Suntop Solar Farm Bushfire Risk Assessment

Prepared for
Pitt & Sherry (Operations) Pty Ltd

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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.
Bushfire Attack Level (BAL)	A means of measuring the severity of a building's potential exposure to ember attack, radiant heat and direct flame contact, using increments of radiant heat expressed in kilowatts per metre squared, which is the basis for establishing the requirements for construction to improve protection of building elements from attack by bushfire.
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.
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
APZ	Asset Protection Zone
BAL	Bushfire Attack Level
ERP	Emergency Response Plan
GFDI	Grassland Fire Danger Index
RFS	New South Wales Rural Fire Service

1 Introduction

1.1 Background

Photon Energy (Photon) propose to construct and operate a 220-megawatt (MW) solar farm using photovoltaic (PV) technology at a 502-hectare site (the “Subject Land) in Suntop, NSW. The solar farm would occupy 472 hectares (the “Site”) out of the 517 hectares (equivalent to approximately 91% of the Site). An estimated 550,000 PV panels would be installed at a fixed angle or on a single axis tracker system across the Site.

Map 1 indicates the location of the site which is approximately 10 km southwest of the town of Wellington.

A detailed description of the site and the proposal was prepared by Pitt and Sherry (2018). The descriptions provided here relate specifically to the fire environment and risks.

1.2 Aims and objectives

This bushfire management plan has the following aims:

- Address the requirements identified in the Secretary’s Environmental Assessment Requirements (SEARs) (**Table 1**)
- Recommend mitigation actions 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

Table 1: Where the SEARs requirements are addressed in this document

SEAR	Section of this document
Bushfire hazard (although not mapped as Bushfire Prone Land)	2.2, 2.3, 2.4, 2.5
10 m trafficable defendable space (fire break)	3.2
Water storage	3.8
Setback requirements (Clause 45 SEPP)	3.3
An assessment of potential hazards and risks associated with bushfires	2.1 to 2.8

2 Bushfire Risk Assessment

2.1 Fire climate

Fire climate strongly influences the likelihood of ignitions and how often, here expressed as the average number of days per year, when fires will be uncontrollable without mitigation measures. Data from the Bureau of Meteorology weather station at Wellington (site 065034 D&J Rural), which is 10 km from the solar farm site, indicate the frequency of occurrence of grassland fire weather **Table 2**. A GFDI of 25 to 49 (Very High fire danger) occur on average 1.0 days per year, while days of GFDI >50 are very rare – three Severe/Extreme days recorded in 38 years. GFDI could not be calculated for 18.4% of the 3 pm records because of incomplete data and a random distribution of missing records should be assumed (i.e. 1.2, not 1.0, days per year of GFDI 25-49).

Table 2: Average number of days per year of daily Grassland Fire Danger Rating and GFDI categories at 3 pm at Wellington (D&J Rural)

Fire Danger Rating & GFDI	Average Days per Year
Catastrophic (150+)	0.0
Extreme (100-149)	0.03
Severe (50-99)	0.1
Very High (25-49)	1.0
High (12-24)	4.4
Low-Moderate (0-11)	285.2
Incomplete	65.4
Total	356.1

Daily records at 3 pm from 1980 to 2017.

High fire danger conditions or worse for grass fires occur in the months of December, January, February and March and rarely, if at all, in the other months (**Table 3**).

Table 3: Number of days in each month of daily Fire Danger Rating and GFDI categories at 3 pm at Wellington (D&J Rural)

	Incomplete	Low-Moderate (0-11)	High (12-24)	Very High (25-49)	Severe (50-99)	Extreme (100-149)	Catastrophic (150+)
January	284	821	65	17	0	0	0
February	194	843	31	5	1	0	0
March	257	872	38	9	1	1	0
April	200	940	0	0	0	0	0
May	174	1004	0	0	0	0	0
June	144	996	0	0	0	0	0
July	121	1057	0	0	0	0	0
August	266	912	0	0	0	0	0
September	194	946	0	0	0	0	0
October	239	939	0	0	0	0	0
November	202	938	0	0	0	0	0
December	277	855	37	9	0	0	0
Totals	**2552**	**11123**	**171**	**40**	**2**	**1**	**0**

Daily records at 3 pm from 1980 to 2017.

The wind directions associated with Very High or worse grassland fire danger are predominantly west but significant fire weather from all other wind directions can occur (**Table 4**). Days of significant grassland fire danger with a southwest wind direction that would carry a fire towards the town of Wellington are very rare (approximately 1.3 per decade).

Table 4: Number of days in eight wind direction categories with significant grass fire weather at 3 pm at Wellington (D&J Rural)

Wind Direction	Total	Total No. of days GFDI >=25	Avg. No. days per year GFDI > =25	Total No. of days GFDI >=50	Avg. No. days per year GFDI > =50
N	3420	5	0.13	0	0.00
NE	771	1	0.03	0	0.00
E	785	2	0.05	0	0.00
SE	649	1	0.03	0	0.00
S	912	2	0.05	0	0.00
SW	2502	5	0.13	0	0.00
W	1683	19	0.49	3	0.08
NW	1377	7	0.18	0	0.00
Incomplete	1790				
Totals	13889	42	1.08	3	0.077

Daily records at 3 pm from 1980 to 2017.

2.2 Fuel hazard

Although the surrounding vegetation is not mapped as bushfire prone land, there is still a bushfire risk. The area surrounding the site is entirely modified agricultural land utilised primarily for cropping and grazing with very little native vegetation. Scattered trees are located throughout the site but the intention is to remove all of these; there is a small number of scattered trees on adjoining land. The boundary of the site has many avenues of planted eucalypts and the intention is to retain these and plant more for screening. Several small areas of forest and woodland are located more than 140 m from the site boundary.

Any significant bushfire around the site would occur in crops, stubble or pasture. The main crops in the area are wheat and lucerne.

The PV panels will be made of glass with aluminium frames. Photon provided 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. Photon Energy has installed large scale solar farms across Europe and has no issues with fires.'

The proponent also advised that the solar panels to be used meet the IEC 61730 (Class C) 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. A fire could still spread in this fuel under severe fire weather conditions (see **Section 2.3**).

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 at this stage, because a case history (i.e. previous fire records from fire agencies and solar farm sites) and or experiments are required for similar environments, climate and solar farm components, ideally from within Australia. No data was found from within Australia, however, 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.

2.3 Fire behaviour potential

Crops and pasture surround the site and are the main fuel for bushfires. There will be periods when the site will be non-flammable because they are either fallow, too green to burn or are recently planted. There will also be periods when some crops are cured and highly flammable. However, given the variability in time and space of crops as a potential fuel, the grassland fire spread model for 'cut/grazed pastures' (Cheney et al 1998) has been chosen for predicting bushfire behaviour potential (Cruz et al 2015).

The fire behaviour potential for this site in crops and pasture is summarised in **Table 5** applying the following parameters:

- grassland fire spread model for 'cut/grazed pastures';
- the range of weather conditions that could occur at the site during the bushfire season (**Section 2.1**); and
- Upslope fire run (1.5 degrees) because the site rises gently from west to east on the west side of the site (**Map 2**).

The rate of spread and fire intensity values in **Table 5** indicate that fires in cured pasture and crops at this site can be very fast moving and intense; and direct attack on such a grass fire will usually fail at GFDI >49 (Cheney and Sullivan 2008). An ignition point 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.

Table 5 shows the firebreak width required for a 99% probability of holding a head fire in grass, applying and extrapolating from the model developed by Wilson (1988). 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 at this site (**Section 2.1**), a fire break of even 40 m width may fail to stop a grass head fire (Cheney and Sullivan 2008). The trees within 20 m of a fire break would significantly increase the spotting potential (**Map 2**). Therefore, the fire break widths indicated in **Table 5** may only be reliable up to Very High fire danger and in the absence of trees.

Table 5: Fire behaviour predicted for grassland fires for 'cut/grazed' fuel (Cheney et al 1998)

Grassland Fire Danger Rating and GFDI[1]	Wind speed (km/h)[2]	Temperature (°C)	Relative Humidity (%)	Fuel Moisture Content (%)	Rate of Spread (km/h)	Head Fire Fireline Intensity (kW/m)[3]	Firebreak Width (m)[4]
Extreme (100-149)	60	40	17	3.7	16.4	22,583	13.7
Severe (50-99)	45	40	17	3.7	12.7	17,525	12.0
Very High (25-49)	35	34	17	5.0	8.9	12,249	10.2
High (12-24)	30	28	28	7.7	5.8	7,909	8.7
Low-Moderate (0-11)	20	23	38	10.1	3.0	4,161	7.4

1. GFDI value within the range for the given fire danger rating, based on wind speed, temperature and relative humidity typical for Wellington (**Section 2.1**).
2. 10 m height measurement for wind speed.
3. Upslope fire spread 1.5 degrees.
4. Heat yield for fuel kJ/kg = 16,500; fuel load = 3 t/ha.
5. Firebreak width required for 99% probability of holding a head fire, relative to fire intensity (after Wilson 1988, extrapolated for Severe and Extreme).

It should be assumed that, under the most extreme weather, a fire would spread between and under solar panels even in heavily grazed grass and embers may breach any fire break.

Table 6 indicates the rate of spread and fire intensity values for 'eaten out pastures' and while the rates of spread are considerably lower compared to 'cut/grazed pastures', 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 and high radiant heat.

Table 6: Fire behaviour predicted for grassland fires for 'eaten out' fuel (Cheney et al 1998)

Grassland Fire Danger Rating and GFDI[1]	Wind speed (km/h)[2]	Temperature (°C)	Relative Humidity (%)	Fuel Moisture Content (%)	Rate of Spread (km/h)[3]	Head Fire Fireline Intensity (kW/m)[4]	Firebreak Width (m)[5]
Extreme (100-149)	60	40	17	3.7	8.5	5,836	8.0
Severe (50-99)	45	40	17	3.7	6.6	4,529	7.5
Very High (25-49)	35	34	17	5.0	4.6	3,166	7.1
High (12-24)	30	28	28	7.7	3.0	2,044	6.7
Low-Moderate (0-11)	20	23	38	10.1	1.6	1,075	6.4

1. GFDI value within the range for the given fire danger rating, based on wind speed, temperature and relative humidity typical for Wellington (**Section 2.1**).
2. 10 m height measurement for wind speed.
3. Upslope fire spread 2 degrees.
4. Heat yield for fuel kJ/kg = 16,500; fuel load = 1.5 t/ha.
5. Firebreak width required for 99% probability of holding a head fire, relative to fire intensity (after Wilson 1988).

The preceding discussion identifies the potential consequence (in fire behaviour terms) of a fire burning under different weather and an assumed site condition. The likelihood of a fire ignition at a point where the pattern of existing crops can carry a fire to or from the site under the wind and weather conditions investigated has not been calculated. However, it is expected to be a low probability and the ignition risk and fire history discussed below seem to support this assumption.

2.4 Fire ignitions

Bushfires occur in most years in this district, typically started by accidents such as escaped burns, machinery and hot works (e.g. welding). Lightning fires are uncommon. There are no ignition occurrence records for the site or nearby that provide statistical validity or a guide to likelihood of nearby ignition.

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. Therefore, construction and ongoing maintenance of the solar farm will be a potential source of ignitions from December to March.

The solar panels are non-reflective and present no risk of ignitions from concentrated solar energy. Ignitions from other PV equipment is theoretically possible from electrical faults such as arc faults, short circuits, ground faults and reverse currents (Allianz Risk Consulting 2012). The proponent advised that arcing issues are normally created from the following:

- incorrect connecting of the inter module connectors
- corroded inter module connectors caused from incorrect storage of modules on site
- electrical connections on isolators / DC combiners
- miss match of inter module connectors causing insufficient electrical connections

The proponent also advises that: 'All the above issues are caused during the installation process but are standard issues that will be picked up during the DC testing phases of the install before commissioning'.

It is conceivable that arcs or melted components resulting from a fault could ignite grass fuels under or surrounding installations and start a bushfire. However, 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 farm operations (e.g. crop harvesting) relative to solar farm operation (see also **Section 2.2**).

2.5 Fire history

Mapped fire records of the Rural Fire Service from 2001 to 2017 were examined and indicate that there were 14 grass or bush fires within 20 km of the site over this period, ranging in size from 0.3 to 56 ha, none closer than 3 km from the solar farm site. The area is regarded as low risk for bushfires; fires are usually small and controlled by direct attack (Peter Fothergill RFS, pers. comm.).

2.6 Assets at risk

The following assets are located on site or within 2 km of the proposed solar farm:

- various agricultural crops
- stock (sheep and cattle)
- fences
- 6 residences (within 1 km)
- radio receivers

The town of Suntop is located approximately 10 km to the northeast.

All of these assets, including the PV panels and other components of the solar farm, are at risk from a bushfire that may propagate within the solar farm, or from an external fire threat.

2.7 Fire-fighter and public safety

The usage of the general area surrounding the site is mostly limited to landowners, who are farmers, and the operators of the solar farm site.

The fire-fighters likely to respond to a bushfire in this area would be volunteers from the Rural Fire Service and or individual property owners. If the solar farm is designated by Fire & Rescue NSW as major infrastructure, then brigades from Wellington town could 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 of DC current can only occur external to any solar array because there is no single point of disconnect internally (Backstrom and Dinni 2011);
- safe use of water spray or foam application is only possible from the perimeter of the solar panelled portion of the farm and could not reach the 250 to 500 m required to reach the furthest internal distance; and
- inhalation of potentially toxic fumes and smoke from any plastic 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).

The materials for individual components within the solar farm infrastructure have not yet been finalised, therefore, the flammability and toxicity of burning components cannot be determined in detail at this time. The proponent, however, advises that 'the burning of materials such as the backing sheet and ethylene vinyl acetate (EVA) will produce hazardous gasses and therefore may require breathing apparatus'. Thus, the level of risk from burning solar panel components is difficult to quantify, exacerbated by the limited experience in Australia with bushfires in similar installations. Any fire-fighters from the Rural Fire Service or neighbouring farms attending bushfires in this area will not be equipped with breathing apparatus and are unlikely to be trained in structural and electrical fire-fighting.

2.8 Bushfire scenarios

Two worst case bushfire scenarios have been considered for the purpose of understanding risk based on the fire climate, fuels, fire behaviour potential and fire history; they assume no risk mitigation strategies:

1. A large, landscape scale bushfire occurs on a day with GFDI of 49 or similar, west wind direction and at a time when crops adjacent to the solar farm are cured. The fire started well to the west and the entire solar farm boundary on the approach side is impacted by head fire. The likelihood of such a fire occurrence is low, given the fire history of the area, but it is still possible given the fire climate and fire behaviour potential. A substantial or complete fire encroachment on all PV equipment could be expected. The impact of this relatively short (but potentially intense) fire exposure on the PV equipment is not known.

2. An electrical fault ignites grass under a PV panel on a day with GFDI of 49 or similar, west wind direction and at a time when crops adjacent to the solar farm are cured. The fire spreads to the east for several kilometres destroying many crops, stock and fences. Liability for losses and potentially suppression costs are potentially sought from those responsible for the ignition cause e.g. as occurs with electricity distribution companies. As for the first scenario, the likelihood of such a fire is low.

A risk of a major fire spreading from the solar farm in the direction of the township of Wellington is low, based on the wind direction associated with significant fire weather, but still possible (**Table 4**).

3 Mitigation Strategies

3.1 Overview

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

- Fuels, weather, topography, predicted fire behaviour;
- Spatial patterns and frequency of unplanned ignitions;
- Suppression capability: resources (air and ground), access (roads, tracks) and water; and
- Values and assets: people, buildings, commerce, industry, services and the natural environment.

Mitigation strategies are also guided by evidence of efficacy of available treatment options. 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.

During the preparation of this plan, discussions were held with officers of the Rural Fire Service at Gunnedah and Dubbo. Advice from these officers was provided on the following:

- fire history and causes: this is a low risk site
- local fire-fighting resources: primarily RFS volunteers
- mitigation measures: recommended fire breaks, water storage and emergency response plan
- fire suppression: fire-fighters unlikely to operate amongst solar panels

3.2 Asset Protection Zone

An Asset Protection Zone (APZ) is typically designed to separate a vulnerable asset from the bushfire hazard (vegetation/fuel). An APZ is either a lower fuel hazard such as mown or heavily grazed grass or a fire break of ploughed or fallow ground. 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, but under winds of >25 kph burning debris can result in a fire breaching a perimeter APZ to ignite grassy fuel within the solar farm itself. A fire emanating from the PV panels may also jump a perimeter APZ by burning debris under similar conditions

Despite the limitations of any APZ it is recommended that a perimeter APZ/fire break be established around the solar farm. An APZ/fire break will significantly reduce the likelihood of a bushfire spreading into the solar farm or from the solar farm into surrounding farmland.

The specifications recommended for the perimeter APZ/fire break are as follows:

- 15 m width for the entire perimeter of the solar farm footprint, with 20 m wide abutting the remnant or planted treed areas.
- the external edge of the APZ setback at least 25 m from the external edge of PV panels or other components.
- mineral earth fire break i.e. dirt or gravel.
- no trees and shrubs planted on the internal side of the fire break.
- APZ preferably located external to any security fence.
- access track located on the internal edge of the APZ, that is trafficable by Category 1 fire appliances.

These specifications will ensure the risk of a fire propagating across the APZ is minimised and that burning embers will not spot across the APZ, except under very high winds.

Trees and shrubs abutting the APZ on the side of an approaching fire will significantly increase the risk of burning embers carrying across the fire break and therefore the fire continuing to spread on the other side (Cheney and Sullivan 2008). Therefore, the planting of 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 but not vice versa. Any of 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)
- increase the width of the APZ (hence the 20 m stated above)
- increase the distance between the trees and the APZ

The objective for the setback of the APZ is to reduce the radiant heat to less than 10 kW/m^2 which is the level at which plastics and rubber components are expected to melt/burn. This is based on a fire intensity of 22,583 kW/m. The placement of the access track on the inside of the APZ is to ensure safety to fire-fighters by reducing radiant heat exposure to fire-fighters.

3.3 The substation

The substation should have a 20 m asset protection zone around all potentially critical components e.g. anything rubber or plastic or with a lower ignition point. There is to be no combustible vegetation within the substation APZ e.g. a gravel surface.

3.4 Solar farm construction

Should construction of the solar farm take place between 1 December and 31 March (see **Table 3** for data on seasonal occurrence of fire weather), the following measures are recommended to control the risk of grass fire ignitions:

- the APZ/fire break is 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);
- a suitable fire appliance is present on site with at least two personnel trained in bushfire fighting;
- on days when Very High fire danger or worse is forecast for Wellington, 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 GFDI is or forecast to be 35 or greater (Rural Fire Service 2018).

3.5 Solar farm ongoing operations

Fuel management within solar farm

It is assumed that a grass fire may start and spread within the footprint of the solar farm (see **Sections 2.3 and 2.4**); 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. If grazing or slashing is not possible under the panels other lower risk ground cover should be considered e.g. gravel or a non-curing ground cover and/or a very low above ground biomass.

Days of Very High or worse fire danger

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 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.

Fire-fighter safety

The safety hazards for fire-fighters from PV panels (**Section 2.7**) 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 several kilometres within an hour (**Section 2.3**). Fire suppression is most likely only to be feasible from the APZ or beyond and no internal access for fire-fighting is proposed.

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 because such equipment could not be utilised safely and effectively.

An Emergency Response Plan (ERP) should be prepared for the solar farm that provides the following:

- addresses foreseeable on-site and off-site fire events
- activation of water spray systems and any other response/protection measures
- 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
    - a safe method of shutting down and isolating the PV system (or noting if this is not possible for safe internal access)
    - any other risk control measures required to be followed by fire-fighters
- evacuation triggers and protocols
- suppression response strategies and tactics, including aerial suppression options/management

Two copies of the ERP should be permanently stored in a prominent 'Emergency Information Cabinet' to be located at the main entrance point to the solar farm, external to any security fence or locked gate, and a copy provided to local emergency responders (**Map 2**).

Once constructed and prior to operation, contact should be made by the site operator with the Local Emergency Management Committee to establish emergency management procedures with relevant authorities for the safety hazards presented by the site. The operator of the solar farm should brief the local volunteer fire brigades and neighbouring farmers at appropriate intervals, for example, at annual pre-season fire meetings, on safety issues and procedures.

3.6 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 (see **Section 2.3**). 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 and circuitry (e.g. metal conduit)

Design of shielding should ideally be informed by experimental testing of components in a laboratory situation that simulates the flame temperature and residence time of a grass fire under extreme weather conditions (e.g. GFDI 100) and low fuel load (1.5 t/ha).

3.7 Fire risks from PV system

All electrical equipment will comply with relevant construction standards and design; installation of electrical equipment such as junction boxes, inverters, transformer and electrical cabling is to be in accordance with AS 3000:2007 Wiring Rules.

It is recommended that research be undertaken into the ignition, flammability and toxicity risks of the solar farm components once the design has been finalised. This information will be required to improve or streamline bushfire mitigation measures for the solar farm. For example, design of shielding of components and schedules for routine maintenance checks may benefit from evidence on potential equipment caused ignitions.

3.8 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 A storage of 50,000 litres is recommended, based on refilling six tanker units (4,000 litres) twice each (local RFS Superintendent pers. comms).

3.9 Summary of recommended mitigation strategies

Table 7 summarises the bushfire mitigation strategies and recommendations made in this document.

Table 7: Summary of recommended mitigation strategies and actions

Mitigation Strategy	Section of Plan	Action
Asset Protection Zone (APZ)	3.2	APZ of mineral earth firebreak, 15 to 20 m wide, setback 25 m from perimeter of solar farm components.
Substation	3.3	APZ 20 m with no internal vegetation (i.e. gravel surface).
Solar farm construction	3.4	If construction occurs from December to March: APZ constructed first, fire appliance on site and machinery/hot works suspended when GFDI >=35.
Solar farm ongoing operations	3.5	Maintain minimal fuel load by grazing, slashing or mowing. Under panel fuels minimised. No vegetation within the Substation. Suspend site maintenance operations when GFDI >=35.
Fire-fighter safety	3.5	Avoid fire-fighting within footprint of solar farm. Avoid operating downwind of smoke from burning solar farm components. Emergency Response Plan prepared and stored at ‘Emergency Information Cabinet’ at main entrance to solar farm and provided to local emergency responders. Include aerial suppression options/management.
Shielding of solar farm components	3.6	Shield all heat sensitive components from potential flame contact.
Investigate further the fire risks from solar farm components	3.7	Research ignition, flammability and toxicity risks of solar farm components.
Water storage	3.8	Designed to supply fire tanker units (50,000 litre storage) near solar farm entrance.

4 Cumulative Impacts

The cumulative impacts related to bushfire mitigation and other major developments in the area are as follows:

- *Volunteer fire-fighter workload* – Response call outs should not increase because the ignition risk will be very low and possibly lower than the risk from surrounding agricultural activities. There will, however, be an ongoing requirement for briefing on the Emergency Response Plan.
- *Construction stage transport and road use* – The bushfire mitigation infrastructure (i.e. fire breaks, and water storage) will add a small percentage to the total construction traffic and road use.
- *Ongoing operations* – there would not be any cumulative operational impacts.

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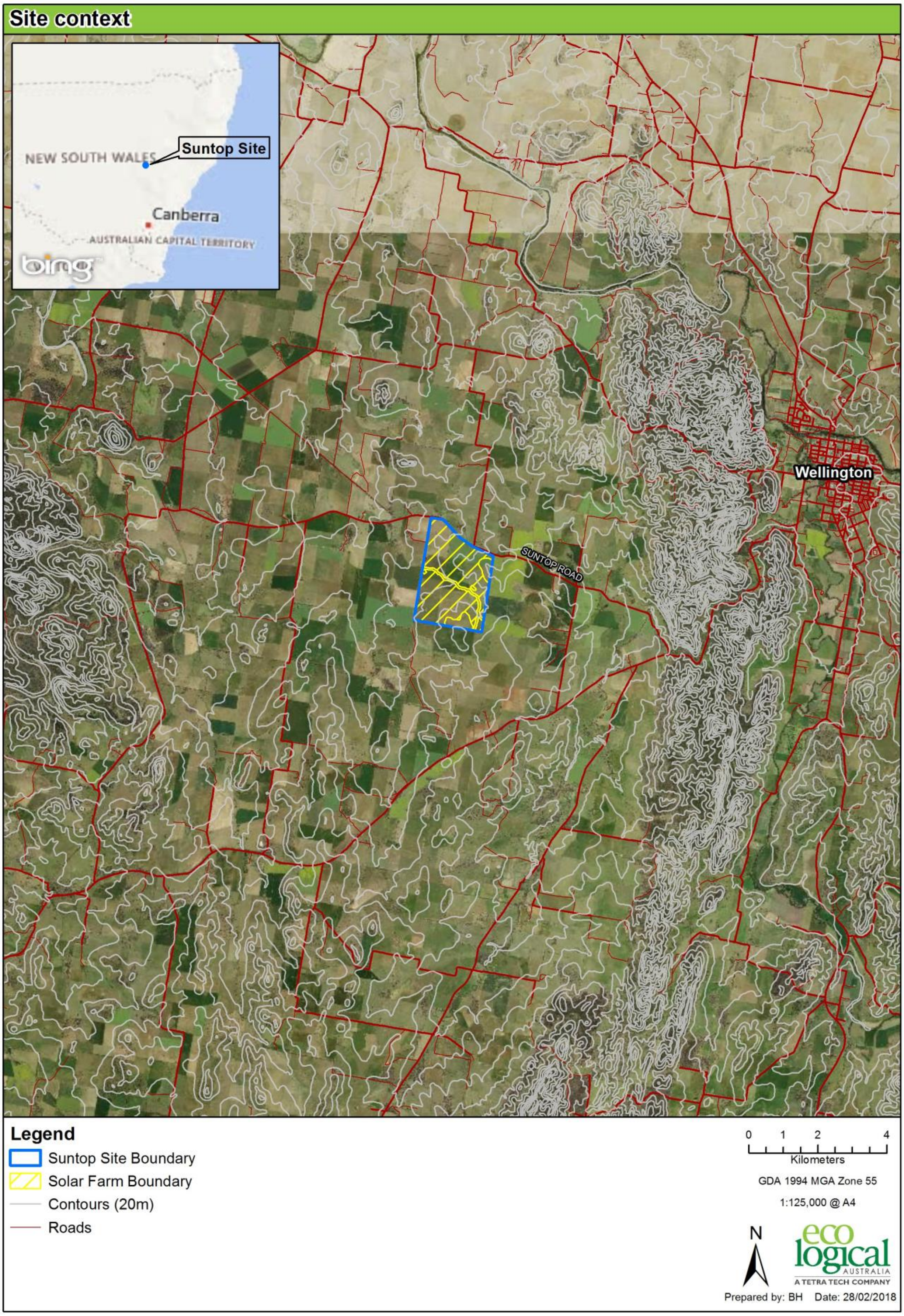
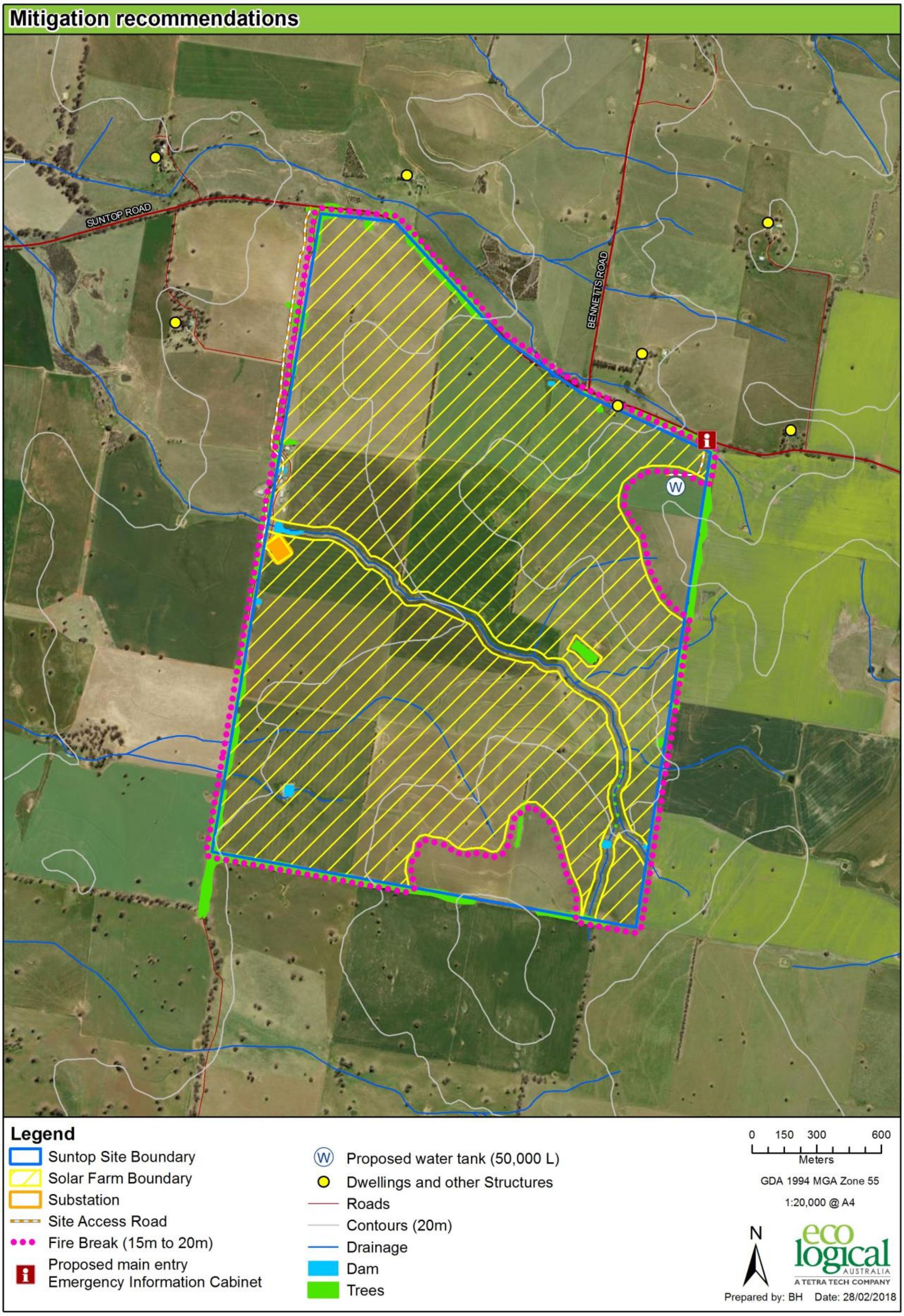
Appendix A - Maps



Map 1: Site Context



Map 2: Mitigation recommendations

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