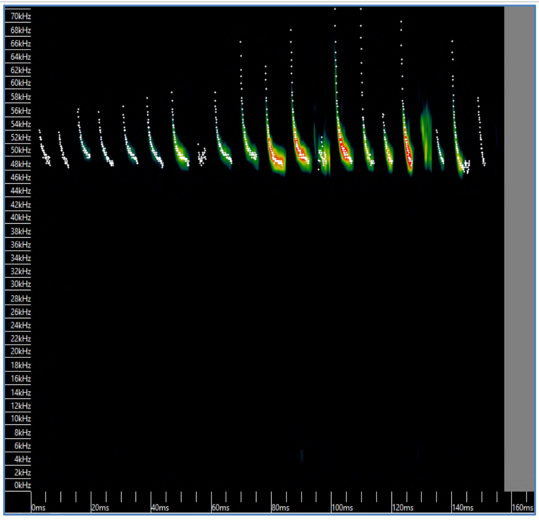
Appendix 1 Bats recorded during the Bonshaw survey: number of calls allocated to each species or unresolved group.

Site code:	S2	S3	S4	S5	S6	S7	S8	Species totals
Positively identified calls								
Chalinolobus gouldii	46	44	33	267	43	9	13	455
Chalinolobus morio	1	3	1	3	1	3	3	15
Chalinolobus picatus	10	12	3	54		5	7	91
Nyctophilus species	5	2	1	11	5	13		37
Scotorepens balstoni	2	1	2	15	12	2		34
Scotorepens greyii	19	6	32	273	17	8	18	373
Vespadelus vulturnus	11	8	15	62	2	7	3	108
Miniopterus orianae oceanensis	69	150	10	390	19	52	67	757
Austronomus australis	24	38	13	16	62	26	14	193
Ozimops ridei	351	227	98	440	216	163	158	1653
Setirostris eleryi	70	40	79	270	31	48	26	564
Saccolaimus flaviventris	343	491	104	377	79	30	73	1497
Unresolved calls								
C. gouldii/O. ridei	181	106	64	257	97	60	60	825
C. gouldii/S. balstoni	16	8	20	111	42	2	6	205
S. balstoni/O. ridei	26	11	4	44	9	4		98
S. greyii/C. picatus	1	5	4	31	3	5		49
S. greyii/S. eleryi		4	7	44	5	6		66
Ozimops species	59	31	15	31	25	31	34	226
V. vulturnus/M. o. oceanensis	32	27	10	75	5	13	3	165
V. vulturnus/V. troughtoni	11	10	117	66	10	10	5	229
V. vulturnus/V. troughtoni/C. morio	6	22	16	12	4	3	2	65
Total calls from site:	1283	1246	648	2849	687	500	492	7705

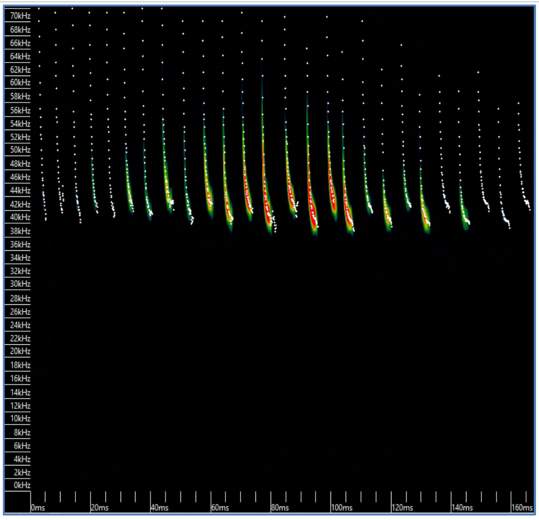
Appendix 2 Representative call sequences from the Bonshaw survey, 10-14 December 2018.
Kaleidoscope spectrograms with zero-crossing overlay (white); time between pulses removed



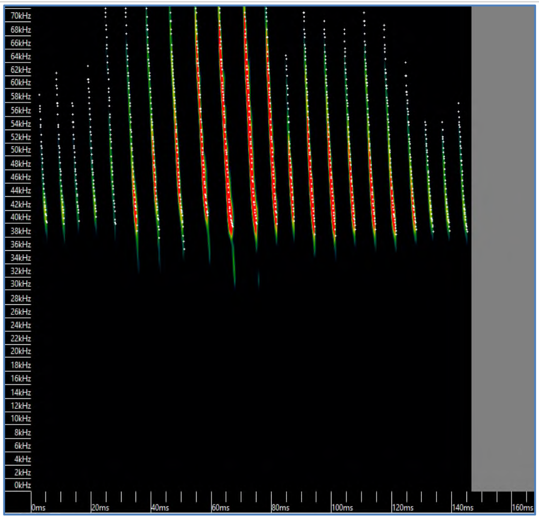
Chalinolobus gouldii



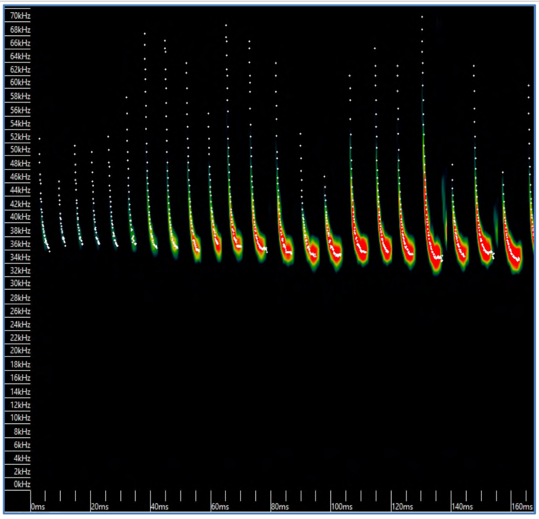
Chalinolobus morio



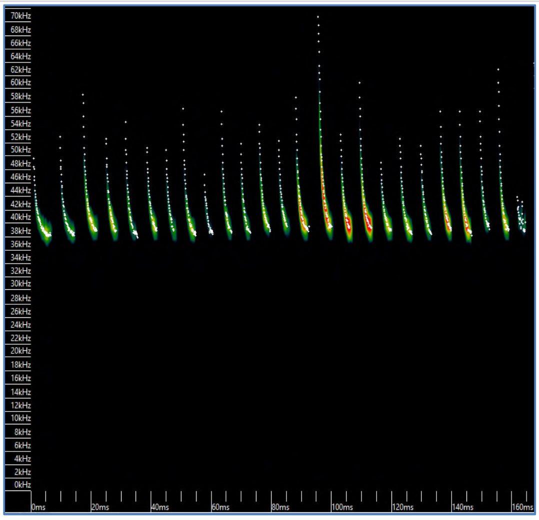
Chalinolobus picatus



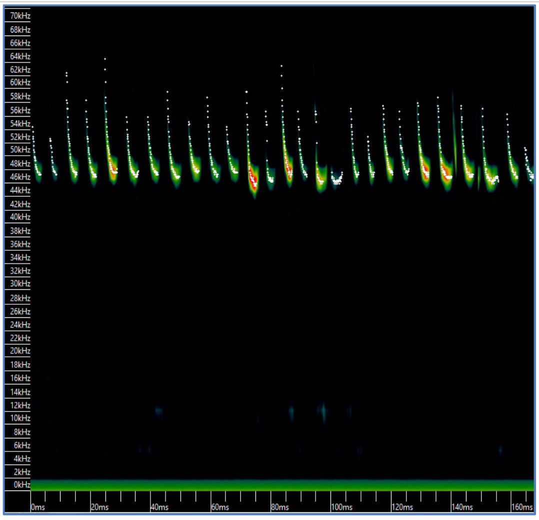
Nyctophilus species



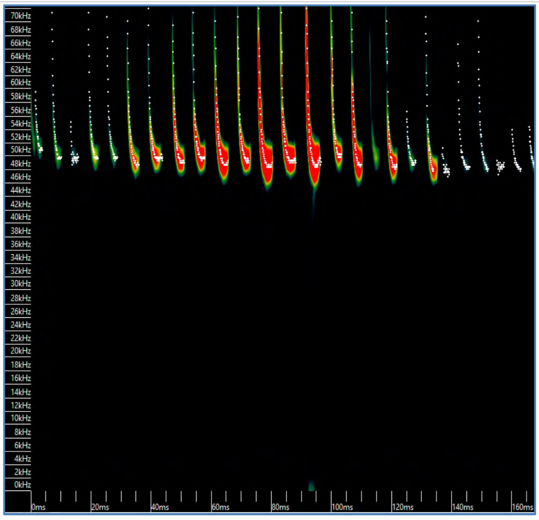
Scotorepens balstoni



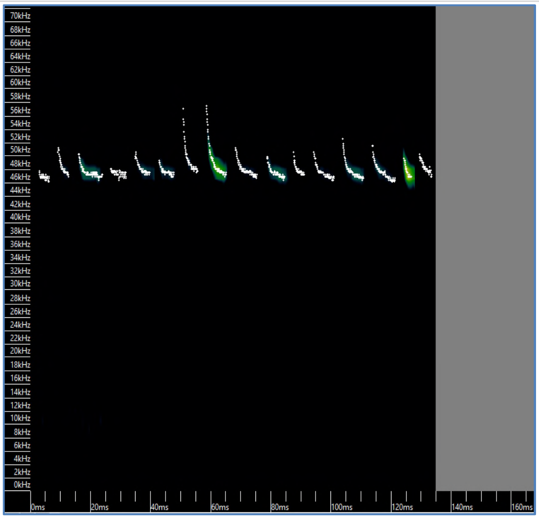
Scotorepens greyii



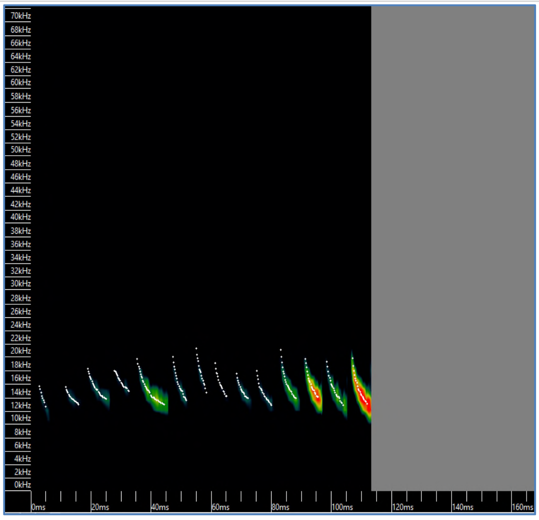
Vespadelus vulturnus



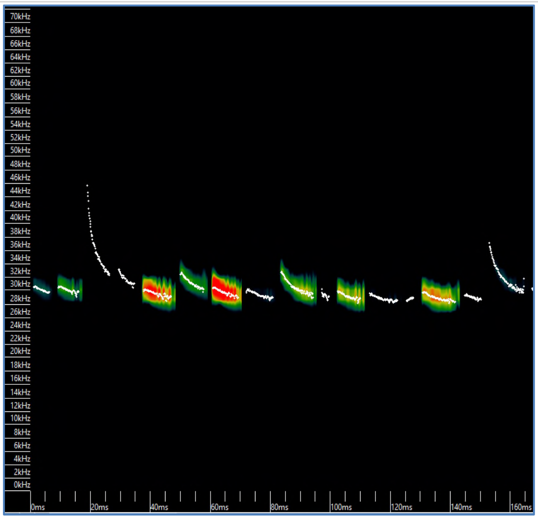
V. vulturnus / V. troughtoni



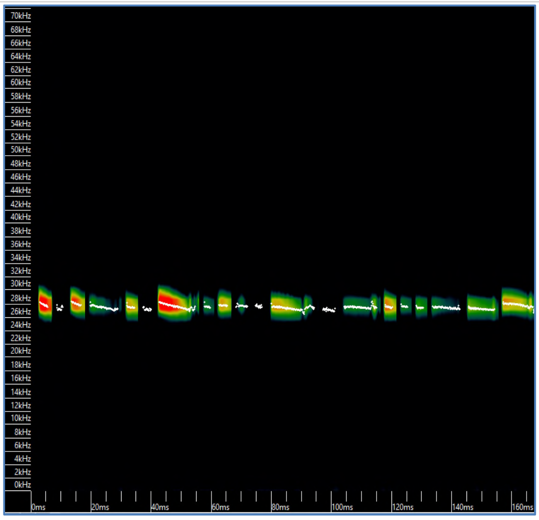
Miniopterus orianae oceanensis



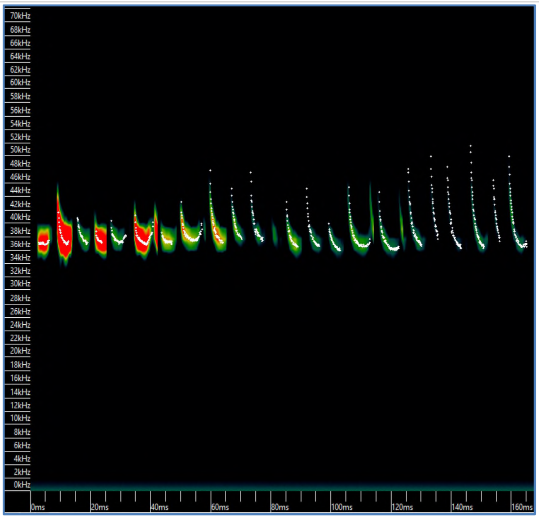
Austronomus australis



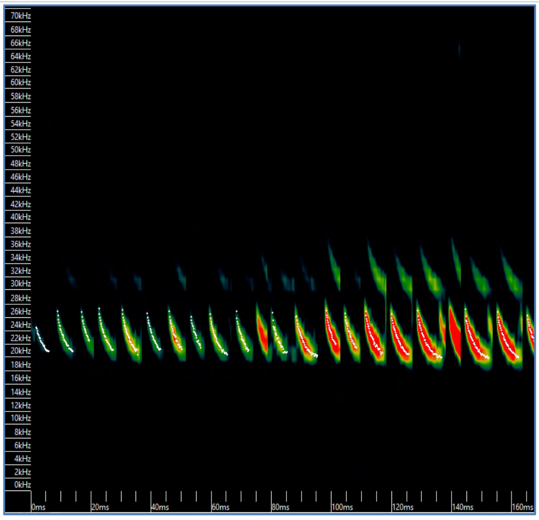
Ozimops ridei



O. ridei / O. petersi / O. planiceps



Setirostris eleryi



Saccolaimus flaviventris

Microbat Call Identification Report

Prepared for ("Client"):	ERM
Survey location/project name:	Bonshaw supplementary analysis
Survey dates:	10-14 December 2018
Client project reference:	0470861
Job no.:	ERM-1901
Report date:	15 April 2019

DISCLAIMER:

Background

The initial results of bat-call analysis on the Bonshaw Solar Farm December 2018 data set were provided to ERM in the *Balance! Environmental* report dated 22 February 2019. That report indicated the presence of the Bristle-faced Free-tailed Bat (*Setirostris eleryi*) in the study area, with calls identified from every detector. Subsequent reporting by ERM was reviewed by the regulator (Office of Environment & Heritage), with feedback from an "OEH expert" suggesting that "…*Mormopterus eleryi* (a.k.a *Setirostris eleryi*) can't be distinguished from *Scotorepens greyii* (Little Broad-nosed Bat) by Anabat call."

Balance! Environmental was therefore requested by ERM to review the initial results and provide supporting evidence for the conclusion that *S. eleryi* was recorded during the Bonshaw surveys.

Approach

Overview

While it is accepted that the search-phase calls of *S. eleryi* and *S. greyii* are difficult to distinguish, Corben (2010) reported that the characteristics of foraging calls (i.e. sequence of "attack-phase" pulses followed immediately by "feeding buzz" pulses) can be used as a diagnostic tool to differentiate free-tailed bats from vespertilionid bats calling in the same frequency range. Unfortunately, where only zero-crossing type data are recorded (such as with 'traditional' Anabat detectors), feeding buzzes are often missed, or poorly represented in recorded calls. In full-spectrum data, however, such as that recorded at Bonshaw using Song Meter detectors, calls with feeding buzzes are much more obvious.

Analysis by *Balance! Environmental* of numerous full-spectrum data-sets from several regions where *S. eleryi* and *S. greyii* are known to co-exist has consistently found examples of two distinctive foraging sequence types that concur with the diagnostic descriptions of Corben (2010). An overview of these findings and promotion of the inclusion of feeding buzz analysis in call identification reporting was presented recently at the International Society of Ecoacoustics Congress (Ford 2018). Support for the use of this approach has also been received from several bat-call analysis experts based throughout eastern Australia.

Foraging call characteristics (after Corben 2010)

Vespertilionidae ("evening bats") – see **Figure 1**

- ***Attack-phase*** has gradual increase in pulse characteristics of slope, characteristic frequency (Fc), maximum frequency (Fmax) and pulse repetition rate (PRR)
- ***Feeding buzz (stage 1)*** – similar pulse-shapes to attack, but rapid increase in PRR and marked drop in Fmax
- ***Feeding buzz (stage 2)*** – dramatic increase in PRR, further drop in Fmax, showing a tapered effect

Molossidae ("free-tailed bats") – see **Figure 2**

- ***Attack-phase*** – gradual increase in pulse slope, Fc, Fmax and PRR

- ***Feeding buzz (stage 1)*** – absent or much reduced (few pulses) and similar to attack with increased PRR
- ***Feeding buzz (stage 2)*** – prominent with dramatic increase in PRR and sudden, significant drop in Fmax, which remains fairly constant through buzz, resulting in a "flat-topped" appearance of the buzz section.

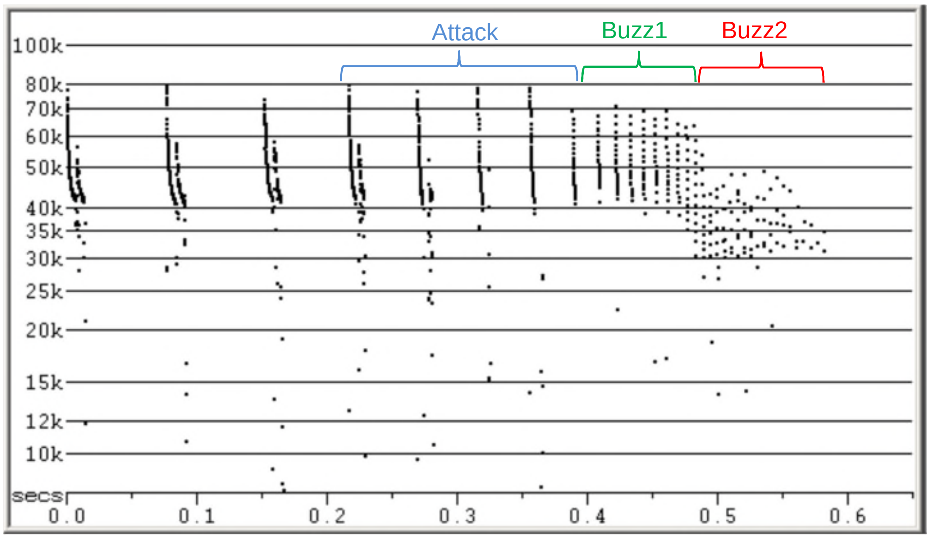


Figure 1 Foraging sequence of 'typical' vespertilionid bat (from Corben 2010).

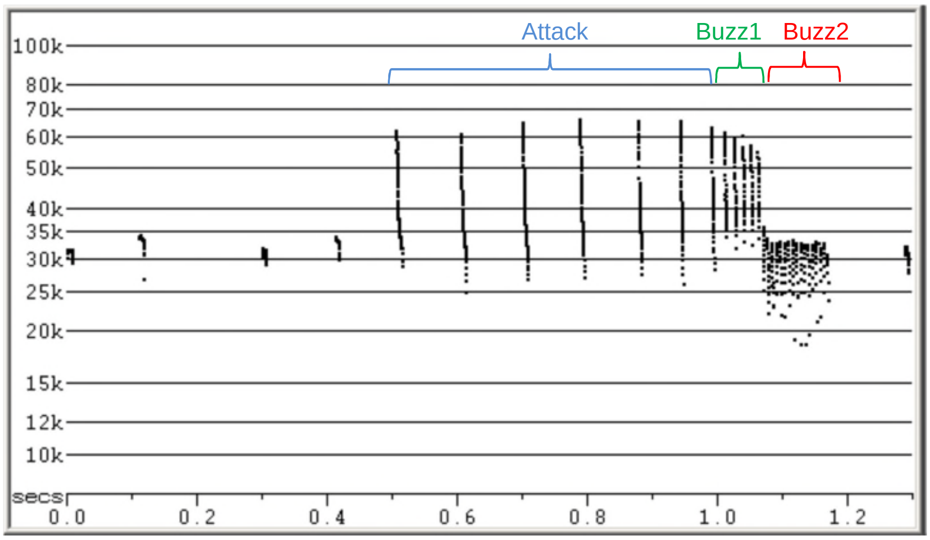


Figure 2 Foraging sequence of 'typical' molossid bat (from Corben 2010).

Method

The original data set (>8000 WAV files) was re-analysed with *Anabat Insight* (version 1.8.3; Titley Scientific, Brisbane), with the results for the relevant calls compared with the original results from the Cluster Analysis output from *Kaleidoscope*.

A two-step filtering process was applied with *Insight* to first exclude all non-bat noise from the data set and then select all calls within the relevant frequency range for *S. eleryi* and *S. greyii* (*i.e.* 35-41 kHz). Selected calls were then analysed manually by viewing spectrograms in *Insight* to search for calls containing attack-phase and feeding buzz sequences. These were allocated to the relevant species based on the characteristics described by Corben (2010).

Where foraging sequences were absent or only partially-recorded, species identity was allocated based on comparing search-phase pulse characteristics with the search-phase pulses present in those calls with foraging components.

Reference calls and published call descriptions (Reinhold et al. 2001; Pennay *et al.* 2004) were also used to support the call identifications, particularly for those calls that did not appear to belong to either of the target species.

Results & Discussion

Based on the more detailed analysis undertaken here, the *Kaleidoscope* cluster analysis process used for the original report resulted in erroneous species labels for some of the calls in the relevant frequency range. However, the supplementary analysis has confirmed the presence of both *S. eleryi* and *S. greyii*, with clear differentiation achieved using feeding buzz characteristics as well as search-phase differences derived from those components of the calls with positively-identified feeding buzzes. In addition to confirming these two species' presence, the revised analysis also identified the possible occurrence of two other threatened species that produce calls in the same frequency range: Eastern Falsistrelle (*Falsistrellus tasmaniensis*); and Hoary Wattled Bat (*Chalinolobus nigrogriseus*).

The *Insight* filtering process extracted 714 calls potentially belonging to *S. eleryi* or *S. greyii*. Identification of those calls revealed a total of 54 positive records of *S. eleryi*, 26 of which included definitive feeding buzz components. These were recorded on five of the seven detectors (S2, S4, S5, S6, S7). *Scotorepens greyii* was recorded on all detectors and contributed 352 of the observed calls, about 20% of which included reliable feeding buzzes. **Table 1** provides a breakdown of the numbers of calls allocated to each species per detector. Sample call spectrograms illustrating the characteristic feeding buzzes of each species are provided in **Figure 3** & **Figure 4**; while **Figure 5** and **Figure 6** show typical search-phase pulses with clear differences in pulse-shapes on the spectrograms and also in the oscillogram trace of amplitude change through each pulse.

The large discrepancy between this and the previous analysis for number of calls attributed to *S. eleryi* is due mainly to the allocation of cluster identities in *Kaleidoscope* based on manual verification of only a sub-set of calls within each cluster. Evidently, some clusters contained numerous calls that varied substantially from the reviewed sub-set.

The erroneously identified calls from the *Kaleidoscope* analysis were mostly allocated to two unresolved species pairs in the supplementary analysis, *viz. S. greyii / Falsistrellus tasmaniensis* and *S. greyii / Chalinolobus nigrogriseus*. Sample calls allocated to these two entities are shown in **Figure 7** and **Figure 8**. It is likely that these calls all represented variants of *S. greyii*, but the NSW BioNet Atlas (http://www.bionet.nsw.gov.au/) contains records for both alternative species within about 30km of Bonshaw.

Table 1. Bonshaw bat survey, December 2018: supplementary analysis for *Setirostris eleryi*.
Number of calls identified to two species and two unresolved species groups in the 35-41 kHz range

Detector:	S2	S3	S4	S5	S6	S7	S8	Total
Scotorepens greyii	17	15	46	210	26	10	27	352
Setirostris eleryi	5		11	25	1	12		53
S. greyii or *Chalinolobus nigrogriseus*	7	14	26	28	3	18	9	105
S. greyii or *Falsistrellus tasmaniensis*	3	4	21	153	15	8		204

References

Churchill, S. (2008). *Australian Bats*. Jacana Books, Allen & Unwin; Sydney.

Corben, C. (2010). Feeding Buzzes. *Australasian Bat Society Newsletter* **35**, 40-44.

Ford, G. (2018). Bat foraging calls: help or hindrance in echolocation analysis? Short paper presented during *Special Session: Novel approaches to bat acoustic analysis* at Ecoacoustics Congress; International Society of Ecoacoustics, Brisbane, 24-28 June 2018.

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Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001). *Key to the bat calls of south-east Queensland and north-east New South Wales*. Department of Natural Resources and Mines, Brisbane.

van Dyck, S., Gynther, I. and Baker, A. (ed.) (2013). *Field Companion to the Mammals of Australia*. New Holland; Sydney.

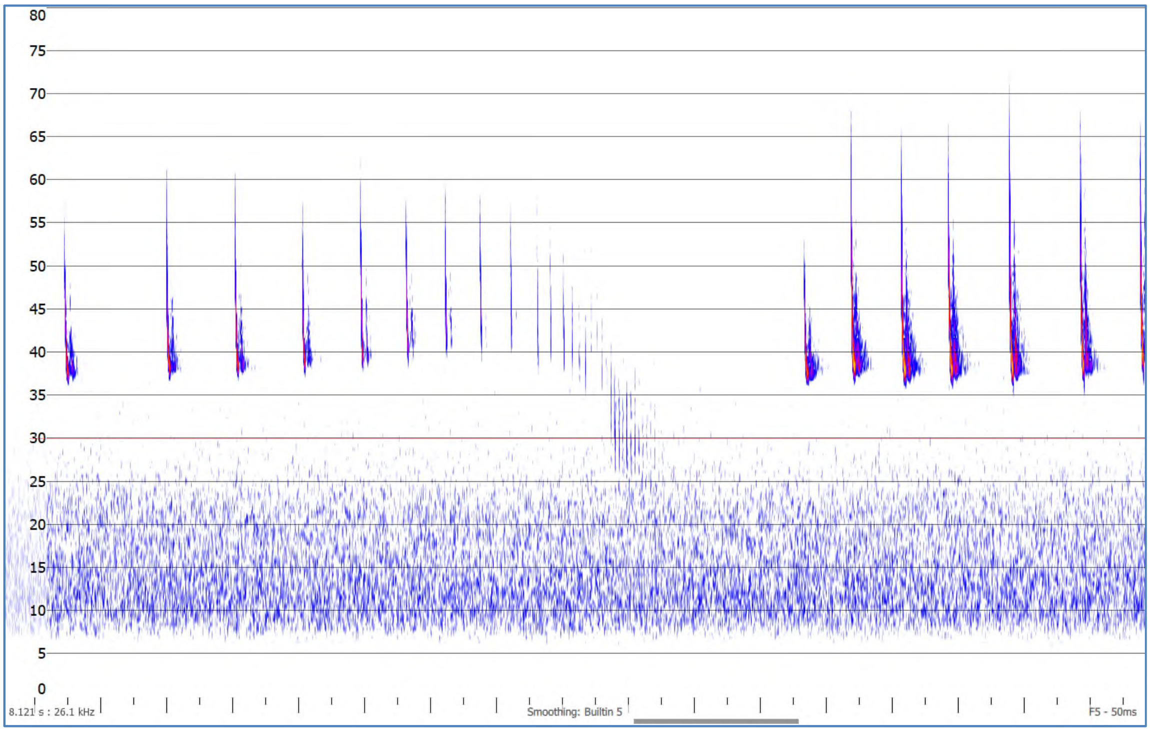

Figure 3 *Scotorepens greyii* call showing typical feeding buzz structure. WAV spectrogram in true-time mode at "F5" time expansion.

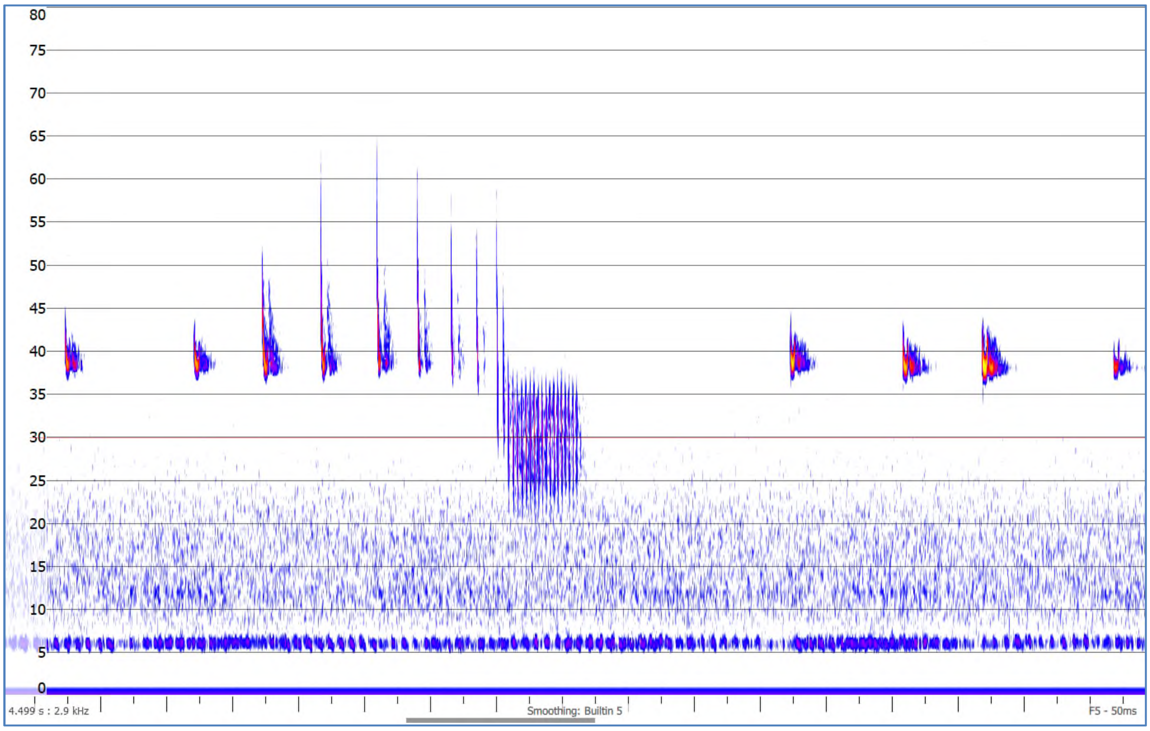

Figure 4 *Setirostris eleryi* call showing typical feeding buzz structure. WAV spectrogram in true-time mode at "F5" time expansion.

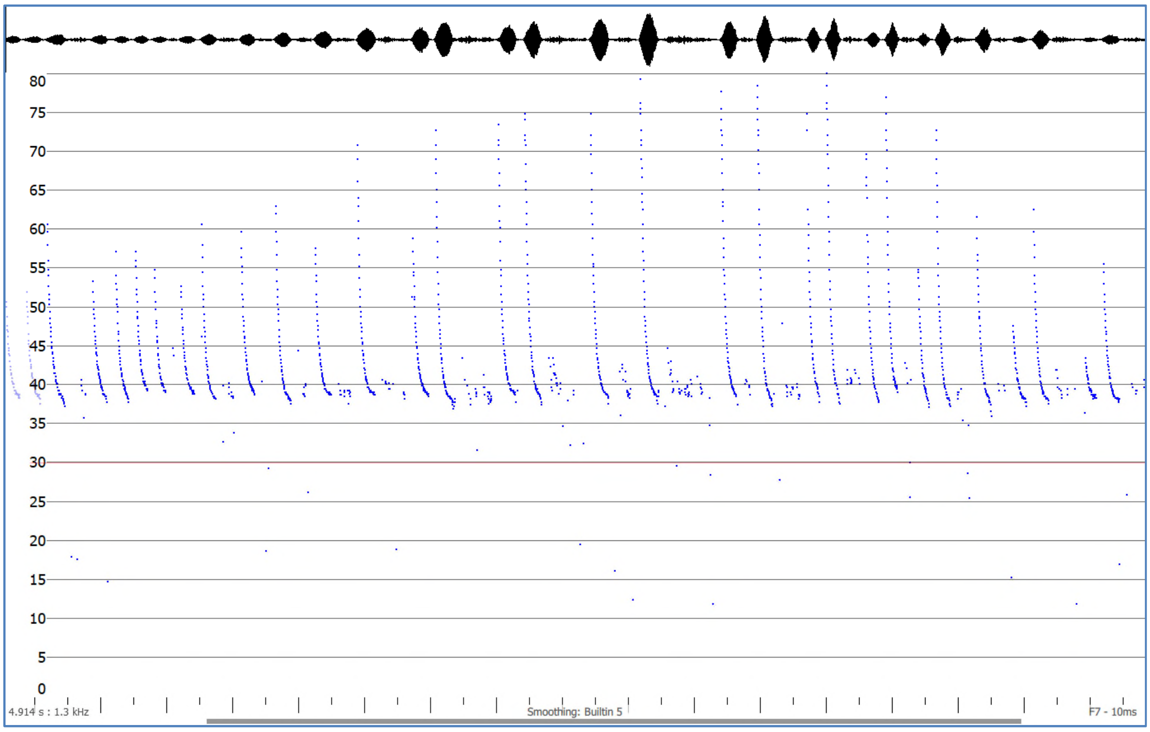

Figure 5 *Scotorepens greyii* call without feeding buzz, showing typical search-phase pulse structure. ZC spectrogram in compressed-time mode at “F7” time expansion.

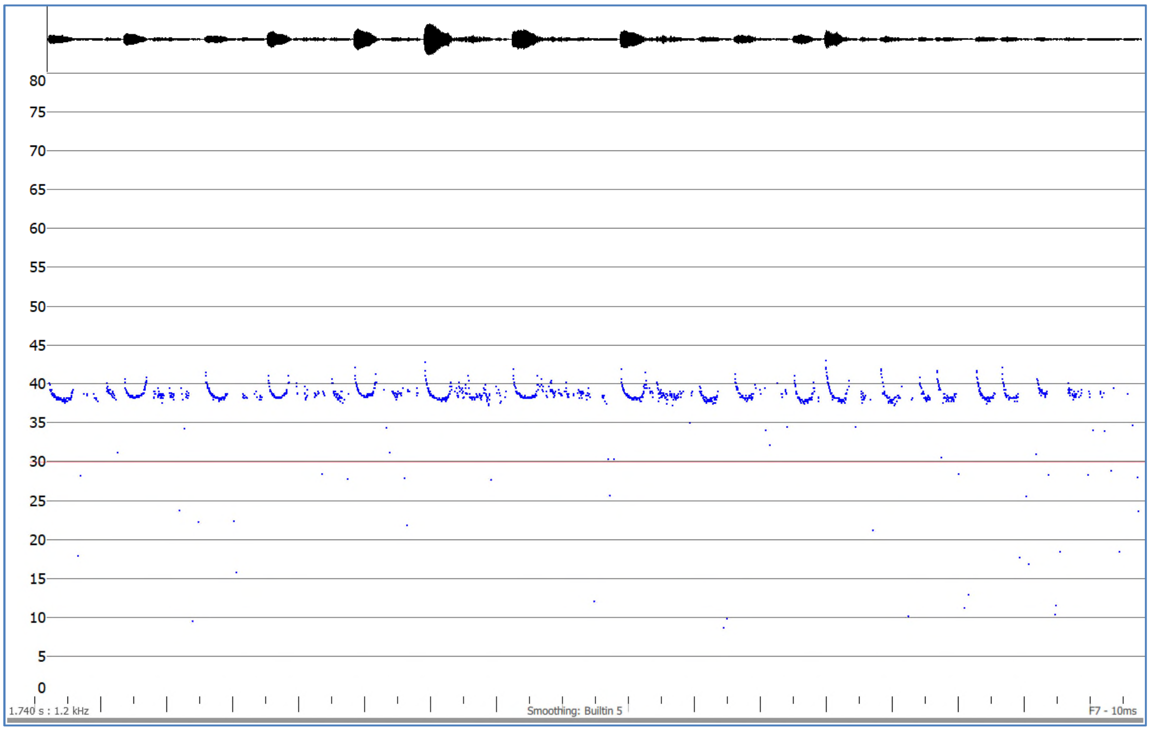

Figure 6 *Setirostris* eleryi call without feeding buzz, showing typical search-phase pulse structure. ZC spectrogram in compressed-time mode at “F7” time expansion.

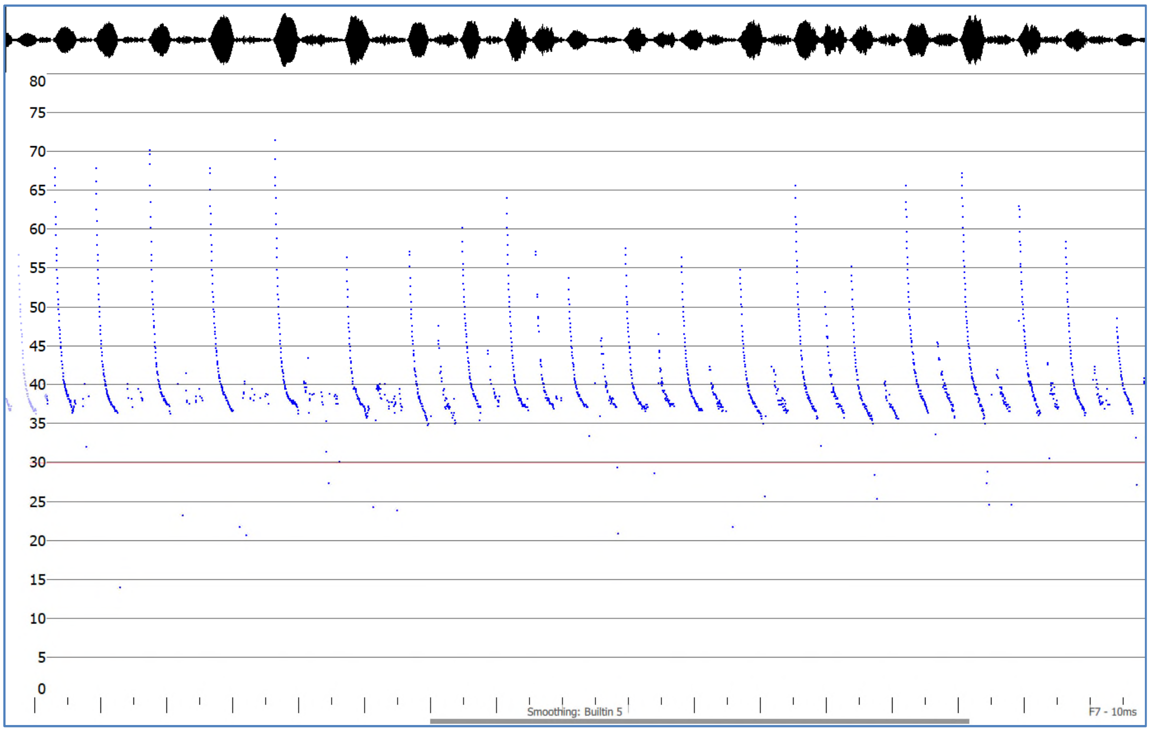

Figure 7 Unresolved call potentially attributable to *Falsistrellus tasmaniensis* but may also represent *Scotorepens greyii* flying in 'cluttered' air-space. ZC spectrogram in compressed-time mode at "F7" time expansion.

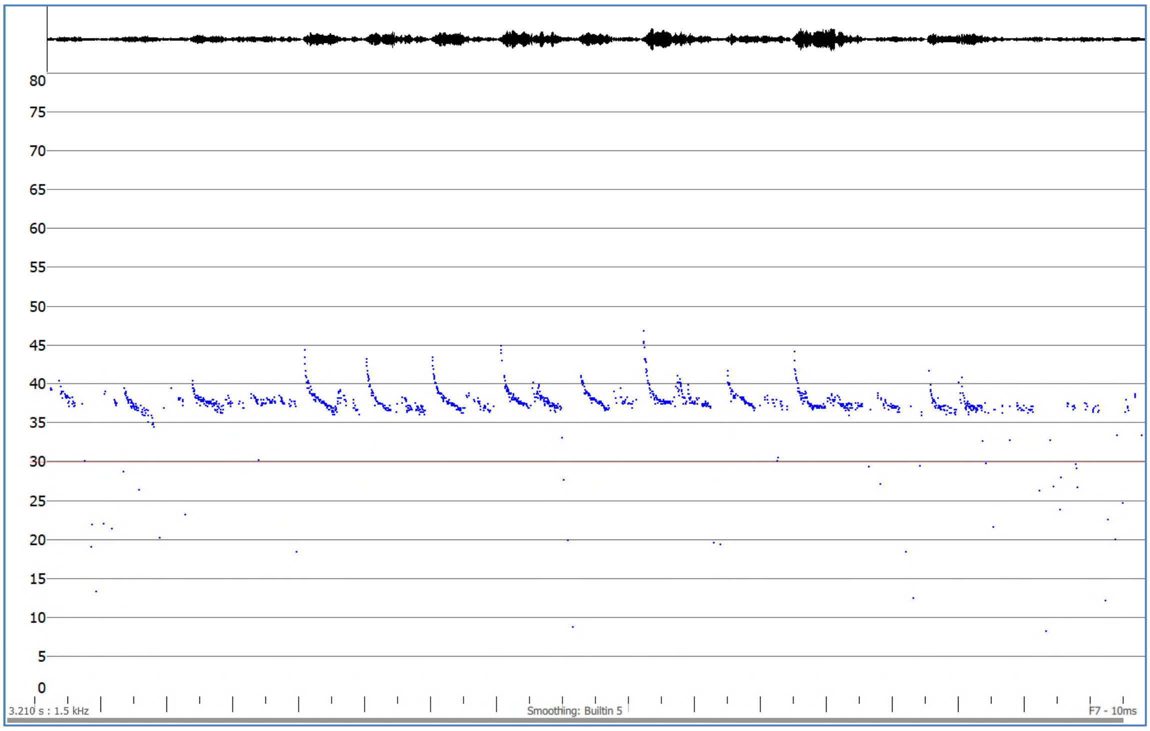

Figure 8 Unresolved call potentially attributable to *Chalinolobus nigrogriseus* but may also represent *Scotorepens greyii* flying in very open, uncluttered air-space. ZC spectrogram in compressed-time mode at "F7" time expansion.

Glossary

Technical terms used in this report are described in the following table.

Approach phase	The part of a bat *call* emitted as the bat starts to home in on a detected prey item; a transitional series of *pulses* between the *search phase* and *feeding buzz*, that become progressively steeper and shorter in duration.
Call	Refers to a single bat call, made up of a series of individual sound *pulses* in one or more *phases* (*search, approach, feeding buzz*).
CF (=Constant Frequency)	A type of *pulse* in which the dominant component consists of a more-or-less 'pure tone' of sound at a Constant Frequency; with *shape* appearing flat on the sonogram. Often also contains a brief *FM* component at the beginning and/or end of the CF component (*viz.* FM-CF-FM).
Characteristic frequency (Fc)	The frequency of the flattest part of a *pulse*; usually the lowest frequency reached in the *qCF* component of a pulse. This is often the primary diagnostic feature for species identification.
Duration	The time period from the beginning of a *pulse* to the end of the pulse.
Feeding buzz	The terminal part of a *call*, following the *approach phase*, emitted as the bat catches a prey item; a distinctive, rapid series of very steep, very short-duration pulses.
FM (=Frequency Modulated)	A type of *pulse* in which there is substantial change in frequency from beginning to end; *shape* ranges from almost vertical and linear through varying degrees of curvature.
FC range	Refers to the range of frequencies occupied by the *characteristic frequency* section of *pulses* within a call or set of calls.
Frequency sweep or "band-width"	The range of frequencies through which a *pulse* sweeps from beginning to end; Maximum frequency (Fmax) – minimum frequency (Fmin).
Knee	The transitional part of a *pulse* between the initial (usually steeper) frequency sweep and the *characteristic frequency* section (usually flatter); time to knee (Tk) and frequency of knee (Fk) can be diagnostic for some species.
Pulse	An individual pulse of sound within a bat *call*; the *shape*, *duration* and *characteristic frequency* of a pulse are the key diagnostic features used to differentiate species.
Pulse body	The part of the *pulse* between the *knee* and *tail* and containing the *characteristic frequency* section.
Pulse shape	The general appearance of a *pulse* on the sonogram, described using relative terms related to features such as slope and degree of curvature. See also *CF, qCF* and *FM*.
qCF (=quasi Constant Frequency)	A type of *pulse* in which there is very little change in frequency from beginning to end; *shape* appears to be almost flat. Some pulses also contain an *FM* component at the beginning and/or end of the qCF component (*viz.* FM-qCF).
Search phase	The part of a bat *call* generally required for reliable species diagnosis. A consistent series of *pulses* emitted by a bat that is searching for prey or and/or navigating through its habitat. Search phase pulses generally have longer duration, flatter slope and more consistent shape than *approach phase* and *feeding buzz* pulses.
Sequence	Literally, a sequence of *pulses* that may be from one or more bats; but generally refers to a *call* or part (e.g. *phase*) of a call.
Tail	The final component of a *pulse*, following the *characteristic frequency* section; may consist of a short or long sweep of frequencies either upward or downward from the Fc; or may be absent.

APPENDIX J BAM REPORTS – VEGETATION INTEGRITY ASSESSMENT

BAM Credit Summary Report

Proposal Details

Assessment Id

00015157/BAAS18113/19/00015159

Proposal Name

Bonshaw Solar Farm

BAM data last updated *

12/06/2019

Assessor Name

Adriana Corona Mothe

Report Created

26/06/2019

BAM Data version *

11

Assessor Number

BAAS18113

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Revision No

0

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAII	Ecosystem credits
Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion								
1	516_Moderate	23.4	0.6	0.25	High Sensitivity to Potential Gain	2.00		7
2	516_Very_Low	17.8	5.8	0.25	High Sensitivity to Potential Gain	2.00		51

3	516_Derived_Moderate	18.1	3.5	0.25	High Sensitivity to Potential Gain	2.00		31
4	516_Disturbed_Grassland	14.1	8.7	0.25	High Sensitivity to Potential Gain	2.00		0
							Subtotal	**89**
Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion								
5	594_Moderate	58.3	18.6	0.25	High Sensitivity to Potential Gain	1.75		475
6	594_Low	30.4	7.0	0.25	High Sensitivity to Potential Gain	1.75		93
7	594_Disturbed_Grassland	13.4	46.1	0.25	High Sensitivity to Potential Gain	1.75		269
							Subtotal	**837**
Tumbledown Red Gum - White Cypress Pine - Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion								
8	596_Moderate	55.1	11.4	0.25	High Sensitivity to Potential Gain	1.50		236
9	596_Low	37.7	0.4	0.25	High Sensitivity to Potential Gain	1.50		6
10	596_Very_Low	19.1	0.3	0.25	High Sensitivity to Potential Gain	1.50		2
11	596_Derived_Low	5.9	9.3	0.25	High Sensitivity to Potential Gain	1.50		0

12	596_Disturbed_Grassland	4.3	54.5	0.25	High Sensitivity to Potential Gain	1.50		0
							Subtotal	**244**
							Total	**1170**

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Potential SAII	Species credits
Mormopterus eleryi / Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat (Fauna)						
516_Moderate	23.4	0.57	0.25	2	False	7
516_Very_Low	17.8	5.76	0.25	2	False	51
516_Derived_Moderate	18.1	3.46	0.25	2	False	31
516_Disturbed_Grassland	14.1	8.71	0.25	2	False	62
594_Moderate	58.3	18.62	0.25	2	False	543
594_Low	30.4	7.02	0.25	2	False	107
594_Disturbed_Grassland	13.4	46.09	0.25	2	False	308
596_Moderate	55.1	11.4	0.25	2	False	314
596_Low	37.7	0.39	0.25	2	False	7

596_Very_Low	19.1	0.3	0.25	2	False	3
596_Derived_Low	5.9	9.32	0.25	2	False	27
596_Disturbed_Grassland	4.3	54.46	0.25	2	False	118
					Subtotal	**1578**
Vespadelus troughtoni / Eastern Cave Bat (Fauna)						
516_Moderate	23.4	0.57	0.25	3	True	10
516_Very_Low	17.8	5.76	0.25	3	True	77
516_Derived_Moderate	18.1	3.46	0.25	3	True	47
516_Disturbed_Grassland	14.1	8.71	0.25	3	True	92
594_Moderate	58.3	18.62	0.25	3	True	814
594_Low	30.4	7.02	0.25	3	True	160
594_Disturbed_Grassland	13.4	46.09	0.25	3	True	462
596_Moderate	55.1	11.4	0.25	3	True	471
596_Low	37.7	0.39	0.25	3	True	11
596_Very_Low	19.1	0.3	0.25	3	True	4
596_Derived_Low	5.9	9.32	0.25	3	True	41

596_Disturbed_Grassland	4.3	54.46	0.25	3	True	176
					Subtotal	**2365**

APPENDIX K BAM CALCULATOR CREDIT REPORT

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00015157/BAAS18113/19/00015159	Bonshaw Solar Farm	12/06/2019
Assessor Name	Assessor Number	BAM Data version *
Adriana Corona Mothe	BAAS18113	11
Proponent Names	Report Created	
	26/06/2019	
Revision No		
0		

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Nil

Species
Vespadelus troughtoni / Eastern Cave Bat
Vespadelus troughtoni / Eastern Cave Bat
Vespadelus troughtoni / Eastern Cave Bat
Vespadelus troughtoni / Eastern Cave Bat
Vespadelus troughtoni / Eastern Cave Bat

Vespadelus troughtoni / Eastern Cave Bat
Vespadelus troughtoni / Eastern Cave Bat
Vespadelus troughtoni / Eastern Cave Bat
Vespadelus troughtoni / Eastern Cave Bat
Vespadelus troughtoni / Eastern Cave Bat
Vespadelus troughtoni / Eastern Cave Bat
Vespadelus troughtoni / Eastern Cave Bat

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

Predicted Threatened Species Not On Site

Name
Calyptorhynchus lathami / Glossy Black-Cockatoo
Haliaeetus leucogaster / White-bellied Sea-Eagle

Ecosystem Credit Summary

PCT	TEC	Area	Credits
516-Grey Box grassy woodland or open forest of the Nandewar Bioregion and New England Tableland Bioregion	Not a TEC	18.5	89.00

594-Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion	Not a TEC	71.7	837.00
596-Tumbledown Red Gum - White Cypress Pine - Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion	Not a TEC	75.9	244.00

Credit classes for 516

Like-for-like options

Class	Trading group	HBT	IBRA region
Western Slopes Grassy Woodlands (including PCT's 201, 202, 266, 267, 274, 275, 276, 277, 278, 280, 282, 283, 286, 301, 337, 383, 426, 433, 437, 441, 444, 483, 509, 516, 589, 590, 593, 599, 847, 955, 1303, 1304, 1315, 1329, 1383, 1695)	Western Slopes Grassy Woodlands - ≥ 70% - <90% cleared group (including Tier 4 or higher).	Yes	Nandewar Northern Complex, Binghi Plateau, Inverell Basalts, Northern Basalts, Severn River Volcanics, Stanthorpe Plateau and Tenterfield Plateau. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Credit classes for 594

Like-for-like options

Class	Trading group	HBT	IBRA region

	North-west Slopes Dry Sclerophyll Woodlands (including PCT's 228, 429, 435, 517, 527, 529, 564, 588, 594, 595, 597, 598, 856, 1165, 1306, 1308, 1317, 1387, 1586, 1607)	North-west Slopes Dry Sclerophyll Woodlands - ≥ 50% - < 70% cleared group (including Tier 6 or higher).	Yes	Nandewar Northern Complex, Binghi Plateau, Inverell Basalts, Northern Basalts, Severn River Volcanics, Stanthorpe Plateau and Tenterfield Plateau. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Credit classes for 596	**Like-for-like options**			
	Class	Trading group	HBT	IBRA region
	North-west Slopes Dry Sclerophyll Woodlands (including PCT's 228, 380, 381, 382, 384, 385, 386, 389, 390, 391, 393, 394, 412, 413, 418, 429, 432, 435, 453, 506, 517, 527, 529, 543, 549, 555, 562, 563, 564, 573, 587, 588, 591, 594, 595, 596, 597, 598, 856, 1165, 1306, 1308, 1317, 1387, 1560, 1586, 1587, 1605, 1606, 1607, 1611, 1613)	North-west Slopes Dry Sclerophyll Woodlands - < 50% cleared group (including Tier 7 or higher).	Yes	Nandewar Northern Complex, Binghi Plateau, Inverell Basalts, Northern Basalts, Severn River Volcanics, Stanthorpe Plateau and Tenterfield Plateau. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

Species	Area	Credits
Mormopterus eleryi / Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	166.1	1578.00
Vespadelus troughtoni / Eastern Cave Bat	166.1	2365.00

Mormopterus eleryi/ Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	516_Derived_Moderate	**Like-for-like options**	
		Spp	IBRA region
		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
	516_Disturbed_Grassland	**Like-for-like options**	
		Spp	IBRA region
		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
	516_Moderate	**Like-for-like options**	
		Spp	IBRA region

		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
	516_Very_Low	**Like-for-like options**	
		Spp	IBRA region
		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
	594_Disturbed_Grassland	**Like-for-like options**	
		Spp	IBRA region
		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
	594_Low	**Like-for-like options**	
		Spp	IBRA region

		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
	594_Moderate	**Like-for-like options**	
		Spp	IBRA region
		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
	596_Derived_Low	**Like-for-like options**	
		Spp	IBRA region
		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
	596_Disturbed_Grassland	**Like-for-like options**	
		Spp	IBRA region

		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
	596_Low	**Like-for-like options**	
		Spp	IBRA region
		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
	596_Moderate	**Like-for-like options**	
		Spp	IBRA region
		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
	596_Very_Low	**Like-for-like options**	
		Spp	IBRA region

		Mormopterus eleryi/Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	Any in NSW
Vespadelus troughtoni/ Eastern Cave Bat	516_Derived_Moderate	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW
	516_Disturbed_Grassland	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW
	516_Moderate	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW

Vespadelus troughtoni/ Eastern Cave Bat	516_Moderate		
	516_Very_Low	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW
	594_Disturbed_Grassland	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW
	594_Low	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW

Vespadelus troughtoni/ Eastern Cave Bat	594_Low		
	594_Moderate	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW
	596_Derived_Low	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW
	596_Disturbed_Grassland	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW

Vespadelus troughtoni/ Eastern Cave Bat	596_Low	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW
	596_Moderate	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW
	596_Very_Low	**Like-for-like options**	
		Spp	IBRA region
		Vespadelus troughtoni/Eastern Cave Bat	Any in NSW

APPENDIX L PERSONNEL

Personnel involved in preparation of this BDAR and their contribution is summarised in Table below.

Table L.1 Summary of Personnel and Duties

Name	Position	Tasks and Responsibilities
Joanne Woodhouse	Principal Ecologist and Project Manager	■ Project Management including liaison with client, OEH and other stakeholders ■ Field work design ■ Bird survey and BAM plots (Spring 2018) ■ Report writing, technical advice and review
Dr Adriana Corona Mothe	Field Ecologist Accredited BAM Assessor	■ Lead field ecologist: fauna survey and BAM plots (all survey periods) ■ Field work design and BAM plots ■ Report writing and BAM Calculator reports
Tom Cotter	Biodiversity and GIS Consultant	■ Field Ecologist: fauna and BAM plots (summer 2018). ■ Vegetation mapping, species polygon ■ Draft figures
Dr Toivo Zoete	Senior Environmental Consultant	■ Flora assessment in the 20m x 20m sub-plot of BAM plots (Autumn 2019).
Georgina Race	GIS Consultant	■ Vegetation mapping and area calculations ■ GIS Support
Viet Nguyen	GIS Consultant	■ GIS Support ■ Vegetation area calculations ■ Figure preparation
Danielle Robinson	GIS Consultant	■ GIS Support ■ Field figure preparation ■ Field map layers preparation

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APPENDIX D CULTURAL HERITAGE ASSESSMENT

GAIA Australia

Bonshaw Solar Farm

Cultural Heritage Assessment

18 April 2019

Project No.: 0464261

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Document details	
Document title	Bonshaw Solar Farm
Document subtitle	Cultural Heritage Assessment
Project No.	0464261
Date	18 April 2019
Version	2.0
Author	Katherine Deverson
Client Name	GAIA Australia

Document history

				ERM approval to issue		
Version	Revision	Author	Reviewed by	Name	Date	Comments
Draft	00	Katherine Deverson	Erin Finnegan	Paul Douglass	11 April 2019	Approved for issue to Client
Draft	01	Katherine Deverson	Erin Finnegan	Paul Douglass	18 April 2019	Approved for issue to Client
Final	02	Katherine Deverson	Amanda Antcliff	Paul Douglass	12 July 2019	Approved for issue to Client

Signature Page

12 July 2019

Bonshaw Solar Farm

Cultural Heritage Assessment

Katherine Deverson
Heritage Consultant

Erin Finnegan
Principal Heritage Consultant

Amanda Antcliff
Project Manager

Paul Douglass
Partner

Environmental Resources Management Australia Pty Ltd

Level 15

309 Kent Street

Sydney, 2000 NSW

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Acronyms and Abbreviations

AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
BP	Before Present
BSS	Battery Storage System
Burra Charter	The Australia ICOMOS Charter for Places of Cultural Significance
CHA	Cultural Heritage Assessment
CHL	Commonwealth Heritage List
CIV	Capital Investment Value
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DECCW	Department of Environment, Climate Change and Water
DP&E	Department of Planning and Environment
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ERM	Environmental Resources Management Australia Pty Ltd
ESD	Ecologically Sustainable Development
GAIA	GAIA Australia
IHO	Interim Heritage Orders
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
LLS	Local Land Services
MW	Megawatts
MWh	Megawatt hour
NNTT	National Native Title Tribunal
NP&W Act	National Parks and Wildlife Act 1974
NPWS	NSW National Parks and Wildlife Service
NTS Corp	Native Title Services corporation
OEH	Office of Environment and Heritage
PA	Project Area
PAD	Potential Archaeological Deposit
PV	Photovoltaic
QA	Quality Assurance
RAP	Registered Aboriginal Party
SEPP	State Environmental Planning Policy
SHI	State Heritage Inventory
SHR	State Heritage Register
SSD	State Significant Development
SU	Survey Unit

1. INTRODUCTION

1.1 Overview

ERM was commissioned to undertake a heritage assessment to support an Environmental Impact Statement (EIS) being prepared for the proposed Bonshaw Solar Farm (the 'Project'), located off the Bruxner Highway, Bonshaw NSW.

This work has been conducted to conform to the Secretary's Environmental Assessment Requirements (SEARs) for the Project. In line with the SEARs, this Cultural Heritage Assessment (CHA) has been prepared in accordance with the *Code of Practice for Archaeological Investigations of Aboriginal Objects in New South Wales (Code of Practice)* (DECCW 2010a), the *Aboriginal Cultural Heritage Consultation requirements for Proponents* (DECCW 2010b), *The Australia ICOMOS Charter for Places of Cultural Significance, The Burra Charter*, 2013 (Burra Charter), and the NSW Heritage Manual.

1.2 Objectives

This CHA assesses the potential impacts of the Project on Aboriginal and historic cultural heritage, and prepares strategies to manage risks to identified heritage values during construction and operation.

This report documents:

- the consultation process undertaken with Aboriginal communities for the Project and their involvement in the Project;
- the landscape and natural resources of the Project Area (PA) in order to establish background parameters;
- a synthesis of local and regional Aboriginal archaeological research to develop a contextual basis for predictive models;
- a review of relevant heritage databases including Australian Heritage Database, the NSW Office of Environment and Heritage (OEH) Aboriginal Heritage Information Management System (AHIMS) database; the NSW State Heritage Inventory, and Schedule 5 of the Inverell Local Environmental Plan 2013;
- a review of the PA's non-Aboriginal history to gain an understanding and appreciation of past land uses and associated historical ground disturbance;
- a predictive model for Aboriginal and historic site types and location relevant to the PA;
- the archaeological methodology implemented during the study;
- the cultural and archaeological sensitivity of landforms that may be subject to impacts;
- the field survey results;
- the significance of any located Aboriginal objects and places;
- a description of the Project and whether or not it has the potential to result in impacts to Aboriginal cultural heritage and historic heritage items; and
- provision of management and mitigation measures based on the results of the investigation.

1.3 Description of the Proposed Development

1.3.1 Location

The proposed Bonshaw Solar Farm is located in the Inverell Local Government Area (LGA) approximately 16 km south of Bonshaw and 66 km north of Inverell. The PA, as shown in *Figure 1.1*, is approximately 352 ha with elevations ranging from 329 m to 500 m Australian Height Datum (AHD) and is located on Lot 2, DP1039185 (the 'Site').

The landholder has been consulted and provided in principle support to be finalised with a landholder agreement. Lot subdivision is not proposed.

The PA is partially bounded on its northern boundary by the Bruxner Highway. The eastern boundary is partially bounded by Glenrock Road. An unsealed road extends perpendicularly from Bruxner Highway towards the southern end of the PA then bends westerly towards the existing 330kV TransGrid Dumaresq Substation located to the south-western from the Subject Land.

The PA consists of open space, and creek and bush areas. Aerial imagery suggests that a significant proportion of the land across the PA had previously been cleared with portions historically being used for agriculture purposes.

1.3.2 Proposed Development

GAIA is proposing to develop a large scale solar photovoltaic (PV) generation facility and associated infrastructure with a capacity of 500 MW within the PA.

The Project will involve the construction, operation and maintenance of a solar PV generation facility and associated infrastructure, supplying electricity to the national electricity grid. The development footprint is approximately 700 ha within the PA. The proposed development footprint is shown in *Figure 1.2.*

The Project would include:

- a network of PV modules in a fixed or tracking arrangement;
- a site office (two proposed options);
- a access tracks from Bruxner Highway;
- underground or overhead cabling for connection between arrays and inverters and transformers;
- parking and internal access tracks;
- perimeter security fencing;
- battery storage; and
- two grid connection options to the 330kV TransGrid Dumaresq Substation, on the boundary of the PA.

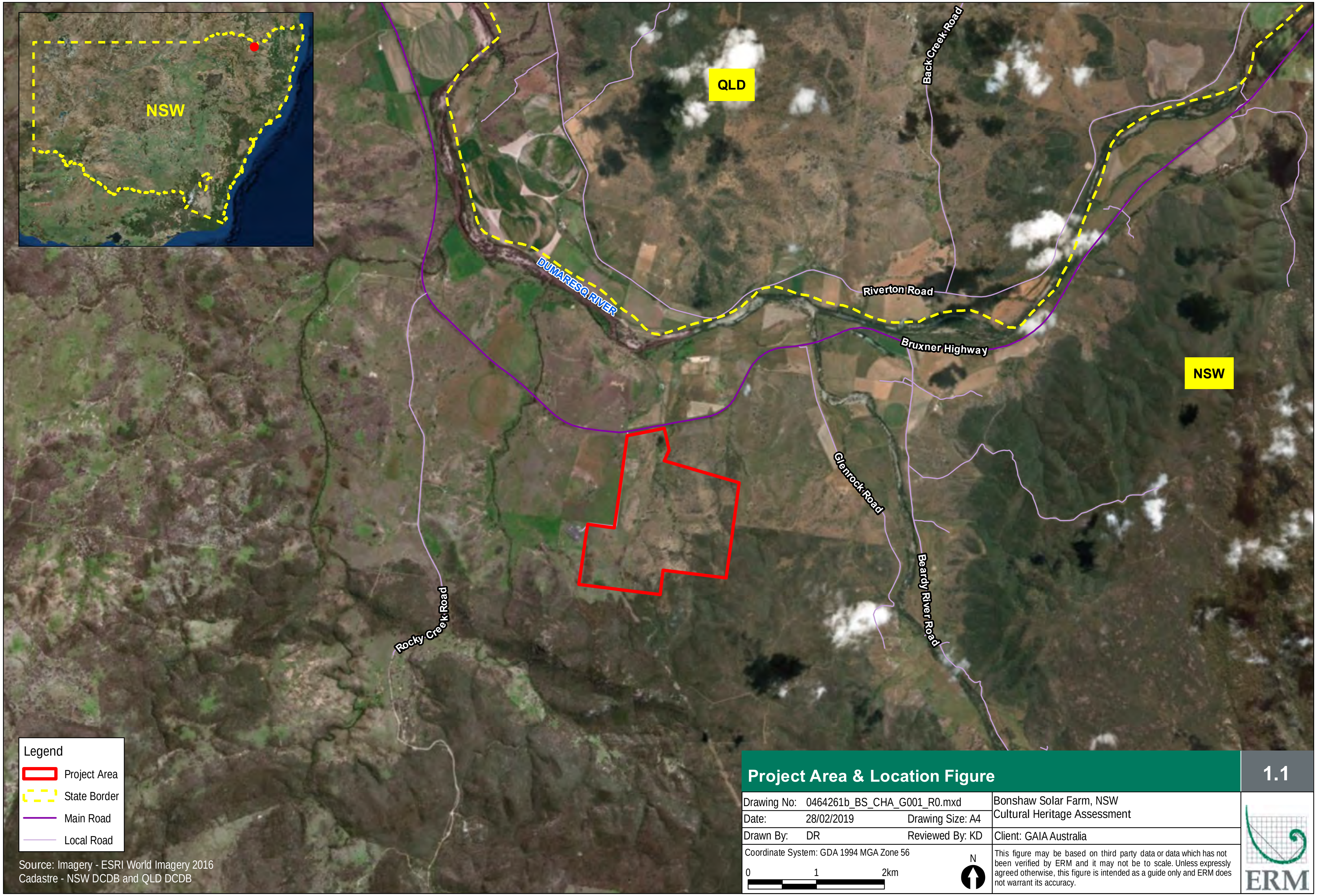
The location within the PA of the PV modules, cabling, battery storage and substation and switchyard infrastructure is subject to further detailed design during the preparation of the EIS.

1.4 Authorship

Katherine Deverson (ERM Heritage Consultant) authored the report and Erin Finnegan (Principal Heritage Consultant) undertook a technical review. Amanda Antcliff (ERM Project Manager) and Paul Douglass (ERM Partner) undertook quality assurance (QA) reviews of the report.

1.5 Report Structure

Chapter 1	Introduction;
Chapter 2	Legislative framework and statutory requirements;
Chapter 3	Aboriginal community consultation process undertaken for the CHA;
Chapter 4	Environmental and landscape background relating to the PA;
Chapter 5	Archaeological context of the PA, including known and potential heritage sites within and in near vicinity to the PA;
Chapter 5	Aboriginal heritage predictive model;
Chapter 6	Historical background of the PA;
Chapter 7	Survey methodology and results;
Chapter 8	*S*ignificance assessment of heritage sites located within the PA;
Chapter 9	Impact assessment; and
Chapter 10	Conclusions and Recommendations.
Appendix A	Aboriginal Stakeholder Consultation Log
Appendix B	Survey Methodology
Appendix C	AHIMS Database Search Results



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB

Project Area & Location Figure

1.1

Drawing No: 0464261b_BS_CHA_G001_R0.mxd
Date: 28/02/2019 Drawing Size: A4
Drawn By: DR Reviewed By: KD
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW
Cultural Heritage Assessment

Client: GAIA Australia

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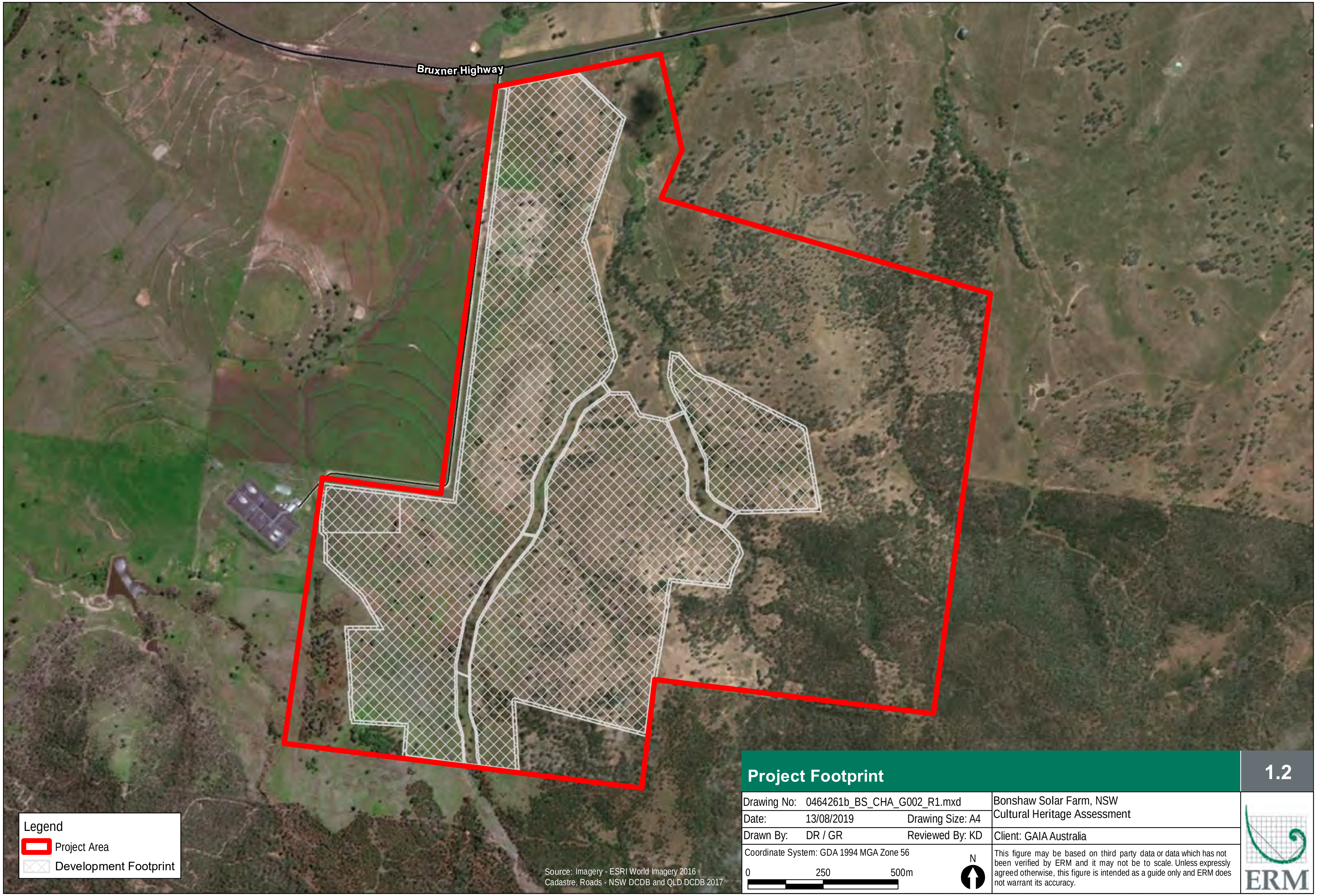

Source: Imagery - ESRI World Imagery 2016
Cadastre, Roads - NSW DCDB and QLD DCDB 2017

Project Footprint

1.2

Drawing No: 0464261b_BS_CHA_G002_R1.mxd
Date: 13/08/2019 Drawing Size: A4
Drawn By: DR / GR Reviewed By: KD
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW
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2. RELEVANT LEGISLATION

Together with best practice principles outlined in documents such as *The Burra Charter* (Australia ICOMOS 2013a), the following legislative and regulatory context forms the basis of the framework within which the historic and Aboriginal heritage values of the PA must be considered.

Aboriginal cultural heritage in NSW is protected by the *National Parks and Wildlife Act 1974* (NP&W Act). Land managers are required to consider the effects of their activities, or proposed development, on the environment under several pieces of legislation, principally the *Environmental Planning and Assessment Act* 1979 (EP&A Act). Cultural heritage, which includes Aboriginal and historical heritage, is subsumed within the definition of "environment". In certain circumstances, Commonwealth legislation protecting heritage may also apply to heritage places in NSW. The key legislation applying to the Project is summarised below in *Table 2.1.*

Table 2.1 Key Legislation

State Legislation
Environmental Planning and Assessment Act 1979 (NSW)
The principal NSW planning legislation is the *Environmental Planning and Assessment Act 1979* (EP&A Act). The EP&A Act provides a system of environmental planning and assessment administered by the NSW Department of Planning and Environment (DP&E). The EP&A Act establishes when and how a development or activity is to be assessed and who is the relevant approval or determining authority. Section 4.36 (2) of the EP&A Act states that *"a State environmental planning policy may declare any development, or any class or description of development, to be State significant development"*. Part 2 Clause 8 of the State Environmental Planning Policy (State and Regional Development) 2011 (State and Regional Development SEPP) states that: *1. Development is declared to be State significant development for the purposes of the Act if:* *a. the development on the land concerned is, by the operation of an environmental planning instrument, not permissible without development consent under Part 4 of the Act, and* *b. the development is specified in Schedule 1 or 2.* Schedule 1 and 2 of the State and Regional Development SEPP contains an extensive list of developments that are considered State Significant Development (SSD). Schedule 1 Cl 20 identifies the following as SSD: ***Electricity generating works and heat or co-generation*** *Development for the purpose of electricity generating works or heat or their co-generation (using any energy source, including gas, coal, biofuel, distillate, waste, hydro, wave,* ***solar*** *or wind power) that:* *a. has a capital investment value of more than $30 million, or* *b. has a capital investment value of more than $10 million and is located in an environmentally sensitive area of State significance.* The project is a development for the purpose of electricity generation using a solar energy source with a capital investment value (CIV) of more than $30 million. The Site is not located in an environmentally sensitive area of State Significance (as defined in the State and Regional Development SEPP). Solar Energy Systems are considered permissible with consent through clause 34 (7) of State Environmental Planning Policy (Infrastructure) 2007.

State Legislation

The project meets both the requirements of clause 8 of the State and Regional Development SEPP as it is not permissible without development consent and is development specified in Schedule 1. Therefore, the project is SSD for the purposes of the EP&A Act.

National Parks and Wildlife Act 1974 (NSW)

The NSW National Parks and Wildlife Services (NPWS) provide guidelines for Aboriginal heritage assessment, including those conducted under the EP&A Act. Where Aboriginal heritage assessment is conducted under the Integrated Development Approval process, a more detailed set of NPWS guidelines applies.

All Aboriginal objects within the State of New South Wales are protected under Part 6, and particularly Section 90, of the NPW Act.

Under Section 5 of the Act, “Aboriginal Object” means any deposit, object or material evidence (not being a handicraft made for sale) relating to the Indigenous habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains.

Sites of traditional significance that do not necessarily contain archaeological materials may be gazetted as ‘Aboriginal places’ and are protected under Section 84 of the Act. This protection applies to all sites, regardless of their significance or land tenure. Under Section 90, a person who, without first obtaining the consent of the Director-General, knowingly destroys, defaces or damages, or knowingly causes or permits the destruction or defacement of or damage to, an Aboriginal object or Aboriginal place is guilty of an offence.

Heritage Act 1977 (NSW)

The NSW *Heritage Act 1977* establishes the NSW Heritage Council and the State Heritage Register (SHR). The aim of the Act is to conserve the heritage of New South Wales. The aim of heritage management is not to prevent change and development, but to ensure that the heritage significance of recognised heritage items is not harmed by changes.

The SHR is a separate listing to the State Heritage Inventory and includes items which are accorded SHR listing through gazettal in the NSW Government Gazette. Nominated items are considered by the NSW Heritage Council which then makes a recommendation to the Minister for Heritage. The Minister is empowered to place Interim Heritage Orders (IHO) on an item of potential State significance on the basis of advice received from the Heritage Council:

a. An item is important in the course, or pattern, of NSW’s cultural or natural history.
b. An item has strong or special association with the life or works of a person, or group of persons of importance in NSW’s cultural or natural history.
c. An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW.
d. An item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons.
e. An item has potential to yield information that will contribute to an understanding of NSW’s cultural or natural history.
f. An item possesses uncommon, rare, or endangered, aspects of NSW’s cultural or natural history.
g. An item is important in demonstrating the principal characteristics of a class of NSW’s a) cultural or natural places: or b) cultural or natural environments.

Refer to *Section 6.2* of this CHA for results of SHR search relating to the PA.

Commonwealth Legislation

Environment Protection And Biodiversity Conservation Act 1999 (Commonwealth)

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government’s central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the Act as matters of national environmental significance. The EPBC Act focuses on the protection of

State Legislation
matters of national environmental significance, with the states and territories having responsibility for matters of state and local significance. The Commonwealth Heritage List (CHL) is established under the EPBC Act and comprises places on Commonwealth land or owned by Commonwealth Agencies that are determined to have "significant" heritage value to Australia. The Act also establishes the National Heritage List, comprising places considered to be of "outstanding" heritage value to Australia. Refer to *Section 6.2* of this CHA for results of CHL search relating to the PA.
Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Commonwealth)
The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* protects areas and/or objects which are of significance to Aboriginal people and which are under threat of destruction. The Act can, in certain circumstances override state and territory provisions, or it can be implemented in circumstances where state or territory provisions are lacking or are not enforced. A significant area or object is defined as one that is of particular importance to Aboriginal people according to Aboriginal tradition. The Act must be invoked by or on behalf of an Aboriginal or Torres Strait Islander or organisation.

3. ABORIGINAL COMMUNITY CONSULTATION

This chapter contains details of the Aboriginal community consultation undertaken regarding the Aboriginal cultural heritage of the PA. In accordance with the guideline *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW, 2010b), consultation with Aboriginal people is an essential part of the heritage assessment process to:

- determine potential harm on Aboriginal cultural heritage from proposed activities; and
- inform decision making for any management and mitigation measures where it is determined that harm cannot be avoided.

The guideline also sets out four stages of consultation requirements. Fulfilment of these requirements is outlined below.

3.1 Stage 1: Notification of Project Proposal and Registration of Interest

On behalf of the Proponent, ERM has actively sought to identify stakeholder groups or people wishing to be consulted about the Project and has invited them to register their interest as follows.

To identify relevant stakeholders, letters about the Project (dated 3 July 2018) were supplied to the following bodies:

- Moombahlene Local Aboriginal Land Council (LALC);
- Local Land Services (LLS) South-East Region;
- National Native Title Tribunal (NNTT);
- Native Title Services Corporation (NTS Corp);
- NSW OEH Regional Operations Coffs Harbour Branch;
- Office of the Registrar, *Aboriginal Land Rights Act* (1983);
- Tenterfield Shire Council; and
- Inverell Shire Council.

The results from the letters indicated two Aboriginal parties with potential interest in the PA. A Project notification letter was sent to each of the identified parties on 24 July 2018. Correspondence from the LLS has suggested that the Site is located within the Toomelah LALC boundaries. Our review of the boundaries placed the Site within Moombahlene LALC. ERM contact the Toomelah LALC to confirm that it is not in Toomelah region, a map with the known LALC boundaries and PA location was generated and forward to the LALC for their review and comment. No response was received following this correspondence.

A local press advertisement requesting Aboriginal party participation was placed in the Inverell Times and Tenterfield Star on 3 July 2018, the advertisements were published on 6 July 2018 and 11 July 2018 respectively (refer to *Appendix A*). The response period for Aboriginal stakeholders to register an interest in the Project was open for two consecutive weeks.

3.2 Stage 2: Presentation of Information about the Proposed Project

The Aboriginal parties that registered an interest in being consulted are presented in *Table 3.1.*

Table 3.1 Registered Aboriginal Parties (RAPs)

Organisation
Aboriginal Cultural Sites Services
Edgerton Kwiambal
Moombahlene LALC

A study methodology was sent to each of the registered parties (dated 9 August 2018). The letter included:

- an outline of proposed works;
- the proposed methodology and dates for pedestrian survey;
- a request for Aboriginal parties to identify any particular areas of interest within the PA to survey; and
- an invitation to attend a site survey between 11 to 13 September 2018.

No comments were received in relation to the proposed methodology. All three groups agreed to attend the site survey.

3.3 Stage 3: Gathering Information about Cultural Significance

All Registered Aboriginal Parties (RAPs) were invited to participate in the field survey on Tuesday 11, Wednesday 12, and 13 Thursday September 2018. Emails and telephone calls were made to each party to confirm attendance and clarify any potential questions or issues about the methodology, and to determine meeting locations and times for each survey day (refer to *Appendix A*).

Information was also sought regarding cultural knowledge of the PA. All groups expressed that the PA holds or possesses potential cultural sensitivity, through historic family connection to and knowledge of the area.

ERM recognise and value the input of all Aboriginal stakeholders in the consultation process. All RAPs were invited to discuss the Project and the results of the field survey during and following the site survey. The aim of this was to ensure that management actions and consultation commitments are developed in full consultation and are based on the recognised cultural heritage values of the sites.

3.4 Stage 4: Review of Draft Cultural Heritage Assessment Report

A draft copy of the CHA report was provided to all Aboriginal parties who registered an interest in the project on 9 May 2019, for the purposes of receiving written or oral general comments and more specific comments on the cultural significance of the PA and the identified sites and the recommended management and mitigation measures.

Feedback was received from two of the RAPs (also refer to *Appendix A*):

Edgerton Kwiambal endorsed the draft ACHA.

Aboriginal Cultural Sites Services provided the comments below that highlight the cultural importance of the area:

> *Yes comment on site I recommend that an AHIP BE ON the sites that they will construct the solar panels .Remove to a safe spot, or find another area for farmers the area is a high occupancy area that was used my Ancestors.*

4. ENVIRONMENTAL BACKGROUND

4.1 Environmental Context

Interactions between people and their surroundings are of integral importance in both the initial formation and the subsequent preservation of the archaeological record. The nature and availability of resources, including water, flora, fauna, and stone materials had (and continues to have) a significant influence over the way in which people utilise the landscape.

Alterations to the natural environment also impact upon the preservation and integrity of cultural materials within that environment. Current vegetation and erosional regimes also affect the visibility and detectability of archaeological evidence. For these reasons, it is essential to consider environmental factors as a component in any cultural heritage assessment.

4.1.1 The Northern Highlands Bioregion

Bioregions and sub-bioregions are large, geographically distinct areas of land with common characteristics such as geology, landform patterns, climate, ecological features and plant and animal communities. The Interim Biogeographic Regionalisation for Australia (IBRA) provides a regional and national planning framework for the systematic development of a comprehensive, adequate and representative National Reserve System. Bioregions delineate salient environmental characteristics which can highlight patterns in Aboriginal site patterning.

The PA is located within the Nandewar Bioregion, which is located inland from the coastal regions and bordered by the North Coast, New England Tablelands and Brigalow Belt South. The region includes parts of NSW, and extends into Queensland. The total area of this bioregion is 2,700,313 hectares (equating to 2.59% of NSW) (NSW NPWS 2003).

Table 4.1 Nandewar Bioregion Attributes

Characteristic	*Description*
Geology	The bioregion overlies part of the New England Fold Belt.The New England Fold Belt is the youngest structural feature in NSW and is separated from the Lachlan Fold Belt by the Sydney-Bowen Basin that is filled with Mesozoic sediments. The oldest rocks in the sequence are Devonian sedimentary and volcanic rocks, formed in an island arc environment. The youngest are Triassic sandstones and shales deposited by rivers on the edge of the Gunnedah Basin, about 250 million years ago, at a time when New England was being lifted by intrusions of granite. Major volcanic eruptions occurred in two phases: in the lava field flood basalts of the Inverell area (34-32 and 22-19 millions of years ago), and in a central volcano similar to that in the Nandewar Ranges (21-17 million years ago). The maximum preserved thickness of the flows is 800m in the variety of lavas present. Only the core of the Nandewar volcano remains as exposed plugs and dykes. Flows from the New England centres buried river gravels and lake sediments that are now being exposed and contain deposits of tin, sapphires and diamonds. A narrow strip of ultrabasic rocks, including serpentinites that are derived from a deep ocean floor, marks the suture where a former island arc complex was linked to the Australian mainland. These rocks pass through Woodsreef and Tamworth where they are associated with limestones in which karst landscapes are formed. The composition of these rocks is so unusual that they always have distinct soils and vegetation
Landforms	The Nandewar Bioregion is formed on Palaeozoic sedimentary rocks on the western edge of the New England Tablelands and includes the Tertiary basalts of Inverell and Kaputar.

Characteristic	Description
	The hilly landscapes are warmer but drier than the tablelands and carry vegetation communities more typical of the western slopes, with some tableland species.
Soils	The bioregion is characterised by clay or loam soils, but siliceous soils derived from acid volcanic rocks are also found. On the sedimentary rocks, shallow stony soils occur on ridges passing to texture contrast soils on almost all slopes. These change in colour from red brown subsoils on upper slopes to yellow subsoils on lower slopes. They support diverse vegetation communities that are also affected by altitude. The granites develop gritty shallow profiles between outcrops and tors on the crests, grading to harsh texture contrast soils with yellow clay subsoils that are prone to gully development on the lower slopes. Basalt areas on Kaputar have frequent rock outcrops interspersed with shallow, stony, brown loams. Black earths are found on lower slopes and in valleys. In the Inverell area the basalts develop black earth profiles that thicken downslope and, where the underlying sands and gravels are exposed, the coarse sandy soils may develop podsol pans and support different vegetation. Alluvial loams and clays with moderate to high fertility are found in the valleys. Dark, alkaline, pedal clays develop on limestone, and the serpentinites have shallow stony profiles with concentrations of elements that are toxic to many plants.
Vegetation	The vegetation of the Nandewar Bioregion is influenced primarily by geology and the influence of altitude on temperature and rainfall. The bioregion is characterised by box woodlands that occur on clay or loam soils, typically at low to mid elevation in agriculturally productive areas. The principal dominants of these box woodlands are white box (Eucalyptus albens), yellow box (Eucalyptus melliodora), Blakely's red gum (Eucalyptus blakelyi) and grey box (Eucalyptus mollucana). Bimbil box (Eucalyptus populnea subsp. bimbil), fuzzy box (Eucalyptus conica) and western grey box (Eucalyptus microcarpa) also occur, particularly in the western half of the bioregion.

Source: Taken directly from https://www.environment.nsw.gov.au/bioregions/NandewarBioregion.htm

4.1.2 Topography and Landforms

The topographical setting incorporates a variety of landforms which have been classified in this assessment according to the definitions set out in Speight (2009). Speight (2009) states that a landscape can be classified by its landform pattern, and then further classified by individual landform elements. The wider landform pattern, for instance, could be one of flood plains or hills. These landscapes can be further categorised into individual landform elements within the wider landform pattern, for instance cliff, foot slopes or valley flats.

According to these definitions, topographic mapping conducted for the Project indicates that the PA is comprised of several landforms that include gentle slopes, upper flats, crests and open depressions. These landforms would have provided suitable areas for hunter gatherers to undertake a range of subsistence activities (for example camping, hunting and tool making). Certain landforms such as flat or gently sloping raised areas near a water source or ridge flats may have been more frequently occupied than others such as areas away from water, where land use may have been more transient in nature.

4.1.3 Flora and Fauna

Prior to European initiated land clearance, the PA would have supported a range of flora and fauna that would have been be utilised by Aboriginal people for subsistence purposes. A broad range of plants would have been available such as white box (Eucalyptus albens), yellow box (Eucalyptus melliodora), Blakely's red gum (Eucalyptus blakelyi) and grey box (Eucalyptus mollucana). Bimbil box (Eucalyptus populnea subsp. bimbil), fuzzy box (Eucalyptus conica) and western grey box (Eucalyptus microcarpa). "Riparian forests of river oak (Casuarina cunninghamiana), sometimes with river red gum (Eucalyptus camaldulensis), occur along the major watercourses, with Blakely's red gum and rough-barked apple (Angophora floribunda) forming the common association along minor drainage lines. Forest and woodlands of northern smooth-barked apple (Angophora leiocarpa) and dirty gum (Eucalyptus chloroclada) are associated with sandstone parent material on the north-western edge of the bioregion" (NSW NPWS 2003).

There is a high diversity of fauna within the bioregion including, woodland birds, diurnal birds such as regent honeyeaters, lorikeets, and little corellas, nocturnal birds such as several owls and bush stone curlews, frogs, turtles, lizards, snakes, koalas, squirrel gliders, greater gliders, and various bats.

4.1.4 Land Use and Disturbance

The PA generally consists of a cleared pastoral landscape primarily utilised for sheep and cattle grazing. Some areas of the upper soil horizon within the PA have been affected by ploughing. Ploughing generally disturbs the upper 300mm of soil horizons (i.e. 300mm is the maximum plough depth), however, depending on ploughing method, it is possible that up to 600mm could be disturbed. Therefore, deeper soil deposits may retain *in situ* Aboriginal archaeological sites. For this reason, the plough zone is not considered as an area of significant disturbance, however, any artefacts located within the top 300-600mm of the soil horizon may be considered as not to be *in situ*, depending on ploughing methods applied in that area in the past.

Other land disturbances to the PA include the construction of roads, land clearance and fencing. Other ground disturbances have also occurred within the PA such as soil erosion and bioturbation (bioturbation is the reworking of soils and sediments by animals and plants). These post depositional processes have likely adversely affected the archaeological record in the PA.

5. ARCHAEOLOGICAL BACKGROUND

The preliminary archaeological and cultural landscape context discussed in this report has been established through a review of documentation relating to regional ethnographic accounts, information from the AHIMS database, and previously conducted archaeological projects and reports. It is noted that there are several limitations to the use of this existing information such as:

- Aboriginal people involved in previous studies may not have disclosed relevant cultural knowledge and the cultural significance of certain areas due to sensitivities in Aboriginal politics;
- no responsibility can be taken by ERM for errors or omissions in primary and secondary source material cited in this report; and
- the AHIMS search results presented below are based on previous archaeological work and is therefore limited to specific locations and field conditions (visibility, time constraints, etc.) and therefore may not necessarily be a true reflection of the archaeological record.

5.1 Ethno-History

Ethnographic information relating to the Aboriginal occupation of the PA has been obtained from sources containing knowledge that has been passed down from Aboriginal people, as well as documentation written by early European settlers and government officials during the mid to late 18th century (Barwick 1984). Human occupation of south east Australia dates from at least 20,000 years BP. Evidence of early Aboriginal occupation of the State has been provided by sites such as the Burrill Lake rock shelter (Lampert 1971), Cloggs Cage (Flood 1980) and New Guinea 2 (Ossa 1995). The major Aboriginal groups thought to traditionally occupy the wider Nandewar Bioregion were the Anaiwan, the Kamilaroi, the Weraerai, and the Kwaimbul (NSW NPWS 2003).

ERM recognises that Indigenous people are the primary source of information on their heritage and culture; the Anaiwan, Kamilaroi, Weraerai, and the Kwaimbul people are the Aboriginal traditional owners of the wider area. This brief history of the region has been compiled through desktop research, regional studies and historical documents. It should be recognised that most of the available ethnographic information relating to the early Aboriginal occupation of the area comes predominantly from historical documentation written by early European settlers and government officials during the mid to late 19th century. However, the Aboriginal ties to the land and cultural significance of the broader region is recognised within this CHA.

The broader area around the PA forms part of the New England Ranges encompassing eastern and western river systems. Walker describes the region as being dominated by undulating uplands, extending as a tableland belt of varying width, with gently rolling country with shallow valleys terminating in the eastern escarpment east of Walcha (1977, pp.11). Australian Aboriginal people occupied the land according to a complex system of spatial organisation and landscape use (Clark 1990, pp.11-14). Individual groups were intimately familiar with their own geographical regions and the seasonal availability of resources within it. Sutton (1989, pp.7-8) writes that Aboriginal people of the area utilised the surrounding natural resources and landscape formations as a part of their subsistence procurement strategies in addition to more traditional hunting methods; for example, they used the trees to trap macropods via nets strung between them and then herded the animals into the nets and they used traps, nets and baskets in the swamps to catch fish, crayfish, hunt water birds and collect their eggs (Rosen 2009). Indigenous people were also able to supplement their diet by digging for yams, roots and foraging for other edible plants, berries and seeds. Grasslands were maintained by burning or 'fire stick farming' to regenerate local plants and vegetation as well as attract large game into the area for hunting (Rosen 2009). Of the flowering and fruiting plants available as food a large number of them grew in spring and summer including geebung, wild parsnip, Apple Berry, spreading *brachyloma* and Honey Pots (Rosen 2009). A number of these species are encouraged to grow and flower by fire, including the *Xanthorrhoea* species, and the *Imperata cylindrical* (Rosen 2009).

The nature of their subsistence practices required Indigenous groups to be seasonally mobile, moving through the landscape and taking advantage of seasonal fluctuations in available resources. As cited in Hudson (2006), researchers McBryde and Belshaw state that Aboriginal populations on the Tablelands moved to warmer climates (eastern coastal and western slopes) during the colder winter months and occupied rock shelters and overhangs likely adapting their diet and subsistence practices to suit their environment as they moved through the landscape. Many plant resources present in the area are known to have been used by Aboriginal people prior to and after European occupation (Rosen 2009). A number of edible plants were available all year round although spring and summer typically would have been the most productive seasons with a proliferation of species including saw-sedge, bearded heath, Australian Bluebell, ferns and the *Styphelia triflora* (Rosen 2009).

Tools used by Aboriginal people of the Northern Tablelands region included spears, clubs, waddies, boomerangs, shields, paddy-melon sticks and fire sticks made of wood; stone was also utilised to create tools including knives, scrapers, ground-edge axes and even composite technologies like hafted stone chisels (McBryde 1974). Spears were both hand-thrown and thrown with the aid of woomeras (spear throwers). Stone axes were sharpened by pulling or rubbing the axe head through cracks or gaps in other stone outcrops or on bedrock material such as granite or sandstone (Rosen 2009).

Traditional or tribal boundaries were not delineated by treaties or surveyor demarcation but were often defined by the people who occupied them and their culture traditions including linguistic associations, social relations and kinship systems, and spiritual links to the land. Through this commonality and shared culture they may have also controlled and regulated who accessed and passed through their territory. Thus, traditional boundaries were most likely fluid and changed position over time. In light of this, the tribal boundaries recorded by European people at, or after, the point of contact can only be considered as current to that period and were probably quite different prior to European observation (Flood 1980, pp.2). To make things more ambiguous, the few European accounts of Aboriginal groups in the Armidale region are limited in detail, often confused in regard to Aboriginal group names and give varying interpretations of territorial boundaries.

Norman Tindale (1974) in his landmark analysis of the 'Aboriginal Tribes of Australia' cites the PA area as the traditional home of the Kwiambal people (refer to *Figure 5.1*).

Figure 5.1 Map of Tribal Boundaries in Aboriginal Australia, PA indicated with blue circle (Tindale 1974)

5.2 Regional Archaeological Background

While many archaeological studies have been carried out in the region, much is focused on the coastal areas of northern NSW rather than the regional area containing the PA. A significant and early example of these studies was carried out by McBryde in 1974 (OzArk EHM 2011). This study dated a rockshelter site to 6,400±300BP, which is the oldest occupation date so far recorded in the coastal region.

Most hinterland studies in the region have been related to development related assessments, these include a series of transmission line assessments carried out by OzArk in the 2000s and at least once by Navin Offer in the 1990s (OzArk EHM 2011). These studies as well as others in the region suggest that the most common Aboriginal site type is an ‘open site’ (or stone artefact scatter), although art sites, modified trees, rockshelters, grinding grooves, and quarry sites have also been recorded. It has been noted that sites are most likely to appear on ridgelines, spurs, and slopes rather than along creek lines (Navin Officer 1990).

In 2013 Tenterfield Shire Council commissioned an Aboriginal Heritage Study (AMBS 2013) which aimed to identify places of significance within the LGA and to inform the listing of heritage items on the LEP. The study was carried out in consultation with Aboriginal stakeholders in the area. It identified 174 previously recorded Aboriginal cultural heritage sites within the LGA, noting that sites general occurred near watercourses in elevated areas. The study also noted that the distribution of sites that had been recorded reflected locations of previous studies, carried out as part of development activities or for academic purposes, rather than reflecting an accurate or complete distribution of sites likely to be found across the landscape (AMBS 2013).

5.3 Local Archaeological Context

There has been limited previous archaeological research within the PA; however at least one development project has been undertaken in its proximity which has required cultural heritage assessment. The results of this investigation helps to provide an indication of the range, nature and distribution of archaeological sites within the local area.

5.3.1 Dumaresq to Lismore Transmission Line Aboriginal and Historic Heritage Assessment

Between 2009 and 2011 OzArk EHM undertook Aboriginal and Historic heritage assessments as part of a project which proposed a transmission line between the Dumaresq Switching Station (approximately 75m from the PA’s western boundary) and the Lismore Substation in far north NSW (OzArk 2011). In 2011, an assessment was carried out on the section of the proposed transmission line easement. Prior to completing the assessment information about previously recorded sites in proximity were gathered from AHIMS, it was noted that 49.2% of previously recorded sites in the area were open sites / artefacts scatters, and 15.2% were modified (scarred) trees. The assessment identified 50 previously unrecorded Aboriginal cultural heritage sites. The assessment found that most cultural heritage sites were located near a water source and that sites in the area are likely to be artefact scatters or modified trees.

5.3.2 OEH AHIMS Register

The AHIMS database provides information concerning previously recorded Aboriginal sites in NSW. AHIMS stores data regarding a sites location, site type, site features and a unique site identification number for all registered Aboriginal heritage sites in NSW. Mapping of an AHIMS database search results will identify any known sites which could be impacted by proposed works as well as help to determine the overall pattern of Aboriginal sites in an area. A summary of the various site types that could be located in the PA can be found in *Table 5.1* and will aid in the development of a site prediction model for the PA.

Table 5.1 Cultural Heritage Site Types Definitions

Site types	Definition
Stone artefact scatters (or open camp sites)	Stone artefact scatter sites, also known as open camp sites, are usually indicated by surface scatters of stone artefacts and sometimes fire blackened stones and charcoal. Where such sites are buried by sediment they may not be noticeable unless exposed by erosion or disturbed by modern activities. The term camp site is used as a convenient label which, in the case of open sites, does not necessarily imply that Aboriginal people actually camped on the sites; rather it indicates only that some type of activity was carried out there.
Isolated finds	Sites consisting of only one identified stone artefact, isolated from any other artefacts or archaeological evidence. They are generally indicative of sporadic past Aboriginal use of an area.
Shell middens	Middens consist of accumulations of shell that represent the exploitation and consumption of shellfish by Aboriginal people. Shell species may be marine, estuarine or freshwater depending on the environmental context and middens may also include other faunal remains, stone artefacts, hearths and charcoal.
Shelter sites	Sandstone shelters and overhangs were used by Aboriginal people to provide camp sites sheltered from the rain and sun. The deposits in such sites are commonly very important because they often contain clearly stratified material in a good state of preservation.
Grinding grooves	Grooves resulting from the grinding of stone axes or other implements are found on flat areas of suitable sandstone. They are often located near waterholes or creek beds as water is necessary in the sharpening process. In areas where suitable outcrops of rock were not available, transportable pieces of sandstone were used.
Quarries	These are areas where stone was obtained for flaked artefacts or ground-edge artefacts, or where ochre was obtained for rock paintings, body decoration or decorating wooden artefacts.
Art sites	Aboriginal paintings, drawings and stencils are commonly to be found where suitable surfaces occur in sandstone shelters and overhangs. These sites are often referred to as rock shelters with painted art. Rock engravings, carvings or peckings are also to be found on sandstone surfaces both in the open and in shelters. These are referred to as rock engraving sites.
Scarred trees	Scarred trees bear the marks of bark and wood removal for utilisation as canoes, shields, boomerangs or containers. It is commonly very difficult to confidently distinguish between Aboriginal scars and natural scars or those made by Europeans.
Burial sites	Burials may be of isolated individuals, or they may form complex burial grounds.
Stone arrangements, carved trees and ceremonial grounds	These site types are often interrelated. Stone arrangements range from simple cairns or piles of rocks to more elaborate arrangements; patterns of stone laid out to form circles and other designs, or standing slabs of rock held upright by stones around the base. Carved trees are trees with intricate geometric or linear patterns or representations of animals carved into their trunks. Ceremonial grounds and graves were often marked by such trees. Bora grounds are a common type of ceremonial site and they are generally associated with initiation ceremonies. They comprise two circles, generally edged with low banks of earth but sometimes of stone, a short distance apart and connected by a path.

A Targeted AHIMS search conducted for the PA on 5 March 2018 and again on 28 February 2019 revealed that one site had been previously recorded within the PA, and another nine sites had been previously recorded within 1.5 km of the PA.

The results of the AHIMS searches are shown in *Tables 5.2* and *5.3,* and *Figure 5.2*.

Table 5.2 AHIMS Extensive Search Details

Date	Client Service ID	Latitude	Longitude	Number of Sites
5 March 2018	331690	From: -29.2336 To: -29.1502	From: 151.2741 To: 151.4063	10

Table 5.3 AHIMS Registered Sites

Site ID	Site Name	Site Features	Site Types	Approximate Distance to Project Area	Status
11-3-0083	Tenterfield-Dumeresq OS14	Artefact	Open Site	Within PA	Valid
11-3-0041	S19	Artefact (Isolated Find)	Open Site	>1.5 km	Valid
11-3-0047	EL35	Artefact	Open Site	>1.5 km	Valid
11-3-0063	EL34	Artefact	Open Site	>1.5 km	Valid
11-3-0064	EL33	Art (Pigment or Engraved)	Open Site	>1.5 km	Valid
11-3-0065	EL32	Artefact	Open Site	>1.5 km	Valid
11-3-0066	EL36	Artefact	Open Site	>1.5 km	Valid
11-3-0080	TSR Dumaresq River OCS	Artefact (500)	Open Site	>1.5 km	Valid
11-3-0084	Tenterfield-Dumeresq OS15	Artefact	Open Site	>1.5 km	Valid
11-3-0093	Tenterfield Dumaresq OS 4 & PAD	Artefact	Open Site	>1.5 km	Valid

Source: Imagery - ESRI World Imagery 2016
Cadastre, Roads - NSW DCDB and QLD DCDB 2017
AHIMS - NSW DEOH 2018

AHIMS Results

5.2

Drawing No: 0464261b_BS_CHA_G003_R1.mxd		Bonshaw Solar Farm, NSW Cultural Heritage Assessment
Date: 13/08/2019	Drawing Size: A4	
Drawn By: DR / GR	Reviewed By: KD	Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

5.4 Implications for the Project Area – Predictive Model

It is important to note that the level of archaeological potential relates to the likelihood of discovering an Aboriginal object or site, within a location. Further description should then be made as to the potential condition and integrity of the soil matrix and potential site itself. Only once all these factors have been considered, can scientific value start to be assessed for an area with potential. Therefore, whilst scientific value and potential are linked, it must be noted that these values and potentials are not the same and can differ substantially for any single site or area with potential.

Areas with archaeological potential were assessed according to the definitions in *Table 5.4* and includes a consideration of landforms, distance to resources, historic disturbances and past land use, and the results of previous surveys. Proximity to a permanent water supply and landform is the primary factor appearing to determine the location of Aboriginal campsites within the region and scar trees can occur anywhere that trees of a suitable age remain.

Table 5.4 Definitions of Archaeological Potential

Rank	Definition	Example
Very Low potential	Artefacts are very unlikely to occur in situ.	Eroded landforms, reconstructed landscapes, hazardous landscape, developed areas.
Low potential	Artefacts are not normally found in comparable contexts but could occur in low densities making detection unlikely.	Landforms with no specific focus for use, i.e. areas not associated with or in proximity to water sources.
Moderate potential	Artefacts are known to occur in comparable landforms in detectable densities (~1artefact/m^2) and there is an unknown possibility for detection.	Landforms with an environmental focus which may have seen seasonal visitation.
High potential	Artefacts are consistently found in comparable landforms or similar environmental contexts and thus will certainly be found in any ground breaking works.	Landforms with known environmental focus encouraging repeat visitation to specific locale, i.e. margins of swamp or near high order creeks.

Archaeological site formation is a complex combination of factors, such as bioturbation and environmental conditions like erosion or the burial of sites through soil movement. Once discarded on the grounds surface, artefacts are often readily incorporated into the topsoil horizons through the process of bioturbation. It is common for dense artefact deposits to exist hidden beneath the grounds surface (cf. Wandsnider and Camilli 1992). Archaeological assessments that do not employ appropriate methods for prediction cannot reliably define an area's archaeological content.

Frequently, only the eroded component of a larger subsurface deposit is detected and recorded as a site. Where soils are soft, sandy or in boggy conditions, artefacts can occur at greater depths below surface level. Therefore, it is crucial that the nature of an area's soils, sands and geomorphology are defined correctly in an archaeological assessment and the resulting archaeological implications identified. An understanding of these factors, linked further to the notions of site integrity and condition, results in an understanding of an area or site's archaeological potential.

The knowledge gained from examining landforms, geology, regional archaeological patterns, and prior archaeological reports have enabled a set of parameters to be established to predict the potential location of Aboriginal sites within the PA. The topographical nature, geology, flora and fauna of the PA would have provided shelter from the elements and a range of subsistence and lithic resources to Aboriginal people. The PA's proximity to a permanent water source, the Dumaresq River and its numerous associated tributaries that run through the PA would have made it a prime source of water and food resources for Aboriginal groups in the area. In line with this and the archaeological context as discussed above, the PA is likely to contain low density stone artefact scatters across all of its landform units. Although the upper layers of soil horizons across the PA have likely been disturbed by non-Aboriginal agricultural activities such as ploughing, *in situ* archaeological deposits may be present within deeper stratigraphic layers. It is also likely that stone artefacts have not been moved far from their original depositional position by ploughing.

5.4.1 Predictive Model

Based on the background studies and comparative analysis, the following predictions are made for Aboriginal cultural heritage within the PA:

- Aboriginal sites are most likely to be stone artefact sites;
- stone artefact sites are most likely to occur within 400 m of a permanent water course, although smaller creek margins may display scatters of stone artefacts, particularly if near to larger water courses;
- surface expressions of artefacts are most likely to be found on flat or gently sloping terrain;
- surface expressions of artefacts are most likely to be found within proximity of water, or within elevated landforms such as ridge crests or spur line crests, or within proximity of open drainage depressions;
- high density open camp sites will likely be representative of a permanent or seasonal occupational camp, and will likely be located within flat raised terrain that is defensible and sheltered from the elements and has access to resources (water, food, wood and potentially stone);
- lower density sites or isolated finds are likely to contain a ‘background scatter’ and be representative of a more transient movement throughout the landscape, or intermittent activities (hunting, food procurement, etc.);
- elevated areas that afford views of the surrounding landscape are likely to contain stone artefact sites;
- cultural modifications or scars may occur on mature trees with the PA;
- areas of subsurface stone artefact deposits (with or without a display of surface level stone artefacts) may be present in the PA. Such sites are likely to be located at depths of between 0 and 30 cm below ground surface level;
- human burials are rare, and are not likely to be present in the PA, but if present would most likely be in the alluvial soils that make up the PA’s flood plain, creek and river terraces or found in crests and hill tops;
- ceremonial sites (bora grounds) may be present on hill tops in the PA, though are very unlikely due to their rarity and previous disturbances across the landscape; and
- the most common stone materials used for the manufacturing of artefacts within the local region of the PA are likely to be silcrete, chert and quartz (with some quartzite and volcanic material).

Much of the material used by Aboriginal people to produce survival equipment (such as wood, bone, shell and fibre material) is highly perishable and does not often survive in the archaeological record. Material culture that has survived, often found in locations where Aboriginal people camped, are generally stone artefacts and scarred trees. Stone artefacts, and to a lesser extent scarred trees, are the most likely artefact types to be located within the PA. Aboriginal archaeological sites within the PA are likely to have been impacted upon (disturbed) due to past European farming practices, the development of transport infrastructure (such as road constructions) and trenching for utility services.

6. HISTORICAL CONTEXT

This chapter considers the potential non-Aboriginal heritage values for the PA. It includes a review of primary and secondary resources including available heritage assessments, reports, publications, historical maps and aerial imagery for the local area. This material will be used to help the PA's history and development over time. The following databases were also searched to determine whether known non-Aboriginal ('historic') heritage sites are located within the PA:

- Commonwealth Heritage List (CHL);
- NSW State Heritage Register and Inventory;
- Inverell Local Environmental Plan (LEP) 2012; and
- The National Trust of Australia.

6.1 Historical Overview

The New England region and Inverell district's first European explorers were Allan Cunningham (1827) and John Oxley (1818), who entered the area on separate expeditions (OzArk 2011). Squatters then moved into the Inverell area around 1835, some establishing large holdings throughout the area, including Campbell in 1837, a significant landholder in Inverell (OzArk 2011; Inverell Shire Council 2018). Campbell, having arrived in Australia from Scotland in 1824 and named the area "Inv" a meeting place and "Ell" meaning swans, as a large amount of these birds were in the area at the time (Inverell Shire Council 2018).

In June 1838 the Myall Creek massacre occurred 35 km from Inverell, becoming a famous case in Australia as the first time that Europeans were hanged for killing Aborigines (Inverell Shire Council 2018). Unfortunately it was not the only massacre in the region at this time, however subsequent massacres and violent episodes went unreported or punished (Inverell Shire Council 2018).

The town of Inverell was incorporated as a municipality in 1872 and tin mining in the region ensured the town's economic growth and remained an important industry in the area for the next century (Inverell Shire Council 2018). The Closer Settlements Acts introduced in NSW between 1901 and 1909 helped to create new small towns in the area in an effort to break large landholding squatter's dominance in country areas (Inverell Shire Council 2018).

6.1.1 Bonshaw

It is not clear when the small township of Bonshaw was formed, however it was built to support local agricultural holdings. The earliest cattle station is thought to have been established in the Bonshaw area in the early 1840s and a track from Bonshaw to Ashford developed in the 1850s (Main Roads 1968). A hotel was constructed at Bonshaw prior to 1867, in time for the bushranger, Captain Thunderbolt (Fred Ward) to rob it in May that year (The Armidale Express 1867). Other community buildings were also built in the town including a church, school, and memorial hall (refer to *Photographs 6.1* and *6.2*). In 1878 £750 was provided for the construction of a track from Tenterfield to Bonshaw (Main Roads 1968). Further roads from Bonshaw to other large towns in the area were established and upgraded over the following decades, including to Ashford, Texas, and Inverell, leading to the formation of State Highway No. 16 in 1938 which became NSW's most northern highway from the coast to the Queensland border at Goondiwindi, it was later renamed Bruxner Highway in 1959 (Main Roads 1968).

Photograph 6.1 School at Maidenhead Station, Bonshaw, c. 1880s (Trove Item #48117813)

Photograph 6.2 Memorial Hall, Bonshaw (Trove Item #252402940)

6.1.2 The Project Area

While little is known about the history of the PA, historical parish maps dating from at least 1909 show that the land was used for pastoral purposes. In 1909, a Charles Strathley Jr was the landholder (refer to *Figure 6.1*). No further detail is included on the map (or any later parish maps) to indicate that any buildings or dwellings were present on the site. Strathley is shown to hold a number of titles within this parish and it is possible that he resided elsewhere and used the land purely for grazing purposes. Strathley is listed as a grazier in several historical sources including the Sydney Stock and Station Journal (5 April 1918). According to later parish maps Strathley was still the landholder in 1939. By 1967 a B.F. Hartley held the land title and continued to do so until at least 1979 (NSWLRS 1965; 1979).

Figure 6.1 1909 Parish of Bowman map, PA is indicated in red (NSWLRS 1909)

6.2 Historical Heritage Database Searches

A search of heritage databases was undertaken in August 2018 and again on 27 February 2019 to determine whether any historical heritage items have previously been recorded within the Project Area. The results are outlined below.

6.2.1 Commonwealth Heritage List

There are no places listed on the CHL within or near the Project Area.

6.2.2 State Heritage Register

A search of the State Heritage Inventory (SHI) indicated that there are no places listed under the NSW Heritage Act (NSW State Heritage Register) within or near the Project Area.

6.2.3 Local Environmental Plan

There are hundreds of places of heritage significance items located within the Inverell Council area that are listed on the LEP Schedule 5: Part 1 Heritage Items. In Bonshaw itself, three places are listed, all of which are located in Bonshaw village approximately 16 km NNW of the PA, and these are:

- Bonshaw Cemetery, Spark Street (Item #I019);
- Church, 10986 Bruxner Highway (Item #I018); and
- Memorial Hall, Miller Street (Item #I021).

No items of local historic heritage are located within or near the general Project Area.

6.3 Historical Heritage Predictive Model

There are no registered or known significant historic heritage sites in or near the PA. There may be evidence of early agricultural activities, timber harvesting, domestic dwellings and domestic remains in the PA. However, the historical background suggests that the PA was used as grazing land. Given the long term pastoral grazing and ongoing site disturbance associated with the installation of and maintenance of the transmission line through the southern section of the PA, it is unlikely that there will be substantial historical remains identified within the AP.

7. SURVEY METHODOLOGY AND RESULTS

This chapter provides an overview of the archaeological surveys of the PA that were undertaken between the 11 and 13 September 2018.

7.1 Field Survey Methodology

The September 2018 field survey was conducted according to the survey methodology developed and sent to RAPs on 9 August 2018 (*Appendix B*). The archaeological survey aimed to assess the ground surface of the PA and targeted all soil exposures and zones with low vegetation such as areas of erosion and any tracks or paths.

Where Aboriginal cultural heritage sites were identified, these were mapped and recorded by the survey team for content, GPS location, landscape features and digitally photographed. Notes were made of soil conditions, evidence of ground disturbance and possible spatial extent of sites.

Visibility refers to the amount of ground upon which artefacts could be seen. The presence of vegetation, leaf litter and other variables can obscure visibility, which is expressed as a percentage. An exposure is defined as an area in which ground surface disturbance (usually in the form of erosion) results in the removal of ground cover and soils and permits the detection of archaeological material that was formerly contained within a surface or subsurface context. The level of exposure is determined as a percentage. As a descriptive tool, *Table 7.1* has been devised which indicates the level of ground surface visibility. It is a subjective method of assessment, but provides a useful tool when attempting to describe the level of ground surface visible during field surveys or inspection.

Table 7.1 Ground Surface Visibility Rating

	Description	GSV Rating %
Very Poor	Heavy vegetation, scrub foliage or debris cover, dense tree of scrub cover. Soil surface of the ground very difficult to see.	0-9%
Poor	Moderate level of vegetation, scrub, and / or tree cover. Some small patches of soil surface visible in the form of animal tracks, erosion, scalds, blow outs etc., in isolated patches. Soil surface visible in random patches.	10-29%
Fair	Moderate levels of vegetation, scrub and / or tree cover. Moderate sized patches of soil surface visible, possibly associated with animal, stock tracks, unsealed walking tracks, erosion, blow outs, etc. Soil surface visible as moderate to small patches across a larger section of the PA.	30-49%
Good	Moderate to low level of vegetation, tree or scrub cover. Greater amount of areas of soil surface visible in the form of erosion, scalds, blow outs, recent ploughing, grading or clearing.	50-59%
Very Good	Low levels of vegetation / scrub cover. Higher incidence of soil surface visible due to recent or past land-use practices such as ploughing, grading, mining, etc.	60-79%
Excellent	Very low to non-existent levels of vegetation/scrub cover. High incidence of soil surface visible due to past or recent land use practices, such as ploughing, grading, mining, etc.	80-100%

Each of the different landforms identified in the PA were surveyed, which included slopes, upper flats, crests and plains (refer to *Table 7.3*). Creek lines, mature trees, erosion scours, and vehicle and animal access tracks were all inspected. In order to ensure the highest likelihood of finding Aboriginal sites, the field survey focussed on areas of highest ground visibility although it is noted that the ground surface visibility was poor (10-29%) to fair (30-49%) across the majority of the survey area.

7.2 Field Survey Results

The PA was surveyed over three days in September 2018 by Katherine Deverson and representatives of the RAPs as outlined in *Table 7.2.* The field survey methodology was adopted to pursue the discovery of new archaeological sites, ensure the accurate recording of such sites and provide sufficient information to provide an assessment of the PA's cultural significance. Discussion also included Aboriginal intangible values and the importance of Aboriginal sites to the local community.

Table 7.2 Field Survey Attendees

Name	Organisation
Vicky Duncan	Aboriginal Cultural Sites Services
Samantha Duncan	Edgerton Kwiambal
Darren Daley	Moombahlene LALC

7.2.1 Description of the Project Area

The PA generally consisted of grazing paddocks with dense grass traversing gently undulating terrain, plains, and crest landforms (refer to *Table 7.3* and *Photographs 7.1* and *7.2*). There was generally a low level of ground surface visibility with some ground exposures under trees, in areas of soil erosion and along tracks. Disturbances observed include the development of fencing, farm dams and vegetation clearance. Several woodland areas, along with a number of small unnamed creeks were also located in the PA (*Photograph 7.3*). Exposures associated with tracks, dams, woodland areas and other disturbances were examined for artefacts.

Soils across the PA range from alluvial soils adjacent to watercourses with thin sandy-silty Aeolian soil in colours of deep orange and red, to a light yellow/brown and dark brown. Disturbance to the soil profile has occurred during past episodes of vegetation clearance.

Table 7.3 Landform Summary

Landform	% of landform effectively surveyed	Number of Sites
Slope	1.5%	6
Upper Flat/Crest	1.75%	1
Plain/Open Depression	2.88%	28

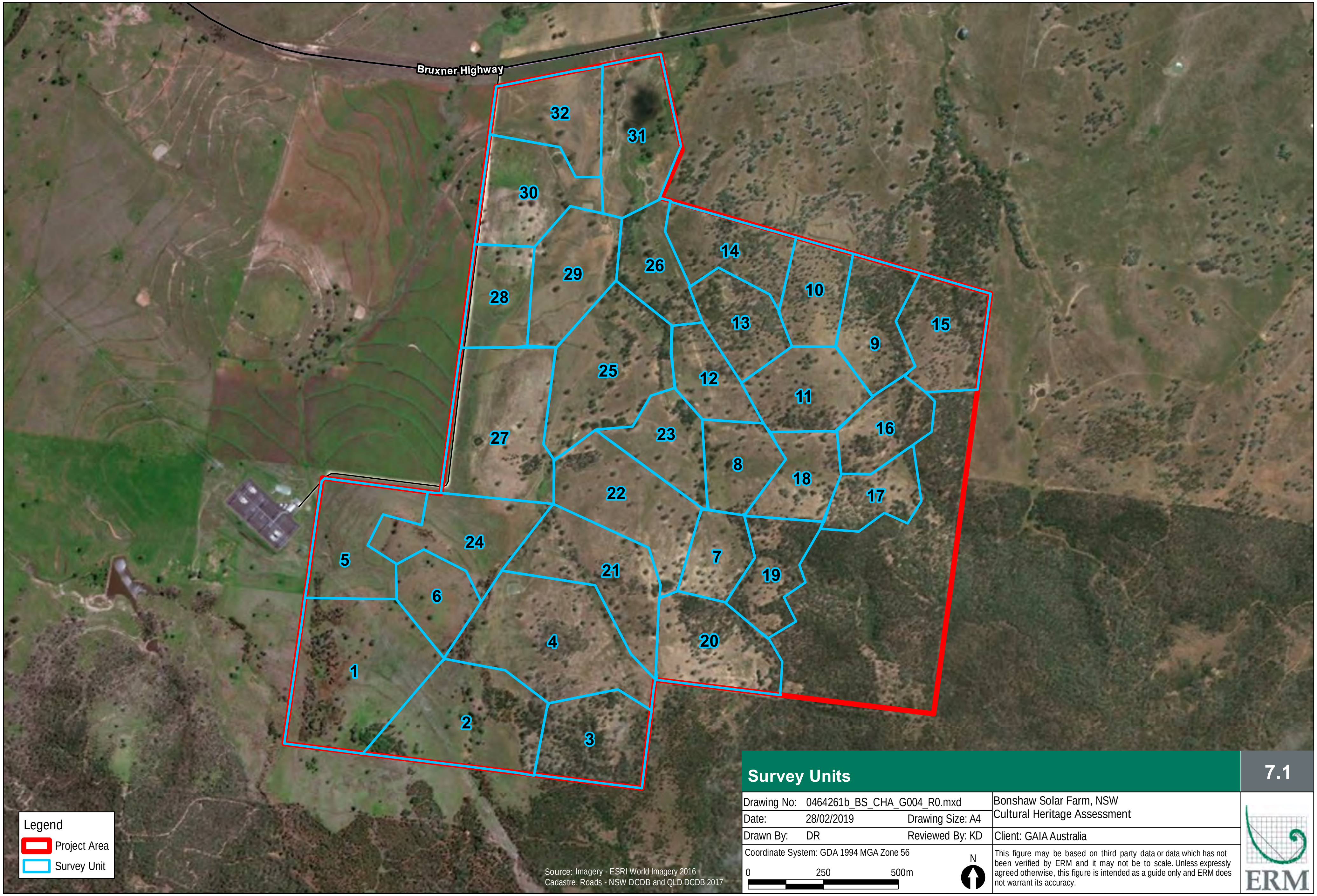
Photograph 7.1 **Densely grassed paddock in PA, view to creek line (ERM 2018)**

Photograph 7.2 **Area of exposure along creek to the left, view to south of PA (ERM 2018)**

Photograph 7.3 View to north, along unnamed creek (ERM 2018)

7.2.2 Survey Coverage

The PA was examined in 32 survey units, based on fenced paddocks/areas throughout the PA for ease of recording and analysis. These survey units are identified as Survey Unit (SU) 1 to SU32. The location of these survey units is shown in *Figure 7.1 and detailed in Table 7.4.*



Legend

🟥 Project Area

🟦 Survey Unit

Source: Imagery - ESRI World Imagery 2016
Cadastre, Roads - NSW DCDB and QLD DCDB 2017

Survey Units

7.1

Drawing No:	0464261b_BS_CHA_G004_R0.mxd		
Date:	28/02/2019	Drawing Size: A4	
Drawn By:	DR	Reviewed By: KD	

Coordinate System: GDA 1994 MGA Zone 56

0 250 500m

N

Bonshaw Solar Farm, NSW
Cultural Heritage Assessment

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Table 7.4 Survey Coverage

Survey Unit	Landform	Visibility %	Exposure %	Effective Coverage %	Number of Sites
SU1	Plain	Poor 10%	10%	1%	2
SU2	Plain/Mid Slope	Poor 15%	10%	1.5%	2
SU3	Upper Slope/Crest	Poor 10%	10%	1%	0
SU4	Plain/Open Depression	Poor 20%	10%	2%	2
SU5	Plain/Mid Slope	Poor 10%	10%	1%	2
SU6	Plain/Mid Slope	Poor 10%	10%	1%	0
SU7	Plain	Poor 20%	10%	2%	1
SU8	Plain	Poor 15%	10%	1.5%	1
SU9	Upper Slope/Crest	Poor 25%	10%	2.5%	0
SU10	Mid Slope	Poor 10%	10%	1%	0
SU11	Mid Slope	Poor 10%	10%	1%	0
SU12	Plain	Poor 20%	10%	2%	0
SU13	Plain	Poor 10%	10%	1%	0
SU14	Plain	Poor 10%	10%	1%	2
SU15	Plain	Poor 10%	10%	1%	1
SU16	Plain/Mid Slope	Poor 15%	10%	1.5%	1
SU17	Mid Slope	Poor 10%	10%	1%	0
SU18	Plain	Poor 10%	10%	1%	0
SU19	Plain/Mid Slope	Poor 10%	10%	1%	0
SU20	Plain/Open Depression/Mid Slope	Poor 15%	10%	1.5%	0
SU21	Plain	Poor 15%	10%	1.5%	1
SU22	Plain	Poor 10%	10%	1%	2
SU23	Mid Slope	Poor 10%	10%	1%	1
SU24	Plain/Slope/Upper Flat	Good 50%	30%	15%	4
SU25	Plain	Fair 30%	10%	3%	2
SU26	Plain	Poor 10%	10%	1%	1
SU27	Plain	Fair 40%	30%	12%	1
SU28	Plain/Mid Slope	Poor 20%	15%	3%	1
SU29	Plain	Fair 40%	20%	8%	4
SU30	Mid/Upper Slope	Fair 30%	15%	4.5%	2
SU31	Plain	Poor 25%	15%	3.75%	2
SU32	Plain	Poor 25%	15%	3.75%	1

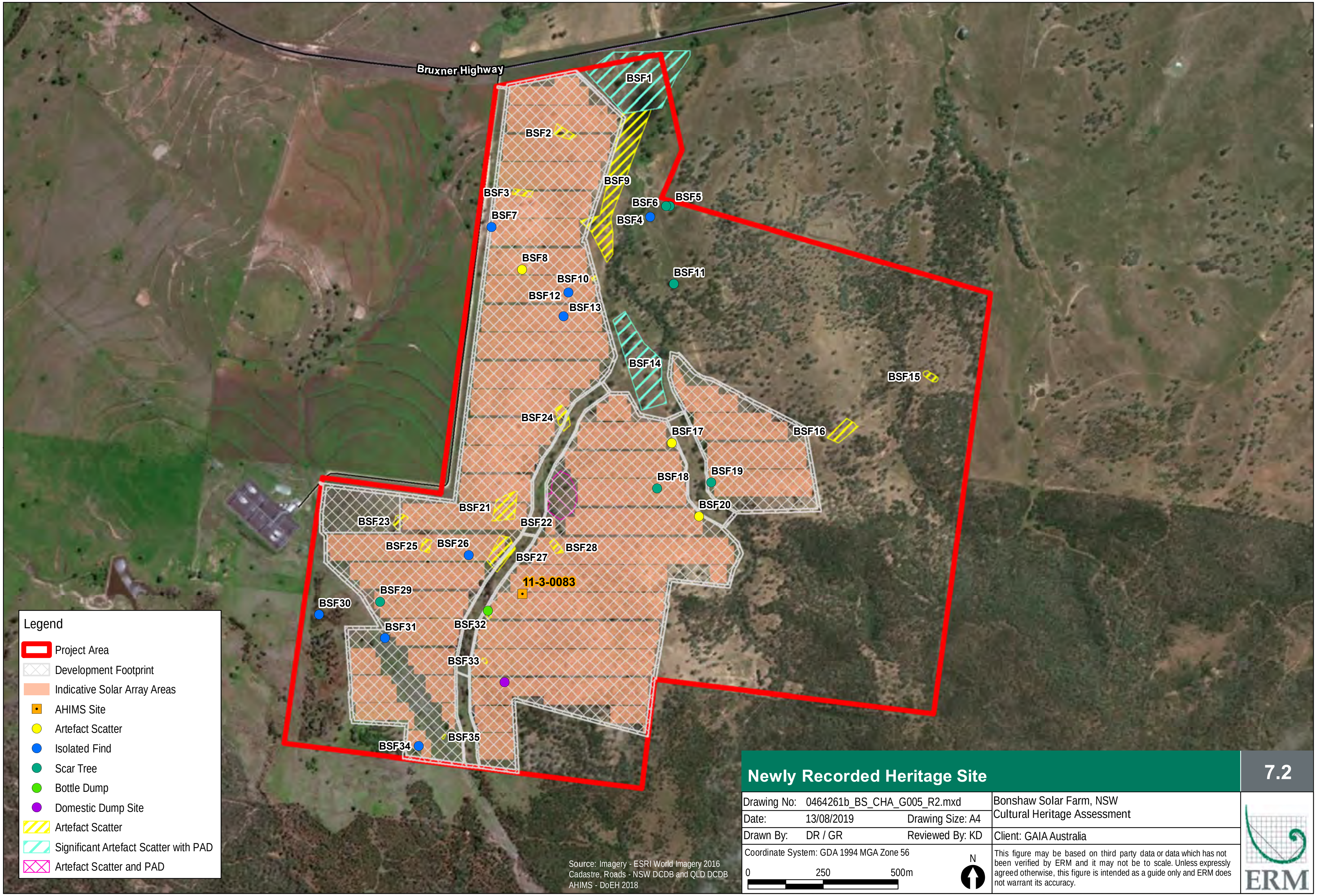
7.2.3 Survey Results

7.2.3.1 Aboriginal Heritage

During the field survey 35 previously unidentified Aboriginal heritage sites were recorded. The sites were located within 3 km of the Dumaresq River to the north, often along small creek lines (*Figure 7.2*). 29 of these sites were stone artefacts including isolated finds and stone artefact scatters. Seven scarred trees were also identified, one of the scarred trees was identified as part of an artefact scatter site. The proximity to water sources and prevalence of artefact scatters or open sites is in line with the predictive model developed in *Section 5.4* and are representative of previously recorded sites in the area. It should be noted that while early studies suggest that sites in the region are less likely to occur along creek lines, this is not the case here and many artefact scatters were located along creeks, rather than in elevated areas or on ridgelines. These sites are described below in *Table 7.5.* Previously unrecorded Aboriginal cultural heritage sites located during the survey were recorded and artefacts and features identified were left *in situ*.

AHIMS Site 11-3-0083

AHIMS Site 11-3-0083 was identified within the PA in 2011 during surveys for the Dumaresq to Lismore 330kV Transmission Line. This site was not re-identified during the 2018 surveys, however given the seven years between surveys and the exposed nature of the location and the relatively poor ground visibility observed in this survey unit during the 2018 survey it is possible that all or some of this site remain *in situ.* It is also possible that some small artefact scatter identified during the 2018 surveys, including BSF33, BSF2, and BSF28 may form part of Site 11-3-0083 which was recorded as a large site complex.



Source: Imagery - ESRI World Imagery 2016
Cadastre, Roads - NSW DCDB and QLD DCDB
AHIMS - DoEH 2018

Newly Recorded Heritage Site

7.2

Drawing No: 0464261b_BS_CHA_G005_R2.mxd
Date: 13/08/2019 Drawing Size: A4
Drawn By: DR / GR Reviewed By: KD
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW
Cultural Heritage Assessment

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

Table 7.5 Aboriginal Cultural Heritage Field Survey Results

Site	Survey Unit	Landform	Description		Associated PAD
BSF1	SU31	Plain	**Large Artefact Scatter / Open Camp** This site comprises a high number of stone artefacts. It is not likely that all surface artefacts were identified and recorded at this site, however more than 50 artefacts were noted, across an area of approximately 350 m (east to west) by 200 m (north to south). The site is located at northern boundary of property along small creek line and vehicle access track. The site is located on a plain set in a wider landscape context of rolling hills. BSF1 is considered to have a moderate potential for further archaeological deposits due to the number of artefacts found with a corresponding low ground surface visibility, as well as its landscape setting and association with the nearby water course. Artefacts located included chert, tuff, basalt and quartz material, a silcrete retouched axe head and quartz round grindstone. Given its location on the creek that (to the south) contains a site also considered to be an occupation site (BSF14) indicating extended or repeated use, and its subsurface potential, it is considered likely that BSF1 may be part of a complex of occupation sites along the creek beginning at BSF1 and continuing south through BSF14 to BSF22.	 	Yes
BSF2	SU32	Plain	**Artefact Scatter** This small artefact scatter of approximately six stone artefacts, including silcrete and basalt flakes and cores, and potentially a quartzite grindstone is located across an area of approximately 75 m (east to west) by 25 m (north to south). The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
			The site may have been formed as a result of wash down from the nearby hill to the south.		
BSF3	SU30	Upper Slope	**Artefact Scatter** This small artefact scatter of four stone artefacts, including dilite/diorite flakes was identified by RAPS on a slope near the hillcrest on a track. It is located across an area of approximately 75 m (east to west) by 25 m (north to south). The site is located on an upper slope set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from the nearby hill top.		No
BSF4	SU31	Plain	**Isolated Find** Broken Granite manuport artefact. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF5	SU14	Plain	**Scarred Tree** During the survey RAPs identified a felled scarred tree located within proximity to another standing but dead scarred tree (BSF6). The oval shaped scar was approximately 1.4 m in length and 40 cm wide. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF6	SU14	Plain	**Scarred Tree** During the survey RAPs identified a standing (but dead) scarred tree, with an oval shaped scar. Within proximity to another felled scarred tree (BSF5). The oval shaped scar was approximately 1.2 m in length and 25 cm wide. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No
BSF7	SU30	Mid Slope	**Isolated Find** Silcrete core located on slope set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF8	SU28	Mid Slope	**Artefact Scatter** Small artefact scatter consisting of at least seven blue chert flakes scattered within a 3 m x 5 m area may have been formed as the result of a single knapping event. The site is located on a slope set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF9	SU29	Plain	**Large Artefact Scatter / Open Camp** This site comprises a widespread surface artefact scatter evident along a track and yard across an area of approximately 500 m (north to south) by 100 m (east to west), the site also contains an associated scar tree. There is no evidence for subsurface material and it is possible that the site could have been caused by wash down from the nearby hill to the west of from the nearby occupation sites at BSF1 and BSF14. It is located near creek line and on a vehicle access track. The site is located on a plain set in a wider landscape context of rolling hills. The site contains more than 40 artefacts which are mostly flakes including silcrete, chert, and quartz, flakes; basalt and tuff artefacts were also identified. The site associated with a scar tree identified by RAPs during survey which has been recorded as part of the site. Given its location near the creek that (to the north and south) contains a sites that are considered to be occupation sites (BSF1 and BSF14), it is considered likely that BSF9 may form part of an area of wider occupation sites at BSF1 and continuing south through BSF 9, BSF14, and BSF22.	 	No

Site	Survey Unit	Landform	Description		Associated PAD
BSF10	SU29	Plain	**Artefact Scatter** Small artefact scatter, comprising 2 x basalt hammerstones. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF11	SU26	Plain	**Scarred Tree** During the survey RAPs identified a standing, live, scarred tree. The roughly oval shaped scar was approximately 1 m in length, 40 cm wide, and very close to the ground. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No
BSF12	SU29	Plain	**Isolated Find** Silcrete core located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF13	SU29	Plain	**Isolated Find** Silcrete core located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF14	SU25	Plain	**Large Artefact Scatter / Open Camp** This site comprises a high number of stone artefacts. It is not likely that all surface artefacts were identified and recorded at this site, however more than 50 artefacts were noted, across an area of approximately 110 m (east to west) by 330 m (north to south). Located along and extending between two small creek lines and vehicle access track. The site is located on a plain set in a wider landscape context of rolling hills. The site is considered to have a high potential for further archaeological deposits due to the number of artefacts found with a corresponding low ground surface visibility, as well as its landscape setting and association with the nearby water course. Sub-surface artefacts were visible in the soil profile along eroded creek line at southern end of site. Artefacts located included chert, granite, basalt and quartz material. Given its location on the creek that (to the south) contains a site also considered to be an occupation site (BSF14) indicating extended or repeated use, and its subsurface potential, it is considered likely that BSF1 may be part of a complex of occupation sites along the creek beginning at BSF1 and continuing south through BSF14 to BSF22.		Yes

Site	Survey Unit	Landform	Description		Associated PAD
			It is not likely that all surface artefacts were identified and recorded at this site, however more than 50 artefacts were noted, across an area of approximately 350 m (east to west) by 200 m (north to south).		
BSF15	SU15	Plain	**Artefact Scatter** This site comprises1 x silcrete flake and 1 x broken silcrete hammerstone. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.	 	No
BSF16	SU16	Plain	**Artefact Scatter** This site comprises1 x silcrete flake and 1 x silcrete hammerstone. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF17	SU23	Mid Slope	**Artefact scatter** This site comprises approximately eight stone artefact including blue chert flakes, silcrete flakes and one core, across an area of approximately 80 m (NW to SE) by 30 m (SW to NE). The site is located on a slope set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from BSF14 which is nearby to the north.		No
BSF18	SU22	Plain	**Scarred Tree** During the survey RAPs identified a standing, live, scarred tree. The oval shaped scar was approximately 1.7 m in length, 40 cm wide, and had significant overgrowth. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF19	SU8	Plain	**Scarred Tree** During the survey RAPs identified a standing, live, scarred tree with a 1.5 m (length) narrow scar that was approximately 40 cm from the ground and showed significant overgrowth. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No
BSF20	SU7	Plain	**Artefact Scatter** This site comprises a three chert flakes. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from larger sites, such as BSF14 which is along the same creek line to the north.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF21	SU24 & SU 27	Plain	**Artefact Scatter** This site comprises five stone artefacts, including a quartz flake, a large coarse grained flake with evidence for retouch, a large blue/grey coarse grained flake, a chert flake displaying at least 50% cortex, and a basalt axe. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from nearby sites along the creek to the north (such as BSF14) or from a small lightly wooded rise immediately to its north, although no artefacts were identified on the rise.		No
BSF22	SU22	Plain	**Artefact Scatter** This site comprises a small artefact scatter with approximately 20 artefacts across a ground surface area on approximately 50 m (NW to SE) by 30 m (SW to NE). The site contains mostly basalt flakes and cores, and at least one chert flake. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site is considered to have potential for further archaeological deposits due to noted evidence for sub-surface artefacts in the soil profile in the eroded creek line along the western edge of site. The presence of the site on the high bank of a creek that (further to the north) contains occupation sites indicating extended or repeated use, and its noted subsurface potential means that it may also be an occupation site and a southern extension of what may be a complex of occupation sites along the creek beginning at BSF1 and continuing south through BSF14 to BSF22.	 	Yes

Site	Survey Unit	Landform	Description		Associated PAD
BSF23	SU5	Crest/Upper Flat	**Artefact Scatter** This site comprises two artefacts a smooth grained modified stone artefact and a granite hammerstone. The site is located on a rocky upper flat set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF24	SU25	Plain	**Artefact Scatter** This site comprises a small artefact scatter of four fine grained (possibly chert) flakes across an area 75 m 40 m. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from nearby sites along the creek to the north (such as BSF14).		No
BSF25	SU24	Mid Slope	**Artefact Scatter** This site comprises two artefacts, 1 x basalt hammerstone and 1 x granite axe. The site is located on a slope set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from nearby sites and terraced landforms to the west.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF26	SU24	Plain	**Isolated Find** This site comprises a silcrete flake. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF27	SU24	Plain	**Artefact Scatter** This site comprises a small artefact scatter of eight stone artefacts including five chert flakes, two basalt flakes and a hammerstone granite. The site is located in a ploughed field across an area of approximately 25 m (SW to NE) by 50 m (NW to SE), on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF28	SU21	Plain	**Artefact Scatter** This site comprises a small artefact scatter of three artefacts with a chert, and quartz flakes identified and a quartzite core, across an area of approximately 110 m (SW to NE) by 50 m (NW to SE). The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified. The site may have been formed as a result of wash down from nearby sites along the creek to the north (such as BSF14).		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF29	SU5	Plain	**Scarred Tree** During the survey RAPs identified a standing, but dead, scarred tree. The long oval shaped scar was approximately 2 m in length and 40 cm wide. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.		No
BSF30	SU1	Plain	**Isolated Find** This site comprises a granite artefact. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF31	SU1	Plain	**Isolated Find** This site comprises a grindstone. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF32	SU4	Plain	**Artefact scatter –** This site comprises a small artefact scatter, 1 x basalt scraper and 1 x basalt flake. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF33	SU4	Plain	**Artefact scatter** – This site comprises a small artefact scatter, 1 x fine-grained core and 1 x basalt core. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

Site	Survey Unit	Landform	Description		Associated PAD
BSF34	SU2	Mid Slope	**Isolated Find** This site comprises a grindstone. The site is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No
BSF35	SU2	Plain	**Artefact scatter** This site comprises a small artefact scatter comprising 3 x blue chert flakes identified in ploughed field located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for additional artefacts, though none were identified.		No

7.2.3.2 Historic Heritage

Two areas with historical items were observed during the field survey:

- A surface scatter of several miscellaneous historical items; and
- A smaller surface scatter of glass bottles to the north of the first surface scatter.

The surface scatter of historical items (refer to *Photographs 7.4* to *7.7*) included three small ceramic fragments, car parts, bottle fragments, and other metal domestic items. The items were sparsely strewn across an area of approximately 25 m x 20 m on the high bank side of an unnamed small creek. Items appeared to approximately date from (after) the 1940s, which is evidenced by the presence of bottles labelled as property of the Australasian Pickle Company Ltd. There was no evidence of any previous structure at the site nor any indication of a PAD.

Photograph 7.4 Domestic dump site (ERM2018)

Photograph 7.5 Ceramic fragments at domestic dump site (ERM 2018)

Photograph 7.6 Car parts at domestic dump site (ERM 2018)

Photograph 7.7 Discarded bottle, inscriptions says "This bottle always remains the property of the Australasian Pickle Company Ltd" (ERM 2018)

The separate surface scatter of bottles, located approximately 230 m NNW of the domestic dump, consists of five complete bottles siting on the ground surface (refer to *Photograph 7.8*). The bottles include:

- one brown glass long necked beer bottle;
- one clear cylindrical bottle labelled "Pick-me-up (regd trade mark)" "this bottle is the property of Pick-Me-Up Condiment Co. Ltd Sydney 1946"; and

- three oblong shaped clear bottles, one of which is labelled as “Clements Tonic” (refer to *Photograph 7.9*).

Given the date on the cylindrical bottle it is likely that this smaller bottle dump dates to a similar period as the domestic dump to the south (from/after the late 1940s). Frederick Moore Clements began manufacturing Clements Tonic in Newtown, Sydney in c.1886 and was commercially successful (Haines1981). The product is still available today (though very likely uses a different formula than the original. The bottles were laying directly on top of the ground surface with no indication of further sub-surface items.

Photograph 7.8 Small bottle dump (ERM 2018)

Photograph 7.9 Clements Tonic bottle (ERM 2018)

8. SIGNIFICANCE ASSESSMENT

The heritage values significance assessment for the PA has been assessed in accordance with the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011), the *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010) and the *Aboriginal cultural heritage consultation requirements for proponents* (DECCW 2010). This assessment encompasses the four values outlined in the *Burra Charter* (social, historical, scientific and aesthetic) (Australia ICOMOS 2013), as shown in *Figure 8.1*.

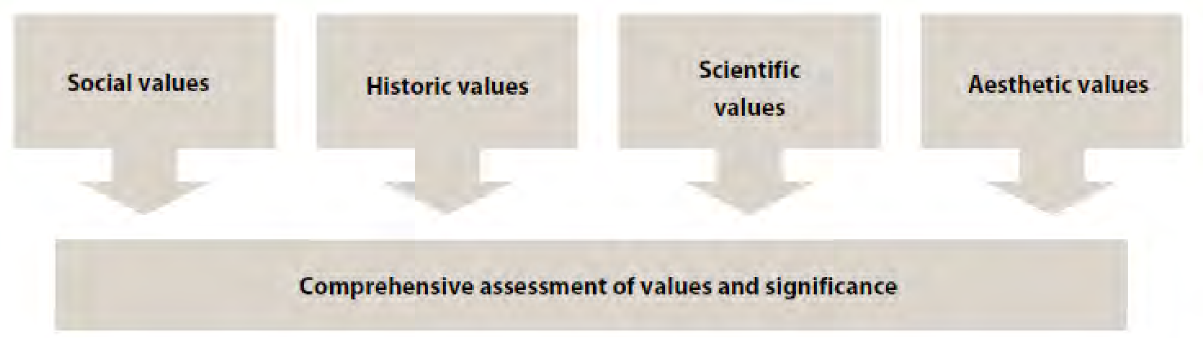


Figure 8.1 Diagrammatic Presentation of the Significance Assessment Process (OEH 2011)

8.1 Assessment of Aboriginal Cultural Significance

Aboriginal heritage sites, objects and places hold value for communities in many different ways. The nature of those heritage values is an important consideration when deciding how to manage a heritage site, object or place and balance competing land use options. Assessing the cultural significance of a place means identifying the reasons why a place is culturally important.

The OEH *Guideline for investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW* (2011) states that analysing cultural heritage significance involves two main steps:

- identifying the range of values present, including social, historic, scientific and aesthetic values; and
- assessing why they are important.

The Australia ICOMOS Burra Charter provides seven key criteria against which significance can be assessed, providing information about why sites are significant for the community. These criteria are identified as:

- *Rarity*: whether any or all aspects of a site (type, location, integrity, content and archaeological potential) can be considered common or rare within a local, regional or national context;
- *Representativeness*: the comparative rarity of the site when considered and contrasted against other similar sites conserved at the local and/or regional level;
- *Archaeological landscapes*: the study of the cultural sites relating to Aboriginal peoples within the context of their interactions in the wider social and natural environment they inhabited. Landscapes can be large or small depending upon specific contexts (i.e. local or regional conditions); they may also may be influenced by Aboriginal social and demographic factors (which may no longer be apparent);

- *Connectedness*: whether the site can be connected to other sites at the local or regional level through aspects such as type, chronology, content (i.e. materials present, manufacturing processes), spatial patterning or ethno-historical information;
- *Integrity & condition*: integrity refers to the level of modification a site has been subject to (the cultural and natural formation process) and whether the site could yield intact archaeological deposits, which could be spatially meaningful. Condition takes into account the state of the material, which is especially relevant for organic materials;
- *Complexity*: the demonstrated or potential ability of a site to yield a complex assemblage (stone, bone and/or shell) and/or features (hearths, fire pits, activity areas); and
- *Archaeological potential*: the potential to yield information (from sub-surface materials which retain integrity, stratigraphical or not) that will contribute to an understanding of contemporary archaeological interest, or which could be saved for future research potential.

The significance assessment presented in *this Section* and summarised in *Table 8.1* utilises these criteria.

8.1.1 Social Significance

Cultural/social significance concerns the value/s of a place, feature or site to a particular community group/s, in this case the local Aboriginal communities. Aspects of cultural or social significance are relevant to sites, objects and landscapes that are important or have become important to local Aboriginal communities. This importance involves both traditional links with specific areas as well as an overall concern by Aboriginal people for sites and their continued protection. As such, Aboriginal cultural significance can only be determined by the Aboriginal community.

During the field survey component of this assessment and in accordance with the relevant Aboriginal consultation guidelines, Aboriginal representatives were queried about the cultural significance (to individuals and the community more broadly) of the PA generally, specific locations within it and at identified sites. It was indicated by all RAP representatives that the PA holds a high level of cultural significance to Aboriginal people as it is situated within areas that were used for hunting, gathering and camping by past Aboriginal groups and therefore represents Aboriginal occupation of the region, a past way of life and a direct link to their ancestors. The wider landscape, particularly the flora, fauna and water courses associated with the PA are significant as they formed part of an economic resource environment.

The large and somewhat dense artefact scatters BSF1, BSF9, and BSF14 close to and extending along creek lines are thought by RAPs to represent large camping sites or meeting places.

8.1.2 Historic Significance

The PA has not demonstrated historic values of significance to the local Aboriginal community, as identified through consultation. Although the PA has been identified as holding cultural/social significance for the local Aboriginal community, the PA cannot be linked to specific historical events which are significant to the community.

8.1.3 Scientific Significance

The majority of areas of archaeological interest occurring in the PA are common site types within the region. Stone artefact sites including open camp sites (or artefact scatters) and isolated finds are the most common regional sites types, and that is reflected in the results of the field survey undertaken for the Project. The description of the low density scatters do not place then as of exceptionally high standard in terms of condition or content. They are therefore assessed as having a low archaeological significance.

The three largest artefact scatter / open camp sites are fairly artefact dense sites that all extend along and near creek lines and could represent extended or repeated occupation of the area. The sites may also be closely related and possible represent one large occupation site. BSF1 and BSF14 are associated with Potential Archaeological Deposits (PADs) and are particularly dense and contain stone artefacts that are not only the by-product of stone tool making and tool use but also several tools themselves, including hammerstones and a retouched axe head found at BSF1. BSF1 and BSF14 are therefore assessed as having moderate significance.

Scarred trees, while less common, are known to be found in the area. Seven scarred trees were identified by RAPs (during the surveys) (refer to *Figure 7.2* and *Table 7.5)*, however they do not present high scientific value due to the apparent age of the trees and relative commonness of the site type, and are assessed as having a low archaeological significance.

8.1.4 Aesthetic Significance

The stone artefact scatters identified within the PA do not reach the threshold of aesthetic significance and do not contribute to the aesthetic value of the broader landscape. The scarred trees identified have a moderate aesthetic value, as visual representations of cultural heritage practices of the local Aboriginal people.

8.2 Aboriginal Heritage Statement of Significance

The PA contains 35 Aboriginal sites and three associated PADs (all recorded as part of this assessment). The majority of these sites are stone artefact sites including open camp sites and isolated finds. The sites recorded during this study have been assigned scientific significance in terms of rarity, representativeness, archaeological landscape, connectedness, integrity and condition, complexity, and archaeological sensitivity.

The significance rating of the identified stone artefact sites is higher or lower based on the presence of particular stone artefact types, formal tool types, diverse or unusual raw stone materials and the potential for stratified subsurface deposits. The sites identified within the PA are common site types at a local and regional level. Stone artefact sites are the main site type represented in the region and those located within the PA have not demonstrated a significantly greater diversity or complexity in comparison to other known sites within the region. Scarred tree sites have also been identified as part of this assessment.

It is for this reason that all but two sites (BSF1 and BSF14) located within the PA have been assessed as having low archaeological significance (separate to cultural significance).

BSF1, BSF14, BSF22 were all within close proximity to watercourses and located within flat terrain with relative shelter from the elements (areas of known Aboriginal occupation) were identified as having moderate potential for subsurface archaeological deposits based on observations of possible subsurface artefacts in soil profiles. These areas incorporate prominent landscape types within the PA (i.e. flat terrain and slightly sloping areas near a water source). Such areas are likely to contain as yet unrecorded Aboriginal sites and/or objects. Careful detailed design of the solar farm following initial heritage survey results has successfully avoided these two sites, however BSF22 may still be impacted by the Project. Given the site's proximity to other significant sites (BSF1 and BSF14) thought to indicate extended or repeated occupation on the banks of the same creek as BSF22 to the north, it is possible that though the surface expression of artefacts at BSF22 is less dense than at sites to the north (BSF1, BSF9, and BSF14), it may also be an occupation site and a southern extension of what may be a complex of occupation sites along the creek.

Table 8.1 Summary Significance of Aboriginal Heritage Sites

Site ID	Social Significance	Historical Significance	Scientific Significance	Aesthetic Significance	Overall Significance Level
BSF1	It is considered that all Aboriginal sites are significant to the local Aboriginal community. No specific comments have been received regarding the social significance of this site. **Significance: High**	BSF1 **does not** meet the threshold for significance under this criterion.	BSF1 is a large artefact scatter containing formal tool types and has been assessed as having potential to contain subsurface archaeological material, and therefore may have some research value. It has been identified in proximity two other large scatters long a creek line indicating it may be part of a larger complex. **Significance: Moderate**	BSF1 **does not** meet the threshold for significance under this criterion.	**Moderate**
BSF2	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF2 **does not** meet the threshold for significance under this criterion.	BSF2 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF2 **does not** meet the threshold for significance under this criterion.	**Low**
BSF3	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF3 **does not** meet the threshold for significance under this criterion.	BSF3 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF3 **does not** meet the threshold for significance under this criterion.	**Low**
BSF4	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF4 **does not** meet the threshold for significance under this criterion.	BSF4 consists of a single manuport stone, transported in the landscape by human action. **Significance: Low**	BSF4 **does not** meet the threshold for significance under this criterion.	**Low**

Site ID	Social Significance	Historical Significance	Scientific Significance	Aesthetic Significance	Overall Significance Level
BSF5	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF5 **does not** meet the threshold for significance under this criterion.	BSF5 is a felled scarred tree identified by RAPs. The site type is relatively common in the region. **Significance: Low**	BSF5 is a visual representation of cultural heritage practices of the local Aboriginal people. **Significance: Moderate**	**Moderate**
BSF6	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF6 **does not** meet the threshold for significance under this criterion.	BSF6 is a scarred tree identified by RAPs. The site type is relatively common in the region. **Significance: Low**	BSF6 is a visual representation of cultural heritage practices of the local Aboriginal people. **Significance: Moderate**.	**Moderate**
BSF7	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF7 **does not** meet the threshold for significance under this criterion.	BSF7 consists of an isolated stone artefact, which holds very little research potential and is unlikely to assist in demonstrating depositional processes or land usage. **Significance: Low**	BSF7 **does not** meet the threshold for significance under this criterion.	**Low**
BSF8	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF8 **does not** meet the threshold for significance under this criterion.	BSF8 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF8 **does not** meet the threshold for significance under this criterion.	**Low**
BSF9	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF9 **does not** meet the threshold for significance under this criterion.	BSF9 is a large artefact that has been identified in proximity (between) two other large scatters near a creek line indicating it may be part of a larger complex. **Significance: Low**	The scarred tree at BSF9 is a visual representation of cultural heritage practices of the local Aboriginal people. **Significance: Moderate**	**Moderate**

Site ID	Social Significance	Historical Significance	Scientific Significance	Aesthetic Significance	Overall Significance Level
BSF10	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF10 **does not** meet the threshold for significance under this criterion.	BSF10 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF10 **does not** meet the threshold for significance under this criterion.	**Low**
BSF11	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF11 **does not** meet the threshold for significance under this criterion.	BSF11 is a scarred tree identified by RAPs. The site type is relatively common in the region. **Significance: Low**	BSF **11** is a visual representation of cultural heritage practices of the local Aboriginal people. **Significance: Moderate**	**Moderate**
BSF12	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF12 **does not** meet the threshold for significance under this criterion.	BSF12 consists of an isolated stone artefact, which holds very little research potential and is unlikely to assist in demonstrating depositional processes or land usage. **Significance: Low**	BSF12 **does not** meet the threshold for significance under this criterion.	**Low**
BSF13	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF13 **does not** meet the threshold for significance under this criterion.	BSF13 consists of an isolated stone artefact, which holds very little research potential and is unlikely to assist in demonstrating depositional processes or land usage. **Significance: Low**	BSF13 **does not** meet the threshold for significance under this criterion.	**Low**
BSF14	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF14 **does not** meet the threshold for significance under this criterion.	BSF14 is a large artefact scatter containing formal tool types and has been assessed as having potential to contain subsurface archaeological material, and therefore may have some research value. It has been identified in proximity two other large	BSF14 **does not** meet the threshold for significance under this criterion.	**Moderate**

Site ID	Social Significance	Historical Significance	Scientific Significance	Aesthetic Significance	Overall Significance Level
			scatters long a creek line indicating it may be part of a larger complex. **Significance: Moderate**		
BSF15	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF15 **does not** meet the threshold for significance under this criterion.	BSF15 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF15 **does not** meet the threshold for significance under this criterion.	**Low**
BSF16	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF16 **does not** meet the threshold for significance under this criterion.	BSF16 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF16 **does not** meet the threshold for significance under this criterion.	**Low**
BSF17	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF17 **does not** meet the threshold for significance under this criterion.	BSF17 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF17 **does not** meet the threshold for significance under this criterion.	**Low**
BSF18	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF18 **does not** meet the threshold for significance under this criterion.	BSF18 is a scarred tree identified by RAPs. The site type is relatively common in the region. **Significance: Low**	BSF18 is a visual representation of cultural heritage practices of the local Aboriginal people. **Significance: Moderate**	**Moderate**
BSF19	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF19 **does not** meet the threshold for significance under this criterion.	BSF19 is a scarred tree identified by RAPs. The site type is relatively common in the region. **Significance: Low**	BSF19 is a visual representation of cultural heritage practices of the local Aboriginal people. **Significance: Moderate**	**Moderate**

Site ID	Social Significance	Historical Significance	Scientific Significance	Aesthetic Significance	Overall Significance Level
BSF20	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF20 **does not** meet the threshold for significance under this criterion.	BSF20 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF20 **does not** meet the threshold for significance under this criterion.	**Low**
BSF21	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF21 **does not** meet the threshold for significance under this criterion.	BSF21 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF21 **does not** meet the threshold for significance under this criterion.	**Low**
BSF22	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF22 **does not** meet the threshold for significance under this criterion.	BSF22 presents a common low density scatter which has low potential to contribute to archaeological research in the region, however it has been assessed as having potential to contain subsurface archaeological material, and therefore may have some research value. **Significance: Moderate - Low**	BSF22 **does not** meet the threshold for significance under this criterion.	**Moderate to Low**
BSF23	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF23 **does not** meet the threshold for significance under this criterion.	BSF23 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF23 **does not** meet the threshold for significance under this criterion.	**Low**
BSF24	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF24 **does not** meet the threshold for significance under this criterion.	BSF24 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF24 **does not** meet the threshold for significance under this criterion.	**Low**

Site ID	Social Significance	Historical Significance	Scientific Significance	Aesthetic Significance	Overall Significance Level
BSF25	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF25 **does not** meet the threshold for significance under this criterion.	BSF25 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF25 **does not** meet the threshold for significance under this criterion.	**Low**
BSF26	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF26 **does not** meet the threshold for significance under this criterion.	BSF26 consists of an isolated stone artefact, which holds very little research potential and is unlikely to assist in demonstrating depositional processes or land usage. **Significance: Low**	BSF26 **does not** meet the threshold for significance under this criterion.	**Low**
BSF27	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF27 **does not** meet the threshold for significance under this criterion.	BSF27 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF27 **does not** meet the threshold for significance under this criterion.	**Low**
BSF28	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF28 **does not** meet the threshold for significance under this criterion.	BSF28 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF28 **does not** meet the threshold for significance under this criterion.	**Low**
BSF29	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF29 **does not** meet the threshold for significance under this criterion.	BSF29 is a scarred tree identified by RAPs. The site type is relatively common in the region. **Significance: Low**	BSF29 is a visual representation of cultural heritage practices of the local Aboriginal people. **Significance: Moderate**.	**Moderate**
BSF30	It is considered that all Aboriginal sites are significant	BSF30 **does not** meet the threshold for	BSF30 consists of an isolated stone artefact, which holds very little research	BSF30 **does not** meet the threshold for significance under this criterion.	**Low**

Site ID	Social Significance	Historical Significance	Scientific Significance	Aesthetic Significance	Overall Significance Level
	to the local Aboriginal community. **Significance: High**	significance under this criterion.	potential and is unlikely to assist in demonstrating depositional processes or land usage. **Significance: Low**		
BSF31	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF31 **does not** meet the threshold for significance under this criterion.	BSF31 consists of an isolated stone artefact, which holds very little research potential and is unlikely to assist in demonstrating depositional processes or land usage. **Significance: Low**	BSF31 **does not** meet the threshold for significance under this criterion.	**Low**
BSF32	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF32 **does not** meet the threshold for significance under this criterion.	BSF32 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF32 **does not** meet the threshold for significance under this criterion.	**Low**
BSF33	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF33 **does not** meet the threshold for significance under this criterion.	BSF33 presents a common low density scatter which has low potential to contribute to archaeological research in the region. **Significance: Low**	BSF33 **does not** meet the threshold for significance under this criterion.	**Low**
BSF34	It is considered that all Aboriginal sites are significant to the local Aboriginal community. **Significance: High**	BSF34 **does not** meet the threshold for significance under this criterion.	BSF34 consists of an isolated stone artefact, which holds very little research potential and is unlikely to assist in demonstrating depositional processes or land usage. **Significance: Low**	BSF34 **does not** meet the threshold for significance under this criterion.	**Low**
BSF35	It is considered that all Aboriginal sites are significant	BSF35 **does not** meet the threshold for	BSF35 presents a common low density scatter which has low potential to	BSF35 **does not** meet the threshold for significance under this criterion.	**Low**

Site ID	Social Significance	Historical Significance	Scientific Significance	Aesthetic Significance	Overall Significance Level
	to the local Aboriginal community. **Significance: High**	significance under this criterion.	contribute to archaeological research in the region. **Significance: Low**		
AHIMS Site #11-3-0083	It is considered that all Aboriginal sites are significant to the local Aboriginal community. The 2011 report (OzArk EHM) assessed this site as being of moderate to high cultural significance. **Significance: Moderate - High**	11-3-0083 **does not** meet the threshold for significance under this criterion.	The 2011 report (OzArk EHM) assessed this site as being of low to moderate scientific cultural significance. **Significance: Moderate - Low**	11-3-0083 **does not** meet the threshold for significance under this criterion.	**Moderate to Low**

8.3 Assessment of Historic Heritage Significance

Two surface scatters of historical items were identified during the 2018 surveys, however no research into these sites has been undertaken. As these sites are fairly sparse scatter with limited historic artefacts and no evidence for structures or subsurface expressions were noted during the survey, it is considered that these are dumpsites that were utilised once (or twice) by a local household sometime in the last 70 years. No items identified are considered rare or representative, or of containing any value for further research. It is considered likely that other properties in the area contain similar sites. Although the identification of five complete historic glass bottles is interesting, these sites are not considered to reach the threshold for local historic heritage significance.

9. IMPACT ASSESSMENT

The proposed works involve the following actions that have the potential to impact on Aboriginal heritage sites and values:

- site establishment including the provision of access and construction compounds and laydown areas/material storage facilities;
- topsoil stripping and stockpiling in windrows along the edge of the trench;
- trench excavation and stockpiling of the spoil on the opposite side to the topsoil;
- installation of a sand bed layer;
- laying of conductor and earth cables, incorporating direct bury of cable joints (located approximately every 500 m to 1000 m) and marking of those with electronic marker devises; and
- trench reinstatement consisting of placement of sand coverage of cables, installation of a hard cover, then backfilling/compaction of spoil and respread of topsoil;
- the grading of roads and upgrading of existing access roads;
- vehicle movement across eroded tracks;
- the development of new access roads;
- clearance of vegetation;
- the construction of hardstands and laydown areas; and
- on-site equipment storage areas for the construction period.

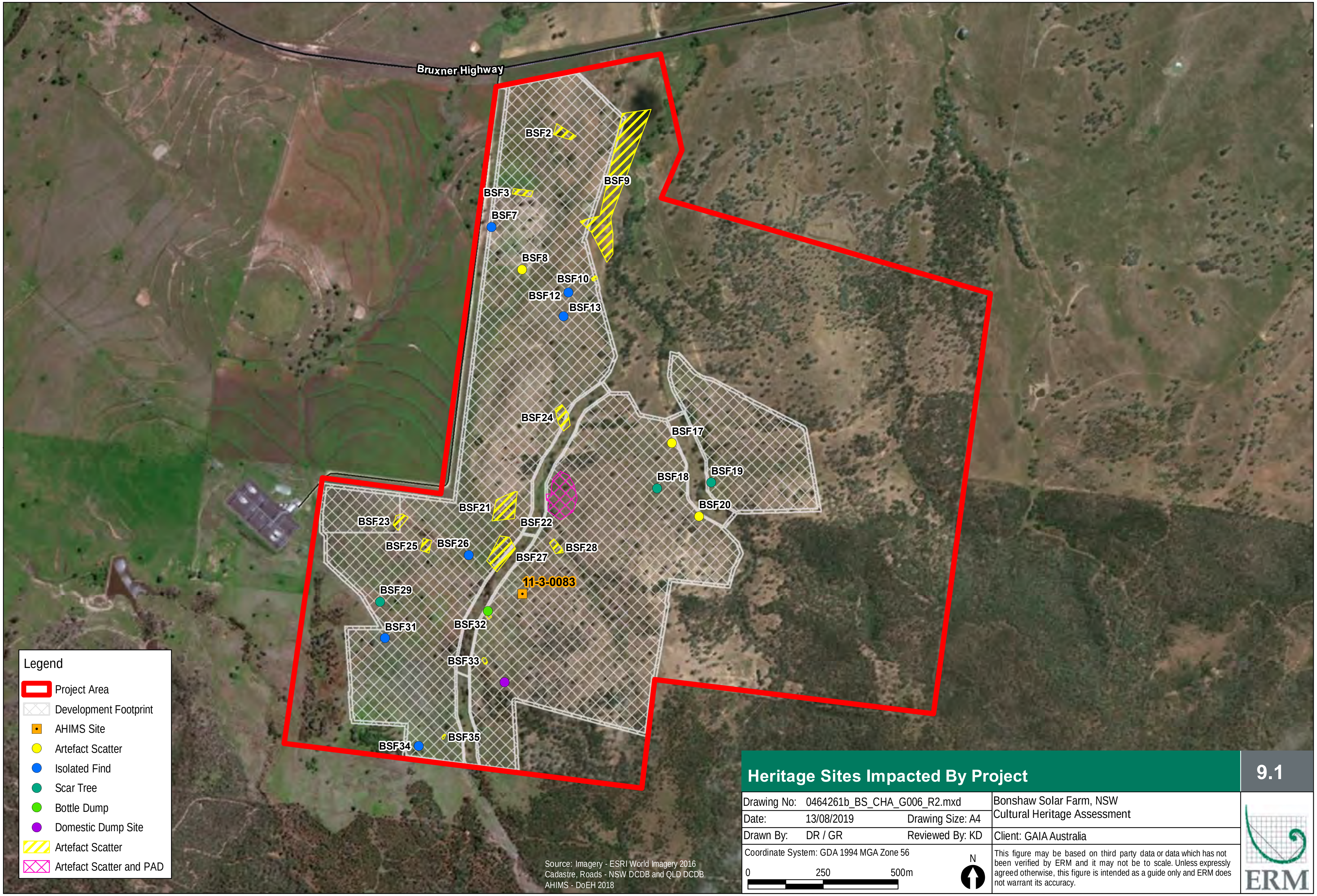
35 Aboriginal heritage sites (and three associated PADs) have been recorded within the PA. 29 of these sites were stone artefacts including isolated finds and stone artefact scatters. Seven scarred trees were also identified, one of the scarred trees was identified as part of an artefact scatter site. Careful detailed design of the Project footprint has successfully avoided several of these sites, including BSF1 and BSF14 which are considered to have moderate archaeological significance (refer to *Table 9.1* and *Figure 9.1*).

Table 9.1 Summary Impact Assessment of Aboriginal Heritage Sites

Site ID	AHIMS	Overall Significance Level	Assessment of Potential Impact
BSF1	TBD	Moderate	No Impact Careful detailed design of the development footprint has successfully avoided this site and PAD
BSF2	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF3	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF4	TBD	Low	No Impact Careful detailed design of the development footprint has successfully avoided this site
BSF5	TBD	Moderate	No Impact Careful detailed design of the development footprint has successfully avoided this scarred tree
BSF6	TBD	Moderate	No Impact Careful detailed design of the development footprint has successfully avoided this scarred tree

Site ID	AHIMS	Overall Significance Level	Assessment of Potential Impact
BSF7	TBD	Low	Possible Impact Isolated find may be impacted by project works
BSF8	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF9	TBD	Moderate	Partial Impact Careful detailed design of the development footprint has successfully avoided most of this site, however a small section of the site may be impacted
BSF10	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF11	TBD	Moderate	No Impact Careful detailed design of the development footprint t has successfully avoided this scarred tree
BSF12	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF13	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF14	TBD	Moderate	No Impact Careful detailed design of the development footprint has successfully avoided this site and PAD
BSF15	TBD	Low	No Impact Careful detailed design of the development footprint has successfully avoided this site
BSF16	TBD	Low	No Impact Careful detailed design of the development footprint has successfully avoided this site
BSF17	TBD	Low	Partial Impact Careful detailed design of the development footprint has successfully avoided most of this site, however a small section of the site may be impacted
BSF18	TBD	Moderate	Possible Impact Scarred tree may be impacted by project works
BSF19	TBD	Moderate	Possible Impact Scarred tree may be impacted by project works
BSF20	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF21	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF22	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF23	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF24	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF25	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF26	TBD	Low	Possible Impact Isolated find may be impacted by project works
BSF27	TBD	Low	Possible Impact Artefact scatter may be impacted by project works

Site ID	AHIMS	Overall Significance Level	Assessment of Potential Impact
BSF28	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF29	TBD	Moderate	Possible Impact Scarred tree may be impacted by project works
BSF30	TBD	Low	No Impact Careful detailed design of the development footprint has successfully avoided this site
BSF31	TBD	Low	Possible Impact Isolated find may be impacted by project works
BSF32	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF33	TBD	Low	Possible Impact Artefact scatter may be impacted by project works
BSF34	TBD	Low	Possible Impact Isolated find may be impacted by project works
BSF35	TBD	Low	Possible Impact Artefact scatter may be impacted by project works



Source: Imagery - ESRI World Imagery 2016
Cadastre, Roads - NSW DCDB and QLD DCDB
AHIMS - DoEH 2018

Heritage Sites Impacted By Project

9.1

Drawing No: 0464261b_BS_CHA_G006_R2.mxd		Bonshaw Solar Farm, NSW Cultural Heritage Assessment
Date: 13/08/2019	Drawing Size: A4	
Drawn By: DR / GR	Reviewed By: KD	Client: GAIA Australia
Coordinate System: GDA 1994 MGA Zone 56		

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

35 Aboriginal heritage sites and three associated PADs have been recorded within the PA. 29 of these sites were stone artefacts including isolated finds and stone artefact scatters. Seven scarred trees were also identified, one of the scarred trees was identified as part of an artefact scatter site. Careful detailed design of the Project footprint has successfully avoided nine of these sites, including BSF1 and BSF14 which are considered to have moderate archaeological significance.

10.2 Recommendations

The following recommendations are made to assist in ongoing management of identified heritage sites. The management recommendation statements are made in light of:

- the results of background desktop investigation as outlined in this report;
- predictive modelling;
- results of the field survey;
- a heritage significance assessment;
- legislative requirements as outlined in this report; and
- consultation with the relevant Aboriginal organisations.

10.2.1 Aboriginal Heritage

Based on the information presented in this report, specific recommendations for each identified Aboriginal site is detailed in *Table 10.1* and the following general recommendations have been developed:

- personnel involved with ground breaking activities in the PA should undertake cultural awareness training in line with the recommendations below;
- during works, the location of all recorded Aboriginal heritage sites should be clearly marked on all construction plans for the PA and site foremen informed of their presence and the need to avoid disturbance;
- if suspected Aboriginal heritage objects are found during works, the Unexpected Find Procedure outlined below should be followed and applies to the entire PA;
- continuing Aboriginal involvement in the Bonshaw Solar Farm project. Ongoing consultation with the Aboriginal community and registered Aboriginal stakeholders for the Project should occur during the construction of the Project. The triggers for consultation with the community during construction may include:
- Any additional heritage assessments for changes in Project scope;
- The implementation of the Unexpected Finds Procedure;
- Endorsement of the heritage information to be contained in the Project induction material;
- a copy of this report should be provided to each of the Aboriginal organisations who expressed an interest in the Project; and
- a copy of this report should be provided to the relevant OEH regional branch.

10.2.1.1 *Cultural Awareness Training*

In order to comply with best practice principles, it is recommended that any personnel involved with ground breaking activities in the PA undertake basic cultural awareness training. This training should be carried out in the form of a pre-work workshop by a qualified heritage specialist in consultation with a Aboriginal Stakeholders, or by a relevant Aboriginal Stakeholder. The heritage induction material, including an unexpected finds procedure should be developed by an appropriately qualified heritage specialist. This training should:

- include information on the Aboriginal archaeological and cultural heritage values of the PA;
- legal responsibilities and statutory obligations for heritage under the NPW Act and the Heritage Act;
- outline the location and type of archaeological sites within the PA including significant landforms and give instructions not to disturb these sites;
- outline the procedures for the discovery of previously unrecorded Aboriginal objects, through the chance finds procedure; and
- only information endorsed for sharing by the registered Aboriginal stakeholders should be included within the induction package for all workers.

10.2.1.2 *Unexpected Finds Procedure*

If any heritage objects and/or relics, as protected under NSW legislation, are uncovered during the Project, then the following steps should be followed:

- all activity in the immediate area should cease;
- and an appropriately qualified heritage professional should be consulted;
- OEH should be immediately contacted;
- local Aboriginal stakeholder groups should be notified; and
- an appropriately qualified heritage professional should record the location and attributes of the site and determine the significance of the find.

In the event of the discovery of human skeletal material (or suspected human skeletal material) during project activities in the PA the following steps should be followed:

- all activities and/or works in the immediate area must cease;
- the NSW Police must be contacted along with the OEH; and
- any sand/soils removed from the near vicinity of the find must be identified and set aside for assessment by the investigating authorities.

10.2.1.3 *Aboriginal Community Endorsement and Recommendations*

A draft copy of the CHA report was provided to all Aboriginal parties who registered an interest in the project on 9 May 2019, for the purposes of receiving written or oral general comments and more specific comments on the cultural significance of the PA and the identified sites and the recommended management and mitigation measures in the ACHA. Feedback was received from two of the RAPs (also refer to *Section 3.4* and *Appendix A*):

10.2.1.4 Dissemination of Information

It is recommended that a copy of the final report be provided to each of the Aboriginal organisations who participated in the project. A copy of this report is to be provided to OEH upon finalisation.

10.2.1.5 Identified Aboriginal Heritage Sites

Direct harm to some sites listed in *Table 10.1* is considered unavoidable. A large number of individual artefacts were identified in the sites listed in *Table 10.1*. It is considered that the cumulative impacts resulting from harm to the sites has the potential to significantly and negatively impact on the Aboriginal cultural heritage values of the area. Therefore, it is considered essential to develop management strategies to minimise this impact as far as possible.

The management measures proposed in *Table 10.1* were formulated during discussions on site with Aboriginal representatives. The recommended mitigation of these direct impacts is to facilitate salvage of artefacts prior to harm occurring, followed by reburial (return to country) outside of impact areas, as close to original location as possible. This management strategy has been formulated with consideration of principles of Ecologically Sustainable Development (ESD), in particular intergenerational equity that holds that various aspects of the environment (including cultural heritage) are available for the benefit of future generations.

If impact to BSF22 is unavoidable it is recommended that subsurface testing be carried out to identify the nature and extent of sub-surface Aboriginal objects at the site in accordance with the *Code of Practice.* The presence of the site on the high bank of a creek that (further to the north) contains occupation sites indicating extended or repeated use, and its noted subsurface potential means that it may also be an occupation site and a southern extension of what may be a complex of occupation sites along the creek beginning at BSF1 and continuing south through BSF14 to BSF22. Test excavations at this site may contribute to the understanding of site characteristics and local and regional prehistory. It may also be used to better inform mitigation measures within the PA.

Where there is a time lapse between collection of artefacts and associated reburial, it is proposed that the Project archaeologist undertaking the artefact collection retain any collected artefacts until such time as they can be reburied.

Note that management measures would be carried out in accordance with the SEARS, and any requirements of the RAPs and the OEH, and therefore the specifics may differ from that presented below.

Table 10.1 Management Measures for identified Aboriginal Heritage Sites

Site ID	Overall Significance Level	Potential Impact?	Management Measure
BSF1	Moderate	No	**Avoidance.** Prior to construction commencing, if works, access tracks or laydowns areas are planned in the same paddock, exclusion fencing and exclusion signage should be erected around the site by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.

Site ID	Overall Significance Level	Potential Impact?	Management Measure
BSF2	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF3	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF4	Low	No	**Avoidance.** Prior to construction commencing, if works, access tracks or laydowns areas are planned in the same paddock, exclusion fencing and exclusion signage should be erected around the site by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.
BSF5	Moderate	No	**Avoidance.** Prior to construction commencing, if works, access tracks or laydowns areas are planned in the same paddock, exclusion fencing and exclusion signage should be erected around the site by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.
BSF6	Moderate	No	**Avoidance.** Prior to construction commencing, if works, access tracks or laydowns areas are planned in the same paddock, exclusion fencing and exclusion signage should be erected around the site by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.
BSF7	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF8	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF9	Moderate	Partial	**Avoidance.** Prior to construction commencing, exclusion fencing and exclusion signage should be erected, around the section of the site that will not be impacted by project works and the scarred tree, by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed. It is recommended that if proposed project works cannot avoid the entire site that surface collection/salvage of the section of the site that will be impacted be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.

Site ID	Overall Significance Level	Potential Impact?	Management Measure
BSF10	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF11	Moderate	No	**Avoidance.** Prior to construction commencing, if works, access tracks or laydowns areas are planned in the same paddock, exclusion fencing and exclusion signage should be erected around the site by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.
BSF12	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF13	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF14	Moderate	No	**Avoidance.** Prior to construction commencing, if works, access tracks or laydowns areas are planned in the same paddock, exclusion fencing and exclusion signage should be erected around the site by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.
BSF15	Low	No	**Avoidance.** Prior to construction commencing, if works, access tracks or laydowns areas are planned in the same paddock, exclusion fencing and exclusion signage should be erected around the site by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.
BSF16	Low	No	**Avoidance.** Prior to construction commencing, if works, access tracks or laydowns areas are planned in the same paddock, exclusion fencing and exclusion signage should be erected around the site by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.
BSF17	Low	Partial	**Avoidance.** Prior to construction commencing, exclusion fencing and exclusion signage should be erected, around the section of the site that will not be impacted by project works and by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed. It is recommended that if proposed project works cannot avoid the entire site that collection/salvage of the section of the site that

Site ID	Overall Significance Level	Potential Impact?	Management Measure
			will be impacted be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF18	Moderate	Yes	**Avoidance.** Prior to construction commencing, exclusion fencing and exclusion signage should be erected around the scarred tree by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.
BSF19	Moderate	Yes	**Avoidance.** Prior to construction commencing, exclusion fencing and exclusion signage should be erected around the scarred tree by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.
BSF20	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF21	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF22	Moderate to Low	Yes	**Avoidance if possible.** While this site is currently within the impact area, it is recommended that the site being avoided. Prior to construction commencing, exclusion fencing and exclusion signage should be erected around the site by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed. It is recommended if proposed project works cannot avoid the entire site that subsurface testing be carried out to identify the nature and extent of subsurface Aboriginal objects at the site. Further to this, surface collection/salvage of the section of the site that will be impacted should be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF23	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF24	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF25	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.

Site ID	Overall Significance Level	Potential Impact?	Management Measure
BSF26	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF27	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF28	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF29	Moderate	Yes	**Avoidance.** Prior to construction commencing, exclusion fencing and exclusion signage should be erected around the scarred tree by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.
BSF30	Low	No	**Avoidance.** Prior to construction commencing, if works, access tracks or laydowns areas are planned in the same paddock, exclusion fencing and exclusion signage should be erected around the site by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.
BSF31	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF32	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF33	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF34	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
BSF35	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.
11-3-0083	Low	Yes	It is recommended that surface collection/salvage be undertaken by Aboriginal stakeholder groups and an appropriately qualified archaeologist prior the commencement of works.

10.2.2 Historic Heritage

While the historic items identified during the this assessment have been assessed as not meeting the threshold for local historic heritage significance, the items at these sites should be carefully collected and offered to a local heritage museum or organisation prior to commencement of project works.

10.2.2.1 Unexpected Historic Heritage Finds Procedure

If any heritage objects and/or relics, as protected under NSW legislation, are uncovered during the Project, then the following steps should be followed:

- all activity in the immediate area should cease;
- and an appropriately qualified heritage professional should be consulted;
- OEH should be immediately contacted; and
- an appropriately qualified heritage professional should record the location and attributes of the site and determine the significance of the find.

In the event of the discovery of human skeletal material (or suspected human skeletal material) during project activities in the PA the following steps should be followed:

- all activities and/or works in the immediate area must cease;
- the NSW Police must be contacted along with the OEH; and
- any sand/soils removed from the near vicinity of the find must be identified and set aside for assessment by the investigating authorities.

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APPENDIX A ABORIGINAL STAKEHOLDER CONSULTATION LOG

AGENCIES CONTACTED

Body/Group	**Contact Details**	**Date Sent**	**Response**	**Date**
OEH Branch : Coffs Harbour	NSW Office of Environment and Heritage Federation House, 24 Moonee Street, Coffs Harbour NSW 2450 info@environment.nsw.gov.au	3/7/18 Via email and post	Refers ERM to contact Mr Craig Archibald and Mr Aaron Broad	11th July Via post
The Registrar, *Aboriginal Lands Right Act*	Office of the Registrar, Aboriginal Land Rights Act PO Box 112 Glebe NSW 2037 adminofficer@oralra.nsw.gov.au	3/7/18 Via email and post	No Registered Aboriginal Owners within project Area on the Register of Aboriginal Owners. Refers ERM to contact Toomelah Local Aboriginal Land Council	11th July Via email
National Native Title Tribunal (NNTT)	enquiries@nntt.gov.au	3/7/18 Via email and post	Overlap report	5/7/18 Via email
Native Title Services Corporation (NTS Corp)	Native Title Services Corporation PO Box 2105 Strawberry Hills NSW 2012 information@ntscorp.com.au	3/7/18 Via email and post		
Inverell Shire Council	Inverell Shire Council Administration Centre 144 Otho Street PO Box 138 Inverell NSW 2360	3/7/18 Via email and post	Referred to LALCs in the Inverell LGA	17th July 2018 Via post

Body/Group	Contact Details	Date Sent	Response	Date
Tenterfield Shire Council		3/7/18 Via email and post	Links to councils Aboriginal Heritage Study lists and relevant groups. Refers ERM to Moombahlene LALC	4/7/18 Via email
Local Land Services – Northern Tablelands	Local Land Services Northern Tablelands 15 Vivian Street PO Box 411 Inverell NSW harry.white@lls.nsw.gov.au	3/7/18 Via email and post	Refers ERM to Toomelah Local Aboriginal Land Council (in their region) Interested in providing quote to conduct detailed assessment.	4th July Via post
Moombahlene Local Aboriginal Land Council	299 Rouse St, Tenterfield NSW 2372 moombahlenelalc1@bigpond.com	3/7/18 Via email and post	Helen Duroux (CEO) Interested in taking part in the cultural assessments.	4/7/18 Email response

NEWSPAPER ADVERTISMENT

Newspaper	Contact	Date Sent	Date Published
Inverell Times	The Inverell Times t 0267 200 100 classifieds.invtimes@fairfaxmedia.com.au 166 Byron Street, Inverell, NSW 2360	03/07/2018	06/07/2018
Tenterfield Star	The Tenterfield Star t 02 6776 0501 classifieds.tentstar@fairfaxmedia.com.au	03/07/2018	11/07/2018

Newspaper	Contact	Date Sent	Date Published
	115 Faulkner Street, Armidale, NSW 2350 www.tenterfieldstar.com.au		

LIST OF STAKEHOLDERS GROUPS IDENTIFIED & PROJECT NOTIFICATION SENT

Organisation/Person	Contact Provided	Date Sent	Comment
Mr Craig Archibald	27 Margaret Street Teralba NSW 2284	24 July 2018	No Response – Letter returned 30/08/2018 marked as "RTS no longer as this address"
Aaron Broad	1 Waratah Ave Albion Park Rail NSW 2527 minnamunnung@gmail.com	24 July 2018	No Response
Toomelah Local Aboriginal Land Council	Toomelah LALC 0746762348 toomelahlandcouncil@gmail.com	Phone call and follow up email 7 August 2018	Correspondence from the LLS has suggested that the site is located within the Toomelah LALC boundaries. Our review of the boundaries places the site within Moombahlene LALC. Request was sent to confirm that it is not in Toomelah region.

REGISTERED ABORIGINAL PARTIES

Organisation/Person	Contact	Date Registered	How the registration was received & any comments
Aboriginal cultural sites services	Vicky Duncan Diane MARLOW acsworknsw@gmail.com	8 July 2018	Email response registering an interest in being consulted

Edgerton Kwiambal	Samantha Duncan and Liza Talbot. PH: 0422098648 6 Bala st, Ashford N.S.W 2361 duncans528@gmail.com	9 July 2018	Email response registering an interest in being consulted
Helen Duroux (CEO)	Moombahlene LALC PO Box 70 Tenterfield ,2372 Ph : 0267363219 Fax : 0267361486 Helen Duroux moombahlenelalc1@bigpond.com	4 July 2018 and 17 July 2018	Email response registering an interest in being consulted

Presentation of information about the proposed project

Presentation of proposed project information

Aboriginal Organisation/Person	Date Sent	Date Reply	Comments, outcomes and/or issues	Notes
Aboriginal cultural sites services	09/08/2018	10/08/2018	Presentation of project information sent with information on known heritage background, proposed survey methodology and invitation to survey included in letter.	VD & DM responded via email accepting invitation to the survey, no comments on methodology or known cultural heritage values in email.
Edgerton Kwiambal	09/08/2018	13/08/2018	Presentation of project information sent with information on known heritage background, proposed survey methodology and invitation to survey included in letter.	SD responded via email accepting invitation to the survey, no

Aboriginal Organisation/Person	Date Sent	Date Reply	Comments, outcomes and/or issues	Notes
				comments on methodology or known cultural heritage values in email.
Moombahlene LALC	09/08/2018	03/09/2018	Presentation of project information sent with information on known heritage background, proposed survey methodology and invitation to survey included in letter.	ERM called on 30/08/18 to enquire if LALC was available for fieldwork on these dates or had any feedback on methodology and project information. No answer, left message. Followed up with email stating the same. HD responded via email 03/09/2018.

The record of agreed outcomes and/or contentious issues should be supplied to all registered Aboriginal parties.

Provision of the proposed assessment methodology to the RAP

Aboriginal Organisation/Person	Date Sent	Date Reply	Comment and details of how input has been considered	Notes
Aboriginal cultural sites services	09/08/2018	10/08/2018	Presentation of project information sent with information on known heritage background, proposed survey methodology, cultural heritage assessment workshop and invitation to survey included in letter.	VD & DM responded via email accepting invitation to the survey, no

Aboriginal Organisation/Person	Date Sent	Date Reply	Comment and details of how input has been considered	Notes
				comments on methodology or known cultural heritage values in email.
Edgerton Kwiambal	09/08/2018	13/08/2018	Presentation of project information sent with information on known heritage background, proposed survey methodology, cultural heritage assessment workshop and invitation to survey included in letter.	SD responded via email accepting invitation to the survey, no comments on methodology or known cultural heritage values in email.
Moombahlene LALC	09/08/2018	03/09/2018	Presentation of project information sent with information on known heritage background, proposed survey methodology, cultural heritage assessment workshop details included in letter.	ERM called on 30/08/18 to enquire if LALC was available for fieldwork on these dates or had any feedback on methodology and project information. No answer, left message. Followed up with email stating the same. HD responded via email 03/09/2018, stating that they were interested in the methodology

Aboriginal Organisation/Person	Date Sent	Date Reply	Comment and details of how input has been considered	Notes
				and looking forward to fieldwork.

Field Survey or opportunity for RAP to visit the proposed project site

RAP	Representative	Date	Comments
Aboriginal cultural sites services	Vicky Duncan	11/09/2018, 12/09/2018 & 13/09/2018	
Edgerton Kwiambal	Samantha Duncan	11/09/2018, 12/09/2018 & 13/09/2018	
Moombahlene LALC	Darren	11/09/2018, 12/09/2018 & 13/09/2018	

Seek information from RAP on (a) the presence of Aboriginal objects of cultural value and (b) places of cultural value

RAP	Date	Comments	Cultural values identified
Aboriginal cultural sites services	09/08/2018	Presentation of project information sent with information on known heritage background, proposed survey methodology, cultural heritage assessment workshop and a request to be provided with any information on the (a) the presence of	No values identified to heritage consultation

		Aboriginal objects of cultural value and (b) places of cultural value, if known or appropriate to divulge.	
Edgerton Kwiambal	09/08/2018	Presentation of project information sent with information on known heritage background, proposed survey methodology, cultural heritage assessment workshop and a request to be provided with any information on the (a) the presence of Aboriginal objects of cultural value and (b) places of cultural value, if known or appropriate to divulge.	
Moombahlene LALC	09/08/2018	Presentation of project information sent with information on known heritage background, proposed survey methodology, cultural heritage assessment workshop and a request to be provided with any information on the (a) the presence of Aboriginal objects of cultural value and (b) places of cultural value, if known or appropriate to divulge.	

ONGOING CONSULTATION

RAP	Contact Made by	Date	Comments	Notes / Follow up
Aboriginal cultural sites services – Vicky Duncan	ERM – Katherine Deverson	03/09/2018	KD called VD to advise that following further desktop it was believed that further fieldwork days were needed and invited RAP to attend fieldwork one day earlier (Tuesday 11 September) and advised likely that fieldwork would now extend to Friday 14 September. VD	KD sent follow up email to confirm extension of fieldwork.

			confirmed availability to attend.	
Edgerton Kwiambal – Samantha Duncun	ERM – Katherine Deverson	03/09/2018	KD called SD to advise that following further desktop it was believed that further fieldwork days were needed and invited RAP to attend fieldwork one day earlier (Tuesday 11 September) and advised likely that fieldwork would now extend to Friday 14 September. No answer message left	KD sent follow up email to invite Edgerton Kwiambal to two further fieldwork days.
Moombahlene LALC – Helen Duroux	ERM – Katherine Deverson	03/09/2018	KD called VD to advise that following further desktop it was believed that further fieldwork days were needed and invited RAP to attend fieldwork one day earlier (Tuesday 11 September) and advised likely that fieldwork would now extend to Friday 14 September. HD advised she would contact LALC heritage officer and advise ERM of their availability.	KD sent follow up email to confirm extension of fieldwork.
Edgerton Kwiambal – Samantha Duncun	Edgerton Kwiambal – Samantha Duncun	04/09/2018	SD emailed to advise she would attend all fieldwork days from 11/09/2018, and email Insurance information	KD emailed to thank SD for her response.
Aboriginal cultural sites services – Vicky Duncan	ERM – Katherine Deverson	18/09/2018	KD emailed to thank everyone for their	

			participation in fieldwork and advise of invoicing details	
Edgerton Kwiambal – Samantha Duncun	ERM – Katherine Deverson	18/09/2018	KD emailed to thank everyone for their participation in fieldwork and advise of invoicing details	
Moombahlene LALC – Helen Duroux	ERM – Katherine Deverson	18/09/2018	KD emailed to thank everyone for their participation in fieldwork and advise of invoicing details	
Aboriginal cultural sites services – Vicky Duncan	ERM – Katherine Deverson	09/05/2019	KD emailed draft ACHA to RAPs requesting any comments by 07/06/2019.	
Edgerton Kwiambal – Samantha Duncun	ERM – Katherine Deverson	09/05/2019	KD emailed draft ACHA to RAPs requesting any comments by 07/06/2019.	
Moombahlene LALC – Helen Duroux	ERM – Katherine Deverson	09/05/2019	KD emailed draft ACHA to RAPs requesting any comments by 07/06/2019.	
Aboriginal cultural sites services – Vicky Duncan	ERM – Katherine Deverson	12/06/2019	KD emailed checking if VD had any comments on the draft ACHA.	
Edgerton Kwiambal – Samantha Duncun	ERM – Katherine Deverson	12/06/2019	KD emailed checking if SD had any comments on the draft ACHA.	SD emailed endorsement of the ACHA 12/06
Moombahlene LALC – Helen Duroux	ERM – Katherine Deverson	12/06/2019	KD emailed checking if HD had any comments on the draft ACHA.	
Edgerton Kwiambal – Samantha Duncun	Edgerton Kwiambal – Samantha Duncun	12/06/2019	SD replied to KD’s email advising 100% endorsement of the ACHA draft	KD emailed reply thanking SD for her response.

Aboriginal cultural sites services – Vicky Duncan	ERM – Katherine Deverson	21/06/2019	KD emailed checking if VD had any comments on the draft ACHA.	VD replied with comment on project recommendations.
Moombahlene LALC – Helen Duroux	ERM – Katherine Deverson	21/06/2019	KD emailed checking if HD had any comments on the draft ACHA.	
Aboriginal cultural sites services – Vicky Duncan	Aboriginal cultural sites services – Vicky Duncan	21/06/2019	VD replied with comment on project recommendations, that sites should be avoided otherwise salvaged, and that the area appeared to be a high occupancy area used by her ancestors.	KD emailed replied thanking VD for her response, advising that comments would be included in the ACHA.
Edgerton Kwiambal – Samantha Duncun	ERM – Katherine Deverson	10/07/2019	KD emailed on behalf of the proponent to advise that three sites (scarred trees) BSF18, BSF19 and BSF29 were currently within the projects impact area and to ask for comment on the possibility of the removal of these trees.	
Aboriginal cultural sites services – Vicky Duncan	ERM – Katherine Deverson	10/07/2019	KD emailed on behalf of the proponent to advise that three sites (scarred trees) BSF18, BSF19 and BSF29 were currently within the projects impact area and to ask for comment on the possibility of the removal of these trees.	
Moombahlene LALC – Helen Duroux	ERM – Katherine Deverson	10/07/2019	KD emailed on behalf of the proponent to advise that	HD replied 11/07/2019, see below entry

			three sites (scarred trees) BSF18, BSF19 and BSF29 were currently within the projects impact area and to ask for comment on the possibility of the removal of these trees.	
Moombahlene LALC – Helen Duroux	Moombahlene LALC – Helen Duroux	11/07/2019	HD emailed to advise that LALC did not support the removal of any scarred trees.	KD replied thanking HD for her response.
Edgerton Kwiambal – Samantha Duncun	ERM – Katherine Deverson	12/07/2019	KD emailed to advise that significance of scarred trees sites BSF5, BSF6, BSF9, BSF11, BSF18, BSF9, and BSF29 had been revised from low overall significance to moderate significance as a result of corrections in the draft ACHA to reflect the aesthetic and social/cultural values of the sites. Updated version of ACHA also sent.	
Aboriginal cultural sites services – Vicky Duncan	ERM – Katherine Deverson	12/07/2019	KD emailed to advise that significance of scarred trees sites BSF5, BSF6, BSF9, BSF11, BSF18, BSF9, and BSF29 had been revised from low overall significance to moderate significance as a result of corrections in the draft ACHA to reflect the	

			aesthetic and social/cultural values of the sites. Updated version of ACHA also sent.	
Moombahlene LALC – Helen Duroux	ERM – Katherine Deverson	12/07/2019	KD emailed to advise that significance of scarred trees sites BSF5, BSF6, BSF9, BSF11, BSF18, BSF9, and BSF29 had been revised from low overall significance to moderate significance as a result of corrections in the draft ACHA to reflect the aesthetic and social/cultural values of the sites. Updated version of ACHA also sent.	

Elise Caldwell

From: Katherine Deverson
Sent: Friday, 21 June 2019 12:38 PM
To: Helen Duroux
Cc: Amanda Antcliff
Subject: FW: 0464261 - Bonshaw ACHA Draft report for you review
Attachments: 0464261 - Bonshaw SF ACHA Draft.pdf

Hi Helen,
I am just checking in again to see if you had any comments on the Bonshaw Solar Farm draft ACHA that I sent through last month?

It you have had a chance to review it, and are able to email back an endorsement of the report and/or any comments you may have, that would be great!

Kind regards,
Kat

Katherine Deverson
Heritage Consultant

Environmental Resources Management Australia Pty Ltd
15 Tench Street | Kingston | ACT 2604 | Australia
T 02 8584 8813 or 02 6126 5311 | **M** 0466 224 250
E katherine.deverson@erm.com | **W** www.erm.com

ERM The business of sustainability

From: Katherine Deverson
Sent: Wednesday, June 12, 2019 1:13 PM
To: Helen Duroux <moombahlenelalc1@bigpond.com>
Cc: Amanda Antcliff <Amanda.Antcliff@erm.com>
Subject: FW: 0464261 - Bonshaw ACHA Draft report for you review

Hi Helen,
I am just checking in to see if you had any comments on the Bonshaw Solar Farm draft ACHA that I sent through last month?

It you have been able to review it, it would be great if you could email back with your endorsement of the report and/or any comments you may have.

Kind regards,
Kat

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Heritage Consultant

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15 Tench Street | Kingston | ACT 2604 | Australia
T 02 8584 8813 or 02 6126 5311 | **M** 0466 224 250
E katherine.deverson@erm.com | **W** www.erm.com

From: Katherine Deverson
Sent: Thursday, May 9, 2019 3:15 PM
To: Helen Duroux <moombahlenelalc1@bigpond.com>
Subject: 0464261 - Bonshaw ACHA Draft report for you review

Hi Helen,

Please find attached the Draft Bonshaw Solar Farm ACHA report which was completed following the surveys we carried out in September 2018.

Please review this report and provide any comments by Friday 7 June 2019.

Feel free to contact me anytime if you would like to discuss anything.

Regards,
Kat

Katherine Deverson
Heritage Consultant

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E katherine.deverson@erm.com | **W** www.erm.com

From: Katherine Deverson
Sent: Friday, 21 June 2019 2:23 PM
To: acsworknsw@gmail.com
Cc: Amanda Antcliff
Subject: RE: 0464261 - Bonshaw ACHA Draft report for you review

Hi Vicky,
Thanks so much for your comment, I will include it in the draft ACHA. As a State Significant Development the Bonshaw Wind Farm does not go through the approvals process that requires an AHIP, however this ACHA will inform the governing body during their development application consideration process and it is expected that the recommendations from the ACHA will be incorporated into the approval, so it is similar to an AHIP in the mitigation requirements for the proponents.

For this project we have recommended, as you have suggested, that the project area be moved where possibly to avoid impacting cultural heritage sites, and so far this has successfully occurred in those high occupancy sites along the creek line at sites like BSF1 (which you will probably remember is the one up near the road where we found lots of artefacts including the retouched axe head).

The draft ACHA recommends avoidance of all sites where possible however direct impact of the project to some sites is considered unavoidable. The draft ACHA recommends that;

- prior to construction all sites that are to be avoided by project works should be fenced so that they are not harmed by construction works or any associated traffic or lay down areas etc.;
- that surface collection/salvage be undertaken at those sites that cannot be avoided by the project by Aboriginal stakeholder groups and an appropriately qualified archaeologist;
- that any artefacts removed from site as part of the salvage works are safely stored until they can be reburied/returned to country in a place agreed upon by RAPs; and
- that ongoing consultation occurs with RAPs throughout the project.

Thanks again for your comment, I really appreciate your input. Feel free to call or email me anytime if you have any further comments or would like to discuss anything in the draft ACHA or to do with the project.

Have a great weekend!

Regards,
Kat

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From: acsworknsw@gmail.com <acsworknsw@gmail.com>
Sent: Friday, June 21, 2019 1:49 PM
To: Katherine Deverson <Katherine.Deverson@erm.com>
Subject: Re: 0464261 - Bonshaw ACHA Draft report for you review

Hi Katherine.
Yes comment on site I recommend that an AHIP BE ON the sites that thay will construct the solor panels.Remove to a safe spot, or find another area for farmas the area is a high occupancy area that was used my my Ancestors.
Kind regards
Vicky Duncan

----- Reply message -----
From: "Katherine Deverson" <Katherine.Deverson@erm.com>
To: "acsworknsw@gmail.com" <acsworknsw@gmail.com>
Cc: "Amanda Antcliff" <Amanda.Antcliff@erm.com>
Subject: 0464261 - Bonshaw ACHA Draft report for you review
Date: Fri., Jun. 21, 2019 12:39 PM

Hi Vicky,
I am just checking in again to see if you had any comments on the Bonshaw Solar Farm draft ACHA that I sent through last month?

It you have had a chance to review it, and are able to email back an endorsement of the report and/or any comments you may have, that would be great!

Kind regards,
Kat

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From: Katherine Deverson
Sent: Wednesday, June 12, 2019 1:15 PM
To: acsworknsw@gmail.com
Cc: Amanda Antcliff <Amanda.Antcliff@erm.com>
Subject: FW: 0464261 - Bonshaw ACHA Draft report for you review

Hi Vicky,

I am just checking in to see if you had any comments on the Bonshaw Solar Farm draft ACHA that I sent through last month?

It you have been able to review it, it would be great if you could email back with your endorsement of the report and/or any comments you may have.

Kind regards,
Kat

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E katherine.deverson@erm.com | **W** www.erm.com

From: Katherine Deverson
Sent: Thursday, May 9, 2019 3:17 PM
To: acsworknsw@gmail.com
Cc: Amanda Antcliff <Amanda.Antcliff@erm.com>
Subject: 0464261 - Bonshaw ACHA Draft report for you review

Hi Vicky,

Please find attached the Draft Bonshaw Solar Farm ACHA report which was completed following the surveys we carried out in September 2018.

Please review this report and provide any comments by Friday 7 June 2019.

Feel free to contact me anytime if you would like to discuss anything.

Regards,
Kat

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The linked image cannot be displayed. The file may have been moved, renamed, or deleted. Verify that the link points to the correct file and location.

Elise Caldwell

From: Katherine Deverson
Sent: Wednesday, 12 June 2019 4:41 PM
To: Samantha Duncan
Subject: RE: FW: 0464261 - Bonshaw ACHA Draft report for you review

Hi Samantha

Thanks so much for getting back to me. I really appreciate your input on this project.

Kind regards,
Kat

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Heritage Consultant

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From: Samantha Duncan <duncans528@gmail.com>
Sent: Wednesday, June 12, 2019 3:00 PM
To: Katherine Deverson <Katherine.Deverson@erm.com>
Subject: Re: FW: 0464261 - Bonshaw ACHA Draft report for you review

Hi Katherine. I apologise for the delay.
I have read the report and 100% endorse the draft.
Kind regards,

Samantha Duncan.

On 12 Jun 2019 1:17 PM, "Katherine Deverson" <Katherine.Deverson@erm.com> wrote:

> Hi Sam,
>
> I am just checking in to see if you had any comments on the Bonshaw Solar Farm draft ACHA that I sent through last month?
>
> It you have been able to review it, it would be great if you could email back with your endorsement of the report and/or any comments you may have.

Kind regards,

Kat

Katherine Deverson

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From: Katherine Deverson
Sent: Thursday, May 9, 2019 3:19 PM
To: Samantha Duncan <duncans528@gmail.com>
Cc: Amanda Antcliff <Amanda.Antcliff@erm.com>
Subject: 0464261 - Bonshaw ACHA Draft report for you review

Hi Sam,

Please find attached the Draft Bonshaw Solar Farm ACHA report which was completed following the surveys we carried out in September 2018.

Please review this report and provide any comments by Friday 7 June 2019.

Feel free to contact me anytime if you would like to discuss anything.

Regards,

Kat

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Elise Caldwell

From: Katherine Deverson
Sent: Thursday, 11 July 2019 3:56 PM
To: Helen Duroux
Cc: Amanda Antcliff
Subject: RE: Bonshaw Solar Farm

Hi Helen,
Thank you for your feedback.

I very much appreciate it.

Kind regards,
Katherine

Katherine Deverson
Heritage Consultant

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E katherine.deverson@erm.com | **W** www.erm.com

ERM The business of sustainability

From: Helen Duroux <moombahlenelalc1@bigpond.com>
Sent: Thursday, July 11, 2019 3:37 PM
To: Katherine Deverson <Katherine.Deverson@erm.com>
Subject: RE: Bonshaw Solar Farm

Hi Katherine,

We don't agree to having the trees removed and would advise against removing them at all costs,

Regards

Helen D

From: Katherine Deverson [mailto:Katherine.Deverson@erm.com]
Sent: Wednesday, 10 July 2019 10:39 AM
To: Helen Duroux
Cc: Amanda Antcliff
Subject: Bonshaw Solar Farm

Hi Helen,
Thank you for your review of the draft ACHA for the Bonshaw Solar Farm.

As you know from our fieldwork and the draft ACHA, numerous sites (including scarred trees and artefact scatters) were located and recorded during our fieldwork.

In considering ecological and heritage constraints within the Project Area the proponent has adjusted the Project's footprint, effectively moving it away from several larger sites located along the creek line to avoid impacting the archaeological record in these areas. However, the Project's proposed footprint currently impacts three scarred trees.

The draft ACHA recommends the following for each of these sites:

> ***Avoidance.***
>
> *Prior to construction commencing, exclusion fencing and exclusion signage should be erected around the scarred tree by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.*

The Proponent would like your comment on the possibility of removing these three scarred trees.

The scarred trees as recorded in the draft ACHA are:

BSF18	**Scarred Tree** **During the survey RAPs identified a standing, live, scarred tree. The oval shaped scar was approximately 1.7 m in length, 40 cm wide, and had significant overgrowth.** **The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.**	
BSF19	**Scarred Tree** During the survey RAPs identified a standing, live, scarred tree with a 1.5 m (length) narrow scar that was approximately 40 cm from the ground and showed significant overgrowth. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.	
BSF29	Scarred Tree During the survey RAPs identified a standing, but dead, scarred tree. The long oval shaped scar was approximately 2 m in length and 40 cm wide. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.	

If you could kindly review the above information and provide your comments, it would be greatly appreciated.

Kind regards,
Kat

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ERM *The business of sustainability*

Elise Caldwell

From: Katherine Deverson
Sent: Wednesday, 10 July 2019 10:38 AM
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Cc: Amanda Antcliff
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> ***Avoidance.***
>
> *Prior to construction commencing, exclusion fencing and exclusion signage should be erected around the scarred tree by Aboriginal stakeholder groups and an appropriately qualified archaeologist. At the completion of construction exclusion zone fencing will be removed.*

The Proponent would like your comment on the possibility of removing these three scarred trees.

The scarred trees as recorded in the draft ACHA are:

BSF18	**Scarred Tree** **During the survey RAPs identified a standing, live, scarred tree. The oval shaped scar was approximately 1.7 m in length, 40 cm wide, and had significant overgrowth.** **The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.**	
BSF19	**Scarred Tree** During the survey RAPs identified a standing, live, scarred tree with a 1.5 m (length) narrow scar that was approximately 40 cm from the ground and showed significant overgrowth. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.	

BSF29	Scarred Tree During the survey RAPs identified a standing, but dead, scarred tree. The long oval shaped scar was approximately 2 m in length and 40 cm wide. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.	

If you could kindly review the above information and provide your comments, it would be greatly appreciated.

Kind regards,
Kat

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Heritage Consultant

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ERM The business of sustainability

Elise Caldwell

From:	Katherine Deverson
Sent:	Wednesday, 10 July 2019 10:39 AM
To:	Samantha Duncan
Cc:	Amanda Antcliff
Subject:	Bonshaw Solar Farm

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>
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The Proponent would like your comment on the possibility of removing these three scarred trees.

The scarred trees as recorded in the draft ACHA are:

BSF18	**Scarred Tree** **During the survey RAPs identified a standing, live, scarred tree. The oval shaped scar was approximately 1.7 m in length, 40 cm wide, and had significant overgrowth.** **The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.**	
BSF19	**Scarred Tree** During the survey RAPs identified a standing, live, scarred tree with a 1.5 m (length) narrow scar that was approximately 40 cm from the ground and showed significant overgrowth. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.	

BSF29	Scarred Tree During the survey RAPs identified a standing, but dead, scarred tree. The long oval shaped scar was approximately 2 m in length and 40 cm wide. The tree is located on a plain set in a wider landscape context of rolling hills. The exposure and surrounding area was checked for stone artefacts, though none were identified.	

If you could kindly review the above information and provide your comments, it would be greatly appreciated.

Kind regards,
Kat

Katherine Deverson
Heritage Consultant

Environmental Resources Management Australia Pty Ltd
15 Tench Street | Kingston | ACT 2604 | Australia
T 02 8584 8813 or 02 6126 5311 | **M** 0466 224 250
E katherine.deverson@erm.com | **W** www.erm.com

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APPENDIX B SURVEY METHODOLOGY SENT TO RAPS AUGUST 2018

November 2018

Environmental
Resources Management
Australia Pty Ltd

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Kingston ACT 2604

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9 August, 2018

Helen Duroux
Moombahlene LALC
PO Box 70
Tenterfield NSW 2372

moombahlenelalc1@bigpond.com

Our Reference: 0464261_SURVEY METHODOLOGY_LALC.DOCX

Dear Helen Duroux,

RE: SOLAR FARM, BONSHAW NSW

Thank you for registering an interest in being consulted for this project.

In accordance with the NSW Office of Environment and Heritage's (OEH) *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (the Guidelines), and the *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW 2010* (Code of Practice), Environmental Resources Management Australia (ERM) is undertaking an Aboriginal cultural heritage assessment (ACHA) associated with the construction and operation of 500 MW capacity solar farm connecting to the existing Dumaresq Substation (*Figure 1*).

This letter provides the relevant information about the proposed project, the current known heritage values of the study area and the proposed archaeological survey methodology.

In accordance with *Section 4.1.6* of the Guidelines, we would also like to provide Moombahlene LALC with a list of the registered groups for this Project:

- Aboriginal Cultural Sites Services;
- Edgerton Kwiambal; and
- Moombahlene LALC.

Annex A also includes a copy of the Newspaper advertisement that was placed in the Inverell Times on 6 July 2018 and the Tenterfield Star on 11 July 2018.

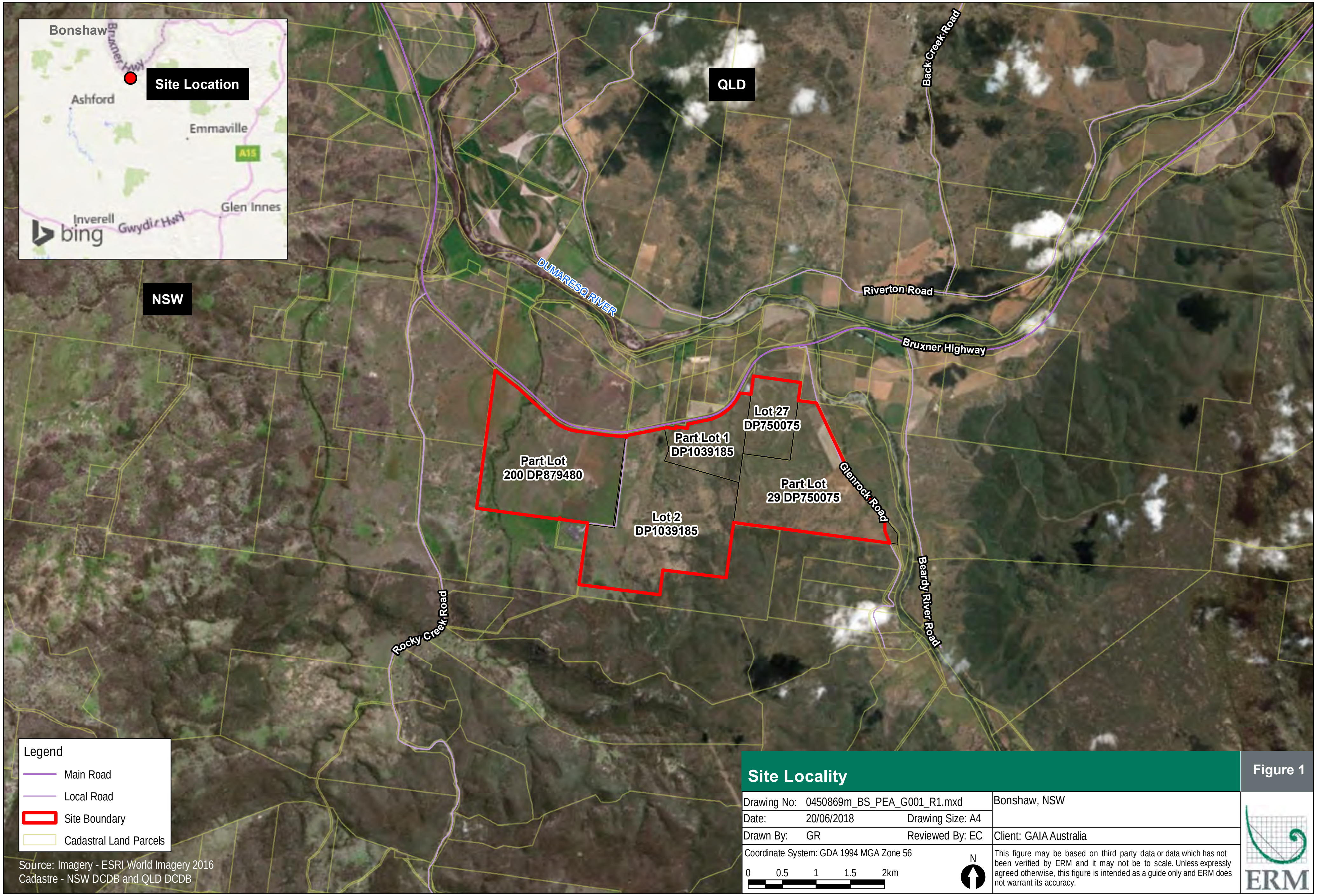
1. PROPOSED DEVELOPMENT

The proponent for the proposed works is GAIA Australia Pty Ltd (GAIA).

The proposed Project Area (PA) is approximately 1097 hectares (ha) with a development footprint of approximately 650 ha. The land is privately owned rural land, currently used for grazing.

Figure 1

Site Locality



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB

Drawing No: 0450869m_BS_PEA_G001_R1.mxd

Date: 20/06/2018 Drawing Size: A4

Drawn By: GR Reviewed By: EC

Coordinate System: GDA 1994 MGA Zone 56

Bonshaw, NSW

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

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With specific reference to Aboriginal cultural heritage and the assessment of potential impacts to the heritage values of the PA, the project will involve the construction, operation and maintenance of a solar PV generation facility and associated infrastructure with a capacity of up to 500 MW, supplying electricity to the national electricity grid.

The Project would include:

- a network of PV modules in a fixed or tracking arrangement;
- a site office (two proposed options);
- three potential access tracts from Bruxner Highway and one from Glenrock Road;
- underground or overhead cabling for connection between arrays and inverters and transformers;
- parking and internal access tracks;
- perimeter security fencing;
- battery storage; and
- two grid connection options to the 330 kV TransGrid Dumaresq Substation, on the boundary of the PA.

2. HERITAGE BACKGROUND

A preliminary due diligence assessment was undertaken by ERM in June 2018. The assessment included a desktop review of the heritage values which have the potential to impact the PA.

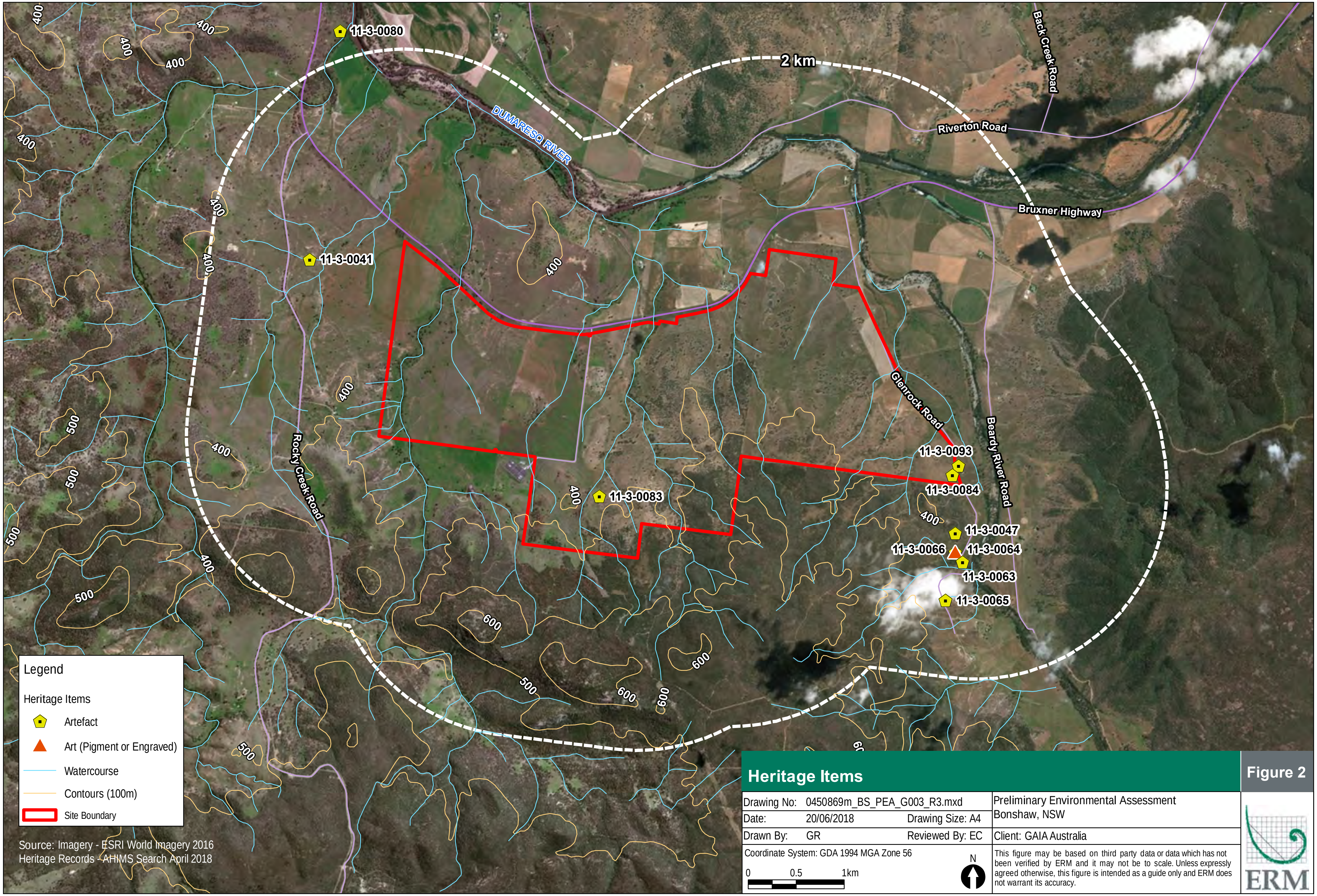
The review was limited to matters identified in the following online resources accessed on Tuesday 6 March 2018:

- Australian Heritage Database register search, including: World Heritage List, National Heritage List, Commonwealth Heritage List, National Trust Register, Register of the National Estate (archive);
- NSW State Heritage Inventory - includes items listed on the State Heritage Register (SHR) and provides a list of places and items of State Significance made under the Heritage Act. Heritage Council approval is required for works proposed to an item on the SHR;
- Inverell LEP 2012 - Schedule 5 and Conservation Areas (Locally listed items);
- Historic Heritage Information Management System (HHIMS) search;

- Aboriginal Heritage Information Management System (AHIMS);
- Schedule 14 of the National Parks and Wildlife Act; and
- Native Title Search.

One active Native Title claim (Comeroi People #NC2011/006) is currently registered within the LGA, and is located on the western side of Rocky Creek Road adjacent to the PA. The PA is not included in this Native Title claim.

An extensive AHIMS register search was conducted for each allotment on 5 March 2018, which identified three previously recorded Aboriginal sites located within the PA. All three of these sites (AHIMS #11-3-0083, #11-3-0084 and #11-3-0093) are reported as artefact scatters, with one potential scar tree also noted at the northern extent of #11-3-0083 (Refer to *Figure 2*). They were recorded as part of the Far North NSW (Dumaresq to Lismore 330kV Transmission Line) Project in 2011 (Ozark, 2011).



Source: Imagery - ESRI World Imagery 2016
Heritage Records - AHIMS Search April 2018

Heritage Items

Figure 2

Drawing No: 0450869m_BS_PEA_G003_R3.mxd
Date: 20/06/2018 Drawing Size: A4
Drawn By: GR Reviewed By: EC
Coordinate System: GDA 1994 MGA Zone 56

Preliminary Environmental Assessment
Bonshaw, NSW

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

3. FIELDWORK METHODOLOGY

Based on the results of the due diligence assessment, the archaeological survey will be undertaken over two days and will aim to identify all Aboriginal sites present within the proposed impact area including the identification of any PADs.

The proposed methodology for the archaeological survey includes:

- the survey will be undertaken on foot where possible with Registered Aboriginal Parties in attendance;
- the survey will consist of all participants traversing the transmission line corridor using walking transects approximately 5 m apart to ensure the entire survey area is covered (subject to surface visibility and accessibility);
- the survey will target each landform in the PA;
- areas of potential such as raised landforms in close proximity to a semi-permanent water source will also be targeted;
- areas of exposure and ground visibility will be targeted;
- any areas of interest to the Registered Aboriginal Parties will be targeted;
- the previously recorded sites will be targeted, re-identified and recorded; and
- any cultural heritage information for the PA held by Aboriginal parties will be recorded during the field survey. Any cultural knowledge provided by Aboriginal Stakeholders will be treated in confidence and the information will be distributed according to their wishes.

ERM propose the dates of **12 and 13 September 2018** to undertake this archaeological survey. One representative from your organisation is invited to attend. Details of the meeting time and location for each day will be provided once we have confirmed attendance.

Each representative is responsible for providing their own Personal Protective Equipment (PPE), including sturdy walking boots, long pants and long sleeve shirts (and wet weather gear, if required). Please ensure that you have sun protection and enough water for the day.

Should you wish to participate, you will need to supply ERM with:

- the name of the individual who will attend as your representative;
- a Certificate of Currency for Public Liability insurance, valid for the period of work; and

- a Certificate of Currency for Workers Compensation insurance, valid for the period of work.

4. FEEDBACK

ERM requests that you respond to this information package and fieldwork methodology prior to **Friday 7 September 2018** with any comments you may have and confirmation of availability for fieldwork.

Please provide feedback to **Katherine Deverson** on the following contact details:

Post: PO Box 4160, Kingston, ACT 2604
Phone: 02 8584 8813 or 02 6126 5311
Email: katherine.deverson@erm.com

If you hold any knowledge of sites within or near the study area or have any specific information concerning the cultural values of the study area, we would be grateful if you could let us know. Our contact details are listed above. Any cultural knowledge provided by Aboriginal Stakeholders will be treated in confidence and the information will be distributed according to their wishes.

Yours faithfully,

for Environmental Resources Management Australia Pty Ltd

Katherine Deverson
ERM Archaeologist

Paul Douglass
ERM Partner

APPENDIX C AHIMS EXTENSIVE SEARCH RESULTS

November 2018

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 0450869

Client Service ID : 331690

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
11-3-0041	S19	AGD	56	335382	6770551	Open site	Valid	Artefact : -	Isolated Find	
	Contact	**Recorders**	Robert Paton					**Permits**		
11-3-0047	EL35	AGD	56	342100	6767700	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Robert Paton					**Permits**		
11-3-0063	EL34	AGD	56	342150	6767550	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Robert Paton					**Permits**		
11-3-0064	EL33	AGD	56	342100	6767500	Open site	Valid	Art (Pigment or Engraved) : -		
	Contact	**Recorders**	Robert Paton					**Permits**		
11-3-0065	EL32	AGD	56	342000	6767000	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Robert Paton					**Permits**		
11-3-0066	EL36	AGD	56	342100	6767500	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Robert Paton					**Permits**		
11-3-0080	TSR Dumaresq River OCS	GDA	56	335700	6772930	Open site	Valid	Artefact : 500		
	Contact Searle	**Recorders**	Miss.Karen Glover					**Permits**		
11-3-0083	Tenterfield-Dumaresq OS14	GDA	56	338395	6768085	Open site	Valid	Artefact : -		
	Contact	**Recorders**	OzArk Environmental and Heritage Management,Mr.Ben Churcher					**Permits**		
11-3-0084	Tenterfield-Dumaresq OS15	GDA	56	342072	6768358	Open site	Valid	Artefact : -		
	Contact	**Recorders**	OzArk Environmental and Heritage Management,Mr.Ben Churcher					**Permits**		
11-3-0093	Tenterfield Dumaresq OS 4 & PAD	GDA	56	342136	6768402	Open site	Valid	Artefact : -		
	Contact	**Recorders**	OzArk Environmental and Heritage Management,Mr.Ben Churcher					**Permits**		

Report generated by AHIMS Web Service on 05/03/2018 for Eliza Collison for the following area at Lat, Long From : -29.2336, 151.2741 - Lat, Long To : -29.1502, 151.4063 with a Buffer of 0 meters. Additional Info : Site Feasibility Report. Number of Aboriginal sites and Aboriginal objects found is 10

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APPENDIX E LAND USE CONFLICT AND RISK ASSESSMENT

GAIA Australia

Bonshaw Solar Farm EIS

Land Use Conflict Risk Assessment

10 July 2019

Project No.: 0470861

The business of sustainability

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Document details	
Document title	Bonshaw Solar Farm EIS
Document subtitle	Land Use Conflict Risk Assessment
Project No.	0470861
Date	10 July 2019
Version	1.0
Author	Lachlan Giles, Tim Haydon
Client Name	GAIA Australia

Document history

				ERM approval to issue		
Version	Revision	Author	Reviewed by	Name	Date	Comments
Draft	01	Tim Haydon	Lachlan Giles	Paul Douglass	10.07.2019	Approved for Client provision
Final	01	Tim Haydon	Lachlan Giles	Murray Curtis	10.07.2019	

Signature Page

10 July 2019

Bonshaw Solar Farm EIS

Land Use Conflict Risk Assessment

Lachlan Giles
Environmental Planner

Tim Haydon

Tim Haydon
Senior Consultant

Amanda Antcliff
Principal Planner

Paul Douglass
Partner

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45 Watt Street
Newcastle NSW 2300

CONTENTS

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1. INTRODUCTION

1.1 Background

GAIA Australia (GAIA) is seeking approval to develop a large scale solar photovoltaic (PV) generation facility and associated infrastructure with the capacity of 200 megawatts (MW) situated near the locality of Bonshaw, New South Wales (NSW) (referred to as the Bonshaw Solar Farm) (the ‘Project’), shown in Figure 1.1. The Project is located approximately 16 kilometres (km) south of Bonshaw and 66 km north of Inverell and is wholly contained within the Inverell Shire Local Government Area (LGA). The Project would connect directly to the 330 kilovolt (kV) Dumaresq Substation.

This Land Use Conflict Risk Assessment (LUCRA) has been prepared in accordance with *Land Use Conflict Risk Assessment Guide* as prepared by the Department of Primary Industries (NSW Government Department of Primary Industries, 2011). This LUCRA is to accompany the Environmental Impact Assessment (EIA) for the proposed State Significant Development (SSD 9438) of Bonshaw Solar Farm.

The Project is proposed on land zoned as Primary Production (RU1) in accordance with the Inverell Local Environment Plan 2012 (LEP). The predominant land use in the proximity of the Project is rural landscape used for grazing and some cropping with natural waterways and vegetated ridgelines.

The location for the Project was selected after an extensive review of land availability and access; land ownership and existing land use; topography; geological formation; transmission grid access and capacity; and solar irradiation.

1.2 Land Use Conflict Risk Assessment (LUCRA) Overview

The LUCRA is a system to manage the potential for land use conflict to occur between the proposed land use (as outlined in Section 2.1) and neighbouring land uses. Land use conflicts arise when a land user is perceived to adversely infringe upon the rights, values or amenity of another. For example, other land uses near banana plantations may result in conflicts over the use of pesticides on neighbouring properties, consequently harming the plantation.

Overall, the purpose of the LUCRA is to identify land use compatibility and potential for conflict between neighbouring land uses, and the identification of conflict avoidance or mitigation measures.

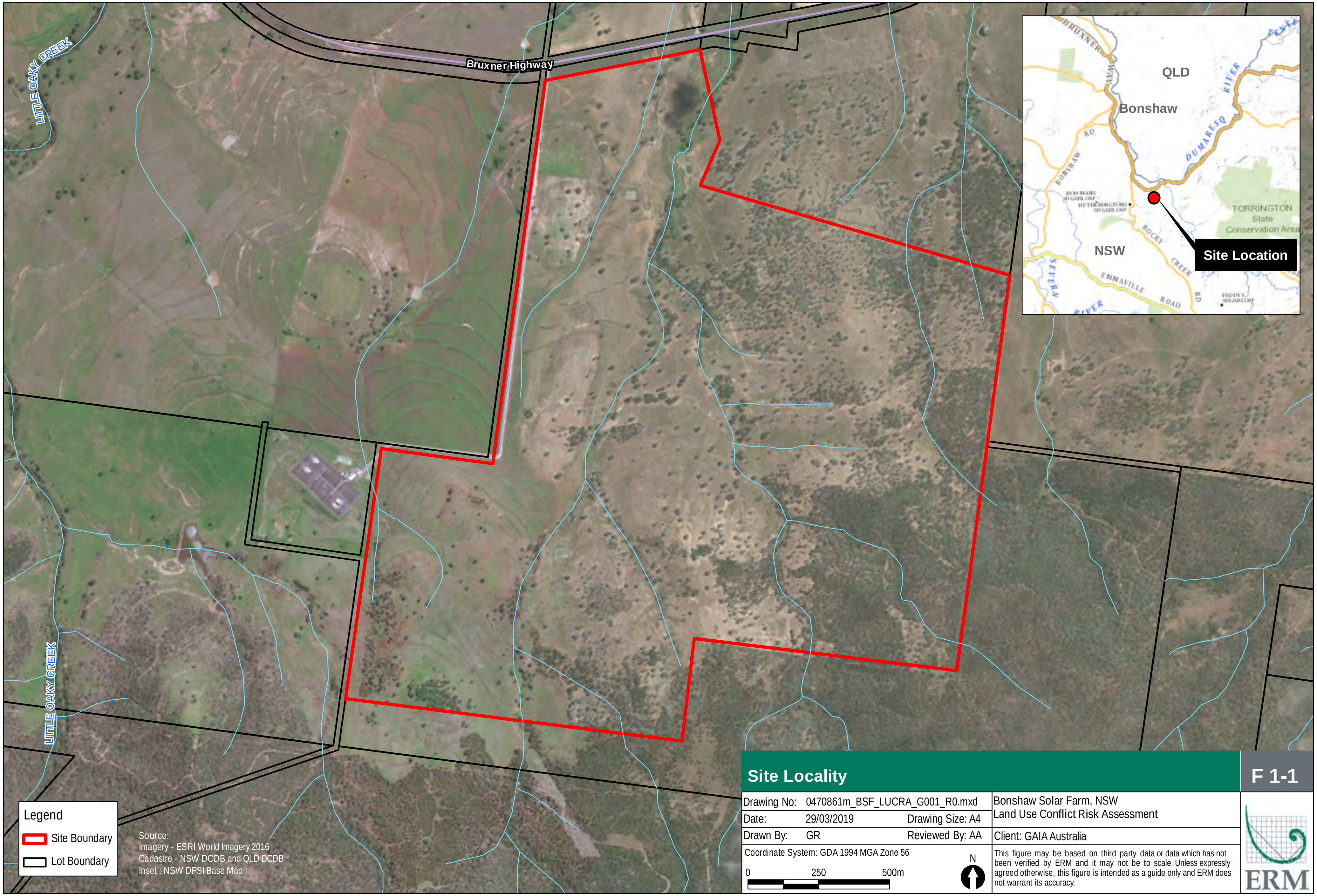
LUCRA aims to:

- *“accurately identify and address potential land use conflict issues and risk of occurrence before a new land use proceeds or a dispute arises*
- *objectively assess the effect of a proposed land use on neighbouring land uses*
- *increase the understanding of potential land use conflict to inform and complement development control and buffer requirements, and*
- *highlight or recommend strategies to help minimise the potential for land use conflicts to occur and contribute to the negotiation, proposal, implementation and evaluation of separation strategies.”* (NSW Government Department of Primary Industries, 2011)

The LUCRA process has four key steps, as summarised in Table 1-1 below, with the corresponding chapter which the LUCRA key step is addressed in.

Table 1-1 Summary of Key Steps in LUCRA

Key Step in LUCRA	Summary of Key Step	Relevant Chapter Addressing Key Step
Step 1: Gather Information	■ Describe the nature of the proposed land use change and proposed development. ■ Describe the nature of the associated activities, including that which may be a potential source of conflict. ■ Evaluate the topography, climate and natural features of the site and broader locality. ■ Research the site history and review previous environmental assessments and approvals for the site. ■ Inspect the site. ■ Interview relevant neighbouring stakeholders. ■ Describe the main activities of adjacent properties and their frequency (include water based activities if relevant). ■ Compare and contrast the proposed and surrounding land uses and activities for incompatibility and conflict issues. ■ Conduct an 'Initial Risk Evaluation' by tabulating each activity and potential conflicts.	Chapter 2
Step 2: Evaluate the Risk Level of Each Activity	Prepare an assessment of the potential for land use conflicts, associated risks and severity of impacts utilising the Risk Ranking Matrix, with due consideration to the: ■ Probability of occurrence, and ■ Consequence of the impact. A Risk Ranking is identified for each activity. The Risk Ranking is recorded in the Initial Risk Evaluation Table.	Chapter 3
Step 3: Risk Reduction Management Strategies	Management strategies are identified to reduce the probability and consequence of each activity, and in turn its risk value. This step is designed to identify and define controls that lower the risk ranking score to 10 or below. Risk Reduction Controls are recorded in a Table to outline the management strategies. A revised risk ranking is calculated and performance targets set, including details of how effectiveness of the strategy will be monitored.	Chapter 3
Step 4: Record LUCRA Results	A record of the key issues, their risk level, and the recommended management strategies provides a valuable planning document for managers and planners. This information should be included in any relevant management plan.	Chapter 3



Legend

🟥 Site Boundary

☐ Lot Boundary

Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Inset : NSW DFSI Base Map

Site Locality

F 1-1

Drawing No: 0470861m_BSF_LUCRA_G001_R0.mxd
Date: 29/03/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW
Land Use Conflict Risk Assessment

Client: GAIA Australia

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2. GATHER INFORMATION

2.1 Project Description

The Project incorporates arrays of PV modules (commonly referred to as “solar panels”), transmission infrastructure and switch yard to enable connection into the existing electricity transmission network via the 330 kilovolt (kV) Dumaresq Substation. The project will have a targeted ‘sent out’ electricity generating capacity of up to 200 megawatts (MW) (AC) and a BESS/battery storage with up to 300 MW (AC) . The exact method and point of connection is being developed in conjunction with TransGrid in parallel with this planning application and the detailed infrastructure layout developed during detailed design will confirm the generating capacity of the Bonshaw Solar Farm.

The key elements of the project include the construction and operation of:

- a network of PV modules in a fixed tilt or single axis tracking arrangement;
- associated battery energy storage system (BESS) / battery storage;
- a switch yard to be connected to the 330 kV TransGrid Dumaresq Substation, on the boundary of the Project Area;
- underground or overhead cabling for connection between arrays and inverters and transformers;
- operations and maintenance (O&M) infrastructure, including O&M buildings incorporating a control room, meeting facilities, a temperature controlled spare parts storage facility, supervisory control and data acquisition (SCADA) facilities, a workshop and associated infrastructure (eg kitchen, toilets and other facilities), and car parking facilities;
- Access point to the site via the Bruxner Highway;
- a new internal road network to enable access from surrounding local roads to the array areas during construction and operations including internal access tracks, creek crossing & perimeter security fencing; and
- Temporary facilities during construction.

The Project Area covers approximately 353 hectares (ha), of which the proposed development area occupies approximately 165ha. The Project Area and broader region is predominately agricultural grazing land. An existing TransGrid-owned 132 kV transmission line runs through the Project Area.

The proposed land use is not planned to change the existing land zoning provisions of the Site. It is noted that the Project will allow ongoing grazing activities to occur concurrently.

2.2 Nature of the Locality

The immediately adjacent properties, along with the general locality surrounding the Project are zoned exclusively as Primary Production (RU1) in accordance with the Inverell LEP. The predominant land use in the locality of the Project is rural landscape used for agricultural purposes, including farming and grazing (refer to Figure 2-1 Surrounding Land Zone.

2.3 Topography, Climate and Natural Features

On a landscape scale, the site is characterised as low hills and ranges, more rugged on granites with abundant rock outcrop and tors with short, steep gorges of major rivers and karst landscapes on limestone (Morgan & Terrey, 1992). Elevations across the site ranges from 340-440 m Australian Height Datum (AHD) from the north to the south respectively (NSW Spatial Services & GDA, 2017). The locality includes natural waterways and vegetated ridgelines.

2.4 Surrounding Land Use

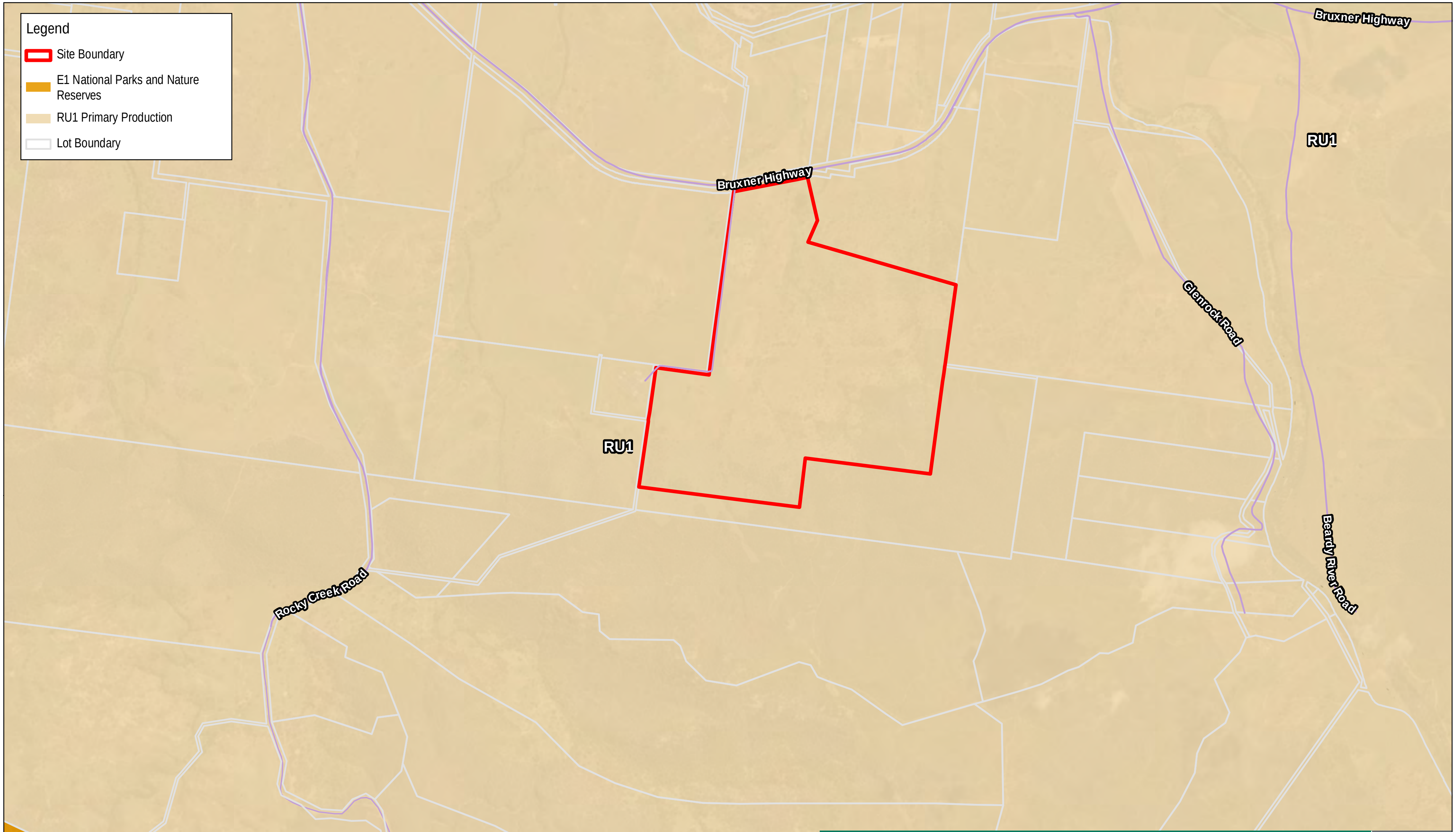
The site has historically been used for agricultural purposes, noting land clearing of the area to allow for agricultural utility. Existing land uses of neighbouring landowners is limited exclusively to farming and grazing as permitted under the land zoning (Primary Production) of the Inverell LEP (as shown in Figure 2-1). Through landowner consultation and site inspections, the surrounding land uses has been summarised in Table 2-1 below, with a visual representation of their locality provided in Figure 2-2.

Table 2-1 Activities of Adjoining Properties

Landholder	Lot	Orientation from Project	Land use activities
Landholder 1	Lot 29 DP 750075	Eastern side	Farming and grazing
Landholder 2	Lot 200 DP 879480	Western side	Farming and grazing
Landholder 3	Lot 201 DP 879480	Western side	Substation
Landholder 4	Lot 46 DP 750075	Southern side	Unoccupied Land
Landholder 5	Lot 1 DP 1039185	Northern side	Grazing

It is noted that through consultation with the landowner of the Project Site, that no cropping activities operate on the adjoining land. Consequently, no seasonal activities or aerial spraying activities occur.

GAIA have met with adjoining landowners during earlier stages of the project during the consultation process and have not found objections to the Project, nor any concerns raised over conflicting land uses.



Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Planning - NSW Government Land Zones Dec 2018
(Inverell LEP 2012)

Surrounding Land Zones

F 2-1

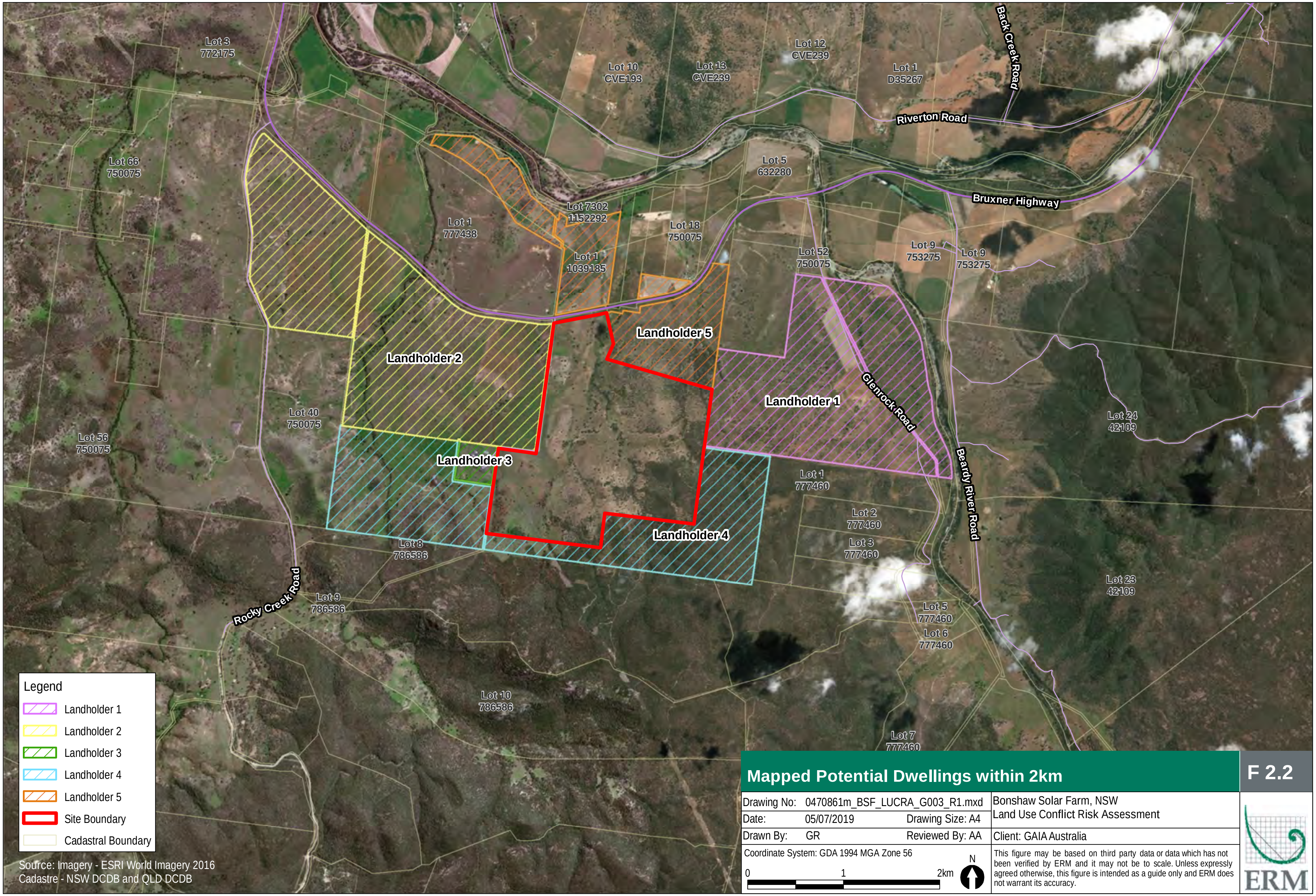
Drawing No: 0470861m_BSF_LUCRA_G002_R0.mxd
Date: 29/03/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW
Land Use Conflict Risk Assessment

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM



Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB

Mapped Potential Dwellings within 2km

F 2.2

Drawing No: 0470861m_BSF_LUCRA_G003_R1.mxd
Date: 05/07/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA

Bonshaw Solar Farm, NSW
Land Use Conflict Risk Assessment

Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

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3. LAND USE CONFLICT ASSESSMENT

3.1 Initial Risk Identification and Risk Ranking

The LUCRA process uses the Risk Ranking Matrix shown in Table 3-1 below. The matrix is used to rank the identified potential land use conflicts, by assessing the environmental, public health and amenity impacts according to the:

- Probability of occurrence, and
- Consequence of the impact.

The risk ranking matrix yields a rank from 25 to 1. A rank of 25 is the highest magnitude of risk (aka. an almost certain and severe risk) while a rank of 1 represents the lowest (aka. a rare and negligible risk).

Table 3-1 Risk Ranking Matrix

		Probability				
		A	**B**	**C**	**D**	**E**
Consequence	**1**	25	24	22	19	15
	2	23	21	18	14	10
	3	20	17	13	9	6
	4	16	12	8	5	3
	5	11	7	4	2	1

The rank is determined by a combination of five levels of ‘probability’ and five levels of ‘consequences’ to identify the risk ranking of each activity. The levels of probability are defined in Table 3-2. Likewise, the levels of consequences are defined in Table 3-3.

Table 3-2 Probability Table

Level	Descriptor	Description
A	Almost Certain	Common or repeating occurrence
B	Likely	Known to occur, or ‘it has happened’
C	Possible	Could occur, or ‘I’ve heard of it happening’
D	Unlikely	Could occur in some circumstances, but not likely to occur
E	Rare	Practically impossible

Table 3-3 Measure of Consequence

Level: 1	**Descriptor: Severe**
Description	■ Severe and/or permanent damage to the environment ■ Irreversible ■ Severe impact on the community ■ Neighbours are in prolonged dispute and legal action involved
Example / Implication	■ Harm or death to animals, fish, birds or plants ■ Long term damage to soil or water ■ Odours so offensive some people are evacuated or leave voluntarily ■ Many public complaints and serious damage to Council's reputation ■ Contravenes Protection of the Environment & Operations Act and the conditions of Council's licences and permits. Almost certain prosecution under the POEO Act
Level: 2	**Descriptor: Major**
Description	■ Serious and/or long-term impact to the environment ■ Long-term management implications ■ Serious impact on the community ■ Neighbours are in serious dispute
Example / Implication	■ Water, soil or air impacted, possibly in the long term ■ Harm to animals, fish or birds or plants ■ Public complaints. Neighbour disputes occur. Impacts pass quickly ■ Contravenes the conditions of Council's licences, permits and the POEO Act ■ Likely prosecution
Level: 3	**Descriptor: Moderate**
Description	■ Moderate and/or medium-term impact to the environment and community ■ Some ongoing management implications ■ Neighbour disputes occur
Example / Implication	■ Water, soil or air known to be affected, probably in the short term ■ No serious harm to animals, fish, birds or plants ■ Public largely unaware and few complaints to Council ■ May contravene the conditions of Council's Licences and the POEO Act ■ Unlikely to result in prosecution
Level: 4	**Descriptor: Minor**
Description	■ Minor and/or short-term impact to the environment and community ■ Can be effectively managed as part of normal operations ■ Infrequent disputes between neighbours
Example / Implication	■ Theoretically could affect the environment or people but no impacts noticed ■ No complaints to Council ■ Does not affect the legal compliance status of Council
Level: 5	**Descriptor: Negligible**
Description	■ Very minor impact to the environment and community ■ Can be effectively managed as part of normal operations ■ Neighbour disputes unlikely
Example / Implication	■ No measurable or identifiable impact on the environment ■ No measurable impact on the community or impact is generally acceptable

Information gathered from Section 2 above has informed the Initial Risk Evaluation provided in Table 3-4 below. The proposed activity associated with the land use change has been listed along with the identified potential conflict. Each activity has been assigned a risk ranking determined through the risk ranking matrix.

Table 3-4 Initial Risk Evaluation

Activity	Identified Potential Conflict	Risk Ranking
Adjacent Land Use Activities	Impacts on the operation of the solar farm by neighbouring land uses: ■ Agricultural activities such as movement of livestock between properties and paddocks. ■ Dust generation caused by agricultural activities. ■ Dust generation caused by construction activities.	Probability: B Consequence: 4 Risk Ranking: 12
Agricultural Land Use	■ Temporary loss of productive agricultural land during construction of the project (grazing unable to offer during the construction period). A portion of the south-western corner of the Site is identified as *Biophysical Strategic Agricultural Land*. ■ Potential changes to soil properties for grazing paddocks.	Probability: C Consequence: 4 Risk Ranking: 8
Air Quality	■ Dust generated due to vehicular movements along access roads, unsealed internal roads and unsealed local roads. ■ Dust generated from livestock movements across paddocks on-site during project operation.	Probability: B Consequence: 4 Risk Ranking: 12
Aviation	■ Perceived glare impacts. ■ Potential adverse impacts to flight paths.	Probability: C Consequence: 2 Risk Ranking: 18
Bushfire	■ Impacts on land surrounding the Solar Farm from structural fires generated on Site. ■ Impacts on the operation of the Project from bushfires in the immediate vicinity of the Project.	Probability: D Consequence: 1 Risk Ranking: 19
Health	■ Potential impacts to health to the general public due to proximity to Project.	Probability: E Consequence: 2 Risk Ranking: 10
Noise	■ Noise will impact sensitive receivers during the construction period, namely increased vehicle movements on local roads. ■ Noise will impact sensitive receivers during operation due to the construction of a switching station onsite. ■ Construction and operational noise and associated impacts are discussed in Section 5.5 of the EIS. ■ Potential associated impacts on livestock.	Probability: B Consequence: 4 Risk Ranking: 12
Property Values and Council Rates	■ Potential devaluation of neighbouring properties due to close proximity to solar farm infrastructure. ■ Impacts to council rates for neighbouring properties due to the change in land use of the Project site.	Probability: C Consequence: 4 Risk Ranking: 8

Activity	Identified Potential Conflict	Risk Ranking
Safety	■ Increased vehicle movements along local road network possess a safety threat to livestock and wildlife.	Probability: D Consequence: 5 Risk Ranking: 2
Soil Erosion	■ Soil erosion leading to land and water pollution.	Probability: C Consequence: 3 Risk Ranking: 13
Traffic	■ Increase in heavy vehicle movements on local roads due to construction traffic. ■ Increased vehicle movements on local roads to Project site during operation. ■ Impact of construction traffic along school bus routes and commute times. ■ Potential conflict between project-related construction vehicle movements and neighbouring stock movements.	Probability: C Consequence: 4 Risk Ranking: 8
Use of land with Mineral Resources	■ The potential exploration, assessment or extraction of minerals onsite would be impeded by the solar farm during the lifetime of the project. (No area of mineral significance has been identified in accordance with available data by the Division of Resources and Geosciences).	Probability: E Consequence: 5 Risk Ranking: 1
Visual	■ Visual impact to sensitive receivers nearby and loss of scenic agricultural views. ■ Visibility of project infrastructure from residences and local road network. ■ Glare (reflectivity) from solar panels. ■ Potential night lighting from the project property impacts on neighbouring residences. ■ Inadequate localised vegetation screening around neighbouring properties. ■ Visual impact of fences on local amenity. Perimeter fences will be constructed around the Project boundary.	Probability: B Consequence: 3 Risk Ranking: 17
Water	■ Change to surface water flows and water quality as a result of construction and operation of the Project infrastructure. ■ Insufficient availability of water for neighbouring properties during the construction and operation of the Project. ■ Potential loss of access to water within dams for livestock due to the Project's construction. ■ Concerns about the effect the solar panels will have on the direction and flow of the flood waters.	Probability: C Consequence: 3 Risk Ranking: 13
Weed and Pest Management	■ The construction stage has the potential to increase the distribution of weeds at the site as a result of increased vehicle and pedestrian movements during. ■ Increased presence of vermin during construction as a result of food waste generated.	Probability: C Consequence: 4 Risk Ranking: 8

3.2 Risk Reduction Controls

In order to lower the risk values of activities associated with the proposed development, relevant risk reduction controls are identified for each identified potential conflict as management strategies. Consideration is given to lower both the probability and the negative consequences. The risk reduction controls will allow a re-assessment of the risk level on the basis of the implementation of the management strategies. The objective is to identify and define controls that lower the risk ranking score to 10 or below.

In this way, management strategies are developed to minimise such effects or potential for land use conflict to arise. For each of the management strategies, performance targets are identified as well as details of how the effectiveness of the strategy will be monitored.

3.3 Performance Monitoring

The LUCRA process has identified and assessed the potential for land use conflicts to arise as a result of the proposed Project. The management strategies listed in Table 3-5 provide plans to reduce identified potential conflict items that originally received a Risk Rating above 10. In order to ensure these management strategies are successfully implemented, performance monitoring is an important ongoing tool throughout the construction and operation stages of the Project. Performance targets are outlined below in Table 3-5.

The Construction Environmental Management Plan (CEMP) will act as the primary method for monitoring performance to ensure the potential for land use conflicts is mitigated. The CEMP will include any specific monitoring measures identified through the specialist studies.

Table 3-5 Management Strategy

Identified Potential Conflict	Management Strategy (Method of Control)	Revised Risk Ranking (RRR)	Performance Target
Adjacent Land Use Activities	■ Consideration of neighbouring activities will be taken during the preparation of the Operational Environment Management Plan (OEMP). ■ On-site dust suppression will be adopted to minimise the potential of dust dispersion generated from the Project impacting upon neighbouring land. ■ Conversely, adjacent land uses are not anticipated to significantly impact upon the operation and functionality of the Project.	Probability: D Consequence: 4 RRR: 5	Comply with CoA, and Management measures in CEMP and OEMP
Noise	■ The Noise and Vibration Impact Assessment has assessed the noise impacts of construction and operation for the Project and provide mitigation measures, as outlined in Section 6.5 of the EIS. ■ Construction activities will be limited to standard working hours: - Monday to Friday, 7am to 6pm - Saturday, 8am to 1pm - No construction work is to take place on Sundays or public holidays. ■ Construction noise management and mitigation will be addressed in the Construction Environment Management Plan (CEMP).	Probability: D Consequence: 4 RRR: 5	Comply with CoA Management measures CEMP, OEMP and noise subplan
Visual	■ The Visual Impact Assessment has considered the visibility of Project infrastructure and has provided mitigation measures as outlined in Section 6.4 of the EIS. ■ Provision of landscaping vegetation screening at appointed sections of the Site boundary will be installed to reduce the level of visual impact.	Probability: C Consequence: 4 RRR: 8	Successful implementation of landscape management measures, and Monitoring of landscaping management measures will be monitored in accordance with the CEMP and OEMP.
Aviation	■ Glare impacts are assessed in the Visual and Glare Assessment. No mitigation measures are required as no impacts are predicted. ■ Solar panels are proposed to be constructed with anti-glare PV panels. ■ The Project is located approximately 65km from Tenterfield Aerodrome, 30 km from Ashford Aerodrome and 43km from Texas Aerodrome. This is considered to be a sufficient distance from these aerodromes to not be of any concern to air navigation.	Probability: E Consequence: 4 RRR: 3	Installation of anti-glare PV panels.

Identified Potential Conflict	Management Strategy (Method of Control)	Revised Risk Ranking (RRR)	Performance Target
Air Quality	■ Dust generated during the construction and decommissioning stages of the Project are to be managed using water carts where required. ■ During operation, dust is not expected to generate a significant potential conflict, however this will be managed in accordance with the OEMP.	Probability: C Consequence: 4 RRR: 8	Comply with CoA, and Management measures in CEMP and OEMP Management measures in OEMP
Soil Erosion	■ Soil erosion measures will be implemented during construction and operation in accordance with the CEMP and OEMP.	Probability: C Consequence: 4 RRR: 8	Comply with CoA, and Management measures in CEMP and OEMP
Water	■ Water management measures will be implemented during construction and operation in accordance with the CEMP and OEMP.	Probability: C Consequence: 4 RRR: 8	Comply with CoA, and Management measures in CEMP, OEMP and Flood subplan.
Bushfire	■ Implementation of a Bushfire Management Plan will significantly reduce the potential for a bushfire arising during operation of the solar farm, and also to reduce the threat of damaging Project infrastructure. ■ Management will include the concurrent use of the Project site as a solar farm and for sheep grazing, assisting in keeping the grass down post-construction as a bushfire prevention method.	Probability: D Consequence: 3 RRR: 9	Implementation of mitigation measures through the Project CEMP and Bushfire Management Plan

4. CONCLUSION AND RECOMMENDATIONS

Overall, the Risk Ranking was low-to-moderate across all potential conflict activities for the Site. The initial risk evaluation as shown in *Table 3-4* identifies relevant project-specific issues. For all Identified Potential Conflict activities with a Risk Ranking score of 10 or more, the objective is to identify controls and management strategies to introduce risk reduction controls to lower the Risk Ranking to 10 or below. Relevant mitigation measures for those activities that exceed a Risk Ranking of 10 are provided in *Table 3-5*, in order to minimise the potential for conflict to arise.

Performance Monitoring provided in *Section 3.3* ensures the relevant mitigation measures are effectively implemented, to promote ongoing land-use management. This process encourages the revision of risk reduction controls to guarantee the Project reduces the potential for neighbouring land use conflict to arise.

With the implementation of mitigation measures, monitoring and consultation with adjacent landowners throughout construction, land use conflict potential is likely to remain low.

5. REFERENCES

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APPENDIX F VISUAL AND GLARE ASSESSMENT

Bonshaw Solar Farm Visual and Glare Assessment

GAIA Australia

26 July 2019

Project No.: 0470861

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Document details	
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Document subtitle	
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Date	26 July 2019
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Author	Alan Simonic
Client Name	GAIA Australia

Document history

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Version	Revision	Author	Reviewed by	Name	Date	Comments
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Signature Page

26 July 2019

Bonshaw Solar Farm Visual and Glare Assessment

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CONTENTS

EXECUTIVE SUMMARY

GAIA Australia (GAIA) is seeking to develop the Bonshaw Solar Farm (the Project) at Bonshaw in the Inverell Shire Council LGA in New South Wales (NSW). Environmental Resources Management Australia Pty Ltd (ERM) has been engaged to assess the potential for Visual and Glare Impacts that might result from the Project.

ERM has undertaken a quantitative and qualitative assessment of the potential for visual and glare impacts, which may be brought about by the Project.

The first step of this assessment was to identify locations where the project may be visible from the areas surrounding the project. This was undertaken via a desktop Geographical Information System (GIS) analysis.

A site visit was undertaken to assess the character and quality of views from locations where the GIS analysis predicted theoretical visibility of the Project. These locations were also used to assess the potential visual and solar glare impacts of the Project.

This assessment determined that views to the Project are limited to a short section of the Bruxner Highway immediately north of the Site. Limited views of the site are achieved from sensitive receptors due to topographic features or vegetation.

Glare affects where assessed using the Forge Solar Assessment Tool from the Bruxner Highway and sensitive receptors within 2 km of the site. Due to the site located generally to the south of any of sensitive receptors, the use of a tracking system and the topographic features, no glare impacts are predicated from the site.

1. INTRODUCTION

GAIA Australia (GAIA) seeks to develop a new solar farm near Bonshaw in northern New South Wales. The Project is located approximately 16 kilometres (km) south of Bonshaw and 66 km north of Inverell and is wholly contained within the Inverell Local Government Area (LGA).

The Bonshaw Solar Farm (the Project) is proposed to be located on the land described as Lot 2 on DP1039185 (the Site).

The Project proposes a grid connection into the existing Dumaresq Substation located to the west of the site on the adjoining Lot 210 on DP879480. Access to the site is via the Bruxner Highway.

1.1 Purpose of this report

ERM has been engaged by GAIA to undertake this visual and glare assessment of the proposed Project. The visual and glare assessment has been prepared to ensure the Project addresses the Visual aspect of the SEARs. The SEARs require that the visual and glare assessment should include: an assessment of the likely visual impacts on the development (including any glare, reflectivity and night lighting) on surrounding residences, scenic or significant vistas, air traffic and road corridors in the public domain, including a draft landscaping plan for on-site perimeter planting, with evidence it has been developed in consultation with affected landowners.

2. PROJECT DESCRIPTION

GAIA Australia (GAIA) is proposing to develop a large scale solar photovoltaic (PV) generation facility and associated infrastructure at Bonshaw in the Inverell Shire Council LGA, in New South Wales (NSW) (referred to as the Bonshaw Solar Farm) (the 'Project'), shown in Figure 2-1.

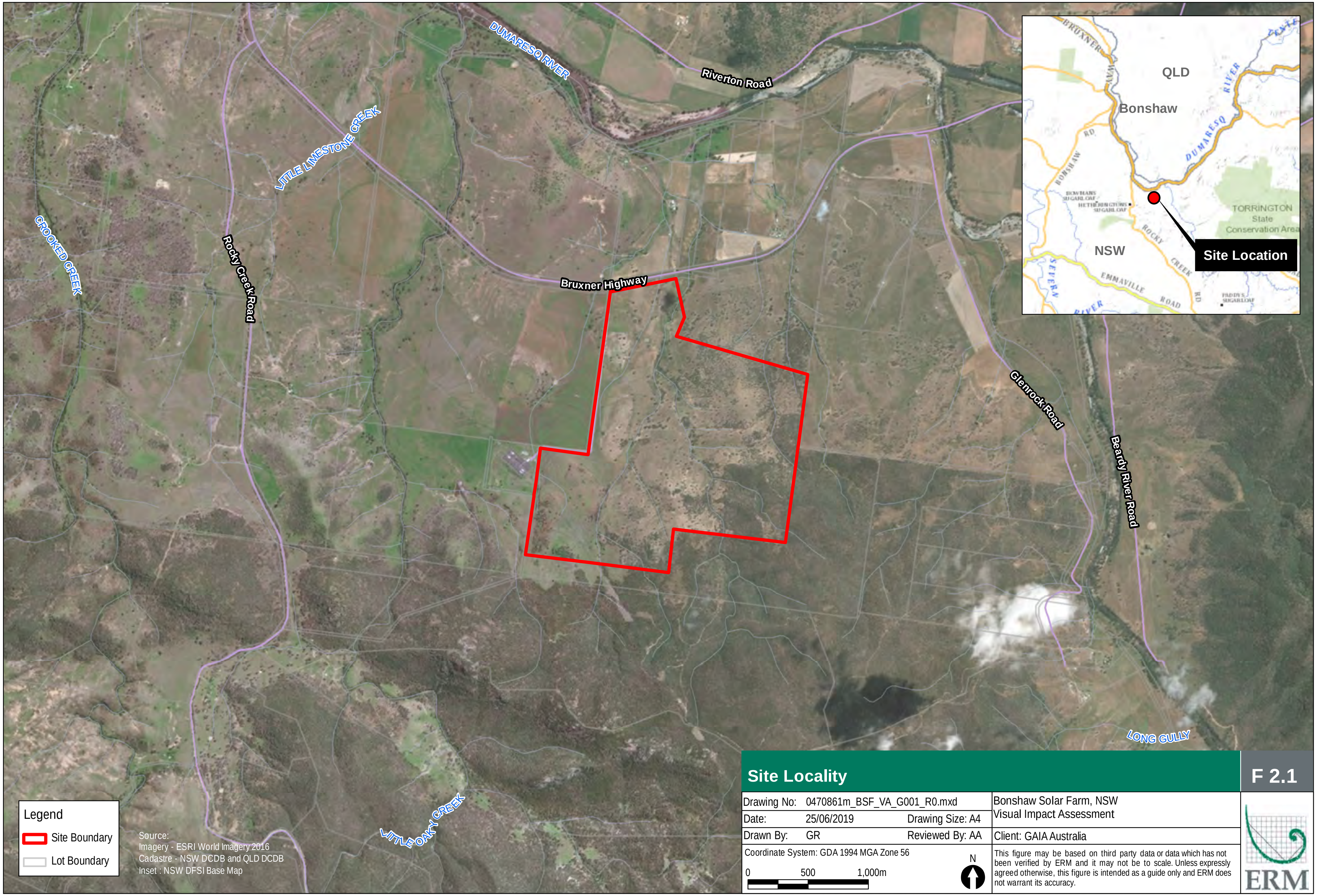
The proposed developed area is approximately 165 ha on part of Lot 2 on DP1039185. Connection of the Bonshaw Solar Farm will be to the 330 kV TransGrid Dumaresq Substation located on the adjoining Lot 210 on DP879480. Access to the site is proposed via the existing access from the Bruxner Highway.

The project will be developed with arrays of photovoltaic (PV) modules (commonly referred to as "solar panels"); incorporating transmission infrastructure and substations to enable connection into the existing electricity transmission network. The project will have a targeted 'sent out' electricity generating capacity of up to 200 megawatts (MW) (AC) and a BESS/battery storage with up to 300 MW (AC) . The exact method and point of connection is being developed in conjunction with TransGrid in parallel with this planning application and the detailed infrastructure layout developed during detailed design will confirm the generating capacity of the Bonshaw Solar Farm.

Figure 2-2 is a Site Proposed Layout in concept form.

The Project would include:

- a network of PV modules in a fixed tilt or single axis tracking arrangement;
- a switch yard to be connected to the 330 kV TransGrid Dumaresq Substation, on the boundary of the Project Area.
- associated battery energy storage system (BESS) / battery storage;
- underground or overhead cabling for connection between arrays and inverters and transformers;
- operations and maintenance (O&M) infrastructure, including:
    - O&M buildings including a control room, meeting facilities, a temperature ‐ controlled spare parts storage facility, supervisory control and data acquisition (SCADA) facilities, a workshop and associated infrastructure (eg kitchen, toilets and other facilities); and
    - car parking facilities;
- access from Bruxner Highway; and
- a new internal road network to enable access from surrounding local roads to the array areas during construction and operations including internal access tracks, creek crossing and perimeter security fencing;



Legend

🟥 Site Boundary

☐ Lot Boundary

Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Inset : NSW DFSI Base Map

Site Locality

F 2.1

Drawing No: 0470861m_BSF_VA_G001_R0.mxd

Date: 25/06/2019 Drawing Size: A4

Drawn By: GR Reviewed By: AA

Coordinate System: GDA 1994 MGA Zone 56

0 500 1,000m

Bonshaw Solar Farm, NSW
Visual Impact Assessment

Client: GAIA Australia

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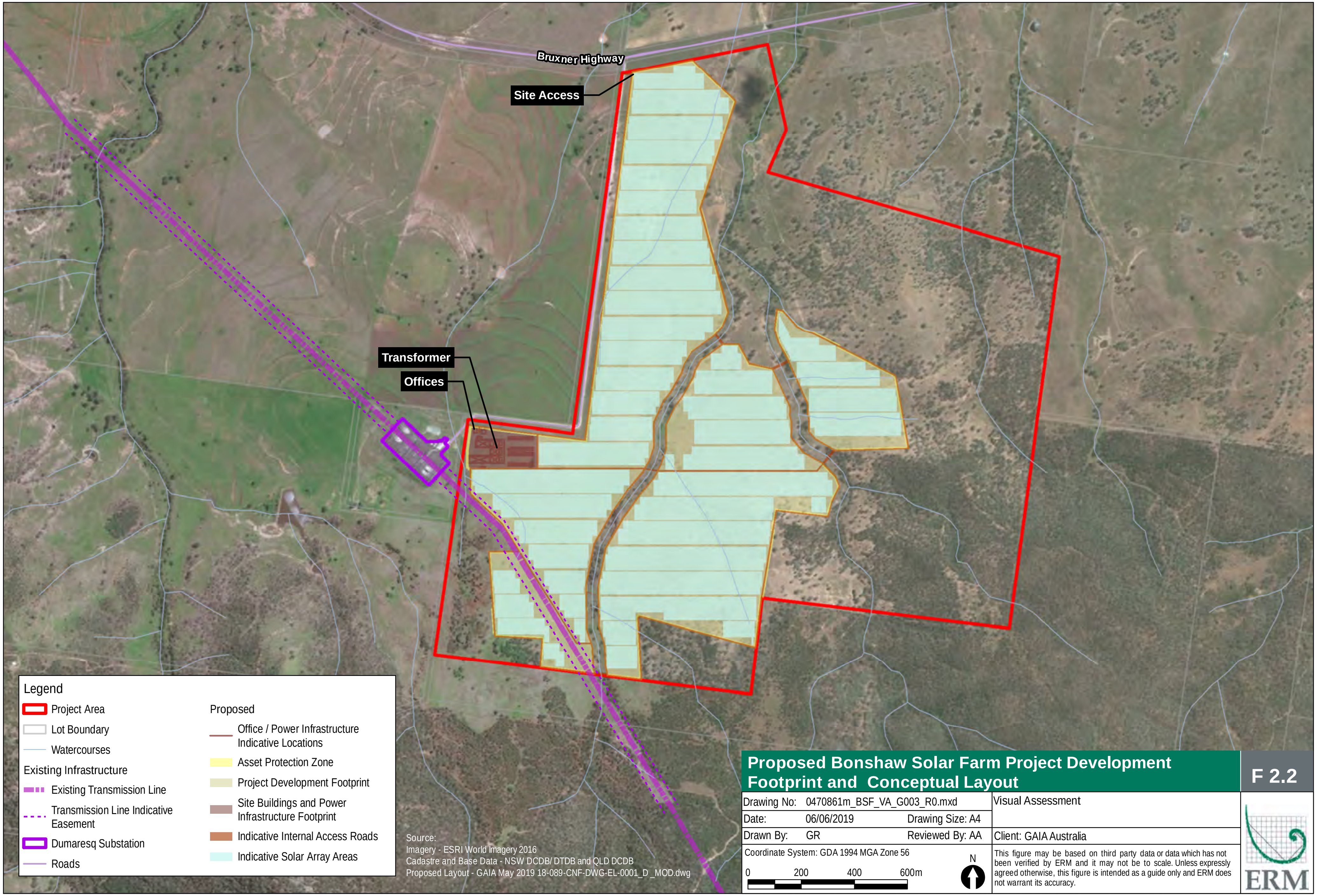
ERM



Source:
Imagery - ESRI World Imagery 2016
Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg

Proposed Bonshaw Solar Farm Project Development Footprint and Conceptual Layout

F 2.2

Drawing No: 0470861m_BSF_VA_G003_R0.mxd		Visual Assessment
Date: 06/06/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: AA	Client: GAIA Australia
Coordinate System: GDA 1994 MGA Zone 56		This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

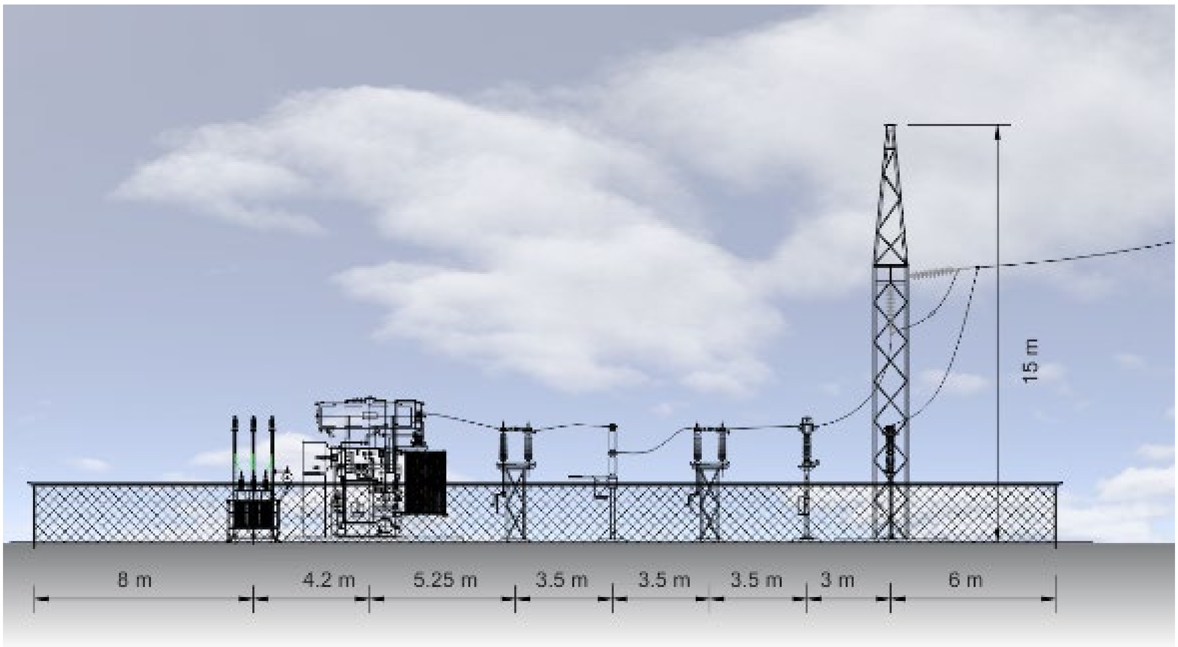
ERM

2.1 Switch yard

A new dedicated solar farm switch yard will be built to connect the Project to the existing Dumaresq Substation. The switch yard will be located within a fenced enclosure at the south-western boundary of the site.

The substation will generally comprise of voltage switching equipment, protection and control equipment, one or multiple transformers and circuit breakers as shown indicatively in Figure 2-3 (indicative dimensions).

Figure 2-3 Typical Switch yard layout



Electrical infrastructure will generally comprise of open air infrastructure similar to that within the adjacent Dumaresq Substation albeit at a smaller scale. There are few, if any reflective surfaces.

The detail design and final location of the switch yard will be determined following permissions and approvals and prior to the construction phase.

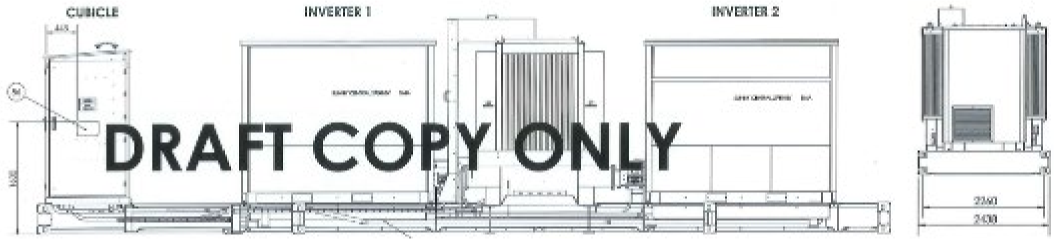
2.2 Inverters

Inverters will convert direct current (DC) electricity generated by the PV modules to alternating current (AC) for reticulation around the site and connection to the electricity grid.

Inverters will either be containerised or skid mounted in an open-air configuration. A containerised solution means inverters and transformers would be housed in shipping containers. The containerised option would be the larger and potentially more noticeable of the two options.

Figure 2-4 shows a skid mounted inverter arrangement, as proposed for the Project.

Figure 2-4 Inverter building



The inverter containers (enclosed or open) are similar, if not smaller, in size and scale to many structures found in the area such as sheds and equipment storage.

2.3 Operations and Maintenance Infrastructure

The control building and maintenance shed each will be approximately 400 - 800 m^2 and approximately 5 m in height. The control building, maintenance shed and car park are proposed close to the proposed substation in the south-west of the site.

These buildings are similar in size, scale and cladding to many other farm sheds, buildings and structures found in the landscape.

2.4 Access Tracks

Access tracks will be required to construct the Project and for ongoing maintenance. External access tracks will be approximately 6 m in width. Site internal tracks will be approximately 4 m in width. Both require local widening in some areas to clear natural features or allow for turning radius of larger vehicles. Where possible, existing farm tracks will be upgraded to reduce the construction of new access tracks.

Construction of new access tracks will require removal of topsoil to a suitable founding layer. The running surface will be constructed by placing and compacting the road base layer.

2.5 Construction

The period from commencement of construction through to completed tests following commissioning of the Project is expected to be approximately 12 months. This period is dependent on weather and ground conditions, as well as, detailed design and delivery of equipment. Construction activities, which are likely to have a landscape and/or visual impact, are likely to be the following:

- Temporary construction compound(s);
- Internal site access tracks;
- Establishing foundations and hardstands;
- Substation and grid connection networks;
- Excavation of trenches and the laying of power and instrumentation cables;
- Erecting PV Arrays; and
- Vehicular traffic.

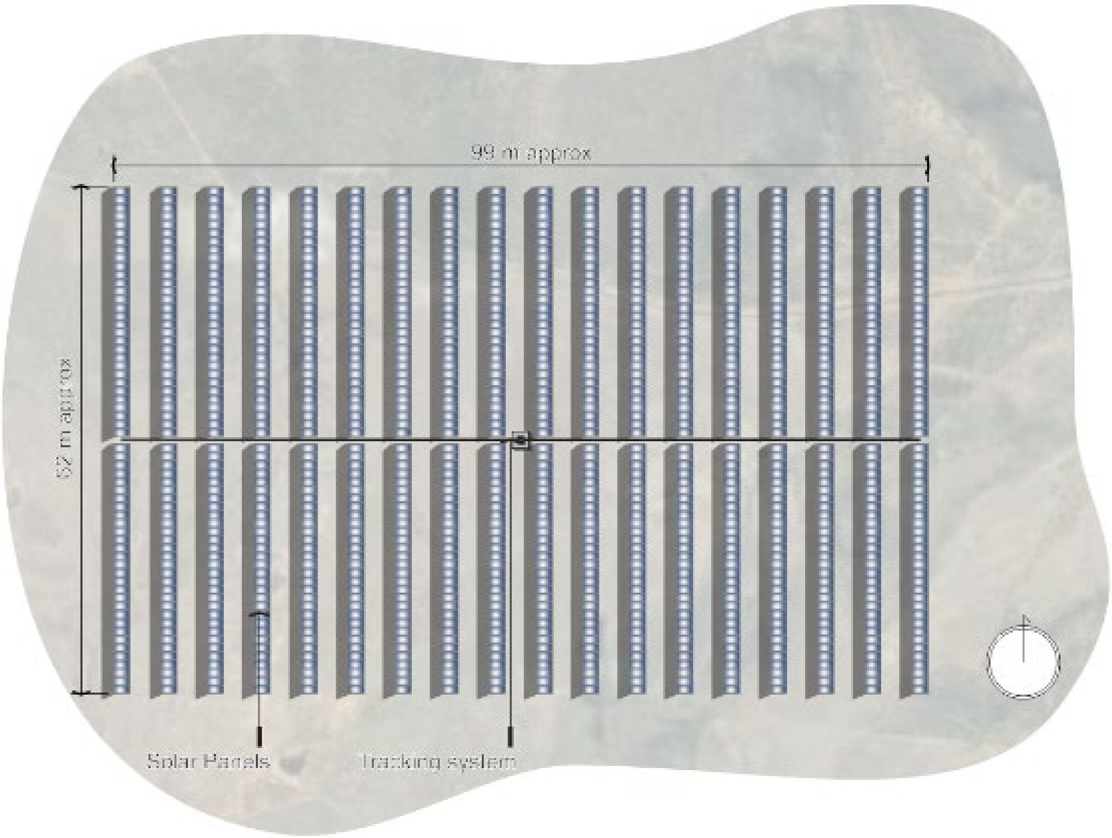
The most noticeable element of the Project would be the Photovoltaic Array.

2.6 Photovoltaic plant array

The PV array will be the largest component of the Project. The array is also the largest potential contributor to glare.

The final configuration of the PV layout will be subject to final choice of technology and final design, the Project will be similar to that described within this section. For the purposes of this report, the assessment has been based on a typical block design approximately 100 m long by 62.0 m wide with rows spaced approximately 5.0 m apart. These dimensions will alter based on site constraints such as boundaries, existing vegetation and access tracks. Figure 2-5 shows the layout and arrangement that has been assumed for the glare assessment.

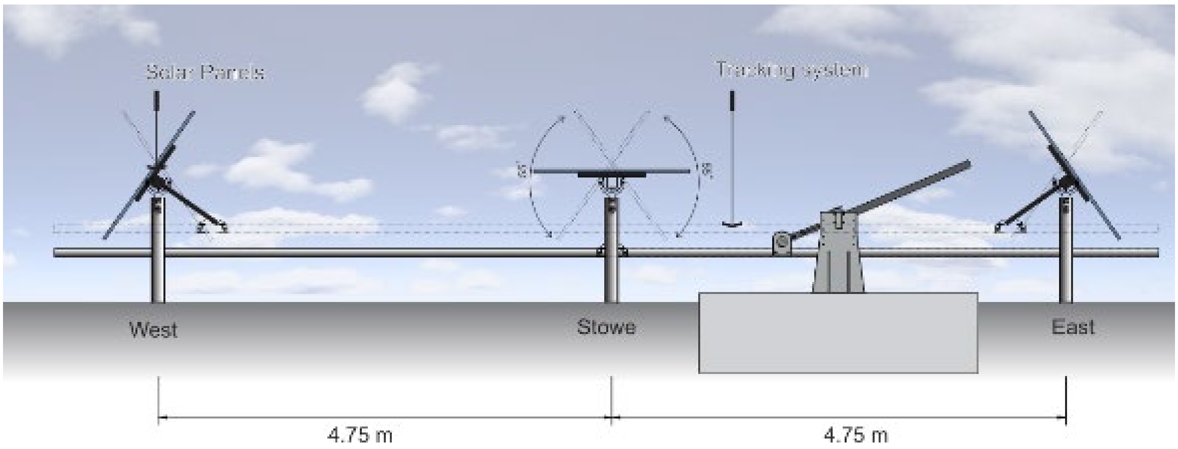
Figure 2-5 Photovoltaic block



The array comprises of PV solar modules mounted horizontally, east west orientated, on a single-axis tracking system support frame, which runs from north to south. Each panel is approximately 2 m high x 1 m wide. The tracking system follows the sun path from the east in the morning to the west in the afternoon, to maintain the best possible sun angle for the PV modules throughout the day. A backtracking function ensures that the module rows are not shading each other to achieve the ‘optimal sun angle’, the system tracks back to a point where shading is avoided. After sunset, the Panels will return to face east.

Figure 2-6 shows the tracking system and rotational angles of the PV panel configurations.

Figure 2-6 Tracking system and rotation angle



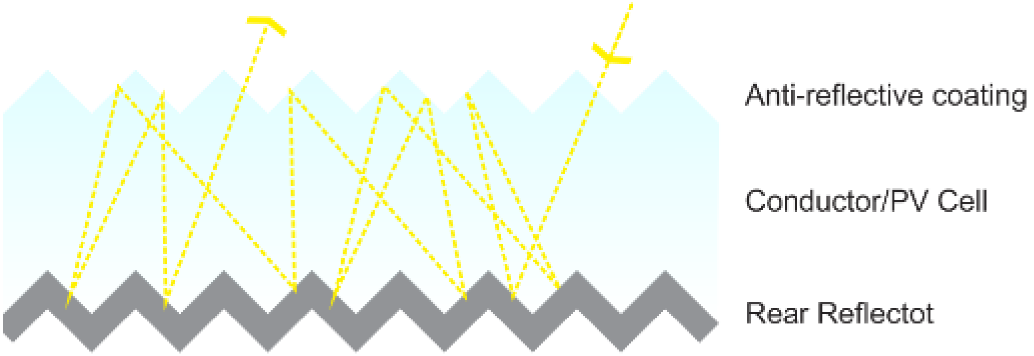
The operational rotation range of the tracking system is approximately 120 degrees from east to west depending on the system used. The height of the PV panels above natural ground is approximately 1.4 m to 4.2 m based on tracer option to be used.

Individual PV panels are constructed using a “high-transmission, low-iron” glass which has lower reflectance and therefore glare than that of normal glass. A coating applied to the panel surface applies a stippled finish to further diffuse the reflected light and therefore energy. The stippled finish gives the panel a hazy appearance as opposed to standard glass.

A solar panel comprises photovoltaic cells, which are either mounted on a supporting frame behind a non-reflective tempered glass layer. Alternatively, if the modules are based on the latest dual-glass (also known as “glass-glass” or bifacial) design, no frames are involved, which significantly reduces the potential for glint and glare. The specific PV modules for the Project have not yet been selected and will not be selected until closer to the commencement of construction.

To be conservative this assessment assumes the use of a traditional framed panel design.

Figure 2-7 Panel Surface



Light trapped or absorbed light within the layers of the solar cell transfers a larger percentage of light to the solar cell than that of reflective surfaces or traditional glass.

Photovoltaic efficiency describes the efficiency or percentage of radiation (sun) energy that can be converted into electrical energy. The more light that can be absorbed by a solar panel, the more efficient the process. For these reasons, photovoltaic panel surfaces are designed to absorb as much light as possible and limit reflection. However, glare or reflection can still occur at various times throughout the day. The panel configuration and assumptions made within the Solar Glare Assessment are discussed at *Section 6* of this report.

2.7 Battery and Energy Storage System

The Project includes the addition of a BESS. A 1.5 ha footprint area has been set aside for the installation of the BESS. Given the substantive advances in storage technologies over time, the exact storage capacity cannot be confirmed at this time, however it is anticipated that a 100MW facility, expandable by a further 200MW would allow the optimisation of the Project in the NEM and aide as frequency stabilizer and safety net of the nearby transmission and distribution system. Option to build a 200MW BESS for safety net is currently under discussion with Transgrid as a part of 'Expanding NSW-QLD Transmission Transfer Capacity' program.

The major components for each BESS include Batteries, Inverters, Transformers, Heating ventilation air conditioning (HVACs), Fire protection. The specific design details for the BESS have not been confirmed and will not be known until the completion of the detailed design stage of the project and general descriptions are as below.

The BESS would either comprise multiple individual cubicles each of circa 130kW; 160kWh, which would be skid mounted and pre-commissioned in packs of 8 to 10 battery cubicles with 2 inverters. Or otherwise a containerised system of circa 10MW capacity per container. Either option would appear similar, as the individual cubicles would be arranged in such a way as to appear as a single container.

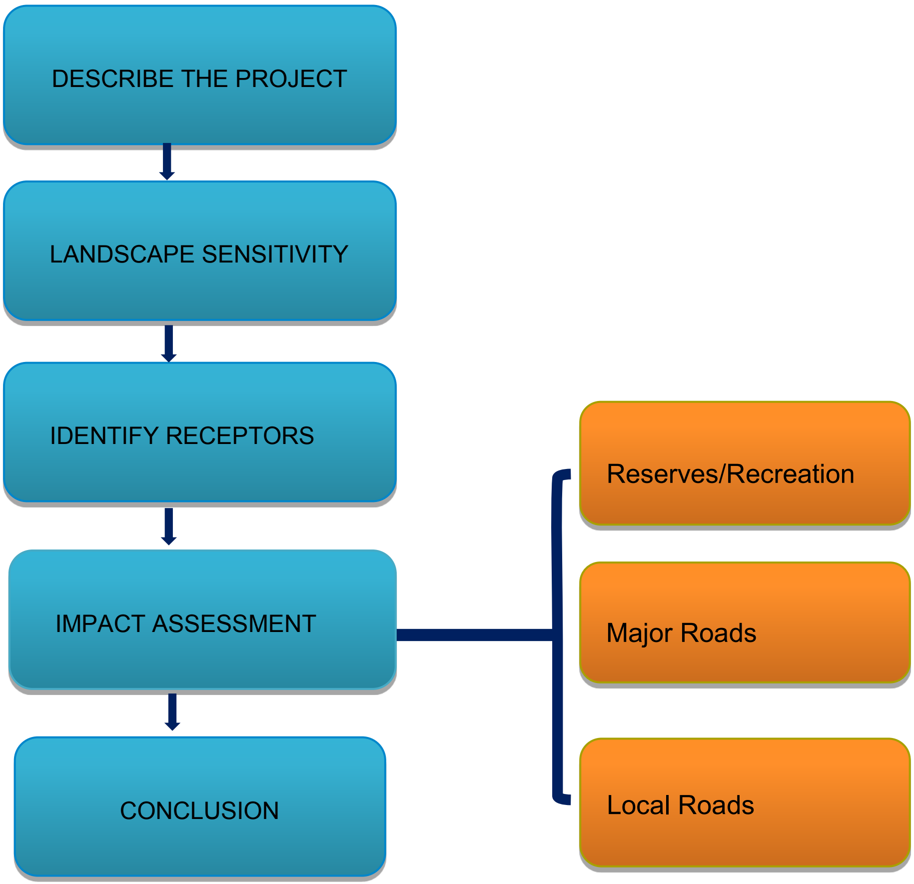
Indicative battery modules would be of the order of 2.5 m in height. An example battery pack is shown below in *Figure 2-8.*

Figure 2-8 Example Battery Module

3. METHODOLOGY

The methodology used within this Visual and Glare Assessment is set out below.

Figure 3-1 Assessment Methodology



3.1 Visual Assessment Methodology

In assessing the visual impact of a solar project from the public domain, the assessment of visual impact is based on four criteria, namely visibility, distance, landscape character & viewer sensitivity and the number of viewers.

- **Visibility**: The visibility can be affected by intervening topography, vegetation and buildings.
- **Distance**: Visibility decreases as distance increases. The Zones of Visual Impact (ZVI) give an indication of the impact based solely on distance.
- **Landscape character and viewer sensitivity**: The character of the surrounding landscape, both around the site and adjacent to the viewing location, must be considered. Generally, a modified landscape such as farmland is considered of low sensitivity, whereby a pristine landscape such as a national park is considered highly sensitive. Similarly a greater sensitivity to visual change is afforded to a residential area or township than that of an industrial landscape.
- **Number of viewers**: The level of visual impact decreases where there are fewer people able to view the Project. Alternatively, the level of visual impact may increase where views are from a recognised vantage point. Viewer numbers from a recognised vantage point would be rated as high.

These four criteria need to be considered in the assessment of each viewpoint. However, the ratings of each criterion are not numerically based and cannot be simply added together and averaged to arrive at an overall rating.

3.2 Glare Assessment Methodology

The assessment of potential for solar glare impacts utilises the Solar Glare Hazard Analysis Tool (SGHAT) developed by Sandi National Laboratory to predict the potential glare from selected locations.

Glare hazard is the human impact caused by exposure to reflected light. Factors that contribute to glare hazard for a solar farm include:

- Reflectivity of surfaces;
- Angle of incidence;
- Strength of the light source;
- Receptors; and
- Distance

Glare can only occur where there is direct line of site to the Project. Views that are filtered or screened by vegetation would reduce the potential for glare affects to occur.

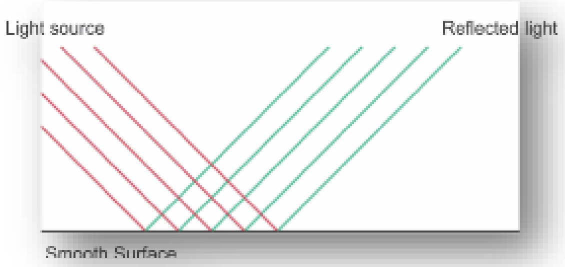
3.3 Reflectivity

Specular and Diffuse reflection are the two main types of light reflection caused by the sun reflecting off the surface of solar panels.

Specular reflection occurs when light is reflected from a smooth surface. In specular reflection, reflected light is usually parallel and the angle of reflected light is similar to that of the incoming light source.

Specular reflection is experienced as a flash similar to that of a moving car windscreen.

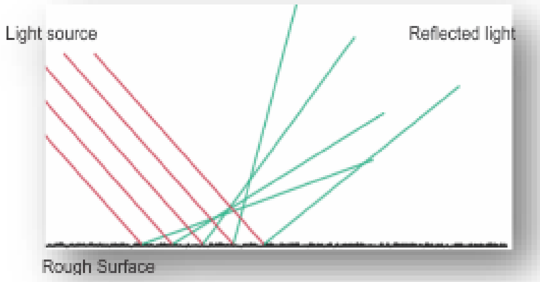
Figure 3-2 Specular reflection



Diffuse reflection occurs when light is reflected from a dull or matt surface. The reflected light is scattered with inconsistent angles. The rougher the surface, the more diffused the reflection.

Diffuse light is usually experienced as a glow, and although usually less intense than specular reflection, the glare effects of diffuse reflection can be longer lasting than Specular reflection.

Figure 3.3-3 Diffuse reflection



The amount of light reflected from a PV panel depends on the amount of sunlight hitting the surface as well as the surface reflectivity. The amount of sunlight exposure will vary based on geographic location, time of year, cloud cover, and solar panel orientation.

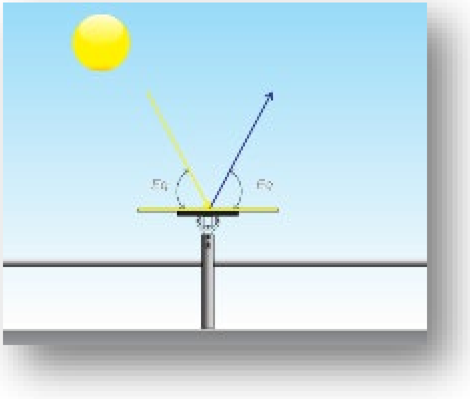
3.4 Reflection and Angle of Incidence

Angle of incidence describes the angle at which a line or trajectory (in this case light) deviates from perpendicular to a surface.

The angle of incidence alters as the sun moves across the sky and during various times of the year. The angle of incidence for the sun is at its lowest around noon where the sun is directly overhead and at its highest at dawn and at dusk.

At a simple level, a single-axis tracking PV array, as is being proposed for the Project, is designed to optimise the efficiency by reducing the angle of incidence over the course of the day, which will also reduce the potential for glare. The tracking systems also utilise backtracking technology, to reduce shading-impacts of individual rows. This means that the angle of incidence will vary across individual rows early in the morning and later in the afternoon. These slight changes in angle have no significant impacts on glare.

Figure 3-4 Angle of incidence



4. LANDSCAPE CHARACTER

Landscape character is defined by areas with similar visual characteristics in terms of topography and geological features such as creeks and drainage lines, soil, vegetation and land use.

4.1 Land use

The predominant land use in the proximity of the Project is rural landscape used for grazing and some cropping with natural waterways and vegetated ridgelines. The 330 kV TransGrid Dumaresq Substation is located to the south-west of the proposed site with a 264 kV power lines running roughly in a south-easterly direction in the southern portion of the site.

The area to the north of the site between the Bruxner Highway and the Dumaresq River (which form the border between New South Wales and Queensland), is relatively flat land used for cropping and grazing, with some irrigation. Isolated farmsteads with associated out buildings and cattle yards are located in the area.

Figure 4-1 – Landscape north of the Bruxner Highway with isolated farms and associated out buildings on the river floodplain

Figure 4-2 Landscape north of the Bruxner Highway – level floodplain with grazing and cropping with larger Eucalypt trees along the Dumaresq River

The land to the north of the Bruxner Highway is predominately grazing and some cropping. The land use of the proposed site is largely grazing, with a few tree lined creeks. The area to the west of the site is cleared land and used for cropping. The land to the east is used largely for grazing. The land to the south of the proposed solar farm is heavily vegetated with native woodland.

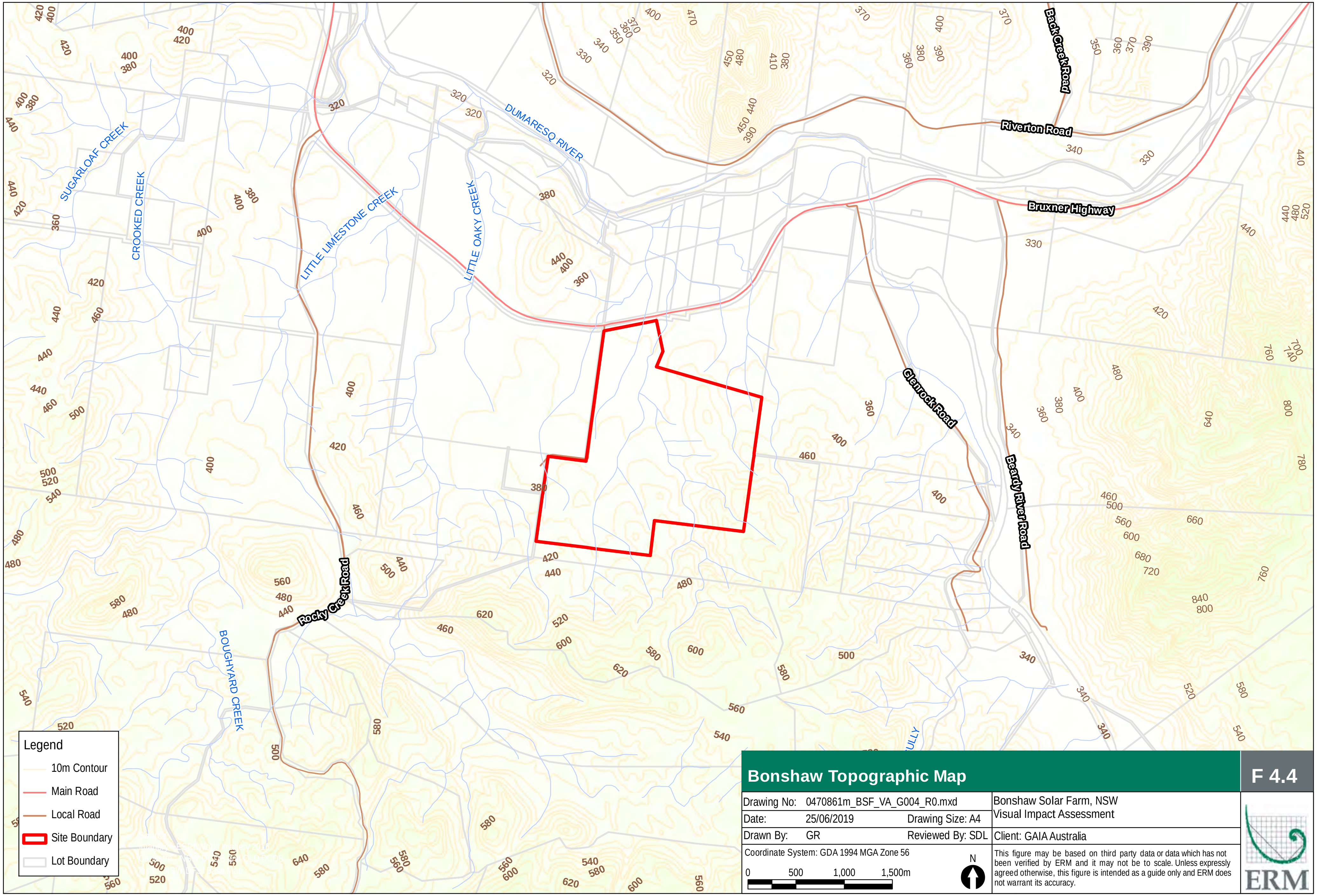
Figure 4-3 Landscape south of the Bruxner Highway – grazing land woodlands on foothills – proposed site in foreground

4.2 Topography

The Project and study area is located on the southern edge of the Dumaresq River floodplain and on the foothills of the ridge line running between Hetherington's Sugarloaf and Hasselmann Pinnacle. The topography within the study area is gently undulating and located between two low ridge lines, thereby forming a slight bowl. The land in proximity to the Bruxner Highway is relatively flat and becomes progressively steeper to the south.

The elevation at the Bruxner Highway (north boundary) is approximately 335 m and rises up to approximately 420 m in the south-western portion of the site. The ridgelines to the south of the project rise up to approximately 660 m forming the dominant landscape feature as shown in Figure 4-3 above and on the topographic map in Figure 4-4 below.

A smaller hill is located to the north-west of the site between the Bruxner Highway and the Dumaresq River which screens the site from views from the north and north-west.



Bonshaw Topographic Map

F 4.4

Drawing No: 0470861m_BSF_VA_G004_R0.mxd		Bonshaw Solar Farm, NSW Visual Impact Assessment
Date: 25/06/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: SDL	Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

0 500 1,000 1,500m

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4.3 Vegetation

The Dumaresq River valley consists largely of natural grasslands on basalt and fine textured alluvial plains of northern New South Wales and southern Queensland. The flood plain is largely cleared of native vegetation with isolated larger trees scattered across the landscape where irrigated fields and grazing dominate. The Dumaresq River is lined on both sides by various large eucalypt tree species.

The area to the south of the Bruxner highway is dominated by open grasslands with wooded waterways with the vegetation becoming progressively denser further south into the foot hills. Larger eucalypt species on granite become more prevalent to the south of the proposed development.

4.4 Landscape units

Three landscape units have been identified within the view shed of the Project.

4.4.1 Cultivated Farmland

Cultivated farmland have been largely cleared of remnant vegetation for agricultural purposes. These areas regularly undergo visual change through cropping practices and are prevalent to the north and west of the proposed site.

Rural farmsteads and related outbuildings, cattle yards and irrigation systems are located along the Bruxner Highway and are generally associated with landscaping and trees around the homesteads. The cultivated areas are generally located on the more fertile and level floodplain and on the lower level slopes of the surround valleys. The landscape is ever changing with the season, from crops through to ploughed fields. These areas are less sensitive to clearing or development due to transformed landscape. Being relatively flat, the visual impacts from surrounding land is generally low as they may be effectively screened.

4.4.2 Grazing Land

The lower and middle slopes of the valley is dominated by grasslands used for grazing. These tend to be the less fertile areas and have isolated stands of trees with partially wooded creek lines. The density of the vegetation tends to increase towards the south closer to the rockier, steep and less fertile soils. Due to the high level of clearing, and provided development maintains the creek lines, sensitivity to changes is seen a low to medium.

4.4.3 Natural Woodland

The steeper rockier slopes to the north of the site are dominated by more dense woodland vegetation which dominate the ridgelines. Any clearing in these areas are generally visible from the surrounding landscape and have a high level of sensitivity to clearing or development.

5. SCALE OF EFFECTS

This section will describe the scale of effects used to determine visual and glare impacts of the Project.

5.1 Visual

The scale of effects, for rating the overall visual impact of the Project from publicly accessible viewpoints, may range from no impact (nil) to a potentially high visual impact.

- **Nil or No Impact** – there is no perceptible visual change.
- **Negligible** – minute level of effect that is barely discernible over ordinary day-to-day effects. The assessment of a “negligible” level of visual impact is usually afforded where the Project is at such a distance that it would be barely discernible or when features in the landscape would screen or filter views.
- **Low** – visual impacts that are noticeable but will not cause any significant adverse impacts. The assessment of a “low” level of visual impact can be derived if the rating of any one of four criteria, (visibility, distance, viewer numbers and landscape sensitivity) is assessed as low.
- **Medium** –The assessment of a “medium” visual impact will depend upon all four assessment criteria being assessed as higher than “low.” Significant effects are also such that they may be mitigated / remedied.
- **High** or **unacceptable** adverse effect – extensive adverse effects that cannot be avoided, remedied or mitigated. The assessment of a “high or unacceptable adverse effect” from a publicly accessible viewpoint requires the assessment of all three criteria to be high. For example, a highly sensitive landscape, viewed by many people, with the Project in close proximity and therefore largely visible would lead to an assessment of an unacceptable adverse effect
- **Positive** – is a change that may improve the outlook or view.

5.2 Glare

Glare effect can be described as the presence of light within the human field of vision that will result in visual discomfort or impairment. This can be experienced when looking at a reflection of the sun from a surface such as glass, water or metal.

The assessment of the effect of glare varies depending on the intensity of the incoming light, relativity to the field of human vision, duration of exposure, size of the glare and distance of the receiver from the glare source.

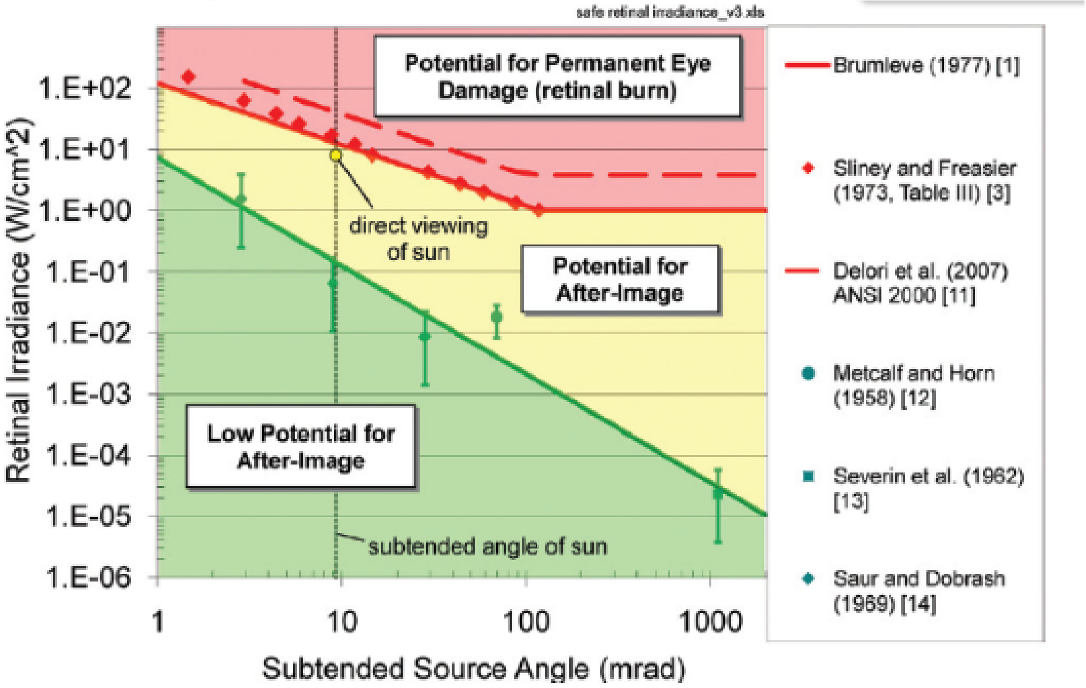
Glare is defined as either discomfort or disability glare. Discomfort glare creates difficulty in seeing the object(s) being focussed upon. Disability glare can impair vision for a short or sustained period. Disability glare is a primary and common cause of concern in relation to traffic safety.

This study uses the following scale of effects for assessing the glare impacts of the Project:

- **Nil effect -** No recorded glare effect at the specified location at any time of the year.
- **Low potential for after image -** Adverse effects that are noticeable however will not cause any significant adverse impacts.
- **Potential for After Image -** Significant effects that may be require mitigation and / or remedied.
- **Potential for Permanent Eye Damage -** Potential for permanent adverse effects that will require mitigation or design changes.

This scale (refer to Figure 5-1 is used when describing the overall Glare Assessment of the Project from indicative publicly accessible and residential observation points.

Figure 5-1 Ocular Impacts and Hazard Ranges



5.3 Solar Glare Hazard Assessment Tool (SGHAT)

ForgeSolar tools are used throughout the world by industry, academia, and military to evaluate PV glare. Based on the R&D 100 Award-winning SGHAT technology, ForgeSolar accommodates FAA, zoning, and other regulatory requirements.

The tool uses latitude and longitudinal coordinates and elevation data from Google Earth in conjunction with proprietary algorithms software to predict the sun position and angle at various times throughout the year.

Information such as the size, type and orientation of the PV arrays, type of solar panels and height above ground level are used to determine potential glare affects from determined viewpoints. The tool will predict glare potential at a nominated observation point as well as the magnitude of potential ocular impact based on the scale of effects identified in *Section 5.2* Scale of Effects (Figure 5-1).

To be conservative, a rotation range of 120 degrees (+/- 60 degrees) and a maximum height of 4.0 m is used in all modelling. A full set of parameters are set out in *Section 6* below.

6. VISUAL AND GLARE IMPACT ASSESSMENT

6.1 Site Visibility Analysis

The first part of the visual and glare assessment is to identify areas where the proposed development may be visible from. Through the use of Geographical Information Systems (GIS) mapping, the theoretical Project visibility is plotted. This theoretical Site Visibility Analysis does not take into account screening offered by vegetation, minor topographic changes and buildings, which may reduce the visibility from many locations. For these reasons, the GIS analysis is a conservative visibility map and is useful to determine locations from which to assess the Visual and Glare Impacts of the Project.

Figure 6-1 is a Site Visibility Analysis which identifies the location of the solar farms, the areas where any part of the proposed development that may be seen from and the amount of the area seen as a percentage. Sensitive receptors are also mapped.

Areas where no shading exists means that no part of the proposed development is visible form these areas and therefore have no potential for visual or glare impacts.

A site visit was undertaken to verify the findings and refine the location of viewpoints based on actual visibility. The site visit also provided insight into the landscape character of the area.

The visual and glare assessments are discussed separately below.

6.2 Visual Impact Assessment

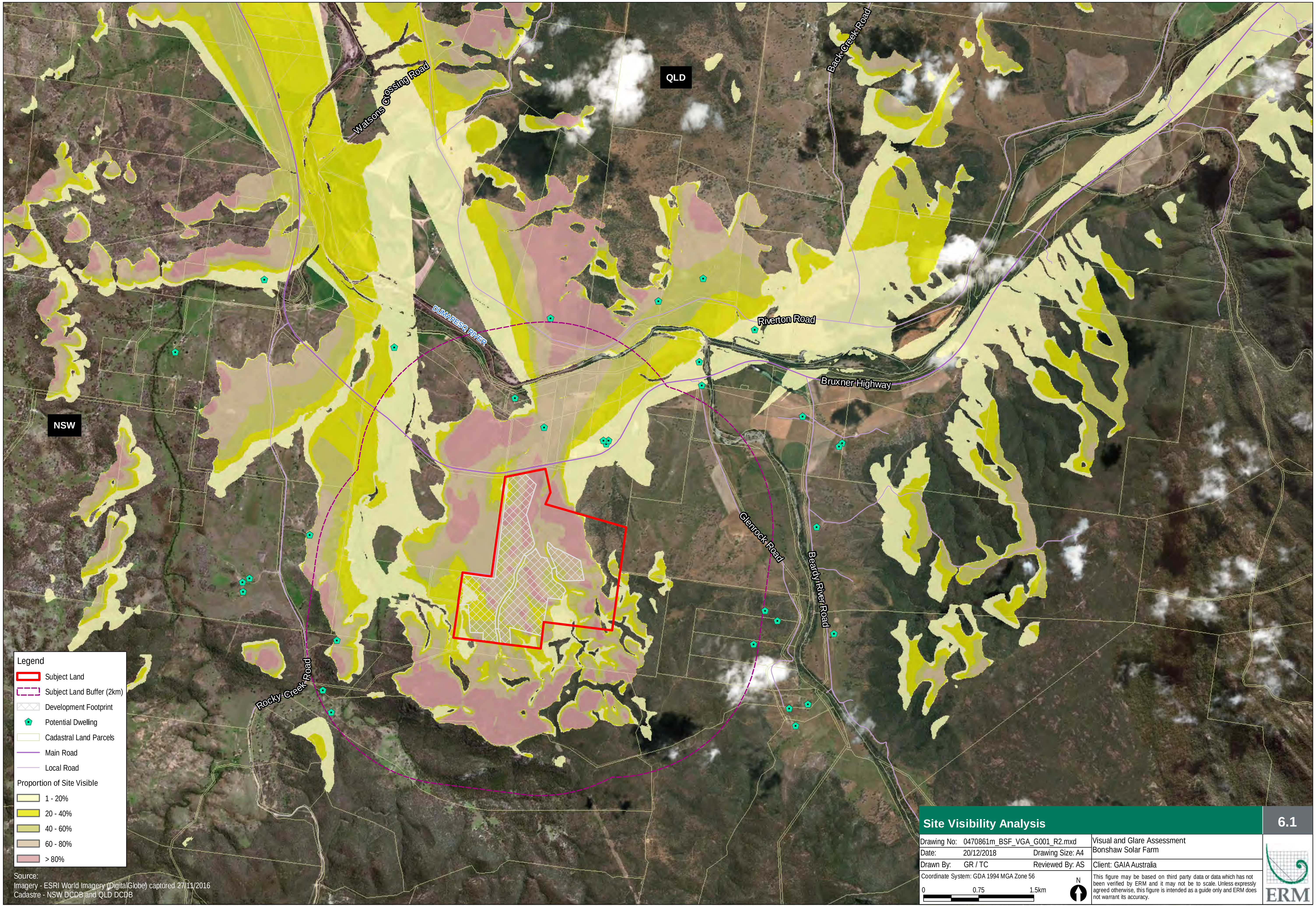
6.2.1 Viewpoints

Eight viewpoints (refer to Figure 6-2) have been selected that have theoretical visibility of the Project.

Viewpoints are selected on the following basis:

- their potential to indicate the scale and extent of the Project at varying distances;
- where a viewer has a likelihood to pause and have a view to the Project such as gaps in roadside vegetation or near road intersections; and
- where it is indicative of the landscape characters defined within the Project area.

Viewpoints are typically located where direct or clear views to the Project are available. In some viewpoints, vegetation within road reserves, river or on private properties may filter views to the Project.



Source:
Imagery - ESRI World Imagery (DigitalGlobe) captured 27/11/2016
Cadastre - NSW DCDB and QLD DCDB

Site Visibility Analysis

6.1

Drawing No: 0470861m_BSF_VGA_G001_R2.mxd
Date: 20/12/2018 Drawing Size: A4
Drawn By: GR / TC Reviewed By: AS
Coordinate System: GDA 1994 MGA Zone 56

Visual and Glare Assessment
Bonshaw Solar Farm
Client: GAIA Australia

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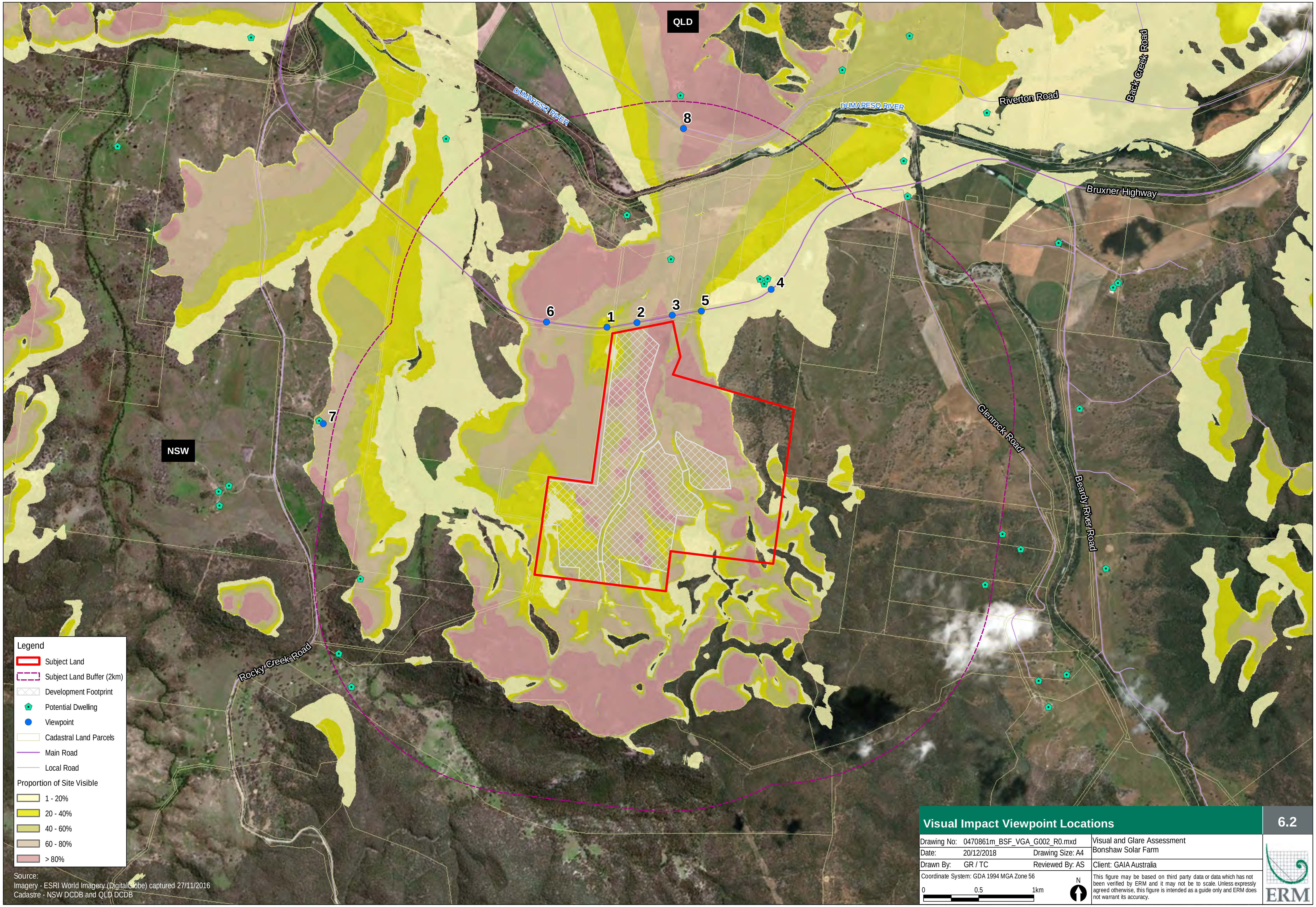

Source:
Imagery - ESRI World Imagery (DigitalGlobe) captured 27/11/2016
Cadastre - NSW DCDB and QLD DCDB

Visual Impact Viewpoint Locations

6.2

Drawing No: 0470861m_BSF_VGA_G002_R0.mxd
Date: 20/12/2018
Drawing Size: A4
Drawn By: GR / TC
Reviewed By: AS
Coordinate System: GDA 1994 MGA Zone 56

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Bonshaw Solar Farm

Client: GAIA Australia

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6.2.1.1 Viewpoint 1

Viewpoint 1 is located to the west of at the north-western corner of the proposed site from the Bruxner Highway near the entrance to the Transgrid Dumaresq Substation looking south.

Figure 6-3 illustrates the views from this location with the red line denoting the approximate location of the solar farm. Due to the topography, only approximately 5% of the northern portion of the site is visible from this location. The wide road reserve and low ridge line to the east of the Transgrid Dumaresq Substation access road effectively screens most of the site from this location.

Impact from this vantage point is deemed to be **medium to low** as only a small part of the site is visible and is set below the ridge line. The limited amount of time that the site is visible when driving along this route further reduces the impact. The relatively narrow visual profile of the solar farm against the existing landscape with the foreground and distant ridges further soften the impact.

Mitigation Measures: A five (5) meter landscaping strip to the east of the Transgrid Dumaresq Substation access road boundary from the north-western boundary to the ridge line (400 m) will mitigate any impacts and result in a **low** level impact.

Visual Impact Assessment - Viewpoint 1

F6.3

Drawing No:	0470861b_BS_VGA_C001_R0.cdr		**Bonshaw Solar Farm**
Date:	20/12/2018	Drawing size: A4	
Drawn by:	DR	Reviewed by: AS	Client: GAIA Australia

0 10 20m

N

ERM

6.2.1.2 Viewpoint 2

Viewpoint 2 is located immediately to the north of the site on Bruxner Highway looking south-east through to south-west. Views from this location cover approximately 30% of the site with the topography screening the central and southern portions of the site. Figure 6-4 is a photo-collage of this view.

The visual impact is deemed to have a **medium** impact due to the proximity of the site to the road.

The relatively short distance that the solar farm will be visible reduces the overall impact while travelling along the Bruxner Highway as the frontage is only 270 m. The site is also relatively low in the field of vision with the southern ridge lines still visible. With the solar farm located at the foothills of the Hetherington’s Sugarloaf and Hasselmann Pinnacle to the south, the backdrop provides relief thereby further reducing the impact.

Mitigation Measures: A five (5) meter landscaping strip along the northern and north-western boundary will effectively mitigate the visual impact of the facility from this locality. This will reduce the overall impact to **low**.

Visual Impact Assessment - Viewpoint 2

F6.4

Drawing No: 0470861b_BS_VGA_C002_R0.cdr
Date: 20/12/2018 Drawing size: A4
Drawn by: DR Reviewed by: AS

0 10 20m

N

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6.2.1.3 Viewpoint 3

Viewpoint 3 is located at the entrance to Glenhill Farm, approximately 220 m to the north-east of proposed development. Figure 6-5 is a view from the entrance towards Glenhill Farm. Note the shed and cattle yards and vegetation screening the views of the farmstead. The farmstead is located 700 m to the north, north-west and views are limited and screened by vegetation around the homestead, the existing shed and stockyards. Impact from the homestead is seen to be **negligible to low**.

Figure 6-5 Viewpoint 3 looking north towards Glenhill Farmstead.

Figure 6-6 illustrates views looking south south-west from this location towards the proposed site.

Approximately 50-60% of the solar facility is likely to be visible from this location, with vegetation along the creek offering some screening. The impact is considered to be medium to low from this locality due to the distance (most of the visible area is over 500 m from this viewpoint), the relatively narrow view and the level terrain in the foreground will ensure that development in the foreground will screen part of the views behind it.

Mitigation Measures: None required due to existing landscape and distance to the facility.

Visual Impact Assessment - Viewpoint 3

F6.6

Drawing No: 0470861b_BS_VGA_C004_R0.cdr		**Bonshaw Solar Farm**
Date: 20/12/2018	Drawing size: A4	
Drawn by: DR	Reviewed by: AS	Client: GAIA Australia

0 10 20m

N

ERM

6.2.1.4 Viewpoint 4

Viewpoint 4 is located to at the entrance to 8930 Bruxner Highway, approximately 1,100 m to the north-east to illustrate views from this locality. Approximately 5% of the site may be visible, however is largely screened by vegetation and the ridgeline to the east of the site. The overall impact from this location is **negligible to low** due the distance, screening from the ridge line and vegetation and the fact that the sight is low in the view shed with the higher ridgelines dominating the view.

The farmstead at 8930 Bruxner Highway is approximately 1,050 m from the site boundary with only partial views of the solar facility beyond that, similar to that illustrated in Figure 6-7 below. The impact on the farmstead is deemed to be **negligible to low.**

No visibility of the site is occurs to the east of this point.

Mitigation Measures: None required.

Figure 6-7 – Visual Impact Assessment Viewpoint 4

6.2.1.5 Viewpoint 5

Viewpoint 5 (Figure 6-8) is taken approximately 450 m to the north-east looking south-west on the Bruxner Highway to illustrate the screening effect of the ridgeline, vegetation and road cutting that effectively screens views of the site when travelling towards to site from the east. This is essentially the first place where glimpses of the site emerge travelling south-west.

Mitigation Measures: None required.

Figure 6-8– Visual Impact Assessment Viewpoint 5

6.2.1.6 Viewpoint 6

Viewpoint 6 (Figure 6-9*)* is located approximately 620 m to the north-west from the Bruxner Highway looking generally south-east and is situated at the top of the ridgeline looking across cultivated land. This is also the first place the site becomes visible traveling in an easterly direction along the Bruxner Highway. T

This location provides most views of the site with approximately 50% of the site being visible. However due to the distance, the low profile of the viewshed in the landscape, the dominance of the ridge lines in the backdrop, the cultivated land with some mature trees and the relatively short duration the site is visible, impact is generally **medium to low** from this locality.

Mitigation Measures: Five (5) meter wide landscape strip along the northern and north-western boundary (distance of 400m) will provide screening in the northern portion of the site closest to the viewpoint. This will reduce the impacts to **low**.

Visual Impact Assessment - Viewpoint 6

F6.9

Drawing No:	0470861b_BS_VGA_C005_R0.cdr		**Bonshaw Solar Farm**
Date:	21/12/2018	Drawing size: A4	
Drawn by:	DR	Reviewed by: AS	Client: GAIA Australia

0 10 20m

N

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6.2.1.7 Viewpoint 7

Viewpoint 7 is located at the farmstead on 3894 Rocky Creek Road is located approximately 2.1 km to the west of the proposed solar farm. This site was chosen due to its elevation and potential views of the site from the homestead.

Figure 6-10 and Figure 6-11 illustrate the views from this location. Note the location of the Dumaresq Substation (right hand side of the photograph in Figure 6-10) and the large electrical pylons in the foreground. Visual impact from the solar farm are **negligible to low** from this location due to the distance, the limited view, other large electrical infrastructure in the middle ground and the dominance of the vegetated mountains in the backdrop. The low profile of the proposed development in the landscape also reduces the impact.

Mitigation Measures: None required due to the distance visibility

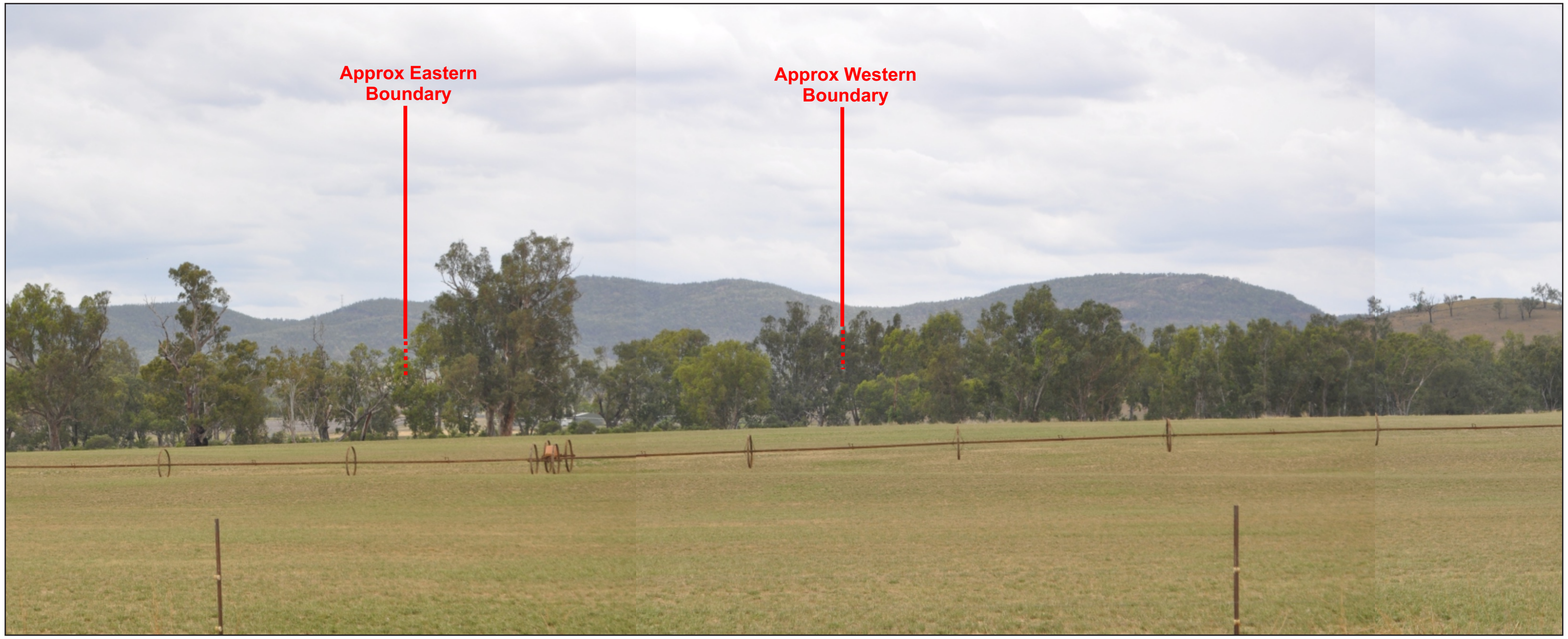
Figure 6-10 Visual Impact Assessment Viewpoint 7, south east

Figure 6-11 Visual Impact Assessment Viewpoint 7 south, south-east

6.2.1.8 Viewpoint 8

Viewpoint 8 is located approximately 1.9 km to the north of the Dumaresq River in Queensland. This location was chosen to illustrate the screening of the vegetation along the Dumaresq River provides from any location along Riverton Road. Figure 6-12 provides a wider view with the approximate location of the solar farm highlighted. There is therefore **no** impact from the area to the north of the Dumaresq River due to the distance and screening offered.

Mitigation Measures: None required.



Visual Impact Assessment - Viewpoint 8

F6.12

Drawing No: 0470861b_BS_VGA_C003_R0.cdr
Date: 21/12/2018
Drawing size: A4
Drawn by: DR
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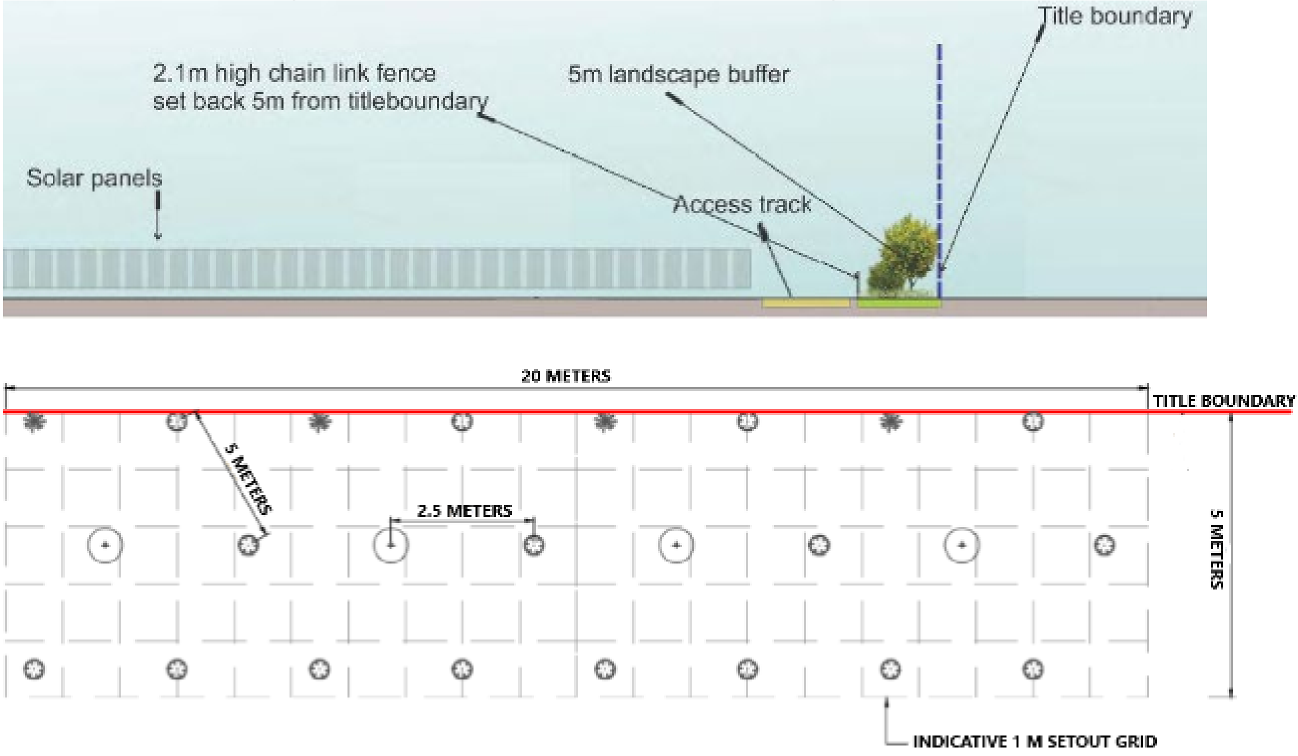
6.3 Landscape Mitigation Measures

The following landscape mitigation measures are proposed along the Bruxner Highway frontage and for 400 m along the north-western boundary adjacent to the Transgrid Dumaresq Substation access road and take in the rural landscape setting:

These include a 10 metre setback to solar farm infrastructure that includes a 5 metre landscape strip between the property boundary and Project fencing, with a perimeter access track between the fence and solar farm infrastructure (refer to Figure 6-13 below). The proposed landscaping treatment will utilise native species endemic to the area that will survive the climatic conditions and require minimal maintenance, while filtering the visual impact of the solar farm.

Figure 6-13 Proposed Landscape Mitigation



Ground Covers

Shrubs

Trees

Plant Density: 4 Ground Covers/100m^2

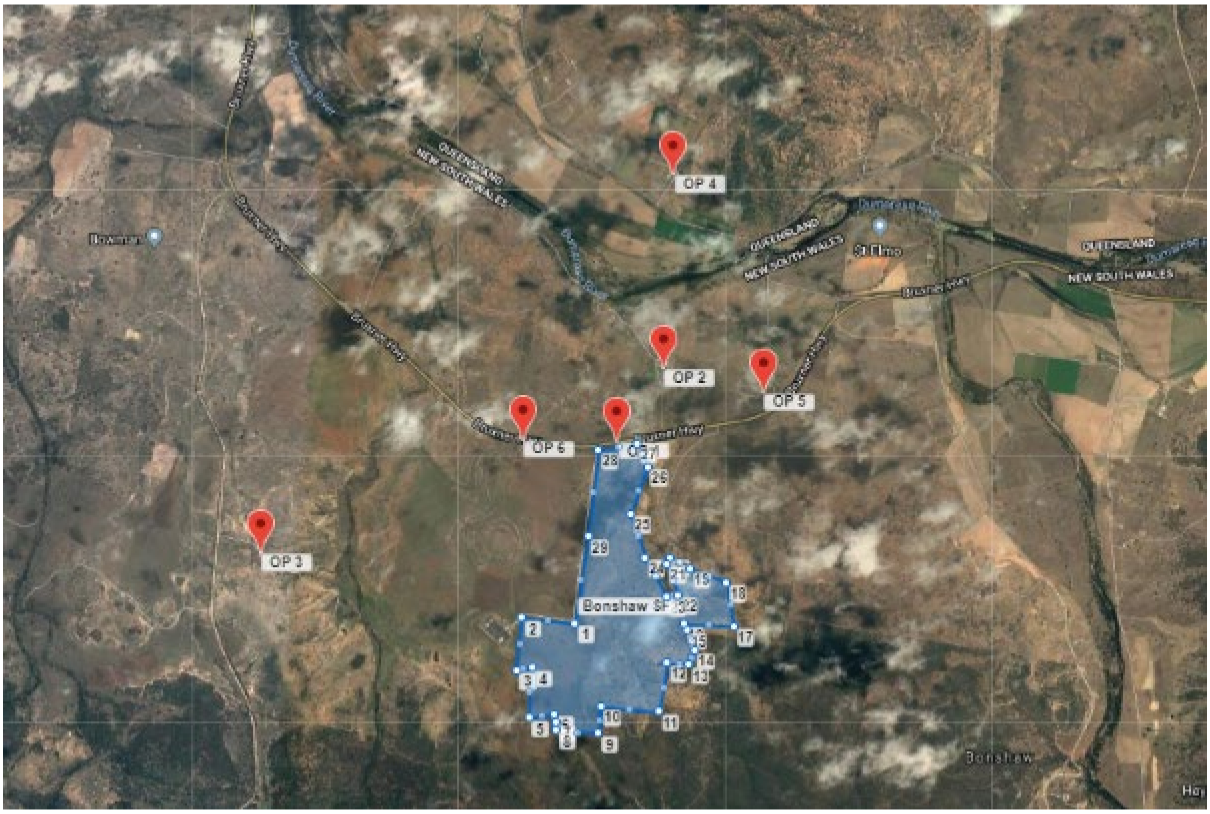
Plant Density 15 Shrubs/100m^2

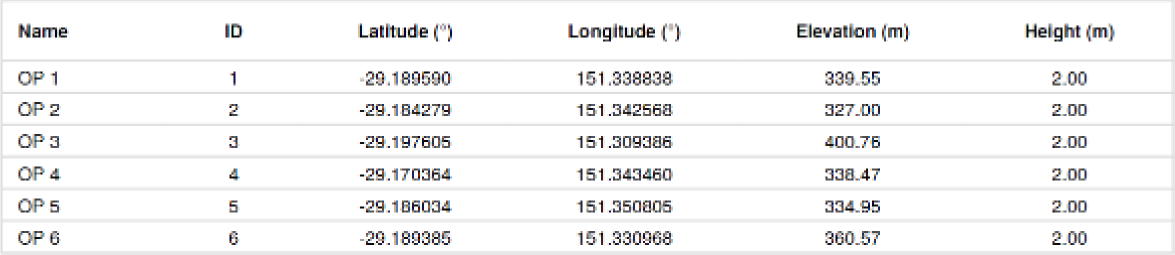
Plant Density 4 Trees/100m^2

6.4 Glare Impact Assessment

Figure 6-14 illustrates the location of the six observation points used to assess glare impacts. Observation Point 1 and 6 were chosen on the Bruxner Highway to the immediate north and north-west of the site. Observation Points 2 – 5 are taken from the identified sensitive receptors farmsteads where some visibility may occur.

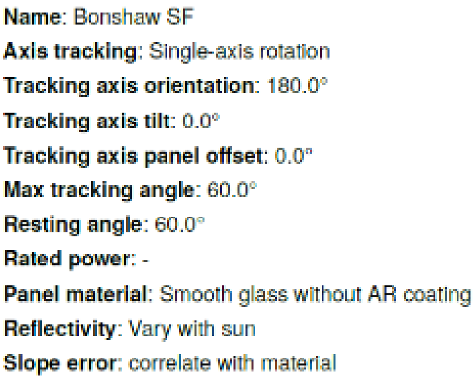
Figure 6-14 Glare Assessment Observation Points





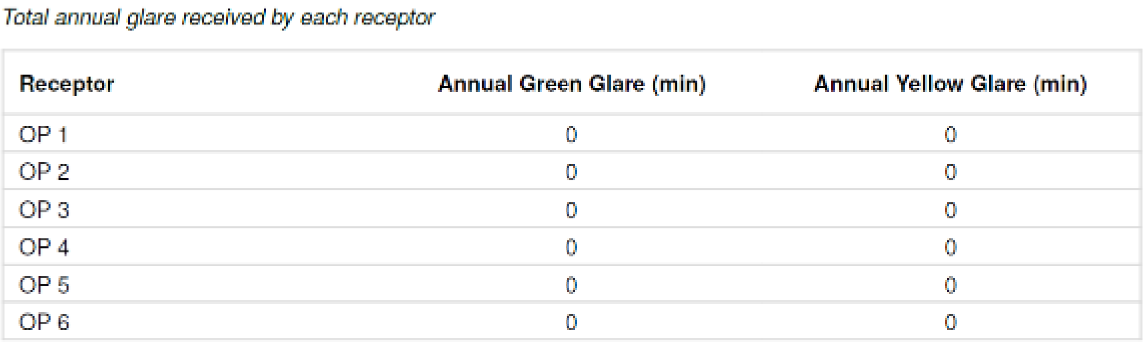
Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-29.189590	151.338838	339.55	2.00
OP 2	2	-29.184279	151.342568	327.00	2.00
OP 3	3	-29.197605	151.309386	400.76	2.00
OP 4	4	-29.170364	151.343460	338.47	2.00
OP 5	5	-29.186034	151.350805	334.95	2.00
OP 6	6	-29.189385	151.330968	360.57	2.00

The following parameters where used for the assessment: in the ForgeSolar Assessment Tool:



Name: Bonshaw SF
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 60.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

A single axis tracking system orientated north-south is proposed. The use of smooth glass without AR coating represents a conservative approach, as this represents the most reflective surface used. The height of the panels were set at 4 m above ground level. The following results were obtained.



Total annual glare received by each receptor

Receptor	**Annual Green Glare (min)**	**Annual Yellow Glare (min)**
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0

The proposed solar facility will have no adverse glare effects on any of the sensitive receptors or along the Bruxner Highway. This is to be expected given the location of the receptors to the north of the facility, the limited views of the site, and the use of a tracking system that reduces glare affects, vegetation screening and the elevations of most of the receptors being below that of the facility.

No mitigation for glare is therefore required.

7. CONCLUSION

The Visual Impact Assessment has identified that other than for a location immediately north of the site on the Bruxner Highway, all visual impacts are **low to none**.

The impact from the Bruxner Highway is deemed as **medium to low** impact, however given the short frontage and period of time the facility is seen, the low traffic volumes along this route and the setback from the road means that the overall impacts from this locality are localised and therefore low. The provision of five meter landscape strip along the northern and a 400 m portion of the north-western boundaries will reduce visual impacts from the Bruxner Highway.

No photomontage has been undertaken as the visual impacts are low to medium and the level terrain close to the Bruxner Highway means that the arrays in the foreground would effectively screen the views of those further back. The dark grey colour of the panels are also considered to be in-keeping with the rural landscape where cattle yard structures, large sheds and irrigation systems are scattered in the landscape. The inverter structures are relatively small and largely screened by the solar arrays and where visible are not dissimilar to small rural structures.

No glare impacts are predicted and therefore no mitigation measures are required for glare.

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APPENDIX G NOISE AND VIBRATION ASSESSMENT

Bonshaw Solar Farm

Noise and Vibration Impact Assessment Report

GAIA Australia

1 July 2019

Project No.: 0470861

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Document details	
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Bonshaw Solar Farm

Noise and Vibration Impact Assessment Report

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EXECUTIVE SUMMARY

Overview

Environmental Resources Management Australia Pty Ltd (ERM) has completed a noise and vibration impact assessment (NVIA) on behalf of GAIA Australia Pty Ltd (GAIA). The NVIA addresses the construction and operation associated with the Bonshaw Solar Farm Project located on the Bruxner Highway in Bonshaw, New South Wales (NSW).

*The assessment was conducted to identify potentially sensitive receptors situated in the vicinity (and potential area of influence) of site emission sources and identify significant noise generating plant, equipment and/or activities associated with the project and their likely/known emissions. The overall assessment methodology is presented in **Chapter 2** of this report.*

*Due to the remoteness of the project site and its surrounding rural environment, the existing background noise levels of the area were assumed to be the minimum rating background levels (RBLs) specified in Table 2.1 of the NPI. The assumed background noise levels are presented in **Chapter 3** of this report. Noise assessment criteria (refer **Chapter 4** of this report) were developed with due regard to and in accordance with recognised NSW standards and guidelines as applicable to the projects operational activities.*

Applicable construction and operational assessment scenarios were developed based on project information provided by GAIA. Noise levels were predicted (and compared to criteria) to establish compliance, evaluate potential impacts and establish potential mitigation/management measures where necessary to reduce levels and minimise impacts.

Outcomes

*The assessment has identified that construction noise levels have the potential to exceed the applicable criteria, limits and thresholds. Therefore, noise mitigation, management measures and/or provisions for monitoring were established for the proposed construction and are outlined in **Chapter 7** of this report.*

*Based on the findings of the operational noise assessment, all predicted $L_{eq,\ 15\ minute}$ (dBA) noise levels for the proposed project operations are below the PNTL at all the identified residential receptors and are compliant with the NPI, 2017 for all assessment periods. As such no recommendations for noise mitigation, management measures or monitoring options are warranted, however suitable safeguards and provisions have been provided in **Chapter 7**.*

All necessary measures are documented as recommendations as presented in Chapter 7 of this report and are considered suitable to the magnitude and extent of the predicted impacts. They are designed to reduce noise levels and minimise impacts as far as is commonly feasible and reasonable to do so and practical to implement.

Recommendations

***Construction Noise:** Based on the findings presented in **Chapter 5** (construction noise assessment), the following management measures are recommended:*

- *Noise generating work and activities should be limited to the ICNG, 2009 recommended standard hours (i.e. 7 AM to 6 PM Monday to Friday and 8 AM to 1 PM Saturdays), with no work on Sundays or public holidays. Any unforeseen work that is required outside the recommended standard hours must be suitably mitigated and managed with a goal of achieving inaudible noise levels at all residential receptors or undertaken with agreement from the appropriate consent authority and any potentially affected neighbours.*

- *Where unforeseen works will occur close to a receptor, and these works are anticipated to generate high levels of noise e.g. > 75 dBA, potential respite periods, e.g. three hours of work, followed by one hour of respite should be applied. Respite should be implemented if it is the preference of the affected receptor/s and if they are feasible and reasonable, and practical, to implement during the works. In some circumstances respite may extend the duration of works and inadvertently increase noise impacts; hence due care should be taken when considering this management measure.*
- *During the construction design, choose appropriate plant, equipment and/or machinery for each task and adopt efficient work practices to minimise the total construction period and the number of noise sources on the site. Select the quietest item of plant, equipment and social machinery available where options that suit the design permit.*
- *During the works, avoid unnecessary noise due to idling diesel engines, and fast engine speeds when equipment can be powered down and/or lower speeds are sufficient.*
- *During the works, instruct drivers to travel directly to the site and avoid any extended periods of engine idling at or near residential areas, especially at night.*
- *During the works, ensure all plant, equipment and/or machinery used on the site are in good condition, with particular emphasis on exhaust silencers, covers on engines and transmissions and squeaking or rattling components. Excessively noisy machines should be repaired or removed from the site.*
- *During the works, ensure that all plant, equipment and vehicles movements are optimised in a forward direction to avoid triggering motion alarms that are typically required when these items are used in reverse. Where it is possible tonal motion alarms should be replaced with broadband "squash duck" motion alarms.*
- *If any unforeseen night works must occur, all activities with the potential to generate impulsive noise should be avoided. These types of events are particularly annoying; especially at night and have the limited potential to generate sleep disturbance or awakening impacts. Any impulsive or transient noise events expected to exceed the sleep disturbance criteria at residential receptors should be strictly avoided at night.*
- *If any validated noise complaints are received, operator attended noise validation and compliance measurements should be undertaken to measure and compare the site noise level contributions to a) the predicted values; and b) the NMLs presented in this report. All site noise levels should be measured in the absence of any influential source not associated with the project. If the measured site noise levels are below the predicted values and comply with the NMLs presented in this report, no further mitigation or management measures are required. If the measured site noise levels are above the predicted noise levels or NML presented in this report, further mitigation and/or management measures should be considered.*

Operational Noise: *based on the findings presented in* ***Chapter 6*** *(operational noise assessment), all predicted* $L_{eq,\ 15\ minute}$ *(dBA) noise levels for existing and proposed operations are below the PNTL at all the identified residential receptors and are compliant with the NPI, 2017 for the day, evening and night-time periods. As such no recommendations for noise mitigation, management measures or monitoring options are warranted, however suitable safeguards and provisions have been provided below.*

Provisions and Safeguards: *Given that operational compliance has been attained with the assumption that the Inverters/ Transformers will achieve individual* L_W *of 92 dBA and Panel Tracking Motors will achieve individual* L_W *of 78 dBA, the following safeguards and provisions are provided.*

- *During equipment procurement, ensure that the Inverters/Transformers will achieve individual* L_W *of 92 dBA and Panel Tracking Motors will achieve individual operational* L_W *of 78 dBA.*

- *If any validated noise complaints are received, operator attended noise validation, and compliance measurements should be undertaken to measure and compare the site noise level contributions to a) the predicted values; and b) the PNTLs presented in this report:*
  - *All site noise levels should be measured in the absence of any influential source not associated with the project;*
  - *If the measured site noise levels are below the predicted values and comply with the PNTLs presented in this report, no further mitigation or management measures are required; and*
  - *If the measured site noise levels are above the predicted noise levels or PNTLs presented in this report, further mitigation and/or management measures should be considered.*

Closing

Construction noise levels will be reduced and impacts minimised with the successful implementation of the recommendations outlined in ***Chapter 7****. Construction impacts may not be reduced to negligible or imperceptible levels at all receptors during all activities; however, the recommendations will assist to ensure that any residual impacts to the closest and/or potentially most affected receptors, and the broader community, minimised as far as is practically achievable.*

Based on the predicted operational compliance and anticipated negligible impact to all receptors a set of suitable safeguards and provisions were provided.

These measures, safeguards and provisions are provided as recommendations in ***Chapter 7*** *of this report. They are designed to assist GAIA in achieving compliance and minimise any residual impacts as far is commonly feasible, reasonable and practical to do so.*

1. INTRODUCTION

This report has been prepared by Environmental Resources Management Australia Pty Ltd (ERM) on behalf of GAIA Australia Pty Ltd (GAIA). It presents the methodology, results and findings of the construction and operational noise and vibration impact assessment (NVIA) completed for the Bonshaw Solar Farm Project (the project). GAIA is seeking approval to develop a large-scale solar photovoltaic (PV) generation facility with a capacity of 200 megawatts (MW) and associated infrastructure, including a Lithium-ion Energy Storage System (ESS/Li-ion) with a capacity of 300MW.

The purpose of this assessment is outlined below:

- Determine the extent of construction noise and vibration impacts (if any) associated with the development of the Bonshaw Solar Farm and associated infrastructure, including a Lithium-ion Energy Storage System.
- Determine the extent of operational noise and vibration impacts (if any) associated with the operation of the proposed Bonshaw Solar Farm and associated infrastructure, including a Lithium-ion Energy Storage System.
- Recommend mitigation measures to be implemented on site (where necessary).

1.1 Background

The Project incorporates arrays of PV modules (commonly referred to as “solar panels”), transmission infrastructure and switch yard to enable connection into the existing electricity transmission network via the 330 kilovolt (kV) Dumaresq Substation. The project will have a targeted ‘sent out’ electricity generating capacity of up to 200 megawatts (MW) (AC) and a BESS/battery storage with up to 300 MW (AC) . The exact method and point of connection is being developed in conjunction with TransGrid in parallel with this planning application and the detailed infrastructure layout developed during detailed design will confirm the generating capacity of the Bonshaw Solar Farm.

The key elements of the project include the construction and operation of:

- a network of PV modules in a fixed tilt or single axis tracking arrangement.
- associated battery energy storage system (BESS) / battery storage.
- a switch yard to be connected to the 330 kV TransGrid Dumaresq Substation, on the boundary of the Project Area.
- underground or overhead cabling for connection between arrays and inverters and transformers.
- operations and maintenance (O&M) infrastructure, including O&M buildings incorporating a control room, meeting facilities, a temperature controlled spare parts storage facility, supervisory control and data acquisition (SCADA) facilities, a workshop and associated infrastructure (eg kitchen, toilets and other facilities), and car parking facilities.
- access point to the site via the Bruxner Highway.
- a new internal road network to enable access from surrounding local roads to the array areas during construction and operations including internal access tracks, creek crossing & perimeter security fencing.
- temporary facilities during construction.

The Project Area (PA) covers approximately 353 hectares (ha), of which the proposed development area occupies approximately 165ha. The PA and broader region is predominately agricultural grazing land. An existing TransGrid-owned 132 kV transmission line runs through the PA.

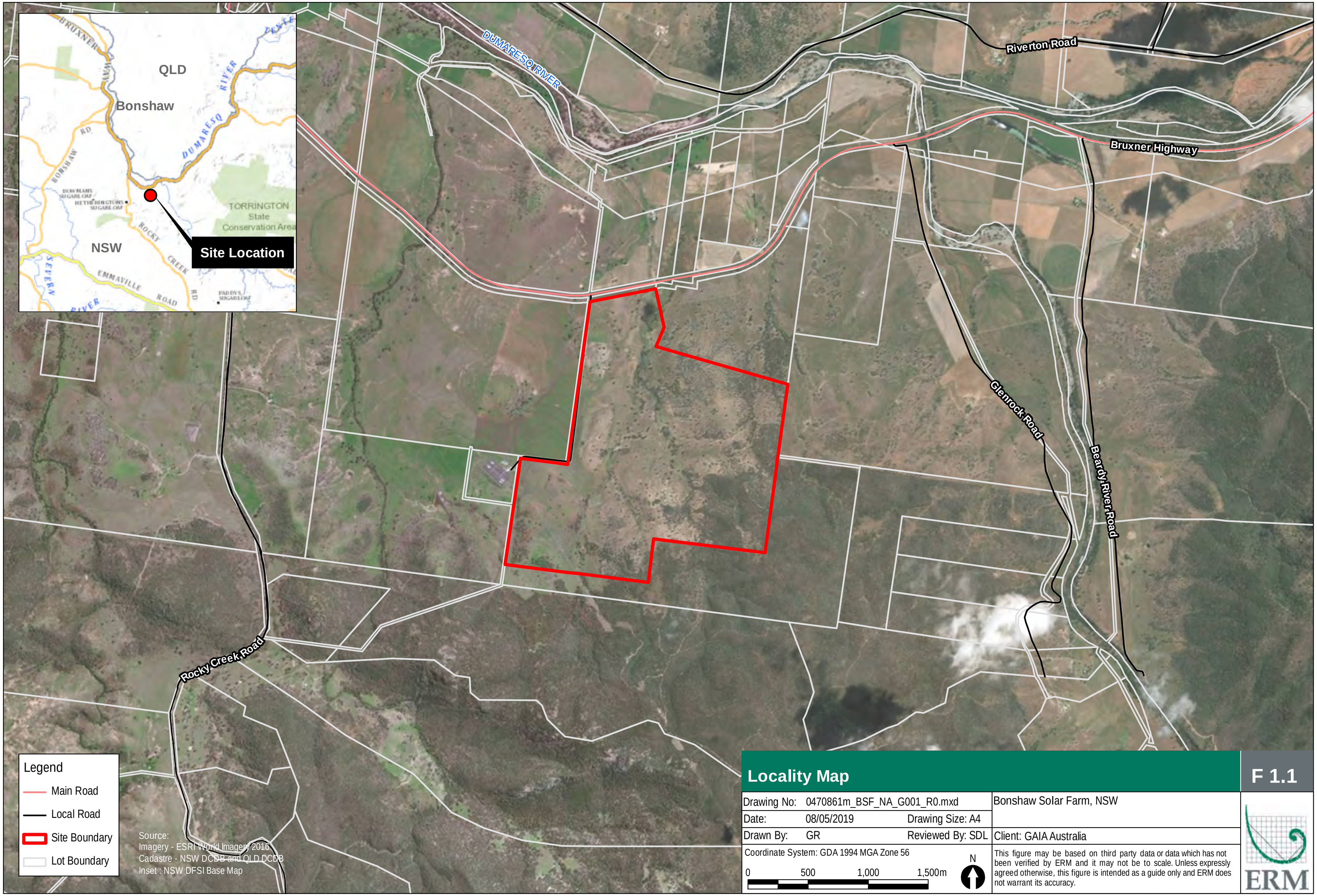
The general arrangement and electrical drawing of the Substation are provided in **Appendix A**.

1.2 Site Description

The proposed development is situated off the Bruxner Highway in Bonshaw in New South Wales (NSW). The site is located approximately 16 kilometres south of Bonshaw and 66 km north of Inverell and is wholly contained within the Local Government Area (LGA) of Inverell Shire Council (Council). The project would connect directly to the 330 kilovolt (kV) Dumaresq Substation located to the west of the Project boundary (refer to **Figure 1.1**).

The proposed development site is zoned as Primary Production (RU1). It is surrounded in all directions by land zoned as Primary Production (RU1). The nearest alternate land zoning is Rural and Rural Activity (QLD) which is located approximately 1.6 kilometres north of the proposed development site.

Due to the large area of Primary Production zoning, the lands surrounding the site are relatively undeveloped with no receptors directly adjacent to the project site. The Bonshaw Solar Farm project development site, the surrounding area and other items of importance to this assessment are identified in **Figure 1.1** to **Figure 1.3** below.



Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Inset : NSW DFSI Base Map

Locality Map

F 1.1

Drawing No: 0470861m_BSF_NA_G001_R0.mxd	Bonshaw Solar Farm, NSW
Date: 08/05/2019 Drawing Size: A4	
Drawn By: GR Reviewed By: SDL	Client: GAIA Australia
Coordinate System: GDA 1994 MGA Zone 56 0 500 1,000 1,500m	This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

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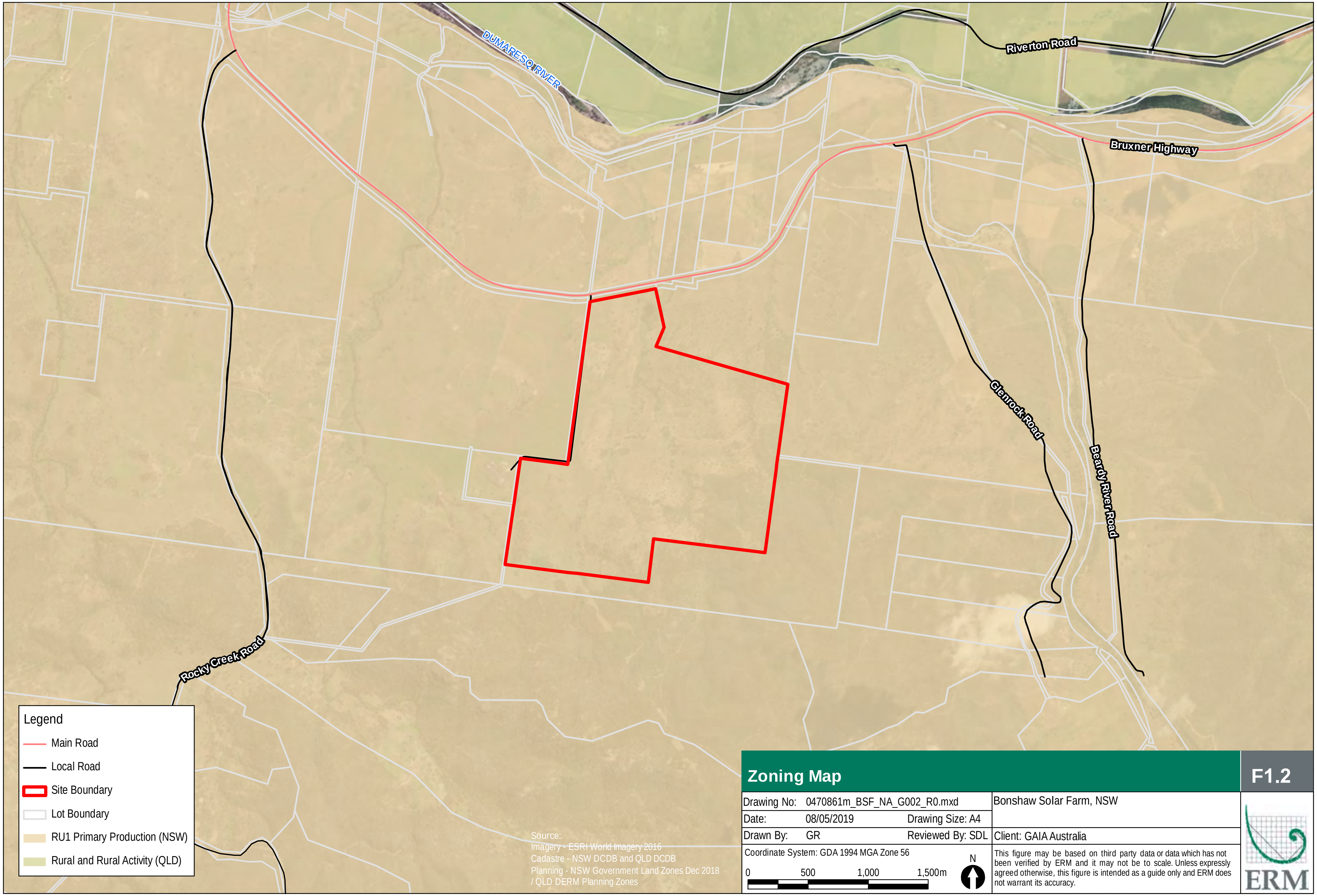

Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Planning - NSW Government Land Zones Dec 2018 / QLD DERM Planning Zones

Zoning Map

F1.2

Drawing No: 0470861m_BSF_NA_G002_R0.mxd	Bonshaw Solar Farm, NSW
Date: 08/05/2019 Drawing Size: A4	
Drawn By: GR Reviewed By: SDL	Client: GAIA Australia
Coordinate System: GDA 1994 MGA Zone 56	This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

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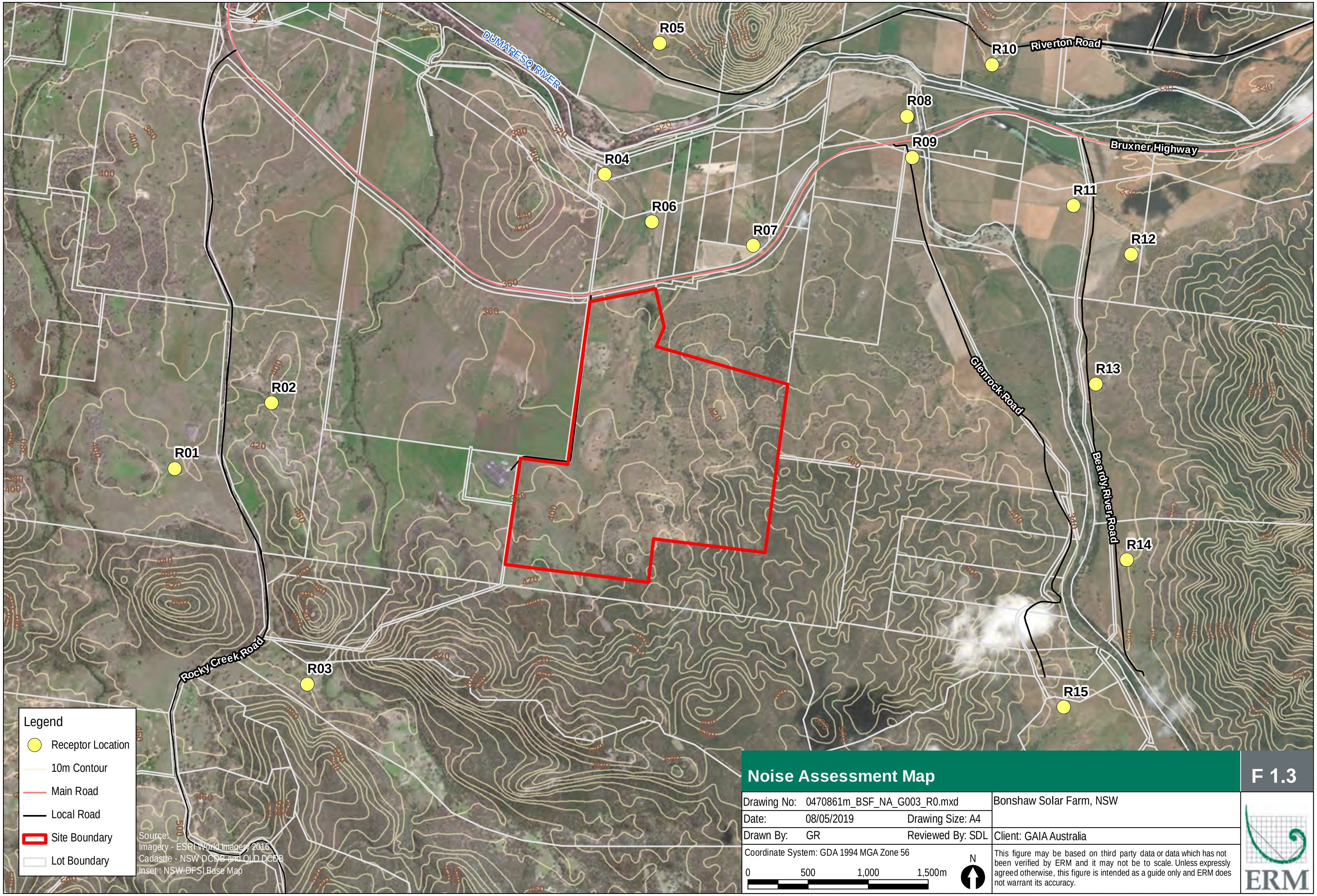


Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Inset : NSW DFSI Base Map

Noise Assessment Map

F 1.3

Drawing No: 0470861m_BSF_NA_G003_R0.mxd

Date: 08/05/2019 Drawing Size: A4

Drawn By: GR Reviewed By: SDL

Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW

Client: GAIA Australia

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

2. ASSESSMENT METHODOLOGY

This chapter describes the assessment methodology adopted to assess potential construction and operational noise impacts at the closest and/or potentially most affected sensitive receptors situated in the vicinity of the project.

An acoustics glossary of relevant acoustical concepts and terminology is provided in **Appendix A**.

All sound pressure levels presented in this report (e.g. noise levels predicted at a receptor) are in decibels referenced to 2×10^{-5} Pa. All sound power levels presented in this report (e.g. noise levels assigned to specific sources) are decibels referenced to 10^{-12}W.

2.1 Scope of Work

To assess project construction and operational noise/vibration, the following scope of work has been completed:

- Review and validate the available project and third-party data and information as considered relevant to the assessment.
- Review aerial photography, zoning data, cadastre data and third-party project data to identify potential residential (dwelling) and other sensitive (commercial and industrial) receptors situated within the potential area of influence of the site (refer **Chapter 3**).
- Identify significant noise generating plant, equipment and machinery that may be in use or activities that will be undertaken as part of the project and their source emission level to develop applicable assessment scenarios (refer **Chapter 5** and **Chapter 6**).
- Develop a project-specific noise model to predict project construction, and operational levels for each of the assessment scenarios developed. Following this, predicted levels were compared to project-specific criteria to identify any noise levels that exceed criteria and determine the magnitude and extent of any impacts (refer **Chapter 5** and **Chapter 6**).
- Recommend noise reducing mitigation, management measures and/or provisions for monitoring suitable to the predicted levels and anticipated impacts. These measures are designed to reduce project noise emissions to compliant levels and to minimise impacts as far as may be feasible, reasonable and practical to implement (refer **Chapter 7**).

2.2 Policy Setting

In NSW, noise pollution is regulated through the *Protection of the Environment Operations Act 1997* (POEO Act) as the key piece of environmental protection legislation. Noise pollution is defined under the POEO Act as:

'*the emission of offensive noise, which means noise that by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances, is harmful (or is likely to be harmful) to or interferes unreasonably (or is likely to interfere unreasonably) with the comfort or repose of a person outside the premises from which the noise is emitted.*'

Under the POEO Act, the '*POEO (Noise Control) Regulation 2008*' addresses common noisy activities that occur in residential situations; it limits the time of day that noisy articles (such as lawn mowers, stereos and leaf blowers) are permitted to be heard in neighbouring residences; however it does not specify noise limits and an applicable approach for the assessment of existing sites.

Various noise assessment guidelines endorsed by NSW consent and regulatory authorities provide a guideline framework and methodology for deriving acceptable levels and standard methods for assessing and measuring construction and operational impacts with due regard to the POEO Act. The guidelines and standards are discussed in **Section 2.3** below.

2.3 Relevant Policy, Guidelines and Standards

This assessment has been conducted with due regard to and in accordance with the following policy, guidelines and standards:

- German Institute for Standardisation – DIN 4150 (2016) Part 3 (DIN4150-3) – *Structural Vibration - Effects of Vibration on Structures*.
- International Organisation for Standardisation (ISO) 9613-2:1996 (ISO 9613:2) - *Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2: General Method of Calculation*.
- International Organisation for Standardisation (ISO) 17534:2015 – (ISO 17534:2015) – *Acoustics - Software for the Calculation of Sound Outdoors*, as achieved by the modelling software referenced in this report.
- NSW Department of Environment and Climate Change (DECC) – *NSW Interim Construction Noise Guideline* (ICNG, 2009), July 2009.
- NSW Environment Protection Authority – *Noise Policy for Industry* (NPI, 2017), October 2017;
- NSW Department of Environment, Climate Change and Water (DECCW) – *NSW Road Noise Policy* (RNP), March 2011.
- NSW Department of Environment and Conservation – *NSW Environmental Noise Management – Assessing Vibration: a Technical Guideline* (the NSW Vibration Guideline), February 2006;
- Standards Australia AS1055–1997™ (AS 1055) – *Description and Measurement of Environmental Noise*, Parts 1, 2 and 3.
- Standards Australia AS IEC 61672.1–2004™ (AS 61672) – *Electro Acoustics - Sound Level Meters Specifications Monitoring or Standards Australia AS 1259.2-1990™ (AS 1259) – Acoustics – Sound Level Meters – Integrating Averaging* as relevant to the device.
- Standards Australia AS/IEC 60942:2004/IEC 60942:2003 (IEC 60942) – Australian Standard™ – *Electroacoustics – Sound Calibrators*.
- Standards Australia AS 2436–2010™ (AS 2436) – *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*.

Further information regarding the application of the key policy and guidelines is provided below.

2.3.1 NSW Interim Construction Noise Guideline

For this project the ICNG, 2009 is the suitable guideline document to quantifiably assess potential noise emissions and impacts associated with project construction. The ICNG, 2009 assessment methodology (refer **Appendix B**) has been adopted to develop project-specific construction noise management levels (refer **Chapter 4**), assess potential impacts (refer **Chapter 5**) and recommend any necessary mitigation, management measures or provisions for monitoring (refer **Chapter 7**).

2.3.2 NSW Noise Policy for Industry

For this project the NPI, 2017 is the suitable guideline document to quantifiably assess potential noise emissions and impacts associated with the project's operation. The NPI, 2017 assessment methodology (refer **Appendix B**) has been adopted to quantify existing conditions (refer **Chapter 3**), develop project-specific operational noise criteria (refer **Chapter 4**), assess potential impacts (refer **Chapter 6**) and recommend any necessary mitigation, management measures or provisions for monitoring (refer **Chapter 7**).

2.3.3 NSW Road Noise Policy

In this case the RNP, 2011 is the suitable guideline document to quantifiably assess potential noise emissions and impacts associated with the project's construction and operational road traffic noise. The RNP, 2011 assessment methodology (refer **Appendix B**) has been adopted to develop project-specific road noise criteria (refer **Chapter 4**), assess potential impacts (refer **Chapter 5** for construction and **Chapter 6** for operation) and recommend any necessary mitigation, management measures or provisions for monitoring (refer **Chapter 7**).

2.4 Qualitative Assessments

This section presents the qualitative assessment of lower risk acoustical factors that were considered during the preliminary stages of the terminal data and information review. The remainder of the assessment focuses on higher risk acoustical factors, construction and operational noise.

2.4.1 Vibration – Construction and Operation

Based on the equipment and activities identified for the construction works and operation of the project, potential sources of vibration are limited and would only occur during the construction works, if at all. This feature combined with the ≥ 100 metres distance offset (vibration dissipates rapidly with distance) to the closest sensitive receptor or buildings identifies that any vibration impacts will be minimal, if any at all.

It is expected that vibration generated by the construction works will comply with the requirements of the NSW Vibration Guideline and DIN 4150-3. During operation, no vibration is expected to be generated and hence levels will comply with the requirements of the NSW Vibration Guideline and DIN 4150-3.

Given the limited potential for any vibration impacts to occur, no further recommendations for vibration mitigation and management measures are warranted or provided in this assessment.

2.4.2 Ground-Bourne Noise – Construction and Operation

As outlined in **Section 2.4.1** above, potential sources of vibration are limited and would only occur during the construction works, if at all. Ground-borne construction noise is usually present on tunnelling projects when significant tunnel boring equipment is operated underground.

Ground-borne noise impacts (generated by vibration) from the project are therefore not anticipated as significant vibration generating source/s, with the potential to generate perceptible ground-borne noise, does not form part of the project design.

It is highly unlikely that any ground-borne noise would be audible or perceptible at any times during the project. Therefore, it is expected that ground-borne noise generated by the construction works will comply with the requirements of the ICNG, and will comply with the NPI (and other relevant requirements for ground-borne noise) during operation.

Given the limited potential for any ground-borne noise impacts to occur, no further recommendations for specific mitigation and management measures are warranted or provided in this assessment.

2.5 Cumulative Impacts

Noise impact assessments are generally based on predicting project-specific levels at the closest and/or most affected receptors and then comparing these to criteria or management levels that apply to the type of emission being considered.

In the case of construction and operational emissions, the noise criteria are derived based on existing noise levels for the area, for road traffic fixed values generally apply. To assess potential cumulative impacts a varied approach has therefore been adopted as described below.

The construction noise criteria (ICNG, 2009) and management levels are also based on existing noise levels surrounding the site but focus on the direct impacts from the site under assessment, cumulative impacts are beyond the control of GAIA, are temporary in most circumstances and are best managed by local or state consent authorities for significant projects. Therefore, a qualitative assessment of potential cumulative impacts has been conducted but limited discussion regarding cumulative impacts is required.

The operational noise criteria are based on existing noise levels or rating background levels (RBLs) of the site under assessment, such that existing conditions and industrial noise contributions are considered as part of the assessment approach. The NPI, 2017 criteria are designed to prevent any long-term increase in cumulative industrial noise. Therefore, they address potential cumulative impacts without further discussion required.

With the above features in mind, the focus of any discussion regarding cumulative impacts is associated with operational noise, as presented in **Chapter 6** of this document.

2.6 Noise Modelling

Key features, inputs and assumptions that have informed the noise modelling and assessment are reproduced or outlined in **Table 2.1** below. Further discussion regarding the effects of meteorological conditions and potentially annoying noise characteristics is provided in **Section 2.6.1** and **Section 2.6.2** below as relevant to this assessment.

Table 2.1 – Noise Modelling Features, Inputs and Assumptions

ID	Feature	Description
1	Noise Modelling Software	■ Brüel & Kjær's Predictor 7810 (Version 12.00) noise modelling software package was utilised to calculate construction and operational noise levels using the ISO9613:2 noise propagation algorithms, international method for general purpose: 1/1 or 1/3 octaves in Hertz (Hz). Brüel & Kjær's Predictor 7810 (Version 12.00) noise modelling software package is ISO 17534 compliant however sound calculated using ISO 9613:2, the indicated accuracy is ±3 dBA at the source to receptor distances of up to 1000 metres and unknown at distances above 1000 metres. ■ The BK Predictor 7810 (Version 12.00) software package allowed 3D elevation data (obtained from the NSW Government - Land & Property Information (LPI) with cadastre and Local Government Area (LGA) zoning data) to be combined with ground regions (a ground factor of 0.7 was adopted for the general modelling area, with a ground factor of 0.0 adopted for site areas where the surface is anticipated to be hard (0.0 is hard (concrete, bitumen etc.) and 1.0 is soft (grass etc.)), foliage, barriers, significant building structures etc. and receptor locations, to create a detailed and accurate representation of the site and surrounding area. The model allowed for the quantification of noise levels from multiple sources, based on sound power or pressure levels emitted from each source. It computed the noise propagation in the assessment area to specifically quantify A-weighted decibels (dBA) at identified receptors, in the applicable $L_{eq,\ 15\ minute}$ and L_{max} (operations only) parameter.
2	Construction and Operational Noise Modelling – ICNG, 2009 and NPI, 2017	■ The Sound Power Level data (overall L_W and spectral (Hertz, Hz) values, in dBA) that was adopted for this assessment was established based on publicly available data for known items of operational plant, equipment and machinery (refer **Chapter 6**). For the construction of the project, all source values have been assumed for this assessment based on data presented in AS2436 or from the ERM noise emission source database. A precautionary approach was adopted when establishing these values for the construction phase as a contractor may be engaged for the site's preparation and construction, and GAIA will not have complete control over the sites noise emission, which by comparison, they will during operations. L_W is a measure of the total power radiated by a source; it is a fundamental property of the source and is independent of the surrounding environment. L_W differs from a Sound Pressure Level (L_P) which is the level of sound pressure as measured at a distance by a standard sound level meter with a microphone. L_P is the received sound (e.g. $L_{eq,\ 15\ minute}$ in dBA) as opposed to L_W which is the sound 'intensity' at the source.

ID	Feature	Description
		■ The BK Predictor 7810 (Version 12.00) noise modelling software offers a range of emission source types to be used to predict levels at receptors, and these include but are not limited to "area sources" and "point sources". Given the nature of construction and operational activities that are anticipated at the site, a combination of area and point sources were utilised to predict noise levels at receptors. This approach was adopted to assist ensure the assessment represents the distribution of project emissions across the site area, capturing the size and number of sources during each project phase. Further information regarding the application of these emission source types is provided in **Chapter 5** and **Chapter 6** of this report, as relevant to construction and operational phases respectively. ■ For the project-specific construction and operational noise models, the emission sources incorporated into each were established based on the information and characteristics summarised in **Chapter 1** of this report, and an understanding of the project's operational activities from previous noise assessments. The construction and operational noise data is presented in **Chapter 5** and **Chapter 6** of this report. ■ Preliminary noise contour mapping and LGA zoning data were utilised to identify the receptor locations where compliance has been assessed. A total of fifteen locations were identified as per **Figure 1.3**, and noise levels were calculated at 1.5 metres above ground level. In all cases, noise has been assessed at the most-affected point at or within the property boundary, with receptor points selected in accordance with the requirements of the NPI, 2017.
3	Road Traffic Noise Modelling (construction and operations) – RNP, 2011	■ For road traffic noise, the BK Predictor 7810 (Version 12.00) software package was again used but adopting the United Kingdom (UK) – *Calculation of Road Traffic Noise* (CoRTN) calculative methods, as adapted to Australia conditions. ■ For the project-specific road traffic noise models, a line source was utilised with the vehicle flows (based on the information and characteristics summarised in **Chapter 1**) and mixes input to the model directly, overall Lw and spectral (Hz) values are not required for the CoRTN algorithm. ■ A ground factor of 0.7 was applied for the general modelling area. ■ The model allowed for the quantification of noise levels based on the input traffic flows and mixes (refer **Chapter 5** and **Chapter 6**) and computed the noise propagation at representative distance offsets (rather than at specific receptor points) to quantify A-weighted decibels (dBA), in the applicable $L_{eq,\ 15\ hour}$, $L_{eq,\ 9\ hour}$ and $L_{eq,\ 1\ hour}$ in parameters.

ID	Feature	Description
4	Meteorological Conditions	■ General meteorological conditions for the project-specific noise models included a temperature of 10.2°C (annual mean minimum), and humidity of 72% (annual mean for 9 AM statistics), representative of average conditions for the Bonshaw area. An assumed atmospheric pressure of 101.33 kPA was adopted. These temperature and humidity values were determined based on annual average weather data publically available from the Bureau of Meteorology (BOM) Weather Station situated at Pindari Dam: ■ Site number: 054104 ■ Location: Latitude: 29.39° South and Longitude: 151.24° East ■ Elevation: 462 metres. ■ The effects of noise-enhancing meteorological conditions, as applicable to the construction and operational noise modelling and assessment, are described in **Section 2.6.1** below.

2.6.1 Effects of Meteorological Conditions

As per the NPI, 2017 meteorological conditions need to be considered for the operational phase of industrial activity, under a range of meteorological conditions. Accordingly, a precautionary approach was adopted and potential worst-case noise-enhancing meteorological conditions have been considered, for the operational noise modelling, based on the following meteorological parameters:

- Noise-enhancing meteorological conditions: daytime and evening Pasquill–Gifford stability Category D conditions, light source-to-receiver winds (3 m/s) and a night-time stability Category F temperature inversion condition, light source-to-receiver winds (2 m/s).

Construction noise modelling has adopted a stability Category D condition only (representing stable conditions commonly experienced during the daytime period, when works will occur) and calm winds for all scenarios.

3. EXISTING CONDITIONS

This chapter summarises the existing noise environment, identifies the noise sensitive receptors within the potential area of influence of the project, describes the baseline noise monitoring approach adopted to quantify existing levels, and presents the resultant baseline environmental noise levels established for this assessment.

3.1 Existing Noise Environment

A key element in assessing noise impacts is an understanding of the existing ambient and background noise levels in the vicinity of the closest and/or potentially most affected noise sensitive receptors situated near the site.

The noise environment in the vicinity of the project receptors is best described as 'rural' defined by the NPI, 2017 as an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. This area often has evening ambient noise levels defined by the natural environment and human activity.

A "rural" area may be located in either a rural landscape, large lot residential, primary production, primary production small lots or environmental living zone, as defined on a council zoning map (i.e. Local Environmental Plan (LEP) or other planning instruments).

Due to the rural setting of the project, the existing noise environment of the surrounding area experiences low ambient and background noise levels. The minimum assumed rating background noise levels have therefore been considered in this assessment (Table 2.1 of the NPI, 2017). This is further outlined in **Section 3.3** below.

3.2 Potentially Sensitive Noise Receptors

The potentially sensitive noise receptors where compliance has been assessed are presented below in **Table 3.1**, as identified in **Figure 1.3** of **Chapter 1** above.

Guidance Note

The locations identified in **Table 3.1** were established based on the following:

- information provided by or on behalf of GAIA;
- a subsequent review of aerial photography;
- review of land use zoning data; and
- the results of preliminary noise modelling, where receptor positions were optimised to predict likely worst-case noise levels.

These locations do not represent every receptor located in the vicinity of the project but have been selected for this noise assessment as they are considered to be representative of the locations that will potentially experience the highest or worst-case impacts associated with the construction and ongoing operation.

The GPS coordinates listed for each receptor in **Table 3.1** are those presented in *Figure 1.3* as adopted for the modelling and assessment scenarios.

Table 3.1 – Potentially Sensitive Receptors

ID	Type	Description	GPS Co-ordinates (UTM, Zone 56J)		Ground Height	Approximate Distance from project, metres	Direction from project
			Easting	Northing			
R01	Residential (Dwelling)	“Needlewood” - 3835 Rocky Creek Rd, Bonshaw NSW 2361	334856	6768390	387	2800	West
R02	Residential (Dwelling)	3894 Rocky Creek Rd, Bonshaw NSW 2361	335677	6768969	399	2100	West
R03	Residential (Dwelling)	“Long Ridge” - 3650 Rocky Creek Rd, Rocky Creek NSW 2371	335966	6766605	398	2000	South West
R04	Residential (Dwelling)	Property to South of Dumaresq River, off Bruxner Hwy, Bonshaw NSW 2361	338430	6770819	336	1200	North
R05	Residential (Dwelling)	Property to North of Dumaresq River, off Riverton Rd, Watsons Crossing, QLD	338891	6771931	281	2300	North
R06	Residential (Dwelling)	“Glen Hill” - 9024 Bruxner Hwy, Bonshaw NSW 2361	338815	6770428	339	830	North
R07	Residential (Dwelling)	“Coo-Ee” - 8930 Bruxner Hwy, Bonshaw NSW 2361	339635	6770241	339	1000	North
R08	Residential (Dwelling)	“St Elmo” - 8782 Bruxner Hwy, Bonshaw NSW 2361	340931	6771313	325	2700	North East
R09	Residential (Dwelling)	Property to South of Bruxner Highway, off Glenrock Rd, Bonshaw NSW 2361	340988	6770977	328	2500	North East
R10	Residential (Dwelling)	Property to North of Dumaresq River, off Riverton Rd, Maidenhead, QLD	341691	6771754	325	3500	North East
R11	Residential (Dwelling)	Property to South of Bruxner Highway, off Beardy River Rd, Dumaresq Valley NSW 2372	342344	6770580	334	3500	North East
R12	Residential (Dwelling)	Property to South of Bruxner Highway, off Beardy River Rd, Dumaresq Valley NSW 2372	342859	6770241	339	4000	North East
R13	Residential (Dwelling)	“Stackhavon” - 207 Beardy River Rd, Dumaresq Valley NSW 2372	342513	6769093	346	3500	East
R14	Residential (Dwelling)	“Haystack” - 345 Beardy River Rd, Dumaresq Valley NSW 2372	342751	6767638	340	3400	East
R15	Residential (Dwelling)	“Glenrock Homestead” - 540 Glenrock Rd, Rocky Creek NSW 2371	342257	6766423	352	3300	East

3.3 Rating Background Noise Levels

The Rating Background Noise Levels (RBL) for the daytime (L90, 11 hour), evening (L90, 4 hour) and night-time (L90, 9 hour) are presented in **Table 3.4** below for all potential noise-sensitive receptors, as established based on the NPI, 2017 minimum assumed rating background noise levels.

The RBL values are adopted to establish ICNG, 2009 construction noise management levels and NPI, 2017 operational criteria for residential (dwelling) receptors as identified in **Chapter 4** of this report.

Table 3.2 – Rating Background Noise Levels

ID	Receptor Type	Rating Background Noise Levels (RBL), dBA		
		L90, 11 hour (Daytime)[1]	L90, 4 hour (Evening)[2]	L90, 9 hour (Night-time)[3]
R01	Residential (Dwelling)	35	30	30
R02	Residential (Dwelling)	35	30	30
R03	Residential (Dwelling)	35	30	30
R04	Residential (Dwelling)	35	30	30
R05	Residential (Dwelling)	35	30	30
R06	Residential (Dwelling)	35	30	30
R07	Residential (Dwelling)	35	30	30
R08	Residential (Dwelling)	35	30	30
R09	Residential (Dwelling)	35	30	30
R10	Residential (Dwelling)	35	30	30
R11	Residential (Dwelling)	35	30	30
R12	Residential (Dwelling)	35	30	30
R13	Residential (Dwelling)	35	30	30
R14	Residential (Dwelling)	35	30	30
R15	Residential (Dwelling)	35	30	30

1. *Daytime: 7:00 am – 6:00 pm,*
2. *Evening: 6:00 pm – 10:00 pm*
3. *Night-time: 10:00 pm – 7:00 am*

4. PROJECT-SPECIFIC ASSESSMENT CRITERIA

This chapter presents the construction and operational noise assessment criteria established for the project concerning the existing conditions described in quantified in **Chapter 3** and in accordance with the ICNG, 2009, the NPI, 2017 and RNP, 2011.

4.1 NSW Interim Construction Noise Guideline

The project-specific construction "Noise Management Levels" (NML), for works within and outside the recommended standard hours for construction, are presented in **Table 4.1** below.

These NML have been established with due regard to the requirements of the ICNG, 2009 for all identified residential (dwelling) and other sensitive (commercial) receptors. In accordance with the ICNG, 2009 NML values for other sensitive receptors, i.e. nearby commercial or industrial premises, are fixed levels based on usage. They do not rely on the RBL utilised for residential receptors. No industrial or commercial premises have been identified for this assessment however the applicable construction noise management levels are provided below.

Table 4.1 – Construction Noise Management Levels (NML)

Description	Construction Noise Management Levels, dBA			HNML, Leq, 15 minute, dBA	Sleep Disturbance Criteria, dBA	
					Night-time only	
	Day	Evening	Night	Daytime (Standard Hours)	Leq, 15min	Lmax
Residential Receptors	45	35	35	75	40	52
Industrial Receptors	75	75	75	-	-	-
Commercial Receptors	70	70	70	-	-	-

1. Dash "-" indicates that this criteria does not apply at that receptor.

4.2 NSW Noise Policy for Industry

The project-specific intrusiveness noise level, recommended amenity noise level (residential receptors) and the project amenity noise levels are presented in **Table 4.2** below. These criteria represent the operational noise criteria used to assess potential impacts, with the most stringent of these values adopted as the project-specific "Noise Trigger Level", PTNL.

In accordance with the NPI, 2017, PTNL for other sensitive receptors, i.e. nearby commercial or industrial premises, are fixed levels based on usage. They do not rely on the RBL utilised for residential receptors. No industrial or commercial premises have been identified for this assessment however the applicable PTNL are provided below.

The NPI, 2017 assessment periods are defined as follows: daytime is the period from 7 AM to 6 PM, Monday to Saturday; or 8 AM to 6 PM on Sundays and public holidays. The evening is the period from 6 PM to 10 PM, Monday to Sunday (seven days per week) and night-time is all remaining periods.

Table 4.2 – Project-specific Noise Trigger Levels (PTNL)

Description	Intrusiveness Noise Level – Leq, 15 minute in dBA			Recommended Amenity Noise Level – Leq, period in dBA			Project Amenity Noise Level – Leq, 15 minute in dBA			PTNL Leq, 15 minute in dBA			Sleep Disturbance Criteria, dBA	
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Night-time only	
													Leq, 15min	Lmax
Residential Receptors	45	35	35	50	45	40	48	43	38	45	35	35	40	52
Industrial Receptors	-	-	-	65	65	65	-	-	-	65	65	65	-	-
Commercial Receptors	-	-	-	70	70	70	-	-	-	70	70	70	-	-

1. Dash “-“ indicates that this criteria does not apply at that receptor.

4.3 NSW Road Noise Policy

The road traffic noise criteria applicable to the project (construction and operation), are presented in **Table 4.3** below.

These road traffic criteria have been established with due regard to the requirements of the RNP, 2011. In accordance with the RNP, 2011 criteria are fixed levels based on road type, they do not rely on the RBL utilised for residential receptors. These criteria are applicable to residential receptors and are assessed at the building façade.

Table 4.3 –Road Traffic Noise Criteria

Assessment Classification	RNP Road Traffic Noise Criteria	
	Daytime (7am to 10pm) assessment period	Night time (10pm to 7am) assessment period
Road traffic noise criteria for existing residences affected by **additional traffic on existing sub-arterial roads** generated by land use developments.	$L_{eq, 15 hour}$ 60 dB (external)	$L_{eq, 9 hour}$ 55 dB (external)
Road traffic noise criteria for existing residences affected by **additional traffic on existing local roads** generated by land use developments.	$L_{eq, 1 hour}$ 55 dB (external)	$L_{eq, 1 hour}$ 50 dB (external)

5. CONSTRUCTION NOISE ASSESSMENT

This chapter presents the construction noise assessment completed for the project as per the requirements of the ICNG, 2009.

5.1 Assessment Scenarios

The following construction assessment scenarios and associated data have been developed based on the construction activities described in **Chapter 1** and the assessment methodology described in **Chapter 2** of this report, as presented in **Table 5.1** below.

These scenarios and associated data are representative of general construction works that are anticipated for the project and has been adopted to predict noise levels and comparison to management levels. Due to the large area over which the development site is situated, each construction scenario has been modelled to occur at three different locations: a) the northern portion of the site; b) the central portion of the site; and c) the southern portion of the site.

Some general modelling features are described in **Table 5.1** as summarised below:

- Quantity: is the number of equipment operating per 15-minute assessment period;
- Duty Factor: is the percentage of time the equipment operates per 15-minute assessment period or represents a reduced emission for part of the period;
- Base LW: Value is source emission or 'Sound Power Level' (LW) directly allocated to the equipment, unadjusted; and
- Total LW: Value is the overall equipment source emission ($L_{W,\ 15\ minute}$) adjusted for the quality, duty factor and penalty.

A modifying correction factor (penalty) for any annoying noise characteristics such as tonality, low-frequency components etc. was considered as per the requirements of NPI, 2017. A penalty was only applied to one equipment noise source (i.e. screw pile driver), no further penalties were applied to the items listed below on the basis of the limited construction works and associated activities that are proposed for the project (and have a limited potential to generate annoying noise characteristics).

Table 5.1 – Construction Noise Assessment Scenarios

Scenario	Description	Equipment	Quantity	Duty Factor	Base LW Value	NPI Penalty, dBA	Total LW Value	Individual Noise Source Term Data - Spectral Data, dB(A)									
								Description	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
CON01	Site Preparation and Establishment Site Area: a) North b) Central c) South	Fork-Lift Toyota 2.5 tone	4	0.75	106	-	110.8	Area Source	82.7	88.7	94.7	101.7	103.7	105.7	104.7	98.7	94.7
		Fork-Lift Toyota 2.5 tone	3	0.75	106	-	109.5		81.4	87.4	93.4	100.4	102.4	104.4	103.4	97.4	93.4
		Fork-Lift 3Tonne Manitou	2	0.75	106	-	107.8		79.7	85.7	91.7	98.7	100.7	102.7	101.7	95.7	91.7
		Telescopic Handler (3 Ton) JCB 531-70	3	0.75	105	-	108.5		74.4	96.6	100.9	96.9	102.2	100.7	101.7	97.3	88.1
		Telescopic Handler (9 Ton) Manitou MHT790	2	0.75	105	-	106.8		72.7	94.9	99.2	95.2	100.5	99.0	100.0	95.6	86.4
		Water Truck Hino	2	0.75	107	-	108.8		71.6	88.1	88.8	89.2	94.4	108.0	98.0	92.4	83.4
		12 Seater -Toyota Hiace Commuter	10	0.5	107	-	114.0		83.1	91.1	99.2	101.6	106.9	109.6	108.1	102.3	97.0
		Holden Colorado 4x4	25	0.5	106	-	117.0		86.1	94.1	102.2	104.6	109.9	112.6	111.1	105.3	100.0
		Self Bunded Mobile Fuel Cell	1	1	99	-	99.0		64.9	87.1	91.4	87.4	92.7	91.2	92.2	87.8	78.6
CON02	Installation/ Construction of Infrastructure Site Area: a) North b) Central c) South	Fork-Lift Toyota 2.5 tone	4	0.75	106	-	110.8	Area Source	82.7	88.7	94.7	101.7	103.7	105.7	104.7	98.7	94.7
		Fork-Lift Toyota 2.5 tone	3	0.75	106	-	109.5		81.4	87.4	93.4	100.4	102.4	104.4	103.4	97.4	93.4
		Fork-Lift 3Tonne Manitou	2	0.75	106	-	107.8		79.7	85.7	91.7	98.7	100.7	102.7	101.7	95.7	91.7
		Telescopic Handler (3 Ton) JCB 531-70	3	0.75	105	-	108.5		74.4	96.6	100.9	96.9	102.2	100.7	101.7	97.3	88.1
		Telescopic Handler (9 Ton) Manitou MHT790	2	0.75	105	-	106.8		72.7	94.9	99.2	95.2	100.5	99.0	100.0	95.6	86.4
		Water Truck Hino	2	0.75	107	-	108.8		71.6	88.1	88.8	89.2	94.4	108.0	98.0	92.4	83.4
		Screw Pile Driver - John Deere Tractor 6125M And Trailer	3	0.5	111	5	117.8		70.8	85.5	107.3	108.6	109.7	113.3	111.7	102.6	95.8
		Screw Pile Driver - John Deere Tractor 6140M And Trailer	3	0.5	111	5	117.8		70.8	85.5	107.3	108.6	109.7	113.3	111.7	102.6	95.8
		Screw Pile Driver - John Deere Tractor 6110M And Trailer	3	0.5	111	5	117.8		70.8	85.5	107.3	108.6	109.7	113.3	111.7	102.6	95.8
		12 Seater -Toyota Hiace Commuter	8	0.5	107	-	113.0		82.1	90.1	98.2	100.6	105.9	108.6	107.1	101.3	96.0
		Holden Colorado 4x4	25	0.5	106	-	117.0		86.1	94.1	102.2	104.6	109.9	112.6	111.1	105.3	100.0
		Self Bunded Mobile Fuel Cell	1	1	99	-	99.0		64.9	87.1	91.4	87.4	92.7	91.2	92.2	87.8	78.6

5.2 Predicted Construction Noise Levels

Based on the construction assessment scenarios and associated data presented in **Table 5.1** above, $L_{eq,\ 15\ minute}$ noise levels (in dBA) have been predicted (refer the methodology summarised in **Chapter 2**) and then compared to the NML identified previously in **Table 4.1**, **Chapter 4** of this report.

The resultant values (and an assessment of compliance, predicted minus criteria) are presented in **Table 5.2** below.

This compliance assessment is provided for the most stringent evening and night-time assessment periods, as construction works could potentially be conducted outside standard hours for construction as presented in the ICNG.

Any noise levels that exceed criteria are highlighted in **bold** typeset.

Table 5.2 – Predicted Construction Noise Levels and Compliance

ID	Predicted Construction Noise Levels, Leq, 15 minute / Lmax (dBA)							Comparison to Most Stringent Night-time NML (35 dBA)						
	CON01a (North)	CON01b (Central)	CON01c (South)	CON02a (North)	CON02b (Central)	CON02c (South)	Lmax (range)	CON01a (North)	CON01b (Central)	CON01c (South)	CON02a (North)	CON02b (Central)	CON02c (South)	Lmax
R01	25	25	26	29	29	29	28 - 31	-10	-10	-9	-6	-6	-6	-21
R02	31	32	32	34	35	35	34 - 36	-4	-3	-4	-1	0	0	-16
R03	25	27	26	29	31	30	28 - 32	-10	-8	-9	-6	-4	-5	-20
R04	36	31	28	40	35	32	31 - 41	1	-4	-7	5	0	-3	-11
R05	30	26	24	34	30	28	27 - 35	-5	-9	-11	-1	-5	-7	-17
R06	45	36	32	49	39	35	35 - 50	10	1	-3	14	4	0	-2
R07	40	33	30	44	37	33	32 - 45	5	-2	-5	9	2	-2	-7
R08	28	26	23	31	29	27	26 - 33	-7	-9	-12	-4	-6	-8	-19
R09	28	26	24	32	30	28	27 - 33	-7	-9	-11	-3	-5	-7	-19
R10	25	23	21	28	26	25	24 - 30	-10	-12	-14	-7	-9	-10	-22
R11	24	24	22	28	27	25	25 - 29	-11	-11	-13	-7	-8	-10	-23
R12	23	23	21	26	26	25	24 - 28	-12	-12	-14	-9	-9	-10	-24
R13	24	25	23	28	28	27	26 - 30	-11	-10	-12	-7	-7	-8	-22
R14	23	23	22	26	27	26	25 - 28	-13	-12	-13	-9	-8	-9	-24
R15	22	21	22	25	25	25	24 - 27	-13	-14	-13	-10	-10	-10	-25

5.2.1 Discussion of Results

The results presented in **Table 5.2** identify the following:

- Predicted $L_{eq,\ 15\ minute}$ noise levels range between 21 and 49 dBA (29 dBA on average) for the construction works and activities envisaged for the project. The highest $L_{eq,\ 15\ minute}$ noise levels are predicted at the closest residential receptor (R06) situated north of the site.
- Predicted $L_{eq,\ 15\ minute}$ noise levels exceed the night-time NML at the most affected residential (dwelling) receptors by between 1 and 14 dBA (5 dBA on average, where levels are above the NML). Based on this compliance assessment, the most affected residential (dwelling) receptor is R06, where levels exceeding the night-time NML by ~14 dBA are predicted. The next most affected residential (dwelling) receptor is R07 (to the north of the site), where levels exceeding the night-time NML by ~9 dBA are predicted.
- Predicted $L_{eq,\ 15\ minute}$ noise levels are lower for the first scenario (CON01 – Installation / Construction of Infrastructure) where noise levels are predicted to exceed the NML at R06 by ~10 dBA and R07 by ~5 dBA.
- Predicted $L_{eq,\ 15\ minute}$ noise levels exceed the daytime NML at the most affected residential (dwelling) receptor (R06) during both CON01 and CON02 while works are being undertaken at the northern portion of the site (i.e. CON01a and CON02a).
- All predicted $L_{eq,\ 15\ minute}$ noise levels are below the daytime HNML (for works within the recommended standard hours of construction) value of $L_{eq,\ 15\ minute} \leq 75$ dBA applicable at residential (dwelling) receptors.
- All predicted L_{max} noise levels are below the L_{max} sleep disturbance criteria (for works outside the recommended standard hours of construction) value of $L_{max} \leqslant 52$ dBA applicable at residential (dwelling) receptors.

5.2.2 Summary of Findings

The predicted noise levels identified above are typical of construction works and activities are undertaken in the vicinity of rural/residential land use precincts. These predicted values do not represent a constant noise emission that would be experienced by the community on a daily basis throughout the project's construction schedule. The predicted noise levels will only be experienced for limited periods of time when works are occurring and will not be experienced over the whole daytime, evening or night time periods. Construction noise emissions will be temporary and do not represent a permanent impact on the community and the surrounding environment.

Some noise from construction sites is inevitable, such that the ICNG, 2009 focuses on minimising construction noise impacts, rather than only on achieving numeric noise levels. These results identify that general good-practice construction noise management techniques should be sufficient to maintain acceptable noise levels at all receptors. It also highlights that construction works should be limited (where reasonable and feasible) to the recommended standard hours for construction to maintain compliance and should be avoided outside the recommended hours (daytime, evening and night) to limit any construction noise impacts to the daytime (standard hours) assessment period. Recommendations are further outlined in **Chapter 7**.

5.3 Construction Road Traffic

To assess potential noise impacts associated with construction road traffic, vehicle movements were estimated based on the construction data provided by GAIA. This construction traffic assessment presents estimated (maximum) light vehicle and heavy vehicle movements that could be expected during the construction phase of the project. These vehicle movements are outlined below:

- A total of 220 vehicles per daytime period (15 hours) made up of 50 light vehicles, 20 mini buses, and 10 heavy vehicles per hour.
- A peak daytime period (1 hour) of 45 vehicles made up of 25 light vehicles, 10 mini buses and 10 heavy vehicles.
- A total of 35 vehicles per the night-time period (9 hours), although not anticipated, this is made up of 25 light vehicles and 10 mini buses potentially arriving before 7am.
- Similarly, the peak night-time (1 hour) of 35 vehicles, made up of 25 light vehicles and 10 mini buses potentially arriving before 7am.

Assumed posted speed limits of 100 km/h for sub-arterial and 60 km/h for local roads have been adopted to predict construction road traffic noise levels for comparison to the RNP criteria i.e. $L_{eq,\ 15\ hour}$, $L_{eq,\ 9\ hour}$ and $L_{eq,\ 1\ hour}$.

Due to the varying distance offsets to nearby residential receptors, road traffic noise levels were predicted at a range of distances; 50m, 100m, 150m and 200m. This precautionary approach was adopted as actual road and dwelling façade distances will vary from property to property along the length of the overall road alignments. The predicted construction road traffic noise levels are presented in **Table 5.3** below.

Table 5.3 – Predicted Construction Road Traffic Noise Levels and Compliance

Assessment Classification	RNP Road Traffic Noise Criteria		Predicted Noise Level (Day / Night) and Distance from Road Alignment, m				
	Daytime (7am to 10pm) assessment period	Night time (10pm to 7am) assessment period	Assessment Type	50 m	100 m	150 m	200 m
Road traffic noise criteria for existing residences affected by **additional traffic on existing sub-arterial roads** generated by land use developments.	$L_{eq,\ 15\ hour}$ 60 dB (external)	$L_{eq,\ 9\ hour}$ 55 dB (external)	Maximum	53/44	49/40	47/38	45/36
Road traffic noise criteria for existing residences affected by **additional traffic on existing local roads** generated by land use developments.	$L_{eq,\ 1\ hour}$ 55 dB (external)	$L_{eq,\ 1\ hour}$ 50 dB (external)	Maximum	53/51	50/47	47/45	45/43

1. *Predicted road traffic noise levels include a +2.5 dB façade correction.*
2. *All noise levels are dBA re 2 x 10^{-5} Pa.*

5.3.1 Discussion of Results

The results presented in **Table 5.3** identify the following:

- Predicted construction road traffic noise levels on sub-arterial roads are below the RNP criteria values at all assessed distances from the road during the daytime period (15 hour).
- Predicted construction road traffic noise levels on sub-arterial roads are below the RNP criteria values at all assessed distances from the road during the night-time period (9 hour).
- Predicted construction road traffic noise levels on local roads are below the RNP criteria values at all assessed distances from the road during the daytime peak period (1 hour).
- Predicted construction road traffic noise levels on local roads are above the RNP criteria values at a distance of 50m from the road during the night-time peak period (1 hour).
- Predicted construction road traffic noise levels on local roads are below the RNP criteria values at all assessed distances greater than 50m from the road during the night-time peak period (1 hour).

5.3.2 Summary of Findings

In summary, and with consideration of the data presented in **Table 5.3**, construction road traffic noise levels are predicted to comply with the relevant daytime RNP criteria despite the increase in proposed construction traffic. The night-time RNP criteria for local roads is predicted to exceed where residential receptors are within 50m from the road.

Some noise from construction sites is inevitable, however these results highlight that construction road traffic should be limited (where reasonable and feasible) to the recommended standard hours for construction to maintain compliance and should be avoided outside the recommended hours (night-time) to limit any construction noise impacts to the daytime (standard hours) assessment period.

Construction road traffic noise from the project may be audible at times, but noise levels will be reduced and impacts (if any) minimised with the successful implementation of the recommendations and safeguards provided in **Section 7.1** of this report.

5.4 Potential Cumulative impacts

As noted in **Chapter 4**, the NML is based on existing background noise levels measured at locations surrounding the project and focus on the direct impacts from the site under assessment. Furthermore, cumulative impacts are beyond the control of GAIA, are temporary and are best managed by local consent authorities for significant projects.

Although cumulative impacts are unlikely, as it is understood that there are no other significant construction projects proposed for the area, due care may be required of the local consent authority to manage/coordinate any other works occurring concurrently.

Where issues arise, GAIA may be able to assist by scheduling certain works or activities to minimise cumulative impacts. Given that the predicted construction noise levels are compliant with the HNML for all residential receptors (during the recommended standard hours of construction), cumulative noise issues are unlikely to occur or to be dominated by the project.

6. OPERATIONAL NOISE ASSESSMENT

This chapter presents the operational noise assessment that was completed for the project. The potential worst-case future noise generating scenario (all plant and equipment operating concurrently) was considered, as applicable to the proposed works described in **Chapter 1** of this report. The potential effect of noise enhancing meteorological conditions is also considered in this section as per the assessment methodology presented in **Section 2.6.1**.

6.1 Assessment Scenario

The following operational assessment scenario and associated data were developed, as presented in **Table 6.1** below. These source term emission values presented in **Table 6.1** were established based on publicly available data for known items of operational plant, equipment and machinery and then adapted for the assessment scenario documented below. The maximum (publically available) sound power level (LW) for each noise source (typical to solar farms) has been adopted for this assessment.

Some general modelling features are described in **Table 6.1** as summarised below:

- Quantity**:** is the number of equipment operating per 15 minute assessment period.
- Duty Factor: is the percentage of time the equipment operates per 15 minute assessment period, or represents a reduced emission for part of the period, e.g. equipment being active for a period of time and then idling.
- Base LW Value: is source emission or 'Sound Power Level' (LW) directly allocated to the equipment, unadjusted. This value was determined for each item based on publicly available data from similar Solar Farm noise assessments and represents the actual (operational/active) emission for each piece of equipment.
- Total LW Value: is the overall equipment source emission (LW) adjusted for the quality, duty factor and penalty (NPI, 2017 or other).

A modifying correction factor (penalty) for any annoying noise characteristics such as tonality, low frequency components etc. was considered as per the requirements of NPI, 2017. Based on the publicly available data and noise assessments for similar solar farms no NPI, 2017 penalties have been applied to the operational emissions from the project. However to ensure a precautionary assessment, the maximum (publicly available) LW for each noise source has been adopted for this assessment. In addition, a 1 dBA penalty has been applied to the inverters/transformers due to the uncertanty of their location. As each inverter/transformer has been modelled to occur in the centre of each solar panel array the 1 dBA penalty allows for variability in the actual (built) position of the inverter/transformer.

Table 6.1 – Operational Noise Assessment Scenario

Scenario	Description	Equipment	Quantity	Duty Factor	Base LW Value	Penalty, dBA	Total LW Value	Individual Noise Source Term Data - Spectral Data, dB(A)									
								Description	31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
OP01	Proposed Solar Farm Operations	2.5 MW Inverter / Transformer (per array)	1.0	1.0	72.0	1.0	93.0	Point Source	59.6	80.7	84.7	90.7	83.7	79.7	75.7	67.7	73.3
		Panel Tracking Motor (per array)	25	0.07	75.1	-	80.2	Area Source	46.1	68.3	72.6	68.6	73.9	72.4	73.4	69.0	59.8

6.2 Predicted Operational Noise Levels

Based on the operational assessment scenario and associated data presented in **Table 6.1** above, daytime, evening and night time $L_{eq,\ 15\ minute}$ noise levels (in dBA) have been predicted for representative worst-case conditions, i.e. concurrent equipment usage across the site. These predicted values have then been compared to the PNTL identified previously in **Table 4.2**, **Chapter 4** of this report.

All predicted operational noise levels are inclusive of the noise enhancing meteorological conditions described in **Section 2.6.1**. The resultant values and an assessment of compliance (predicted minus criteria for unmanaged and managed scenarios) are presented in **Table 6.2** below. A noise contour map for the worst-case (night-time) conditions is presented in **Appendix B**.

Table 6.2 – Predicted Operational Noise Levels and Compliance

ID	Scenario	Predicted Operational Noise levels $L_{eq\ 15\ minute}$, dBA			Comparison to PNTL (Predicted – Criteria) $L_{eq,\ 15\ minute}$ in dBA				Compliant?
		Day	Evening	Night	Day	Evening	Night	Sleep Disturbance	
R01	OP01	21	21	21	-19	-14	-14	-19	Y
R02		26	26	26	-14	-9	-9	-14	Y
R03		22	22	22	-18	-13	-13	-18	Y
R04		27	27	27	-13	-8	-8	-13	Y
R05		22	22	22	-18	-13	-13	-18	Y
R06		32	32	32	-8	-3	-3	-8	Y
R07		29	29	29	-11	-6	-6	-11	Y
R08		21	21	21	-19	-14	-14	-19	Y
R09		22	22	22	-18	-13	-13	-18	Y
R10		18	18	18	-22	-17	-17	-22	Y
R11		19	19	19	-21	-16	-16	-21	Y
R12		18	18	18	-22	-17	-17	-22	Y
R13		20	20	20	-20	-15	-15	-20	Y
R14		19	19	19	-21	-16	-16	-21	Y
R15		18	18	18	-22	-17	-17	-22	Y

6.2.1 Discussion of Results

The results presented in **Table 6.2** identify the following:

- Predicted $L_{eq,\,15\ minute}$ (dBA) noise levels for proposed operations are below the PNTL at all the identified residential receptors and are compliant with the NPI, 2017 for the daytime, evening and night-time periods.
- Predicted $L_{eq,\,15\ minute}$ (dBA) noise levels for proposed operations are below the $L_{eq,\,15\text{-}minute}$ sleep disturbance criteria (40 dBA) at all the identified residential receptors and are compliant with the NPI, 2017 for the night-time period.

Due to the nature of operational activities on the site, an L_{max} model was not considered necessary. The operation of the Solar Farm equipment generally involves a constant noise emission; therefore, the $L_{eq,\,15\ minute}$ is the key assessment parameter for sleep disturbance.

6.2.2 Summary of Findings

The predicted noise levels and compliance status summarised above, are as expected for a Solar Farm operation of this nature proposed in the vicinity of rural/residential land use precincts.

It should also be noted that as per typical solar farm operations, there will be minimal load on the inverters/transformers during the night-time period, resulting in minimal noise impacts. This assessment has conservatively assumed that all operations will remain the same for each assessment period (i.e. daytime, evening and night-time). Dispute this approach, predicted $L_{eq,\,15\ minute}$ (dBA) noise levels are complaint with the NPI, 2017 for the daytime, evening and night-time periods.

6.3 Operational Road Traffic

To assess potential noise impacts associated with operational road traffic, vehicle movements were estimated based on previous experience with operational road traffic assessments. This operational traffic assessment presents estimated (maximum) light vehicle and heavy vehicle movements that could be expected during the construction phase of the project. These vehicle movements are outlined below:

- A total of 21 vehicles per daytime period (15 hours) made up of 20 light vehicles, and one heavy vehicle per hour.
- A peak daytime period (1 hour) of 11 vehicles made up of 10 light vehicles, one heavy vehicle.
- A total of 10 vehicles per the night-time period (9 hours), although not anticipated, this is made up of 10 light vehicles potentially arriving before 7am.
- Similarly, the peak night-time (1 hour) of 10 vehicles, 10 light vehicles potentially arriving before 7am.

Assumed posted speed limits of 100 km/h for sub-arterial and 60 km/h for local roads have been adopted to predict construction road traffic noise levels for comparison to the RNP criteria i.e. $L_{eq,\,15\ hour}$, $L_{eq,\,9\ hour}$ and $L_{eq,\,1\ hour}$.

Due to the varying distance offsets to nearby residential receptors, road traffic noise levels were predicted at a range of distances; 50m, 100m, 150m and 200m. This precautionary approach was adopted as actual road and dwelling façade distances will vary from property to property along the length of the overall road alignments. The predicted operational road traffic noise levels are presented in **Table 6.3** below.

Table 6.3 – Predicted Operational Road Traffic Noise Levels and Compliance

Assessment Classification	RNP Road Traffic Noise Criteria		Predicted Noise Level (Day / Night) and Distance from Road Alignment, m				
	Daytime (7am to 10pm) assessment period	Night time (10pm to 7am) assessment period	Assessment Type	50 m	100 m	150 m	200 m
Road traffic noise criteria for existing residences affected by **additional traffic on existing sub-arterial roads** generated by land use developments.	$L_{eq, 15 hour}$ 60 dB (external)	$L_{eq, 9 hour}$ 55 dB (external)	Maximum	35/33	31/28	29/26	27/24
Road traffic noise criteria for existing residences affected by **additional traffic on existing local roads** generated by land use developments.	$L_{eq, 1 hour}$ 55 dB (external)	$L_{eq, 1 hour}$ 50 dB (external)	Maximum	42/38	38/34	36/31	34/30

1. *Predicted road traffic noise levels include a +2.5 dB façade correction.*
2. *All noise levels are dBA re 2 x 10^{-5} Pa.*

6.3.1 Discussion of Results

The results presented in **Table 6.3** identify the following:

- Predicted operational road traffic noise levels on sub-arterial roads are below the RNP criteria values at all assessed distances from the road during the daytime (15 hour) and night-time (9 hour) assessment periods.
- Predicted operational road traffic noise levels on local roads are below the RNP criteria values at all assessed distances from the road during the daytime peak and night-time periods (1 hour).

6.3.2 Summary of Findings

In summary, and with consideration of the data presented in **Table 6.3**, operational road traffic noise levels are predicted to comply with the relevant daytime and night-time RNP criteria despite the increase in proposed operational traffic on existing roads.

Operational road traffic noise from the project may be audible at times, but the traffic management measures outlined in the broader environmental assessment for the project, will assist any adverse effects to be maintained at acceptable levels. The measures described in the broader environmental assessment are considered adequate to reduce the potential impacts (if any) associated with operational road traffic. Therefore, no further recommendations for operational road traffic noise mitigation and management measures are warranted or provided in this assessment.

6.4 Potential Cumulative Operational Impacts

As noted in **Chapter 4**, the operational criteria (PTNL) are based on rating background noise levels adopted for the project and focus on the direct impacts from the site under assessment.

Based on the predicted noise levels, project noise emissions are unlikely to significantly increase (by a perceptible margin) the overall ambient (L_{eq}) and background (L_{90}) noise levels of the area.

7. RECOMMENDATIONS

This chapter presents any recommendations for construction and operational noise mitigation, management measures; or provisions for monitoring. These recommendations are based on the predicted noise levels and an evaluation of the magnitude and extent of potential impacts identified in **Chapter 5** (for construction) and **Chapter 6** (for operations) of this report.

They are designed to reduce project construction noise emissions towards achieving compliant levels and to minimise impacts to an acceptable value as far as may be feasible, reasonable and practical to implement. These recommendations also provide a general reassurance that suitable safeguards and provisions for monitoring are documented in this report, to manage construction and operational noise if other issues arise.

7.1 Construction Noise

Based on the findings presented in **Chapter 5** (construction noise assessment), the following management measures are recommended:

- Noise generating work and activities should be limited to the ICNG, 2009 recommended standard hours (i.e. 7 AM to 6 PM Monday to Friday and 8 AM to 1 PM Saturdays), with no work on Sundays or public holidays. Any unforeseen work that is required outside the recommended standard hours must be suitably mitigated and managed with a goal of achieving inaudible noise levels at all residential receptors or undertaken with agreement from the appropriate consent authority and any potentially affected neighbours.
- Where unforeseen works will occur close to a receptor, and these works are anticipated to generate high levels of noise e.g. > 75 dBA, potential respite periods, e.g. three hours of work, followed by one hour of respite should be applied. Respite should be implemented if it is the preference of the affected receptor/s and if they are feasible and reasonable, and practical, to implement during the works. In some circumstances respite may extend the duration of works and inadvertently increase noise impacts; hence due care should be taken when considering this management measure.
- During the construction design, choose appropriate plant, equipment and/or machinery for each task and adopt efficient work practices to minimise the total construction period and the number of noise sources on the site. Select the quietest item of plant, equipment and machinery available where options that suit the design permit.
- During the works, avoid unnecessary noise due to idling diesel engines, and fast engine speeds when equipment can be powered down and/or lower speeds are sufficient.
- During the works, instruct drivers to travel directly to the site and avoid any extended periods of engine idling at or near residential areas, especially at night.
- During the works, ensure all plant, equipment and/or machinery used on the site are in good condition, with particular emphasis on exhaust silencers, covers on engines and transmissions and squeaking or rattling components. Excessively noisy machines should be repaired or removed from the site.
- During the works, ensure that all plant, equipment and vehicles movements are optimised in a forward direction to avoid triggering motion alarms that are typically required when these items are used in reverse. Where it is possible tonal motion alarms should be replaced with broadband “squash duck” motion alarms.
- If any unforeseen night works must occur, all activities with the potential to generate impulsive noise should be avoided. These types of events are particularly annoying; especially at night and have the limited potential to generate sleep disturbance or awakening impacts. Any impulsive or transient noise events expected to exceed the sleep disturbance criteria at residential receptors should be strictly avoided at night.

- If any validated noise complaints are received, operator attended noise validation and compliance measurements should be undertaken to measure and compare the site noise level contributions to a) the predicted values; and b) the NMLs presented in this report. All site noise levels should be measured in the absence of any influential source not associated with the project. If the measured site noise levels are below the predicted values and comply with the NMLs presented in this report, no further mitigation or management measures are required. If the measured site noise levels are above the predicted noise levels or NML presented in this report, further mitigation and/or management measures should be considered.

7.2 Operational Noise

Based on the findings presented in **Chapter 6** (operational noise assessment), all predicted $L_{eq,\ 15\ minute}$ (dBA) noise levels for the proposed project operations are below the PNTL at all the identified residential receptors and are compliant with the NPI, 2017 for the day, evening and night-time periods. As such no recommendations for noise mitigation, management measures or monitoring options are warranted, however suitable safeguards and provisions have been provided below.

Provisions and Safeguards

Given that operational compliance has been attained with the assumption that the Inverters/ Transformers will achieve individual L_W of 92 dBA and Panel Tracking Motors will achieve individual L_W of 78 dBA, the following safeguards and provisions are provided.

- During equipment procurement, ensure that the Inverters/Transformers will achieve individual L_W of 92 dBA and Panel Tracking Motors will achieve individual operational L_W of 78 dBA.
- If any validated noise complaints are received, operator attended noise validation, and compliance measurements should be undertaken to measure and compare the site noise level contributions to a) the predicted values; and b) the PNTLs presented in this report:
  - All site noise levels should be measured in the absence of any influential source not associated with the project;
  - If the measured site noise levels are below the predicted values and comply with the PNTLs presented in this report, no further mitigation or management measures are required; and
  - If the measured site noise levels are above the predicted noise levels or PNTLs presented in this report, further mitigation and/or management measures should be considered.

8. CONCLUSION

This noise impact assessment was completed on behalf of GAIA for the Bonshaw Solar Farm located on the Bruxner Highway in Bonshaw NSW.

The assessment was conducted to identify potentially sensitive receptors situated in the vicinity (and potential area of influence) of site emission sources and identify significant noise generating plant, equipment and/or activities associated with the project and their likely/known emissions. The overall assessment methodology is presented in **Chapter 2** of this report.

Due to the remoteness of the project site and its surrounding rural environment, the existing background noise levels of the area were assumed to be the minimum rating background levels (RBLs) specified in Table 2.1 of the NPI. The assumed background noise levels are presented in **Chapter 3** of this report. Noise assessment criteria (refer **Chapter 4** of this report) were developed with due regard to and in accordance with recognised NSW standards and guidelines as applicable to the projects operational activities.

Applicable construction and operational assessment scenarios were developed based on project information provided by GAIA. Noise levels were predicted (and compared to criteria) to establish compliance, evaluate potential impacts and establish potential mitigation/management measures where necessary to reduce levels and minimise impacts.

The construction and operational noise assessments are presented in **Chapter 5** (for construction) and **Chapter 6** (for operation) of this report. The assessment has identified that construction noise levels have the potential to exceed the applicable criteria, limits and thresholds. Therefore noise mitigation, management measures and/or provisions for monitoring were established for the proposed construction and are outlined in **Chapter 7** of this report.

Based on the findings of the operational noise assessment, all predicted $L_{eq,\ 15\ minute}$ (dBA) noise levels for existing and proposed operations are below the PNTL at all the identified residential receptors and are compliant with the NPI, 2017 for all assessment periods. As such no recommendations for noise mitigation, management measures or monitoring options are warranted, however suitable safeguards and provisions have been provided in **Chapter 7**.

All necessary measures are documented as recommendations as presented in **Chapter 7** of this report, and are considered suitable to the magnitude and extent of the predicted impacts. They are designed to reduce noise levels and minimise impacts as far as is commonly feasible and reasonable to do so and practical to implement.

Construction noise levels will be reduced and impacts minimised with the successful implementation of the recommendations outlined in **Chapter 7**. Construction impacts may not be reduced to negligible or imperceptible levels at all receptors during all activities; however, the recommendations will assist to ensure that any residual impacts to the closest and/or potentially most affected receptors, and the broader community, minimised as far as is practically achievable.

REFERENCES

German Institute for Standardisation – DIN 4150 (2016) Part 3 (DIN4150-3) – **Structural Vibration - Effects of Vibration on Structures.**

International Organisation for Standardisation (ISO) 9613-2:1996 (ISO 9613:2) - **Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2: General Method of Calculation**.

International Organisation for Standardisation (ISO) 17534:2015 – (ISO 17534:2015) – **Acoustics - Software for the Calculation of Sound Outdoors**, as achieved by the modelling software referenced in this report.

NSW Department of Environment and Climate Change (DECC) – **NSW Interim Construction Noise Guideline** (ICNG, 2009), July 2009.

NSW Environment Protection Authority – **Noise Policy for Industry** (NPI, 2017), October 2017.

NSW Department of Environment, Climate Change and Water (DECCW) – **NSW Road Noise Policy** (RNP), March 2011.

NSW Department of Environment and Conservation – **NSW Environmental Noise Management – Assessing Vibration: a Technical Guideline** (the NSW Vibration Guideline), February 2006.

Standards Australia AS1055–1997™ (AS 1055) – **Description and Measurement of Environmental Noise**, Parts 1, 2 and 3.

Standards Australia AS IEC 61672.1–2004™ (AS 61672) – **Electro Acoustics - Sound Level Meters Specifications Monitoring or Standards Australia AS 1259.2-1990™ (AS 1259) – Acoustics – Sound Level Meters – Integrating Averaging** as relevant to the device.

Standards Australia AS/IEC 60942:2004/IEC 60942:2003 (IEC 60942) – Australian Standard™ – **Electroacoustics – Sound Calibrators.**

Standards Australia AS 2436–2010™ (AS 2436) – **Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites.**

APPENDIX A ACOUSTICS GLOSSARY

A1. GLOSSARY – ACOUSTICAL CONCEPTS AND TERMINOLOGY

A1.1 What Is Noise And Vibration?

Noise

Noise is often defined as a sound, especially one that is loud, unpleasant or that causes disturbance or simply as unwanted sound, but technically, noise is the perception of a series of compressions and rarefactions above and below normal atmospheric pressure.

Vibration

Vibration refers to the oscillating movement of any object. In a sense noise is the movement of air particles and is essentially vibration, though in regards to an environmental assessment vibration is typically taken to refer to the oscillation of a solid object(s). The impact of noise on objects can lead to vibration of the object, or vibration can be experienced by direct transmission through the ground, this is known as ground-borne vibration.

Essentially, noise can be described as what a person hears, and vibration as what they feel.

A1.2 What Factors Contribute To Environmental Noise?

The noise from an activity, like construction works, at any location can be affected by a number of factors, the most significant being:

- How loud the activity is?
- How far away the activity is from the receptor?
- What type of ground is between the activity and the receptor e.g. concrete, grass, water or sand?
- How the ground topography varies between the activity and the receptor, for example, is it flat, hilly, mountainous? Blocking the line of sight to a noise source will generally reduce the level of noise at the receptor.
- Are there any other obstacles that block the line of sight between the source and the receptor e.g. buildings or purpose built noise walls?

A1.3 How to Measure and Describe Noise?

Noise is measured using a specially designed “sound level meter” which must meet internationally recognised performance standards. Audible sound pressure levels vary across a range of 10^7 Pascals (Pa), from the threshold of hearing at 20μPa to the threshold of pain at 200Pa. Scientists have defined a statistically described logarithmic scale called Decibels (dB) describe noise more manageably.

To demonstrate how this scale works, the following points give an indication of how an average person perceives the noise levels and differences:

- 0 dB - represents the threshold of human hearing (for a young person with ears in good condition).
- 50 dB – represents average conversation.
- 70 dB – represents average street noise, local traffic etc.
- 90 dB – represents the noise inside an industrial premises or factory.
- 140 dB - represents the threshold of pain – the point at which permanent hearing damage may occur.

Unless otherwise stated in this report, all sound pressure levels (predicted or measured noise levels at a location or point) are expressed in decibels (dB, re: 2 x 10^{-5} Pascals, Pa) with the “A-weighting” curve applied and adopting the relevant acoustical or statistical noise level parameter e.g. $L_{eq, 15 minute}$, $L_{eq, 1hour}$ or $L_{90, 9 Hour}$.

All sound power levels (source noise emission values) are expressed in decibels (dB, re: 10^{-12} Watts, W) with the “A-weighting” curve applied (represents human hearing) and adopting the relevant acoustical or statistical noise level parameter.

A1.4 Human Response to Changes in Noise Levels

The following concepts offer qualitative guidance in respect of the average response to changes in noise levels:

- Differences in noise levels of less than approximately 2 dBA are generally imperceptible in practice, an increase of 2 dBA is hardly perceivable.
- Differences in noise levels of around 5 dBA are considered to be significant.
- Differences in noise levels of around 10 dBA are generally perceived to be a doubling (or halving) of the perceived loudness of the noise. An increase of 10 dBA is perceived as twice as loud. Therefore an increase of 20 dBA is four times as loud and an increase of 30 dBA is eight times as loud etc.
- The addition of two identical noise levels will increase the dBA level by about 3 dBA. For example, if one car is idling at 40 dBA and then another identical car starts idling next to it, the total dB level will be about 43 dBA.
- The addition of a second noise level of similar character which is at least 8 dBA lower than the existing noise level will not add significantly to the overall dBA level.
- A doubling of the distance between a noise source and a receptor results approximately in a 3 dBA decrease for a line source (for example, vehicles travelling on a road) and a 6 dBA decrease for a point source (for example, the idling car discussed above).
- A doubling of traffic volume for a line source results approximately in a 3 dBA increase in noise, halving the traffic volume for a line source results approximately in a 3 dBA decrease in noise.

A1.5 Terms to Describe the Perception of Noise

The following terms offer quantitative and qualitative guidance in respect of the audibility of a noise source:

- Inaudible / Not Audible - the noise source and/or event could not be heard by the operator, masked by extraneous noise sources not associated with the source. If a noise source is ‘inaudible’ its noise level may be quantified as being less than the measured L_{A90} background noise level, potentially by 10 dB or greater.
- Barely Audible – the noise source and/or event are difficult to define by the operator, typically masked by extraneous noise sources not associated with the source. If a source is ‘barely audible’ its noise level may be quantified as being 5 - 7 dB below the measured L_{A90} or L_{Aeq} noise level, depending on the nature of the source e.g. constant or intermittent.
- Just Audible – the noise source and/or event may be defined by the operator. However, there are a number of extraneous noise sources contributing to the measurement. The noise level should be quantified based on instantaneous noise level contributions, noted by the operator.
- Audible - the noise source and/or event may be easily defined by the operator. There may be a number of extraneous noise sources contributing to the measurement. The noise level should be quantified based on instantaneous noise level contributions, noted by the operator.

- Dominant – the noise source and/or event are noted by the operator to be significantly 'louder' than all other noise sources. The noise level should be quantified based on instantaneous noise level contributions, noted by the operator.
- The following terms offer qualitative guidance in respect of acoustic terms used to describe the frequency of occurrence of a noise source during an operator attended environmental noise measurements:
- Constant – this indicates that the operator has noted the noise source(s) and/or event to be constantly audible for the duration of the noise measurement e.g. an air-conditioner that runs constantly during the measurement.
- Intermittent – this indicates that the operator has noted the noise source(s) and/or event to be audible, stopping and starting intervals for the duration of the noise measurement, e.g. cars passing by.
- Infrequent – this indicates that the operator has noted the noise source(s) and/or event to be constantly audible, however; not occurring regularly or at intervals for the duration of the noise measurement e.g. a small number of aircraft are noted during the measurement.

A1.6 How to Calculate or Model Noise Levels

There are two recognised methods which are commonly adopted to determine the noise at a particular location from a proposed activity. The first is to undertake noise measurements while the activity is in progress and measures the noise, the second is to calculate the noise based on known noise emission data for the activity in question.

The second option is preferred as the first option is largely impractical regarding cost and time constraints, notwithstanding the meteorological factors that may also influence its quantification. Furthermore, it is also generally considered unacceptable to create an environmental impact simply to measure it. In addition, the most effective mitigation measures are determined and implemented during the design phase and often cannot be readily applied during or after the implementation phase of a project.

Because a number of factors can affect how 'loud' a noise is at a certain location, the calculations can be very complex. The influence of other ambient sources and the contribution from a particular source in question can be difficult to ascertain. To avoid these issues, and to quantify the direct noise contribution from a source/site in question, the noise level is often calculated using noise modelling software packages. The noise emission data used in may be obtained from the manufacturer or from ERM's database of measured noise emissions.

A1.7 Acoustic Terminology & Statistical Noise Descriptors

Environmental noise levels such as noise generated by industry, construction and road traffic are commonly expressed in dBA. The A-weighting scale follows the average human hearing response and enables comparison of the intensity of noise with different frequency characteristics. Time-varying noise sources are often described in terms of statistical noise descriptors. The following descriptors are commonly used when assessing noise and are referred to throughout this acoustic assessment:

- **Ambient noise** – the all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far.
- **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 described using the LA90 descriptor.
- **Cognitive noise** – noise in which the source is recognised as being annoying.

- **Decibel** (dB is the adopted abbreviation for the decibel) – A measure of sound level. The decibel is a logarithmic way of describing a ratio. The ratio may be power, sound pressure, voltage, intensity or other parameters. In the case of sound pressure, it is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure squared to a reference sound pressure squared.
- **dBA** -Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
- **dBC** – unit used to measure 'C-weighted' sound pressure levels. C-weighting is an adjustment made to sound-level measurements which takes account of low-frequency components of noise within the audibility range of humans.
- **dBZ or dBL** – unit used to measure 'Z-weighted' sound pressure levels with no weighting applied, linear.
- **Hertz (Hz)** - the measure of frequency of sound wave oscillations per second. 1 oscillation per second equals 1 hertz.
- **Octave** – a division of the frequency range into bands, the upper frequency limit.
- 1**/3 Octave** – single octave bands divided into three parts.
- **L_{eq}** - this level represents the equivalent or average noise energy during a measurement period. The $L_{eq,\ 15\ min}$ noise descriptor simply refers to the Leq noise level calculated over a 15 minute period. Indeed, any of the below noise descriptors may be defined in this way, with an accompanying time period (e.g. $L_{10,\ 15\ minute}$) as required.
- **$L_{AF90,\ 15\ min}$** - The A-weighted sound pressure level measured using fast time weighting that is exceeded for 90% of the time over a 15-minute assessment period. This is a measure of background noise.
- **$L_{AF90,\ period\ (day/evening/night)}$** – The A-weighted sound pressure level, obtained by using fast time weighting that is equal to or exceeded for 90% of the day, evening and night periods (as defined in this policy) for each 24-hour period.
- **$L_{AF90,\ (shoulder\ period)}$** - The A-weighted sound pressure level measured using fast time weighting that is exceeded for 90% of aggregate sound pressure level data for the equivalent of one week's worth of valid data taken over the shoulder period.
- **$L_{Aeq,\ T}$** - The time-averaged sound pressure level. The value of the A-weighted sound pressure level of a continuous steady sound that, with a measurement time interval T, has the same mean square sound pressure level as a sound under consideration with a level that varies with time (AS1055.1-1997).
- **L_{Amax}** - The maximum sound pressure level of an event measured with a sound level meter satisfying AS IEC 61672.1-2004 set to 'A' frequency weighting and fast time weighting.
- **L_N** - the percentile sound pressure level exceeded for N% of the measurement period calculated by statistical analysis.
- **L_{10}** - the noise level exceeded for 10 per cent of the time and is approximately the average of the maximum noise levels.
- **L_{90}** - the noise level exceeded for 90 per cent of the time and is approximately the average of the minimum noise levels. The L_{90} level is often referred to as the "background" noise level and is commonly used as a basis for determining noise criteria for assessment purposes.
- **Low frequency** - Noise containing major components in the low-frequency range (10 hertz [Hz] to 160 Hz) of the frequency spectrum.

- **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 (Bies and Hansen, 1996).
- **Sound Power Level (L_W)** - this is a measure of the total power radiated by a source. The Sound Power of a source is a fundamental property of the source and is independent of the surrounding environment.
- **Sound Pressure Level (L_P)** - the level of sound pressure; as measured at a distance by a standard sound level meter with a microphone. This differs from L_W in that this is the received sound as opposed to the sound 'intensity' at the source.
- **Spectral characteristics** - The frequency content of noise.
- **Tonal noise (tonality)**: noise containing a prominent frequency and characterised by a definite pitch.

1.7.1 Noise Policy for Industry (NPI, 2017) Specific Terminology

The following terminology is from the NSW Environment Protection Authority – Noise Policy for Industry (NPI, 2017), October 2017.

- **Annoyance** - An emotional state connected to feelings of discomfort, anger, depression and helplessness. It is generally measured by means of the ISO15666 defined questionnaire (EEA, 2010).
- **Assessment period** - The period in a day over which assessments are made: day (7 am to 6 pm); evening (6 pm to 10 pm); or night (10 pm to 7 am).
- **Best available technology economically achievable (BATEA)** - Equipment, plant and machinery incorporating the most advanced and affordable technology available to minimise noise output.
- **Best management practice (BMP)** - Adoption of particular operational procedures that minimise noise while retaining productive efficiency.
- **Cluster of industry** - An industrial/port estate, area, zone, or proposed area or zone where more than three separate industrial uses are co-located in a contiguous fashion and are operating or proposed to operate.
- **Construction activities** - Activities that are related to the establishment phase of a development and that will occur on a site for only a limited period of time.
- **Correction for duration**: this is applied where a single-event noise is continuous for a period of less than two and a half hours in any assessment period. The allowable exceedance of the $L_{Aeq,\ 15\ min}$ equivalent noise criterion for the duration of the event is shown in Table C3 of the NPI. This adjustment is designed to account for unusual and one-off events, and does not apply to regular and/or routine high-noise level events.
- **Cumulative industrial noise level** - The total level of noise from all industrial sources.
- **Greenfield site** - Undeveloped land.
- **High traffic amenity level** - The level of transport noise, road traffic noise in particular, may be high enough to make noise from an industrial source effectively inaudible, even though the L_{Aeq} noise level from that industrial noise source may exceed the project amenity noise level. In such cases the project amenity noise level may be derived from the $L_{Aeq,\ period\ (traffic)}$ minus 15 dBA. Refer to Section 2.4.1 of the NPI for additional details.
- **Impulsive noise** - Noise with a high peak of short duration, or a sequence of such peaks.

- **Industrial noise sources** - As defined in Section 1.4 of the NPI, noise from mechanical plant and equipment; industrial and commercial processes; mobile sources confined to a particular location (for example, drag lines, haul trucks, intermodal facilities and rail shunting yards); and vehicle movements within the premises and/or on private roads.
- **Intrusive noise** - Refers to noise that intrudes above the background level by more than 5 dB. The intrusiveness noise level is set out in further detail throughout Section 2.3 of the NPI.
- **Intermittent noise**: noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dBA; for example, equipment cycling on and off. The intermittency correction is not intended to be applied to changes in noise level due to meteorology.
- **Maximum correction**: the maximum correction to be applied to the predicted or the measured level where two or more modifying factors are present. The maximum adjustment is 10 dBA where the noise contains two or more modifying factors (excluding the duration correction).
- **Noise impact assessment (NIA)** - The component of an Environmental Impact Statement, Environmental Assessment, Statement of Environmental Effects, or licence application that considers the impacts of noise resulting from a development or activity.
- **Noise-sensitive land uses** - Land uses that are sensitive to noise, such as residential areas, churches, schools and recreation areas.
- **Non-compliance** - Any exceedance of a consent/licence limit is considered a non-compliance. However, the type of regulatory action taken by a regulatory authority will depend on a number of factors, in accordance with the authority's prosecution policies and guidelines.
- **Non-mandatory** - In this policy this means not required by legislation. The policy specifies project noise trigger levels to be strived for, but the legislation does not make these levels compulsory. However, the policy will be used as a guide to setting statutory (legally enforceable) limits for licences and consents.
- **Performance-based goals** - Goals specified in terms of the outcomes/performance to be achieved, but not in terms of the means of achieving them.
- **Premises** - includes: (a) a building or structure, or (b) land or a place (whether enclosed or built on or not), or (c) a mobile plant, vehicle, vessel or aircraft, as defined in the Protection of the Environment Operations Act 1997.
- **Proponent** - The developer of the industrial noise source.
- **Residence** - A lawful and permanent structure erected in a land-use zone that permits residential use (or for which existing use rights under the EP&A Act apply) where a person/s permanently reside and is not, nor associated with, a commercial undertaking such as caretakers' quarters, hotel, motel, transient holiday accommodation or caravan park.
- **Receiver** - The noise-sensitive land use at which noise from a development can be heard.
- **Significant meteorological effects** - In relation to temperature inversions, this means at least 30% of the total night time during the winter months. In relation to wind speeds this means at least 30% of the time or more in any assessment period (day, evening, night) in any season.
- **Sleep disturbance** - Awakenings and disturbance to sleep stages.
- **Temperature inversion** - An atmospheric condition in which temperature increases with height above the ground.
- **Very noise enhancing meteorological conditions** – Meteorological conditions outside of the range of either standard or noise-enhancing meteorological conditions as adopted in the noise impact assessment following the procedures in Fact Sheet D of the NPI.

A1.8 Operator Attended Measurements

Table A.1 below presents typical abbreviations that are used to describe common noise sources that may be noted during environmental noise measurements.

Table A.1 General Field Note Abbreviations

Abbreviation	Noise Source
ANML (B-I-D-L)	Animals (birds – insects – domestic - livestock)
ACF T	Aircraft
CPBY	Car pass by
DLCN	Dialogue, conversations e.g. with passers-by
DTRF	Distant traffic
LTRF	Local traffic
OIND	Other industry/industrial sites
OPTR	Operator
RDOC	Residential/occupants
RHUM	Rural harm
SHUM	Suburban harm
UHUM	Urban harm
WBVG	Windblown vegetation

During operator attended noise measurements, the sound level meter will present the instantaneous noise level and record acoustical and statistical parameters. In certain acoustical environments, where a range of noise sources are audible and detectable, the sound level meter cannot measure a direct source noise level, and it is often necessary to account for the contribution and duration of the sources.

Noted Percentile Contribution – **Table A.2** presents noise level deductions that are typically applied based on the percentage contribution of a noise source(s).

Noted Time Contribution – **Table A.3** presents noise level deductions that may be applied based on the percentage of time that a noise source(s) is audible during a 15-minute measurement. Where the noise emission from a source is clearly detectable, and the contribution can be measured, these deductions are not necessary.

Table A.2 - Noise Level Deductions – Noted Percentile Contribution

Percentage Contribution	Noise Adjustment Level, dBA
5%	-13.0
10%	-10.0
15%	-8.2
20%	-7.0
25%	-6.0
30%	-5.2
35%	-4.6
40%	-4.0
45%	-3.5
50%	-3.0
55%	-2.6
60%	-2.2
65%	-1.9
70%	-1.5
75%	-1.2
80%	-1.0
85%	-0.7
90%	-0.5
95%	-0.2
100%	0.0

Table A.3- Noise Level Deductions – Noted Time Contribution

Event Duration (Minutes)	Noise Level Adjustment, dBA
1	-11.8
2	-8.8
3	-7.0
4	-5.7
5	-4.8
6	-4.0
7	-3.3
8	-2.7
9	-2.2
10	-1.8
11	-1.3
12	-1.0
13	-0.6
14	-0.3
15	0.0

A2. VIBRATION - GLOSSARY OF TERMS, DEFINITIONS AND METHODOLOGY

A2.1 How to Measure and Control Vibration

Vibration refers to the oscillating movement of any object. In relation to construction projects, ground-borne vibration is the most likely outcome of works and potentially has three (3) effects on vibration sensitive receptors, these are:

- Ground-borne vibration that may cause annoyance.
- Ground-borne vibration that may have adverse effect on a structure e.g. a building.
- Regenerated noise due to ground-borne vibration.

Each of these potential effects can be assessed in accordance with the relevant standard. Perceptible levels of vibration often create concern for the surrounding community at levels well below structural damage guideline values; this issue needs to be managed as part of the vibration monitoring program.

Vibration is typically measured using specific devices that record the velocity or acceleration at a designated receptor location – usually being the closest premises to works. Modern vibration monitoring devices will typically capture amplitude data for the three (3) orthogonal axes being, the transverse, longitudinal and vertical and also the frequency at which the measured vibration event occurs.

Monitoring of this level of detail enables analysis of significant vibration events to determine compliance with relevant guidelines such as the NSW Department of Environment and Conservation – NSW Environmental Noise Management – *Assessing Vibration: a Technical Guideline* (the NSW vibration guideline), February 2006 and the German Institute for Standardisation – DIN 4150 (2016) Part 3 (DIN4150-3) – *Structural Vibration - Effects of Vibration on Structures*.

Vibration propagates in a different manner to noise and can be difficult to control depending on the frequency of the source in question, although identifying the strategy best suited to controlling vibration follows a similar approach to that of noise. This includes elimination, control at the source, control along the propagation path and control at the receptor and/or a combination of these, such as no work/respite periods.

A2.2 Vibration Descriptions

The following terms are often used to describe measured vibration levels.

- **Parameter** – an attribute with a value - for example, weighting.
- **Particle Velocity** – the instantaneous value of the distance travelled by a particle per unit time in a medium that is displaced from its equilibrium state by the passage of a sound or vibration wave.
- **Peak Component Particle Velocity (PCPV)** – is the highest (maximum or peak) particle velocity which is recorded during a particular vibration event over the three (3) axes. PCPV is measured in the unit, mm/s.
- **Phase** – the relative position of a sound wave to some reference point, the phase of a wave is given in radians, degrees, or fractions of a wavelength.
- **Acceleration** – the change in velocity over time. Acceleration is dependent on the velocity and the frequency of the vibration event (velocity is a vector), as such acceleration changes in two ways - magnitude and/or direction. Acceleration is measured in the unit, m/s2.
- **Perceptible** – vibration levels that a receptor of building occupant may ‘feel’. 0.2mm/s is typically considered to be the human threshold for perception of vibration.
- **Geophone or accelerometer** – the transducer/device typically used to measure vibration.

- **Damage** – is defined in DIN 4150-3 to include minor non-structural effects such as cosmetic damage or superficial cracking in paint or cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.
- **Vibration Dose Value (VDV)** – a concept outlined in the NSW vibration guideline, which is a calculative approach to assessing the impact of intermittent vibration or extended periods of impulsive vibration. VDV require the measurement of the overall weighted RMS (Root Mean Square) acceleration levels over the frequency range 1Hz to 80Hz. To calculate VDV the following formula (refer Section 2.4.1 of the guideline) is used:

  $$VDV = \left[\int_0^T a^4(t)dt \right]^{0.25}$$

  Where VDV is the vibration dose value in m/s1.75, a (t) is the frequency-weighted RMS of acceleration in m/s2 and T is the total period of the day (in seconds) during which vibration may occur.
- **MIC** - Maximum Instantaneous Charge or explosive charge mass (kg) detonated per delay (any 8ms interval).
- **SD (m)** - The scaled distance for air-blast and ground vibration from the charge to the receptor.

APPENDIX B DETAILED METHODOLOGY (ICNG, NPI AND RNP)

B.1 NSW INTERIM CONSTRUCTION NOISE GUIDELINES (ICNG, 2009) METHODOLOGY AND APPLICATION NOTES

The aim of the NSW Department of Environment and Climate Change (DECC) – *NSW Interim Construction Noise Guideline, July 2009* (ICNG, 2009) is to provide guidance on managing construction works to minimise noise (including airborne noise, ground-borne noise and blasting), with an emphasis on communication and cooperation with all involved in, or affected by, construction noise.

The main objectives of the ICNG, 2009 are to:

- promote a clear understanding of ways to identify and minimise noise from construction works.
- focus on applying all ‘feasible’ and ‘reasonable’ work practices to minimise construction noise impacts.
- encourage construction to be undertaken only during the recommended standard hours (refer **Section B1.2**), unless approval is given for works that cannot be undertaken during these hours.
- streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage.
- provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts.

No single approach can minimise noise from all types of construction. The level of effort and sophistication needed to assess impacts and identify ways to minimise noise will be guided by factors such as the duration of works and the extent of the noise. Short-term works or low noise level works will be typically easier to assess and manage. The Guideline may also be useful for determining authorities and other approval authorities when dealing with noise from construction and maintenance works on smaller-scale projects.

The steps for managing noise impacts from construction are:

- identify sensitive land uses that may be affected;
- identify hours for the proposed construction works;
- identify noise impacts at sensitive land uses; and
- select and apply the best work practices to minimise noise impacts.

B1.1 Recommended Standard Hours

The ICNG, 2009 presents an accepted method by which construction noise impacts may be assessed for a range of receptor types for works completed in NSW. It provides as set of recommended standard hours of construction, as reproduced below:

- Monday to Friday: 7 am to 6 pm;
- Saturday: 8 am to 1 pm; and
- No work on Sundays or public holidays.

The ICNG, 2009 encourages works to occur within the recommended standard hours of construction unless justification is provided. It focuses on minimising construction noise impacts, rather than only on achieving numeric noise levels, and recognises that some noise from construction sites is inevitable. The ICNG, 2009 encourages organisations involved with construction, maintenance or upgrading works (e.g. large scale contractors or Government agencies) to develop their best-practice techniques for managing construction noise and vibration, and implementing feasible and reasonable mitigation measures.

B1.2 Noise Management Levels (NML)

1.2.1 Residential Receptors

People’s reaction to noise from construction will depend on the time of day that works are undertaken. Residents are usually most annoyed by work at night-time as it has the potential to disturb sleep. Noise from work on evenings, Saturday afternoons, Sundays and public holidays can also be annoying to most residents as it may interrupt leisure activities.

The ICNG sets out noise management levels (NML) for residences and how they are to be applied for construction projects. Restrictions to the hours of construction may apply to activities that generate noise at residences above the ‘highly noise affected’ noise management level. The RBL is used when determining the NMLs, consistent with the approach described for the NPI (refer **Section B.2**).

The method for developing construction NMLs for residential noise sensitive receptors is detailed in **Table 1.1** below. The method for developing construction NMLs for other sensitive receptors are outlined in the sections below.

Table 1.1 Construction Airborne Noise Management Levels for Residential Receptors (ICNG)

Time of day	Noise management level, L_{eq} – dBA	How to apply
Recommended standard hours (SH): Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected Rating Background Level (RBL) + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. ■ Where the predicted or measured $L_{eq, 15 \text{ minute}}$ 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 works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	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 works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours (OOH) - All other times including Public Holidays	Noise affected Rating Background Level (RBL) + 5 dBA	■ A strong justification would typically be required for works 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 5 dBA above the noise affected level, the proponent should negotiate with the community. ■ For guidance on negotiating agreements see Section 7.2.2 of the ICNG.

1.2.2 Other Sensitive Land Uses

Other sensitive land uses, such as schools, typically consider noise from construction to be disruptive when the properties are being used (such as during school times). Table 3 of the ICNG presents management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed. Table 3 of the ICNG is reproduced below as **Table 1.2**.

Table 1.2 – Other Sensitive Receptors (NML)

Land Use	Management level, $L_{Aeq,\ 15\ minute}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level 45 dBA *(External noise level 55 dBA)**
Hospital wards and operating theatres	Internal noise level 45 dBA *(External noise level 55 dBA)**
Places of worship	Internal noise level 45 dBA *(External noise level 55 dBA)**
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dBA
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

** Internal noise levels are to be assessed at the centre of the occupied room. External noise levels are to be assessed at the most affected point within 50 m of the area boundary. Where internal noise levels cannot be measured, external noise levels may be used. A conservative estimate of the difference between internal and external noise levels is 10 dB for buildings other than residences. Some buildings may achieve greater performance, such as where windows are fixed (that is, cannot be opened).*

1.2.3 Commercial and Industrial Receptors

Due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining management levels is separated into three categories. As defined by the ICNG the external noise levels should be assessed at the most-affected occupied point of the premises:

- Industrial premises: external $L_{eq,\ 15\ minute} \leqslant 75$ dBA.
- Offices, retail outlets: external $L_{eq,\ 15\ minute} \leqslant 70$ dBA.
- Other businesses that may be very sensitive to noise, where the noise level is project specific as discussed in the ICNG.

1.2.4 Ground-borne Noise at Residences

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. Ground-borne noise caused, for example, by underground works such as tunnelling can be more noticeable than airborne noise. The following ground-borne noise levels for residences indicate when management actions should be implemented. The ICNG outlines fixed NML for ground-borne noise. These ground-borne NMLs are applicable at residences and indicate when management actions should be implemented. These levels recognise the temporary nature of construction and are only applicable when ground-borne noise levels are higher than airborne noise levels. The ground-borne noise levels are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

- **Evening** (6 pm to 10 pm): $L_{eq,\ 15\ minute}$ 40 dBA (internal).
- **Night-time** (10 pm to 7 am): $L_{eq,\ 15\ minute}$ 35 dBA (internal).

The internal noise levels are to be assessed at the centre of the most affected habitable room.

B1.3 NSW Noise Policy for Industry, 2017 Methodology

1.3.1 Overview

The purpose of the policy is to ensure noise impacts associated with particular industrial developments are evaluated and managed in a consistent and transparent manner. It provides noise levels for assessing the potential impact of noise from industry and includes a framework for considering feasible and reasonable noise mitigation measures. The *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Protection of the Environment Operations Act 1997* (POEO Act) require that authorities examine and take into account matters affecting the environment when making decisions about development and activities. The policy also provides a procedure for the development of appropriate and achievable statutory noise limits and operational requirements for development consents and environment protection licences.

The policy sets out a process for industrial noise management involving the following main steps:

- Determining the project noise trigger levels for a development (refer **Section B2.1**); these are the benchmark levels 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 (refer **Section B2.1.1**), and maintaining the noise amenity of an area (refer **Section B2.1.2**). Measurement of existing background levels, using procedures outlined in Fact Sheets A and B, is required for this step.
- Predicting or measuring the noise levels produced by the development (refer **Section B2.3**), having regard to the presence of annoying noise characteristics (Fact Sheet C) and meteorological effects such as temperature inversions and wind (Fact Sheet D).
- Comparing the predicted or measured noise level with the project noise trigger level, and assessing impacts and the need for noise mitigation and management measures (refer **Section B2.4**).
- Considering residual noise impacts, that is, noise levels that exceed the project noise trigger levels 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 (refer **Section B2.5**).
- Setting statutory compliance levels that reflect the best achievable and agreed noise limits for the development.
- Monitoring and reporting environmental noise levels from the development.

1.3.2 Project Noise Trigger Levels

The project noise trigger level provides a benchmark or objective for assessing a proposal or site. It is not intended for use as a mandatory requirement. The project noise trigger level is a level that, if exceeded, would indicate a potential noise impact on the community, and so ‘trigger’ a management response; for example, further investigation of mitigation measures.

The project noise trigger level, feasible and reasonable mitigation, and consideration of residual noise impacts are used together to assess noise impact and manage the noise from a proposal or site. It is the combination of these elements that is designed to ensure that acceptable noise outcomes are determined by decision makers.

The trigger level is tailored for each specific circumstance to take into account a range of factors that may affect the level of impact, including the:

- receiver’s background noise environment;
- time of day of the activity;
- character of the noise; and
- type of receiver and nature of the area.

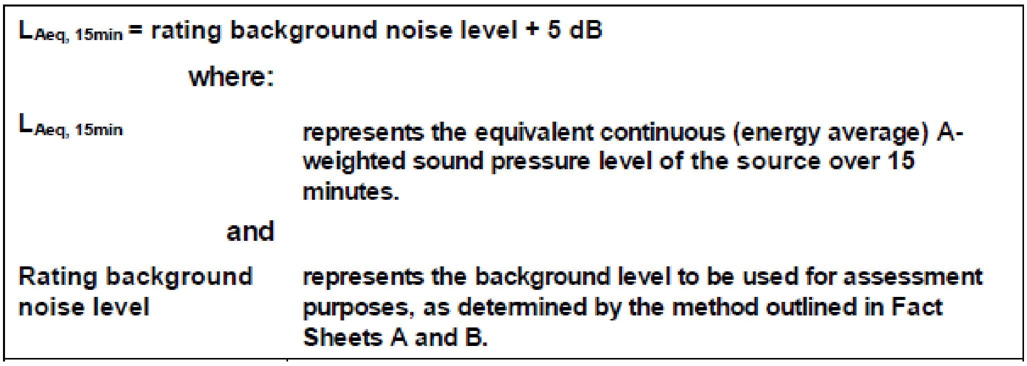
The project noise trigger level is the lower (that is, the more stringent) value of the project intrusiveness noise level and project amenity noise level determined in **Sections B2.2.2** and **B2.2.3** summarised below.

The project **intrusiveness** noise level aims to protect against significant changes in noise levels, whilst the project **amenity** noise level seeks to protect against cumulative noise impacts from industry and maintain amenity for particular land uses. Applying the most stringent requirement as the project noise trigger level ensures that both intrusive noise is limited and amenity is protected and that no single industry can unacceptably change the noise level of an area.

When determining whether noise mitigation is ‘feasible and reasonable’, the starting point is identifying mitigation measures that would result in achieving the relevant project noise trigger levels, and then identifying why particular measures may not be either feasible or reasonable.

1.3.3 Project intrusiveness noise level

The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level by more than 5 dB when beyond a minimum threshold. This intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment. The intrusiveness noise level is determined as follows:



$L_{Aeq,\,15min}$ = rating background noise level + 5 dB

where:

$L_{Aeq,\,15min}$	represents the equivalent continuous (energy average) A-weighted sound pressure level of the source over 15 minutes.
and	
Rating background noise level	represents the background level to be used for assessment purposes, as determined by the method outlined in Fact Sheets A and B.

Minimum assumed RBLs apply in this policy. These result in minimum intrusiveness noise levels are reproduced from the NPI in **Table 2.1** below.

Table 2.1 - Minimum assumed RBLs and project intrusiveness noise levels.

Time of day	Minimum assumed rating background noise level (dBA)	Minimum project intrusiveness noise levels ($L_{Aeq,15min}$ dBA)
Day	35	40
Evening	30	35
Night	30	35

1.3.4 Amenity noise levels and project amenity noise levels

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in **Table 2.2** below, where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.

The recommended amenity noise levels represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

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:

Project amenity noise level for industrial developments = recommended amenity noise level (Table 2.2) minus 5 dB(A)

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess reasonable and feasible mitigation options, and subsequently determine achievable noise requirements.

Table 2.2 – Amenity Noise Levels

Receiver	Noise Amenity Area	Time of Day	Recommended Amenity Noise Level ($L_{Aeq, period}$ dBA)
Residential	Rural	Day[2]	50
		Evening[3]	45
		Night[4]	40
	Suburban	Day[2]	55
		Evening[3]	45
		Night[4]	40
	Urban	Day[2]	60
		Evening[3]	50
		Night[4]	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5 dBA above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School classroom – internal	All	Noisiest 1-hour period when in use	35 (see notes for table)
Hospital ward internal external	 All All	 Noisiest 1-hour Noisiest 1-hour	 35 50
Place of worship – internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5 dBA to recommended noise amenity area

1. *The recommended amenity noise levels refer only to noise from industrial 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.*
2. *day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays*
3. *evening – the period from 6 pm to 10 pm*
4. *night – the remaining periods.*

Table 2.3 below provides guidance on assigning residential receiver noise categories; however, careful judgement based on site-specific circumstances and consultation with the relevant planning/licensing authority may be required in some circumstances.

Table 2.3: Determining which of the residential receiver categories applies.

Receiver Category	Typical planning zoning – standard instrument*	Typical existing background noise levels	Description
Rural residential	U1 – primary production RU2 – rural landscape RU4 – primary production small lots R5 – large lot residential E4 – environmental living	Daytime RBL <40 dBA Evening RBL <35 dBA Night RBL <30 dBA	Rural – an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse. Note: Where background noise levels are higher than those presented in column 3 due to existing industry or intensive agricultural activities, the selection of a higher noise amenity area should be considered.
Suburban residential	RU5 – village RU6 – transition R2 – low density residential R3 – medium density residential E2 – environmental conservation E3 – environmental management	Daytime RBL<45 dBA Evening RBL<40 dBA Night RBL <35dBA	Suburban – an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.
Urban residential	R1 – general residential R4 – high density residential B1 – neighbourhood centre (boarding houses and shop-top housing) B2 – local centre (boarding houses) B4 – mixed use	Daytime RBL> 45 dBA Evening RBL> 40 dBA Night RBL >35 dBA	Urban – an area with an acoustical environment that: ■ is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources ■ has through-traffic with characteristically heavy and continuous traffic flows during peak periods ■ is near commercial districts or industrial districts ■ has any combination of the above.

B1.4 Sleep disturbance

As stated in the NPI the potential for sleep disturbance from maximum noise level events generated by premises during the night-time period needs to be considered. The term "sleep disturbance" is considered to be both awakenings and disturbance to sleep stages.

Where the subject development/premises night-time noise levels at a residential location exceed:

- $L_{eq,15\ minute}$ 40 dBA or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{max} 52 dBA or the prevailing RBL plus 15 dB, whichever is the greater,

a detailed maximum noise level event assessment should be undertaken.

The 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. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy (RNP, 2011)

B1.5 Predicting Noise Levels

The important parameters for predicting noise are listed below. These will set the boundaries of the noise prediction process. They need to be determined and clearly identified for noise impacts to be predicted adequately. The parameters are:

- all noise sources related to the proposed development, including vehicles that operate on site
- source noise levels, site location and effective height of the noise source – references should be provided for all source noise levels used in the assessment (for example, direct measurement, previous Environmental Impact Statement, and manufacturers' specifications)
- annoying characteristics of the noise sources that may be experienced at receiver locations (for example, tonality, low frequency, and intermittency; see NPI Fact Sheet C)
- all stages of project development, including whether noise emissions may vary depending on site operations, for example, during delivery/despatch activities
- all receivers potentially affected by the development
- meteorological conditions applicable to the site (from NPI Fact Sheet D) to determine the meteorological conditions that should be adopted for the noise impact assessment
- site features (including natural and constructed, development and surrounding land uses) that affect noise propagation
- operating times of the development.

The noise impact of the development can be determined by comparing the predicted noise levels at the receiver with the corresponding project noise trigger levels that have been derived for that particular location. The development is considered to cause a noise impact if the predicted noise level at the receiver exceeds the corresponding project noise trigger level. The extent of noise impact from the development is defined by the extent the predicted noise level exceeds the project noise trigger level.

B1.6 Mitigating Noise from Industrial Developments

Where the project noise trigger levels are exceeded, feasible and reasonable noise mitigation measures should be evaluated, with the aim of reducing noise to the project noise trigger levels. Section 3.4 of the NPI gives a broad overview of ways to mitigate noise from industrial activities. It is not intended to be prescriptive guidance. It will be the responsibility of the proponent to demonstrate the selected mitigation measures are appropriate, and to justify any mitigation measures proposed (or disregarded) as part of a noise impact assessment. This advice provides useful guidance to developers of industrial activities to consider during the early stages of planning and design. The aim of this process is to evaluate what mitigation measures are both feasible and reasonable and the effect these will have on noise outcomes if applied.

Measures for reducing noise impacts from industrial activities follow three main control strategies:

- reducing noise at the source
- reducing noise in transmission to the receiver
- reducing noise at the receiver.

These control strategies should be considered in a hierarchical way so that all the measures that reduce noise for a large number of receivers (that is, source controls) are exhausted before more localised mitigation measures are considered. When determining whether noise mitigation is 'feasible and reasonable', the starting point is identifying mitigation measures that would result in achieving the relevant project noise trigger levels, and then identifying why particular measures may not be either feasible or reasonable.

B1.7 Residual noise

A residual noise impact may exist where the best-achievable noise level from a development, when assessed at a sensitive receiver location, remains above the project noise trigger levels. Chapter 4 of NPI, 2017 presents the method for determining the significance of residual noise impacts that may exist where the best-achievable noise level from development, when assessed at a sensitive receiver location, remains above the project noise trigger levels.

Residual noise impacts are identified **after** all source and pathway feasible and reasonable noise mitigation measures have been considered. The significance of the residual impact and the need to assess receiver-based treatment options may need to be considered as part of an authority's determination/approval process.

Determining the significance of any residual noise impact is an essential component of the noise assessment process, to ensure that effective and appropriate mitigation measures are taken in each case. A guide to the significance of residual noise impacts is outlined in **Table 2.4** below.

Table 2.4: Significance of residual noise impacts.

If the predicted noise level minus the project noise trigger level is:	And the total cumulative industrial noise level is:	Then the significance of residual noise level is:
≤ 2 dBA	Not applicable	Negligible
≥ 3 but ≤ 5 dBA	< recommended amenity noise level or > recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from the development is less than or equal to 1dB	Marginal
≥ 3 but ≤ 5 dBA	> recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is more than 1 dB	Moderate
> 5 dBA	≤ recommended amenity noise level	Moderate
> 5 dBA	> recommended amenity noise level	Significant

Examples of noise mitigation at a residence that may be required by planning authorities to mitigate residual noise impacts are outlined below, based on the significance of the residual noise levels.

- Negligible: The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls.
- Marginal: Provide mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal air quality/amenity.
- Moderate: As for ‘marginal’, but also upgraded façade elements, such as windows, doors or roof insulation, to further increase the ability of the building façade to reduce noise levels.
- Significant: May include suitable commercial agreements where considered feasible and reasonable.

B1.8 Fact Sheets

1.8.1 Fact Sheet A: Determining existing noise levels.

Fact Sheet A provides guidance for determining the background noise level or rating background noise level (RBL) which can be utilised in relevant noise assessments.

The background noise level is defined here as ‘the underlying level of noise present in ambient noise, generally excluding the noise source under investigation, when extraneous noise is removed’. Sound levels contributing to background levels can include sound from nearby traffic, birds, insects, animals, machinery and similar sources, if these sounds are a normal feature of the location.

The background noise level is represented by the $L_{AF90,\ 15\ min}$ descriptor when undertaking short-term monitoring. In comparison, the rating background noise level is the single-figure background noise level derived from monitoring over a representative period of time, typically one full week. The rating background noise level is used for assessment purposes.

Fact Sheet A also provides information regarding:

- determining existing industrial noise levels;
- ‘shoulder’ assessment periods;
- meteorological conditions for background noise monitoring; and
- duration of monitoring.

1.8.2 Fact Sheet B: Measurement procedures for determining background noise

Fact Sheet B gives a detailed description of instrumentation requirements, and procedures for measurement and analysis for determining background noise levels. It also contains information regarding the determination of background noise using long-term noise measurements, determining background noise using short-term noise measurements and reporting requirements.

1.8.3 Fact Sheet C: Corrections for annoying noise characteristics

Some noise sources may contain certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content and there is evidence to suggest that these characteristics can cause greater annoyance than other noise emissions at the same level.

Fact Sheet C outlines the “correction factors” (penalties) that are to be applied to the source noise level at the receptor (before comparison to criteria) to account for the potential additional annoyance caused by these characteristics. Fact Sheet C also provides definitions to support these modifying factor corrections.

1.8.4 Fact Sheet D: Accounting for noise-enhancing weather conditions

Certain meteorological conditions have the potential to increase noise levels at receptors influenced by the effects of temperature inversions, being atmospheric conditions where temperatures increase with height above ground level, or wind gradients, that is, wind velocities increasing with height, and with wind direction from the source to the receptor. The extent that noise-enhancing temperature inversions and winds can increase levels will vary depending on the distance to the receptor from the source and condition being experienced.

Fact Sheet D provides guidance around noise-enhancing weather conditions, and outlines approaches for consideration of meteorological conditions for both the impact assessment phase (pre-operation) and compliance assessment phase (post-operation) for an industrial activity.

Fact Sheet D also contains methods for determining the frequency of temperature inversions, and methods for determining the frequency of wind.

1.8.5 Fact Sheet E: Worked case studies

Fact Sheet E includes a number of worked case studies that describe how to successfully apply the principles of the NPI in a variety of circumstances. Worked case studies include:

- a general application case study;
- a high traffic noise case study;
- an extractive industry proposed for quiet rural area (significance of meteorological assessment);
- existing intensive primary industry; and
- modifications to existing industrial premises co-located with existing urban residential land uses.

1.8.6 Fact Sheet F: Feasible and reasonable mitigation

Fact Sheet F describes and provides guidance for the application of feasible and reasonable mitigation measures. The following should be taken into consideration when determining feasible and reasonable mitigation measures:

- Noise impacts;
- Noise mitigation benefits;
- Cost effectiveness of noise mitigation; and
- Community views.

B1.9 NSW Road Noise Policy (RNP, 2011) Methodology and Application Notes

The NSW Government approved the Road Noise Policy (RNP), to replace the Environmental Criteria for Road Traffic Noise (ECRTN) with effect from 1 July 2011. The RNP outlines the range of measures needed to minimise road traffic noise and its impacts. It is intended for use by:

- road project proponents;
- determining authorities and regulators involved in the approval and construction of road projects and land use developments that generate additional traffic on existing roads;
- city and transport planners and policymakers dealing with issues such as route corridors, heavy vehicle transport and building codes; and
- acoustic specialists.

The RNP aims to identify the strategies that address the issue of road traffic noise from: existing roads; new road projects; road redevelopment projects; and new traffic-generating developments.

B1.10 Road types

Table 3.1 below (reproduced from the RNP) outlines the road categories in NSW and the corresponding management responsibility. Roads are functionally classified by a range of factors, these include: their role in facilitating traffic movement; their relationship to other road categories; and whether they support through or local traffic, access to adjacent land uses and applicable traffic management options.

Table 3.1 Road categories and management responsibility

Road Category	Functional Role	Examples	Management Responsibility
Freeways or motorways/ arterial roads	Support major regional and inter-regional traffic movement. Freeways and motorways usually feature strict access controls via grade separated interchanges.	■ Pacific Highway, Taree ■ M4 Motorway, Eastern Creek ■ Princes Highway, Arncliffe	State government
Sub-arterial roads1	Provide connection between arterial roads and local roads. May support arterial roads during peak periods. May have been designed as local streets but can serve major traffic-generating developments or support non-local traffic.	■ Bourke Street, Surry Hills ■ Cook Street, Baulkham Hills ■ Forest Road, Lugarno	Local councils
Local roads	Provide vehicular access to abutting property and surrounding streets. Provide a network for the movement of pedestrians and cyclists, and enable social interaction in a neighbourhood. Should connect, where practicable, only to sub-arterial roads.	■ Prince Street, Randwick ■ Pell Street, Howlong ■ Killarney Drive, Killarney Heights	Local councils

B1.11 Assessment criteria

Impacts from road traffic noise on public roads, as with other sources of environmental pollution, are assessed in the RNP through criteria that are transparent, equitable and consistent both on an individual project and on a state-wide basis.

The criteria aim to provide protection primarily inside and immediately around permanent residences, and at schools, hospitals and other sensitive land uses, rather than at all points in a given locality, which would not be practical or possible.

1.11.1 Noise assessment criteria – residential land uses

Table 3 of the RNP, reproduced as **Table 3.2** below, sets out the assessment criteria for residences to be applied to particular types of project, road category and land use. These criteria are for assessment against façade corrected noise levels when measured in front of a building façade as recommended in Table 7 of the RNP.

Table 3.2 Road traffic noise assessment criteria for residential land uses

Road Category	Type of project/land use	Assessment criteria – dBA	
		Day (7 am – 10 pm)	Night (10 pm – 7 am)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	LAeq, (15 hour) 55 (external)	LAeq, (9 hour) 50 (external)
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	LAeq, (15 hour) 60 (external)	LAeq, (9 hour) 55 (external)
Local roads	4. Existing residences affected by noise from new local road corridors 5. Existing residences affected by noise from redevelopment of existing local roads 6. Existing residences affected by additional traffic on existing local roads generated by land use developments	LAeq, (1 hour) 55 (external)	LAeq, (1 hour) 50 (external)

The RNP also presents permissible increases in noise levels above the existing road traffic noise of the area. However, the relative increase criteria are primarily intended to protect existing quiet areas from excessive changes in amenity due to noise from a road project.

Where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce them through feasible and reasonable measures to meet the assessment criteria. A secondary objective is to protect against excessive decreases in amenity as the result of a project by applying the relative increase criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dBA represents a minor impact that is considered barely perceptible to the average person.

1.11.2 Noise assessment criteria – other non-residential land uses

In some cases, there will be existing land uses that are sensitive to noise (e.g. hospitals and schools) where more stringent standards are expected, and there are other land uses where different criteria than those specified for residential land use are more appropriate. For existing schools, child care facilities, hospitals, places of worship and recreation, specific criteria have been set so the characteristic activities for each of these land uses will not be unduly disturbed.

The noise assessment criteria outlined in Table 4 of the RNP must be applied for assessing the impact and determining mitigation measures in the following situations:

- when there is a new road or road redevelopment
- when there is a land use development with the potential to generate additional traffic on local, sub-arterial or arterial roads.

The external criteria are for assessment against façade-corrected noise levels when measured in front of a building façade as recommended in Table 7 of the RNP.

Table 3.3 Road traffic noise assessment criteria for non-residential land uses

Existing sensitive land use	Assessment criteria – dBA	
	Day (7 am – 10 pm)	Night (10 pm – 7 am)
School classrooms - when in use	$L_{\text{Aeq, (1 hour)}}$ 40 (internal)	-
Hospital wards	$L_{\text{Aeq, (1 hour)}}$ 35 (internal)	$L_{\text{Aeq, (1 hour)}}$ 35 (internal)
Places of worship	$L_{\text{Aeq, (1 hour)}}$ 40 (internal)	$L_{\text{Aeq, (1 hour)}}$ 40 (internal)
Open Space (active) - when in use	$L_{\text{Aeq, (15 hour)}}$ 60 (external)	-
Open Space (passive) - when in use	$L_{\text{Aeq, (15 hour)}}$ 55 (external)	-
Childcare facilities	Sleeping rooms $L_{\text{Aeq, (1 hour)}}$ 35 (internal) Indoor play areas $L_{\text{Aeq, (1 hour)}}$ 40 (internal) Outdoor play areas $L_{\text{Aeq, (1 hour)}}$ 55 (external)	-
Aged care facilities	Residential land use noise assessment criteria should be applied to these facilities.	

B1.12 Relative increase criteria

In addition to the assessment criteria outlined in above, any increase in the total traffic noise level at a location due to a proposed project or traffic-generating development must be considered.

Residences experiencing increases in total traffic noise level above the relative increase criteria in **Table 3.4** below should also be considered for mitigation.

For other existing sensitive land uses as outlined in **Table 3.3**, the relative increase criteria should be applied to the respective $L_{\text{Aeq, (period)}}$ for that land use type, except for open space. For road projects where the main subject road is a local road, the relative increase criterion does not apply.

Table 3.4 Relative Increase Criteria

Road Category	Type of project/development	Assessment criteria – dBA	
		Day (7 am – 10 pm)	Night (10 pm – 7 am)
Freeway/ arterial/ sub-arterial roads	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road	Existing traffic $L_{Aeq,\ (15\ hour)}$ + 12dB (external)	Existing traffic $L_{Aeq,\ (9\ hour)}$ + 12 dB (external)

Where the existing $L_{Aeq,\ (period)}$ road traffic noise level is found to be less than 30 dBA, it is deemed to be 30 dBA.

A relative increase of 12 dB represents slightly more than an approximate doubling of perceived loudness (AS2659.1–1988) and is likely to trigger community reaction, particularly in environments where there is a low existing level of traffic noise.

The relative increase criteria are primarily intended to protect existing quiet areas from excessive changes in amenity due to noise from a road project. A similar approach is adopted in both the United States Federal Highway Administration’s Noise Abatement Criteria (United States Department of Transportation 1982) and the VicRoads Traffic Noise Reduction Policy (VicRoads 2005).

APPENDIX C DETAILED NOISE ASSESSMENT DATASET

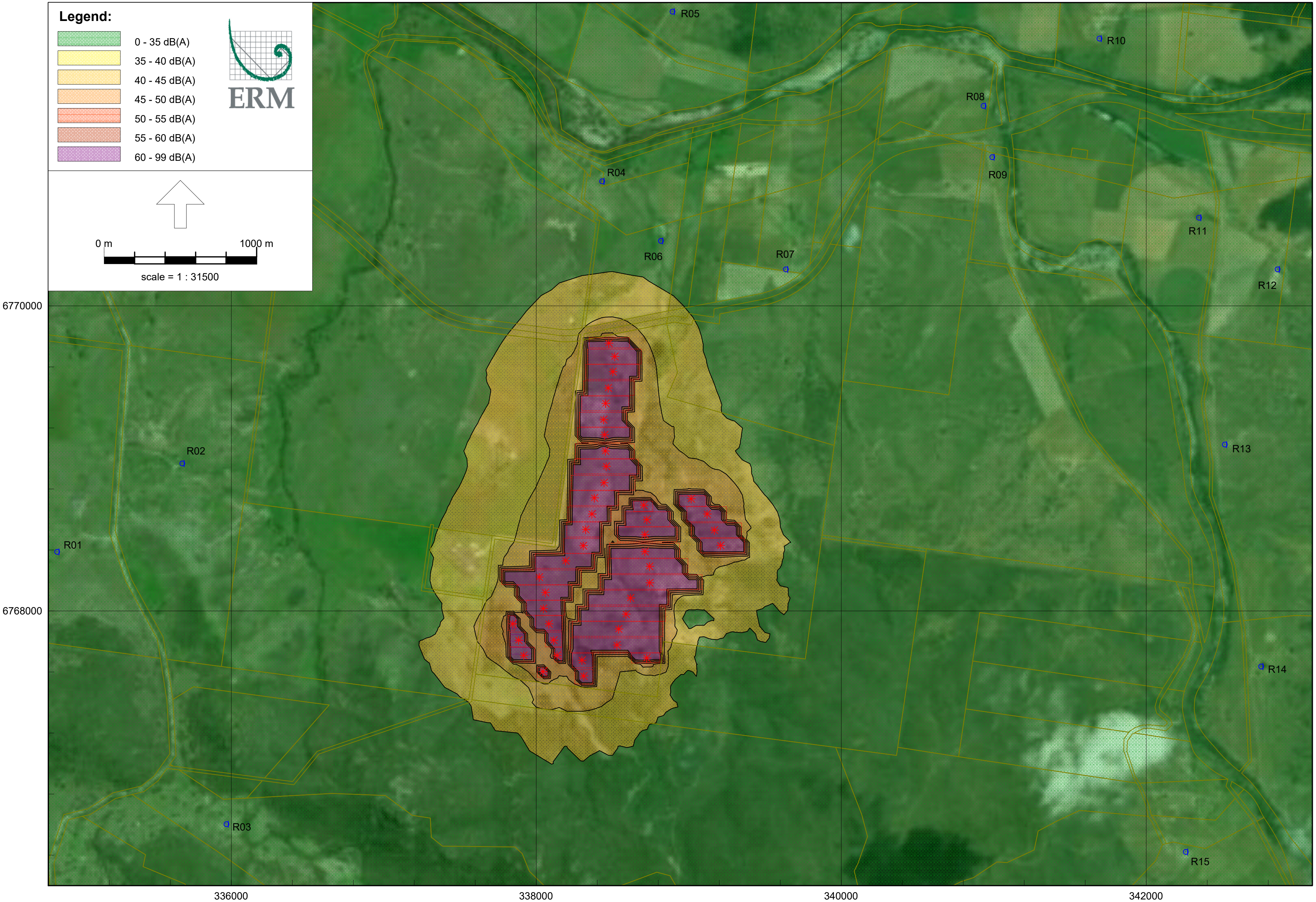
ID	Description	Equipment	Quantity	Duty Factor	Base Lw Value	NPI Penalty, dBA	Total Lw Value	Emission Height, m	Source	Individual Noise Source Term Data - Spectral Data, dB(A)									
										31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	LW Total, dB(A)
CON01	Site Preparation and Establishment	Fork-Lift Toyota 2.5 tone	4	0.75	106	-	110.8	2.0	Adopted from Australian Standard AS2436	82.7	88.7	94.7	101.7	103.7	105.7	104.7	98.7	94.7	110.8
		Fork-Lift Toyota 2.5 tone	3	0.75	106	-	109.5	2.0	Adopted from Australian Standard AS2436	81.4	87.4	93.4	100.4	102.4	104.4	103.4	97.4	93.4	109.5
		Fork-Lift 3Tonne Manitou	2	0.75	106	-	107.8	2.0	Adopted from Australian Standard AS2436	79.7	85.7	91.7	98.7	100.7	102.7	101.7	95.7	91.7	107.8
		Telescopic Handler (3 Ton) JCB 531-70	3	0.75	105	-	108.5	2.0	Adopted from Australian Standard AS2436	74.4	96.6	100.9	96.9	102.2	100.7	101.7	97.3	88.1	108.5
		Telescopic Handler (9 Ton) Manitou MHT790	2	0.75	105	-	106.8	2.0	Adopted from Australian Standard AS2436	72.7	94.9	99.2	95.2	100.5	99.0	100.0	95.6	86.4	106.8
		Water Truck Hino	2	0.75	107	-	108.8	2.0	Adopted from Australian Standard AS2436	71.6	88.1	88.8	89.2	94.4	108.0	98.0	92.4	83.4	108.8
		12 Seater -Toyota Hiace Commuter	10	0.5	107	-	114.0	2.0	Adopted from Australian Standard AS2439	83.1	91.1	99.2	101.6	106.9	109.6	108.1	102.3	97.0	114.0
		Holden Colorado 4x4	25	0.5	106	-	117.0	2.0	Adopted from Australian Standard AS2440	86.1	94.1	102.2	104.6	109.9	112.6	111.1	105.3	100.0	117.0
		Self Bunded Mobile Fuel Cell	1	1	99	-	99.0	2.0	Adopted from Australian Standard AS2436	64.9	87.1	91.4	87.4	92.7	91.2	92.2	87.8	78.6	99.0
CON02	General Construction of Infrastructure	Fork-Lift Toyota 2.5 tone	4	0.75	106	-	110.8	2.0	Adopted from Australian Standard AS2436	82.7	88.7	94.7	101.7	103.7	105.7	104.7	98.7	94.7	110.8
		Fork-Lift Toyota 2.5 tone	3	0.75	106	-	109.5	2.0	Adopted from Australian Standard AS2436	81.4	87.4	93.4	100.4	102.4	104.4	103.4	97.4	93.4	109.5
		Fork-Lift 3Tonne Manitou	2	0.75	106	-	107.8	2.0	Adopted from Australian Standard AS2436	79.7	85.7	91.7	98.7	100.7	102.7	101.7	95.7	91.7	107.8
		Telescopic Handler (3 Ton) JCB 531-70	3	0.75	105	-	108.5	2.0	Adopted from Australian Standard AS2436	74.4	96.6	100.9	96.9	102.2	100.7	101.7	97.3	88.1	108.5
		Telescopic Handler (9 Ton) Manitou MHT790	2	0.75	105	-	106.8	2.0	Adopted from Australian Standard AS2436	72.7	94.9	99.2	95.2	100.5	99.0	100.0	95.6	86.4	106.8
		Water Truck Hino	2	0.75	107	-	108.8	2.0	Adopted from Australian Standard AS2436	71.6	88.1	88.8	89.2	94.4	108.0	98.0	92.4	83.4	108.8
		Screw Pile Driver - John Deere Tractor 6125M And Trailer	3	0.5	111	5	117.8	2.0	Adopted from Australian Standard AS2436	70.8	85.5	107.3	108.6	109.7	113.3	111.7	102.6	95.8	117.8
		Screw Pile Driver - John Deere Tractor 6140M And Trailer	3	0.5	111	5	117.8	2.0	Adopted from Australian Standard AS2436	70.8	85.5	107.3	108.6	109.7	113.3	111.7	102.6	95.8	117.8
		Screw Pile Driver - John Deere Tractor 6110M And Trailer	3	0.5	111	5	117.8	2.0	Adopted from Australian Standard AS2436	70.8	85.5	107.3	108.6	109.7	113.3	111.7	102.6	95.8	117.8
		12 Seater -Toyota Hiace Commuter	8	0.5	107	-	113.0	2.0	Adopted from Australian Standard AS2436	82.1	90.1	98.2	100.6	105.9	108.6	107.1	101.3	96.0	113.0
		Holden Colorado 4x4	25	0.5	106	-	117.0	2.0	Adopted from Australian Standard AS2436	86.1	94.1	102.2	104.6	109.9	112.6	111.1	105.3	100.0	117.0
		Self Bunded Mobile Fuel Cell	1	1	99	-	99.0	2.0	Adopted from Australian Standard AS2436	64.9	87.1	91.4	87.4	92.7	91.2	92.2	87.8	78.6	99.0

ID	Description	Equipment	Quantity	Duty Factor	Base Lw Value	NPI Penalty, dBA	Total Lw Value	Emission Height, m	Source	Individual Noise Source Term Data - Spectral Data, dB(A)									
										31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	LW Total, dB(A)
CON01	Site Preparation and Establishment	Fork-Lift Toyota 2.5 tone	4	0.75	106	-	110.8	2.0	Adopted from Australian Standard AS2436	82.7	88.7	94.7	101.7	103.7	105.7	104.7	98.7	94.7	110.8
		Fork-Lift Toyota 2.5 tone	3	0.75	106	-	109.5	2.0	Adopted from Australian Standard AS2436	81.4	87.4	93.4	100.4	102.4	104.4	103.4	97.4	93.4	109.5
		Fork-Lift 3Tonne Manitou	2	0.75	106	-	107.8	2.0	Adopted from Australian Standard AS2436	79.7	85.7	91.7	98.7	100.7	102.7	101.7	95.7	91.7	107.8
		Telescopic Handler (3 Ton) JCB 531-70	3	0.75	105	-	108.5	2.0	Adopted from Australian Standard AS2436	74.4	96.6	100.9	96.9	102.2	100.7	101.7	97.3	88.1	108.5
		Telescopic Handler (9 Ton) Manitou MHT790	2	0.75	105	-	106.8	2.0	Adopted from Australian Standard AS2436	72.7	94.9	99.2	95.2	100.5	99.0	100.0	95.6	86.4	106.8
		Water Truck Hino	2	0.75	108	-	109.8	2.0	Adopted from Australian Standard AS2436	72.6	89.1	89.8	90.2	95.4	109.0	99.0	93.4	84.4	109.8
		12 Seater -Toyota Hiace Commuter	10	0.5	108	-	115.0	2.0	Adopted from Australian Standard AS2439	84.1	92.1	100.2	102.6	107.9	110.6	109.1	103.3	98.0	115.0
		Holden Colorado 4x4	25	0.5	111	-	122.0	2.0	Adopted from Australian Standard AS2440	91.1	99.1	107.2	109.6	114.9	117.6	116.1	110.3	105.0	122.0
		Self Bunded Mobile Fuel Cell	1	1	99	-	99.0	2.0	Adopted from Australian Standard AS2436	64.9	87.1	91.4	87.4	92.7	91.2	92.2	87.8	78.6	99.0
CON02	General Construction of Infrastructure	Fork-Lift Toyota 2.5 tone	4	0.75	106	-	110.8	2.0	Adopted from Australian Standard AS2436	82.7	88.7	94.7	101.7	103.7	105.7	104.7	98.7	94.7	110.8
		Fork-Lift Toyota 2.5 tone	3	0.75	106	-	109.5	2.0	Adopted from Australian Standard AS2436	81.4	87.4	93.4	100.4	102.4	104.4	103.4	97.4	93.4	109.5
		Fork-Lift 3Tonne Manitou	2	0.75	106	-	107.8	2.0	Adopted from Australian Standard AS2436	79.7	85.7	91.7	98.7	100.7	102.7	101.7	95.7	91.7	107.8
		Telescopic Handler (3 Ton) JCB 531-70	3	0.75	105	-	108.5	2.0	Adopted from Australian Standard AS2436	74.4	96.6	100.9	96.9	102.2	100.7	101.7	97.3	88.1	108.5
		Telescopic Handler (9 Ton) Manitou MHT790	2	0.75	105	-	106.8	2.0	Adopted from Australian Standard AS2436	72.7	94.9	99.2	95.2	100.5	99.0	100.0	95.6	86.4	106.8
		Water Truck Hino	2	0.75	108	-	109.8	2.0	Adopted from Australian Standard AS2436	72.6	89.1	89.8	90.2	95.4	109.0	99.0	93.4	84.4	109.8
		Screw Pile Driver - John Deere Tractor 6125M And Trailer	3	0.5	111	5	117.8	2.0	Adopted from Australian Standard AS2436	70.8	85.5	107.3	108.6	109.7	113.3	111.7	102.6	95.8	117.8
		Screw Pile Driver - John Deere Tractor 6140M And Trailer	3	0.5	111	5	117.8	2.0	Adopted from Australian Standard AS2436	70.8	85.5	107.3	108.6	109.7	113.3	111.7	102.6	95.8	117.8
		Screw Pile Driver - John Deere Tractor 6110M And Trailer	3	0.5	111	5	117.8	2.0	Adopted from Australian Standard AS2436	70.8	85.5	107.3	108.6	109.7	113.3	111.7	102.6	95.8	117.8
		12 Seater -Toyota Hiace Commuter	8	0.5	108	-	114.0	2.0	Adopted from Australian Standard AS2436	83.1	91.1	99.2	101.6	106.9	109.6	108.1	102.3	97.0	114.0
		Holden Colorado 4x4	25	0.5	111	-	122.0	2.0	Adopted from Australian Standard AS2436	91.1	99.1	107.2	109.6	114.9	117.6	116.1	110.3	105.0	122.0
		Self Bunded Mobile Fuel Cell	1	1	99	-	99.0	2.0	Adopted from Australian Standard AS2436	64.9	87.1	91.4	87.4	92.7	91.2	92.2	87.8	78.6	99.0

Description	Equipment	Quantity	Duty Factor	Base Lw Value	Penalty, dBA	Total Lw Value	Emission Height, m	Source	Individual Noise Source Term Data - Spectral Data, dB(A)									
									31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	LW Total, dB(A)
Operations	2.5 MW Inverter / Transformer (per array)	1	1	92	1	93.0	2.0	Publicly Available Solar Farm Noise Assessments (Gullen Solar Farm)	59.6	80.7	84.7	90.7	83.7	79.7	75.7	67.7	73.3	93.0
	Panel Tracking Motor (per array)	25	0.07	78	-	80.2	2.0	Publicly Available Solar Farm Noise Assessments (Beryl Solar Farm)	46.1	68.3	72.6	68.6	73.9	72.4	73.4	69.0	59.8	80.2

APPENDIX D OPERATIONAL NOISE CONTOUR MAP

Potential Worst-Case Operational Noise (Night-time)



Industrial noise - ISO 9613.1/2, [V01 - Operation] , Predictor V12.00

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ERM

APPENDIX H TRAFFIC IMPACT ASSESSMENT

Proposed Solar Farm,

Bruxner Highway, Bonshaw

ERM

Traffic Impact Assessment and Management Plan

Final Report

October 2019

SECA solution

Solar Farm Project, Bonshaw NSW

Traffic Assessment Report

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1 Introduction

Seca Solution has been commissioned by Environmental Resources Management (ERM) Pty Ltd to review the traffic impacts associated with the construction and operational phase of a new Solar Farm development and to determine traffic management measures associated with the construction activities for the project. The project involves construction, operation and eventual decommissioning of a 200 megawatt (MW AC) solar farm located in Bonshaw, to the west of Tenterfield in NSW.

The following works and infrastructure would be required to support the construction and operation of the solar farm:

- Construction of a main access road for all access and egress for the Site
- Installation of Electrical infrastructure including:
- A 132kV Substation including two transformers and associated 132kV switchgear.
- Inverters to collect and convert DC to AC.
- BESS/battery storage with up to 300 MW (AC);
- Cabling and other electrical infrastructure (e.g. security systems).
- A maintenance compound and buildings.
- Fencing, landscaping and environmental works.

The operational life of the solar farm is expected to be 30 years at which point the panels are either replaced and operations continue, or the infrastructure is removed, and the site is decommissioned and rehabilitated.

Construction of the site will take approximately 12 months.

Power generated by the facility will be transmitted via existing 330kV transmission lines, in an easement owned by TransGrid that traverses the Site.

As part of the development consent, and prior to work on site, a Traffic Management Plan will need to be prepared to the satisfaction of the road authorities (Inverell Shire Council and the Roads and Maritime Services (RMS)). The busiest period associated with the development with regards to traffic is during construction, with the operational phase of the project only requiring between 6-10 staff on site for the majority of the time. Seca Solution has prepared this Construction Traffic Management Plan (CTMP) for the project to ensure traffic issues can be safely and efficiently managed during the construction activities on site.

This CTMP has been developed for the construction activity for the project and the potential decommissioning element for the project, which may occur in 30 years' time. The potential decommissioning of the project site will require a similar level of activity, although will probably require less staff and would be completed over a shorter timeframe. The requirements and protocols for the decommission stage of the project will be as per the construction phase, although it is acknowledged these may need to be reviewed and altered in 30 years to suit the road conditions at that time as well as the work requirements.

The site is located within the locality of Bonshaw, west of Tenterfield and is shown in Figure 1-1 and 1-2 to follow.

The site is currently arable land and has road frontage to the Bruxner Highway along its northern boundary.

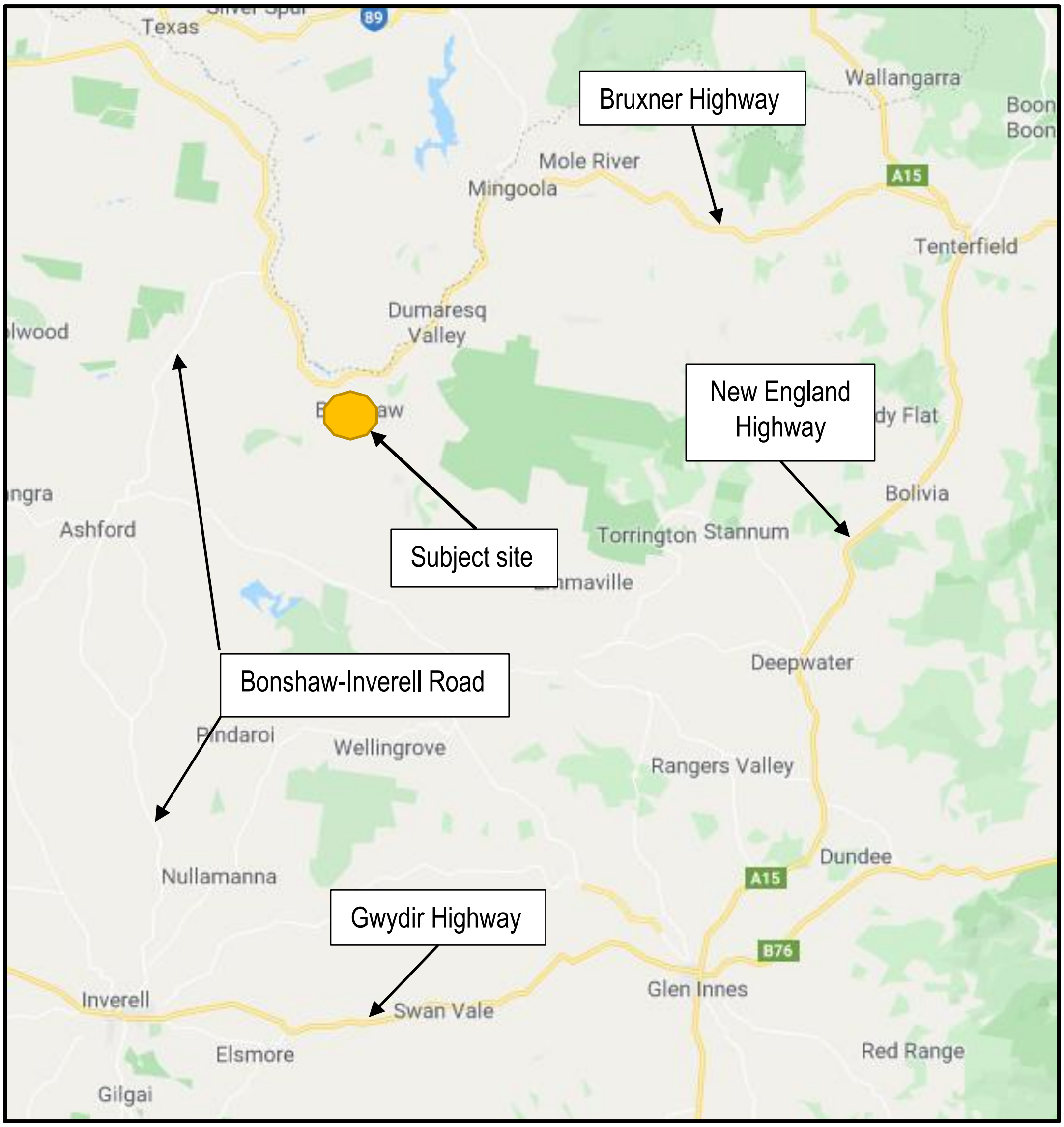
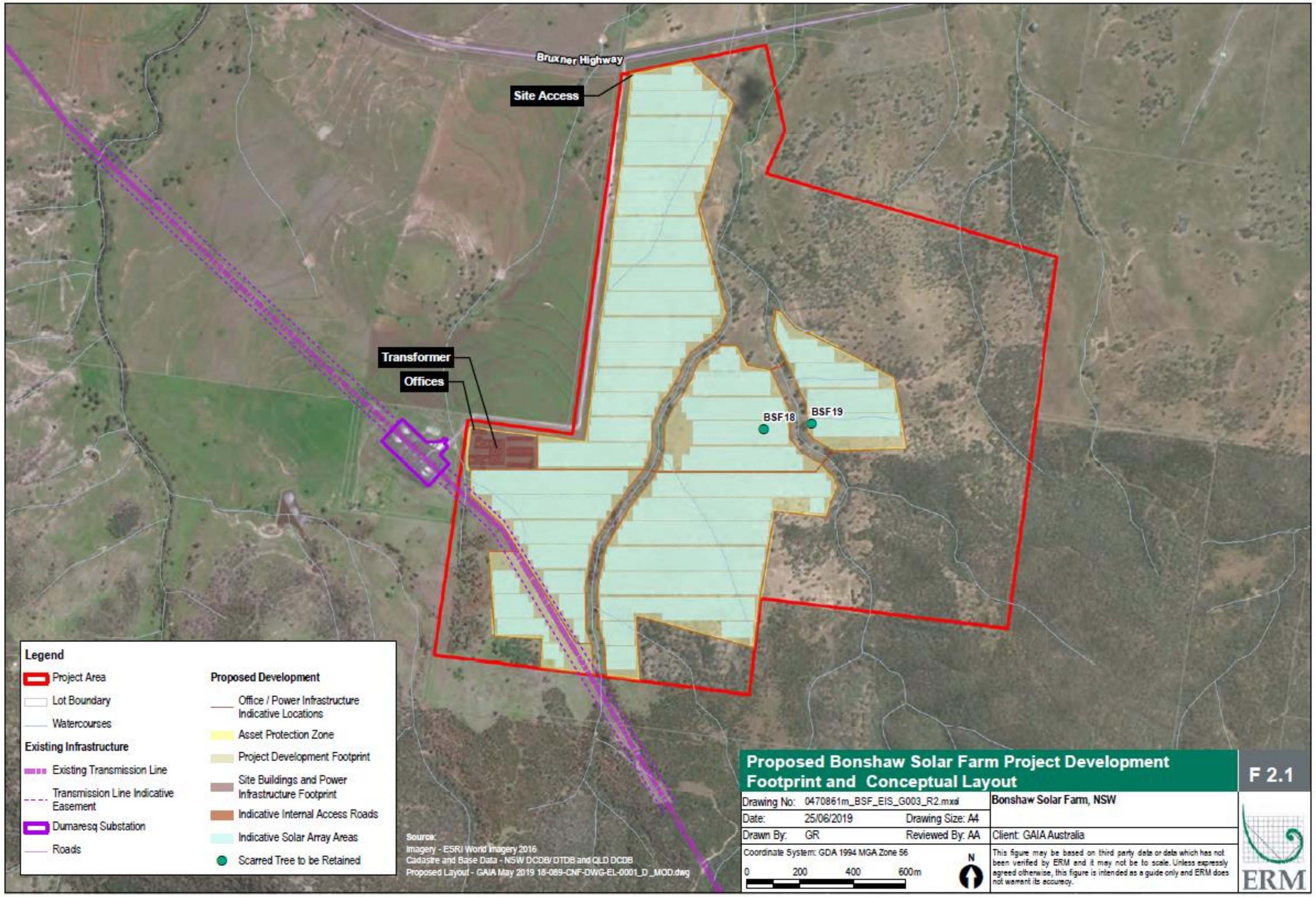


Figure 1-1: Site Location within the greater road network



Source:
Imagery - ESRI World Imagery 2016
Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 1-2 – Detailed site access and layout

1.1 Consultation and Authority Requirements

As part of the project, there has been consultation with the Department of Planning and Environment by the project manager and SEARs have been issued. A summary of the SEARs as they relate to traffic and access issues is presented below and the response is provided within this table.

SEARs issue	Response / Section of report
An assessment of the peak and average traffic generation including over-dimensional vehicle and construction worker transportation	The volume of traffic has been assessed for both the construction and operational phase. *Construction*: Peak staffing levels will require 65 light vehicles and 15 heavy vehicle inbound movements per day and similar outbound. For the sub-station installation there will be 3 over sized vehicles. *Operational*: 10 light vehicles per day inbound and outbound. Infrequent heavy vehicle for specific maintenance work only *Distribution:* Heavy vehicles via the designated heavy vehicle route to connect with the Bruxner Highway and New England Highway to east or west to Goondiwindi. **Refer Section 2.3, 2.4 3.1.1**
An assessment of the likely transport impacts to the site access route (including Bruxner Highway, Glenrock Road and Rocky Creek Road), site access point, rail safety issues, any Crown Land, particularly in relation to capacity and condition of the road	ALL heavy vehicles approaching the site will travel via the Bruxner Highway and New England Highway. For heavy vehicles exiting the site, they shall travel via the Bruxner Highway, then south via Inverell – Bonshaw Road to Inverell then along the Gwydir Highway to the New England Highway at Glen Innes. No heavy vehicle access via Glenrock Road or Rocky Creek Road. **Refer Section 3, Figure 3.1** Existing traffic flows on New England Highway, Bruxner Highway and Gwydir Highway are low and well within acceptable limits. Minimal impact created by traffic during construction and operations. **Refer Section 4.1**
A cumulative impact assessment of traffic from nearby developments (including cumulative impacts from Sundown Solar Farm, Sapphire Solar Farm and White Rock Solar Farm)	Sundown Solar Farm located off Gwydir Highway and currently EIS being prepared. Limited interaction with the Bonshaw site on Bruxner Highway. Sapphire Solar Farm constructed and operational. Limited interaction with Bonshaw site on Bruxner Highway. White Rock Solar farm under construction. Limited interaction with Bonshaw site on Bruxner Highway. **Refer Section 4.2**
A description of any proposed road upgrades developed in consultation with the relevant road authority and rail authorities (if required)	New access provided on Bruxner Highway to allow for access to site, designed in accordance with Austroad guidelines and constructed in accordance with RMS / Council requirements under the WAD process. **Refer Section 2.2.2**

A description of the measures that would be implemented to mitigate any transportation impacts during construction	Map of route for heavy vehicles provided **Refer Section 3 Figure 3.1.** All drivers will sign code of conduct which specifies all road rules must be obeyed including driving through school zones - Refer Appendix A All staff and delivery drivers will be inducted to site and sign a driver code of conduct – Refer Appendix A The contractor on site shall establish a complaint handling process and resolution process. During construction activities nearby properties along the local haulage route on Bruxner Highway will be notified via a letter drop of construction work and timeframe – Refer Appendix A.

RMS Consultation

Consultation has been held via a phone conversation with Andrew McIntyre, manager Land Use Assessment, Western Region (September 2017) with regard to a number of solar farms proposed to be constructed across rural NSW. The relevant outcome of the discussion with Andrew McIntyre is provided below:

- The critical phase for the assessment is the construction activities as this involves heavy vehicle access to the site along regional and local roads as well as a high number of workers;
- Consideration to the movement of staff to and from the site must be given. In remote areas where the solar farms are constructed, there are a large number of staff who can be drive in/drive out re-locating for temporary work from the established east coast centres such as Sydney and Newcastle. This requires staff to drive a long-distance home after working on the site for long hours for a week or more – consideration to controls for staff driving home after working on site should be considered;
- Provide details on the access routes to the site for heavy vehicles and the size / number of heavy vehicle movements associated with the construction and operation of the site;
- Provide details on the operational characteristics of the project – it is recognised that the staff levels and traffic volumes for the operational stage of the project are low;
- Provide comment with regard to the decommissioning stage of the project and the potential traffic impacts;
- Prepare a driver code of conduct for the project to control vehicle access and maintain safety;
- Assess impacts on road safety, including pedestrians and cyclists and any bus routes impacted
- Review alternative transport options for the site including pedestrians, cyclists and bus use
- Provide details on any road upgrades identified as part of the project and include a Road Safety Audit as required

2 Existing Road Network and Local Characteristics

The **Bruxner Highway** is a state classified road, which runs to the north of the subject site with an east-west orientation providing connection between the New England Highway to the east and Boggabilla to the west where it connects with the Newell Highway. The south, east and west boundaries of the subject lands are defined by neighbouring agricultural lots with some sections of unnamed, unsealed rural roads. The Bruxner Highway is sealed (refer Photo 1 below) and provides a width of approximately 6 metres passing the site allowing for 2-way traffic movements as required. It operates under the posted speed limit of 100 km/h.

The Bruxner Highway connects with the New England Highway to the east of the site at a four way give way controlled intersection with the New England being the priority road and Old Ballandean Road being the opposite minor road.

Photo 1 – View along Bruxner Highway

The **New England Highway** is a state classified road that is a key freight route in NSW and forms part of the road network designated by the Roads and Maritime to carry oversize, over mass vehicles. It typically provides a single lane of travel in both directions and operates under the posted speed limit of 110 km/h outside of the urban areas where the alignment permits. As part of the state road network, the New England Highway carries a mixture of local, regional and inter-state traffic with a significant number of trucks including B-double combinations. The **Cunningham Highway** operate in a similar manner providing key transport routes between Ipswich and the New England Highway at Warwick.

Bonshaw Road is a local road managed by Inverell Shire Council, located to the west of the site. It is a sealed two-way road with an overall width in the order of 7 metres. It intersects with the Bruxner Highway via a simple give way controlled intersection with the Bruxner Highway being the priority road. This road continues south and connects with **Ashford Road** in Ashford to provide a road link through to Inverell. This route provides a consistent road standard and forms part of the approved B-double road network in NSW.

From Inverell, the empty trucks will then travel along the Gwydir Highway to connect with the New England Highway at Glen Innes. This road provides a typical sealed width of 7 metres and provides overtaking lanes as appropriate. It forms part of the approved B-double road network in NSW.

As part of the project, it is proposed that all heavy vehicles will travel via the roads identified above. Local supplies could be sourced from Goondiwindi or Tenterfield as well as accommodation for workers associated with the project.

2.1 Traffic Volumes and Road Operation

Traffic volumes in the immediate vicinity of the subject site are very low, reflective of the rural environment. The Bruxner Highway carries relatively low traffic flows, reflective of its rural setting with a mixture of local traffic as well as regional traffic demands. Observations on site during a typical morning period (Tuesday 11th September 2018) shows that the current road network in the vicinity of the subject site operates very well with no delays. The route proposed to be used for the project carries low traffic flows and operates with no delays except for those associated with drivers slowing down to observe traffic flows on the approaches to the various intersections and negotiating the intersections.

The RMS webpage provides traffic data on the Bruxner Highway at Mingoola (station Id 91170), approximately 15 kms east of the subject site. The traffic data from 2011 shows that the daily traffic flow was 213 vehicles per day with around 23% heavy vehicles, reflective of rural demands in this location. It is considered that there has been limited growth in traffic since this time and as such the current daily traffic flows are considered to be similar.

The same web page shows that in 2011 the daily traffic flow on the New England Highway to the immediate north of Tenterfield (station Id 91577) was 2421. It is considered that there has been limited growth in this area since 2011 and as such the daily traffic flows would be similar. In 2012 the traffic flows on Bonshaw Road were 232 vehicles per day northbound. Assuming southbound flows to be the same would give daily flows in the order of 500 vehicles per day. It is considered that these flows would not have altered much since 2012.

2.2 Road Safety

It is recognised that as part of the project work, there will be a significant number of heavy vehicle movements associated with construction which may impact the local road network. All inbound heavy vehicle access to the project site will be via the Bruxner Highway and the New England Highway. For traffic from Goondiwindi, the route will be via the Newell Highway to town and along the Bruxner Highway. Inbound items such as the solar panels will be via the New England Highway (north from the Port of Newcastle) or via the Cunningham Highway connecting with the Port of Brisbane. No alternative route for inbound heavy delivery vehicles has been considered as this route is appropriate.

For outbound empty truck movements, movements to Goondiwindi would be the same, as would truck movements to the Brisbane area. However, for trucks heading back towards Newcastle, the right turn out of the Bruxner Highway onto the New England Highway is not considered appropriate due to its poor visibility and intersection layout it represents a road safety risk for the project. As such, trucks wishing to head south towards Newcastle shall use the route via Inverell - Bonshaw Road to connect to Inverell and the Gwydir Highway. This is via the approved B-double road network and shall have an acceptable impact upon road safety.

The major road safety impact is associated with the delivery trucks accessing the site and their impact upon the operation of the intersections. The trucks carrying the solar panels and other specialist materials will be accessing the site from either the Port of Newcastle or the Port at Brisbane, to which the solar panels shall be shipped. The trucks will then access Bonshaw via the regional road network which will include the New England Highway and the Cunningham Highway if from Brisbane. These regional roads currently provide a high standard of road and allow for the movement of local, regional and national road freight and carry B-double trucks. It is considered that the additional truck movements associated with the construction activities for the project will have a minimal and acceptable impact upon road safety along these roads.

For the sub-station installation there is a requirement for 3 over sized vehicles to access the site. These will require a separate approval and permit through the National Heavy Vehicle Regulator with RMS approval. Safety requirements and impacts are assessed as part of the permit application and the necessary safety controls applied which can include escort vehicles and Police vehicle support.

The nominated vehicle route currently caters for a large number of heavy vehicles including B-double combinations. This route provides a wide road pavement and in major built up areas cater for kerb side parking and the safe 2-way movement of trucks along the road. The intersections along this route are well laid out and provide good visibility in all directions to allow for the safe turning movements of vehicles. It is considered that this route through the various towns can safely accommodate the additional traffic movements associated with the project.

For the local traffic impacts, consideration has been given to the existing alignment of the road, intersection layouts, current traffic flows and existing users along the Bruxner Highway. Observations on site with regard to road safety are summarised below:

- Existing traffic flows on the local road are very low
- The sealed width of the road allows for two-way traffic movements
- The alignment of the road is generally good
- There are a number of sub-standard curves where there are advisory signs provided in advance with 55 and 65 km/h speed limit guidance signs
- A number of heavy vehicles were observed travelling along the Bruxner Highway during the site work, associated with local farm requirements as well as general deliveries in the area. These included semi-trailers.

These routes are provided below (Figure 2-1) and will be included within the Driver's Code of Conduct which will form part of the project inception meeting for the project for all staff and drivers.

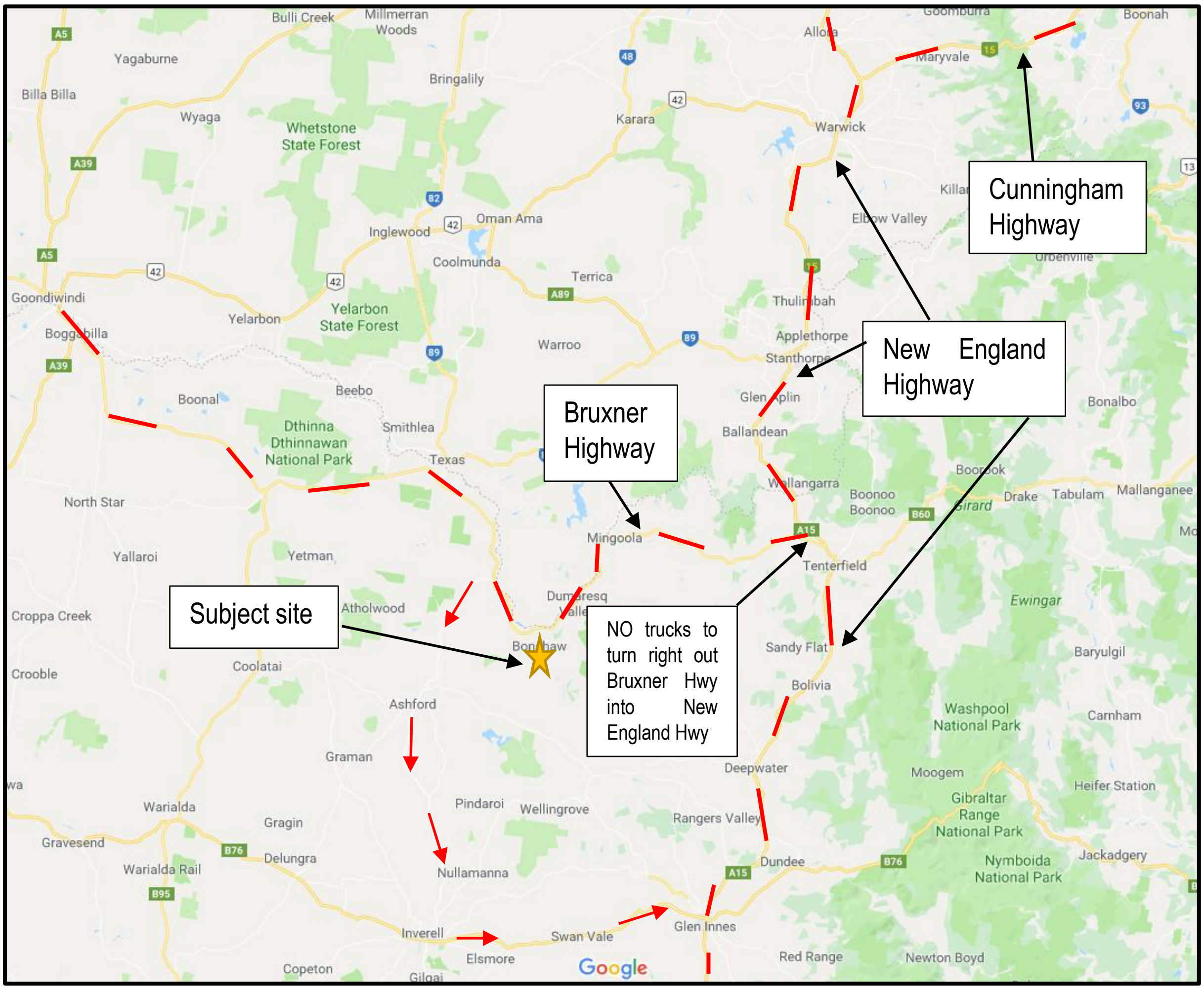


Figure 2-1 – Designated Heavy Vehicle route to project site

2.2.1 Intersection of Bruxner Highway and New England Highway

The intersection of the Bruxner Highway and New England Highway is 4-way cross road with the New England Highway being the priority road. Give way signs delineate the controls for the side road. This intersection has been upgraded with new line marking that provides a sheltered right turn lane for traffic turning off the New England Highway into the Bruxner Highway from the north as well as a right turn lane for traffic from the south turning into Old Ballandean Road. It allows for all turning movements and as part of the main transport route in this area caters for the swept path of B-double combinations. This intersection is located within a posted speed zone of 100 km/h. The sight line requirements for drivers approaching the intersection have been assessed against the requirements of Austroads Guidelines. For the posted speed limit of 100 km/h the sight distance requirement is 248 metres. To the right, looking south this sight line is available for drivers. However, to the left (north) the sight line is restricted due to the vertical alignment of the road, which creates a safety concern. In addition, for a truck turning right out of this road onto the New England Highway, there is a single lane southbound which creates further safety concerns for the project. A truck turning right out of the Bruxner Highway could then be a hazard for a southbound vehicle leading to rear end accidents. In a 100 km/h speed zone this is not considered to be acceptable.

For all other movements at the intersection of the Bruxner Highway and the New England Highway the existing intersection controls are considered to be appropriate. For traffic from the north turning right onto the Bruxner Highway, there is a sheltered right turn lane and visibility south exceeds 250 metres permitting a driver to safely judge an appropriate gap to turn right across the opposing traffic lane. For traffic from the south on the New England Highway, the forward visibility is good allowing a driver to adjust their vehicle speed to cater for a vehicle in front turning left onto the Bruxner Highway. The traffic flows on the New England Highway in this location are relatively low and as such this will create minimal delays for other drivers.

Overall it is considered that this intersection provides a high level of control (other than for the right turn out from the Bruxner Highway) and operates to a high safety standard and as such no upgrade works are required at this intersection to accommodate the traffic movements associated with the proposed solar farm (both construction and operation phase).

To mitigate the issue associated with the right turn out of the Bruxner Highway into the New England Highway, all trucks leaving the site wishing to head south shall instead turn left out of the site onto the Bruxner Highway, then turn left onto Bonshaw Road to head south to Ashford continuing south on Ashford Road to Inverell via the approved B-double route. These vehicles shall then travel along the Gwydir Highway to Glen Innes to connect to the New England Highway.

2.2.2 Site access on Bruxner Highway

The access to the site will be via a new access point located on the Bruxner Highway, approximately 70 metres to the east of the access to the electric substation in this location. The access will allow for all turning movements and will be designed in accordance with Austroads Guidelines. The design and construction of this access will be completed under a Works Authorisation Deed (WAD) with the RMS, due to the Bruxner Highway forming part of the State Road network.

With the majority of the heavy vehicles approaching the site from the east, as part of the access design a left turn deceleration lane will be provided to allow for safe entry to the site. This deceleration lane will be designed in accordance with Austroads Guidelines allowing for the posted speed limit of 100 km/h in this location. Refer Appendix C.

During the construction work, there will be some heavy vehicles arriving to the site from Goondiwindi, west of the site. These movements would be associated with the supply of equipment for the construction work. For traffic approaching from the west, the forward sight distance to the site access is approximately 700 metres. Austroads Guidelines require a sight distance of 248 metres for the posted speed limit of 100 km/h and 300 metres for a speed limit of 110 km/h. With the forward sight distance available, a driver can adjust their vehicle speed if required on the approach to the site access if there is a vehicle propped waiting to turn right into the site. However, given the very low traffic flows on the Bruxner Highway, it is not considered that vehicles turning right into the site will need to prop on the highway with the only delays created by vehicles slowing down to negotiate the site access driveway.

Trucks exiting the site will generally turn right onto the Bruxner Highway. With the low traffic flows on the Bruxner Highway, this can safely occur as there are large gaps in the through traffic movements in both directions in this location. A Traffic Control Plan will be provided during construction to advise drivers on the Bruxner Highway of construction activities and turning traffic movements.

For trucks turning left out of the site, the sight distance available to the right (east) exceeds 700 metres allowing a driver to safely exit the site and travel along the highway. No left turn acceleration lane is required for this movement.

Photo 2 – View to right along Bruxner Highway for drivers exiting the project site

Photo 3 - View to left along Bruxner Highway for drivers exiting the project site

This site access will allow for a length of sealed section of driveway within the site together with a shaker to stop dirt being carried from the site onto the road. Further within the site the roads will not be sealed.

2.3 Mitigation Measures

From the details above the following mitigation measures are proposed.

- Provide a temporary TCP on the site frontage on the Bruxner Highway, adjacent to the site access, for construction work associated with upgrading the access and for traffic entering and exiting the site. This TCP shall only be in place during construction and signs shall be removed or covered outside of construction activities on the site. Once the construction work is complete this TCP shall be fully removed. This TCP will be prepared in accordance with "Traffic Control at work sites" published by the RMS dated July 2018. This TCP is provided in Appendix D to this report;
- Provide regular community updates for residents along the Bruxner Highway in the vicinity of the site to advise of construction activities and increased heavy vehicle movements along this road;

2.3.1 Light Vehicle Route

For light vehicles associated with workers, the proposed access route will be via the designated heavy vehicle route shown in Figure 2-1 above. This route provides a safe and acceptable route for light vehicles which can safely and conveniently access the site. Light vehicle access could also be from Goondiwindi associated with construction workers.

The project will be utilising workers local to the site from the main centres e.g. Tenterfield, Goondiwindi, Inverell who will use this route as well as other local roads to connect between Inverell and the site. Additional specialist staff may be required, and these staff members would be located in accommodation in Tenterfield, Inverell and Goondiwindi.

3 Construction Activities

The construction and commissioning phase is expected to last approximately 12 months with expected commencement in late 2019 / early 2020. The main construction activities would include:

- **Site preparation:** geotechnical investigations to confirm ground conditions; site survey to confirm allotment boundary, riparian zone, and infrastructure positioning and placement; installation of fencing, internal access tracks, establishment of foundations and hardstands; office and car parking area;
- **Construction activities:** including installation of mounting structures and tracker tubes; securing PV modules to tracker tubes; installation of cabling and switching station, establishment of BESS / battery storage and maintenance compounds and associated site infrastructure; and testing and commissioning;
- **Plant and Equipment:** will include earthmoving plant and equipment for site preparation and clearing; cable trenching and laying equipment; pile drive equipment; forklifts and cranes; water truck for dust suppression and machinery equipment for construction of BESS / battery storage and associated facilities.

The project does not require any concrete footings to be provided for the solar panels construction.

A site office and compound will be established on site for the duration of the works with temporary access tracks provided to allow for access as required across the site.

Staffing levels at peak construction activities is expected to be 190 personnel on site maximum. The demand for staff numbers will be lower at the commencement of the project and shall increase overtime to the maximum of 190 staff. This demand is also expected to decrease towards the end of the project.

All staff vehicles will be able to park within the site adjacent to the site office with no external parking demands. The car park area will allow for up to 80 vehicles to park within this compound area. The size of the overall site footprint however will allow for all construction staff vehicles to park on site. As part of the project construction it is proposed to maximise the local workers content and car-pooling will be encouraged and supported as part of these trips. With 2 or 3 people arriving in a single vehicle it can be seen that the parking demands can be contained within the site.

The access road to the site will be via a dedicated new construction road off the Bruxner Highway. This shall be to the east of the existing access to the adjacent electric substation, near the western boundary of the site in the north-west corner of the project site.

3.1 Timing

The construction of the solar farm is expected to commence in 2020 and be completed within a 12 month timeframe.

The first stage of the project works requires the construction of the site access including the left turn deceleration lane and that shall be completed prior to commencement of construction activities on site

3.2 Working Hours

Construction hours are in accordance with the *Interim Construction Noise Guidelines* (DECC 2009) (ICNG) with standard construction hours being

- 7:00am and 6:00pm Monday to Friday
- 8.00 AM to 1.00 PM on a Saturday
- No construction work is to be carried out on a Sunday or public holiday.

No construction work, upgrading or decommissioning activities will be undertaken outside of these hours with the exception of:

- The delivery of material as requested by the NSW Police Force to other authorities for safety reasons; or
- Emergency work to avoid the loss of life, property and / or material harm to the environment.

3.3 Construction staff numbers

Peak demand levels for the construction work will vary with a peak of 190 people for a 6 month duration and a lower level outside of this peak period. The staff will be sourced locally where appropriate with some specialist and project management staff being temporarily located in Tenterfield, Inverell and potentially Goondiwindi. Staff will be encouraged and supported to carpool as appropriate with other staff transferred to and from the site via mini coaches to reduce vehicle demands. Due to the size of the site footprint, these same vehicles will also be used on site to move staff across the site.

With a peak of 190 staff, a vehicle occupancy rate of 3 people per vehicle has been assumed based upon carpooling and the use of a mini bus e.g. Toyota Hiace. This would give around 65 vehicle movements inbound and outbound for staff movements during this peak construction activity. Either side f this peak the staff levels will be lower and hence light vehicle numbers will correspondingly decrease.

All light construction vehicles will be able to park on site within the office compound area as required.

3.4 Heavy vehicle requirements

The number of heavy vehicles accessing the site will vary across the project timeframe. At the beginning of the project there will be a requirement for some earth moving equipment to construct the access road and some minor earthworks across the site as required. This may require a scraper or bulldozer which will be transported to site on a low loader. This machinery will remain on site for the duration of the earthworks portion of the project construction work.

While extensive earthworks are not proposed, some land forming (including localised cut and fill areas) may be undertaken to achieve more consistent gradients beneath the PV modules. Additionally, earthworks are required for trenching works.

In total:

- Approximately 15,000 m^3 of gravel would be required to cap the access road
- Approximately 15,000 m^3 of sand (subject to detailed design) would be required for the bedding of cables that are to be buried throughout the site

Should any excavated material not be suitable for reuse or additional fill material required, the maximum amount of fill is estimated to be 12,000 m^3.

Once the earthworks have been completed, the balance of the construction work will commence requiring machinery including:

- Pile driver (20)
- Piling rig
- All terrain fork-lift (20)
- All terrain utility vehicles (10)
- Backhoe (10)
- Flatbed trucks (10)
- Mobile crane (1)

Other equipment if required may include an elevated work platform, scraper, roller and winches. All of the plant will be located on site and will therefore be only required to access the site once for the construction works.

The solar panels are expected to be delivered from either the Port of Newcastle or Port of Brisbane. Other specialist equipment is generally sourced from Newcastle or Brisbane as required whilst consumables such as concrete and general material supplies will be sourced locally from the Tenterfield area.

A summary of the expected vehicle movements associated with the construction work is provided below and shows the full movements for the duration of the project. These movements are spread out across the project, with the site set up and earthworks commencing at the beginning of the project. Once this work is complete, the balance of the construction work will commence with deliveries of the specialist equipment etc along with the import of backfill material being over a number of weeks to suit the construction timeframe.

These traffic numbers are based on the concept design work for the project and could alter through the detailed design phase of the project.

3.5 Vehicle movements

A summary of the vehicle movements is provided below.

Phase	Purpose	Vehicle Type / Trailer Type	No. of one-way vehicle movements
Site Set-Up and Demobilisation	Portacabin delivery and removal	Low loader	20
	Skip delivery and removal	Low loader	40
	Generator delivery and removal	Semi-trailer	4
	General deliveries	Semi-trailer	40
	Crane mobilization and demobilization	Crane	4
	Water tank delivery and removal		4
Roads and hardstands	Delivery of imported capping for road laydowns and crane hardstands	Truck and dog	500
	Plant delivery and removal: excavators, compactors drill rig	Low loader	40
	Concrete deliveries for maintenance container hardstands	Concrete agitator	120
Generating Equipment	Tool container delivery and removal	Low loader	4
	Module deliveries	Semi-trailer	2000
	Mounting structure and pile deliveries	Semi-trailer	1600
	Inverter Station deliveries	Low loader	3
	DC cabling trays and combiner boxes	Semi-trailer	400
AC Cable Installation	AC Cable delivery	Semi-trailer	400
	Backfill material delivery	Dump Truck	1800
Plant delivery and removal	Telescopic handler and excavator	Low loader	50
Overhead Line	Conductor delivery	Semi-trailer	25
	Pole deliveries	RAV	6
	Pole dressing delivery	Semi-trailer	2
Other	Miscellaneous deliveries	Light vehicle	40
	Monitoring equipment fibre SCADA servers etc	Truck	2
	Waste Collection	Truck	400
	Consumables (Oil and Fuel)	Truck	40
		TOTAL	**7,544**

In summary, typical vehicle movements during the peak construction period (over 6 months) are in the order of 65 light and 20 heavy vehicles two-way (65/20 inbound, 65/20 outbound) per day. For the light vehicles, the vast majority of these will be inbound movements in the morning bringing workers to the site with these vehicles then remaining on site for the full working day before leaving at the end of the working day. It is expected that there will be limited light vehicle movement outside of these periods, other than support staff e.g. office staff or the occasional visitor to the site.

For the heavy vehicles, these will typically be spread across the working day. For the solar panel deliveries, these trucks are arriving from either the Port of Brisbane or the Port of Newcastle and the journey length will be over 5 or 7 hours respectively, seeing a spread of these vehicles not all arriving at the same time. Allowing for each truck to be emptied on site one at a time, the outbound movements will also be spread out and not all leave at the same time. All other heavy vehicles will also be spread out across the normal working day with no concentration of heavy movements expected.

Outside of the peak period of construction, the staff levels will be lower and the daily light vehicle numbers will be less than 65 inbound and outbound per day. The heavy vehicle numbers will also be lower outside of the peak construction activity and less than 20 vehicles inbound and outbound per day.

4 Traffic Management Assessment

The proposed traffic management measures allow for all access off the Bruxner Highway only. The access to be used will be for the construction traffic movements as well as the future on-site operational demands. This access is to be provided in accordance with the requirements for the site operations (including swept path requirements for delivery vehicles) and take into account the design requirements of Inverell Shire Council.

The designated access route to the site will be used by both light and heavy vehicles.

All vehicle movements in and out of the site are as shown below in Figure 4-1.

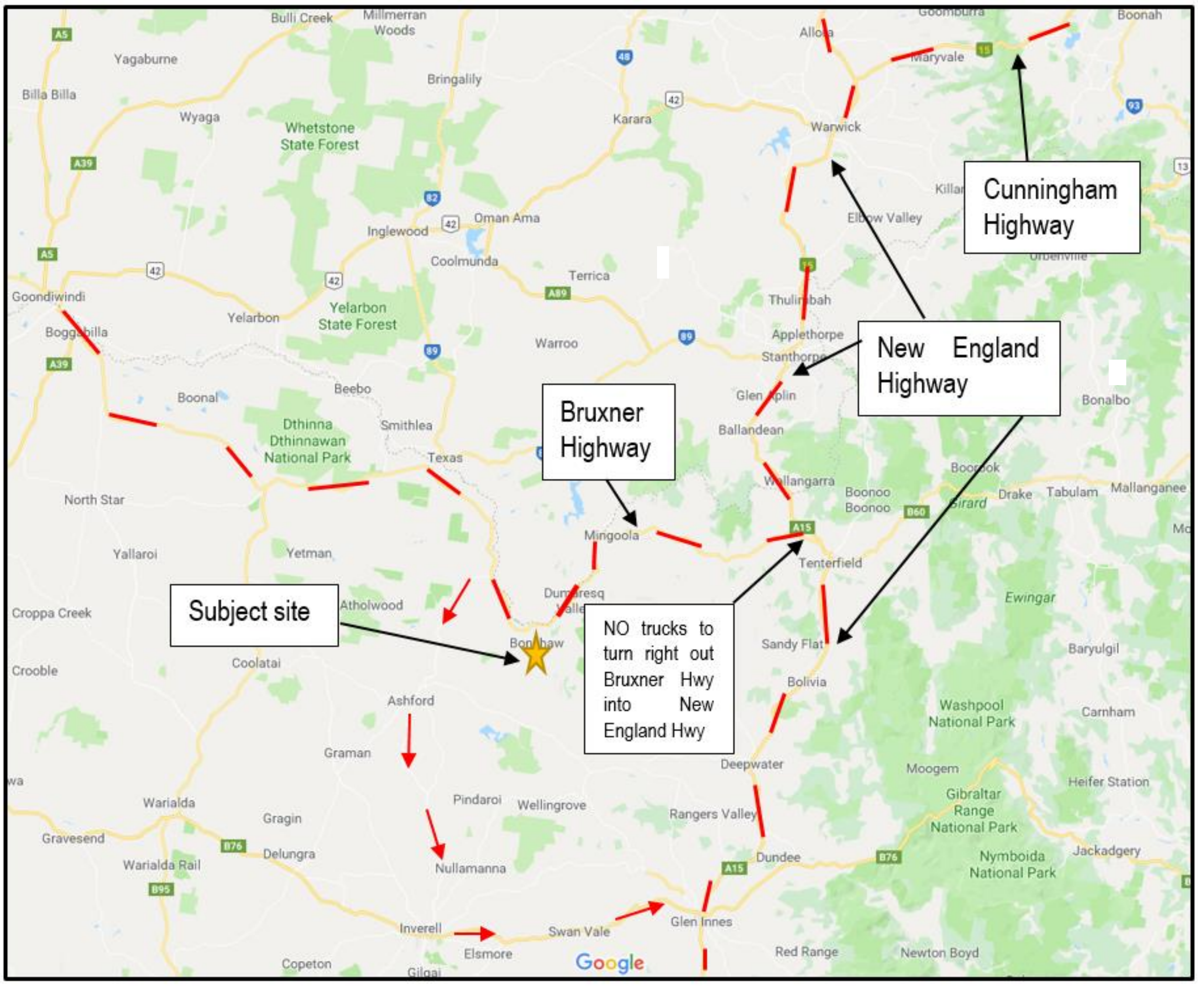


Figure 4-1 – Heavy and Light Vehicle access route to subject site

4.1 Impact Assessment

The project will require the delivery of the solar panels and other specialist equipment from Newcastle or Brisbane with the access route via:

- Newcastle metropolitan regional road network
- Hunter Expressway / New England Highway
- New England Highway to Bruxner Highway turn off
- Bruxner Highway to site access
- Bonshaw-Inverell Road
- Gwydir Highway
- Brisbane metropolitan regional road network
- Cunningham Highway
- New England Highway to Bruxner Highway.

These roads all form part of the road freight routes within the State road network and all are approved for heavy vehicle movements including B-double access for the full length of the routes. These routes will be documented as the Haulage Route for all delivery vehicles associated with haulage of the solar panels and other specialist materials for the project site.

These roads carry a high number of heavy vehicles, including B-doubles associated with local and regional agricultural demands. These agricultural demands are seasonal in nature and occur 24 hours a day often involving night travel and operations. There are a number of farms in the general locality of the project site as well as in the wider area that use these local and regional roads during these seasonally high demand periods. Due to the seasonal nature of this work and the requirement for quick turnaround of crop deliveries it is considered that it is not appropriate to limit truck movements for these farms. Similarly, it is considered that it is not appropriate to limit truck movements to and from the project site at these times as the traffic movements on the local roads will continue to remain low.

For the regional road network e.g. New England Highway / Hunter Expressway, Bruxner Highway, Cunningham Highway the total traffic flows will remain well within acceptable limits and as such will continue to operate to a good level of service and accommodate all road users.

The traffic flows along the local roads giving access for the heavy and light vehicle movements associated with the project are currently very low based on-site observations. Therefore, during the peak construction period and peak staff / material demands, the additional 65 light vehicle movements associated with the staff movements and 20 daily truck movements (per direction) will have a minimal and acceptable impact upon the operation of these local roads during construction. Once operational, the traffic movements are much lower with a maximum of 10 staff on site per day and as such the impact will be negligible.

There is minimal background traffic growth in this location. The RMS count data from the station located between Tenterfield and Glen Innes (Station I.D. DNDSTC) shows traffic flows of 2,201 in 2012 and 2,091 in 2019, with minor fluctuations up and down for the intervening years. Other counts along the regional road network show similar or lower increases in values. For the assessment of the future impacts in 10 years-time, it can be seen that the site at that time will be operational with 10 staff located on the site. The impact of these ten staff will be very low on the local road network.

The site is expected to be operational for more than 10 years so that the impact of the decommissioning of the site cannot be assessed in detail at this stage. The site could remain operational beyond 10 years and the impact will remain low beyond the10 year design horizon.

There will be no public vehicle access within the work site during the construction works, with a fence provided at the commencement of the project along the entire site boundary. This fence will remain once the project is constructed for security purposes with a locked gate to be provided at the site access off the Bruxner Highway.

There will be no pedestrian access to the site for the general public. There are no pedestrian paths in the locality of the site nor expected demands in this remote rural area so there will be no impacts for pedestrians created by the project works.

There is a school bus that runs along the Bruxner Highway to Bonshaw in the morning with the return trip in the afternoon. There may be some deliveries occurring in the morning and afternoon during the school bus operation, depending on the stage of the construction work and travel requirements for the deliveries. All staff will be on site prior to the morning bus run and will depart site after the afternoon bus run. As such it is considered that there is very limited interaction with the school bus. On the regional and state road network all school zones will be delineated in accordance with RMS Guidelines with reduced speed limits in accordance with normal NSW road rules. All drivers associated with the project construction work will adhere to the road rules as applicable and will be advised of the school bus operation on the Bruxner Highway.

There will be no impact upon public transport services with no diversions required. There are no bus stops impacted upon by the proposal.

There will be minimal impact for emergency vehicles and heavy vehicles with no diversions required.

There will be minimal impact upon any other development within the locality of the site.

There will be minimal impact upon adjoining Council areas. Traffic routes in and out of the locality will be along the arterial road network which will experience minimal impacts due to the works.

There are no residential dwellings in the immediate locality of the site access that will be impacted upon by the project and construction work. There are a number of residences along the heavy and light vehicle access route. The residents along the Bruxner Highway will be notified in writing of the construction works and the activities as required.

Construction vehicle movement on internal roads could lead to dust generation. A water truck will be used for dust suppression to minimise the production of dust, with the amount of water spreading adjusted accordingly to respond to the conditions. Additionally, any significant deposits of dirt and other construction materials will be promptly removed from public roadways.

Post construction, the traffic numbers generated by the project are very low, with staffing levels varying daily with a maximum on-site workforce of 10 people on any one day. There will not be any need for regular heavy vehicle access to the site once the solar farm is operational except for the occasional heavy vehicle for emergency repairs or irregular maintenance.

4.2 Cumulative impacts

A search of the Major Projects Register on the DPE website was undertaken together with the requirements of the SEARs for the project. The following projects are in the council area that may add to cumulative impacts.

- Sundown Solar Farm
- Sapphire Solar Farm
- White Rock Solar Farm

Project	Cumulative construction Impacts	Cumulative operational Impacts
Sundown Solar Farm (EIS currently being prepared)	Site located off Gwydir Highway between Inverell and Glen Innes. No overlap with construction along Gwydir Highway. If constructed at same time cumulative impact along New England Highway. As a state highway there is adequate capacity to accommodate these vehicles movements.	Operational traffic would be expected to be less than 10 light vehicles per day in the morning and afternoon and no impact with traffic for Bonshaw Solar Farm site.
Sapphire Solar Farm	Site located off Gwydir Highway and currently under constructed. This site will be fully constructed before the Bonshaw Solar Farm commences construction.	Operational traffic would be expected to be less than 10 light vehicles per day in the morning and afternoon and no impact with traffic for Bonshaw Solar Farm site.
White Rocks Solar Farm	Construction complete.	Operational traffic would be expected to be less than 10 light vehicles per day in the morning and afternoon and no impact with traffic for Bonshaw Solar Farm site.

4.2.1 Delivery vehicles

The majority of the deliveries for the project will be via 19 metres semi-trailers and B-doubles. The access routes along the regional / state road network to the site are all along approved B double routes.

Delivery vehicles would be required throughout the project period. The travel time between the ports (Newcastle or Brisbane) and the site for the solar panels is approximately 5 to 7 hours and these deliveries will be spaced out over the construction period, to minimise the impact upon the road network and to reduce the need to store the panels on site. Other deliveries will include the metal structures for the solar panels, sand and gravel for the foundations and internal tracks and cabling. There will also be some deliveries of specialist equipment such as photovoltaic boxes or skids and delivery stations.

The trucks associated with the delivery of the supplies will all travel along the State and regional road network. There are a number of schools located along these routes, however all have marked school zones and speed limit restrictions as per State guidelines. As these routes are all on the State and regional road network it can be seen that heavy vehicles currently operate on these roads safely. It is considered that the additional truck movements associated with the construction work will result in no noticeable impact upon road safety adjacent to these schools.

There is no requirement to divert traffic as part of this construction work.

The substation will require 3 over sized vehicle deliveries to the site. These will require a separate approval and permit through the National Heavy Vehicle Regulator with RMS approval. Safety requirements and impacts are assessed as part of the permit application and the necessary safety controls applied which can include escort vehicles and Police vehicle support.

4.2.2 Construction staff movements

For the construction work, the staffing levels will peak at 190 on site and as part of the project, staff will be encouraged and supported to carpool as part of the Code of Conduct for the project and use mini buses provided to allow for shared trips to the site from shared accommodation in Tenterfield, Glen Innes and Goondiwindi. There could be 65 vehicles inbound in the morning associated with on-site staff and a similar number departing at the end of the working day. Either side of the peak demand for construction staff the light vehicle demands associated with staff movements will be less than 65 inbound and outbound per day.

The site is in a rural location well away from the local towns and as such it is considered that there will be no pedestrian or cyclists accessing the site in conjunction with staff movements.

The vehicle numbers associated with the construction work are relatively low and it is considered that the movement of vehicles in and out of the site for construction works can occur in a safe manner. No limitation on truck access times is considered appropriate for the project. Given the journey length between the port and the subject site, the vehicles as they are approaching the site will be spread out reducing the impact of the arrivals. With unloading of vehicles taking 30 minutes or more, trucks exiting the site will also be spread out.

4.3 Impacts on road pavement

A protocol will be provided for both undertaking dilapidation surveys and making any necessary repairs following construction to Bruxner Highway to within 200 metres to both sides of the site access. It is considered that there could be some impact here due to the turning movements and braking / accelerating of trucks. Beyond these limits it is considered that the impact on the state road will be minor and shall not impact upon the overall pavement construction.

With regards to any emergency repairs required within the above zone, the contractor on site would contact the relevant authorities and will ensure the road is safe. Repairs will be made in accordance with the relevant authority standard.

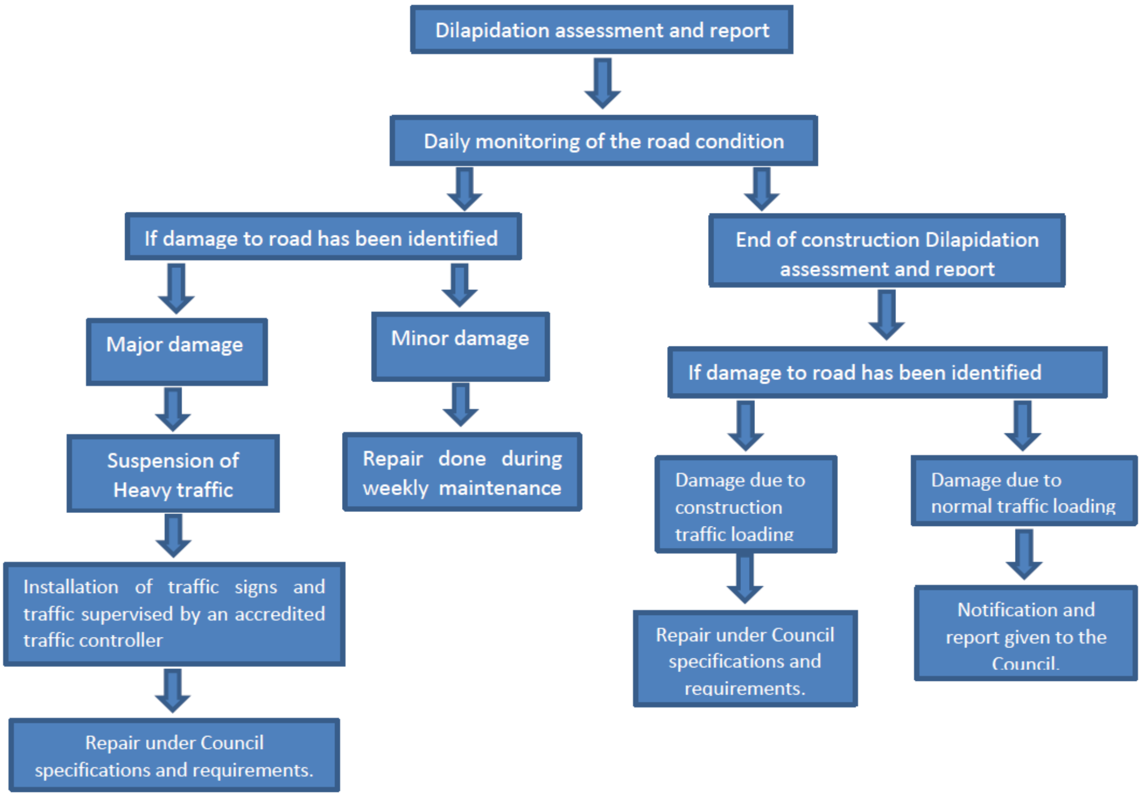


Figure 4-2 Dilapidation Assessment Protocol

5 Summary and Conclusion

The project allows for the construction of a solar farm in the locality of Bonshaw in northern NSW located off the Bruxner Highway. The construction work is planned to commence in late 2019 or early 2020 and will take approximately 12 months to construct. During construction there will be a requirement for a significant number of trucks to access the site for material delivery as well as light vehicles associated with construction staff. All vehicle access will be direct off the Bruxner Highway with the majority of deliveries expected to be via the New England Highway, with the solar equipment arriving via the Port of Newcastle or Port of Brisbane.

The trucks accessing the site will all travel along the regional and state road network, which currently carries heavy vehicle movements including B-doubles. The site is located in a rural setting and as such the hourly and daily traffic flows along the Bruxner Highway and the New England Highway in this location are relatively low. As such there is considerable spare capacity to cater for the additional traffic movements associate with the project construction stage. During peak construction activities, the project will generate 65 inbound vehicle movements in the morning associated with the construction staff with a similar number of vehicles leaving the site in the late afternoon. At these peak activity times, the site will also generate approximately 20 trucks inbound and outbound per day, associated with the delivery of material and specialist equipment to the site. Outside of the peak construction activity the light and heavy vehicle movements will be lower per day.

Post construction, the operational traffic demands are very low with around 10 people working on the site. There will also be the requirement for occasional heavy vehicle movements, associated with on-going maintenance for the facility.

Prior to commencing the construction of the works on site, a new access will be constructed on the Bruxner Highway to cater for the heavy vehicles accessing the site. With the vast majority of the heavy vehicles accessing the site from the east (via the New England Highway) it is proposed to provide a left turn deceleration lane for the site access to allow for a safe entry for the construction traffic. With limited demand for access to the west of the site, there is no requirements for a sheltered right turn lane to be provided at the access point.

A review of the access route shows that the layout of the intersection of the Bruxner Highway and the New England Highway does not safely cater for the right turn out movement. The sight distance for this right run is restricted and the width of the New England Highway in this location does not allow for a run off area for vehicles. It is proposed that as part of the construction traffic management plan, southbound empty trucks leaving the site shall turn left onto the Bruxner Highway then proceed south via Bonshaw-Inverell Road to Inverell then along the Gwydir Highway to connect to the New England Highway via Glen Innes.

A Traffic Control Plan will be in place during construction work to ensure safety for road users and construction workers is managed in an appropriate manner.

The overall conclusion for the project shows that the construction traffic can safely and efficiently access the site with minimal impact for existing road users. The management plan for the construction traffic access ensures that the trucks accessing the site shall have an acceptable impact on the road network and safety concerns at the intersection of the Bruxner Highway and the New England Highway are address through the drivers code of conduct. Once operational, the traffic demands are minimal and shall have little impact upon the local road network.

Appendix A. Safe Construction Actvities

The contractor on site is responsible for the management of all traffic in connection with its activities and the construction works conducted on the site. The Contractor will provide all traffic management, safety warnings and signage including such persons as necessary to direct traffic, as required by AS 1742:2009 – Manual of uniform traffic control devices.

External traffic movements

The Contractor will:

Ensure traffic management controls are established, maintained and monitored to underpin the safety of workers, other personnel and the general public

Establish traffic management controls in consultation with relevant stakeholders

Ensure traffic management controls comply with regulatory and legislative requirements

Ensure traffic management controls comply with the contract

Ensure traffic management controls maintain the flow of traffic within the site and on surrounding public roads

Reinstate any areas affected by the temporary construction access requirements to their original condition

The primary drivers for determining the traffic management controls during the construction period are:

- Safety of personnel, the general public and construction workers
- Minimising impact (if any) on operations
- Contractual requirements (including site access)
- Road traffic authority and local government requirements
- OHS requirements in relation to the movement of all vehicular traffic and pedestrians either within or adjacent to sites
- Environmental management requirements
- The impact construction traffic has on the local community in the surrounding area, and
- The need to meet construction requirements (including any schedule and cost constraints)

The traffic management controls will be communicated to appropriate stakeholders which will include the local community in the site vicinity via a letter box drop.

The Contractor will ensure:

Any significant deposit of dirt and other materials caused by construction traffic and other operations (in relation to the works) will be promptly removed from existing public roadways

Suitable precautions are taken to ensure no rock is dislodged onto any roadway from construction vehicles

Construction plant and equipment do not park on or within the pavement or shoulders of any existing trafficked roadway

Construction vehicles (when loaded) comply with the mass, loading and access requirements of the road traffic authority

Construction traffic will cause the least possible obstruction to public and other traffic

Directional signage will be installed to direct construction traffic, and warn other motorists of construction traffic.

This signage is positioned in accordance with the approved Traffic Control Plans.

All drivers will be provided with a copy of the access routes to and from the site as part of their induction for the project;

A Vehicle Movement Strategy has been developed to eliminate the impact on local roads arising from additional construction traffic (e.g. solar panel delivery vehicles). The Vehicle Movement Strategy directs all drivers to access the site from the Bruxner Highway to eliminate the impact on the local roads. There is no requirement to restrict the direction of flow and/or time of day for movements.

The Contractor will comply with any client or Road Traffic Authority signage requirements for traffic control. Where construction work is to be undertaken either on or adjacent to a public roadway that is open to traffic, the work must be undertaken in accordance with all regulatory and legislative requirements that govern the movement of vehicles and pedestrians on any public roadway.

Within the Worksite

All employees, subcontractors, suppliers and any other persons connected with the project must adhere to all such Statutory Requirements and comply with all lawful directions. Any breach of such requirements may result in disciplinary action of the persons concerned.

The maximum speed limits within the Worksite are:

40 kph on formed roads
20 kph during foggy/dusty conditions with headlights on
10 kph when passing pedestrians

The Contractor will manage access to and from the site by all employees, subcontractors, suppliers and any other persons connected with its activities and the works; and all occupants within the worksite and through each area of the site.

The Contractor shall provide for safe and continuous operation of normal pedestrian and vehicular traffic along all roads, pedestrian paths and vehicular access to the worksite and must provide and maintain all necessary watchmen, lights, barriers, notices and signs.

The Contractor will not unnecessarily obstruct any side road, branch track, drain or watercourse and will not break down or remove any fences or gates without prior notification to the client. If unavoidable, the Contractor will remove such obstruction or repair such breakage as soon as possible, or as directed by the Client.

A Vehicle and Traffic Management Procedures briefing will be included in the Project Site Induction.

Pedestrian Traffic

The Contractor may encounter pedestrian traffic at and near to the site. The Contractor will ensure that sites are appropriately isolated and secured from unauthorised entry; and that the Site is appropriately sign-posted and controlled. Given the location of the site it is considered that any pedestrian activity will be negligible.

Site Construction Traffic

Traffic within the Site will be managed in accordance with the Site Management Plan. The Sites Layout Plans will indicate site access and egress points and detail any required separation of construction plant and personnel. These plans will be communicated during Tool Box Meetings and/or Daily Pre-start Meetings.

The Site Layout Plan will incorporate details of parking arrangements for the site construction workers, speed limits within the construction works or through access roads established for vehicular and plant construction traffic.

The Sites Layout Plan will detail traffic management controls that are appropriate within each site.

Traffic controls shall be regularly reviewed for effectiveness and will be amended to maintain or improve a safe work environment. Traffic management controls established for sites will be inspected at ***weekly intervals*** to verify that a safe work environment is being maintained. Records of inspections shall be maintained.

Access Roads and Site Movement

Unless sign-posted otherwise, load limits on public roads adjoining the sites apply within them.

If required the Contractor shall request approval from the client prior to any over-dimensional load, or load in excess of load limits entering the site, or using the roads within the site.

All workers must travel to and from the site via the nominated access roads.

Parking

All workers must park in the Designated Parking Areas as specified in the Site Management Plan. The Contractor shall ensure no persons (in connection with its activities) parks in any other area of the site or in any other area without prior written consent.

Monitoring, Measurement and Review

The purpose of Monitoring and Measurement is to ensure that all construction works, including subcontracted activities, are being performed in accordance with the contract requirements, statutory requirement and in a controlled and safe environment. Ongoing monitoring and audit of Traffic Management procedures and the worksite implementation of traffic control shall be conducted.

Audits of the Traffic Control measures under differing operating conditions are to be carried out including during overcast and rainy weather, at night or at any other restrictive times where conditions may change in accordance with the requirements of AS1742.3.

Results of audits, inspections and improvements are to be reported in the reporting cycle of the contract to enable assessment of the adequacy of the implementation of the Traffic Control within contract performance and system review meetings.

Inspection and Auditing of Traffic Control Plan (TCP)

Regular Site Inspections by designated supervisory and field staff of worksite protection are to be arranged on a ***daily frequency*** depending on the complexity of traffic control on the site.

Site Inspections will be carried out and the following Traffic Management Forms completed:

Traffic Control Daily Checklist
Traffic Control Weekly Checklist

A daily record of the inspections should be kept. This should include:

- When traffic controls were erected
- When changes to controls occurred and why the changes were undertaken
- Any significant incidents or observations associated with the traffic controls and their impacts on road users or adjacent properties
- Where significant changes to the work or traffic environment or adverse impacts are observed, the controls should be reviewed as a matter of urgency.

The monitoring program should generally incorporate inspections:

- Before the start of work activities on site
- During the hours of work
- Closing down at the end of the shift period

The inspection program shall be adjusted to suit changing circumstances and/or risk environment such as during times of increased traffic flows or speeds, contra-flow arrangements or when changed controls are introduced.

The Audits of the implemented Traffic Management features will be undertaken following setup in accordance with the TCP and prior to the TCP being put into service.

Appendix B. Drivers Code of Conduct

1.1 General Requirements

All vehicles / drivers accessing the site must:

i) Be registered and hold a valid driver's licence for the class of vehicle being operated;
ii) Operate the vehicle in a safe and appropriate manner whilst travelling to / from the site or when operating within the site. This includes obeying all New South Wales state road rules.
iii) ALL heavy vehicles must adhere to the designated heavy vehicle routes as far as practical;
iv) NO trucks shall turn right from the Bruxner Highway onto the New England Highway.
v) ALL trucks heading south shall turn left out of the site then proceed via Bonshaw-Inverell Road to Inverell then travel along the Gwydir Highway to Glen Inness to connect with the New England Highway.
vi) Comply with the directions of authorised personnel when operating within the site and obey any relevant signage installed along the internal roads.
vii) Not use a mobile phone while operating any vehicle.
viii) Must always wear a seatbelt when operating any vehicle.

1.2 Vehicle Speeds

Drivers shall observe the posted speed limit along the designated transport route and adjust their vehicle speed as required to suit the road environment and prevailing weather conditions. Vehicle speeds must be appropriate to ensure the safe movements of the vehicle with consideration to the vehicle configuration.

Maximum speeds limits within the project site shall be as follows:

i) 40 km/hr along formed roads.
ii) 20 km/hr during foggy / dusty conditions. Headlights must be on.
iii) 10 km/hr when passing pedestrians or any plant equipment.

1.3 Driver Fatigue

Drivers shall not be permitted to operate a vehicle or plant equipment when impaired by fatigue. If you suspect that you or someone else is experiencing fatigue, please inform your supervisor.

Operators of heavy vehicles shall be aware of the requirements relating to fatigue as outlined in the Heavy Vehicle National Law. Drivers shall also be aware of their adopted fatigue management scheme (shown below) and ensure that they are operating within its requirements.

i) Standard Hours of Operation
ii) Basic Fatigue Management (BFM)
iii) Advanced Fatigue Management (AFM)

Basic Fatigue Management (single driver)

Time	Work	Rest
In any period of…	A driver must not work for more than a maximum of…	And must have the rest of that period off work with at least a minimum rest break of…
6 ¼ hours	6 hours work time	15 continuous minutes rest time
9 hours	8 1/2 hours work time	30 minutes rest time in blocks of 15 continuous minutes
12 hours	11 hours work time	60 minutes rest time in blocks of 15 continuous minutes
24 hours	14 hours work time	7 continuous hours stationary rest time*
7 days	36 hours long/night work time**	No limit has been set
14 days	144 hours work time	24 continuous hours stationary rest time taken after no more than 84 hours work time and 24 continuous hours stationary rest time and 2 x night rest breaks# and 2 x night rest breaks taken on consecutive days.

Advanced Fatigue management:

The seven principles are grouped into three categories:

Work-related rest breaks (such as short rest breaks):

1. Reduce the time spent continuously working in the work opportunity

2. The more frequent breaks from driving, the better

Recovery breaks (such as major rest breaks):

1. Ensure an adequate sleep opportunity in order to obtain sufficient sleep

2. Maximise adequate night sleep

3. Minimise shifts ending between 00:00-06:00

4. Minimise extended shifts

Reset breaks (such as long periods of rest or extended leave):

1. Prevent accumulation of fatigue with reset breaks of at least 30hrs (and include two night periods, 00:00 – 06:00) between work sequences

ALL details relating to fatigue management for delivery vehicles are covered by the National Heavy Vehicle Regulator

1.4 Operating Hours

Construction

Construction is to be in completed in accordance with the *Interim Construction Noise Guideline* (DECC 2009) which defined standard construction work hours as:

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sunday and Public holidays: No work

The following construction, upgrading and decommissioning activities may be undertaken outside these hours without the approval of the secretary:

- The delivery of materials as requested by the NSW Police Force or other authorities for safety reasons; or
- Emergency work to avoid loss of life, property and / or material harm to the environment.

Vehicle movements shall be undertaken during standard construction hours (or just before to allow workers to get to site). Oversize vehicles up to 26 metres long may require access to the site after hours however this would be subject to the requirements of Roads and Maritime, Dubbo Regional Council or NSW Police.

Normal Operations

Daily operations and maintenance by site staff would be undertaken during standard working hours:

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sunday and Public holidays: No work

During normal operations, all vehicle movements shall be undertaken during the standard operating hours (or just before to allow workers to get to site). There may be a requirement for vehicles to access the site after hours during an emergency however these would be infrequent.

Vehicles which arrive at the site prior to commencement of working hours shall have the engine turned off to minimise noise impacts on surrounding residences.

1.5 Transport Routes

All vehicles must travel to and from the project site via the route as shown below (Figure 1).

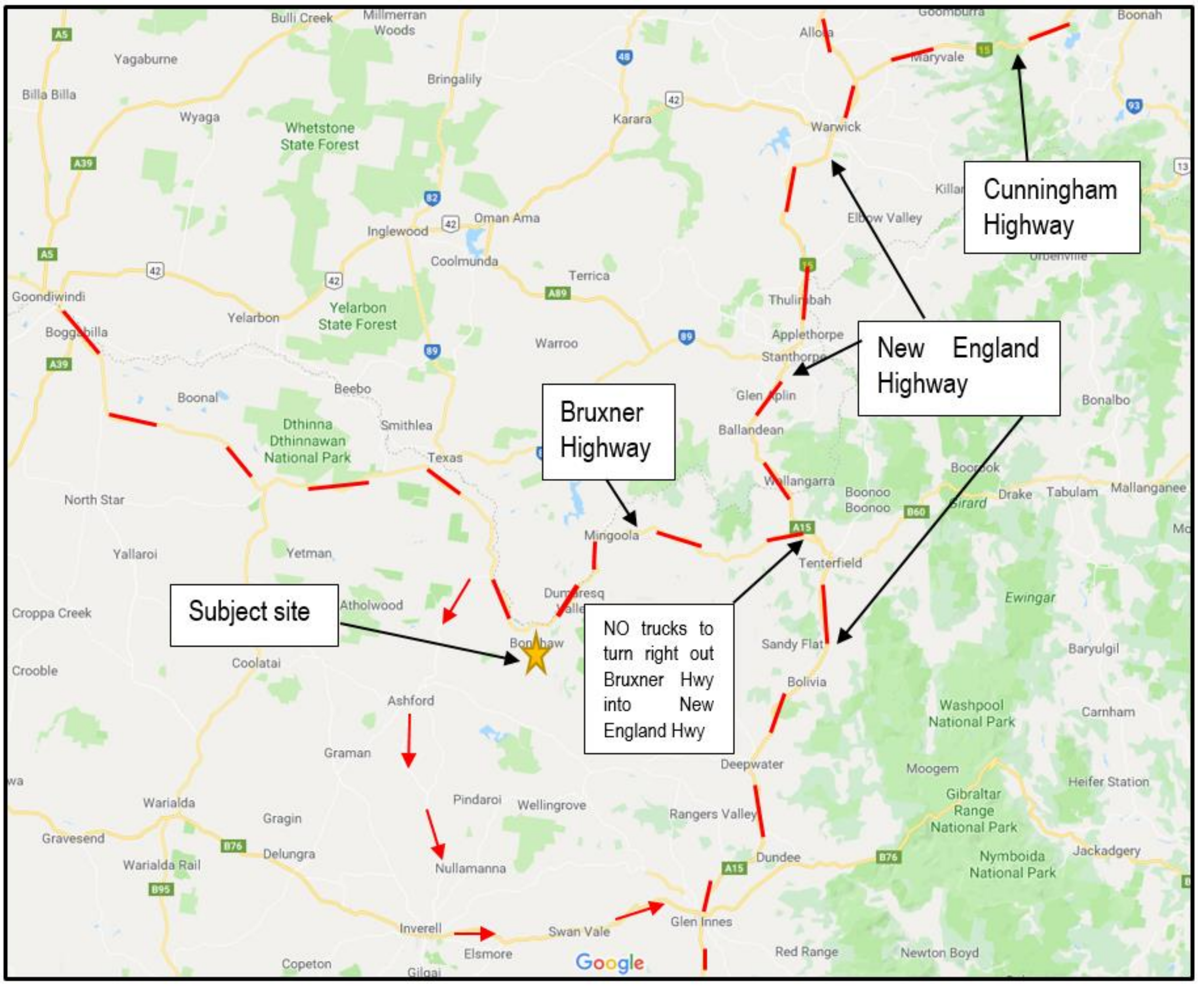


Figure 1 - Transport route to/from the site for ALL 19 m semi-trailers or greater

1.6 Vehicle Departure and Arrival

Heavy vehicles departing the site shall have a minimum 5 minute separation to reduce the impacts upon the local road network.

Always maintain a minimum separation of at least 50 metres between vehicles when travelling within the site.

Drivers must contact the site supervisor upon arrival and await further instructions or direction before proceeding.

Drivers must also report to the site supervisor prior to departure.

All vehicles must enter and exit the site in a forward direction. Vehicles are to have clean tyres upon exiting the site to prevent dirt being tracked onto the public road network.

ALL 19 metres semi-trailer or greater must turn left out of the site and proceed via Bonshaw-Inverell Road to Inverell then via the Gwydir Highway to Glen Innes and the New England Highway when heading south.

1.7 Overtaking

Overtaking shall not be permitted within the site unless the intention to overtake has been communicated to the driver of the leading vehicle and consent to overtake granted.

1.8 Breakdowns and Incidents

Heavy Vehicles

In the case of a breakdown, the vehicle must be towed to the nearest breakdown point as soon as possible. All breakdowns must be reported to the RMS Transport Management Centre on 131 700 and the vehicle protected in accordance with the Heavy Vehicle Drivers Handbook. The relevant shift manager on site shall also be notified.

If a breakdown occurs on-site please remain inside your vehicle, notify the shift manager of your location and await further instruction.

If you are involved in an accident, please notify the shift manager immediately and contact emergency services if required.

Light Vehicles

In the case of a breakdown, ensure that the vehicle is secure, notify the shift manager of your location and await further instruction.

If you are involved in an accident, please notify the shift manager immediately and contact emergency services if required.

1.9 Penalties and Disciplinary Action

Any driver who fails to comply with the above requirements will have their details recorded and may be subject to disciplinary action.

1.10 Emergency Contact Numbers

i)	RMS Transport Management Centre	131 700
ii)	Queensland Traffic	131 940
iii)	Inverell Shire Council	(02) 6728 8288
iv)	NSW Police Service	(02) 6722 0599
v)	Site Office	________________
vi)	Shift Manager on Duty	________________

1.11 Driver Declaration

I, the undersigned, hereby agree to abide by this Driver Code of Conduct for the transport of equipment or personnel to / from the Bonshaw Solar Farm, located off Bruxner Highway in the general locality of Bonshaw, NSW. I have read and understand the requirements outlined in the attached document and will, to the best of my ability, comply and assist with their implementation, requirements or ongoing administration.

The subject document to which this declaration relates is included as part of this overall document and signing of this declaration confirms that the signee has read and understood their requirements as outlined throughout.

Driver Details

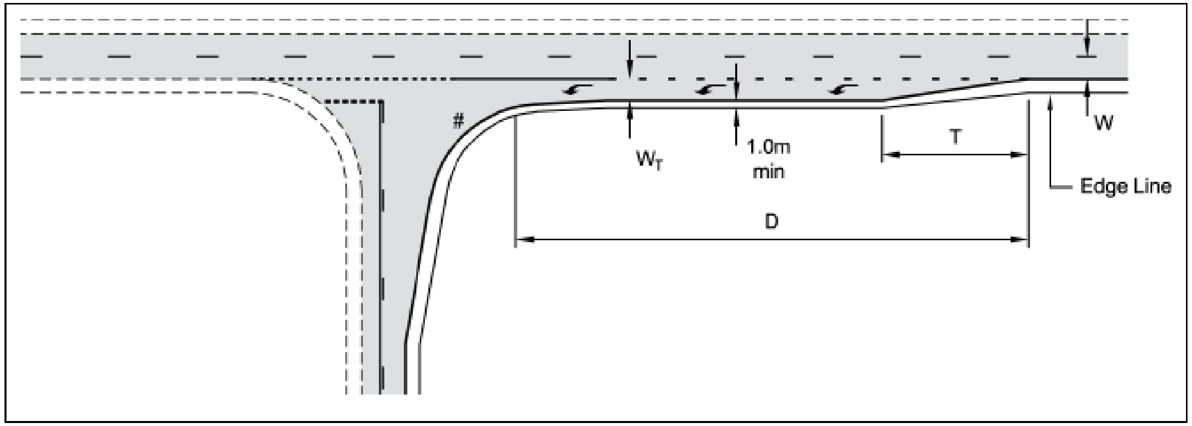
Full Name	
Organisation	
Signature	
Date	

Representative of:

Full Name	
Signature	
Date	

Appendix C. Layout for access on Bruxner Highway for construction activities (Austroads Part 4a : Unsignalised and Signalised Intersections

Note – Distance D below to be 185 metres based on design seed of 110 km/h



Notes:

1. # For setting out details of the left-turn geometry, use to vehicle turning path software or templates.
2. Approaches to left-turn slip lanes can create hazardous situations between cyclists and left-turning motor vehicles. Treatments to reduce the number of potential conflicts at left-turn slip lanes are given in this guide.
3. The dimensions of the treatment are defined thus:

W = Nominal through lane width (m) (incl. widening for curves). For a new intersection on an existing road, the width is to be in accordance with the current link strategy.

W$_T$ = Nominal width of turn lane (m) (incl. widening for curves based on the design turning vehicle) = 3.0 m minimum.

D = Diverge/deceleration length including taper – Table 5.2. (Adjust for grade using the 'correction to grade' in Table 5.3).

T = Physical taper length (m) given by:

$$T = \frac{0.33VW_T}{3.6}$$

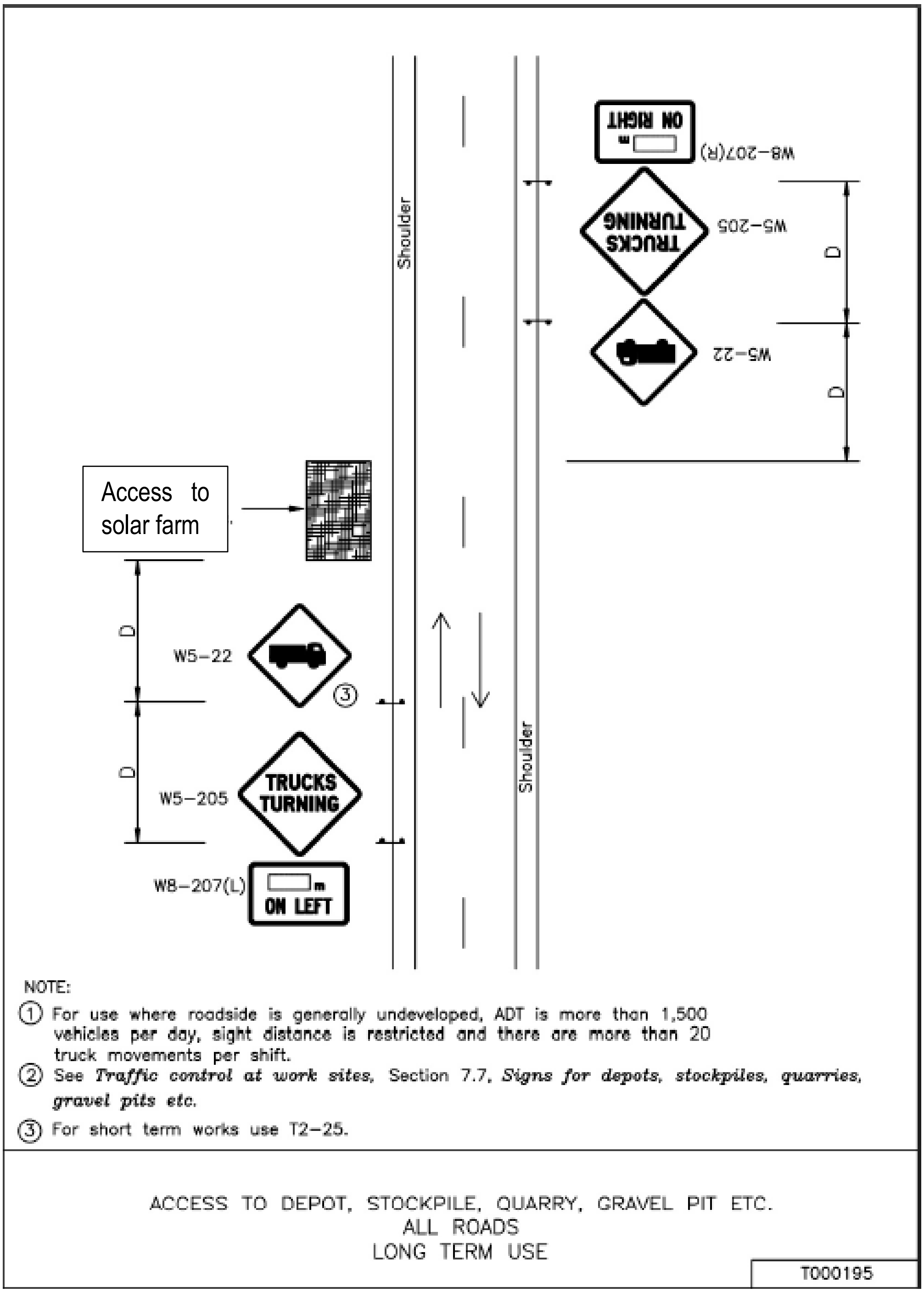
V = Design speed of major road approach (km/h).

Figure 8.4: Auxiliary left-turn treatment (AUL) on a rural road

Appendix D. Traffic Control Plan for Works at Site Access on Bruxner Highway

Access controls for on-site construction (upon completion of construction of site access). Distance D = 100 metres

TCP 195



NOTE:

① For use where roadside is generally undeveloped, ADT is more than 1,500 vehicles per day, sight distance is restricted and there are more than 20 truck movements per shift.

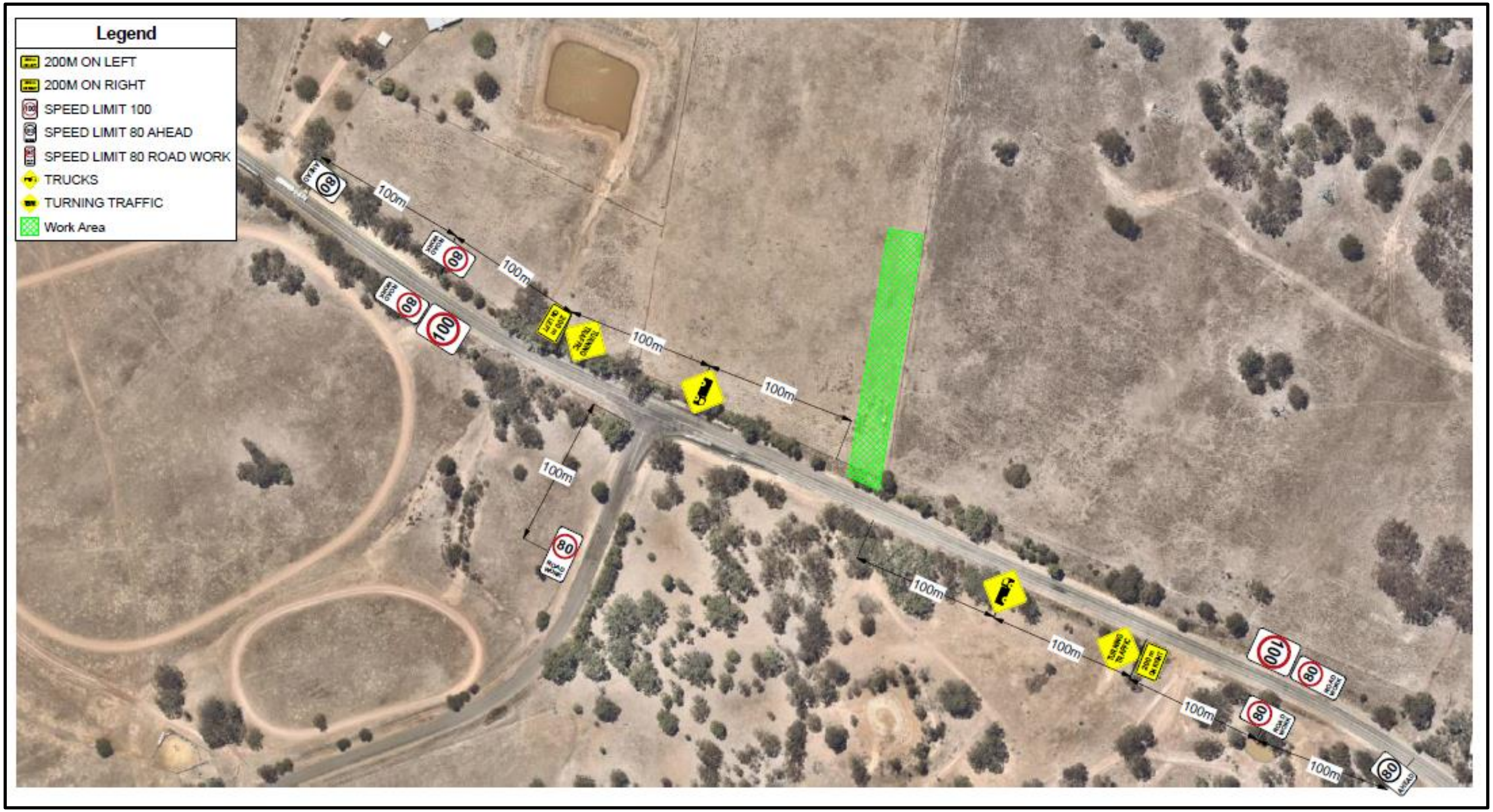
② See *Traffic control at work sites,* Section 7.7, *Signs for depots, stockpiles, quarries, gravel pits etc.*

③ For short term works use T2-25.

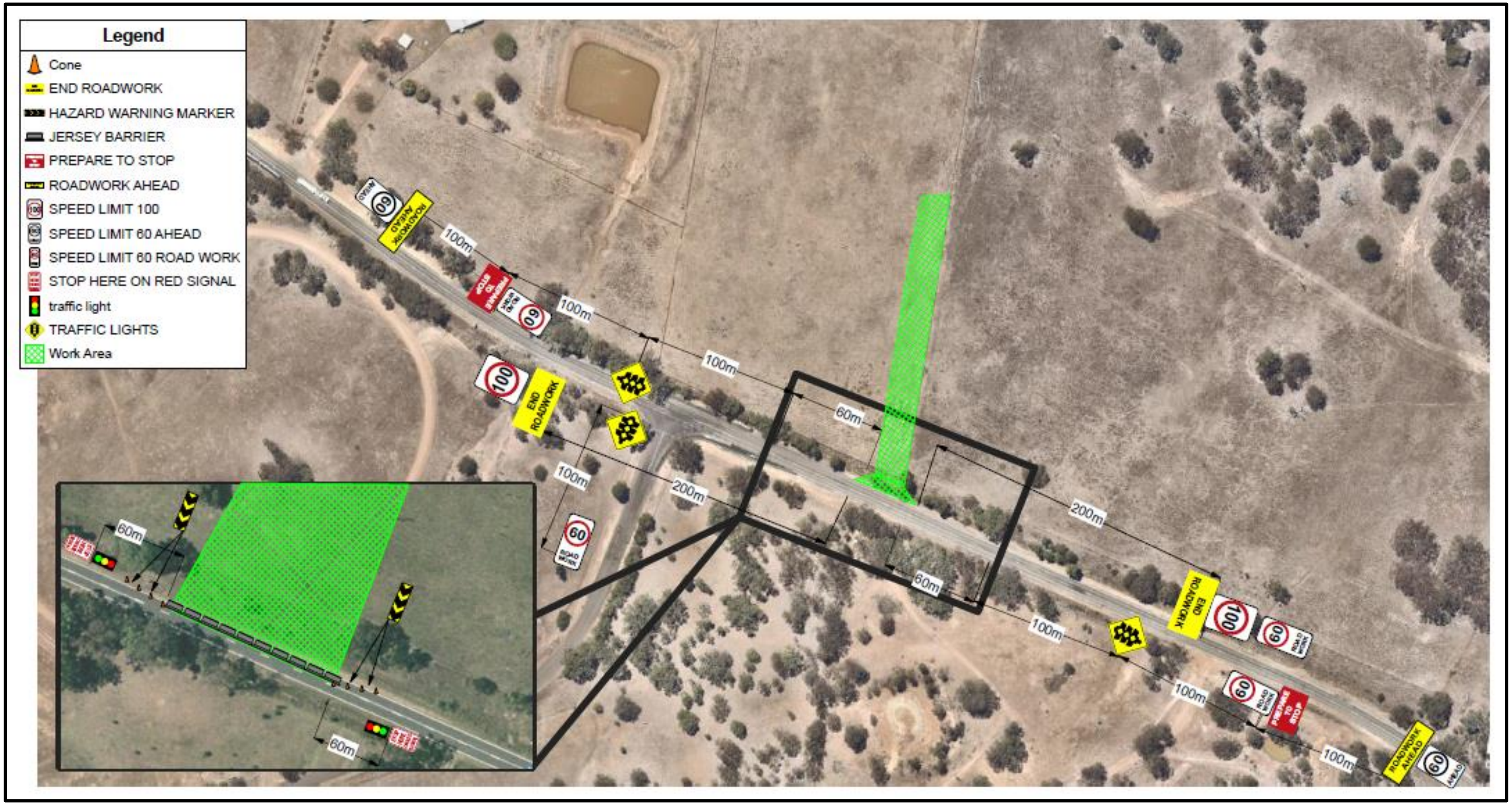
ACCESS TO DEPOT, STOCKPILE, QUARRY, GRAVEL PIT ETC.
ALL ROADS
LONG TERM USE

T000195

EXAMPLE ONLY - Traffic Control Plan for Construction of Internal Road prior to connection to Bruxner Highway. Final plans to be provided as part of the detailed design process and prior to any works commencing on site.



EXAMPLE ONLY Traffic Control Plan whilst intersection work being constructed – allows for single lane of travel and traffic signals. Required to provide protection to workers adjacent to the westbound travel lane



APPENDIX I FLOODING ASSESSMENT

Environmental Resources Management

Bonshaw Solar Project

Flood Impact Assessment

August 2019

N1209_002

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<table>
<tr><th colspan="6">N1215_001 GARDINER STREET RUTHERFORD STORMWATER MANAGEMENT PLAN</th></tr>
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<tr><td>Rev 0</td><td>Client Issue</td><td>M. Best</td><td>S. Shield</td><td>S. Shield</td><td>10 July 2019</td></tr>
<tr><td>Rev 1</td><td>Client Issue</td><td>M. Best</td><td>S. Shield</td><td>S. Shield</td><td>26 July 2019</td></tr>
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1. INTRODUCTION

Engeny Water Management (Engeny) has been commissioned by Environmental Resources Management (ERM) to undertake a Flood Impact Assessment (FIA) for the Bonshaw Solar Project, proposed by GAIA (the Project).

The objective of the FIA is to assess the potential impacts of the Project on flooding flows and behaviours.

Secretary's Environmental Assessment Requirements (SEARs) for the Project were issued by the NSW Department of Planning and Environment (DP&E) on 16 August 2018 for preparation of an Environmental Impact Statement (EIS). This FIA addresses the SEARs outlined below.

The EIS must address the following specific issues:

- ***Water** – including:*
  - *an assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources (including Beady River, Little Oaky Creek, Little Limestone Creek and Dumaresq River, drainage channels, wetlands, riparian land, farm dams, groundwater dependent ecosystems and acid sulfate soils), related infrastructure, adjacent licensed water users and basic landholder rights, and measures proposed to monitor, reduce and mitigate these impacts.*

The project area was revised following issue of the SEARs to a single allotment only. The Project no longer exists within the Little Oaky Creek, Little Limestone Creek or Beardy River catchments and as such assessment of flood impacts in these catchment areas are not included in the scope of this FIA.

1.1 Proposed Development

The Project is located on Lot 2, DP 1039185 within the Inverell Local Government Area (LGA), approximately 16 km south of Bonshaw, NSW and directly south of the Dumaresq River. The proposed development consists of a large scale solar photovoltaic generation facility and associated infrastructure.

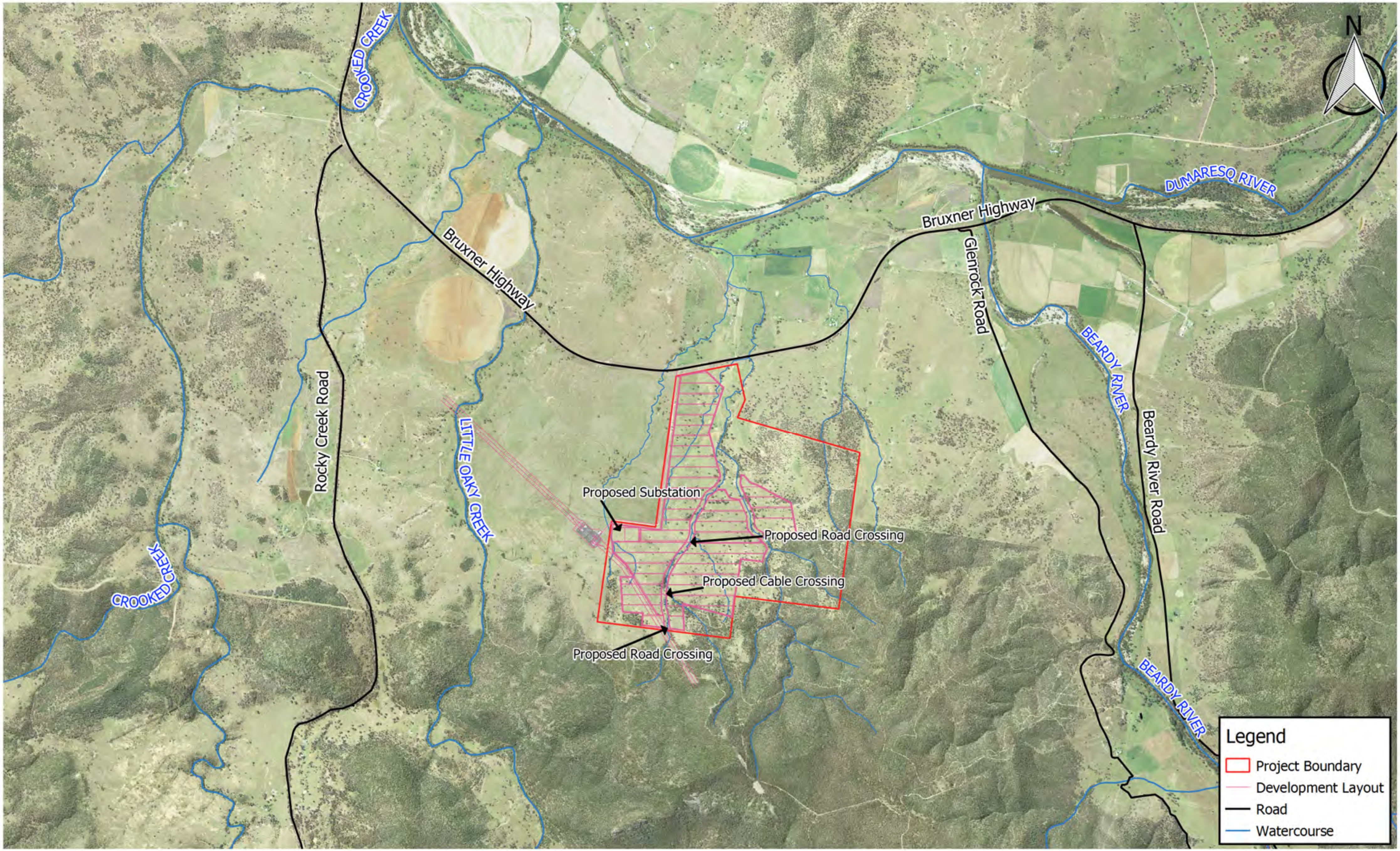
A preliminary development layout was provided to Engeny however, is it understood that refinements to the layout are likely to occur during detailed design. This FIA assumes that there is no construction within a 40m buffer from 3rd order watercourses. The preliminary development layout includes two vehicle crossing locations and one services (e.g. electrical cabling) crossing location, as well as the proposed substation location.

The potential impacts of the Project on flooding are limited to impacts associated with the vehicle crossings. The proposed cable crossing will be located above the 1% Annual Exceedance Probability (AEP) flood event. Outside of works associated with the proposed vehicle crossings, there is no proposed filling of the floodplain (i.e. land located within the 1% AEP flood extent).

2. SITE OVERVIEW

The Project is located within the Inverell LGA, south of the Bruxner Highway (refer to the site locality plan in Figure 2.1). A number of unnamed tributaries of the Dumaresq River flow from the south to the north through the project area. Major watercourses surrounding the project area include Little Oaky Creek to the west and the Beardy River to the east of the project area. The combined catchment area of the unnamed tributaries upstream of the project area is approximately 1,245 ha.

The project and upslope catchment areas are predominantly rural land use. Existing infrastructure downstream of the project area includes three culvert crossings at the Bruxner Highway. Additionally, the existing 330 kV Transgrid Dumaresq Substation is located on the project boundary with an access road running along the western boundary of the project area providing access to the substation.



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Map Projection: Tranverse Mercator
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Bonshaw Solar Project
Flood Impact Assessment

Figure 2.1 Site Locality Plan

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Checked: SS
Date: 25 /7 /2019

3. STORMWATER QUANTITY MANAGEMENT

Hydrologic modelling was undertaken for the FIA using the XP-RAFTS software package (refer to Section 3.2) to consider runoff from the local catchment at the site and a Flood Frequency Analysis to consider mainstream flooding from the Dumaresq river (discussed further in Section 3.3). XP-RAFTS hydrologic engine was utilised to determine catchment flows for the existing and developed scenarios. The hydrographs were then routed through a two-dimensional TUFLOW hydraulic model (refer to Section 3.5).

Two model scenarios were run: existing and developed scenarios.

3.1 Flood Impact Assessment Objectives

The objectives of the FIA were to:

- Identify whether the proposed development is likely to result in an increase in peak flood levels or velocities at the boundary of the project area for the 1% AEP flood event.
- Determine the 1% AEP flood extent / levels to assist in infrastructure design/siting.

3.2 Hydrological Modelling

Sub-catchment delineation was undertaken manually using geospatial (GIS) software. A 5 m Digital Elevation Model (DEM) generated from NSW LPI LiDAR data (2011) was used to delineate hydrologic catchments. The adopted sub-catchment delineation for the catchment areas modelled is shown in Figure 3.1. Catchment parameters are summarised in Table 3.1.

The impervious fraction for the existing conditions was considered to be 0 for all sub-catchments due to the location of the impervious area in each sub-catchment. Modelling the impervious fraction as a sub-area would cause the runoff generated from this area to be routed to the outlet of the catchment faster than is realistic which would result in unrealistic peak runoff from these sub catchments. The applied approach was considered to result in a more conservative outcome from the hydrologic model.

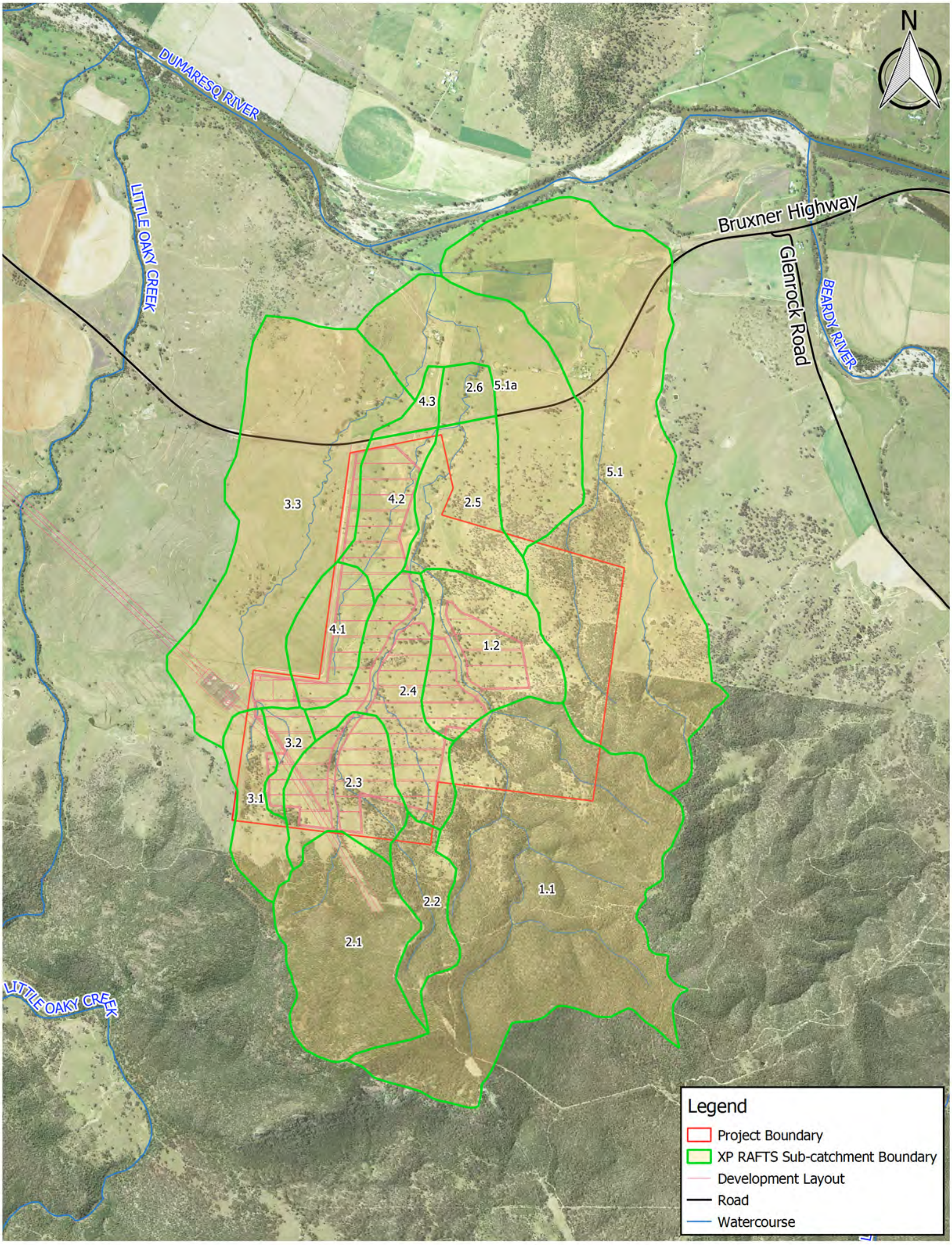
To determine the flooding impacts of the proposed development, the fraction of impervious area within sub-catchments containing solar arrays was increased in the developed scenario. A 5% increase to areas within the proposed development layout was adopted to represent access tracks and other associated hardstand areas, based on an estimate from the provided layout. The adopted developed impervious fraction therefore considers a 5% increase to the areas within each individual catchment entirely covered by the proposed development layout.

Table 3.1 Sub-Catchment Summary

Catchment	Area (ha)	Slope (%)	Existing Impervious Fraction (%)	Developed Impervious Fraction (%)
1.1	256.41	9.23	0	0.00
1.2	59.84	6.65	0	1.87
2.1	87.53	17.25	0	0.00
2.2	29.23	13.69	0	0.00
2.3	45.11	5.71	0	2.37
2.4	56.69	5.13	0	3.57
2.5	48.37	7.00	0	0.00
2.6	10.86	2.59	0	0.00
3.1	28.44	6.26	0	0.13
3.2	11.12	6.15	0	4.50
3.3	174.57	2.43	0	3.63
4.1	31.57	4.64	0	2.44
4.2	31.62	3.82	0	3.59
4.3	7.20	1.71	0	0.00
5.1	270.13	4.82	0	0.00
5.1a	96.77	3.23	0	0.00

Initial (IL) and continuing (CL) losses of 28.0 mm and 3.8 mm/hr have been adopted for pervious areas whilst 2.5 mm (IL) and 0 mm/hr (CL) have been adopted for impervious areas.

Each of the above sub-catchment areas were modelled in XP-RAFTS using Laurenson hydrological routing methods and intensity frequency duration (IFD) data sourced from Australian Rainfall and Runoff 2016 (ARR 2016).



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Flood Impact Assessment

Figure 3.1 Hydrologic Model

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Checked: SS
Date: 25/7/2019

3.3 Flood Frequency Analysis

A flood frequency analysis (FFA) was undertaken for the Dumaresq River downstream of the site using the TUFLOW FLIKE software package. The 1% AEP peak flows were estimated based on historic flood records using the Log Pearson Type III flood probability model.

Streamflow data was available at two nearby WaterNSW gauging stations on the Dumaresq River, including:

Table 3.2 Streamflow Data

Gauge Name	Gauge Number	Site Commence	Catchment Area (km^2)
Dumaresq at Bonshaw	416007	09/08/1934	7,280
Dumaresq at Roseneath	416011	22/01/1937	5,550

- Dumaresq at Bonshaw (416007).
- Dumaresq at Roseneath (416011).

Gauge 416007 was selected for use in the FFA due to the long historical record of flood levels and having larger recorded flows than the Dumaresq at Roseneath gauge. The FFA design flows were determined for gauge 416007 and then scaled to match the catchment area of gauge 416011 and the ungauged catchments in shown in Figure 3.2.

The shape of the design hydrograph was estimated after analysis of several historic events. The February 1976 event was considered to be the most appropriate hydrograph to represent the design flood hydrograph curve due to the magnitude of the flood and the fact that the peak flow was influenced by a single rainfall event. The peak discharge of this event was 3895 m^3/s and the time to the peak of the hydrograph is approximately 48 hours. It is considered that the runoff hydrograph sourced from the Dumaresq at Bonshaw gauge is suitable for developing flood flow/level estimates.

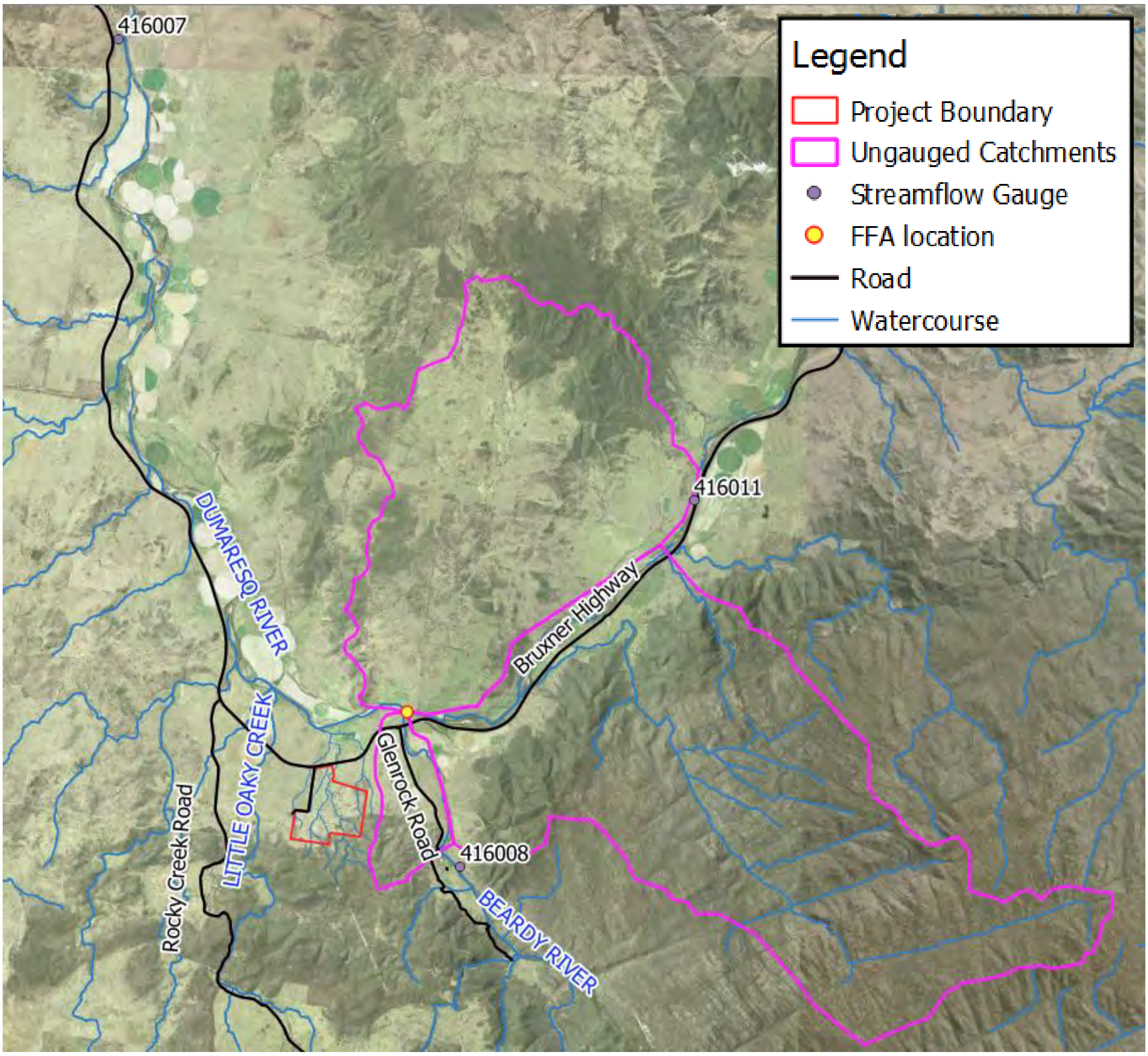


Figure 3.2 Flood Frequency Analysis Overview

3.4 Hydraulic Modelling

Hydraulic modelling was undertaken using the TUFLOW software package. A dynamically-linked 1D/2D model was developed, including upstream and downstream reaches of tributaries through the project area. The TUFLOW modelling software is used extensively throughout Australia for similar flood studies.

The following sections provide a summary of key hydraulic modelling input parameters (i.e. drainage assets, 2-D grid size, model extent and surface roughness).

3.4.1 Topography and Model Extent

The TUFLOW model utilises the 5 m DEM based on NSW LPI LiDAR data captured October 2011 to capture the floodplain and areas unaffected by mainstream flooding. A 1 m grid based on NSW LPI LiDAR was used to capture all watercourses within the model (see Section 3.4.5).

The hydraulic model extends from approximately 3 km upstream of the Bruxner Highway to approximately 5 km downstream of the project area on the Dumaresq River. Figure 3.3 provides an overview of the hydraulic model domain.

3.4.2 Grid Size and Timestep

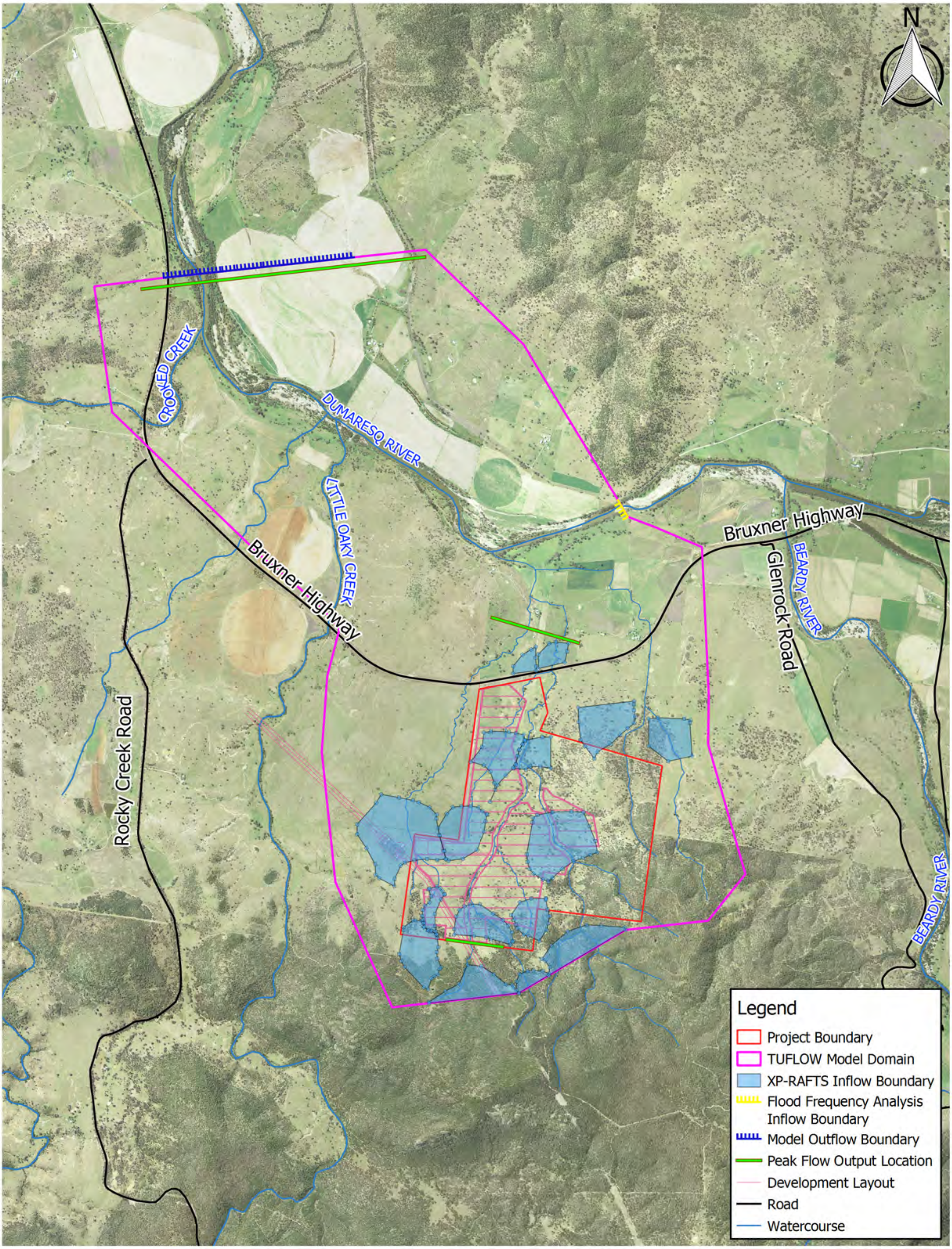
Following an analysis of typical sections of the waterway area within the hydraulic model extent and review of available LiDAR, a 5 m grid cell size was considered appropriate for providing sufficient definition of the watercourses in the model domain. A model time step of 1.5 seconds was found to provide a stable model configuration for the 1% AEP design flood event.

3.4.3 Model Boundary Conditions

Rainfall runoff flows from the hydrologic model within the model domain have been applied as ‘flow over area’ boundaries. This type of boundary applies inflows initially in the lowest elevation cell within the catchment and then to all wet cells subsequently. Inflows were applied along streamlines within the model extent.

The hydrograph determined by FFA for the Dumaresq River was applied as an inflow, upstream of the site at the model boundary.

A stage-discharge boundary was applied on the Dumaresq River, approximately 5 km downstream of the project area (refer to Figure 3.3). The stage discharge relationship is automatically generated by TUFLOW based on an inputted bed slope and normal depth assumption. Bed slopes were estimated from LiDAR survey data.



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Bonshaw Solar Project Flood Impact Assessment

Figure 3.3 Hydraulic Model

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3.4.4 Hydraulic Roughness

The hydraulic roughness (Manning's 'n') applied in the TUFLOW model was based on the existing land use conditions obtained from Google Earth aerial photography dated 2018. Land use types and associated Manning's 'n' values are displayed in Table 3.3.

Table 3.3 **Manning's Roughness**

Material	Manning's 'n'
Buildings/sheds	0.20
Open space/ low density vegetation	0.05
Moderate density vegetation	0.07
Roads/ hardstand	0.03
Dirt roads	0.04
Channel	0.03
Channel with moderate vegetation	0.07
Solar Arrays	0.07

3.4.5 Channel Representation

Channels within the 2D domain have not been accurately captured from the 5 m LiDAR data due to grid resolution and vegetation within the channel area and are therefore not considered an adequate representation of channel geometry. Breaklines have been incorporated into the model to adjust the topography by lowering the DEM, removing unwanted consistencies. The source of accurate elevations for the channel breaklines is 1 m point cloud data.

3.4.6 Hydraulic Structures

Dimensions and invert levels of the culverts at the Bruxner Highway were not available for the TUFLOW model. The adopted modelling approach included lowered breaklines across the Bruxner Highway in place of culverts to ensure that conveyance under the Bruxner Highway was adequately represented and did not inaccurately attenuate flows upstream of the highway.

The proposed development also requires the construction of two vehicle crossings of the local tributary through the site (refer to Figure 2.1). Engeny has undertaken preliminary sizing of these structures so that they adequately convey both low and high flows through the site. Table 3.4 details the sizing specifications of the proposed vehicle crossings. The culvert size and road crest level have been designed to convey low flows through the culvert with the peak flow in larger events spilling over the road crest.

Table 3.4 Culvert Specifications

Aspect	Culvert 1	Culvert 2
Culvert Type	Circular Reinforced Concrete	Circular Reinforced Concrete
Diameter (mm)	1200	1200
Invert Level (mAHD)	371.6	396.0
Road Crest Level (mAHD)	373.4	397.8

3.4.7 Critical Storm Duration

The critical storm duration at the downstream project area boundary was found to be the 3 hour storm.

3.5 Model Verification

The peak design flows adopted in this FIA, as modelled using XP-RAFTS, have been validated using the Rational Method and the Regional Flood Frequency Estimation Model (RFFE) (ARR, 2016). A comparison of the 1% AEP peak flow at the downstream boundary of the hydrologic model compared to the Rational Method and RFFE is outlined in Table 3.5.

Table 3.5 Hydrologic Model Verification

Method	Peak Q_{100} (m^3/s)
XP-RAFTS	96.2
Rational Method	90.9
RFFE	121.0

The 5% and 95% confidence limits for the RFFE are 35 m^3/s 414 m^3/s respectively, indicating a large variability in predicted peak flows. It was therefore determined that the peak flow from the rational method was more appropriate for model verification. There is a 5.5% difference in peak flows between the rational method and the XP-RAFTS model which is considered to be acceptable for this study.

3.6 Modelling Results

Peak flood depth maps for pre and post development for the 1% AEP event are presented in Appendix A. Afflux mapping is presented in Figure 3.4 and Figure 3.5. The modelling results indicate that the proposed development will not increase peak flood levels or peak flows at the downstream boundary of the site, or in the Dumaresq River. Flooding in the Dumaresq River does not have a hydraulic impact on site runoff.

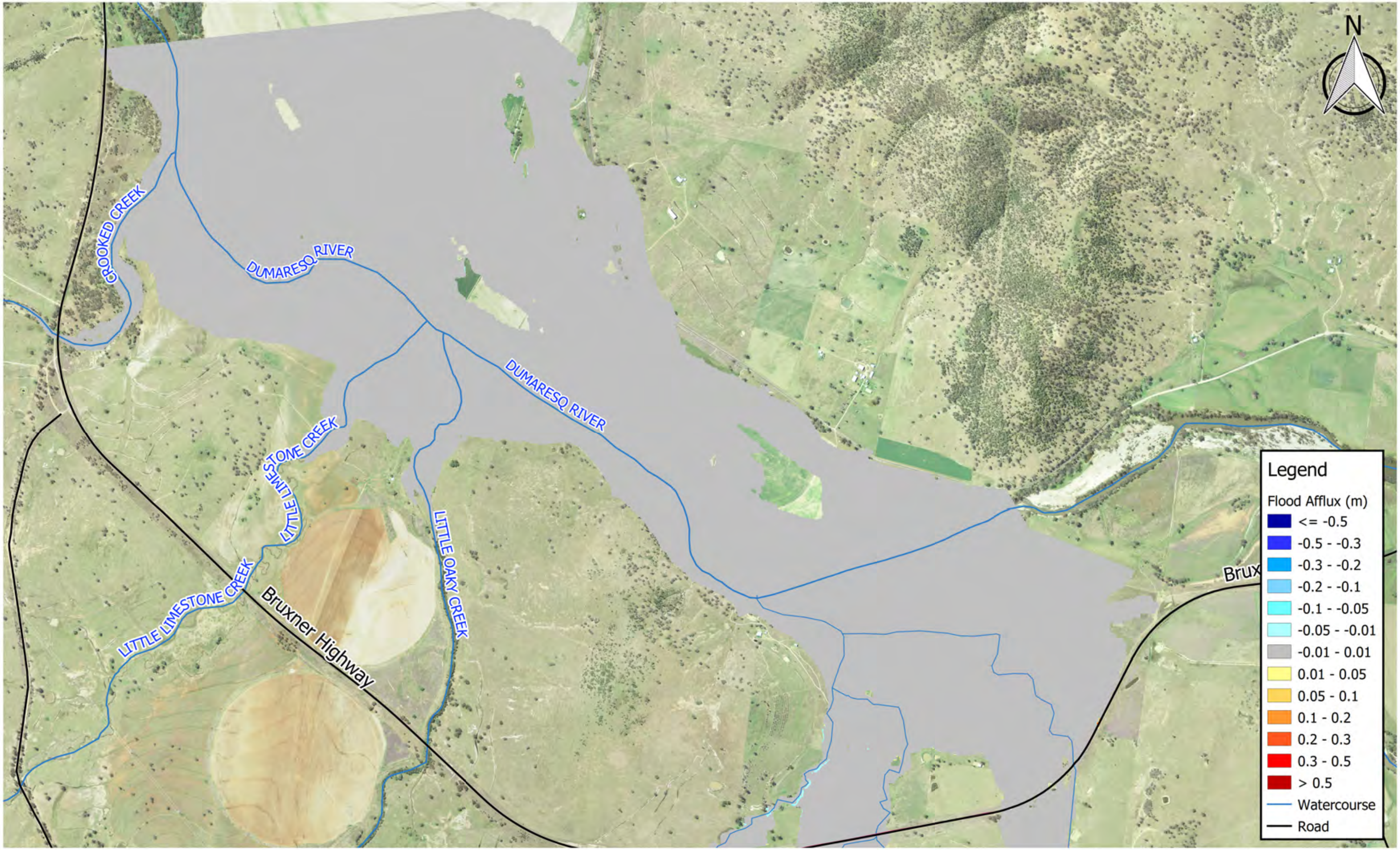
Peak flows at locations upstream and downstream of the site boundary and at the Dumaresq River for the 1% AEP event are presented in Table 3.6. The chosen locations are shown in Figure 3.3. There are no modelled changes in peak flow directly upstream of the site and a decrease of less than 0.5% at the downstream boundary. Negligible changes in peak flow are modelled for the Dumaresq River.

Table 3.6 Modelled Peak Flows

Location	Existing (m^3/s)	Developed (m^3/s)	Change (m^3/s)
Upstream Site	8.8	8.8	0.0
Downstream Site	69.3	69.0	-0.3
Dumaresq River	3868.3	3868.0	-0.3

No modelled changes in peak flood levels are observed outside of the site boundary. There is a small localised increase to flood levels in the 1% AEP event at each of the modelled crossings but these minor impacts are confined to within the site boundary. There are minor modelled increases (between 0 and 0.1 m) to flood levels across the site due to the small increase in impervious area, however, these are contained in channel and there are no modelled changes to flow dynamics.

Due to culvert design specified in Table 3.4, proposed road crossings are overtopped in the 1% AEP event. Flood levels at these crossings are observed to increase by greater than 0.5 m immediately upstream of the culverts (refer to Figure 3.5). It is anticipated that these culverts and ponding levels behind them will be investigated further in the detailed design phase.



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Flood Impact Assessment

Figure 3.4 Developed Scenario
1% AEP Event Flood Afflux (Dumaresq River)

Job Number: N1209_002
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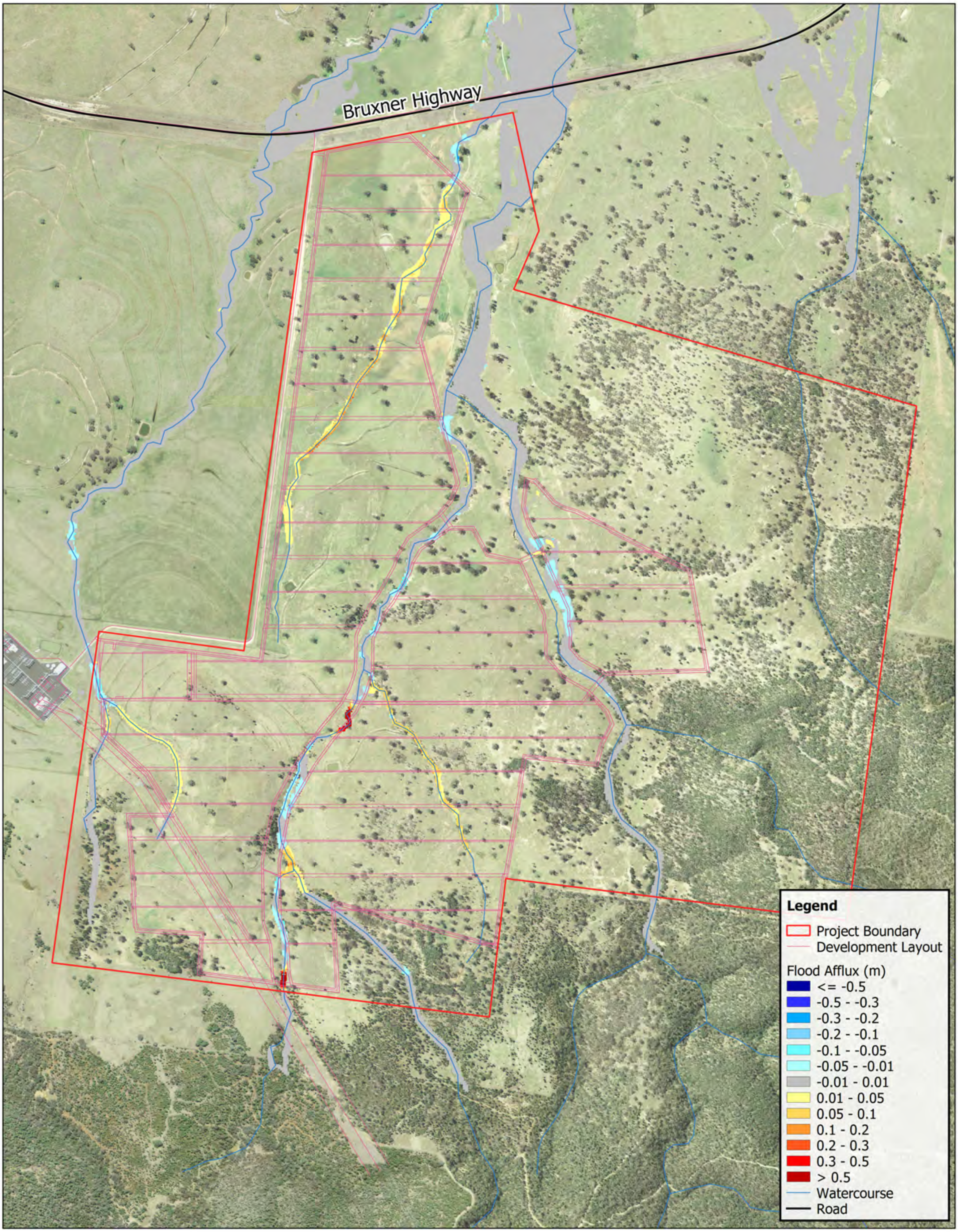
Date: 25 /7 /2019



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Horizontal Datum: Australia Geodetic Datum
Vertical Datum: Australia Geodetic Datum
Grid: Australian Map Grid, Zone 56

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Flood Impact Assessment

Figure 3.5 Developed Scenario
1% AEP Event Flood Afflux (Site)

Job Number: N1209_002
Revision: 1
Drawn: LV
Checked: SS
Date: 25/7/2019

4. CONCLUSIONS

This Flood Impact Assessment for the proposed Bonshaw Solar Project has been prepared to assess the potential impacts of the development on flood flows and behaviours.

Modelling of the proposed development indicates that there will be no increase to peak flows or peak flood levels either upstream or downstream of the site. Minor increases to peak flood levels within the site immediately upstream of the proposed crossings were observed, however, these impacts are contained within the channel and the site boundary.

5. QUALIFICATIONS

a. In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

b. Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

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g. This report does not provide legal advice.

6. REFERENCES

Ball et al. (2019) Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia (Geoscience Australia), 2019.

BMT WBM Pty Ltd, 2018, TUFLOW User Manual, GIS Based 2D/1D Hydrodynamic Modelling, Build 2018-09-AB.

Pilgrim, DH (ed) (1987) Australian Rainfall and Runoff - A Guide to Flood Estimation, Institution of Engineers, Australia, Barton, ACT, 1987.

Queensland Department of Transport and Main Roads (Palmen & Weeks, 2008).

APPENDIX A

Hydraulic Model Results

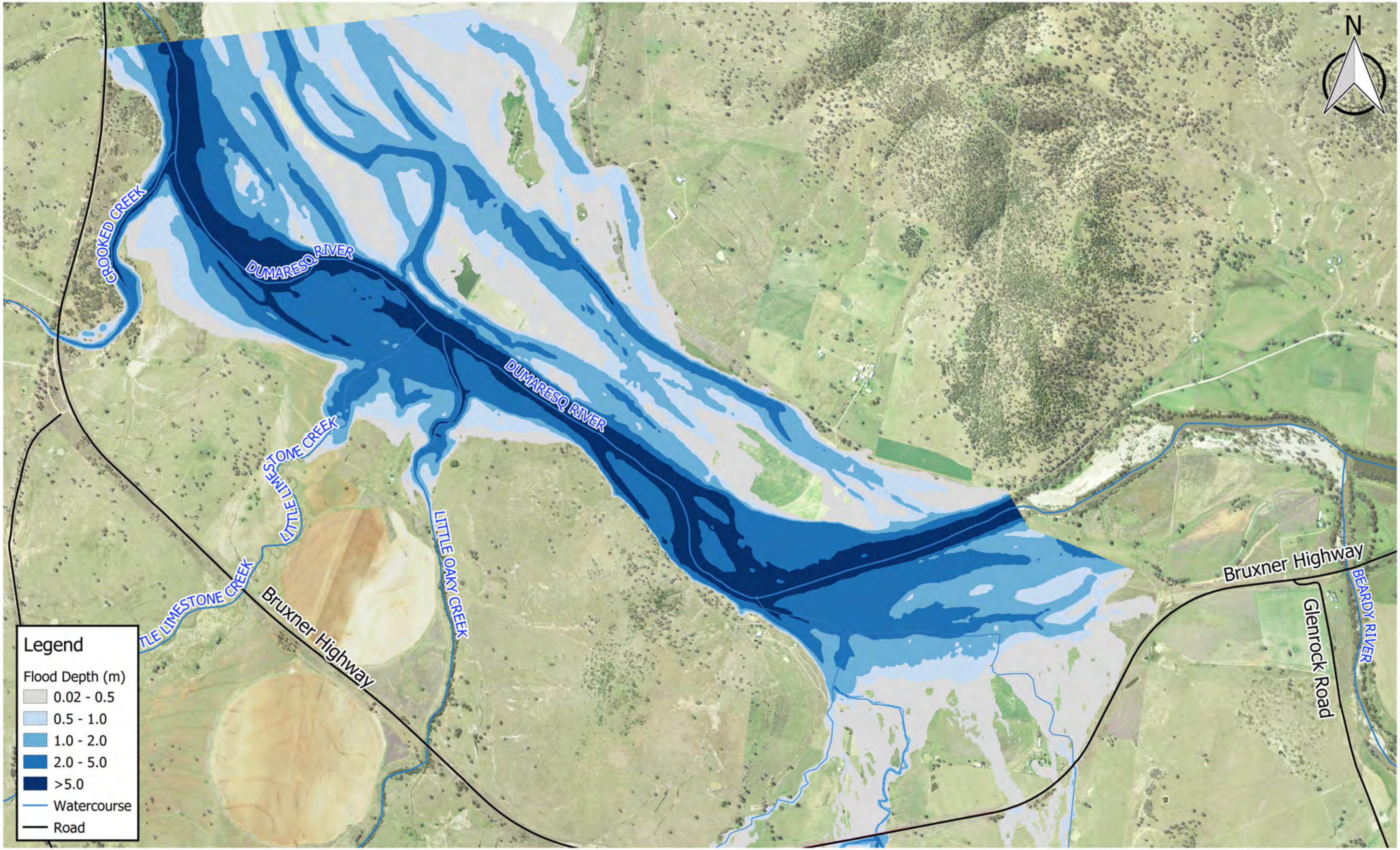

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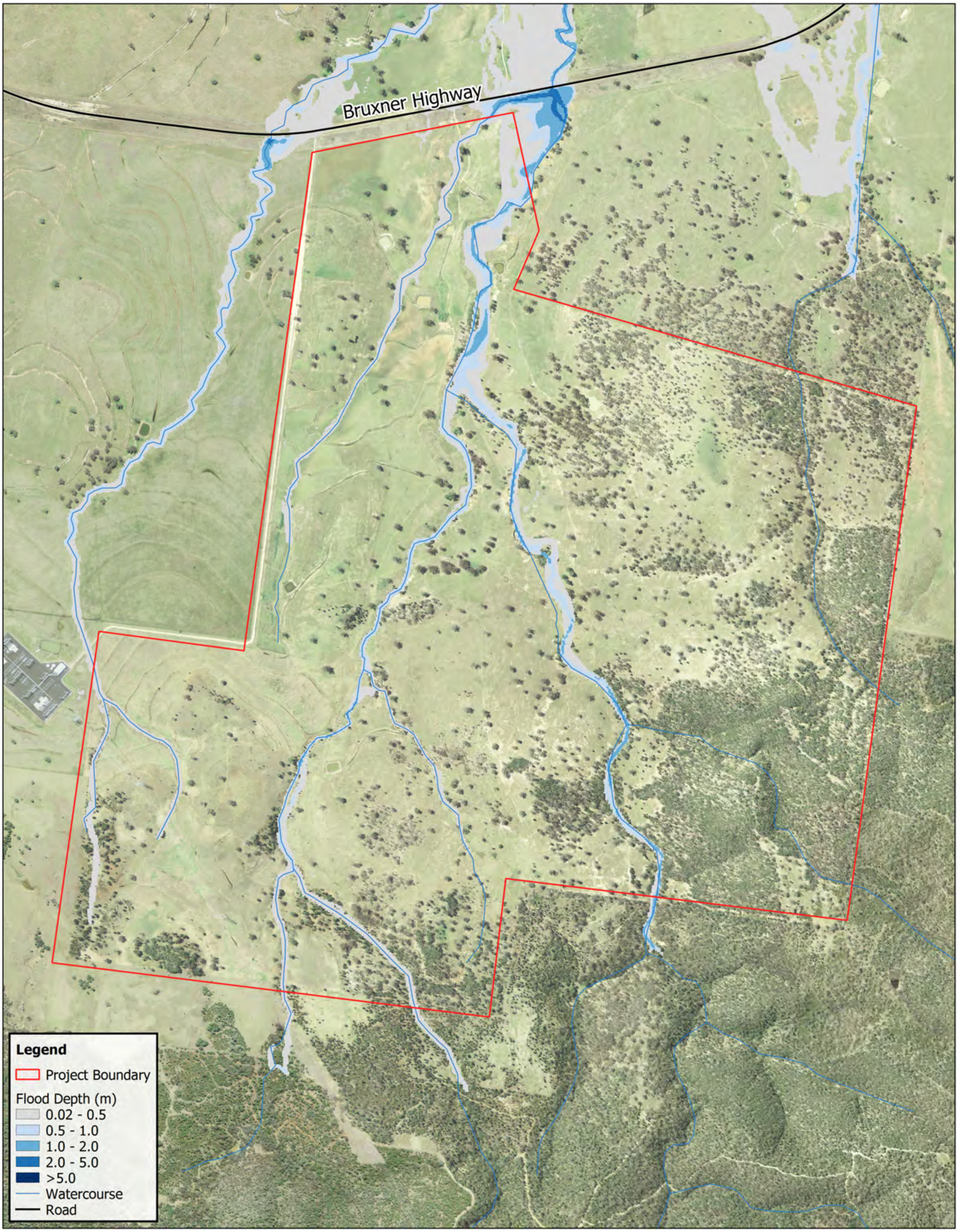
Figure A1 Existing Scenario
1% AEP Event Maximum Modelled Flood Depth
(Dumaresq River)

Job Number: N1209_002
Revision: 1
Drawn: LV
Checked: SS
Date: 25 /7 /2019



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0 100 200 300 400 m

Scale in metres (1:9000 @ A3)

Map Projection: Tranverse Mercator
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Vertical Datum: Australia Geodetic Datum
Grid: Australian Map Grid, Zone 56

Bonshaw Solar Project
Flood Impact Assessment

Figure A2 Existing Scenario
1% AEP Event Maximum Modelled
Flood Depth (Site)

Job Number: N1209_002
Revision: 1
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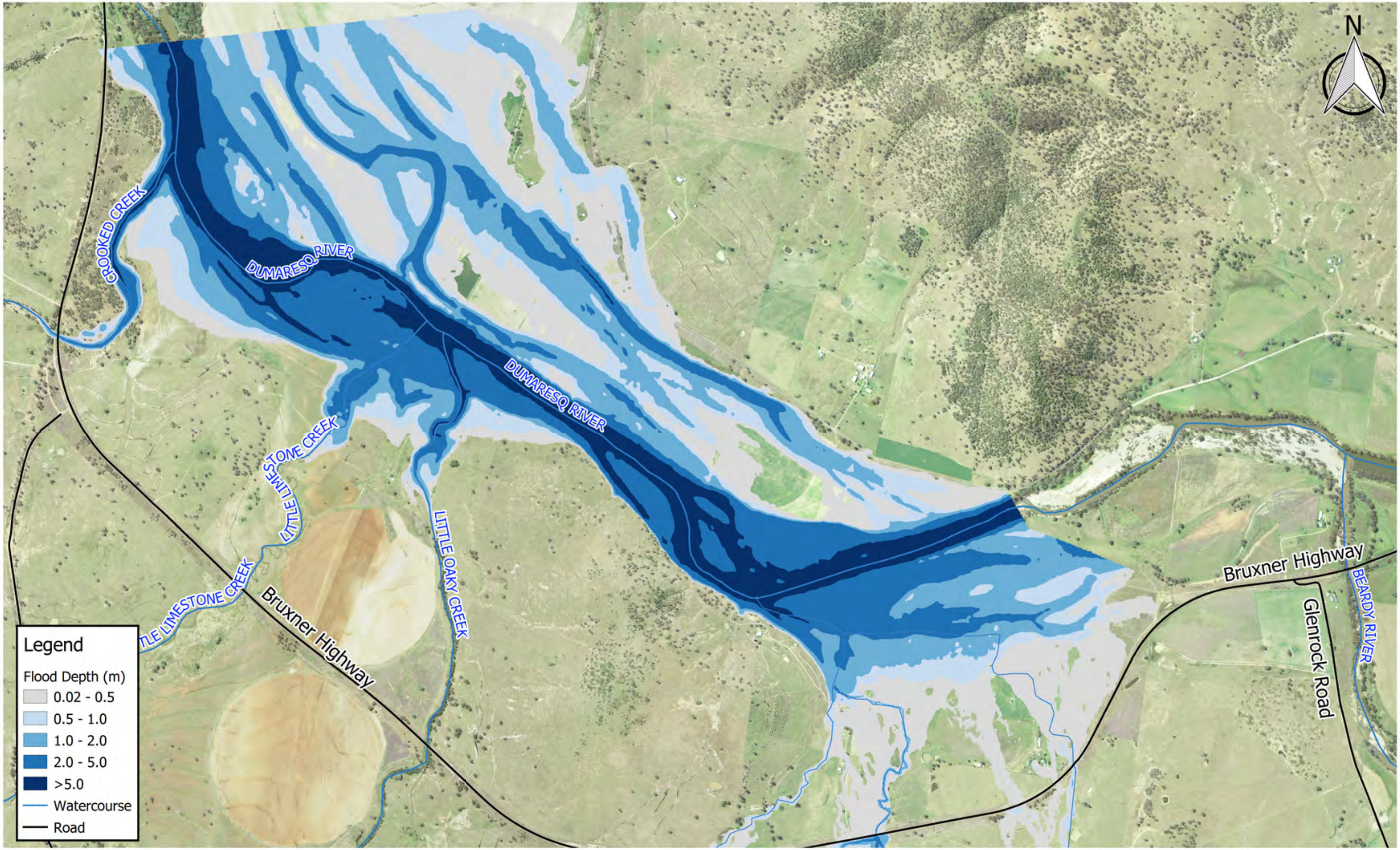

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Bonshaw Solar Project
Flood Impact Assessment

Figure A3 Developed Scenario
1% AEP Event Maximum Modelled Flood Depth
(Dumaresq River)

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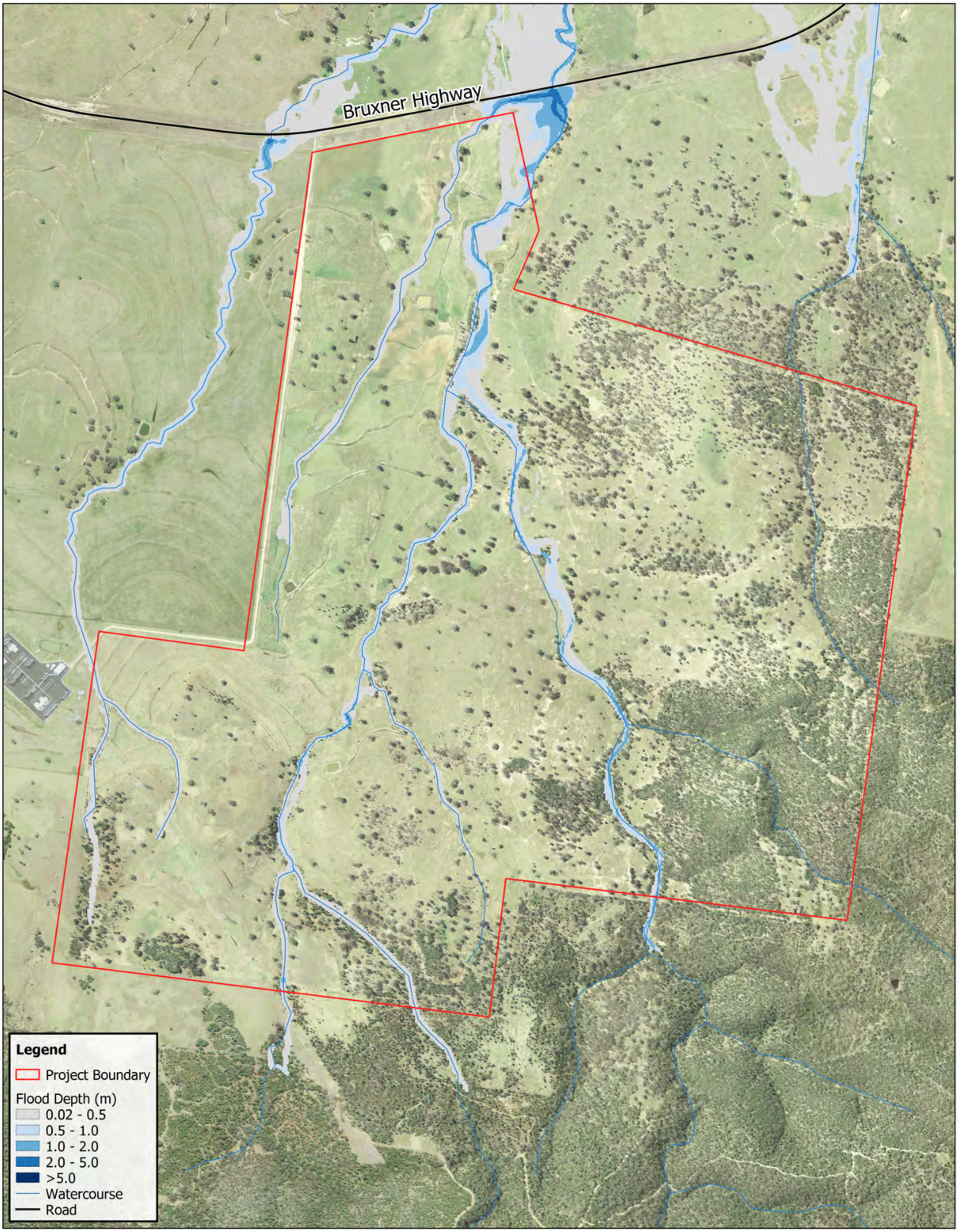
Date: 25 /7 /2019



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0 100 200 300 400 m

Scale in metres (1:9000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Australia Geodetic Datum
Vertical Datum: Australia Geodetic Datum
Grid: Australian Map Grid, Zone 56

Bonshaw Solar Project
Flood Impact Assessment

Figure A4 Developed Scenario
1% AEP Event Maximum Modelled
Flood Depth (Site)

Job Number: N1209_002
Revision: 1
Drawn: LV
Checked: SS
Date: 25/7/2019

APPENDIX J SEPP33 SCREENING ASSESSMENT

GAIA Australia Pty Ltd

Bonshaw SEPP 33 Assessment

SEPP 33 Hazardous and Offensive Development Assessment

26 July 2019

Project No.: 0470861

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Document details	
Document title	Bonshaw SEPP 33 Assessment
Document subtitle	SEPP 33 Hazardous and Offensive Development Assessment
Project No.	0470861
Date	26 July 2019
Version	1.0
Author	Lachlan Giles
Client Name	GAIA Australia Pty Ltd

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Final	01	Lachlan Giles	Daryl Colgan	Paul Douglass	26.07.2019	

Signature Page

26 July 2019

Bonshaw SEPP 33 Assessment

SEPP 33 Hazardous and Offensive Development Assessment

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Acronyms and Abbreviations

Name	Description
AS	Australian Standard
BESS	Battery Energy Storage System
the Department	NSW Government Department of Planning and Environment
EIS	Environmental Impact Statement
ERM	Environmental Resources Management Pty Ltd
GAIA	GAIA Australia Pty Ltd
ha	hectare
km	kilometre
kV	kilovolt
kWh	kilowatt hour
m	metre
MW	megawatts
NEM	National Electricity Market
O&M	operations and maintenance
PHA	Preliminary Hazard Analysis
Project	Bonshaw Solar Farm
SEARs	Secretary's Environmental Assessment Requirements
SEPP 33	*State Environmental Planning Policy No. 33 – Hazardous and Offensive Development*
T	tonne

1. INTRODUCTION

1.1 Project Overview

GAIA Australia Pty Ltd (GAIA) is seeking to develop the Bonshaw Solar Farm (the 'Project') at Bonshaw in the Inverell Shire Council in New South Wales (NSW). Environmental Resources Management Australia Pty Ltd (ERM) has been engaged to assess the potential for hazardous and offensive impacts that might result from the Project.

This screening assessment has been prepared in accordance with *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development* (SEPP 33) and the supporting guidelines 'Hazardous and Offensive Development Application Guidelines' provided by the NSW Government Department of Planning and Environment (the Department). The purpose of the screening is to address certain activities which fall under the definition of 'potentially hazardous industry' or 'potentially offensive industry' in SEPP 33. The screening assessment considers the risk to people, property and the environment at the Project location. This is discussed in detail in *Section 3* below.

The Project will adopt a lithium-ion battery storage system, which will include consideration for advanced lead acid and other battery chemicals, selected for their cost effectiveness and safety value.

The location of battery components and the relative distance to neighbours is provided in *Section 1.3* and outlined in *Figure 1-2.* The closest neighbouring dwelling to the battery components is approximately 2.1 km, which highlights the unlikely potential for any significant impacts to be experience by neighbouring landowners.

1.2 Project Description

The proposed developed area is approximately 165 ha on part of Lot 2 on DP1039185. Connection of the Bonshaw Solar Farm will be to the 330 kilovolt (kV) TransGrid Dumaresq Substation located on the adjoining Lot 210 on DP 879480. Access to the site is proposed via the existing access from the Bruxner Highway.

The Project incorporates arrays of PV modules (commonly referred to as "solar panels"), transmission infrastructure and switch yard to enable connection into the existing electricity transmission network via the 330 kV Dumaresq Substation. The project will have a targeted 'sent out' electricity generating capacity of up to 200 megawatts (MW) (AC) and a BESS/battery storage with up to 300 MW (AC) . The exact method and point of connection is being developed in conjunction with TransGrid in parallel with this planning application and the detailed infrastructure layout developed during detailed design will confirm the generating capacity of the Bonshaw Solar Farm.

The key elements of the project include the construction and operation of:

- a network of PV modules in a fixed tilt or single axis tracking arrangement;
- associated battery energy storage system (BESS) / battery storage;
- a switch yard to be connected to the 330 kV TransGrid Dumaresq Substation, on the boundary of the Project Area;
- underground or overhead cabling for connection between arrays and inverters and transformers;
- operations and maintenance (O&M) infrastructure, including O&M buildings incorporating a control room, meeting facilities, a temperature controlled spare parts storage facility, supervisory control and data acquisition facilities, a workshop and associated infrastructure (eg kitchen, toilets and other facilities), and car parking facilities;
- Access point to the site via the Bruxner Highway;

- a new internal road network to enable access from surrounding local roads to the array areas during construction and operations including internal access tracks, creek crossing & perimeter security fencing; and
- Temporary facilities during construction.

The Proposed Site Layout is outlined in *Figure 1-3* in concept form.

1.2.1 Battery and Energy Storage System

The Project includes the addition of a battery energy storage system (BESS). A 1.5 ha footprint area has been set aside for the installation of the BESS. Given the substantive advances in storage technologies over time, the exact storage capacity cannot be confirmed at this time, however it is anticipated that a 100MW facility, expandable by a further 200MW would allow the optimisation of the Bonshaw Solar Farm in the National Electricity Market (NEM) and aide as frequency stabilizer and safety net of the nearby transmission and distribution system. The option to build a 200MW BESS for safety net is currently under discussion with Transgrid as a part of 'Expanding NSW-QLD Transmission Transfer Capacity' program.

The major components for each BESS include batteries, inverters, transformers, heating ventilation air conditioning and fire protection. The specific design details for the BESS will not be finalised until the completion of the detailed design stage of the project. The general description of the alternatives for the BESS are as follows:

- **Multiple individual cubicles** each of between 130kWh and 160kWh. These would be skid mounted and pre-commissioned in packs of 8 to 10 battery cubicles with 2 inverters. The cubicle system manages fire risk via containment; each cubicle is a fire-rated and sealed system which prevents the spread of fire from one cubicle to another and the fire can quickly burn out without a material loss of battery capacity or capital value across the system as a whole; or
- **A containerised system** of approximately 10MW capacity per container. A containerised system has a fire suppression system (typically inert gas or water deluge) to prevent the spread of fire within the container.

Both options would have a similar appearance, as the individual cubicles would be arranged in such a way as to appear as a single container. The BESS facility will encompass a surface area of up to 15,000m^2 and include a series of concrete pads, suitably spaced for optimum operations and maintenance and separated by gravel/road-base to assist in fire management. The final decision on the preferred technology provider and detailed technology specification would be confirmed during the detailed design phase of the Project, and would comply with applicable Australian standards, licences and codes.

Indicative battery modules would be of the order of 2.5 metres in height. An example battery pack is shown in in *Figure 1-1.*

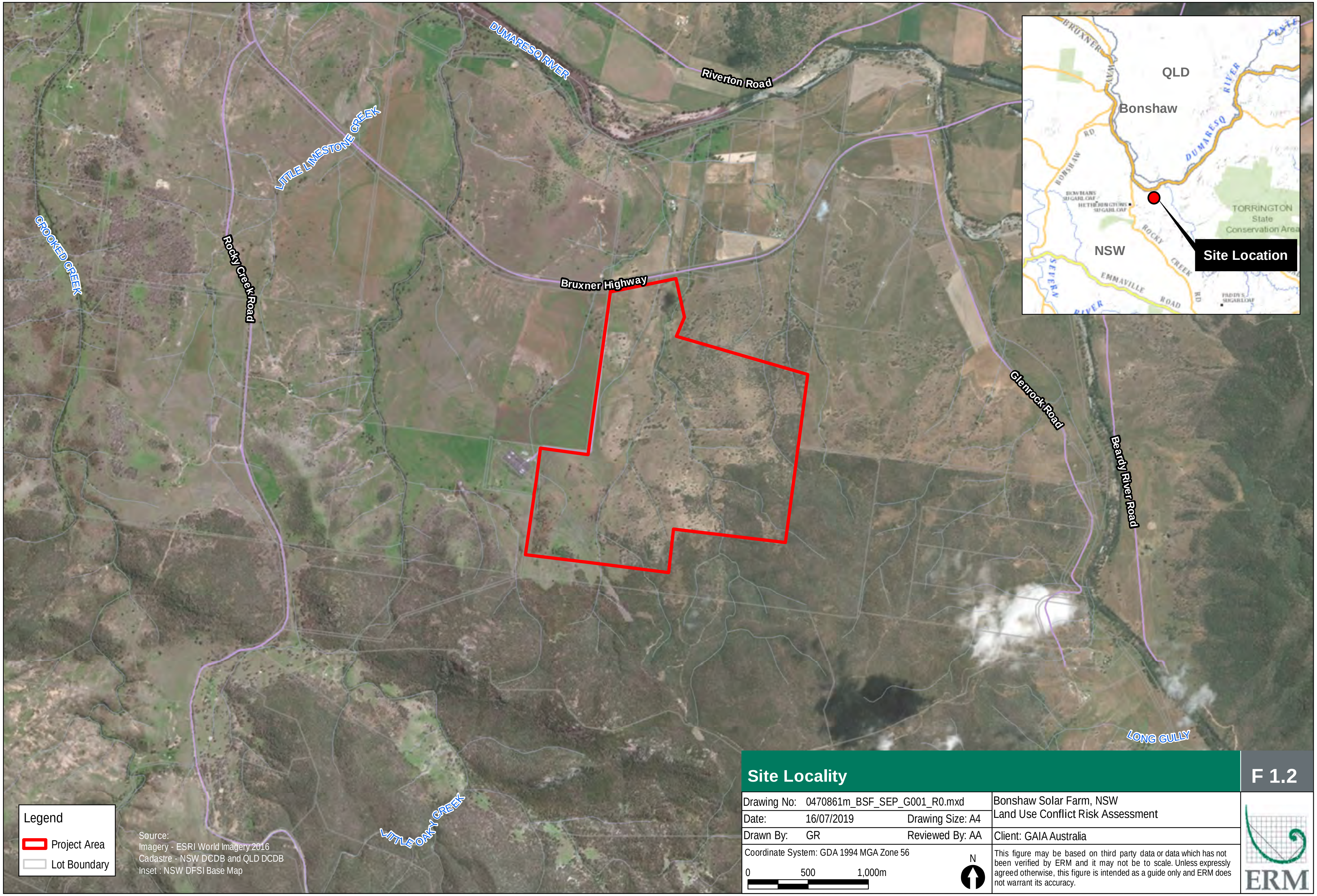
Figure 1-1 Example Battery Module

1.3 Proximity to Neighbours

The screening assessment recognises the relative proximity of neighbouring properties to consider the likely significance of impacts upon neighbours of the Project. Given the rural setting of the area, neighbouring landowner dwellings are scattered over a vast area, with the closest being located just over 2 km from the battery energy storage system. The substantial distance, in regards to proximity, provides a sufficient buffer, rendering the potential for impacts insignificant. The proximity to neighbouring landowner dwellings are outlined in *Table 1-1* and displayed in *Figure 1-4* below.

Table 1-1 Proximity of Neighbours to Battery Components

Landowner	Direction from Site	Approximate Distance to Dwelling
Lot 200 DP 879480	West	3.2 km *(Dwelling of property owner located in Lot 1 DP 77438)*
Lot 201 DP 879480	West	N/A – Dumaresq Substation
Lot 46 DP 750075	West, South and East	N/A – Unoccupied Land
Lot 29 DP 750075	East	3.7 km *(Dwelling of property owner located in Lot 52 DP 750075)*
Lot 16 DP 750075	North	2.3 km *(Dwelling of property owner located in Lot 18 DP 750075)*
Lot 1 DP 1039185	North	2.1 km
Lot 1 DP 777438	North-west	3.2 km



Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Inset : NSW DFSI Base Map

Site Locality

F 1.2

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Date: 16/07/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56
0 500 1,000m
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Bonshaw Solar Farm, NSW
Land Use Conflict Risk Assessment
Client: GAIA Australia

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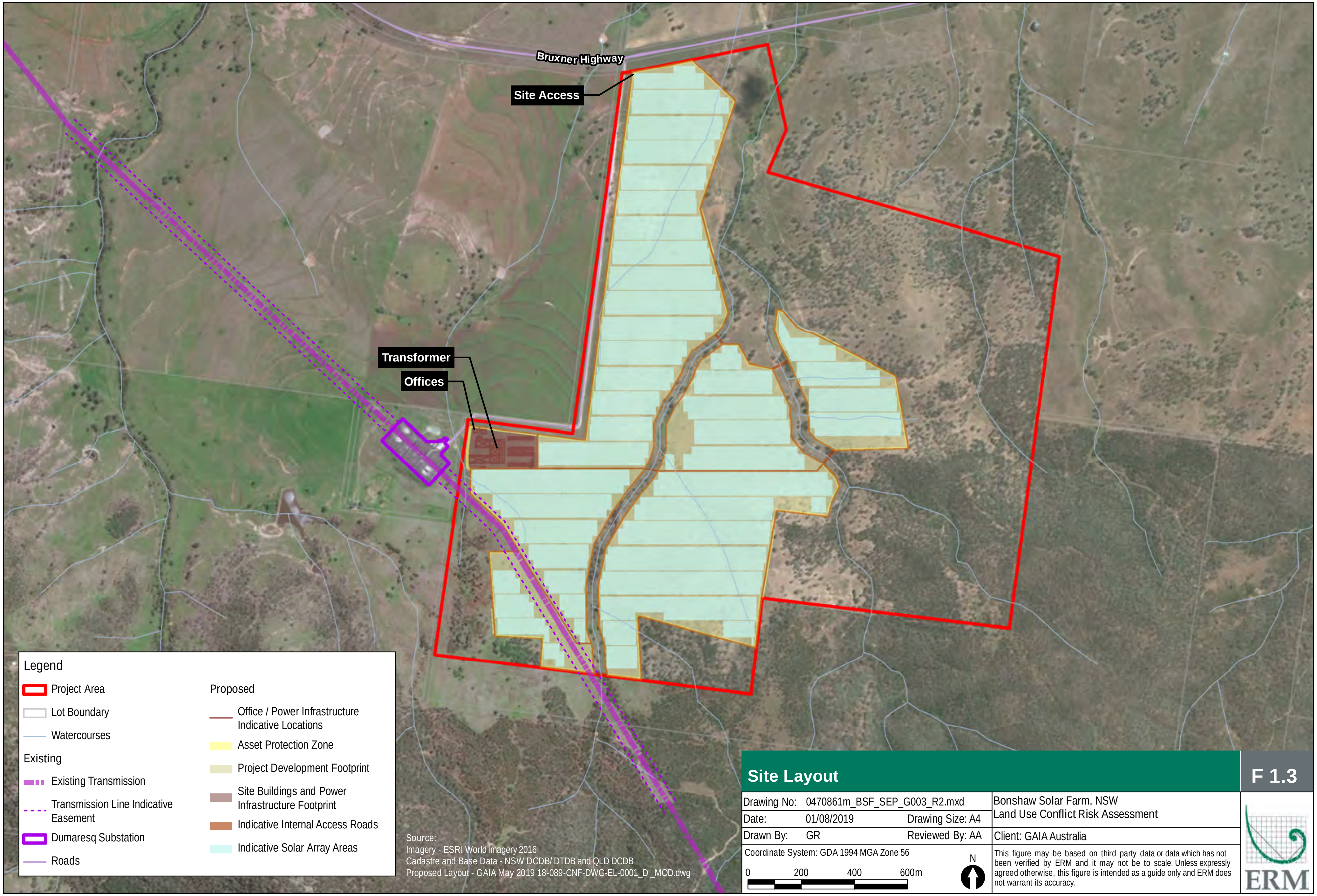

Legend

- Project Area
- Lot Boundary
- Watercourses

Existing

- Existing Transmission
- Transmission Line Indicative Easement
- Dumaresq Substation
- Roads

Proposed

- Office / Power Infrastructure Indicative Locations
- Asset Protection Zone
- Project Development Footprint
- Site Buildings and Power Infrastructure Footprint
- Indicative Internal Access Roads
- Indicative Solar Array Areas

Source:
Imagery - ESRI World Imagery 2016
Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg

Site Layout

F 1.3

Drawing No: 0470861m_BSF_SEP_G003_R2.mxd
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Drawn By: GR Reviewed By: AA

Bonshaw Solar Farm, NSW
Land Use Conflict Risk Assessment

Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

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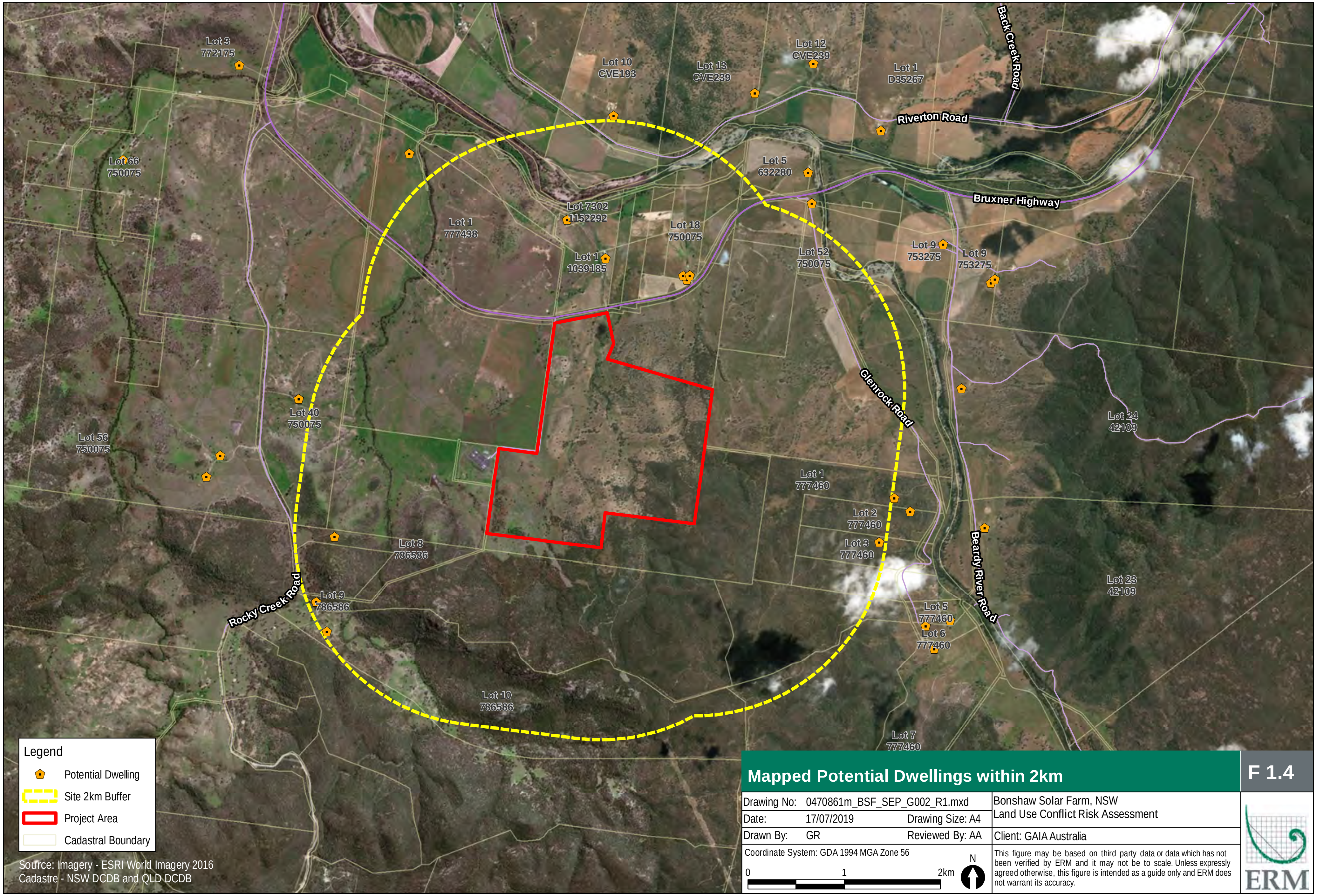

Source: Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB

Mapped Potential Dwellings within 2km

F 1.4

Drawing No: 0470861m_BSF_SEP_G002_R1.mxd		Bonshaw Solar Farm, NSW Land Use Conflict Risk Assessment
Date: 17/07/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: AA	Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

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2. ASSESSMENT METHODOLOGY

A desktop assessment was carried out to identify environmental hazards and risks that could arise during the construction and operation of the Project, as well as mitigation measures to address such issues.

The assessment focused on those hazards and risks with the potential to adversely affect the quality of the surrounding environment, land uses and communities, with consideration of the following relevant policies and guidelines:

- *State Environmental Planning Policy 33 – Hazardous and Offensive Development* (SEPP 33);
- *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning, 2011);
- *Hazardous Industry Planning Advisory Paper No 6: Hazard Analyses* (Department of Planning, 2011);
- *Multi-level Risk Assessment* (Department of Planning, 2011);
- *Australian Standard 1940: The storage and handling of flammable and combustible liquids* (AS 1940:2017);
- *Australian Standard 4332: The storage and handling of gases in cylinders and welding gases* (AS 4332:2004);
- *Australian Standard 4839: The safe use of portable and mobile oxy-fuel gas systems for welding, cutting, heating and allied processes* (AS 4839:2001);
- *International Standard (ISO / IEC 31010) Risk Management – Risk Assessment Technique*;
- *Australian Code for the Transport of Dangerous Goods by Road and Rail (7.5th edition)* (National Transport Commission, 2007); and
- *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover, 2005).

There may be additional health and safety hazards that are not specifically considered in this assessment and would be addressed by the construction contractor.

3. APPLICATION OF SEPP 33

3.1 Definitions

Industries or projects determined by the risk screening process to be hazardous or potentially hazardous require the preparation of a Preliminary Hazard Analysis (PHA) in accordance with Clause 12 of SEPP 33.

Definitions of ‘potentially hazardous industry’ and ‘potentially offensive industry’ are provided in SEPP 33:

‘potentially hazardous industry’ means a development for the purposes of any industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:

a. to human health, life or property, or

b. to the biophysical environment, and includes a hazardous industry and a hazardous storage establishment.

‘potentially offensive industry’ means a development for the purposes of an industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would emit a polluting discharge (including for example, noise) in a manner which would have a significant adverse impact in the locality or on the existing or likely future development on other land, and includes an offensive industry and an offensive storage establishment.

3.2 Assessment

3.2.1 Hazard Screening

In assessing the proposed Project, the emphasis is on preventing hazardous incidents on-site or offsite, such as spontaneous combustion and fire, or the contamination of land by the use of significant quantities of toxic or biologically harmful materials that could result in substantial effects.

3.2.2 Potential Impacts During Construction and Operation

Potential hazards and risks during construction and operation include (but are not limited to):

- the on-site storage, use and transport of dangerous goods and hazardous substances; and
- risk of damage to existing infrastructure due to ground movement and geotechnical instability.

These hazards and risks are described further in the following sections. An indicative list of the types of potentially hazardous materials anticipated to be used, stored and transported during construction and operation of the Project is provided in *Table 3-1* along with the relevant storage and transport thresholds established under Applying SEPP 33.

Table 3-1 Proposed Hazardous Material Storage at Bonshaw Solar Farm (Construction and Operation)

Material	Australian Dangerous Goods Class	Storage Location	Storage Method	Quantity (T)	Applying SEPP 33 Threshold		
					Min quantity	Min. storage distance from sensitive receptors	Transport
Chemicals	Various	Workshop	Domestic Storage	Domestic Quantities	N/A	N/A	N/A
Welding Cylinders	Class 2.1, 2.2	Workshop	Cylinders (AS 4332, AS 4839)	5 Welding Sets (<0.1 T)	0.5 T	N/A	N/A
Lithium Battery	Class 9	Battery Energy Storage System	Container	Undefined	N/A	N/A	N/A
Diesel	Combustible	South Gate	Self bunded tank AST (AS 4332, AS 4839)	2000 T	5000 T	3m (AS 1940)	N/A
Oil Store	Combustible	Workshop	Domestic Storage (AS 4332, AS 4839)	<10 T	N/A	N/A	N/A

The thresholds in applying SEPP 33 represent the maximum quantities of hazardous materials that can be stored or transported without causing a significant off-site risk.

In most instances, low volumes of potentially hazardous materials would be stored on site. The volume required to be stored on site would largely depend on the anticipated rates of consumption, with deliveries of dangerous goods coordinated to match consumption rates.

Construction site planning would ensure hazardous materials are stored appropriately and at the required distance from sensitive receptors, in accordance with the thresholds established under Applying SEPP 33 and relevant Australian Standards (specifically AS1970, AS4332 and AS4839).

Environmental hazards and risks associated with the on-site storage, use and transport of chemicals, fuels and materials would be managed through standard mitigation measures to be developed as part of the construction environmental management documentation. These measures would include the storage and management of all hazardous substances in accordance with the *Work Health and Safety Act 2011*, the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005) and Applying SEPP 33.

The risk screening process for the storage of hazardous materials at the Project site and the transportation of hazardous materials to/from the site demonstrates that in all cases, types and quantities would be below the Applying SEPP 33 thresholds. For storage, this demonstrates that operational inventories would not pose a significant risk of harm beyond the site boundary. For transportation, this also demonstrates that risks are unlikely to be significant.

It can be concluded that the risks associated with storage and transportation of hazardous materials are unlikely to be significant or pose a risk to public safety. Given that Applying SEPP 33 thresholds are not exceeded, the Project is not considered to be a hazardous or potentially hazardous industry under SEPP 33. Therefore a PHA is not required to be undertaken for the Bonshaw Solar Farm.

3.2.3 Potentially Offensive Assessment

The assessment of the suitability of the Project site to accommodate existing or proposed development of a potentially offensive nature is based on consideration of:

- the nature and quantities of materials stored and processed on the site;
- the type of plant and equipment in use;
- the adequacy of proposed technical, operational and organisational safeguards;
- the surrounding land uses or likely future land uses; and
- the interactions of these factors.

The potential polluting discharges a development of this type could generate that would be deemed offensive and cause adverse impacts if unmitigated are outlined in *Table 3-2*. Discussion of where these issues are addressed in the Environmental Impact Statement (EIS) (ERM, 2019) and hence why they are considered to be mitigated is also outlined.

Table 3-2 Potentially Offensive Assessment

Potential Impacts	Discussion
Noise	No issues identified. Refer to Section 6.5 and Appendix G (Noise and Vibration Impact Assessment) of the EIS.
Odour	Given the nature of the Solar Farm, any odour is unlikely to arise, and is therefore not required to be assessed as a requirement of the SEARs.

Potential Impacts	Discussion
Air emissions	Given the nature of the Solar Farm, no air emissions are likely to arise, and is therefore not required to be assessed as a requirement of the SEARs.
Water discharge/runoff	No issues identified. Refer to Section 6.7 of the EIS.
Ground contamination	No issues identified. Refer to Section 6.3 of the EIS.

3.3 Potentially Offensive Impacts Mitigation Measures

The mitigation measures to be implemented to address potential offensive impacts are provided below.

3.3.1 Potentially Offensive Assessment

With the nature of the material stored, mitigation measures implemented for the project, immediate proximity of the Dumaresq power substation, and the impacts as they are assessed in the EIS, it can be concluded that the potentially offensive impacts associated with the project are unlikely to be significant to either neighbouring properties or on the existing or likely future development. Therefore a PHA is not required to further analyse the project.

4. CONCLUSION

It has been recognised that the Project is to include small quantities of hazardous materials which do not trigger the threshold. With consideration of the insignificant quantity of materials stored on site, along with the significant distance to neighbouring properties, it can be concluded that the risks associated with storage and transportation of hazardous materials are unlikely to be significant or pose a risk to public safety. Given that Applying SEPP 33 thresholds are not exceeded, the Project is not considered to be a hazardous or potentially hazardous industry under SEPP 33*.* Therefore a PHA is not required to be undertaken for the Bonshaw Solar Farm.

Potentially offensive impacts have been previously assessed as minimal, and are to be managed as specified within relevant technical reports and as outlined within Section 7 of the EIS.

This assessment has taken into consideration the relevant materials, quantities and details as provided by GAIA for the Bonshaw Solar Farm. Compliance to the SEPP 33 by GAIA is dependent upon adhering to storage methods and procedures outlined in this assessment, and the relevant supporting Australian Standards aforementioned.

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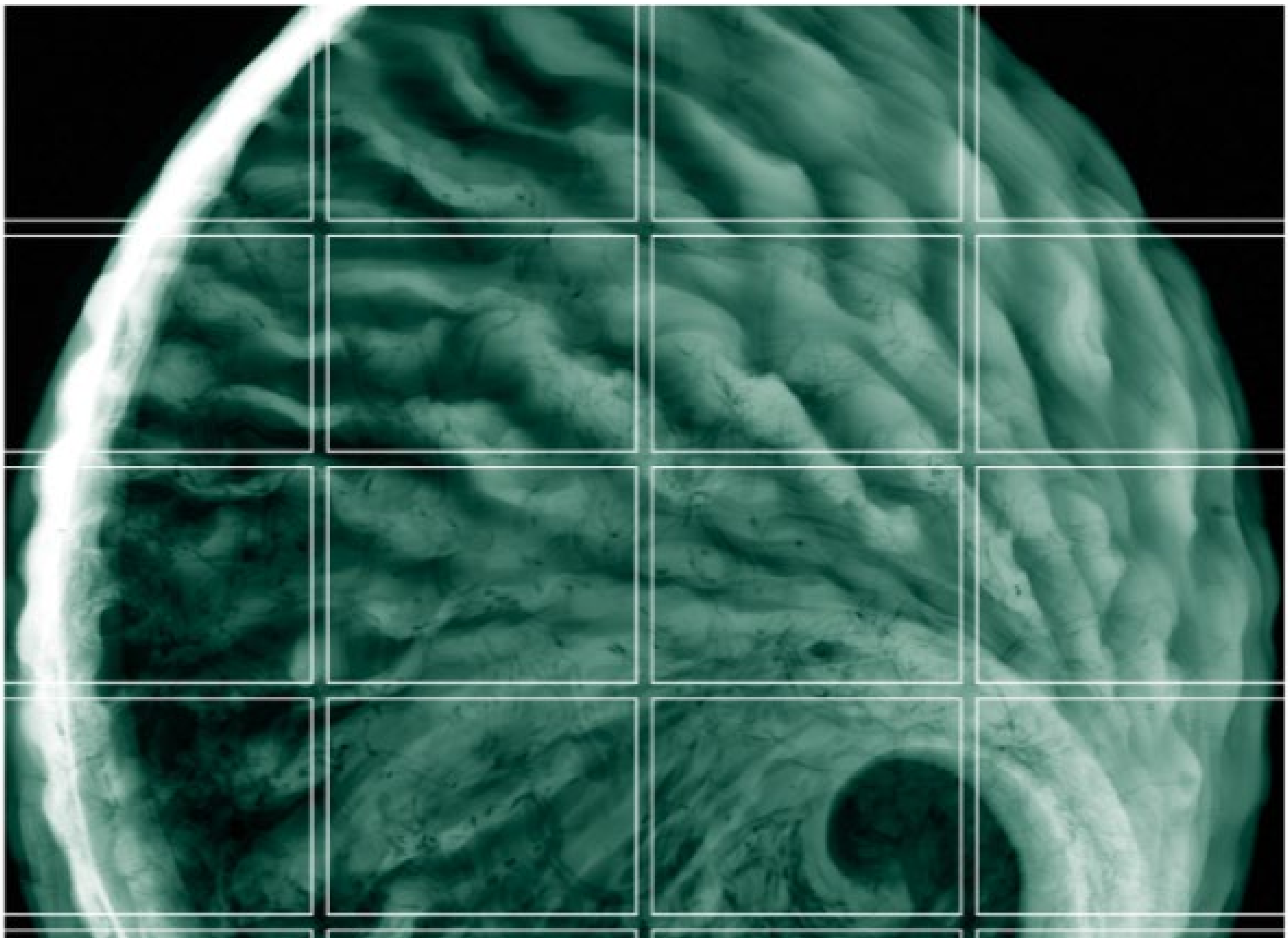
APPENDIX K BUSHFIRE RISK ASSESSMENT



GAIA Australia Pty Ltd

Bonshaw Solar Farm

Bushfire Hazard Assessment

26 July 2019

Project No.: 0470861

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Document details	
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Client Name	GAIA Australia Pty Ltd

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Final	01	Joanne Woodhouse	Amanda Antcliff	Paul Douglass	26.07.2019	

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Bonshaw Solar Farm

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CONTENTS

List of Tables

Acronyms and Abbreviations

Name	Description
Assets	Anything valued by people which includes houses, utilities, agricultural land, and in many cases, the environment.
Bushfire	Unplanned vegetation fire. A generic term which includes grass fires, forest fires and scrub fires both with and without a suppression objective.
Bushfire Hazard	The potential severity of a bushfire, which is determined by fuel load, fuel arrangement and topography.
Contained	The status of a bushfire suppression action signifying that a control line has been completed around the fire, and any associated spot fires, which can reasonably be expected to stop the fire's spread.
Fire Management	All activities associated with the management of fire prone land, including the use of fire to meet land management goals and objectives.
Fuel Hazard	Fine fuels in bushland that burn in the continuous flaming zone at the fire's edge. These fuels contribute the most to the fire's rate of spread, flame height and intensity. Typically, they are dead plant material, such as leaves, grass, bark and twigs thinner than 6 mm thick, and live plant material thinner than 3 mm thick.
Intensity	The rate of energy release per unit length of fire front usually expressed in kilowatts per metre (Kw/m).
APZ	Asset Protection Zone
ERP	Emergency Response Plan
GFDI	Grassland Fire Danger Index
Likelihood	The chance of a bushfire igniting and spreading.
BFMC	Bushfire Management Committee
AFAC	Australasian Fire and Emergency Service Authorities Council Limited
GAIA	GAIA Australia
ISC	Inverell Shire Council
FRNSW	Fire and Rescue NSW
RFS	NSW Rural Fire Service
PBP	Planning for Bushfire Protection (PBP) Guidelines
LEMC	Local Emergency Management Committee
BoM	Bureau of Meteorology
PCT	Plant Community Type
FDR	Fire Danger Ratings. FDR give you an indication of the consequences of a fire, if one was to start. The higher the fire danger, the more dangerous the conditions.

** Most terms are taken from the Bushfire Glossary prepared by the Australasian Fire and Emergency Service Authorities Council Limited (AFAC) and the BFMC (2011) Northern Tablelands Bush Fire Risk Management Plan.*

1. INTRODUCTION

GAIA Australia (GAIA) is seeking to develop a large scale solar photovoltaic (PV) generation facility and associated infrastructure with the capacity of 200 megawatts (MW) situated near Bonshaw in the Inverell Shire Council (ISC) of New South Wales (NSW) (the Project). The location of the Project Area is shown in Figure 1.1 and the proposed solar farm development footprint and conceptual layout is shown in Figure 1.2.

The need for a Bushfire Hazard Assessment was identified within the Secretary's Environmental Assessment Requirements (SEARs) for the further assessment and subsequent approval of the Project and the *Rural Fires Act 1997* imposes obligations on land managers to take all reasonable measures to prevent the occurrence and spread of wildfire to adjoining lands from lands under their care and management. This report contains management and mitigation measures designed to address these obligations.

1.1 Description of the Project

A description of the works associated with the construction and operational phases of the Project, of relevance to this Bushfire Hazard Assessment are provided below. A detailed description of the Project components is provided in the Environmental Impact Statement (EIS) (ERM, 2019). The Project will consist of:

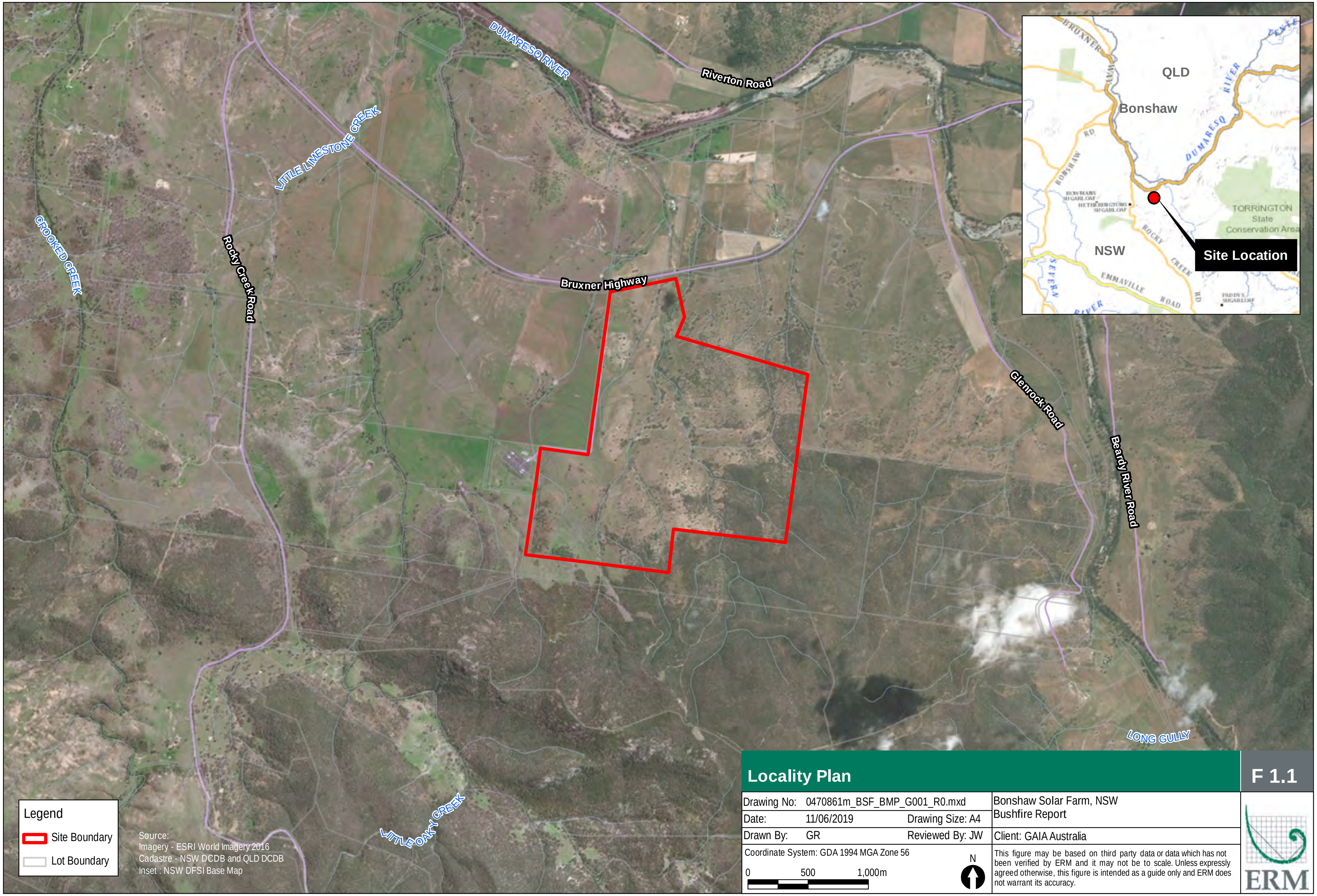
- a network of PV modules in a fixed tilt or single axis tracking arrangement;
- associated battery energy storage system (BESS) / battery storage;
- a switch yard to be connected to the 330 kV TransGrid Dumaresq Substation, on the boundary of the Project Area;
- underground or overhead cabling for connection between arrays and inverters and transformers;
- operations and maintenance (O&M) infrastructure, including O&M buildings incorporating a control room, meeting facilities, a temperature controlled spare parts storage facility, supervisory control and data acquisition (SCADA) facilities, a workshop and associated infrastructure (eg kitchen, toilets and other facilities), and car parking facilities;
- one main entry/exit point to the Bruxner Highway to the north and an additional two access points on the western and southern boundaries of the site.
- a new internal road network up to a combined total length of 13.75km connecting the arrays and other proposed infrastructure to the public road network; and
- Temporary facilities during construction

The final layout of the Project will be dependent on detailed design, availability and commercial considerations at the time of construction.

1.2 Aims and Objectives

Bushfire presents a threat to human life and assets and can adversely impact ecological values. Bushfire risk can be considered in terms of environmental factors that increase the risk of fire (fuel quantity and type, topography and weather patterns), as well as specific activities (such as hot works) or infrastructure components that exacerbate combustion or ignition risks (such as transmission lines and other electrical components). This bushfire hazard assessment aims to address the requirements identified by the NSW Rural Fire Service (RFS) and Fire and Rescue NSW (FRNSW) in the Secretary's Environmental Assessment Requirements (SEARs) (refer Table 2.2) and to demonstrate that the proposed solar farm can be designed, constructed and operated to minimise ignition risks and provide for asset protection consistent with relevant Rural Fire Service (RFS) design guidelines (Planning for Bushfire Protection (PBP) 2018 and Standards for Asset Protection).

The objectives of this assessment are to reduce the likelihood of a bushfire impacting the site or spreading from the site to surrounding properties.



Source:
Imagery - ESRI World Imagery 2016
Cadastre - NSW DCDB and QLD DCDB
Inset : NSW DFSI Base Map

Locality Plan

F 1.1

Drawing No: 0470861m_BSF_BMP_G001_R0.mxd	Bonshaw Solar Farm, NSW Bushfire Report
Date: 11/06/2019 Drawing Size: A4	
Drawn By: GR Reviewed By: JW	Client: GAIA Australia
Coordinate System: GDA 1994 MGA Zone 56 0 500 1,000m	This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

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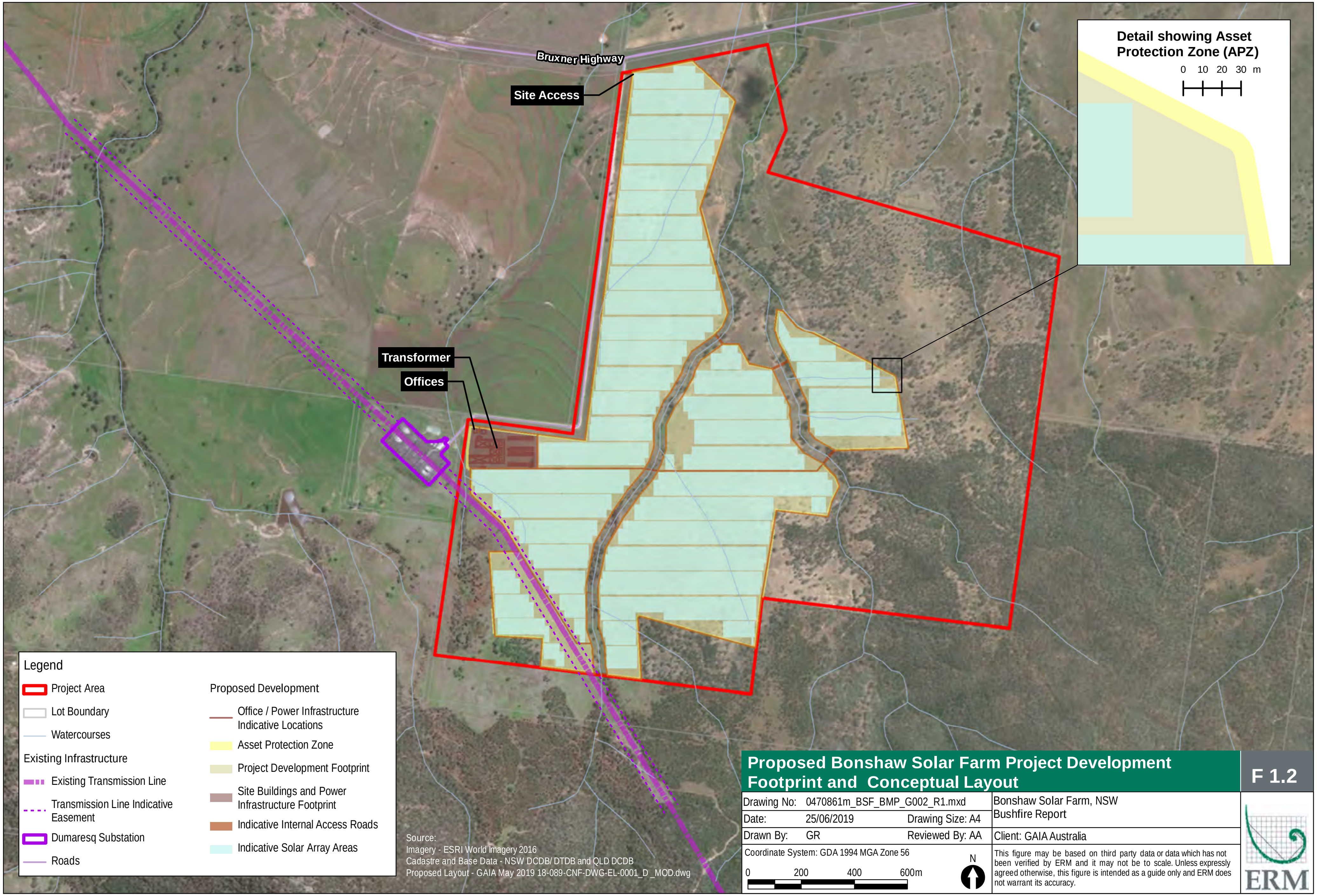

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Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg

Proposed Bonshaw Solar Farm Project Development Footprint and Conceptual Layout

F 1.2

Drawing No: 0470861m_BSF_BMP_G002_R1.mxd
Date: 25/06/2019
Drawing Size: A4
Drawn By: GR
Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56
0 200 400 600m

Bonshaw Solar Farm, NSW
Bushfire Report

Client: GAIA Australia

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ERM

2. PLANNING FRAMEWORK

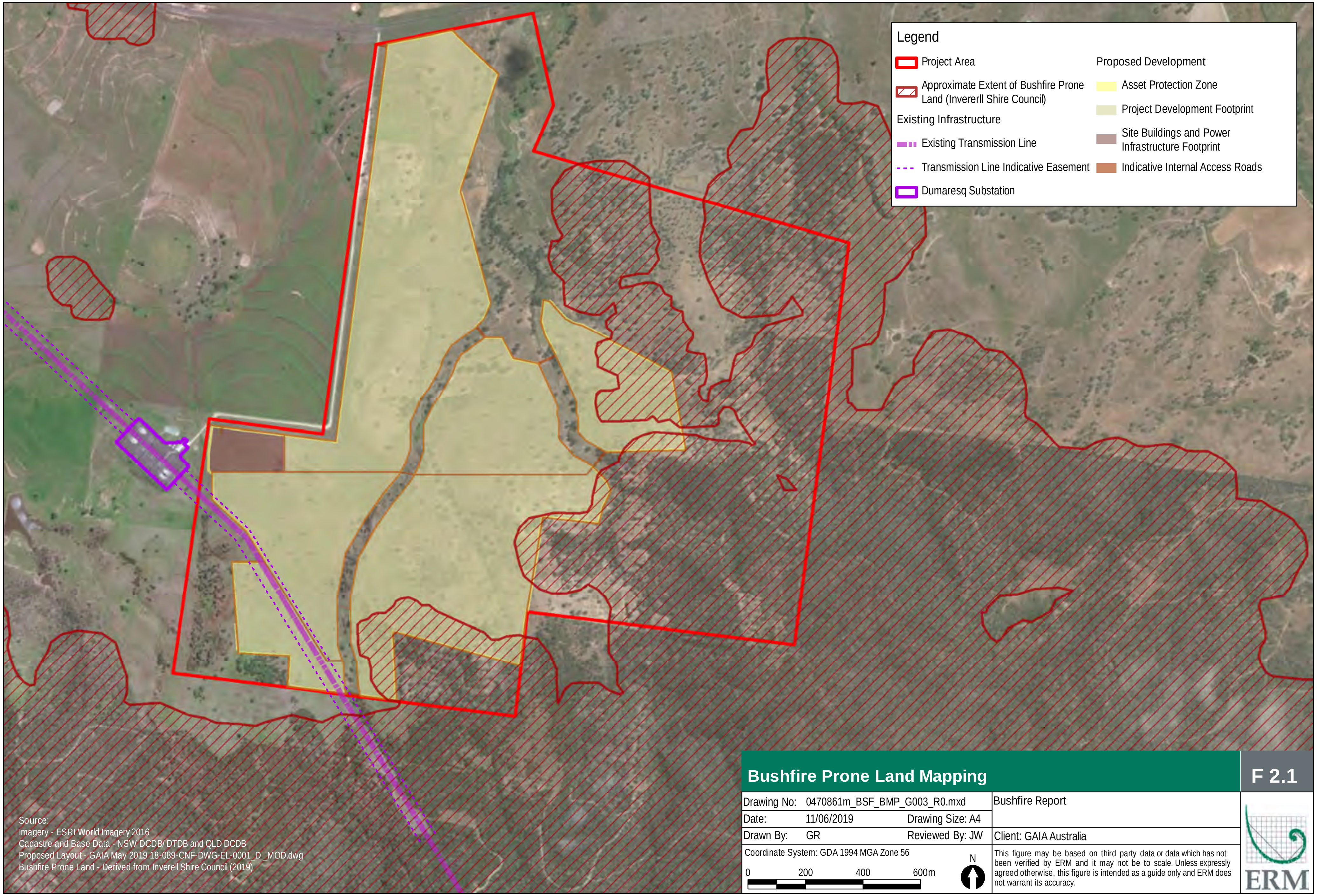
Table 2.1 outlines the relevant legislation and planning controls and how they have been considered within this Bushfire Hazard Assessment.

Table 2.1 Key Legislation and Guidelines Addressed within the Assessment

Key Legislation/Guidelines	Description
NSW Rural Fires Act 1997	The main objectives of the *Rural Fires Act 1997* (RF Act) are to: ■ prevent, mitigate and suppress bush and other fires in NSW; ■ co-ordinate bushfire fighting and bushfire prevention throughout the State; ■ protect people from injury or death and property from damage as a result of bushfires; and ■ protect the environment. The proposed development does not require subdivision of land and is not defined as a special fire protection purpose (SFPP) development under Section 100B of the RF Act. Accordingly, the proposal does not require a bushfire safety authority. It is also noted that under Section 63 of the RF Act, owners and occupiers of land have a duty to take practicable steps to prevent the occurrence of bushfires on, and to minimise the danger of the spread of bushfires on or from, that land. This assessment considers the risk of spread of bushfires from the Project to the surrounds and provides measures to minimise the risk of bushfires.
Planning for Bushfire Protection 2018	*Planning for Bushfire Protection 2018* (NSW RFS) (PBP 2018) is a planning document to link responsible planning and development control with the protection of life, property and the environment. It is anticipated that PBP 2018 will become legislated by mid – 2019, to coincide with the enactment of the National Construction Code 2019 (due to be adopted on 1 May 2019). Until then, PBP 2018 is in a 'pre-release' stage, also known as the transitionary period. We have used this guideline here to ensure consistency with AS 3959-2018, specifically Section 2 which has been simplified to address interpretational issues related to slope, grasslands and low threat vegetation. PBP applies to all development applications on land that is classified as bushfire prone land on a council's Bushfire Prone Land Mapping. The Inverell Shire Council Bushfire Prone Land mapping shows the eastern and southern portion of Lot 2 contains bushfire prone land (refer to Figure 2.1). Therefore, consideration has been given to the following overall aims and objectives of PBP 2018: ■ afford buildings and their occupants protection from exposure to a bushfire; ■ provide for a defendable space to be located around buildings; ■ provide appropriate separation between a hazard and buildings which, in combination with other measures, minimises material ignition; ■ ensure that appropriate operational access and egress for emergency service personnel and residents is available;

Key Legislation/Guidelines	Description
	■ provide for ongoing management and maintenance of bushfire protection measures; and ■ ensure that utility services are adequate to meet the needs of firefighters. PBP 2018 provides an assessment framework for the identification of potential impacts of bushfire upon the proposed new assets and establishes six key bushfire protection measures that are to be addressed and collectively form an effective mitigation strategy in order to reduce the bushfire impacts. These six key bushfire protection measures are: ■ the provision of clear separation of buildings and bushfire hazards, in the form of a fuel-reduced Asset Protection Zone (APZ); ■ construction standards and design; ■ appropriated access standards for residents, fire fighters, emergency service workers and those involved in evacuation; ■ adequate water supply and pressure; ■ emergency management arrangements for fire protection and/or evacuation; and ■ suitable landscaping, to limit fire spreading to a building.
Australian Standard 3959 - 2018 Construction of Buildings in Bushfire-prone Areas (AS 3959-2018)	For the purposes of this assessment the Project is considered 'other development', as it is not residential subdivision, residential infill, or Special Fire Protection Purpose (SFPP) and the National Construction Code 2019 does not provide for any bushfire specific performance requirements. In a designated bushfire prone area, a Class 2 building, a Class 3 building, a Class 4 part of a building or a Class 9 building that is a special fire protection purpose or a Class 10a building or deck associated with such a building or part, must comply with AS 3959-2018 as a set of 'deemed to satisfy' provisions. These deemed-to-satisfy provisions are not applicable to this Project. General fire safety provisions and the methodology for determining the bushfire attack level (Section 2 *AS 3959-2018*) are taken as acceptable solutions. The aims and objectives of PBP 2018 apply in relation to other matters such as access, water and services, emergency planning and landscaping/vegetation management. The proposed mitigation measures as appropriate for the solar farm proposal are discussed in *Section 4.* *Also note that the new National Construction Code 2019 was adopted on 1 May 2019. A new non-mandatory Fire Safety Verification Method (VM) has been introduced with a delayed adoption date from 1 May 2020. The new VM, which is a voluntary tool under a Performance Solution pathway, provides for a documented process in the design of fire safety Performance Solutions, and is based on the International Fire Engineering Guidelines (IFEG). The applicability of this VM has not been addressed in this assessment and does not apply to this solar farm proposal.*
Biodiversity Conservation Act 2016	Projects determined by a statutory authority of the NSW State Government are required to be assessed in accordance with the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Biodiversity Conservation Act 2016* (BC Act).

Key Legislation/Guidelines	Description
	The BC Act requires the consideration of threatened species and their habitats in the developmental planning process and a responsibility of the proponent to determine potential impacts on listed species and Endangered Ecological Communities (EECs). Schedule 3 of the BC Act lists Key Threatening Processes for species, populations and ecological communities within NSW. 'Clearing of native vegetation', 'high frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' and 'removal of dead wood and dead trees', are listed by the TSC Act as Key Threatening Processes and need to be carefully considered and managed when implementing fire management activities. The Project site contains threatened species that may be impacted by the proposal (refer to *Section 3.1*). *Refer to Bonshaw Solar Farm Ecology Impact Assessment (ERM 2019) for more detail on the habitat requirements and confirmed records of these species.*
Commonwealth Environment Protection and Biodiversity Act 1999	The *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act) is the primary piece of Federal legislation relating to the environment. Under the EPBC Act any action that has, or is likely to have, a significant impact on a matter of National Environmental Significance (NES) requires approval from the Commonwealth Minister for the Environment. An action is defined as a project, development, undertaking, activity (or series of activities), or alteration to any of these. Consideration of the impact of the proposed activity on matters of NES has been provided in *Bonshaw Solar Farm Biodiversity Development Assessment Report (ERM 2019)* and summarised in *Section 3.1*.
Environment Planning and Assessment Act 1979	The Project was declared a State Significant Development (SSD) in accordance with clause 20 of Schedule 1 the *State Environmental Planning Policy* (State and Regional Development) 2011 and will be assessed under Part IV of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Section 4.41 of the EP&A Act excludes projects approved under Part 4 of the EP&A Act from requiring *"a bush fire safety authority under section 100B of the Rural Fires Act 1997".*



Source:
Imagery - ESRI World Imagery 2016
Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg
Bushfire Prone Land - Derived from Inverell Shire Council (2019)

Bushfire Prone Land Mapping

F 2.1

Drawing No: 0470861m_BSF_BMP_G003_R0.mxd
Date: 11/06/2019
Drawing Size: A4
Drawn By: GR
Reviewed By: JW
Coordinate System: GDA 1994 MGA Zone 56

Bushfire Report

Client: GAIA Australia

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2.1 Secretary's Environmental Assessment Requirements

The NSW Department of Planning and Environment (DP&E) issued SEARs for the Project (SSD 13_6039) on 16 August 2018.

The SEARs identify a number of key assessment requirements with respect to hazard and risk. These requirements and comments and where they are addressed within this assessment are identified in Table 2.2.

Table 2.2 Secretary's Environmental Assessment Requirements

Secretary's Environmental Assessment Requirements (SEARs)		Addressed
Key Assessment Requirements	Hazard/Risks– an assessment of all potential hazards and risks including but not limited to bushfires, spontaneous ignition, electromagnetic fields or the proposed grid connection infrastructure.	This Bushfire Hazard Assessment has been prepared to meet this requirement.

2.2 Agency Assessment Requirements

In addition to the SEARs, the NSW Rural Fire Service (RFS) and Fire and Rescue NSW (FRNSW) provided detailed assessment requirements for consideration. This Bushfire Hazard Assessment has been prepared to meet these requirements as outlined in Table 2.3.

Table 2.3 Agency Assessment Requirements

Secretary's Environmental Assessment Requirements (SEARs)		Addressed
Fire and Rescue NSW	It is Fire and Rescue NSW (FRNSW) experience that small and large scale photovoltaic installations present unique electrical hazard risks to our personnel when fulfilling their emergency first responder role. Due to the electrical hazards associated with large scale photovoltaic installations and the potential risk to the health and safety of firefighters, both FRNSW and the NSW Rural Fire Service must be able to implement effective and appropriate risk control measures when managing an emergency at the proposed site. Should a fire or hazardous material incident occur, it is important that first responders have ready access to information which enable effective hazard control measures to be quickly implemented.	Considered in Section 3.8 and Section 4.3.3.
	Recommendations: ▪ That a comprehensive Emergency Response Plan (ERP) be developed. ▪ That the ERP addresses foreseeable on-site and off-site fire events and other emergency incidents (eg fires involving solar panel arrays, bushfires in the immediate vicinity or potential hazmat incidents).	Management and mitigation measures outlined in Section 4 include preparation of an Emergency Response Plan (ERP) in consultation with both NSW Rural Fire Service (RFS) and Fire and Rescue NSW (FRNSW).

Secretary's Environmental Assessment Requirements (SEARs)		Addressed
	■ That the ERP details appropriate risk control measures that would need to be implemented to safely mitigate potential risks to the health and safety of the firefighters and first responders. ■ That two copies of the ERP be stored in an Emergency Information Cabinet located at the main entrance points ■ Once constructed and prior to operation, that the operator of the facility contacts the relevant Local Emergency Management Committee (LEMC).	
NSW Rural Fire Service	The NSW Rural Fire Service (RFS) identify that the land is partially mapped as bushfire prone land by Inverell Shire Council. The NSW RFS is the primary response agency for fighting fires within the site and surrounding locality.	Noted. The Inverell Shire Council Bushfire Prone Land mapping shows the eastern and southern portion of Lot 2 contains bushfire prone land (refer to Figure 2.1).
	The NSW RFS recommends that the project address following, having regard to the requirements of Planning for Bushfire Protection 2006: ■ Potential bushfire threats to the facility; ■ Potential hazards to fire fighters; ■ Management of bushfire (including grassfire) impacting on and structural fire emanating from the proposed solar farm and its associated infrastructure; ■ Fire fighting water supplies; ■ Vehicle access and defendable space around the solar array; ■ Land and vegetation management opportunities; and ■ Proposed emergency management procedures.	■ Potential bushfire threats to the facility are discussed in Section 3.6; ■ Potential hazards to fire fighters are discussed in Section 3.8; ■ Management of bushfire (including grassfire) are discussed in Section 4; ■ Fire fighting water supplies are discussed in Section 4.3.5; ■ Vehicle access and defendable space around the solar array are discussed in Section 4.1; and ■ Preparation of an Emergency Response Plan (ERP) is outlined in Section 4.3.3 and Section 0, and will include emergency management procedures.
	As part of any consent issued for the project, the NSW RFS will require the proponent to develop a Fire Management Plan in consultation with the local NSW RFS District Fire Control Centre.	Management and mitigation measures outlined in Section 4.3.3 and Section 4.4 include preparation of an Emergency Response Plan (ERP) in consultation with both NSW Rural Fire Service (RFS) and Fire and Rescue NSW (FRNSW).

3. BUSHFIRE HAZARD ASSESSMENT

The following steps were undertaken in the assessment process:

- determine whether the development area has been mapped as bushfire prone land and requires compliance with PBP 2018 (Figure 2.1);
- identify the assets within and surrounding the Project site requiring protection (Section 3.1);
- identify the bushfire risk factors such as bushfire history and known bushfire behaviour in the Project site and within the surrounding lands (Sections 3.2 to Section 3.7);
- map the bushfire hazard at a site specific scale following the relevant guidelines and compare with bushfire prone area mapping (Figure 2.1); and
- produce risk mitigation and management treatments and satisfy PBP 2018 requirements (Section 4).

3.1 IDENTIFICATION OF ASSETS

The Project is set amongst a historically cleared landscape where rolling hills dominate and the majority of native vegetation has been partially or fully cleared for grazing and cropping. However, patches of woodland and open forest remain along riparian corridors and within the undeveloped eastern portion of the property (outside of the Project site).

Assets within and surrounding the Project site are shown in Figure 3.1 and described in Table 3.1.

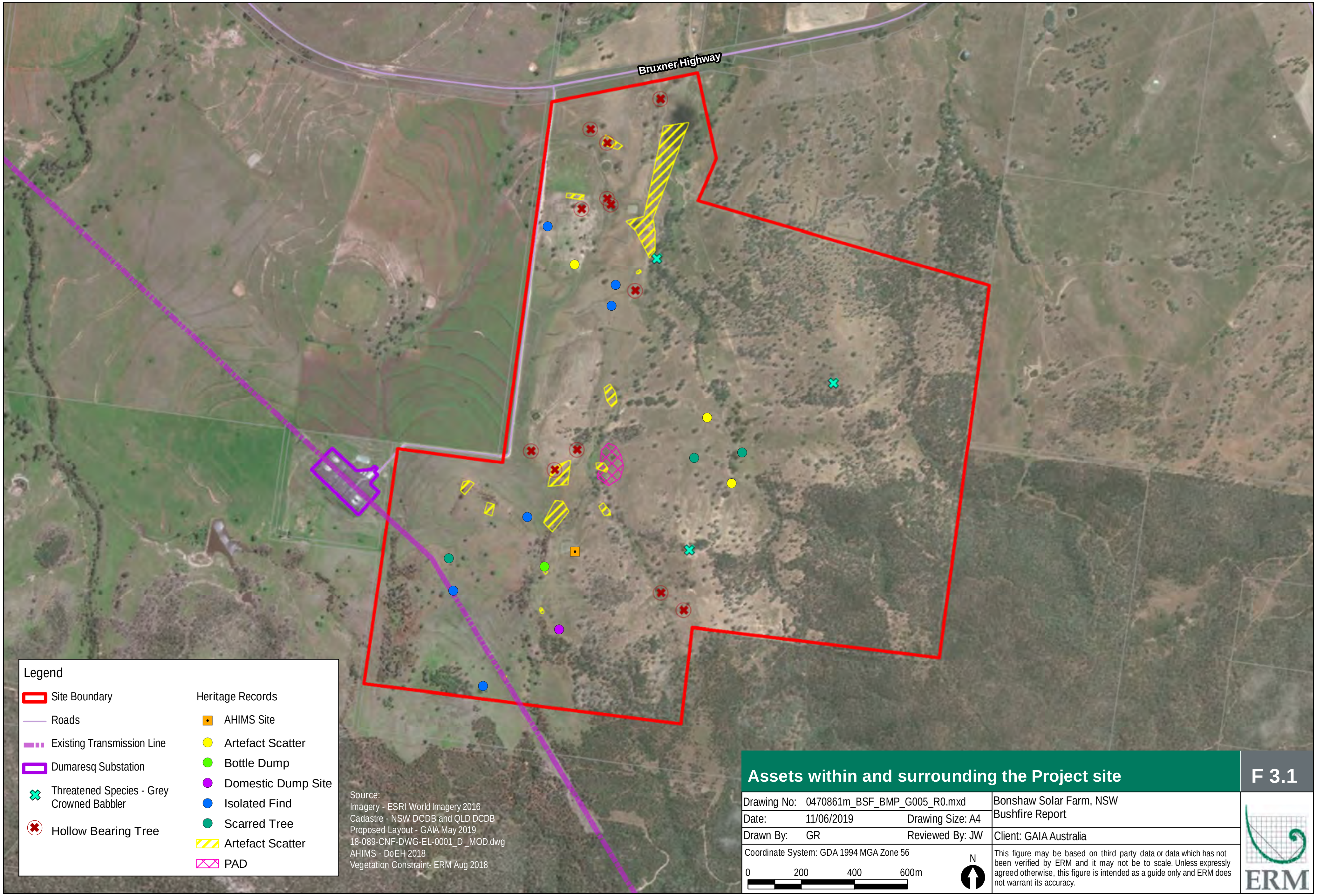
Table 3.1 Identification of Assets

Asset	Description
Assets Within The Project site	
Project Infrastructure (Figure 1.2)	Solar Farm Switching Station A new dedicated solar farm switching station will be built to connect the Project to the existing Dumaresq Substation. The switching station will be located within a fenced enclosure at the south-western boundary of the site. The switching station will comprise transformers, voltage switching equipment, metering, and protection and communications infrastructure. Inverter Building Inverters will convert direct current (DC) electricity generated by the Project to alternating current (AC) for reticulation around the site and connection to the electricity grid. Inverters will either be housed in shipping containers or skid mounted in an open-air configuration. Control Building, Car Park and Refuse Storage Area The control building and car park will be located close to the proposed substation in the south-west of the site. Photovoltaic (PV) Array The PV array will be the largest component of the Project. The array will comprise solar panels mounted on a supporting frame behind a non-reflective tempered glass layer. The height of the PV panels above natural ground is approximately 1.4 to 4.2 m based on tracker option to be used. The tracking system orients each panel towards the sun from the east in the morning through to the west in the afternoon. Following sunset, the Panels will “backtrack” to face east.

Asset	Description
	Individual PV panels are constructed using a "high-transmission, low-iron" glass which has lower reflectance than that of normal glass. A coating applied to the panel surface applies a stippled finish to further diffuse the reflected light and therefore energy.
Site Access	The Project site is located adjacent to the Bruxner Highway, which provides direct access to the proposed solar farm. The current project design provides one main entry/exit point to the Bruxner Highway to the north and an additional two access points on the western and southern boundaries of the site. The construction and maintenance of the Project will also require the construction of approximately 13.75km of private access roads within the Project site. The roads will provide ongoing access to the solar arrays and other project infrastructure. The internal access tracks will be up to 4.0 m in width with local widening in some areas to allow for turning radius of larger vehicles. The perimeter roads will be 6m wide and will form part of the required 10 m wide APZ The proposed road network is shown in Figure 1.2. *The majority of the proposed internal access roads are in areas identified as low bushfire hazard. There are some small sections of access roads in the southern and south-eastern portion of the Project site identified as high and medium bushfire hazard.*
Heritage	35 Aboriginal heritage sites (and three associated Potential Archaeological Deposits) have been recorded within the PA (ERM 2019b). 29 of these sites were stone artefacts including isolated finds and stone artefact scatters. Seven scarred trees were also identified. Careful detailed design of the Project footprint has successfully avoided several of these sites and they will be retained and protected from any direct and/or indirect impacts. A full description of heritage values is provided in the Bonshaw Solar Farm Heritage Assessment (ERM 2019b).
Biodiversity	Although the Project is set amongst a landscape where the majority of native vegetation has been partially or fully cleared for grazing, there are large patches of remnant vegetation and numerous other habitat values within and surrounding the Project site. Ground cover has been largely reduced due to heavy grazing practices and has been identified as a mixed of native and exotic grassland. Grazing (sheep) will continue across the Project site during operation of the solar farm. A full description of biodiversity values is provided in the Bonshaw Solar Farm Biodiversity Development Assessment Report (ERM 2019a). In summary, and with respect to assets requiring protection from bushfires, seven threatened fauna have been confirmed to occur within the Project site (refer to Table 4.2) and occur within the surrounding habitats.
Assets Surrounding The Project Site	
Substation	The 330 kV TransGrid Dumaresq Substation is located to the south-west of the proposed site with a 264 kV power lines running roughly in a south-easterly direction in the southern portion of the site.

Asset	Description
Residential Properties and Farms	The predominant land use in the proximity of the Project is rural landscape used for grazing and some cropping with natural waterways and vegetated ridgelines. The area to the north of the site between the Bruxner Highway and the Dumaresq River (which form the border between New South Wales and Queensland), is relatively flat land used for cropping and grazing, with some irrigation. Isolated farmsteads with associated out buildings and cattle yards are located in the area. There are 10 residential dwellings located within a 2km buffer of the proposed solar farm and are not directly involved with the Project. There are also farm sheds, shearing sheds, machinery sheds and a range of other structures associated with farming, scattered in the lands surrounding the Project site.
Nearest Towns and Localities	Small townships/localities are located in the broader region, which include Bonshaw (16 km north west), Ashford (23 km to the south west) and Dumaresq Valley (13 km to the east). In the 2016 census, Bonshaw had a population of 133 people, Ashford had a reported population of 652 people and Dumaresq Valley had a population of 49 people.
Public Roads	Access routes have been designed to achieve practical transport paths that minimise disruption to local traffic and environmental impacts.

Assets within and surrounding the Project site



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AHIMS - DoEH 2018
Vegetation Constraint- ERM Aug 2018

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Bonshaw Solar Farm, NSW
Bushfire Report

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Table 3.2 Threatened Species Recorded within the Project Area

Species	Conservation Status	Location within the Project site[1]	Vulnerability to bushfire[2]
Setirostris eleryi (Bristle-faced Free-tailed Bat)	EPBC Act: Not Listed BC Act: Endangered	Calls within the Project site were attributed to the Bristle-faced Free-tailed Bat with 'Definite' confidence. Knowledge of the ecology of this species is limited, however they are likely to utilise a variety of habitats across the Project site, including woodland habitats, tree hollows and adjacent cleared areas.	Frequent, high intensity fires may cause the degradation of roosting and foraging habitats and direct mortality of individuals and modification of habitat from fires is listed as a threat to this species. It is noted that mobile species such as bats are less likely to be impacted by bushfire as they are able to escape the direct impacts of flame and smoke.
Miniopterus schreibersii oceanensis (Eastern Bentwing-bat)	EPBC Act: Not Listed BC Act: Vulnerable	Calls within the Project site were attributed to the Eastern Bentwing-bat with 'Definite' confidence. Although the calls were not definitive, the Eastern Bentwing-bat may utilise a variety of habitats across the Project site, including woodland habitats and adjacent cleared areas.	Frequent, high intensity fires may cause the degradation of foraging habitats and hazard reduction and wildfire fires during the breeding season is listed as a threat to this species. It is noted that mobile species such as bats are less likely to be impacted by bushfire as they are able to escape the direct impacts of flame and smoke.
Chalinolobus picatus (Little Pied Bat)	EPBC Act: Not Listed BC Act: Vulnerable	Calls within the Project site were attributed to the Little Pied Bat with 'Definite' confidence. This species may utilise a variety of habitats across the Project site, including woodland habitats, tree hollows and adjacent cleared areas.	Frequent, high intensity fires may cause the degradation of roosting and foraging habitats and inappropriate fire regimes is listed as a threat to this species. It is noted that mobile species such as bats are less likely to be impacted by bushfire as they are able to escape the direct impacts of flame and smoke.
Nyctophilus corbeni (Corben's Long-eared Bat)	EPBC Act: Vulnerable BC Act: Vulnerable	Calls within the Project site were attributed to the Corben's Long-eared Bat with 'Definite' confidence. This species may utilise a variety of habitats across the Project site, including woodland habitats, tree hollows and adjacent cleared areas.	Frequent, high intensity fires may cause the degradation of roosting and foraging habitats and inappropriate fire regimes is listed as a threat to this species. It is noted that mobile species such as bats are less likely to be impacted by bushfire as they are able to escape the direct impacts of flame and smoke.
Vespadelus troughtoni (Eastern Cave Bat)	EPBC Act: Not Listed BC Act: Vulnerable	Calls within the Project site were attributed to the Eastern Cave Bat with 'Possible' confidence. This species may utilise a variety of habitats across the Project site, including woodland habitats and adjacent cleared areas.	Loss of suitable feeding habitat near roosting and maternity sites as a result of modifications from timber harvesting and inappropriate fire regimes usually associated with grazing is listed as a threat to this species. No roosting habitat has been recorded within the Project site.

Species	Conservation Status	Location within the Project site[1]	Vulnerability to bushfire[2]
Saccolaimus flaviventris (Yellow-bellied Sheath-tailed Bat)	EPBC Act: Not Listed BC Act: Vulnerable	Calls within the Project site were attributed to the Yellow-bellied Sheath-tailed Bat with 'Possible' confidence. This species may utilise a variety of habitats across the Project site, including woodland habitats, tree hollows and adjacent cleared areas.	Frequent, high intensity fires may cause the degradation of roosting and foraging habitats and inappropriate fire regimes is listed as a threat to this species. It is noted that mobile species such as bats are less likely to be impacted by bushfire as they are able to escape the direct impacts of flame and smoke.
Falsistrellus tasmaniensis (Eastern Falsistrelle)	EPBC Act: Not Listed BC Act: Vulnerable	Calls within the Project site were attributed to the Eastern Falsistrelle with 'Possible' confidence and it is likely that these calls represent variants of *Scotorepens greyii* (Little Broad-nosed Bat). This species, if present, may utilise a variety of habitats across the Project site, including woodland habitats, tree hollows and adjacent cleared areas.	Frequent, high intensity fires may cause the degradation of roosting and foraging habitats and loss of roosting habitat is listed as a threat to this species. It is noted that mobile species such as bats are less likely to be impacted by bushfire as they are able to escape the direct impacts of flame and smoke.
Chalinolobus nigrogriseus (Hoary Wattled Bat)	EPBC Act: Not Listed BC Act: Vulnerable	Calls within the Project site were attributed to the Hoary Wattled Bat with 'Possible' confidence and it is likely that these calls represent variants of *Scotorepens greyii* (Little Broad-nosed Bat). This species, if present, may utilise a variety of habitats across the Project site, including woodland habitats, tree hollows and adjacent cleared areas.	Frequent, high intensity fires may cause the degradation of roosting and foraging habitats and inappropriate fire regimes is listed as a threat to this species. It is noted that mobile species such as bats are less likely to be impacted by bushfire as they are able to escape the direct impacts of flame and smoke.
Grey-crowned Babbler	EPBC Act: Not Listed BC Act: Vulnerable	A breeding population of this species has been recorded across the Project site and has been observed nesting and foraging within the woodland habitats.	Inappropriate fire regimes is listed as a threatening process for this species. Excessive fires lead to loss of tree and shrub regeneration and absence of fire may lead to the grass sward being too dense and therefore unsuitable for foraging by babblers.

1. Refer to *Bonshaw Solar Farm Biodiversity Development Assessment Report* (ERM 2019a) for more detail on the habitat requirements and confirmed records of these species.
2. *NSW OEH (2019) Threatened Species Profiles.* https://www.environment.nsw.gov.au/threatenedSpeciesApp/

3.2 Regional fire weather

As reported by BFMC (2011), the typical/average climate in the Northern Tablelands is consistent with a Temperate Zone (warm summer, cool winter). Autumn and spring are the most comfortable seasons in most parts. The weather is more changeable than in the tropics, with cool cloudy days alternating with warmth and sunshine. Rain falls occasionally but doesn't usually last very long and the bushfire season generally runs from August to March annually.

Prevailing weather conditions associated with the bushfire season in the Northern Tablelands BFMC area are north-westerly winds accompanied by high daytime temperatures and low relative humidity. Dry lightning storms occur frequently during the bushfire season (BFMC 2011).

Data from the Bureau of Meteorology weather station at Pindari Dam, which is 4 km from the solar farm site, confirms that both low humidity and high temperature occur within the bushfire season and would contribute to the fire hazard within this region.

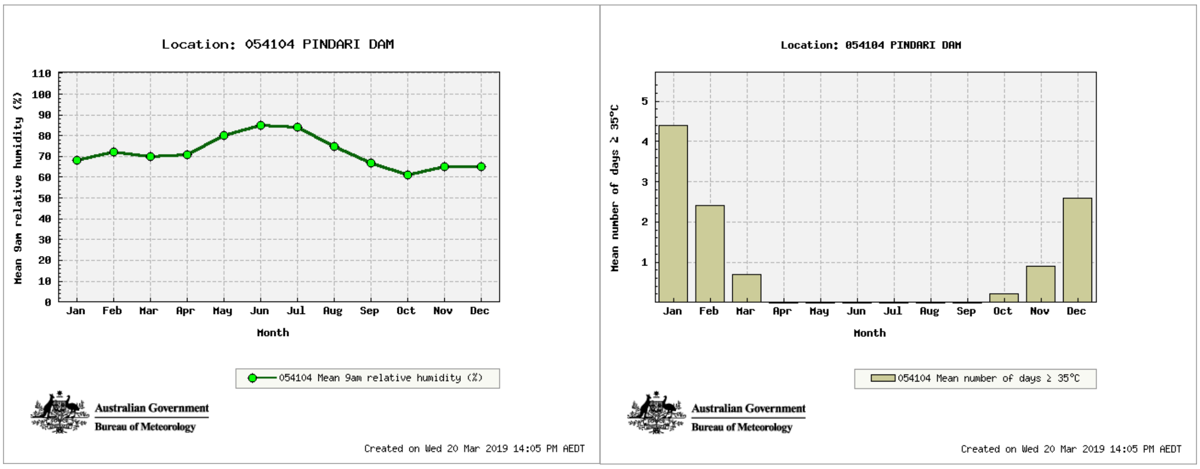


Figure 3.2 - Low humidity and high temperature within the bushfire season (BOM 2019)

Data from the Bureau of Meteorology weather station at Pindari Dam indicates that north westerly winds are uncommon within the region, with strong north easterly winds being more common during the bushfire season (refer to Figure 3.3).

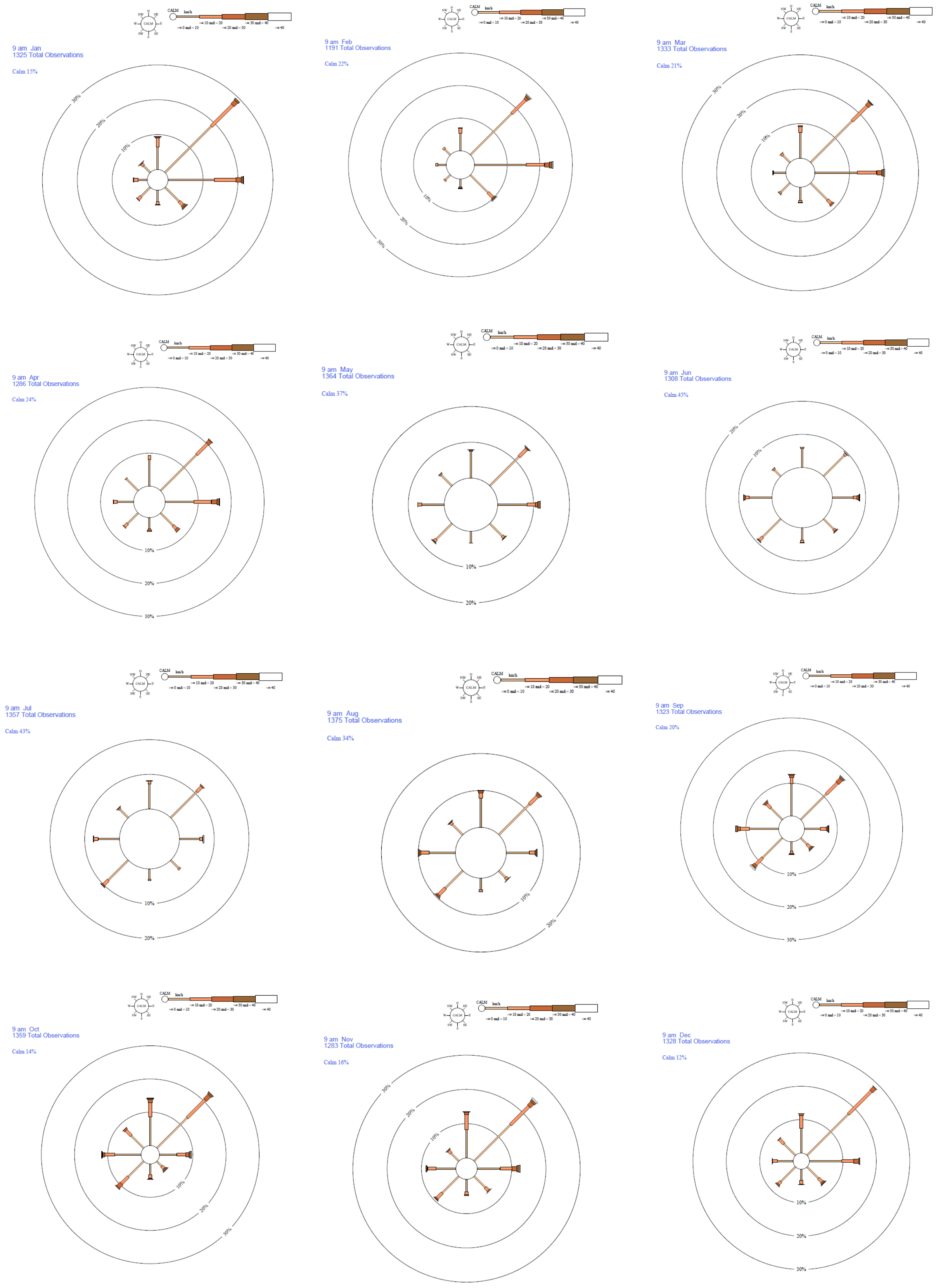


Figure 3.3 –Monthly Wind direction versus Wind speed (km/h), Pindari Dam 1971-2018 (BOM 2019)

3.3 Vegetation

The vegetation of the Project site is typical of an agricultural landscape of the Northern Tablelands region of NSW. Generally, the vegetation is a combination of grasslands (both native and non-native pastures) with scattered patches (or 'islands') of woodland (refer to Figure 3.4). The Project site is comprised of 35% native vegetation types and 65% non-native or highly disturbed vegetation types and other land covers (dams and watercourses).

Descriptions of the vegetation types including species composition and structural diversity is provided in the Bonshaw Solar Farm Biodiversity Development Assessment Report (ERM 2019a).

The vegetation has been simplified in line with the vegetation formations as per Keith (2004). The vegetation types have been classified into fuel groups using the following parameters:

- frequency that the vegetation provides 'available fire fuel';
- structure of the vegetation and the ability of ground level fuels to carry fire into higher vegetation levels eg. from understorey into crown fire;
- arrangement of the fuel within the vegetation type, eg fine fuels that are elevated, such as in heath, contribute more to fire intensity than a similar quantity of leaf litter fuel; and
- amount of fuel that accumulates after a long period without fire.

Table 3.3 Description and Characteristics of Fuel Groups

Bushfire Fuel Group	***Characteristics***	**Plant Community Type *within the Project Area***	**Keith Formation (2004)**
High	Continuous fuels, higher quantity, available to burn during average seasons (higher fire intensity expected e.g. woodland and forest fuels).	PCT 594_Moderate	Dry Sclerophyll Forests (Shrub/grass sub-formation)
		PCT 596_Moderate	Dry Sclerophyll Forests (Shrub/grass sub-formation)
		PCT 516_Moderate	Grassy Woodlands
Medium	Less continuous fuels, medium level quantity, available to burn during average seasons but may be less often than high (medium or high fire intensity expected).	PCT 594_Low	Grassy Woodlands
		PCT 596_Low	Grassy Woodlands
		PCT 516_Low	Grassy Woodlands
		PCT 596_Very Low	Native Grassland
		PCT 516_Very Low	Native Grassland
		PCT 516_Derived	Native Grassland
		PCT 596_Derived	Native Grassland
Low	Possibly discontinuous fuels, low-medium fuel quantity, moister fuels unlikely to contribute to high intensity fires in average season, fuel structure facilitates easier control, (fire intensities expected range from low-high and generally regarded as easier to control e.g. moist and wet forests).	PCT 516_Disturbed Grassland	Disturbed Grassland
		PCT 594_Disturbed Grassland	Disturbed Grassland
		PCT 596_Disturbed Grassland	Disturbed Grassland
Minimal	Unlikely to burn or always burn within controllable limits.	Farm Dams	N/A

The risk of a grassfire should not be underestimated within the Project site. The areas of moderate quality native grassland have been given a Medium classification compared to the areas of heavily grazed low quality grasslands (Low). The difference in spread rate between a fire in the heavily grazed pasture and areas of native grassland is only about 20%, although the native grasslands will generally have taller flames that may burn across tracks or firebreaks (Bradstock et al 2012) attributing it to the higher classification in Table 3.3 above.

3.4 Slope

Steeper slopes can also significantly increase the rate of spread of fires, and the relationship of the steepness of slope, and whether a fire moves upslope or downslope, is vital to understanding bushfire behaviour potential. Slope and wind are often the major factors determining the direction of fire spread.

The Project site is dominated by a gently undulating landscape to the north, forming steep slopes to the south and east dissected by second and third order streams. Based on a review of topographic maps and aerial imagery, landforms present within the Project site include drainage depressions, gentle to steeply inclining slopes, and upper flat ridges. The elevation at the Bruxner Highway (north boundary) is approximately 335 m and rises up to approximately 420 m in the south-western portion of the site. The ridgelines to the south of the project rise up to approximately 660 m forming the dominant landscape feature.

The slope map is included as Figure 3.5.

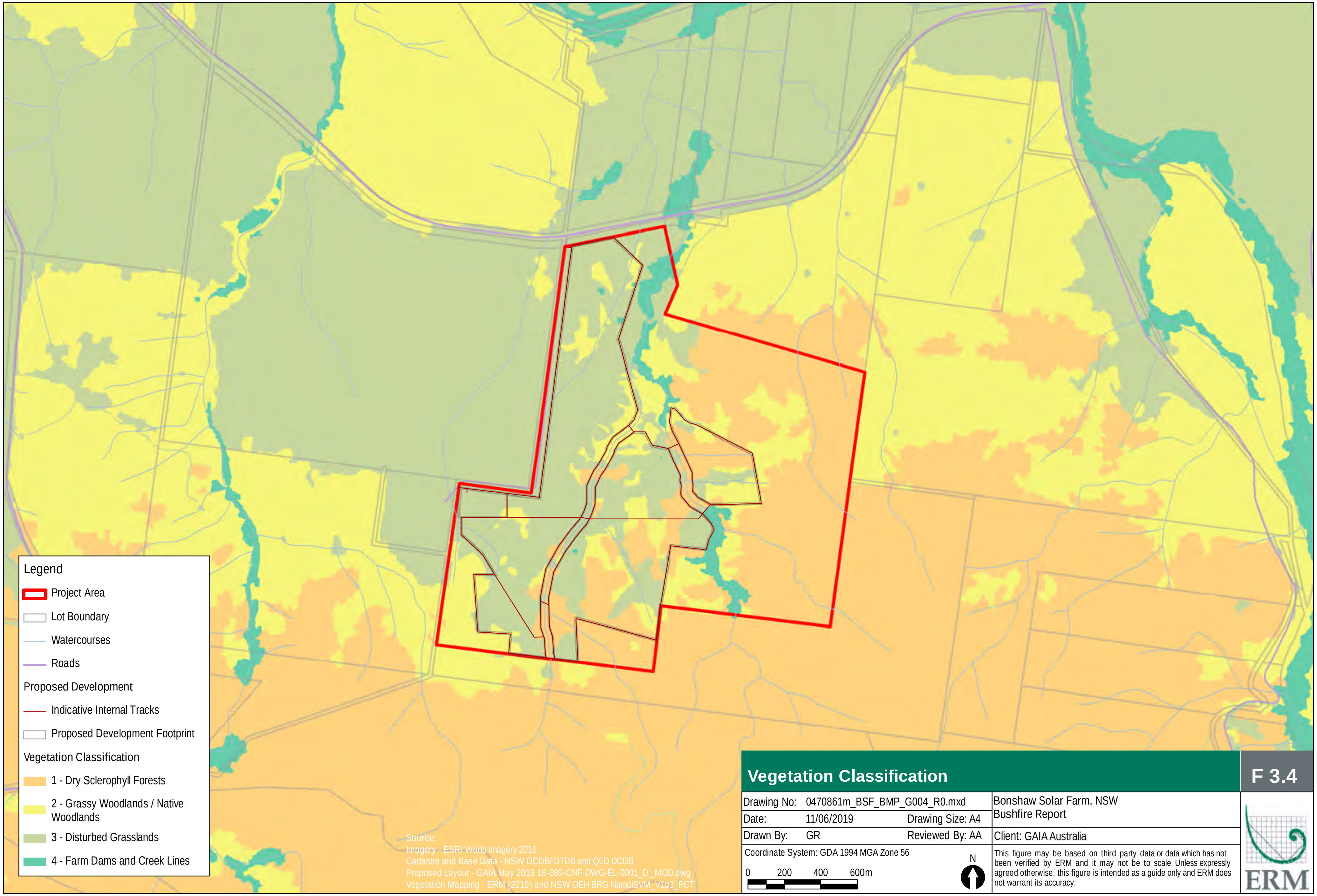
3.5 Fire behaviour potential

Bushfire hazard classes were identified across the landscape by applying relative weightings to the varying fuel groups (refer Table 3.3) and combining them with available slope classes (ie 0-5°, 5-10°, 10-15°, >15°) within a Geographic Information System (GIS) model. The vegetation fuel load and slope data sets were loaded into a Weighted Overlay Model, to combine the data and highlight areas of overall higher hazard considering both fuel load and slope. Slope was calculated in degrees and bushfire hazard rating based on steepness and movement speeds of potential bushfire up or down these slopes. The model assumed in this case that both slope and fuel load were equally important or weighted the same in the analysis process.

The result is a Risk Assessment Overlay that identifies overall bushfire hazard classes for the entire Project site (refer to Figure 3.6*)*. This analysis does not indicate how often an area will receive potentially damaging fires or the actual intensity of a fire, it does however, provide a useful comparative ranking, identifying sites of higher and lower potential fire behaviour compared to others in an area.

Based on the information provided in the fire weather and fire hazard analysis above, the greatest hazard is a combination of undesirable fire weather (ie hot and dry winds and low humidity during summer) and the potential for a fire to spread towards farm assets in the surrounding area. Strong north easterly winds are common during the bushfire season in this region (based on BOM data from the nearby Pindari Dam) and would quickly carry a bushfire or grassfire from surrounding properties towards the solar farm assets. A fire under the influence of wind may travel very fast, reaching assets before fire fighters can attend the scene.

Grassfires should not be under estimated and can start and spread quickly. They can travel up to 25 km per hour and pulse even faster over short distances. As described by Bradstock et al (2012), grass is a fine, high surface area to volume ratio fuel with high thermal conductivity, low density and vertical orientation, which rapidly ignites (and rapidly burns out). Grassfires are also generally more open to wind than forest fuels (Cheney and Sullivan 2008) making them unpredictable. Grassfires tend to be less intense and produce fewer embers than bushfires, but still generate enormous amounts of radiant heat. Grassfires can also start earlier in the day than bushfires, because grass dries out more quickly when temperatures are high and humidity is low.



Source:
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Cadastre and Base Data - NSW DCDB/ DTDB and QLD DCDB
Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg
Vegetation Mapping - ERM (2019) and NSW OEH BRG NamoiSVM_V1p3_PCT

Vegetation Classification

F 3.4

Drawing No: 0470861m_BSF_BMP_G004_R0.mxd
Date: 11/06/2019 Drawing Size: A4
Drawn By: GR Reviewed By: AA
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW
Bushfire Report

Client: GAIA Australia

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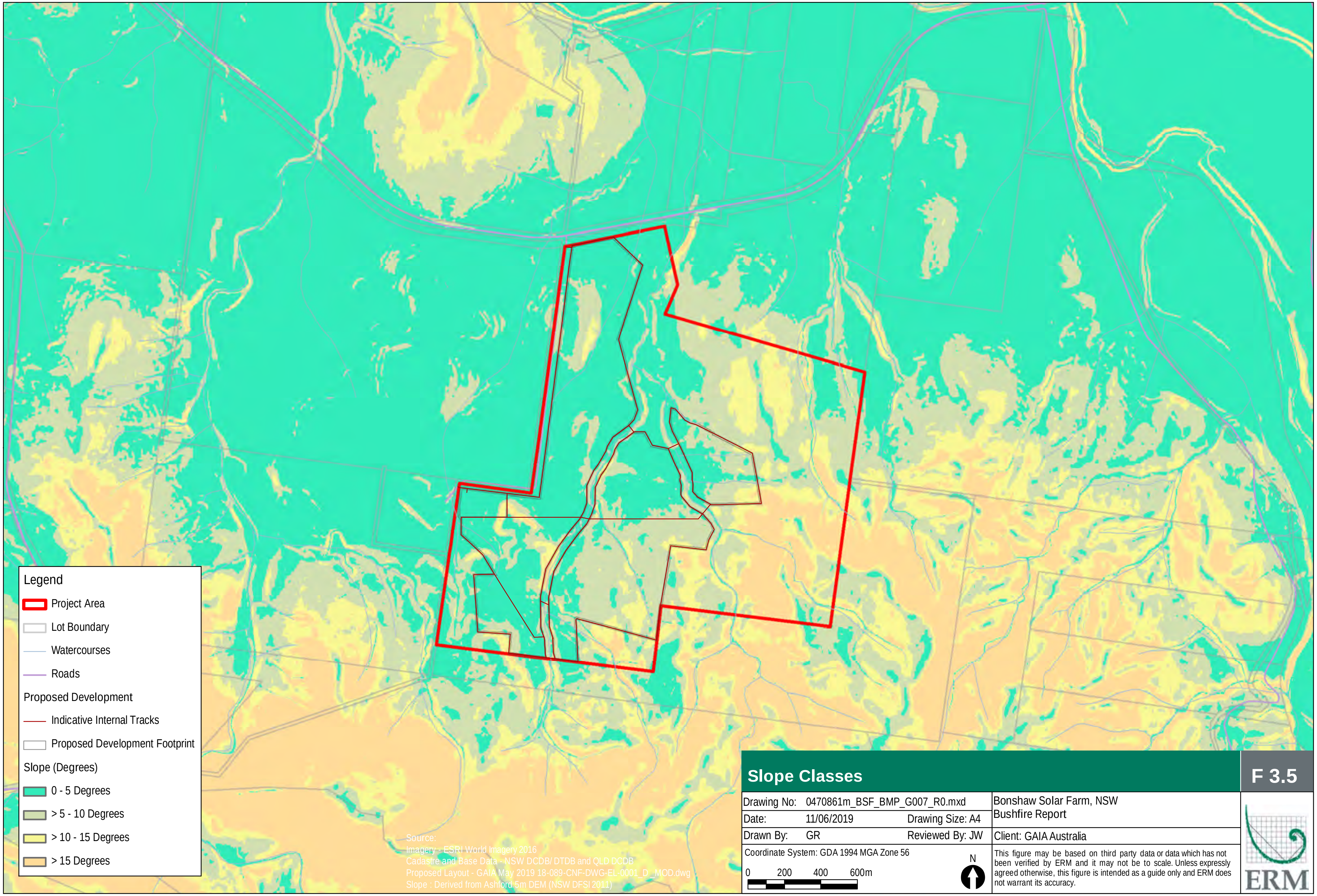

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Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg
Slope : Derived from Ashford 5m DEM (NSW DFSI 2011)

Slope Classes

F 3.5

Drawing No: 0470861m_BSF_BMP_G007_R0.mxd
Date: 11/06/2019 Drawing Size: A4
Drawn By: GR Reviewed By: JW
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW
Bushfire Report

Client: GAIA Australia

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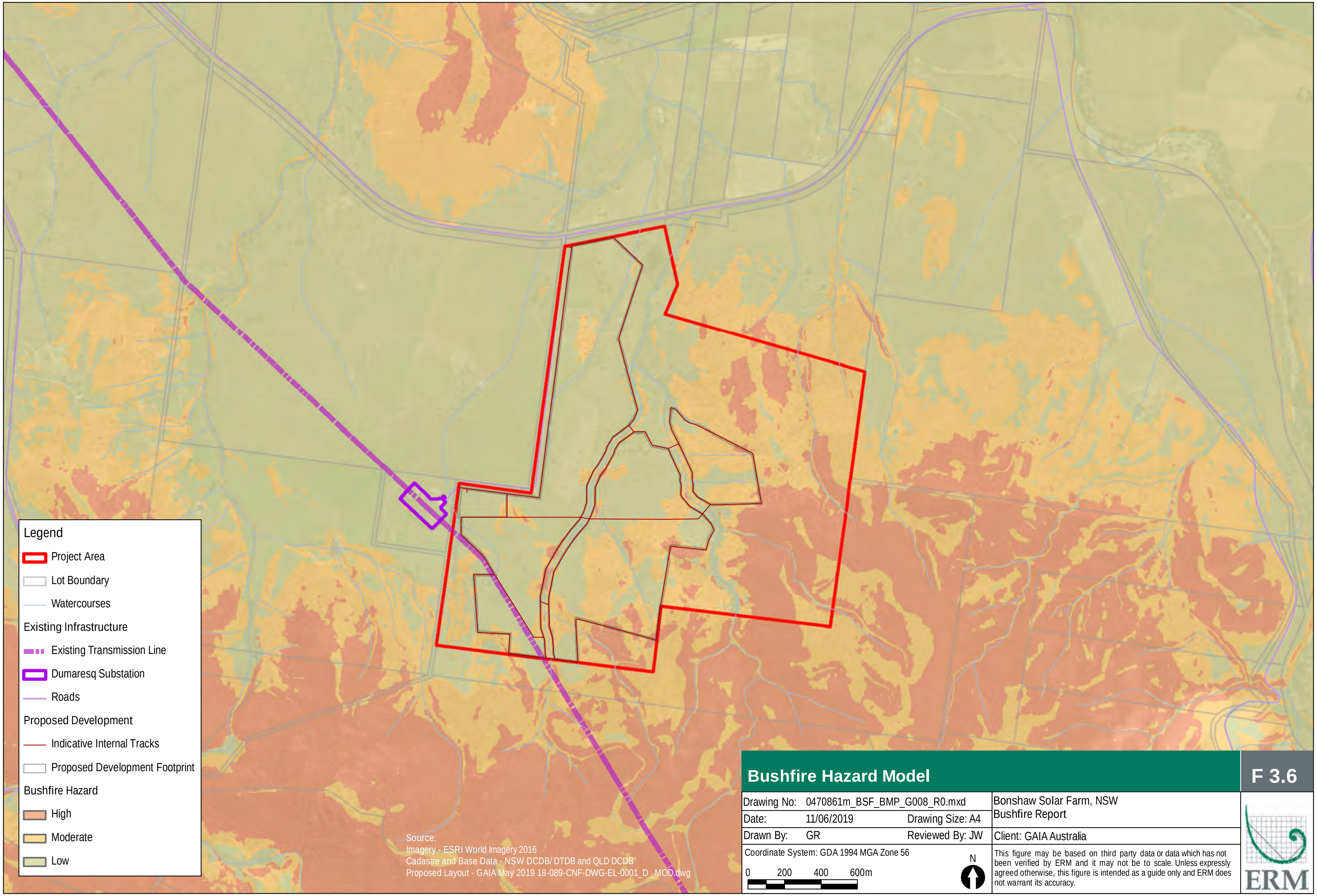

Source:
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Bushfire Hazard Model

F 3.6

Drawing No: 0470861m_BSF_BMP_G008_R0.mxd
Date: 11/06/2019 Drawing Size: A4
Drawn By: GR Reviewed By: JW
Coordinate System: GDA 1994 MGA Zone 56

Bonshaw Solar Farm, NSW
Bushfire Report
Client: GAIA Australia

The difference in spread rate between a fire in the heavily grazed pasture and areas of native grassland is only about 20%, although the native grasslands will generally have taller flames that may burn across tracks or firebreaks (Bradstock et al 2012). Under the most extreme weather, a fire could spread between and under solar panels even in the heavily grazed grass and embers may breach any fire break. Therefore, the asset protection zones recommended may only be reliable up to Very High fire danger.

3.6 Fire ignitions

The Northern Tablelands BFMC area has on average 170 bushfires per year, of which five on average can be considered to be major fires. The main sources of ignition in the Northern Tablelands BFMC area are escaped private burns and occasional lightning strike fires (BFMC 2011).

There are no publically available ignition occurrence records for the site or nearby that provide statistical validity or a guide to likelihood of nearby ignition.

3.6.1 Construction (and decommissioning)

Earth moving equipment, power tools (e.g. welders, grinders), mowers and slashers are well known for starting bushfires under conditions of high temperature, low humidity and high wind. Activities associated with solar farm construction that may cause or increase the risk of bushfire include:

- Site maintenance activities such as mowing, slashing and using other petrol-powered tools.
- Hot works, including welding and soldering activities.
- Operating a petrol, LPG or diesel vehicle in grassland areas.
- Operating plant fitted with power hydraulics in grassland areas.
- Smoking and disposal of cigarettes on site.

Construction and ongoing maintenance of the solar farm will be a potential source of ignitions, with a greater risk within the declared fire danger period (typically from August to March). Site access would be formalised at the beginning of the construction stage, which would increase the ability to access and suppress any fire onsite or on adjoining sites.

The bushfire hazard associated with the construction activities listed above is considered manageable and would be minimised through the implementation of fire and bushfire mitigation measures outlined in Section 4, including the preparation of an emergency response plan.

Any bushfire risk associated with decommissioning of the project would be similar the construction phase and would be subject to the same management and mitigation measures.

3.6.2 Operation

Repairs and maintenance activities during operation could also increase bushfire risk.

GAIA have confirmed the following information regarding the fire risk for the PV panels:

- *All electrical components are required to be manufactured in material that does not allow self-combustion and ignition and should self-extinguish. In addition, the electrical equipment is fitted with over current protection devices and isolation switches along with earth leakage protection devices as standard components.*
- *The PV panels will be made of tempered glass with aluminium frames. GAIA have also advised that the solar panels to be used meet the IEC 61730 and UL1703 (Type 1) fire resistance test standards under fire conditions.*
- *It is intended that the vegetation fuel under and between the PV panels will be maintained in a low fuel state by sheep grazing and other land management activities such as mowing and application of pesticides. It is recognised that a fire could still spread in this fuel under severe fire weather conditions.*

- *The likelihood of a fire spreading within the area of the proposed PV panels, by propagating from panel to panel in a solar farm installation, is difficult to assess as no fire history within a solar farm was found from within Australia. GAIA have confirmed that solar panels are non-reflective and present no risk of ignitions from concentrated solar energy. All electrical LV and MV components are in enclosures that will contain any arcing should a fault occur.*
- *The risk of a fire spreading widely from panel to panel is likely to be very low because of the panel construction materials (i.e. fire resistance rating) and the time of flame exposure to initiate these materials.*

The level of risk from faults cannot be assessed at this stage because there is no case history available and it is not possible to compare the ignition risk from existing farm operations (e.g. grazing) relative to solar farm operation.

An Asset Protection Zone of 10 m will be maintained around all buildings at the site including the solar farm substation, inverters, control building and external perimeter of the PV arrays throughout the operational phase of the project. It is anticipated that TransGrid would continue maintain their adjacent substation infrastructure to minimise bushfire ignition risks.

The perimeter road will be 6m wide (located within the 10m wide perimeter APZ), with internal access tracks a minimum of 4 m wide allowing adequate access for emergency vehicles including fire trucks.

3.7 Fire history

No fire history is available from the Project Area itself although large scale fires are known to occur within the Northern Tableland Region. A review of the RFS Fire History Mapping available via SEED maps shows three major fires within the past 10 years (refer to Figure 3.7):

- Black Creek and Granite Creek fires burnt 23391 ha in 2009/2010;
- South Valley Road fire burnt 1328 ha in 2009/2010; and
- Emmaville Road fire burnt 4555 ha in 2012/2013.

3.8 Fire-fighter and public safety

The usage of the general area surrounding the site is mostly limited to landowners.

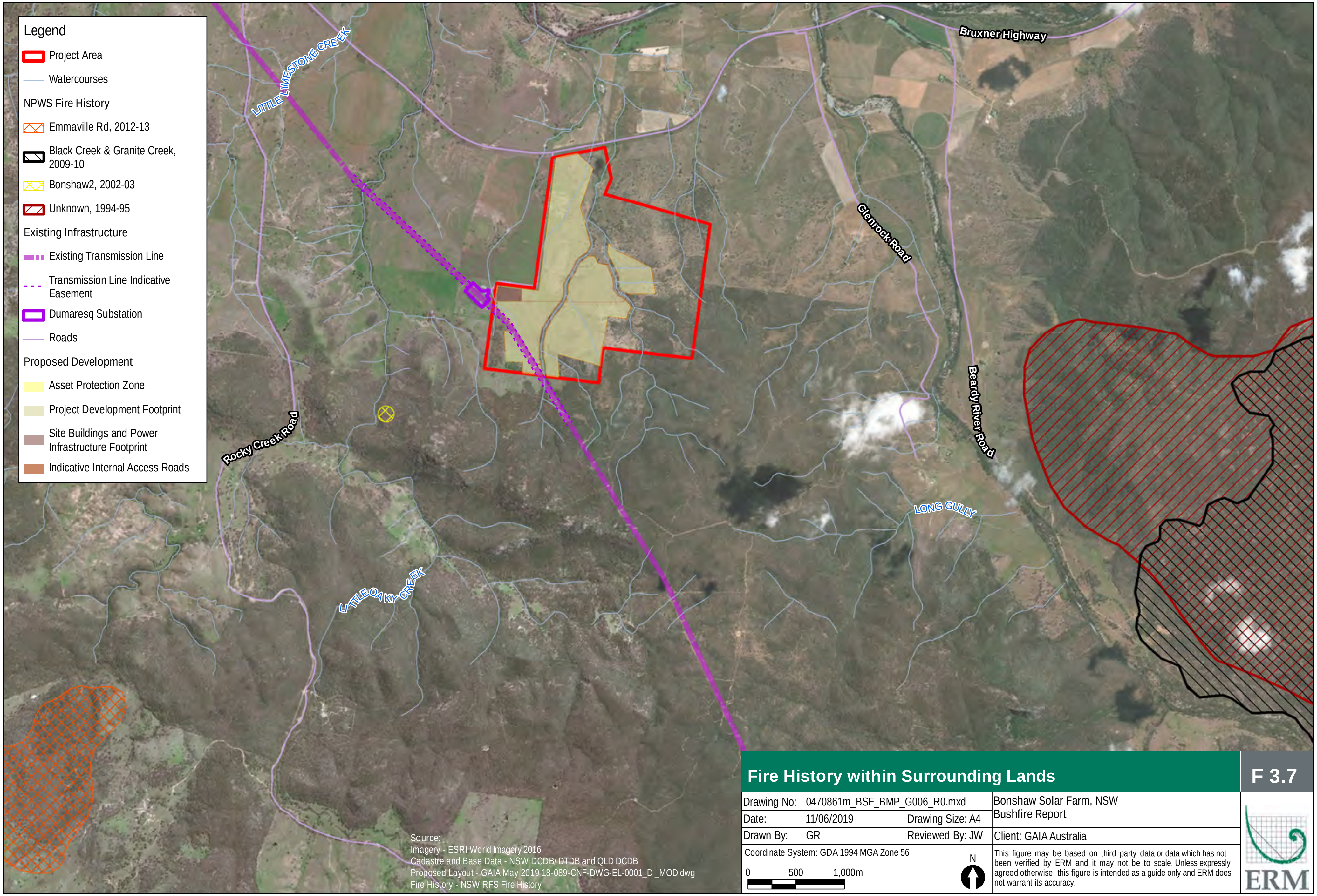
The fire-fighters likely to respond to a bushfire in this area would be volunteers from the NSW Rural Fire Service and or individual property owners. Brigades from NSW Fire and Rescue could also respond.

The risks to fire-fighter safety associated with a fire burning the solar panels and associated equipment include:

- electrocution – solar panels would be energised under any natural or artificial light conditions. Isolation and shut down procedures in the case of a fire or other emergency are a key safety risk and must be included in the Emergency Response Plan;
- safe use of water spray or foam application is likely only possible from the perimeter of the solar arrays and would not reach the 250 plus m required to reach the centre of the arrays; and
- inhalation of fumes and smoke from any plastic components such as cables (although the main structure of the panels will be tempered glass and aluminium).

The materials for individual components within the solar farm infrastructure have not yet been finalised, therefore, the flammability and toxicity of burning components have not been determined in detail although this information will form part of the Emergency Response Plan that will be development prior to construction.

Any volunteer fire-fighters from the NSW Rural Fire Service, NSW Fire and Rescue or property owners from neighbouring farms attending bushfires in this area may not be trained in structural and electrical fire-fighting. The Emergency Response Plan will detail appropriate risk control measures that would need to be implemented to safely mitigate potential risks to the health and safety of the firefighters and first responders. At least two copies of the ERP will be stored in an Emergency Information Cabinet located at the main entrance point and must be accessible to all first responders. Two copies of the ERP will also be stored within the operations facilities.



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Proposed Layout - GAIA May 2019 18-089-CNF-DWG-EL-0001_D _MOD.dwg
Fire History - NSW RFS Fire History

Fire History within Surrounding Lands

F 3.7

Drawing No: 0470861m_BSF_BMP_G006_R0.mxd		Bonshaw Solar Farm, NSW Bushfire Report
Date: 11/06/2019	Drawing Size: A4	
Drawn By: GR	Reviewed By: JW	Client: GAIA Australia

Coordinate System: GDA 1994 MGA Zone 56

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4. MITIGATION STRATEGIES

Consideration is given to whether the proposed Solar Farm will result in people congregating in large numbers. The operation of the proposed Solar Farm is considered to be a low intensity use in terms of the number of people on site at any one time, with only 10 full time staff on site during the operational phase. However, there could be up to 190 people on site during construction phase over a period of up to 52 weeks. Although the construction period does not pertain to the expected end use of the Project site, the number of people who could be on Site at one time does warrant consideration in terms of providing adequate defendable space and access as the first stage of construction.

Mitigation strategies are guided by the following factors that contribute to bushfire risk:

- Fuels, weather, topography and predicted fire behaviour;
- Suppression resources (air and ground), access (roads, tracks) and water supply; and
- Values and assets

Mitigation must be a combination of complementary strategies, all of which are required to provide the best possible protection outcome for the solar farm and the community.

4.1 Asset Protection Zone

An Asset Protection Zone (APZ) is typically designed to separate a vulnerable asset from the bushfire hazard (vegetation/fuel). APZs do not eliminate the fire risk, but may lower it to an extent where fire control is more feasible or damage to the asset is reduced or eliminated.

Understanding the value and limitations of APZ is important, and as is the understanding that bushfires attack built assets by either flame contact, radiant heat or burning debris. An APZ can be used to lower or eliminate the bushfire attack from flame contact and radiant heat around the perimeter of the solar farm and all built assets, but under strong winds or during a major fire event burning debris can result in a fire breaching an APZ to ignite grassy fuel within the solar farm itself. A fire emanating from the PV panels may also jump the APZ by burning debris under similar conditions.

Despite the limitations of any APZ it is recommended that a minimum 10m wide APZ be established around the perimeter of the solar farm and around the solar farm substation, inverter building and control building. A 6m wide APZ is provided to the riparian corridors which run through the centre of the project footprint.

A 10m wide APZ is also consistent with the requirements of the Victorian CFA renewable energy guidelines (CFA 2018) which require that all containers/infrastructure for battery installations must be clear of vegetation for 10m on all sides and that a fire break area of 10m width is to be maintained around the perimeter of the facilities, electricity compounds and substations.

The specifications recommended for the APZ are as follows:

- mineral earth fire break i.e. dirt or gravel.
- no trees and shrubs planted within the APZ.
- 6m wide perimeter access track and external fence can be located within this 10m wide APZ.

The planting of any trees and shrubs for visual screening on the external side of the APZ will increase the risk of burning embers from an external fire entering the solar farm. The following measures will mitigate the risk of planted or remnant trees carrying embers into the solar farm:

- use species suitable for the environment that have low fire spotting characteristics (e.g. smooth bark); and
- where possible, increase the distance between the trees and the APZ.

4.2 Solar farm construction

Should construction of the solar farm take place between 1 December and 31 March (increased fire weather), the following measures are recommended to control the risk of grass fire ignitions:

- Ensure that appropriate permits have been issued for work during the Fire Danger Period, and that any conditions on permits are adhered to;
- Adhere to restrictions on Total Fire Ban or days of high fire danger;
- Carry fire extinguishers or firefighting equipment in vehicles;
- Carry emergency communications equipment;
- Ensure vehicles keep to tracks whenever possible;
- Restrict smoking to prescribed areas, and provide suitable ash and butt disposal facilities;
- the APZ and perimeter road must be constructed as the first stage of development;
- all plant, vehicles and earth moving machinery are cleaned of any accumulated flammable material (e.g. soil and vegetation);
- suitable fire fighting equipment (specific requirements to be confirmed in consultation with RFS) is present on site with at least two personnel trained in bushfire fighting;
- on days when Very High fire danger or worse is forecast, the “fires near me’ app is to be checked hourly for the occurrence of any fires likely to threaten the site; and
- all operations involving earth moving equipment, vehicles, slashers and hot works (e.g. grinders, welders) cease while the Grassfire Danger Index (GFDI) is or forecast to be 35 or greater (Rural Fire Service 2018).

4.3 Solar farm ongoing operations

4.3.1 Fuel management within solar farm

It is assumed that a grass fire may start and spread within the footprint of the solar farm. Ignitions could include lightning fires, human error or electrical faults. For this reason, it is recommended that vegetation fuels internal to the APZ and throughout the solar farm are maintained in a minimal condition by grazing, slashing or mowing. This will minimise the radiant heat exposure to solar farm components and reduce the risk of a fire spreading beyond the solar farm.

In 2018, Parkes Solar Farm in NSW undertook a three week trial using sheep to manage grass fire hazards on solar farms. The sheep were monitored closely throughout the trial period, and toward the end of the trial all of the sheep were observed to be relaxed, eating and moving freely around the 15 hectares block. By the end of the trial, all of the grass had been eaten to a reasonable length (not less than 50mm) and the hazard reduction was determined a complete success (https://crystalbrookenergypark.com.au/wp-content/uploads/2019/01/Attachment-F-Sheep-Trial-Parkes-1.pdf). Continued grazing is recommended within the Bonshaw Project site to ensure that grass is maintained below 100mm high.

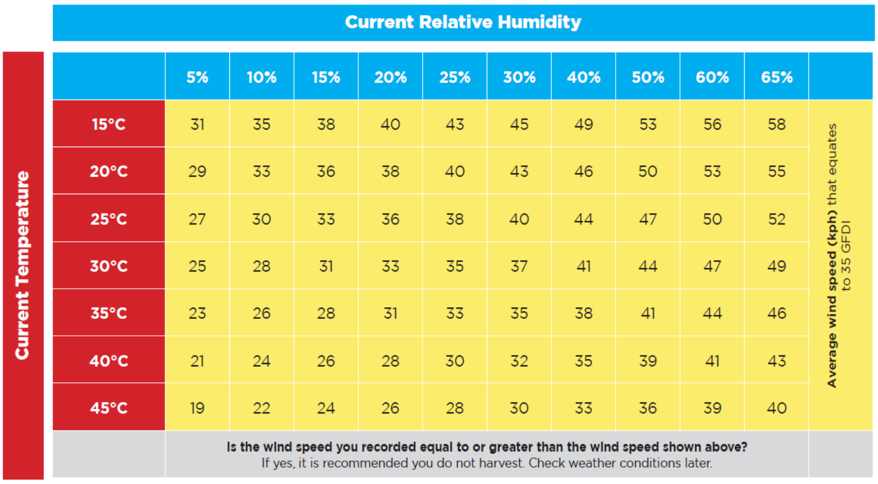
4.3.2 Days of Very High or worse fire danger

Fire Danger Ratings give you an indication of the consequences of a fire, if one was to start. The higher the fire danger, the more dangerous the conditions. These forecasts are updated daily during the fire danger season and are available on the RFS website (http://www.rfs.nsw.gov.au/fire-information/fdr-and-tobans) and the BOM website (http://www.bom.gov.au/nsw/forecasts/fire-danger-ratings.shtml).

To reduce the risk of fires damaging or destroying life, property and the environment the NSW RFS Commissioner may also declare a Total Fire Ban (TOBAN). In a Total Fire Ban no fire may be lit in the open and all fire permits are suspended. No general purpose welding, grinding, soldering or gas cutting can be done in the open.

To minimise the risk of grass fire ignitions, all operations on the site involving earth moving equipment, vehicles, slashers and hot works (e.g. grinders, welders) should cease while the Fire Danger rating is Very High or when the GFDI is or forecast to be 35 or greater. This will require establishing an operational procedure for onsite recording of temperature, relative humidity and wind speed, as well as associated training.

For example, if the temperature is 35ºC, the relative humidity is 14% (round down to 10%) then high risk activities must stop when the average wind speed is greater than 26km/hr.



Current Relative Humidity

Current Temperature

	5%	10%	15%	20%	25%	30%	40%	50%	60%	65%
15°C	31	35	38	40	43	45	49	53	56	58
20°C	29	33	36	38	40	43	46	50	53	55
25°C	27	30	33	36	38	40	44	47	50	52
30°C	25	28	31	33	35	37	41	44	47	49
35°C	23	26	28	31	33	35	38	41	44	46
40°C	21	24	26	28	30	32	35	39	41	43
45°C	19	22	24	26	28	30	33	36	39	40

Average wind speed (kph) that equates to 35 GFDI

Is the wind speed you recorded equal to or greater than the wind speed shown above?
If yes, it is recommended you do not harvest. Check weather conditions later.

4.3.3 Fire-fighter safety

The safety hazards for fire-fighters from PV panels (Section 3.8) and local fire-fighting capability are such that fire suppression within the footprint of the solar farm cannot be expected or relied upon. The only exception to this would be aerial water bombing that is compliant with air operations safety procedures; however, these resources may not be available at short notice for a fire that could spread quickly under strong winds. Fire suppression is most likely only to be feasible from the APZ and perimeter road system or beyond.

Given the possible toxicity of smoke from burning solar farm components, fire-fighters, farm workers and neighbours should avoid working down wind of any fire burning within the solar farm.

Given these safety concerns for fire-fighters, it is not recommended that fire-fighting equipment for fire-fighters be located permanently on site unless directed to by NSW RFS because such equipment may not be utilised safely or effectively.

An Emergency Response Plan (ERP) should be prepared for the solar farm that provides the following:

- a safe method of shutting down and isolating the PV system;
- control and coordination arrangements for emergency response (eg evacuation procedures, emergency assembly areas and procedures for response to hazards);
- agreed roles and responsibilities of on-site personnel (eg equipment isolation, liaison, evacuation management);
- up-to-date contact details of site personnel and any relevant off-site personnel who could provide technical support during an emergency;

- a manifest (and safety data sheets) for any battery, diesel or other dangerous goods storage/handling, including the class identification, quantity, type (bulk or packaged) and location. Appropriate material (including absorbent, neutralisers, equipment and personal protective equipment) for the clean-up of spills is to be provided and available on-site;
- clearly states work health safety risks and procedures to be followed by fire-fighters, including personal protective clothing;
- minimum level of respiratory protection;
- minimum evacuation zone distances;
- activation of water spray/foam systems and any other response/protection measures; and
- any other risk control measures required to be followed by fire-fighters.

The ERP must be prepared with consideration of Australian Standard/ISO 31000 Risk management principles and guidelines and Australian Standard 3745: Planning for emergencies in facilities.

Two copies of the ERP should be permanently stored in a prominent ‘Emergency Information Cabinet’ to be located at each vehicle entrance point to the solar farm, external to any security fence or locked gate, and a copy provided to local emergency responders. Two copies of the ERP will also be stored within the operations facilities.

The Emergency Information Cabinets must be clearly visible, installed at a height of 1.2m - 1.5m and accessible by all emergency services.

A schedule for ongoing site familiarisation to account for changing personnel, site infrastructure and hazards should be developed in conjunction with the local RFS.

4.3.4 Shielding of solar farm components

Solar panels and other components (e.g. cables) will be exposed to flame contact in the event of a bushfire spreading within the solar farm footprint. Therefore, it is recommended that components that are vulnerable to damage from temperatures associated with flame contact are shielded as far as possible. Design should consider the following features:

- burial of cables underground;
- shielding of above ground cables (e.g. metal conduit).

4.3.5 Water storage

Whilst the likelihood of a damaging fire impacting the solar farm is considered low, the consequence could be significant e.g. large number of panels and/or related electrical systems damaged.

The risk of a fire starting from the solar farm and spreading to surrounding areas is also considered low. Water supply should be designed to provide filling points for fire tanker units near the solar farm entrance only as internal access may not be possible. A storage of 50,000 litres is recommended, based on refilling six tanker units (4,000 litres) twice each although the required capacity will be confirmed in consultation with RFS.

4.4 Summary of recommended mitigation strategies

Table 4.1 summarises the bushfire mitigation strategies and recommendations made in this document.

Table 4.1 Summary of recommended mitigation strategies

Mitigation Strategy	Action	Timing
Asset Protection Zone (APZ)	A minimum 10m wide APZ is to be established around the perimeter of the solar farm and around the control room, electricity compounds and substations. The specifications recommended for the APZ are: ■ mineral earth fire break i.e. dirt or gravel. ■ no trees and shrubs planted within the APZ. ■ 6m wide perimeter access track can be located within this 10m wide APZ.	The APZ and perimeter road must be constructed as the first stage of development.
Solar farm construction	Should construction of the solar farm take place between 1 December and 31 March (increased fire weather), the following measures are recommended to control the risk of grass fire ignitions: ■ Ensure that appropriate permits have been issued for work during the Fire Danger Period, and that any conditions on permits are adhered to; ■ Adhere to restrictions on Total Fire Ban or days of high fire danger; ■ Carry fire extinguishers or firefighting equipment in vehicles; ■ Carry emergency communications equipment; ■ Ensure vehicles keep to tracks whenever possible; ■ Restrict smoking to prescribed areas, and provide suitable ash and butt disposal facilities; ■ the APZ and perimeter road must be constructed as the first stage of development; ■ all plant, vehicles and earth moving machinery are cleaned of any accumulated flammable material (e.g. soil and vegetation); ■ suitable fire fighting equipment (specific requirements to be confirmed in consultation with RFS) is present on site with at least two personnel trained in bushfire fighting; ■ on days when Very High fire danger or worse is forecast, the “fires near me’ app is to be checked hourly for the occurrence of any fires likely to threaten the site; and ■ all operations involving earth moving equipment, vehicles, slashers and hot works (e.g. grinders, welders) cease while the Grassfire Danger Index (GFDI) is or forecast to be 35 or greater (Rural Fire Service 2018).	During Construction

Mitigation Strategy	Action	Timing
Access roads and road network	The perimeter road and site access points must be constructed as the first stage of development. One main entry/exit point to the Bruxner Highway to the north and an additional two access points on the western and southern boundaries of the site must be maintained for the life of the project.	During construction and operation
Solar farm ongoing operations	Maintain minimal fuel load by grazing, slashing or mowing. Continued grazing is recommended within the Bonshaw Project site to ensure that grass is maintained below 100mm high. No vegetation within the Substation or within the 10m wide APZ. Suspend site maintenance operations when GFDI >=35.	During construction and operation
Fire-fighter safety	Emergency Response Plan prepared and stored at 'Emergency Information Cabinet' at main entrance to solar farm and provided to local emergency responders. The ERP must include: ■ a safe method of shutting down and isolating the PV system; ■ control and coordination arrangements for emergency response (eg evacuation procedures, emergency assembly areas and procedures for response to hazards); ■ agreed roles and responsibilities of on-site personnel (eg equipment isolation, liaison, evacuation management); ■ up-to-date contact details of site personnel and any relevant off-site personnel who could provide technical support during an emergency; ■ a manifest (and safety data sheets) for any battery, diesel or other dangerous goods storage/handling, including the class identification, quantity, type (bulk or packaged) and location. Appropriate material (including absorbent, neutralisers, equipment and personal protective equipment) for the clean-up of spills is to be provided and available on-site; ■ clearly states work health safety risks and procedures to be followed by fire-fighters, including personal protective clothing; ■ minimum level of respiratory protection; ■ minimum evacuation zone distances; ■ activation of water spray/foam systems and any other response/protection measures; and ■ any other risk control measures required to be followed by fire-fighters. A schedule for ongoing site familiarisation to account for changing personnel, site infrastructure and hazards should be developed in conjunction with the local RFS.	ERP to be developed and approved by both NSWRFS and NSWFS prior to construction.
Shielding of solar farm components	Shield all heat sensitive components from potential flame contact. Design should consider the following features: ■ burial of cables underground; ■ shielding of above ground cables (e.g. metal conduit).	Considered during project design. Maintained for life of the Project
Water storage	Water supply should be designed to provide filling points for fire tanker units near the solar farm entrance only as internal access may not be possible. A storage of 50,000 litres is recommended, based on refilling six tanker units (4,000 litres) twice each although the required capacity will be confirmed in consultation with RFS.	Considered during project design. Maintained for life of the Project

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- Malaysia
- Mexico
- The Netherlands
- New Zealand
- Panama
- Peru
- Poland
- Portugal
- Puerto Rico
- Romania
- Russia
- Singapore
- South Africa
- South Korea
- Spain
- Sweden
- Taiwan
- Thailand
- UAE
- UK
- US
- Vietnam

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