Barwon Solar Farm Fire Risk Assessment

Urbis

ADVERTISED
PLAN

1300 646 131
www.ecoaus.com.au

DOCUMENT TRACKING

Project Name	Barwon Solar Farm Fire Risk Assessment
Project Number	22SYD1820
Project Manager	John Norris
Prepared by	John Norris
Reviewed by	Nathan Kearnes – FPAA BPAD Certified Practitioner No. BPAD23575-L3
Approved by	Nathan Kearnes – FPAA BPAD Certified Practitioner No. BPAD23575-L3
Status	**Final**
Version Number	**V2**
Last saved on	**12 April 2023**

This report should be cited as 'Eco Logical Australia. 2023 Barwon Solar Farm Fire Risk Assessment. Prepared for Urbis on behalf of Elgin Energy.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Urbis

Contents

List of Figures

List of Tables

Glossary of Terms

Term	Description
Assets	Anything valued by people which includes houses, crops, forests 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.
Fire break	A fire break is a gap in fuel (vegetation) that reduces the potential for fire to enter or leave an area. Fire breaks may be used for emergency vehicle access.
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.
Head fire	The part of the fire where the rate of spread, flame height and intensity are greatest, usually when burning downwind or upslope.
Intensity	The rate of energy release per unit length of fire front usually expressed in kilowatts per metre (Kw/m).
Residence time	The time required for the flaming zone of a fire to pass a stationary point; the width of the flaming zone divided by the rate of spread of the fire.
Spotting	Behaviour of a fire producing sparks or embers that are carried by the wind and start new fires beyond the zone of direct ignition by the main fire.

Most terms are taken from the Bushfire Glossary prepared by the Australasian Fire and Emergency Service Authorities Council Limited (AFAC).

Abbreviations

Abbreviation	Description
BESS	Battery Energy Storage System
BMO	Bushfire Management Overlay
BPA	Bushfire Prone Area
CFA	Country Fire Authority
FDR	Fire Danger Rating
FFDI	Forest Fire Danger Index
FRA	Fire Risk Assessment
GFDI	Grassland Fire Danger Index
PCS	Power Conversion System
PV	Photovoltaic
RMU	Ring Main Unit
RFS	Rural Fire Service

1. Introduction

1.1 Background

The Barwon Solar Farm (the project) is a renewable energy facility comprising of solar generation equipment, associated infrastructure, and a Battery Energy Storage System (BESS). The project is situated on approximately 735 hectares of land near Little River (the subject land) being located approximately 49 km south-west of Melbourne Central Business District and 24km northeast of Geelong.

The project site is located on rural zoned land within the City of Greater Geelong and is required to obtain a Planning Permit for the renewable energy facility under Clause 53.13 of the Planning Scheme. The purpose of Clause 53.13 is to facilitate the establishment of renewable energy facilities in appropriate locations with minimal impact on the amenities of the area.

This Fire Risk Assessment (FRA) for the project has been prepared in accordance with the *Design Guidelines and Model Requirements, Renewable Energy Facilities* (CFA 2022) (herein referred to as the *CFA Design Guidelines*) and in support of an application to obtain a Planning Permit approval from the Minister for Planning under the *Planning and Environment Act 1987*.

The proposed project is for the construction, operation, and ultimately decommissioning of a commercial large scale solar farm, producing renewable energy to power up to 98,000 Victorian homes annually. The project is estimated to have an installed generating capacity of approximately 330 MW.

The subject land is comprised of multiple properties (shown in Table 1) which are currently predominately used for agricultural purposes. The site also currently accommodates 500kV and 220kV transmission lines being infrastructure advantageous to export renewable energy from the project.

Table 1: Area of the subject land

Address of Subject Land	Parcel	Approximate Area (ha)
1000 Little River-Ripley Road, Little River	24 \ PP3910	106.6
1050 Little River – Ripley Road, Little River	2 \ TP15944	82.4
1240 Little River-Ripley Road, Balliang	17 \ PP3910	109.5
1150-1190 Little River-Ripley Road, Little River	1 \ PS434520 & 1 \ TP15944	123.1
1085-1135 Little River-Ripley Road, Little River	23 \ 993910	126.3
1145-1215 Little River-Ripley Road, Little River	22 \ PP3910	128.0
1320 Little River-Ripley Road Balliang	2 \ LP140470	78.6
TOTAL		**754.5**

1.2 Legislative and Policy Frameworks

The primary legislative and policy context for the proposed renewable energy project is through the *Planning and Environmental Act 1987* (PE Act) and Clause 13.02-1S of the Planning Policy Framework.

The PE Act outlines all the requirements that need to be assessed for a renewable energy facility, for a Planning Permit to be issued by the Minister for Planning. Fire management planning conditions contained within the Planning Permit are required to meet the requirements of the current CFA Design Guidelines. Section 2.3 and Section 2.4 of the CFA Design Guidelines also reference the need to comply with other appropriate Australian / New Zealand Standards and International Standards.

Referral of planning applications to the CFA by the Department of Environment, Land, Water and Planning (DELWP) is not a requirement as part of the planning application process under Section 55 of the PE Act but may be prudent for large scale installations such as the proposed project.

Clause 13.02-1S of the Planning Policy Frameworks for Victoria sets out the specific compliance strategies for the protection of human life which is the overall objective of this Victorian state bushfire policy. The four key strategies that are required to be addressed for facilities located within the Bushfire Management Overlay (BMO) and Bushfire Prone Areas (BPA) include:

- Consideration of bushfire impacts where there is a bushfire hazard;
- Direct proposals to be situated low risk locations;
- Assess and apply bushfire protection measures; and
- No increased risk and risk reduction where applicable.

This FRA aims to address these legislative and policy requirements to ensure that the facility complies in its design; is suitably situated in a low risk fire environment; is appropriately supported by fire protection and risk mitigation measures; and does not contribute to an increased level of fire risk to life, property and the environment.

1.3 Aims and Objectives

This FRA has the following aims and objectives:

- To identify fire risks and mitigation strategies and actions in accordance with the CFA Design Guidelines, in order to:
    - Protect fire-fighters in the event of a fire within the site.
    - Reduce the likelihood of a bushfire impacting the site or spreading from the site.
    - Identify measures to prevent or mitigate fires starting.
    - Identify work that should not be carried out during total fire bans.
    - Assess availability of fire-suppression equipment, access and water.
    - Recommend appropriate storage and maintenance of fuels and other flammable materials.
    - Guide notification of the local CFA for any works that have the ignition potential and are proposed to be carried out during a bush fire danger period, to ensure weather conditions and suppression resources are appropriate.
    - Guide appropriate bush fire emergency management planning.
- Address all principles contained in the CFA Design Guidelines (CFA 2022) for:
    - *"Effective identification and management of hazards and risks specific to the siting, infrastructure, layout, and operations at the facility.*
    - *Siting of renewable energy infrastructure so as to eliminate or reduce hazards to emergency responders.*
    - *Safe access for emergency responders in and around the facility, including to renewable energy and firefighting infrastructure.*
    - *Provision of adequate water supply and fire- fighting infrastructure to allow safe and effective emergency response.*

- *Vegetation sited and managed so as to avoid increased bushfire and grassfire risk.*
- *Prevention of fire ignition on-site.*
- *Prevention of fire spread between site infrastructure (solar panel banks, wind turbines, battery containers/enclosures).*
- *Prevention of external fire impacting and igniting site infrastructure.*
- *Provision of accurate and current information for emergency responders during emergencies.*
- *Effective emergency planning and management, specific to the site, infrastructure and operations.*
- *Effective bushfire emergency planning and response, that prioritises absence of personnel on days of Severe and above Fire Danger Rating".*

1.4 Project Overview

The key components of the project consist of:

- A 510 ha development footprint.
- A generating capacity of approximately 330 MW.
- A total of approximately 210 inverters.
- Solar photovoltaic (PV) modules/panels (540,690) mounted on a single portrait, single-axis tracking system.
- Power Conversion System (PCS) including inverter, transformer and associated switchgear.
- A 500 MW Battery Energy Storage System (BESS) consisting of approx. 406 Battery Storage Containers over a footprint of 3.4 ha.
- 10m wide fire break around the facility and the BESS.
- Security fencing and six (6) access gates.
- Distribution Network Operator (DNO) and Customer Substation.
- Roads and tracks:
  - New internal all weather roads, suitable for heavy vehicle access to BESS and PCS.
- Electrical infrastructure:
  - Connection to the electricity grid via the existing Geelong Terminal to Keilor Terminal 220kV powerline which passes through the southeast corner of the development site
- Ancillary infrastructure:
  - A temporary construction compound (details to be determined post planning permit approval) and likely to include the following facilities:
    - Lunch room;
    - Site office;
    - Composting toilet;
    - diesel fuel tank; and
    - diesel generator.
- Water supply:

7 x 45,000 L static water tanks supply for dedicated firefighting (total of 315,000L).

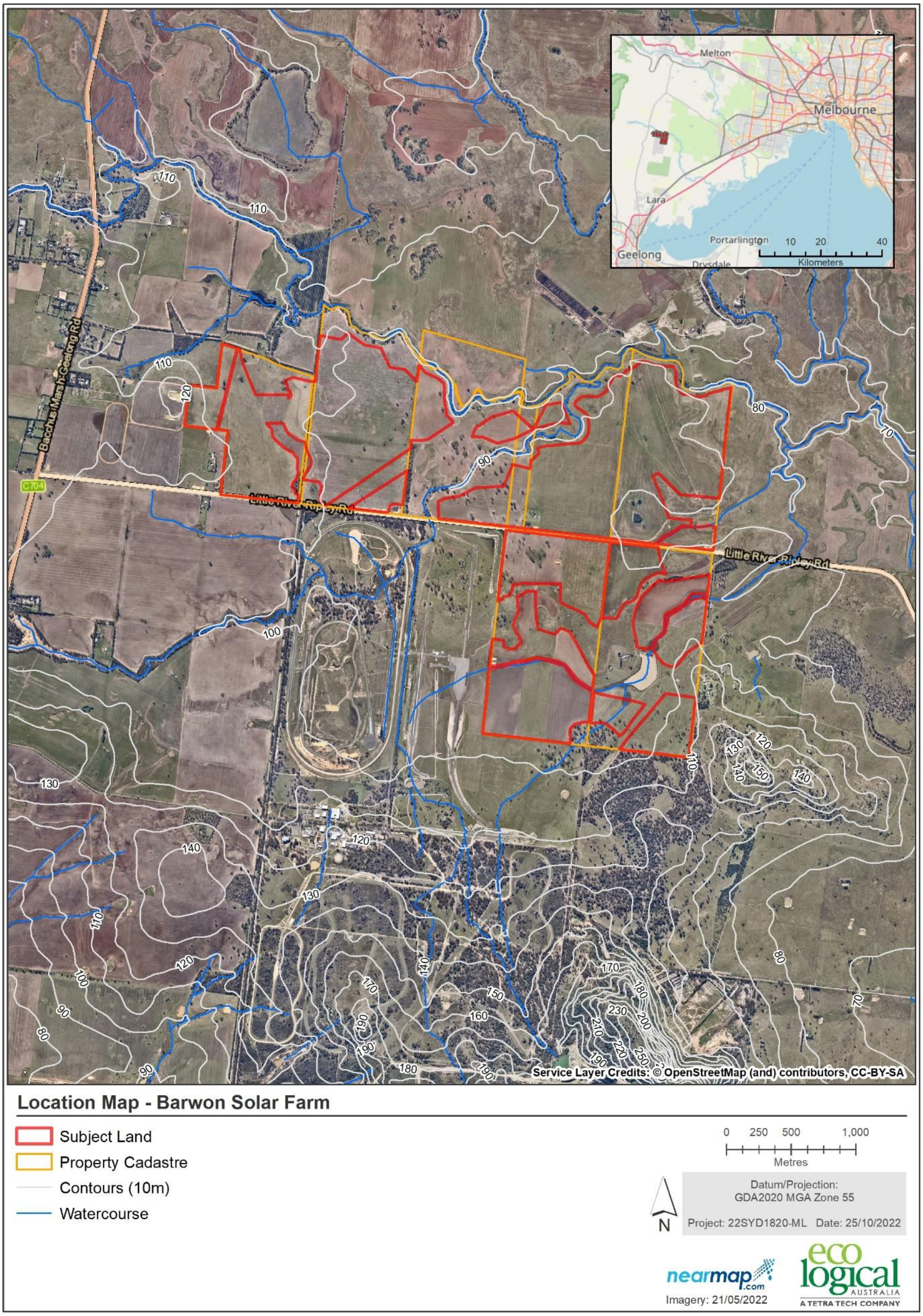

Figure 1: Project Site Locality

ADVERTISED
PLAN

ADVERTISED
PLAN

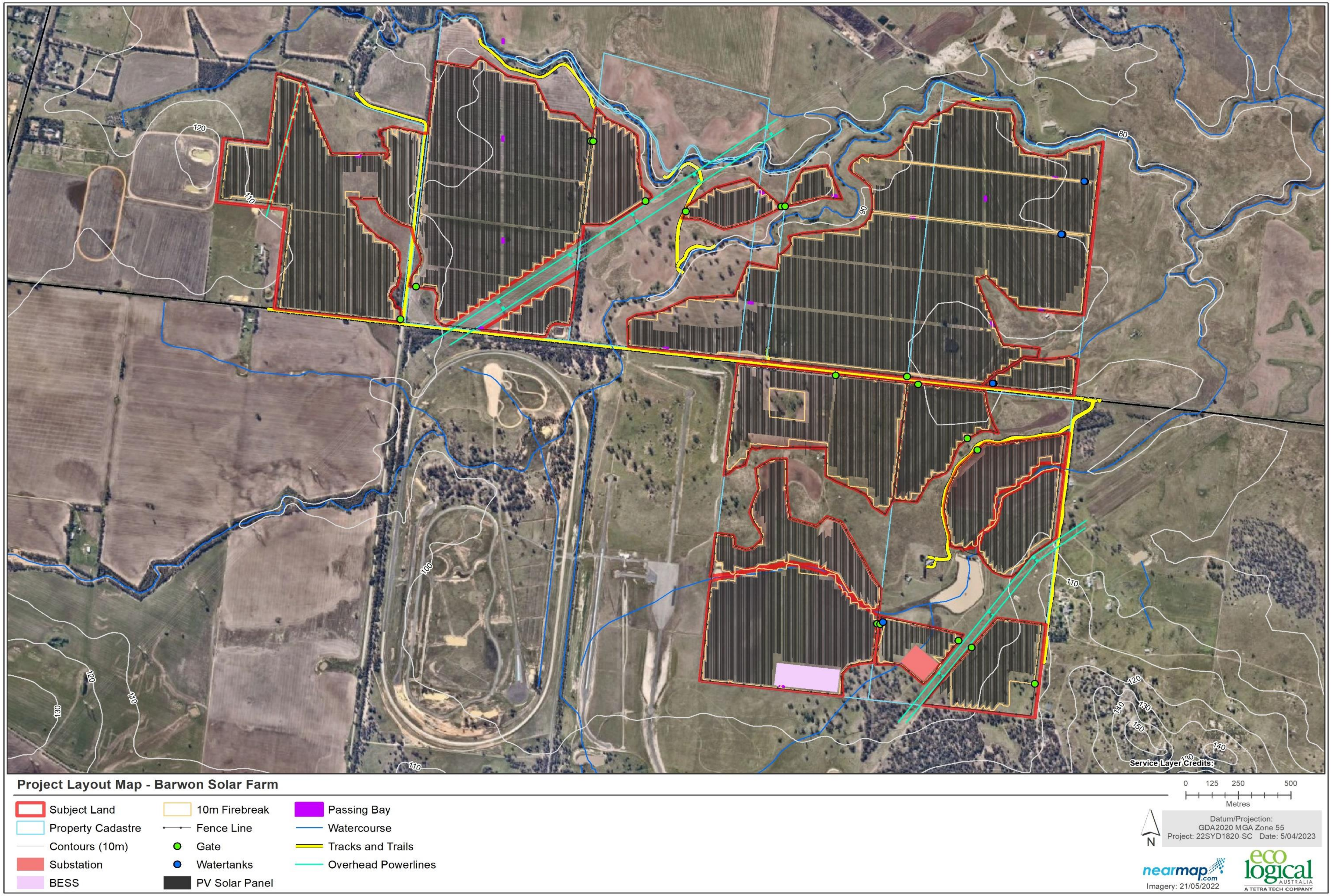

Figure 2:Project Layout

1.5 Facility Location

The level of risk exposure in the location proposed for the project is an important evaluation consideration. The CFA Design Guidelines promote the locating of renewable energy facilities on lower risk sites, however where located in higher risk environments, the guidelines state that 'strengthened or additional risk mitigation measures will be required'. Table 2 below indicates the model requirements under Section 6.1.1 of the CFA Design Guidelines for facilities located in high risk environments.

Table 2: CFA model requirements for renewable energy facilities located in high-risk environments.

Model Requirements	Compliance Notes
Planning applications for all renewable energy facilities proposed in high-risk environments must address the following, in addition to providing an assessment against policy at *Clause 13.02-1S (Bushfire Planning)*: •The impact of any ignitions arising from the infrastructure (solar panels, wind turbines, battery energy storage systems, electrical infrastructure) on nearby communities, infrastructure and assets. •The impact of bushfire on the infrastructure (eg. ember attack, radiant heat impact, flame contact). •Assessment of whether the proposal will lead to an increase in risk to adjacent land and how the proposal will reduce risks at the site to an acceptable level.	**Can comply** The facility is located within a low fuel hazard type (i.e. grassland) on existing agricultural grazing lands (Farming Zone), with the majority of the site within a Bushfire Prone Area (BPA). However, the south-eastern extent of the site is also located within the Bushfire Management Overlay (BMO) buffer due to adjoining wooded vegetation. In accordance with the CFA Design Guidelines, being located within a BMO is considered a high-risk environment. Potential impacts of fire ignition and spread to nearby communities arising from the solar infrastructure include adjoining agricultural lands, rural residential dwellings, crops, stock, fencing and the nearby township of Barwon. Bushfire impact on the solar infrastructure (i.e. from ember attack, radiant heat, and flame contact) is possible from fire spreading to the site. The most prominent bushfire attack path is most likely under fully cured fuels with a hot and dry west to north-west wind direction. Direct bushfire attack on PV panels, the BESS, substation and other electrical infrastructure is likely to be rapid but short duration due to the nature of the fuel hazard. The proposal overall will not result in an increased level of fire risk and would be mitigated to an acceptable level given: a) Predominately low hazard vegetation type (grassland) in the form of agricultural grazing / cropping land (external) together with established fire breaks (internal) around key solar farm infrastructure (BESS, PV panels, substation, electricity supply lines, water tanks, and other onsite infrastructure); b) Availability of a 315,000L static water supply (7 x 45,000 L tanks); c) Access roads and tracks for fire fighter access around all key solar infrastructure; d) Use of low flammability screening vegetation for landscaping requirements; e) The development of a fire management plan for the site to identify, manage and mitigate risks from fire ignition onsite or potential bushfire attack on the facility from offsite; and f) The development of a fire emergency management plan for the site, addressing fire preparedness and fire response measures.

2. Hazards and Risks

Section 2 of this FRA is to identify the assets that are at risk from various fire sources, their potential hazards, and the factors that contribute to affecting the overall risk exposure.

Fire sources include bushfires (including attack on the facility from adjoining lands, or ignition onsite and fire spread externally to impact on other community assets) as well as fires associated with machinery, structures, electricity, liquid fuel, BESS and associated infrastructure.

Factors that affect the level of risk exposure include assets at risk as well as fire influences such as climate, fuel hazards, topography, fire behaviour potential, fire ignition factors and fire history.

2.1 Assets at Risk

The following assets are located on site or surrounding the proposed solar farm site:

- Modified grazing pastures
- Stock (sheep and cattle)
- Boundary fences
- Scattered rural residences and sheds
- Human settlement including the localities of Anakie, Balliang, Balliang East, Quandong, Manor Lakes, Wyndham Vale, Weeribee, Cocoroc, Little River, Avalon, Lara, Corio, and Moorabool
- You Yangs Regional Park
- Mount Rothwell Biodiversity Interpretation Centre
- Boral Quarries
- Woolooomanata Station

All of these existing assets and the proposed components of the solar farm are at risk from a bushfire that may propagate within the solar farm site, or from an external fire threat.

Solar wind farm assets that are at risk include:

- External perimeter fencing;
- PV panels;
- Battery Energy Storage System (BESS);
- Electrical infrastructure (powerlines, substations, switchyards);
- Ancillary infrastructure (Operations and Maintenance facility);
- Temporary construction compound and site office;
- Storage facilities;
- Laydown areas; and
- Temporary construction facilities.

2.1.1 Fire fighter and public safety

The use of the general area surrounding the solar farm site is mostly limited to local landowners, who are generally farmers undertaking agricultural activities. There will be no public access to the solar farm site and thus no direct public safety concern.

The fire-fighters likely to respond to a bushfire in this area would be fire fighters from Little River CFA and or individual property owners. Other CFA brigades who could respond to fire outbreaks in the area would include those from Anakie, Balliang, Eynesbury, Lara, Wyndham Vale, and Werribee fire stations. The normal risks to fire-fighter safety when attending a fire in grassland fuels apply both on and off the site.

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 of DC current can only occur external to any solar array because there is no single point of disconnect internally (Backstrom and Dinni 2011); and
- Inhalation of potentially toxic fumes and smoke from any plastic or rubber components such as cables (although the main structure of the panels will be glass and aluminium) or other decomposed products of the panels (Allianz Risk Consulting 2012).

Potential risks to fire fighter safety associated with the supporting BESS infrastructure (Worksafe 2019) include:

- Electrocution - BESS have the potential to deliver a severe electrical shock when interconnected as battery banks, reaching hazardous voltage levels;
- Arc Flash/Fire & Explosion - this occurs where the battery short circuits or a fault occurs which can result in temperatures reaching 12,000 degrees Celsius with the capacity to melt metal and cause fires and explosions. The higher the battery energy capacity the higher to risk of arc flash. They can also produce flammable gases if there is a fault. Fire and explosions can result from excessive temperatures, component failure, short circuit or loose connections; and
- Hazardous Chemicals - this occurs where battery casings rupture as a result of extreme temperatures occurring from chemical reactions, such as from over-changing. Where ruptured the electrolyte contained internally within the battery can leak externally releasing toxic fumes, and posing risk of burns or explosions.

In addition, other potential risks to fire fighter safety associated with the facility are related to:

- Liquid fuel fires, such as in stored diesel and petrol;
- Structure fire (e.g. site office building);
- Vehicle or machinery fire.

The majority of a solar farm by area is comprised of PV arrays (the panels and their supporting tracking system). The panels are considered to have a low level of combustibility given only a small portion of materials in the panels are flammable, and those components cannot self-support a significant fire. Flammable components of PV panels include the thin layers of polymer encapsulates surrounding the PV cells, polymer backing sheets (framed panels only), plastic junction boxes on rear of panel, and insulation on wiring. The majority of the panel is composed of non-flammable components, notably including one or two layers of protective glass.

Provided that there is a limited heat source under the panel together with active vegetation management underneath, their low combustibility means that fires at a solar farm are not likely to be supported by fuels associated with the PV arrays themselves and as such pose a low risk to overall fire fighter safety.

2.2 Fire ignition

The main potential sources of fire ignition in the locality can occur from harvesting operations, farm machinery, lightning strikes, escape from legal and illegal burning operations, and accidental causes (cigarettes, motor vehicle accidents, slashing machinery, earthmoving plant, angle grinders, and welders).

Harvesting and farm machinery are well known for starting bushfires under conditions of high temperature, low humidity and high wind. These can be associated with the harvesting of cereal and oilseed crops during the months of November and December.

Lightning strikes during heavy storm activity can also be experienced in the summer months each year, resulting in ground strikes and fire ignitions supported with little to no rainfall.

Construction and ongoing maintenance of the solar farm will be a potential source of ignitions during the bushfire fire season including:

- Fires as a result of electrical or mechanical faults;
- Fault in the BESS and associated electrical / powerline infrastructure;
- The use of or inappropriate storage of flammable fuels;
- Utilisation of machinery and equipment;
- Land management activities (e.g. fire break maintenance, vegetation management along access road or powerlines);
- Construction or maintenance activities (e.g. welding, grinding and other ignition generating works); and
- Other anthropogenic sources (e.g. from discarded cigarette butts, cooking fires, fire starts from vehicles or accidents, etc.).

2.3 Bushfires

2.3.1 Fire Weather

Fire weather strongly influences the likelihood of ignition and how often fires that are ignited will be uncontrollable. The bushfire season is declared annually by the CFA Chief Officer and generally commences on the 1st October and concludes on the 31st March the following year, however these dates can be modified depending on the season and conditions.

The fire weather relevant to the Barwon Solar Farm site has been investigated using data from the Bureau of Meteorology (BOM). Elevated fire danger weather conditions from these data findings mostly occur during the months of November, December, January, February and March.

2.3.2 Fuel hazard

The area within and surrounding the site is largely used for cattle and sheep grazing within modified pasture or native vegetation. The landscape is predominately grassland, scrubland and woodlands (Figure 3).

To the south-south west of the project area, the vegetation is scrubland and woodland through the Mount Rothwell Biodiversity Interpretation Centre and adjoining Wurdi Youyang Bushland Reserve.

On all other aspects surrounding the proposed solar farm infrastructure the area is largely grassland modified by periodic cropping, agricultural grazing and private property rural lifestyle residential development (Figure 4).

It is intended that the vegetative fuel around the PV panels, will be maintained in a low fuel state by mechanical or manual methods prior to construction activities commencing and as part of ongoing maintenance activities for the duration of the Project.

2.3.3 Topography

The topography of the land is characterised by flat to rolling hills, with slope categories varying across the site from 0-5 degrees to 5 to 10 degrees. Given the large expanse of the project site of 735 ha, it is expected that the majority of the PV panels would be located on agricultural land with flat to gentle slope.

2.3.4 Fire behaviour potential

Within the study area there are grassland, scrubland and woodland fuels (Figure 3) which along with the topography and fire weather contribute to the bushfire behaviour potential.

2.3.4.1 Grassland areas

In relation to grassland fuels, there will be periods when the agricultural lands will be non-flammable because they are either fallow, too green to burn or are recently planted. There will also be periods when the pastures are cured and highly flammable.

Within and surrounding the site, the grassland fuels are generally in a modified/fuel reduced state i.e. ‘eaten out’ or ‘cut/grazed’. This lessens the likelihood for an ignition source developing into a fire and can reduce the spread potential under mild conditions, along with the effectiveness of fuel breaks (e.g. roads, tracks and fire breaks). Despite this, it should be assumed that, under the most extreme weather, a fire would spread even in heavily fuel reduced grass. The rate of spread and fire intensity values for ‘eaten out pastures’ are considerably lower compared to ‘cut/grazed pastures’, however significant fires can still develop. The residence time for flames in heavily grazed pasture are likely to be very short, probably less than five seconds (Cheney and Sullivan 2008), so the solar farm components will have a similarly short time of exposure to flame contact (if any) and high radiant heat.

Previous studies on predicting bushfire behaviour potential for grassland at similar locations found fires in cured pasture and crops can be very fast moving and intense, with direct attack on such a grass fire usually failing at GFDI >49 (Cheney and Sullivan 2008). A fire ignition takes some time to build to a quasi-steady state rate of spread, however, under extreme weather conditions a grass fire can be expected to reach maximum rate of spread within 30 minutes or even less (Cheney and Sullivan 2008) by which time the fire is probably uncontrollable.Fire breaks can be effective at stopping grass fires, however, at wind speeds greater than 25 km/h even very wide fire breaks can fail (Cheney and Sullivan 2008). Under the worst weather conditions that could be expected, a fire break of even 40 m width may fail to stop a grass fire (Cheney and Sullivan 2008).

2.3.4.2 Woodland and Forest Areas

There are smaller tracts of woodland vegetation in the vicinity of the study area (Figure 3) that will influence fire behaviour in those parts of the landscape.

The tree canopy within vegetation associated with woodland is typically up to 20 m tall with well-spaced crowns. Tussock grasses and herbs dominate the understory. Fuel load understorey contributing to rate of spread for grassy woodlands are typically up to 15 t/ha, and overall fuel loads that contribute to intensity are up to 25t/ha (AS3959:2018 Table B3, SA 2018).

Previous studies predicting bushfire behaviour potential for ‘ woodland’ vegetation (Nobel *et al.* 1980) found rate of spread and fire intensity values in woodland vegetation can be fast, intense. Given the bushfire behaviour potential for the ‘woodland’ (i.e. potential for significant levels of intensity beyond controllability limits) direct attack on such fires will usually fail at FFDI >49 (Table 3 from Cary, 2011).

Table 3:Suppression capabilities at increasing fire line intensities (Cary 2011)

Fireline Intensity (kW/m)	Suppression
<350	Head/flank attack using hand tools Hand constructed breaks should hold
350 - 2000	Too intense for hand attack Dozers and tankers with retardant effective on flanks and possibly head Fires may jump dozer breaks
2000 - 5000	Fires represent serious control problem May be crowning and long-distance spotting Head fire attack will fail and will endanger lives of fire fighters
> 5000	Crowning, long distance spotting, whirlwinds and highly erratic fire behaviour Control efforts at the head of fire will fail Mass spotting and erratic fire behaviour can endanger fire fighters many kilometres ahead of the main fire front

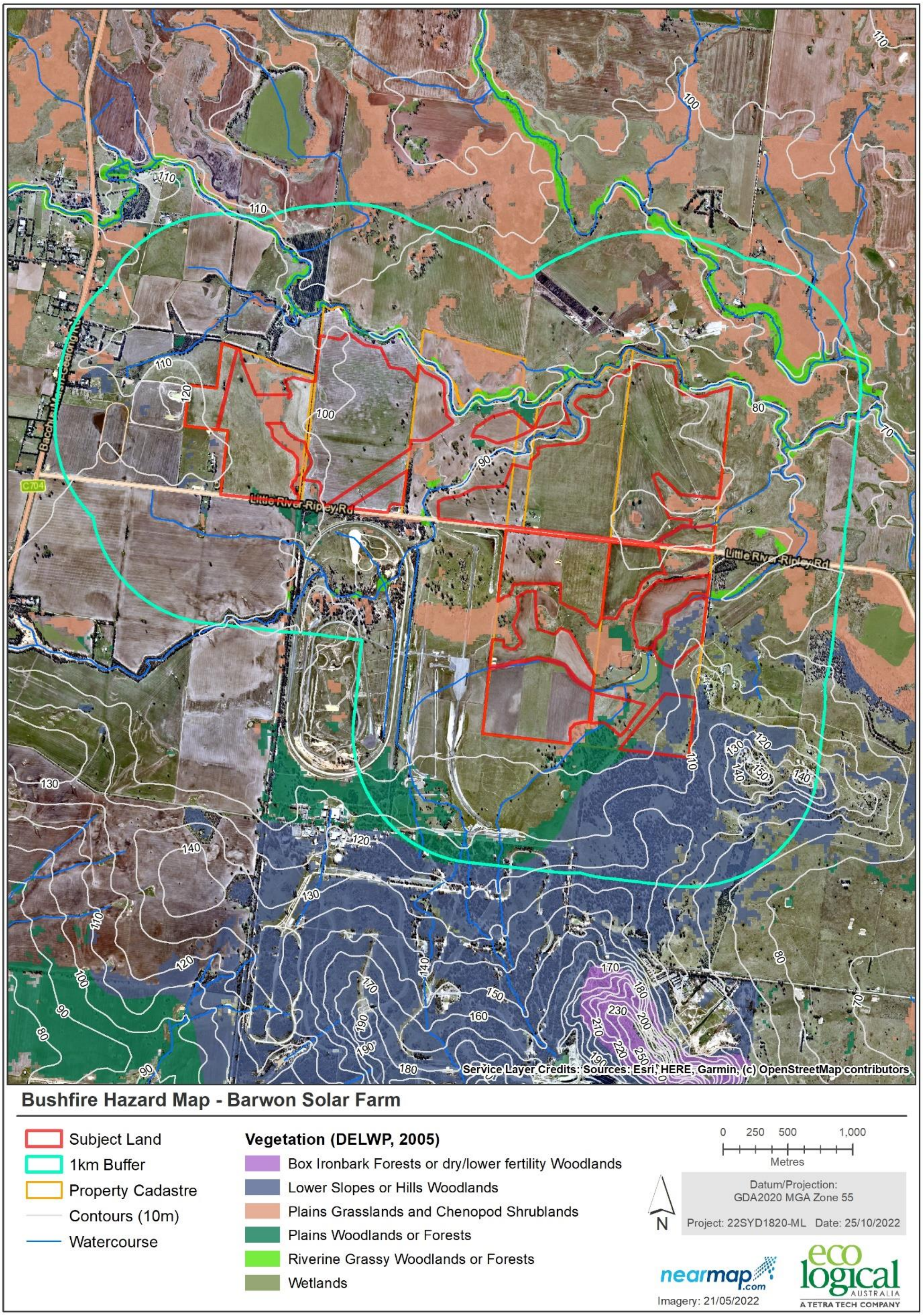

Figure 3: Bushfire Hazard Map.

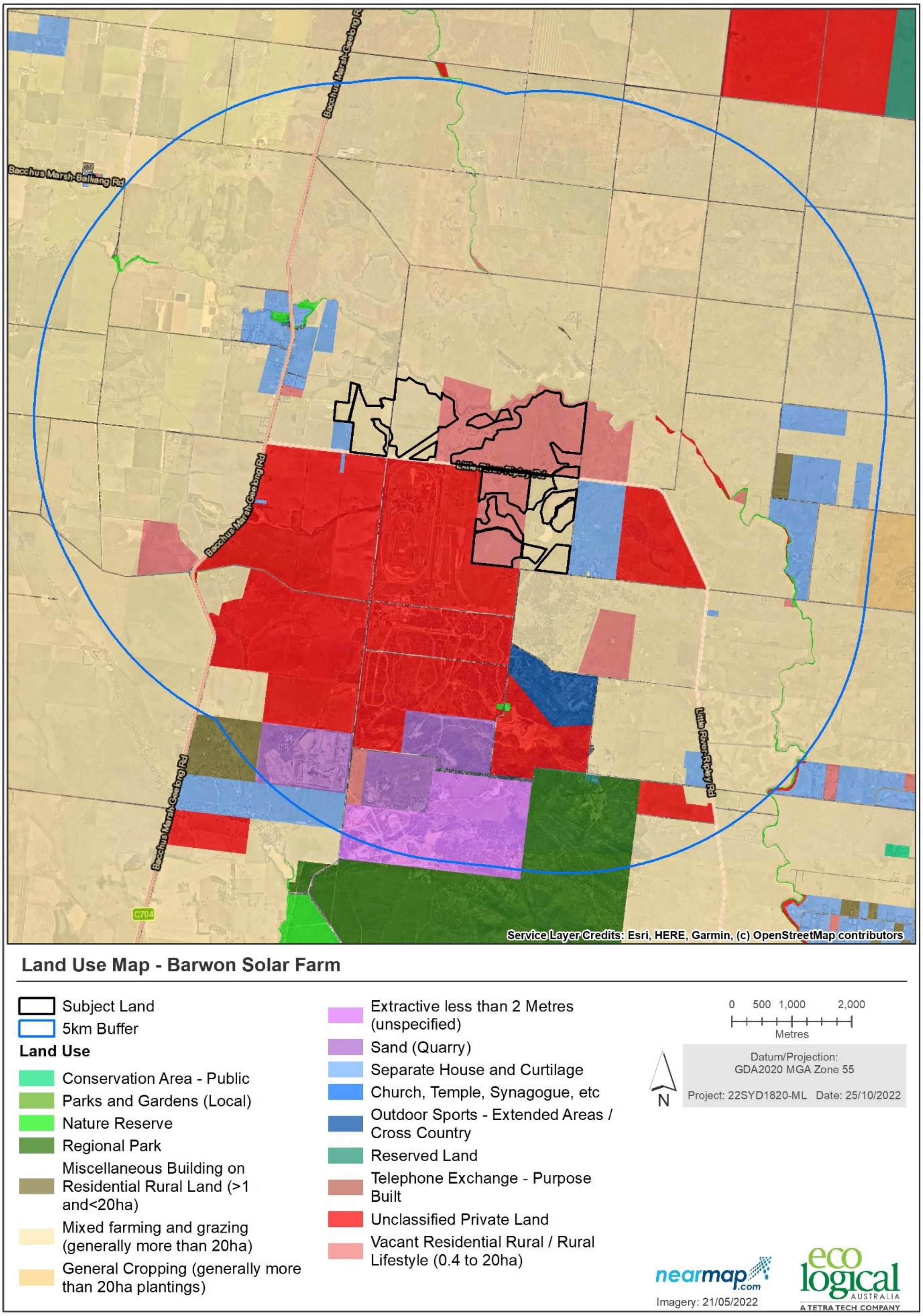

Figure 4: Land Use

ADVERTISED PLAN

2.3.5 Fire history

Three major bushfires have been recorded within 5km of the site in 1977, 1985, and 2019. Other smaller bushfires surrounding the project area occurred in 2014 and 2018 (DELWP 2022).

Further south of the site a number of prescribed burns have been undertaken in 2005, 2006, 2008, 2009, 2011, 2012, 2013, 2015, 2021, and 2022.

The collated fire history over a period of 25 years indicates a generally low number of large bushfire events and an absence of landscape scale bushfire from the majority of the project area with the exception of the very north-east corner of the site during 1977. The compiled fire history dataset indicates a lower likelihood of bushfires impacting the subject site, especially larger landscape scale events burning under significantly elevated bushfire weather conditions.

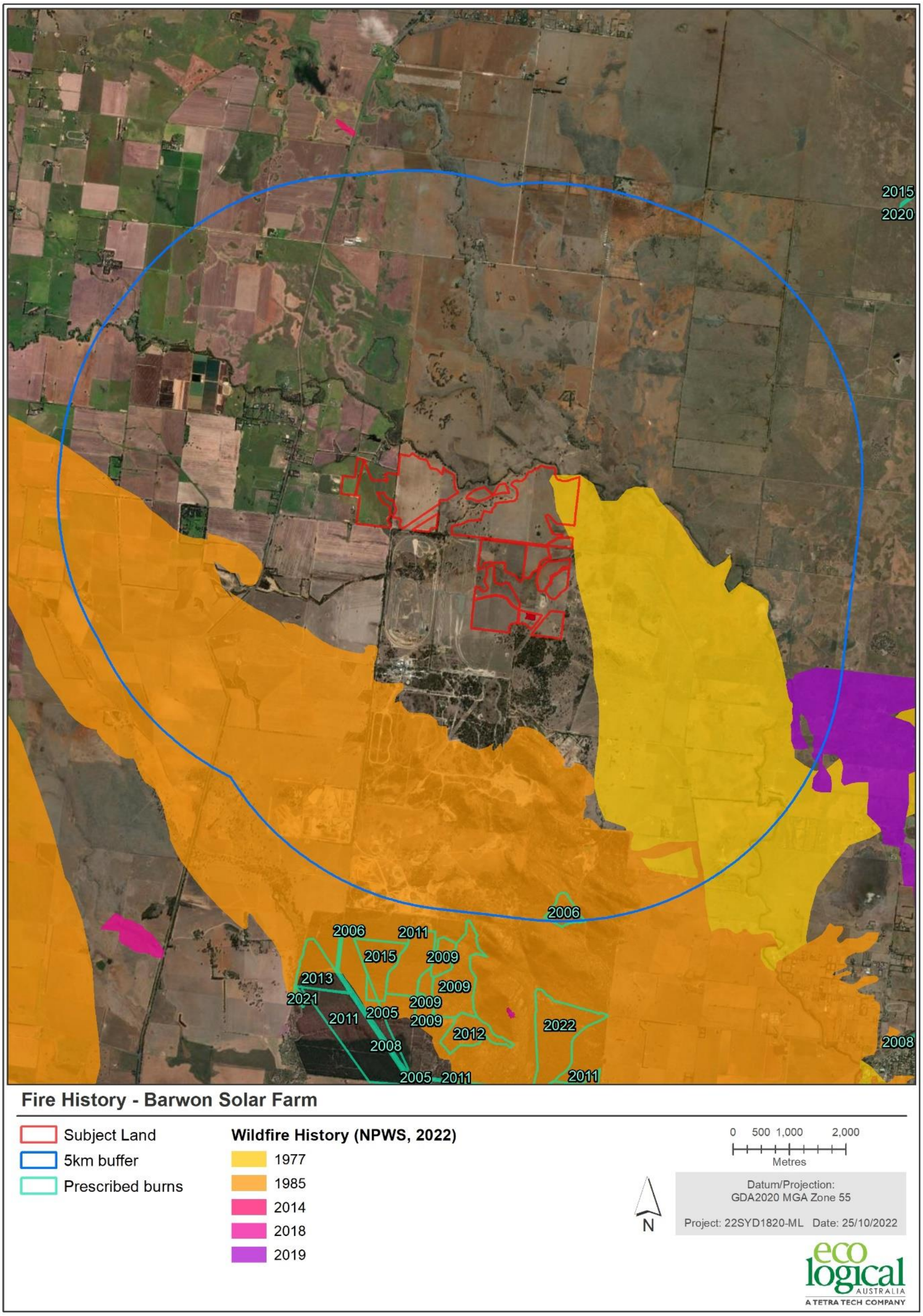

Figure 5: Fire History

ADVERTISED PLAN

2.3.6 Bushfire Scenarios

The perceived worst case bushfire scenarios have been considered for the purpose of understanding the level of bushfire risk exposure based on the fire weather, fuels, terrain, fire behaviour potential and fire history. They assume bushfire risk mitigation strategies have been implemented for the development:

1. A large landscape bushfire starts outside of the project site to the south to south-west on a day with a GFDI of 50 or higher, winds are from the south-west, with woodland fuels having low fuel moisture contents together with un-grazed agricultural lands surrounding the solar farm area in a fully cured state. The fire progresses further to the north to northeast and the head fire impacts on the Barwon Solar Farm site. The likelihood of such a fire occurrence is low, given the low incidence of wildfire history surrounding the project area, generally modified/reduced grassland fuels from agricultural practices, not cured or non-curing fuels, and interruptions in fuel continuity. However, it is still possible given the fire weather and fire behaviour potential, with a substantial or complete fire encroachment on all solar farm equipment possible but very unlikely likely.

2. A large landscape bushfire starts outside of the project site to the west on a day with a GFDI of 50 or higher, winds are from the west, with grassland fuels having low fuel moisture contents together with un-grazed agricultural lands surrounding the solar farm area in a fully cured state. The fire progresses further to the east and the head fire impacts on the Barwon Solar Farm site. The likelihood of such a fire occurrence is low, given the low incidence of wildfire history surrounding the project area. and interruptions in fuel continuity. However, it is still possible given the fire weather and fire behaviour potential, with a substantial or complete fire encroachment on all solar farm equipment possible but very unlikely likely.

3. An electrical fault ignites unmanaged grass (greater than 100mm in height) under a solar panel array on a day with GFDI of 50 or greater, with a north-westly wind direction and at a time when grassland fuels within the development site as well as agricultural lands adjacent to the wind farm and beyond are fully cured. The fire spreads to the south-east for 5 km to 6 km impacting on established rural residential dwellings, crops, stock, fences and the township of Barwon. As for the first scenario, the likelihood of such a fire is very low.

The risk of a major fire spreading from the solar farm in the direction of Barwon is very low, based on the low likelihood of ignition, good suppression opportunities, impedances to fire development and spread (i.e. fuel breaks and reduced fuel areas). Despite the low likelihood of bushfire impact, the risk still warrants mitigation.

2.4 Other Fire Types

2.4.1 Machinery or Vehicle

Machinery or vehicle fires pose a hazard in that toxic gases are released and other hazardous substances along with flying debris and explosions are serious danger to staff, site visitors, and fire fighters. A by product of these fires is lethal quantities of carbon monoxide.

2.4.2 Structural

Structural fires within the solar facility are possible in likely temporary buildings (to be confirmed post planning permit approval) such as office buildings, lunch room, and toilet blocks. The likely causes are a result of cooking, heating, electrical distribution, lighting equipment, intentional fire setting, and smoking materials.

2.4.3 Electrical

Electrical fires within the solar facility can occur as a result of PV panel and inverter electrical faults as well as DC electricity being retained within the solar panel post shut-down or isolation of the units. Other sources of electrical fires include the BESS units as a result of a thermal runaway event triggered from such events as battery faults, internal short circuits, overcharging, and lightning strikes.

2.4.4 Flammable Liquids

Liquid fuel fires within the facility are a possible fire source. During the construction phase it is likely that diesel storage tank (s) will be located within the temporary construction compound (to be determined post planning permit approval). This flammable liquid has a flashpoint around 52°C and 93°C which can catch fire (or explode) very easily when it is exposed to a flammable substance and oxygen.

2.4.5 Other Fires Risk Summary

The risk of fire development from other fires types covered in Section 2.4.1 to 2.4.4 and propagating outside of the facility is considered to be low in combination with a number of risk mitigation factors covered in Section 3.

These risk mitigation factors include appropriate solar design practices; ignition management practices; fire response resources (fire breaks, water supply, and access), fire awareness training, compliance with the appropriate Australian Standard (AS 1940-2017), remote site monitoring, isolation, shutdown and regular inspection and maintenance schedules of solar infrastructure; and emergency awareness and preparedness.

3. Mitigation Strategies

ADVERTISED PLAN

3.1 Overview

Mitigation strategies are guided by knowledge of the factors that contribute to the risk:

- Fuels, fire weather, topography, potential bushfire behaviour;
- Spatial patterns and frequency of unplanned ignitions;
- Plausible worst case bushfire spread and attack scenarios;
- Suppression capability: resources (air and ground), access (roads, tracks) and fire fighting water supply; and
- Values and assets at risk and the degree or consequence of impact: people, buildings, commerce, industry, services, heritage and the natural environment.

Mitigation strategies are also guided by evidence of the efficacy of available treatment options, likelihood of risk reduction, implementation practicalities and cost-benefit. Mitigation must be a combination of complementary strategies, all of which are required to provide the most appropriate risk mitigation outcome for the facility and the community.

3.2 Model Design

The intent of Section 3.2 is to ensure that all renewable energy facilities are designed to eliminate or the reduce the overall risk of fire occurring within or fire impacting the facility and the consequences of any fire. Model design measures used to mitigate the risk include compliance with separation between solar farm components including PV panels, BESS, and onsite buildings. Other compliance requirements relating to BESS include provision of fire breaks, the safety of emergency responders, suitable siting, fire detection and suppression systems, ember protection, and access.

It should be noted that whilst suitable ember protection compliance requirements are called up for battery containers / enclosures in the CFA Design Guidelines, no BAL construction requirements under AS3959:2018 for ember protection are specified as a requirement to achieve compliance.

Table 4 indicates the model requirements for facility design under Section 6.2.5 of the CFA Design Guidelines for Solar Farms and associated BESS.

Table 4: CFA model requirements for design of renewable energy facilities.

Model Requirements	Compliance Notes
Design Specific to Facility Type (Solar Energy Facilities)	
Solar energy facilities are to have a minimum six (6) metre separation between solar panel banks.	**To Comply** Solar panel banks are to be separated throughout the solar farm facility by perimeter access roads and / or fire breaks that equal or exceed 6m.
Design Specific to Facility Type (Battery Energy Storage Systems)	
1) The design of the facility must incorporate: **a)** A separation distance that prevents fire spread between battery containers/enclosures and: • Other battery containers / enclosures • On-site buildings • Substations	**To Comply** **a)** The BESS unit battery rack cabinets will all be housed in non-combustible steel shipping containers that provide good mitigation of radiant heat. A Fire Engineering Design Brief, Fire Safety Study (as per NSW Planning's Hazardous Industry Planning Advisory Paper 2: Fire Safety Study Guidelines (2011)) or an equivalent assessment, should be undertaken for the project so as to ascertain adequate

Model Requirements	Compliance Notes
• The site boundary • Any other site buildings • Vegetation *Separation must be at least the distance where the radiant heat flux (output) from a battery energy storage system container/enclosure fully involved in fire does not create the potential for ignition of these site elements.* **b)** A fire break around the battery energy storage system and related infrastructure, of a width of no less than 10m, or greater where determined in the Risk Management Plan. Fire breaks must be non-combustible, constructed of concrete, mineral earth or non-combustible mulch such as crushed rock. *The width must be calculated based on the ignition source being radiant heat of surrounding vegetation, including landscaping.* **c)** A layout of site infrastructure that: **i.** Considers the safety of emergency responders. **ii.** Minimises the potential for grassfire and/or bushfire to impact the battery energy storage system. **iii.** Minimises the potential for fires in battery containers/enclosures to impact on-site and off- site infrastructure.	separation distance between the BESS units to prevent fire spread between enclosures and other natural and built assets. **b)** A mineral earth fire break to a width of 10m is to be established and maintained around the entire perimeter of the BESS compound. This is deemed to provide adequate radiant heat mitigation from the surrounding 'managed' grassland, woodland, and scrubland to the non-combustible steel shipping containers which will house the BESS. **c)** To enhance the safety of emergency responders, the site layout (Figure 2) contains: • Up to 6 gate access points including multiple road access points to 6m wide (off Little River-Ripley Road and Mount Rothwell Road); • A 6m wide ring road (with 2m wide passing bays) is provided around the BESS compound and the Customer Substation; • 10m wide mineral earth firebreaks around the BESS compound, Customer Substation and the entire solar farm facility, and maintained by herbicide spraying; • Alternate gated emergency access off both Little River-Ripley Road and Mount Rothwell Road; • Non-combustible static water supply tanks (7 x 45,000L) containing a total of 315,000L dedicated to firefighting. All Storz fire hose connections to be located on the lee side so that they are shielded from radiant heat in the event of a BESS fire; • The BESS compound will be afforded barrier protection such as bollards to prevent potential damage from vehicle or machinery impact. • Onsite safety and advisory signage. The impact of grassfire and /or bushfire spread to the BESS units is minimised (beyond any intervention by emergency services) through the provision of 10m wide mineral earth fire breaks around the entire facility perimeter as well as the BESS compound and the robust non-combustible construction of the BESS units. The potential for fires in BESS units is mitigated by being housed within fully enclosed non-combustible shipping containers modules, along with monitoring, safety and coolant fire suppression systems (see Figure 7 and Figure 8). This will mitigate the propagation of fire escape (together with adjoining fire breaks) both on and off site, should thermal battery runaway occur.
2) Battery energy storage systems must be: **a)** Located so as to be reasonably adjacent to a site vehicle entrance (suitable for emergency vehicles). **b)** Located so that the site entrance and any fire water tanks are not aligned to the prevailing wind direction (therefore least likely to be impacted by smoke in the event of fire at the battery energy storage system.) **c)** Provided with in-built detection and suppression systems. Where these systems are not provided, measures to effectively detect and/or suppress fires within containers must be detailed within the Risk Management Plan. **d)** Provided with suitable ember protection to prevent embers from penetrating battery containers/enclosures.	**To Comply** **a)** The proposed BESS compound is currently located approximately 1,630 m from the south-east site entrance off Mount Rothwell Road. Further consultation with the CFA recommended to confirm a revised location of the BESS closer to nearest site entrance. **b)** As the predominate wind direction is likely to be from the east the effect of smoke propagation as a result of a BESS fire is unlikely to impact on site access and access to the onsite water tanks located away from the BESS off Little River-Ripley Road and Mount Rothwell Road (see site layout).

Model Requirements	Compliance Notes
e) Provided with suitable access roads for emergency services vehicles, to and within the site, including to battery energy storage system(s) and fire service infrastructure. **f)** Installed on a non-combustible surface such as concrete. **g)** Provided with adequate ventilation. **h)** Provided with impact protection to at least the equivalent of a W guardrail-type barrier, to prevent mechanical damage to battery containers/enclosures. **i)** Provided with enclosed wiring and buried cabling, except where required to be above-ground for grid connection. **j)** Provided with spill containment that includes provision for management of fire water runoff.	**c)** All BESS units will include an inbuilt Solbank cooling, fire monitoring and detection system (Figure 6 and Figure 7). **d)** BESS units to have all openable doors affixed with rubber protection strips to seal in a closed position against ember entry. All ventilator openings to be screened with metal mesh with aperture size no greater than 2mm to prevent ember entry. e) An all-weather site access loop road (6m wide) is provided to and around all BESS infrastructure and nearby Customer Substation. The 315,000L additional static fire water supply tanks (7 x 45,000L) are accessible off three road access point off Little River -Ripley Road for use by emergency service heavy rigid, medium rigid and personnel carrier vehicles (see site layout). The CFA should be consulted based on the current design layout to locate water tanks near primary site entrances. f) The BESS units will be installed on concrete foundations. g) The BESS units will have installed a heating ventilation and air conditioning system (HVAC) with four (4) ventilator entry and exit points per housed shipping container (see Figure 8). h) The BESS compound will be provided with perimeter barrier impact protection, being concrete bollards or a metal guard rail to prevent vehicle impact damage. i) All cabling between the BESS containers and PCS units will be enclosed underground to the Customer Substation. These will be communication and I/O circuit cables to receive information from these units and to monitor alarm signals. All communication and I/O circuit cables will be buried in HDPE conduit. j) Spill containment for the BESS units will need to be designed with a concrete bund with a 400mm high retaining wall (approximately), retention basin, or a combination of both. The bunded area will incorporate a manual shut-off valve installed to the graded sump pit, such that under standard operation the valve remains open to enable rainwater to drain away. In the event of an emergency and a fire within the BESS, emergency personnel will manually close the valve to isolate the spill. The sump capacity is to meet the required fire water supply capacity for the solar farm facility, being 315,000 L. .

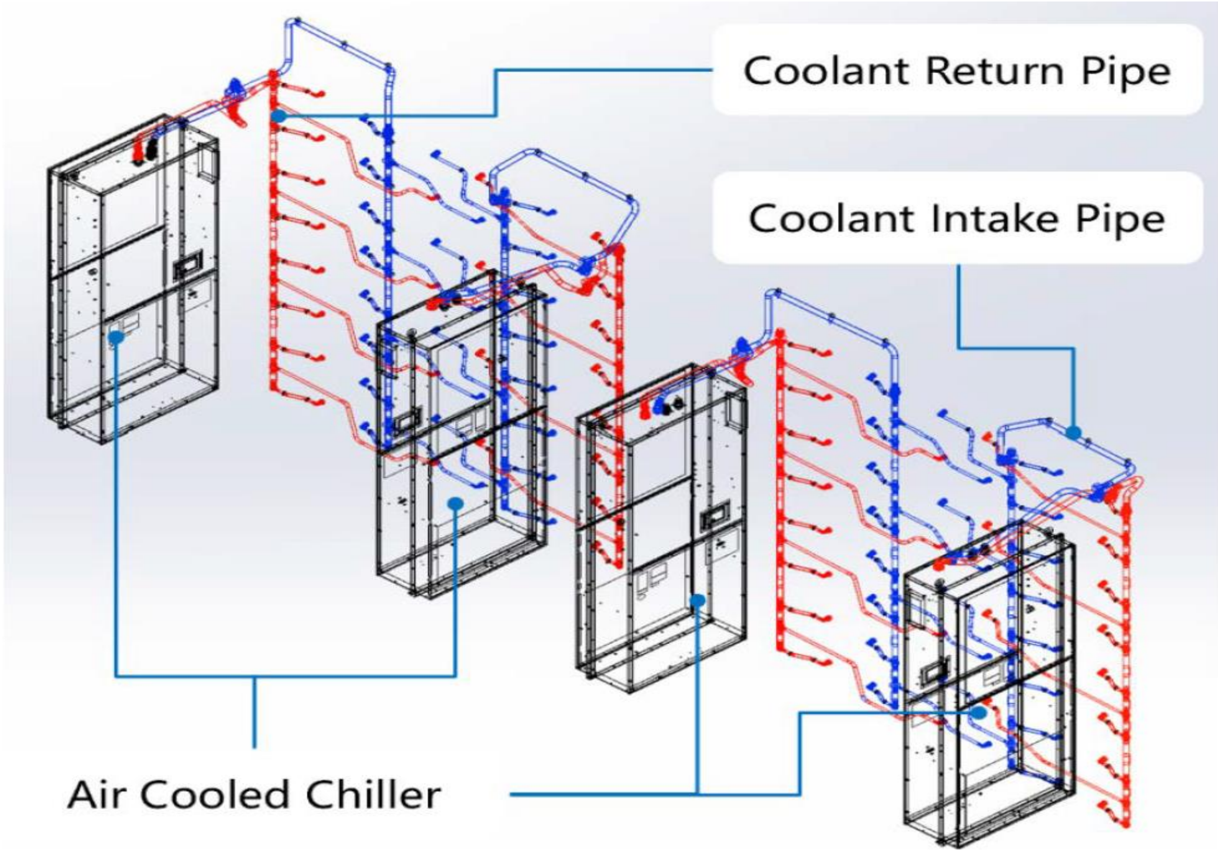

Figure 6: BESS (SolBank) Heating and Cooling System utilising Ethylene Glycol

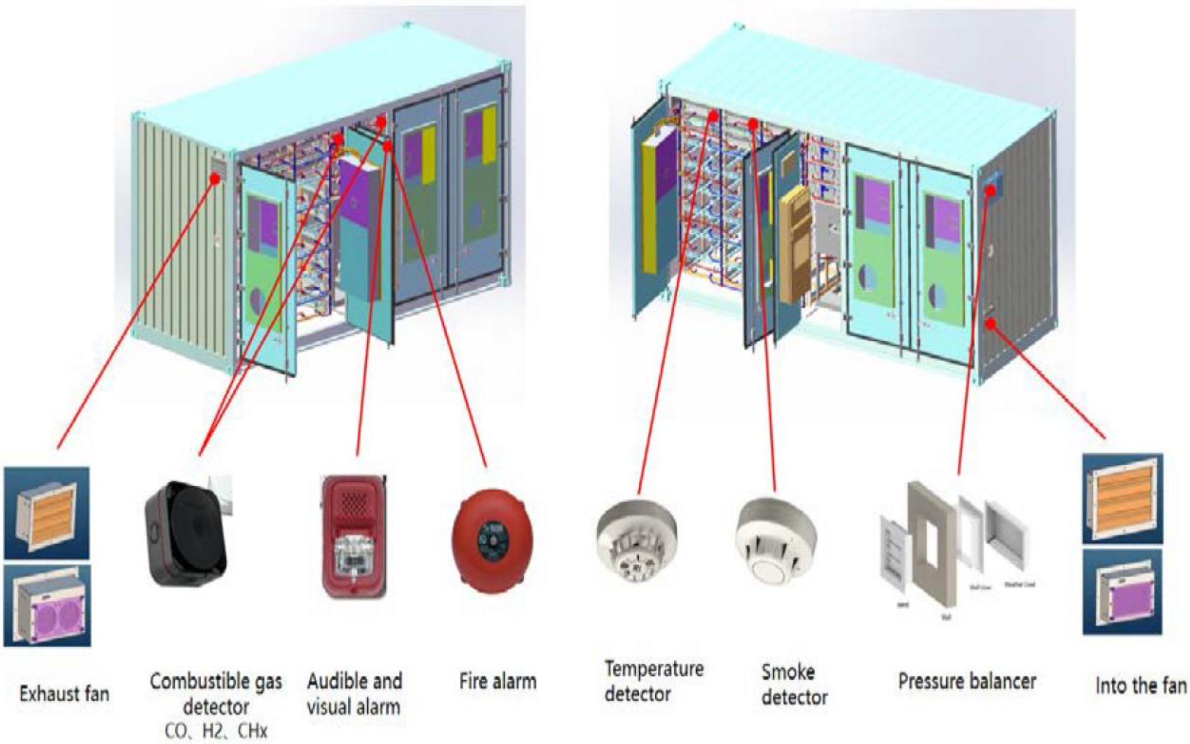

Figure 7: BESS (Solgate)-Fire monitoring and detection systems.

Figure 8: A BESS (Solbank) Heating Ventilation and Airconditioning Cooling (HVAC) system.

3.3 Ignition Management

3.3.1 Australian Fire Danger Rating System

The Fire Danger Rating (FDR) under the new Australian Fire Danger Rating System adopted on the 1st September 2022 calculates, forecasts and reports fire danger using up-to-date fuel state data, spatial and satellite data, weather data, science, and technology. It uses decades of research incorporated into eight fire behaviour models. The Fire Behaviour Index (FBI) which adopts values between 0 to 100 is used to review in finer detail and assist in better decision making within the four Fire Danger Ratings The higher the FBI the more dangerous the fire behaviour and therefore fire danger risk The four FDR categories are displayed in Figure 9.

Figure 9: Fire Danger Ratings

During both the solar farm construction and ongoing operational phase, consideration should be given to cease or modify potential ignition generating activities on elevated fire danger days. These are discussed in further detail in Section 3.3.2 and Section 3.3.3 below.

Daily forecast FDR and declared Total Fire Bans (as determined by the Bureau of Meteorology and the Country Fire Authority respectively) can be viewed at www.cfa.vic.gov.au/warnings-restrictions/total-fire-bans-and-ratings.

3.3.2 Solar Farm Construction

Should construction of the solar farm take place during a period of elevated bushfire risk, which based on the bushfire danger period would generally be expected to be between 1 October and 31 March on average for most years, the following mitigation measures are recommended to control the risk of grass fire ignitions during construction:

- Fire breaks to be constructed and maintained for the facility prior to infrastructure installation and building construction.
- All plant, vehicles and earth moving machinery are kept clean of any accumulated flammable material (e.g. soil and vegetation).

- All operations involving earth moving equipment, vehicles, slashers, hot works (e.g. grinders, welders) and any other works with potential to generate ignitions, cease while the FDR is or forecast to be Extreme or greater, unless in an area free of combustible materials.
- Controls are put in place to avoid or minimise the risk of other anthropogenic ignition sources such as from cigarettes, cooking fires, vehicles.
- All vehicles should contain a fire extinguisher and all activities with ignition risk potential should have a fire extinguisher readily available nearby and someone trained in how to use it.
- The handling and storage of flammable goods on the site is undertaken in accordance with AS1940-2017.
- Promote awareness amongst employees, contactors etc to prevent all potential fire ignitions within the subject site and especially on days of elevated fire danger (i.e. Extreme FDR or above) and / or TOBAN.

3.3.3 Solar Farm Ongoing Operations

To minimise the risk of fire ignitions, all operations involving earth moving equipment, vehicles, slashers, hot works (e.g. grinders, welders) and any other works with potential to generate ignitions, cease while the FDR is or forecast to be Extreme or greater, unless in an area free of combustible materials.

3.4 Fuel Management

It is assumed that there is potential for a fire to start and spread within the footprint of the solar farm. Fire ignitions could include lightning strikes, human error, electrical faults or arson. For this reason, it is recommended that vegetative fuels throughout the solar farm site are maintained in a minimal condition by grazing, slashing, mowing or herbicide treatment if required. This will minimise the radiant heat exposure to solar farm components and reduce the risk of a fire spreading beyond the solar farm, should an onsite fire occur. Where fuel management is not possible under the PV panels other lower risk ground cover should be considered e.g. mineral earth, gravel or non-curing ground cover vegetation.

It is recommended that a Fire Management Plan (FMP) be developed for the facility that includes a schedule of works implementation to establish and maintain fire breaks around both the site perimeter and all solar farm infrastructure to reduce the risk of fire impacting on the site or escaping the site to impact on assets within the broader community.

3.4.1 Fire Breaks

Table 5 shows the model requirements for fire breaks from Section 6.2.4 of the CFA Design Guidelines that are required to be addressed at the facility.

Table 5: Model requirements for fire breaks for Solar Farm Facilities

Model Requirements	Compliance Notes
Fire Breaks-All Facilities	
A fire break must be established and maintained around: • The perimeter of the facility, commencing from the boundary of the facility or from the vegetation screening inside the property boundary. • The perimeter of control rooms, electricity compounds, substations and all other buildings on- site.	**To Comply** A perimeter fire break of 10m wide to mineral earth is to be created and maintained around the site. Herbicides to be used to control vegetation regrowth within the fire break. Within the perimeter and BESS fire breaks, all structures within the temporary construction compound, BESS, PCU and around the PV solar panel arrays during the construction and operations phases will use mowing,

Model Requirements	Compliance Notes
The width of fire breaks must be a minimum of 10m, and at least the distance where radiant heat flux (output) from the vegetation does not create the potential for ignition of on-site infrastructure.	slashing, and herbicide treatment to achieve a low fuel load state with grass height to be maintained below 100mm during the bushfire danger period. Further consultation between the CFA and Urbis to confirm fire break requirements of a minimum of 10m for the solar farm facility provide adequate radiant heat protection.
Fire Breaks (Battery Energy Storage Systems)	
• A fire break must be established and maintained around battery energy storage systems and related infrastructure.	**Complies** A perimeter fire break of 10m wide to mineral earth is to be created and maintained around the BESS compound. Herbicides to be used to control vegetation regrowth within the fire break.

A fire break is typically designed to separate a vulnerable asset from the bushfire hazard (vegetation/fuel). The CFA Design Guidelines recommend that fire breaks are mineral earth, crushed rock or other fuel free land / non-combustible surface. Fire breaks 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, and where fire spread may be impeded, slowed or stopped.

Understanding the value and limitations of a fire break is important, as is the understanding that bushfires attack built assets by either flame contact, radiant heat or burning debris (i.e. embers). A fire break can be used to lower or eliminate the bushfire attack from flame contact and radiant heat around the perimeter of the solar farm towers facilities, but under winds of >25 kph burning debris can result in a fire breaching a fire break to ignite grassy fuel within other parts of the site. A fire emanating from the proposed development may also jump a fire break by burning debris triggering a spot fire downwind.

Despite the limitations of any firebreak, they provide one of the most valuable bushfire protection and mitigation strategies. A fire break will significantly reduce the likelihood of a bushfire spreading to the proposed infrastructure (particularly with regard to flame contact and excessive radiant heat) but will also significantly mitigate the risk of fire spread from an on-site ignition.

Where vegetation management around overhead powerline infrastructure is required to be undertaken, it should be in accordance with the ISSC3 guidelines (ISSC 2016).

3.4.2 Landscaping

Table 6 shows the model requirements for landscaping from Section 6.2.3 of the CFA Design Guidelines that are required to be addressed at the facility.

Table 6: Model requirements for landscaping for Solar Farm Facilities

Model Requirements	Compliance Notes
Landscaping Screening and On-Site Vegetation (Solar Farms)	
• Where practicable, low-flammability vegetation (such as root vegetables) may be planted under solar panels, provided foliage does not extend beyond the panel footprint.	**Can Comply** Any proposed planting of screening vegetation including trees and hedges to be low flammability vegetation and discontinuous in nature.

3.5 Hazard Management

The planning, design, construction, handling and storage of flammable goods on the site is undertaken in accordance with AS1940-2017.

Given the storage of flammable liquids on the facility site (to be determined post planning permit approval), Safe Work Australia (SWA 2009) recommends that external storage tanks be located outside and away from normal work area so as to segregate fuels from workers in the event of an incident. Storage tanks also where possible should be protected from impact and damage using bollards, barriers or fencing.

3.6 Infrastructure Risk Management

To identify an appropriate approach for the installation, equipment operation, monitoring systems, alarm systems, and fire suppression systems associated with fire protection of the proposed solar farm infrastructure, a Fire Safety Study (as per NSW Planning's Hazardous Industry Planning Advisory Paper 2: Fire Safety Study Guidelines (2011)) or equivalent assessment, should be undertaken at the post-approval stage of the project .

An inspection and maintenance schedule should also be developed and documented under a Fire Management Plan as per Section 9 of the CFA Design Guidelines for all solar infrastructure including BESS, PCS, PV panels and other electrical components to mitigate the level of risk and incidence of solar infrastructure fires occurring.

3.7 Emergency Response Resources

3.7.1 Emergency Vehicle Access

Table 7 shows the model requirements for vehicle access from Section 6.2.1 of the CFA Design Guidelines that are required to be addressed at the facility.

Table 7: Model requirements for vehicle access for Solar Farm Facilities

Model Requirements	Compliance Notes
Emergency Vehicle Access-All Facilities	
Construction of a four (4) metre perimeter road within the perimeter fire break.	**To Comply** Construction of 4m wide perimeter roads within the 10m perimeter firebreak around the facility to be incorporated into the design layout.
Roads must be of all-weather construction and capable of accommodating a vehicle of fifteen (15) tonnes.	**Can Comply** Roads to be engineered to accommodate the largest construction vehicle (a semi-trailer vehicle) entering and exiting the site exceeding 15 tonnes.
Constructed roads should be a minimum of four (4) metres in trafficable width with a four (4) metre vertical clearance for the width of the formed road surface.	**Complies** A 4m trafficable width entrance road together with a perimeter roads are to be constructed around the solar infrastructure (including BESS and sub-station is proposed). All roads to have no vegetation obstructions within 4m vertical clearance of the formed road surface.
The average grade should be no more than 1 in 7 (14.4% or 8.1°) with a maximum of no more than 1 in 5	**Can Comply** To be resolved in detailed design.

Model Requirements	Compliance Notes
(20% or 11.3°) for no more than fifty (50) metres.	
Dips in the road should have no more than a 1 in 8 (12.5% or 7.1°) entry and exit angle.	**Can Comply** To be resolved in detailed design.
Roads must incorporate passing bays at least every 600 metres, which must be at least twenty (20) metres long and have a minimum trafficable width of six (6) metres. Where roads are less than 600 metres long, at least one passing bay must be incorporated.	**To Comply** The perimeter road around the solar facility to be 4m wide and with passing bays provided every 600m to a length of 20m and width of 2m so as to make a total trafficable width of 6m.
Road networks must enable responding emergency services to access all areas of the facility, including fire service infrastructure, buildings, and battery energy storage systems and related infrastructure.	**Complies** The Solar Facility with BESS has a perimeter road around the BESS and the entire solar farm perimeter. This road provides direct access to the PV solar array panels, water tanks, BESS, Power Conversion Station (PCS) and the Customer Substation.
The provision of at least two (2) but preferably more access points to the facility, to ensure safe and efficient access to and egress from areas that may be impacted or involved in fire. The number of access points must be informed through a risk management process.	**Complies** The Solar Facility incorporates six (6) emergency access points, five (5) points off Little River-Ripley Road Little River and one (1) off the end of Mount Rothwell Road Little River.
Emergency Vehicle Access-Solar Energy Facilities	
Construction of a four-metre perimeter road and the incorporation of passing bays to perimeter roads may be disregarded for micro solar facilities <u>without</u> battery energy storage systems.	**Complies** To facilitate emergency vehicle access perimeter roads have been designed around the solar facility (including BESS) to be 4m wide and with passing bays provided every 600m to a length of 20m and width of 2m so as to make a total trafficable width of 6m.

3.7.2 Fire Fighting Water Supply

Given the proposed development is located on bushfire prone land and within a non-reticulated water supply area, provision of a fire water supply is critical to support fire fighting efforts undertaken by emergency services, should a bushfire incident occur adjoining on or within the subject site. Table 8 shows the model requirements for fire fighting water supply from Section 6.2.2 of the CFA Design Guidelines that are required to be addressed at the solar farm facility.

Table 8: Model requirements for fire fighting water supply for Solar Farm Facilities

Model Requirements	Compliance Notes
Firefighting Water Supply-All Facilities	
Water access points must be clearly identifiable and unobstructed to ensure efficient access.	**To Comply** Water access points (four locations) off Little River Road-Ripley Road to be clearly signed posted to indicate availability of static water supply on site. Access to the static water supply tank to be kept clear of any obstructions at all times.
Static water storage tank installations must comply with AS 2419.1-2005: Fire hydrant installations – System design, installation and commissioning.	**Not applicable** No hydrant system proposed.
The static water storage tank(s) must be an above-ground water tank constructed of concrete or steel.	**To Comply** The proposed 315,000L total static water storage supply tanks (7 x 45,000L) will be constructed of concrete or steel and located above ground on a hardstand area.
The static water storage tank(s) must be capable of being completely refilled automatically or manually within 24 hours.	**Complies** The static water storage tank to be at full capacity during facility operation. Tank water levels to be checked by the facility operator post fire activity and manually filled by water cart within a 24 hour period.
The static water storage tanks must be located at vehicle access points to the facility and must be positioned at least ten (10) metres from any infrastructure (solar panels, wind turbines, battery energy storage systems, etc.).	**To Comply** The seven (7) static water storage tanks to be located in close proximity to each of the site access road access points, and to be positioned 10m or more away from any infrastructure.
• The hard-suction point must be provided, with a 150mm full bore isolation valve equipped with a Storz connection, sized to comply with the required suction hydraulic performance. • Adapters that may be required to match the connection are: 125mm, 100mm, 90mm, 75mm, 65mm Storz tree adapters with a matching blank end cap to be provided.	**To Comply** A hard-suction point with Storz adaptor(s) to be connected to the tank to the specifications as detailed (left) for this requirement.
• The hard-suction point must be positioned within four (4) metres to a hardstand area and provide a clear access for emergency services personnel.	**To Comply** The hard suction point to comply with the specification as detailed (left) for this requirement.
• An all-weather road access and hardstand must be provided to the hard-suction point. The hardstand must be maintained to a minimum of 15 tonne GVM, eight (8) metres long and six (6) metres wide or to the satisfaction of the CFA.	**To Comply** The all-weather site access roads and BESS compound perimeter road along with hardstand provides access to the hard-suction point. The hardstand area to meet the minimum GVM and dimensions as detailed (left) for this requirement.
• The road access and hardstand must be kept clear at all times.	**To Comply** The access road and hardstand to be kept clear of obstructions at all times.

Model Requirements	Compliance Notes
• The hard-suction point must be protected from mechanical damage (eg. bollards) where necessary.	**To Comply** Concrete bollards or equivalent barrier system to be constructed to protect the hard-suction point.
• Where the access road has one entrance, a ten (10) metre radius turning circle must be provided at the tank.	**To Comply** A turning radius of 10m to be provided near each of the seven (7) tank locations. Vehicles are also able to turn around utilising the junction of nearby loop access and site access roads located off Little River Road-Ripley Road Little River.
• An external water level indicator must be provided to the tank and be visible from the hardstand area.	**To Comply** To be resolved in detailed design.
• Signage indicating 'FIRE WATER' and the tank capacity must be fixed to each tank.	**To Comply** To be resolved in detailed design.
• Signage must be provided at the front entrance to the facility, indicating the direction to the static water tank.	**To Comply** To be resolved in detailed design.
Fire Fighting Water Supply – Solar Energy Facilities	
The fire protection system for solar energy facilities must incorporate at least one (1) x 45,000L static water tank for every 100ha. For example, a 500ha site requires a minimum of five (5) x 45,000L static water tanks.	**Complies** A static water supply tank with a capacity of 315,000L (7 x 45,000L tanks) is to be provided on site.
A fire water tank must be located at the primary vehicle access point to the facility, and elsewhere in consultation with CFA.	**Complies** The fire water tanks are located in close proximity to each of the three respective road access points into the facility (see Figure 2).
• Fire water must be provided to cover buildings, control rooms, substations and grid connections, in consultation with CFA. • Additional fire protection systems or equipment required under any Australian Standards for dangerous goods must be provided as prescribed.	**To Comply** Seven (7) dedicated static water supply tanks to a total capacity of 315,000L to be provided near site entrances to protect onsite solar infrastructure. . Any equipment used for the storage and handling of flammable and combustible liquids on the site (diesel) to comply with the requirements of AS 1940-2004.
Fire Fighting Water Supply – Solar Energy Facilities (Micro Solar Facilities (up to and including 5MW)	
• For micro solar facilities, up to and including 5MW <u>without battery storage</u>, fire water of not less than 22,500 litres effective capacity may be provided. • Fire water tank(s) must be located at the primary vehicle access point to the facility. • Where micro solar facilities <u>include battery energy storage systems</u>, additional fire protection must be provided.	**Not applicable**
Fire Fighting Water Supply – Solar Energy Facilities (Battery Energy Storage Systems)	

Model Requirements	Compliance Notes
• For facilities with battery energy storage systems, the fire protection system must include at a minimum: ○ A fire hydrant system that meets the requirements of *AS 2419.1-2005: Fire hydrant installations*, Section 3.3: Open Yard Protection, and Table 3.3: Number of Fire Hydrants Required to Flow Simultaneously for Protected Open Yards. Except, that fire hydrants must be provided and located so that every part of the battery energy storage system is within reach of a 10m hose stream issuing from a nozzle at the end of a 60m length of hose connected to a fire hydrant outlet. OR	**Not applicable**
• Where no reticulated water is available, a fire water supply in static storage tanks, where: ○ The fire water supply must be of a quantity no less than 288,000L or as per the provisions for Open Yard Protection of *AS 2419.1-2005* flowing for a period of no less than four hours at 20L/s, whichever is the greater. ○ The quantity of static fire water storage is to be calculated from the number of hydrants required to flow from AS 2419.1-2005, Table 3.3. (E.g., For battery installations with an aggregate area of over 27,000m2, 4 hydrant outlets are required to operate at 10L/s for four hours, which equates to a minimum static water supply of 576kL.) ○ Fire hydrants must be provided and located so that every part of the battery energy storage system is within reach of a 10m hose stream issuing from a nozzle at the end of a 60m length of hose connected to a fire hydrant outlet. ○ The fire water supply must be located at vehicle entrances to the facility, at least 10m from any infrastructure (electrical substations, inverters, battery energy storage systems, buildings). ○ The fire water supply must be reasonably adjacent to the battery energy storage system and shall be accessible without undue danger in an emergency. (Eg., Fire water tanks are to be located closer to the site entrance that the battery energy storage system).	**To Comply** The facility contains 406 BESS battery cabinet container units. To meet water supply requirements a dedicated static fire water supply of 315,000L will be provided on site (7 x 45,000L tanks). As no reticulated water supply is available for the site, it is not proposed to connect the tank to a hydrant system. Fire water tanks to be located in close proximity to site entrance access points off Little River-Ripley Road and Mount Rothwell Road.. Given the gently undulating topography and managed pastoral land on site, the tanks will be clearly visible from each site entrance off Little River-Ripley Road and Mount Rothwell Road. Fire water supply to be located reasonably adjacent to the battery energy storage system. Further consultation between the CFA and Urbis to confirm these requirements on the site layout.

Model Requirements	Compliance Notes
○ The fire water supply must comply with *AS 2419.1-2005: Fire hydrant installations –* Section 5: Water storage.	
Fire Fighting Water Supply – Solar Energy Facilities (Substations)	
Fire water must be available to substations.	**To Comply** Static water supply tanks to be located within a reasonable distance from the site entrance and the substation facility off Mount Rothwell Road. Further consultation between the CFA and Urbis to confirm these requirements on the site layout.

3.7.3 Fire Response Equipment

An Emergency Management Plan (EMP) must be developed under Section 10 and Section 11 of the CFA Design Guidelines, which provides a list of equipment that needs to be checked and maintained and available before, during or after a fire emergency.

The range of fire equipment for inclusion in the plan would include, but not limited to the following:

- Torch / light bar;
- Reflective vest;
- Logbook and pen;
- Mobile phone (with up to date emergency contacts);
- UHF radio;
- Fire extinguishers;
- Water supply;
- Emergency information;
- Signage;
- Fire blankets;
- Personnel Protection Clothing and Personal Protective Equipment;
- Whistle;
- Handheld public address speaker; and
- First Aid Kit.

Documentation should also be included in the EMP detailing the operational procedures in which fire response is made to fire incidents involving BESS, PCS, PV panels and other electrical infrastructure so as to monitor, isolate, and restore facility operations.

3.7.4 Training

An EMP should be developed under Section 10 and Section 11 of the CFA Design Guidelines which identifies the need for new staff or associated contractors to undertake Bushfire / Other Fire Awareness training. The training would be focused on their role pre, during and post an emergency.

Training would also need to cover:

- Fire weather and fire behaviour;
- Emergency prevention, preparedness, and response;
- Use of fire fighting equipment; and

- Emergency response drill exercises.

3.8 Protection of Life (Emergency Management)

To protect human life during an emergency event(s) on the site, an EMP is to be prepared and maintained in accordance with Section 10 and Section 11 of the CFA Design Guidelines prior to construction commencing at the site.

The EMP is to detail the emergency procedures (including communications) that are necessary to conduct both onsite refuge or off site evacuation (where safe to do so) to prioritise the protection of life.

4. Conclusion

Overall, the potential risk of fire impacting on the proposed solar farm is considered to be low, given the background hazard context and landscape risk profile, its siting, construction, design and mitigation strategies. In addition, the solar farm is not expected to result in a noticeable increase in fire risk in the locality and to downwind assets and values.

This FRA can demonstrate compliance with both Section 5.3 of the CFA Design Guidelines (CFA 2022) model requirements and also the overall the aims and objectives as covered in Section 1.3. Although the proposed facility is situated predominately within a Bushfire Prone Area (BPA) and only partially within a Bushfire Management Overlay (BMO) the overall design layout (once all required compliances with the CFA Guidelines are addressed for the Barwon Solar Farm Facility) is considered to be appropriate within the identified lower fire risk environment comprised mostly of mixed farming, grazing, and cropping land management practices. This is supported further with additional mitigation strategies as covered in Section 3 which are compliant or can become compliant with the CFA Design Guideline requirements. Although some areas in the layout design are currently non-compliant with the CFA Design Guidelines, further consultation between Urbis and the CFA should be undertaken to discuss and refine design as required to meet the overall intent of the model requirements for solar farm facilities.

The mitigation strategies for the proposed development (detailed above in Section 3 and summarised below in Section 4.1) not only provide an appropriate level of risk reduction for the solar farm, but also a significantly lower risk of impacts from the solar farm facility to life, property, agricultural and environmental assets. Key mitigation measures include ignition prevention procedures; the provision of fire breaks/vegetation maintenance; bulk static water supply; emergency access provision to and around the site; design and systems for the prevention, monitoring and suppression of operational hazards; and sound emergency management arrangements.

4.1 Summary of recommended mitigation strategies

A suite of fire risk mitigation strategies are outlined in this report, which are summarised in Table 9.

Table 9: Summary of key recommended mitigation strategies and actions

Matter	Section of Plan	Mitigation Strategy
Model Design	3.2	Primary solar panel banks are separated throughout the solar farm facility by perimeter/internal access roads and / or fire breaks that equal or exceed 6m. A mineral earth fire break to a width of 10m is to be established and maintained around the entire perimeter of the BESS compound. To enhance the safety of emergency responders, the site layout to contain: • A total of six (6) site access gate points into and around the facility off Little River-Ripley Road and Mount Rothwell Road. • A 6m wide ring loop road around the BESS compound; • 10m wide firebreaks around the BESS compound and the entire solar farm facility; • Non-combustible static water supply tanks (seven) combined containing a total of 315,000 L dedicated to firefighting in the current design. • The BESS compound will be afforded barrier protection such as bollards to prevent potential damage from vehicle or machinery impact.

Matter	Section of Plan	Mitigation Strategy
		• Onsite safety and advisory signage. The potential for fires in BESS units is mitigated by being housed within fully enclosed non-combustible shipping containers modules, along with monitoring, safety and coolant fire suppression systems (see Figure 7 and Figure 8). This will mitigate the propagation of fire escape (together with adjoining fire breaks) both on and off site, should thermal battery runaway occur. BESS units to have all openable doors affixed with rubber protection strips to seal in a closed position against ember entry. All ventilator openings to be screened with metal mesh with aperture size no greater than 2mm to prevent ember entry. The BESS units will be installed on concrete foundations. The BESS units will have four ventilation points installed per housed shipping container. The BESS compound will be provided with perimeter barrier impact protection, being concrete bollards or a metal guard rail to prevent vehicle impact damage. Spill containment for the BESS units will be a concrete bund with a 400mm high retaining wall (approximate height), retention basin, or a combination of both. The bunded area will have a manual shut-off valve installed to the graded sump pit. A Fire Safety Study to be undertaken at the post-approval stage of the project (as indicated by the Fire Safety Study Guidelines) to ascertain adequate separation distance requirements of the BESS units to prevent fire spread between containers / enclosures.
Solar farm construction (Ignition Management)	3.3.1	If construction occurs during the bushfire danger period, the use of cutting and slashing machinery together with any hotworks is to be suspended on days of elevated fire danger ratings (i.e. Extreme FDR or above). A range of ignition prevention measures are to be implemented. An Emergency Management Plan is to be prepared and stored in an 'Emergency Information Cabinet' at the main entrance to the Facility and provided to local emergency services.
Solar farm ongoing operations (Ignition Management).	3.3.2	Maintain minimal fuel load in firebreaks by grazing, slashing, mowing, or by use of herbicides. OR through the use of mineral earth, crushed rock or other non-combustible ground cover . Vegetation management to occur around overhead powerline infrastructure in accordance with the ISSC3 guidelines (ISSC 2016). With the exception of emergencies, suspend site maintenance operations that pose an increased ignition potential on days of elevated fire danger ratings where the FDR is Extreme or above. Checking of, maintenance of, and training of staff in the use of fire detection and suppression systems. Training of staff in emergency management and evacuation procedures.
Fuel Management	3.4	A Fire Management Plan (FMP) be developed for the facility that includes a schedule of works implementation to establish and maintain fire breaks around both the site perimeter and all solar farm infrastructure to reduce the risk of fire impacting on the site or escaping the site to impact on assets within the broader community.
Fire Breaks	3.4.1	A fire break of 10m width is to be created and maintained around the perimeter of the site. A fire break of 10m width is to be created and maintained around the BESS compound.

Matter	Section of Plan	Mitigation Strategy
Landscaping	3.4.2	Any proposed planning of screening vegetation including trees and hedges to be low flammability vegetation and discontinuous in nature.
Hazard Management	3.5	The planning, design, construction, handling and storage of any flammable goods on the site (to be determined post planning permit approval) is undertaken in accordance with AS1940-2017. Any external flammable storage tanks be located outside and away from normal work area so as to segregate fuels from workers in the event of an incident. Storage tanks also where possible should be protected from impact and damage using bollards, barriers or fencing.
Infrastructure Risk Management	3.6	A Fire Safety Study to be undertaken at the post-planning permit approval stage of the project (as indicated by the Fire Safety Study Guidelines) to identify best practices for the installation, equipment operation, monitoring systems, alarm systems, and fire suppression systems associated with fire protection of the proposed solar farm infrastructure. An inspection and maintenance schedule should also be developed under a Fire Management Plan as per Section 9 of the CFA Design Guidelines for all solar infrastructure including BESS, PCS, PV panels and other electrical components to mitigate the level of risk and incidence of solar infrastructure fires occurring.
Emergency Vehicle Access.	3.7.1	A 4m wide road located within the firebreak around the BESS, is incorporated in the layout. The all-weather site access & perimeter roads to be engineered to accommodate to accommodate a large heavy vehicle (fire tanker) entering and exiting the site minimum 15 tonnes. All constructed roads to be a minimum of 4m trafficable width and to have no vegetation obstructions within 4m vertical clearance of the formed road surface. A 10m wide fire break provided around the perimeter of the entire facility providing informal access for emergency services.
Fire Fighting Water Supply	3.7.2	A 315,000L static water storage tank(s) capacity in total dedicated for fire water supply to be provided and constructed of concrete or steel and located above ground on a hardstand area. The water level to be maintained at full capacity during facility operation. Tank water levels to be checked by the facility operator post any fire activity and refilled within a 24 hour period. Water tanks are required to be positioned at least 10m or more away from nearby solar array, BESS, PCS, and substation, and other auxiliary transformer infrastructure. A hard suction point to be installed within 4 m of the hardstand area and readily accessible by emergency service personnel. An all weather access road and hardstand to be provided to all suction points. The installed hardstand area to be a minimum of 8m by 6m and support a minimum of 15 tonne GVM. The access road and hardstand to be kept clear of obstructions at all times. Concrete bollards or equivalent barrier system to be constructed to protect the hard-suction points. Provision of a 10 m radius turning area adjoining the static water supply tank. The tank to be fitted with a water a level indicator, and clearly sign posted as “fire water” and displaying available capacity. Access points to water supply to be clearly sign posted.
Fire Response Equipment	3.7.3	Development of an Emergency Management Plan (EMP)under Section 10 and Section 11 of the CFA Design Guidelines which provides a list of equipment that needs to be checked and maintained and available before, during or after a fire emergency.

Matter	Section of Plan	Mitigation Strategy
		The EMP to also detail the operational procedures in which fire response is made to fire incidents involving BESS, PCS, PV panels and other electrical infrastructure so as to monitor, isolate, and restore facility operations.
Training	3.7.4	Development of an Emergency Management Plan under Section 10 and Section 11 of the CFA Design Guidelines which identifies the need for new staff or associated contractors to undertake Bushfire / Other Fire Awareness training.
Protection of Life (Emergency Management)	3.8	An Emergency Management Plan is prepared and maintained in accordance with Section 10 and Section 11 of the CFA Design Guidelines prior to construction commencing at the site addressing emergency management procedures for onsite refuge and off site evacuation.

5. References

Backstrom R. and Dinni D.A. 2011. *Firefighter Safety and Photovoltaic Installations Research Project.* Underwriters Laboratories Inc., Northbrook, USA.

Bureau of Meteorology (BOM) 2021. *Bureau of Meteorology (BOM) national gridded dataset for Forest Fire Danger Index (FFDI).*

Cary, G (2011) ENVS6204 Lecture 3.2 Fire Regime, Australian National University.

Cheney N.P., Gould J.S. Catchpole W.R. 1998. Prediction of Fire Spread in Grasslands. *International Journal of Wildland Fire* 8, 1-13.

Cheney N.P., Sullivan, A.L. 2008. *Grassfires: Fuel weather and fire behaviour*. CSIRO Publishing 2nd Edition, Collingwood, Vic.

Country Fire Authority (VIC). 2022. *Design Guidelines and Model Requirements Renewable Energy Facilities Version 3, March 2022*. CFA Specialist Risk and Fire Safety Unit.

Department of Environment, Land, Water & Planning 2022. *Fire history overlay of most recent fires - Dataset - Victorian Government Data Directory.*

Department of Environment, Land, Water & Planning 2018. *Native Vegetation - Modelled 2005 Ecological Vegetation Classes (with Bioregional Conservation Status).*

Gould, J.S 2008. *Project Vesta: Fire in Dry Eucalypt Forest: Fuel Structure, Fuel Dynamics and Fire Behaviour.*

Standards Australia (SA). 2017. *AS 1940:2017 – The storage and handling of flammable and combustible liquids.*

Safe Work Australia (SWA). 2009. *Managing risks of storing chemical in the workplace.*

The Industry Safety Steering Committee (ISSC). 2016. *Guide for the Management of Vegetation in the Vicinity of Electricity Assets.*

ADVERTISED
PLAN

eco
logical
AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au