BUSHFIRE PRONE PLANNING

Kojonup BESS

Bushfire Risk Report

Assessments of Risk Levels and Risk Management

3680 Collie-Changerup Road, Kojonup

Shire of Kojonup

11 May 2026

Job Reference No: 241243

BPP GROUP PTY LTD T/A BUSHFIRE PRONE PLANNING

ACN: 39 166 551 784 | ABN: 39 166 551 784

SUITE 11, 36 JOHNSON STREET
GUILDFORD WA 6055

PO BOX 388
GUILDFORD WA 6935

08 6477 1144 | admin@bushfireprone.com.au

DOCUMENT CONTROL

PREPARATION		
Author:	Neil Stoney (BPAD Level 1 No. 58627)	
Reviewed:	Mike Scott (BPAD Level 3 No. 27795)	

VERSION HISTORY		
Version	Details	Date
1.0	Draft 1 for client review	3 February 2026
1.1	Draft 2 for client review	17 April 2026
1.2	Original for submission	11 May 2026

DISTRIBUTION					
Destination		Version	No. Copies	Hard Copy	Electronic Copy
Person	Email				
Eliza Budd	eliza.budd@mintrenewables.com	1.0	1	☐	☒
Ali Whittaker	ali.whittaker@mintrenewables.com	1.1	1	☐	☒
Ali Whittaker	ali.whittaker@mintrenewables.com	1.2	1	☐	☒

Limitations: *The protection measures contained in this Bushfire Risk – Assessment and Management Report, are considered to be minimum requirements and they do not guarantee that buildings or infrastructure will not be damaged in a bushfire, persons injured, or fatalities occur either on the subject site or off the site while evacuating. This is substantially due to the unpredictable nature and behaviour of fire and fire weather conditions. Additionally, the correct implementation of the recommended protection measures will depend upon, among other things, the ongoing actions of the landowners and/or operators over which Bushfire Prone Planning has no control.*

All surveys, forecasts, projections, and recommendations made in this report associated with the proposed development are made in good faith based on information available to Bushfire Prone Planning at the time. All maps included herein are indicative in nature and are not to be used for accurate calculations.

Notwithstanding anything contained therein, Bushfire Prone Planning will not, except as the law may require, be liable for any loss or other consequences whether or not due to the negligence of their consultants, their servants or agents, arising out of the services provided by their consultants.

TABLE OF CONTENTS

List of Figures

EXECUTIVE SUMMARY

This Bushfire Risk Report has been prepared to support a Development Application for the proposed Kojonup Battery Energy Storage System (BESS) (the 'Project') located at 3680 Collie-Changerup Road, Kojonup, within the Shire of Kojonup. The subject site is located within a bushfire-prone landscape, where surrounding vegetation and fire weather conditions present a relatively low bushfire hazard. Ember attack, radiant heat and direct flame contact remain risks to be addressed by the proposal.

The report provides a comprehensive assessment of bushfire risk and demonstrates how the proposal achieves an acceptable level of risk to satisfy the Policy Intent of *State Planning Policy 3.7 Bushfire*:

> *"To implement effective, risk-based land use planning and development which in the first instance avoids the bushfire risk, but where unavoidable, manages and/or mitigates the risk to people, property and infrastructure to an acceptable level. The preservation of life and the management of bushfire impact are paramount."*

While specific guidance for renewable energy facilities is limited in Western Australia, the assessment has also considered:

- Best-practice guidance including the Victorian Country Fire Authority's *Guidelines and Model Requirements – Renewable Energy Facilities* v4.4.
- Standards Australia (AS series) and International Organization for Standardization (ISO series).
- Professional experience and expert opinion
- Academic research

This ensures a robust and conservative approach.

Methodology

The assessment has been undertaken whereby bushfire risk is determined through the interaction of hazard, exposure and vulnerability. This is an appropriate methodology in considering natural disasters, adopted by:

- *Sendai Framework for Disaster Risk Reduction 2015-2030* (United Nations Office for Disaster Risk Reduction)
- *National Disaster Risk Reduction Framework* (National Resilience Taskforce, Australian Department of Home Affairs)
- *Australian Emergency Management Arrangements Handbook* (Australian Institute for Disaster Resilience, National Emergency Management Agency)

The analysis considers all relevant elements at risk of bushfire impact, including persons, buildings and structures, BESS infrastructure, substations, and access/egress arrangements.

Inherent and Residual Risk levels have been summarised in Section 3.1.

- Inherent Risk represents the risk based on current conditions, including the application of minimum bushfire planning requirements in alignment with the *Planning for Bushfire Guidelines*.
- Residual Risk represents the risk where the additional recommendations (Table 4.2.1), beyond the minimum bushfire planning requirements, are applied.

The subject proposal therefore achieves a risk level which is ALARP (As Low As Reasonably Practicable).

Compliance with Bushfire Planning Framework

The proposal has been assessed against the intent of the *Planning for Bushfire Guidelines* and relevant bushfire protection principles, including:

- Location – The development is sited within predominantly cleared land, minimising exposure to unmanaged vegetation.
- Siting and Design – Adequate separation distances (Asset Protection Zones - APZs) are applied to achieve acceptable radiant heat thresholds for all assets.

- Vehicular Access – Access and egress arrangements are designed to support safe evacuation and emergency services access.
- Water Supply – A compliant firefighting water supply is provided to support both bushfire and asset protection.
- Emergency Management – A comprehensive Emergency Management Plan will be implemented to support Prevention, preparedness, response and Recovery.

Risk Mitigation and Outcomes

The development has incorporated a suite of bushfire protection measures, including:

- Establishment and ongoing maintenance of appropriate APZs;
- Provision of a minimum 288,000L firefighting water supply with appropriate access;
- Multiple fit-for-purpose access arrangements;
- Bushfire-resilient construction standards for buildings and critical infrastructure;
- Implementation of operational procedures to minimise ignition risk;
- Development and maintenance of a detailed Emergency Management Plan, including staff training, monitoring and communication protocols;
- Ongoing engagement with local emergency services.

Following implementation of these measures, the assessment demonstrates that:

- All elements achieve acceptable residual risk levels;
- Risks to life are reduced to acceptable or ALARP levels;
- Risks to property and infrastructure are appropriately mitigated consistent with planning policy expectations.

Conclusion

The proposed development is considered to achieve an acceptable level of bushfire risk, consistent with the objectives of the *State Planning Policy 3.7 Bushfire* and the broader State planning framework.

The report demonstrates that bushfire risk has been appropriately identified, assessed and mitigated, and that the development can be supported from a bushfire planning perspective, subject to the implementation and ongoing management of the recommended protection measures through design, construction and operation.

1 REPORT USE GUIDANCE - FOR MANAGERS & DECISION MAKERS

LOCATION OF KEY INFORMATION	
The applied risk assessment process as pre-requisite reading to assist with understanding the assessments and the presentation of the results.	Section 2 and Appendices 1 & 2
The assessed bushfire risk levels and the relative contribution of each primary factor contributing to that risk.	Section 3
The recommended additional bushfire protection measures and their implementation priority rating.	Section 4.2.1
Identified additional issues and advice provided for consideration by management.	Section 4.2.2

SECTION 5 - THE ASSESSMENT OF BUSHFIRE RISK

For the proposed Kojonup Battery Energy Storage System (BESS) (the 'Project') facility at the intersection of Tunney Road and Collie-Changerup Road, Kojonup, the risk assessment derives defined levels of risk associated with a bushfire event within the immediate and broader surrounding landscape, to the identified elements at risk (i.e., relevant classes of persons and property).

The adopted assessment approach applies a methodology that considers bushfire risk levels to be determined due to the interaction of three factors:

1. The bushfire hazard (which presents varying threats and threat levels);
2. The levels of exposure of each element at risk to those threats; and
3. The levels of vulnerability of each element at risk to those threats.

The assessment considers both the current level of risk (inherent), and the potential level of risk (residual) should proactive management be able to implement the recommended additional bushfire protection measures.

The assessment is largely qualitative in nature but incorporates quantitative processes and information when relevant and available. This results in the derivation of 'indicative' bushfire risk levels.

The assessment is conducted by a bushfire planning consultant with practical bushfire event management experience and relevant accreditation. An important objective is to present understandable and practical protection measures that can be justifiably applied by management.

SECTION 6 - THE ASSESSMENT OF BUSHFIRE RISK MANAGEMENT

Assessments are conducted that consider how well two defined pathways for implementing both the required and any additionally recommended bushfire protection measures, are being applied. Guidance for best practice application of these measures is provided. The two pathways are:

1. The application of 'informative' risk management mechanisms which include:
    a. The organised application and maintenance of all applicable bushfire protection measures through a range of operational documents, as relevant to a site and its use; and
    b. The development and application of advice to inform management's planning of future modifications and/or development of a site and its use. This is necessary where bushfire risk mitigation measures are necessary inputs to design and construction.
2. The application of 'regulatory' risk management mechanisms that are to be complied with. These include operating and construction regulations and standards, and relevant planning authority guidelines/standards.

*****

2 INTRODUCTION

2.1 THE ASSESSED ASSET AND ITS USE

SITE USE AND DESIGN

The Project is proposed to be sited in cleared pasture in the north-eastern corner of Lot 3194 (#3680) Collie-Changerup Road.

A 330kV transmission line runs approximately north-south through the eastern portion of the subject lot. The Project will be located between the transmission line and Tunney Road. it will connect to the existing Kojonup Substation (262 Tunney Road, Kojonup- operated by Western Power) immediately to the south of the lot.

The Project has an intended operating capacity of approximately 800MWh (100MW x 8 hours). An onsite electrical substation will be installed as part of the Project. An Operation and Maintenance (O&M) compound will be included, with the intent to house majority temporary staff during construction. During operations, the O&M compound will be used by the 1-2 permanent staff as required.

A comprehensive Bushfire Advice Brief has previously been provided, which has been integrated into the submitted design and supported by the submitted Bushfire Management Plan and this Bushfire Risk Report.

The site assessment for the Project was conducted on the 27th March 2025.

ASSESSED ASSETS

Numerous components have been identified for assessment. This Bushfire Risk Report considers each asset, or group of comparable assets, separately.

- The BESS and PCS.
- The onsite Substation.
- An Operations and Maintenance building.
- Laydown areas.
- Internal access network.

ASSETS NOT ASSESSED

Some assets/components of the site have not been assessed. These are described below.

Transmission Lines (conductors)

The conductors will be installed below ground. Below ground conductors are not subject to bushfire impact.

Roads/Tracks

Persons on access routes are assessed. The roads/tracks themselves are not, as any damage to the track itself (tree strike, melting bitumen etc) is relevant to its usability by people rather than its own inherent value.

2.2 ESTABLISHING THE REPORT OBJECTIVES

The applied risk assessment process (refer to s2.3 and Appendix 1), and the methodology used to inform the management of risk (refer to s2.4), provide a flexible platform for producing the required evaluations and reporting.

It can account for all types of development and use and be constructed to deliver the required management and decision-making information.

Consequently, to ensure the required information outcomes are met, the specific objectives for the Project need to be identified to guide the report development.

These objectives are established in the checklist on the following page.

CHECKLIST ESTABLISHING THE REPORT OBJECTIVES TO BE MET FOR THE PROJECT					
AVAILABLE OBJECTIVES			**THE OBJECTIVES TO BE MET**	**THE OBJECTIVES TO BE MET ARE ESTABLISHED BY**	
				The Owner and/or Operator of the Project in Discussion with the Bushfire Consultant	The 'Planning' Bushfire Management Plan
RISK ASSESSMENT					
Hazard	Identify all bushfire hazards with potential to impact the Project.		✓		✓
Risk Levels	Assess inherent bushfire risk levels, for each identified element at risk, by accounting for existing and/or planned implementation of bushfire protection measures, along with all other interacting factors.		✓	✓	
	Assess residual bushfire risk levels, for each identified element at risk, by additionally accounting for implementation of recommended bushfire protection measures, along with all other interacting factors.		✓	✓	
RISK MANAGEMENT					
Compliance	Assess current compliance and/or future compliance capability against the 'mandatory' bushfire risk management mechanisms. Note for operating standards, assessment is restricted to the requirements that have direct relevance to a bushfire event. These can include: • Separation from bushfire prone vegetation (APZ/firebreaks); • Access/egress for firefighting services/site occupants, including firebreaks; and • Firefighting water supply & delivery for structure and surrounds fire, not the bushfire.	Planning Guidelines/Standards - for development & uses on bushfire prone land	✓		✓
		Operating Standards / Regulations			
		Construction Standards - for buildings in bushfire areas			
Recommendations	Recommend additional bushfire protection measures to be implemented and their priority.		✓	✓	
	Identify the relevant planning and/or site operations documents in which the recommended bushfire protection measures should be included.		✓	✓	
Advice	Provide specific advice to inform planning for design and construction.		✓		✓
	Provide general advice that identifies issues for management to consider.		✓	✓	

OBJECTIVE VARIATIONS TO BE APPLIED:

Planning advice regarding bushfire risks to/from renewable energy facilities is not available in Western Australia. The most comprehensive and stringent guidance globally is provided in the Guidelines and Model Requirements – Renewable Energy Facilities v4.4 (Victorian Country Fire Authority June 2025).

Risk assessments are tenure-blind, and thus the capacity of the proposal to align with the CFA Guidelines has been assessed. The recommendations within the CFA Guidelines are integrated into the appropriate protection measures within the relevant section of this Report, as this allows a single 'package' of protection measures to be provided.

LEGEND

	SITE ACCESS GATE		PROPOSED SECURITY FENCE
	PROPOSED NEW ACCESS TRACK		EXISTING SUBSTATION
	BATTERY CONTAINER		PROPOSED LANDSCAPE SCREENING (APPROX. 5m WIDE)
	POWER CONVERSION SYSTEM UNIT (PCS)		PROPOSED LANDSCAPE SCREENING (APPROX. 3m WIDE)
	EXISTING OVERHEAD LINE		INTERNAL ACCESS TRACK
	EXISTING OVERHEAD LINE EASEMENT		PROPOSED SUBSTATION AREA
	PROPERTY BOUNDARY		PROPOSED WATER DETENTION BASIN AREA
	PROPOSED NEW CONNECTION ROUTE		
	PROPOSED WATER TANK		
	PROPOSED O&M BUILDING AND CAR PARK AREA		

REVISIONS

REV	STATUS	DESCRIPTION	DATE	D.B.	C.B.
A	DA	INITIAL ISSUE	10/02/26	X.Z	S.Y
B	DA	DETAIL AMENDED	19/02/26	X.Z	S.Y
C	DA	DETAIL AMENDED	03/03/26	X.Z	S.Y
D	DA	DETAIL AMENDED	10/03/26	X.Z	S.Y
E	DA	DETAILS INFORMATION AMENDED	23/03/26	X.Z	S.Y
F	DA	NOTES AMENDED	25/03/26	X.Z	S.Y

PROJECT DETAILS:

KOJONUP BESS

Collie–Changerup Rd, Kojonup WA 6395
–33.804452, 117.136471

PROJECT DEVELOPER:

MINT RENEWABLES

DRAWING TITLE:

INDICATIVE SITE LAYOUT

DA–2.0_F_KOJONUP

DRAWN BY : X.Z	APPROVED BY : S.Y	PROJECT MANAGER : K.D
SCALE : NOT SCALED	ISSUE : CONCEPT PLAN	ISSUE DATE : 25/03/2026
SHEET SIZE: A3	CONCEPT ONLY NOT FOR CONSTRUCTION PURPOSE	REV. NO: F

Mint

2.3 BUSHFIRE RISKS AND THE APPLIED ASSESSMENT PROCESS

THE RELEVANT RISKS

For this Bushfire Risk Report, the relevant risks:

- Are associated with the natural hazard event of a bushfire; and
- Are the potential for loss of life, injury, or destroyed or damaged assets resulting in personal loss and economic loss due to disruption of services and/or repair or replacement of buildings and infrastructure.

Note that the 'risk' of a bushfire event occurring (as might be determined by consideration of the calculated likelihood of its occurrence), is not part of the relevant risk in this report. For most scenarios, it is assumed that due to the presence of bushfire prone vegetation, a bushfire will occur at some time and the inherent and residual risk levels need to be known for this worst case scenario.

THE APPLIED RISK ASSESSMENT PROCESS

Bushfire Prone Planning (BPP) has adapted the concept for 'Understanding Disaster Risk' as recognised by the United Nations Office for Disaster Risk Reduction [46].

In applying this concept, bushfire risk can be considered a consequence of the interaction of bushfire hazard threats and the exposure and vulnerability of the elements at risk from those threats (i.e., the 'exposed elements' which can include various classes of persons and/or property).

The level of risk associated with bushfire will be reduced by applying bushfire protection measures that:

- Reduce the number and/or level of hazard threats; and/or
- Reduce the level of exposure and/or vulnerability of the elements at risk.

The risk assessment process framework is shown in Figure 2.2 and additional detail is presented in Appendix 1.

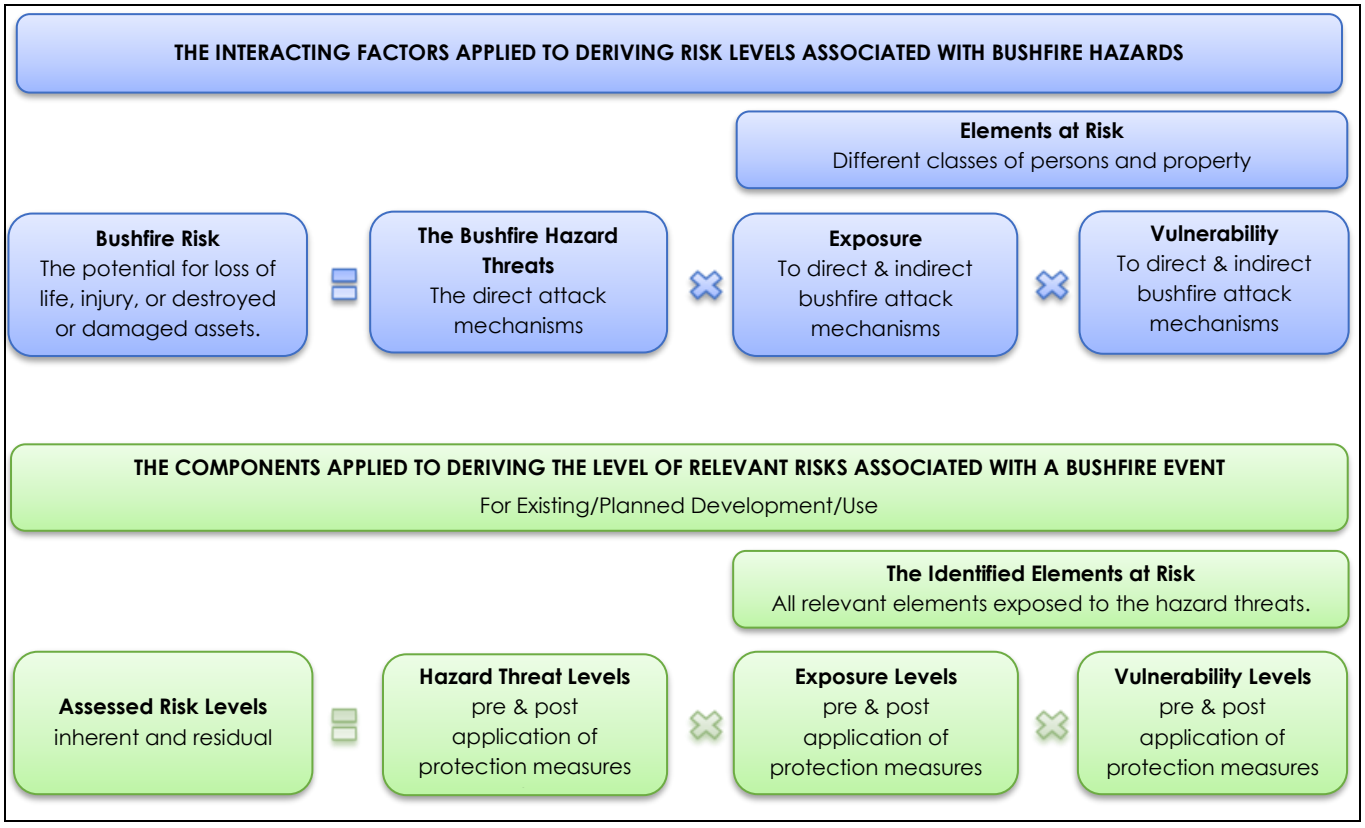
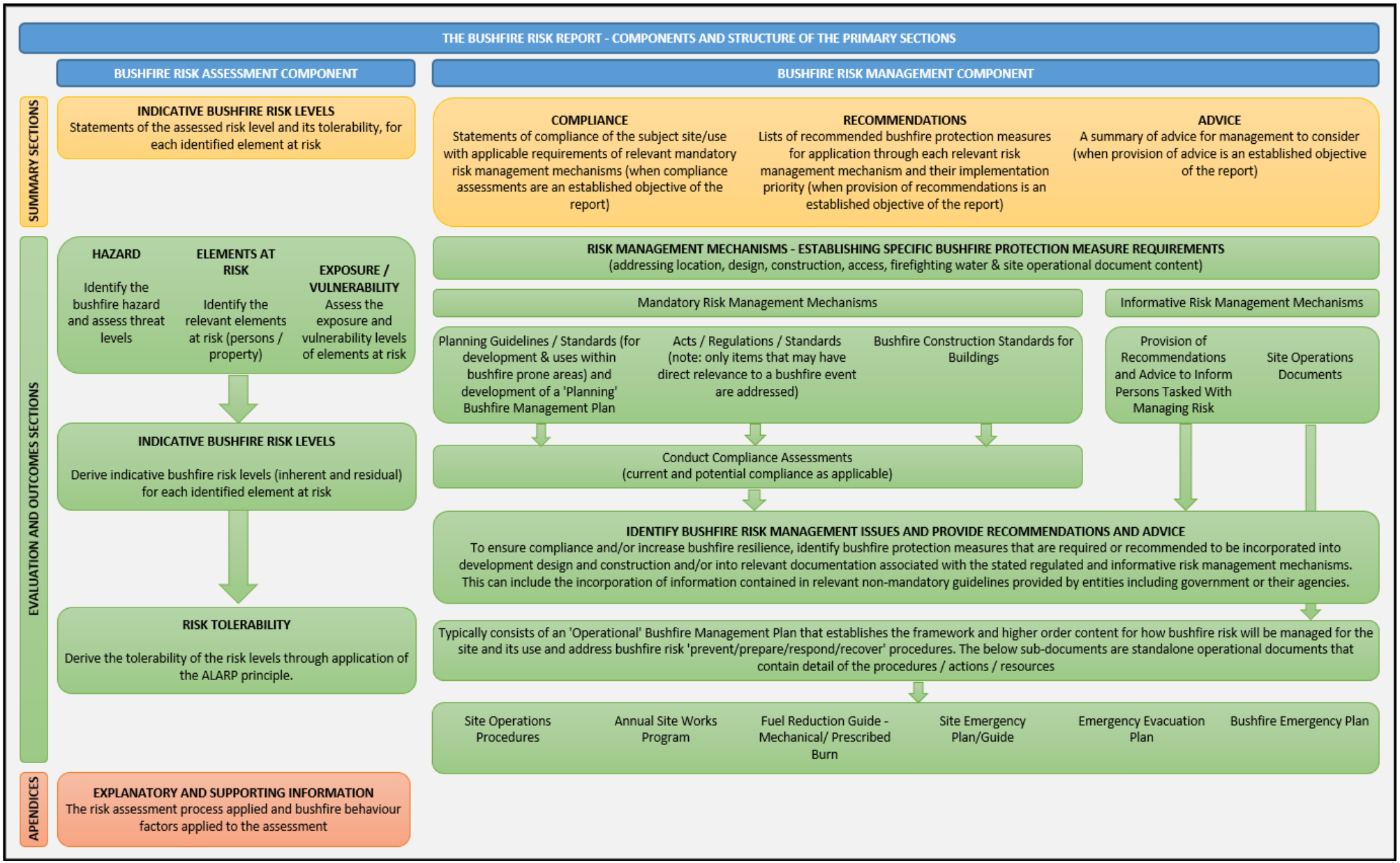


Figure 2.2: The framework of the applied bushfire risk assessment process.

2.4 REPORT STRUCTURE OVERVIEW



3 SUMMARY: BUSHFIRE RISK ASSESSMENT

The Summary: Presents the outcomes of the risk assessment process conducted for the Project and use which is presented in Section 5.

The Worst Case: For each identified element at risk, the worst assessed risk level is stated, along with its tolerability. This will correspond to the worst levels of bushfire hazard threats, and exposure and vulnerability of the element to those threats. Refer to Section 3.2. for the relative contributions of each component that has been assessed as the primary drivers of the level of risk associated with a bushfire event.

Indicative Risk versus Determined Risk: When the assessed bushfire risk levels are stated as 'indicative', rather than 'determined', as they have been derived through the application of a largely qualitative assessment process that applies quantitative information when it exists. Refer to Appendix A1.3 for explanatory and supporting information.

Appendix 1: Explains the bushfire risk level analysis, the risk tolerance methodologies applied, and the terminology used.

3.1 THE ASSESSED BUSHFIRE RISK LEVELS (INDICATIVE) AND THEIR TOLERABILITY

THE ASSESSED BUSHFIRE RISK LEVEL AND ITS TOLERABILITY					
ASSESSED ELEMENTS AT RISK [1]	LEVEL OF RISKS ASSOCIATED WITH A BUSHFIRE EVENT [2]		TOLERABILITY OF THE BUSHFIRE RISK LEVEL (ALARP) [3]		
	Inherent Risk	Residual Risk	Inherent Risk Tolerability	Residual Risk Tolerability	Adjusted Residual Risk Tolerability
Persons onsite and temporarily offsite	L5	VL3	Acceptable but NOT ALARP	Acceptable	N/A
Persons on access/egress routes in vehicles	L4	VL3	Acceptable but NOT ALARP	Acceptable	Tolerability can be adjusted. However, Residual Risk is Very Low regardless of Tolerability.
Buildings/Structures - NCC classes 1-10 (Operations and Maintenance)	M8	L4	Tolerable but NOT ALARP	Acceptable	N/A
Materials stored outdoors	H9	M7	Intolerable as NOT ALARP	Acceptable as IS ALARP	N/A
BESS units and Associated Infrastructure	L6	VL3	Acceptable but NOT ALARP	Acceptable	N/A
Substation	L6	L4	Acceptable but NOT ALARP	Acceptable	N/A

Note 1: Refer to Section 5.2.

Note 2: Refer to Appendices A1.1 and A1.3.3 and the Glossary for explanatory and supporting information. The Bushfire Risk Level is not the risk of a bushfire event occurring. The relevant risks are those associated with a bushfire event and to which the assessed elements at risk are potentially subjected.

Inherent risk accounts for the risk reducing impact of bushfire protection measures already or planned to be implemented. Residual risk additionally accounts for any protection measures recommended for implementation by the bushfire consultant.

Note 3: Refer to Appendix A1.3.6 for explanatory and supporting information and adjustment justification when applicable.

3.2 THE DERIVATION OF THE BUSHFIRE RISK LEVELS (SUMMARISED)

BUSHFIRE HAZARD THREAT LEVEL AND EXPOSURE AND VULNERABILITY LEVELS OF ELEMENTS AT RISK						
ASSESSED ELEMENTS AT RISK [2]	THE INTERACTING FACTORS FROM WHICH THE BUSHFIRE RISK LEVEL IS DERIVED [1]					
	ASSESSED INHERENT LEVELS [3]			ASSESSED RESIDUAL LEVELS [3]		
	Bushfire Hazard Threat [Section 5.1]	Exposure of Element at Risk [Section 5.3]	Vulnerability of Element at Risk [Section 5.4]	Bushfire Hazard Threat [Section 5.1]	Exposure of Element at Risk [Section 5.3]	Vulnerability of Element at Risk [Section 5.4]
Persons onsite and temporarily offsite	Low	Moderate	Low	Low	Low	Very Low
Persons on access/egress routes in vehicles		Low	Low		Low	Very Low
Buildings/Structures - NCC classes 1-10 (Operations and Maintenance)		High	High		Low	Low
Materials stored outdoors		Extreme	High		High	Moderate
BESS unitsand Associated Infrastructure		Moderate	Moderate		Very Low	Low
Substation		Moderate	Moderate		Low	Low

Note 1: Refer to Appendix 1 and Appendix 2 for explanatory and supporting information.

Note 2: Refer to Section 5.2.

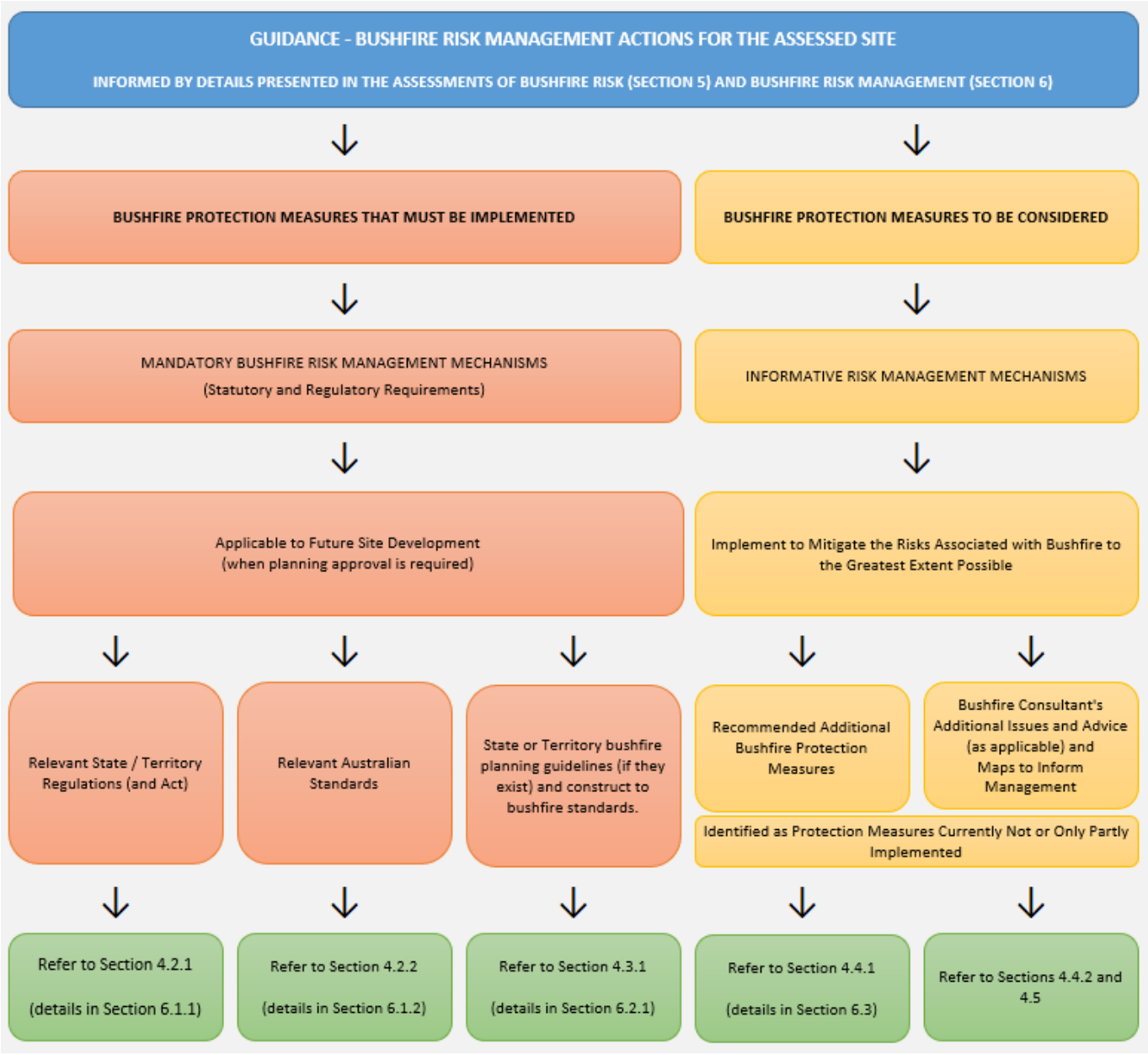
Note 3: Refer to Appendix A1.3.3. Inherent levels account for the threat/exposure/vulnerability reducing impact of applying existing and planned bushfire protection measures. Residual levels additionally account for any protection measures recommended by the bushfire consultant.

4 SUMMARY: BUSHFIRE RISK MANAGEMENT

4.1 MANAGEMENT ACTIONS TO BE ADDRESSED

The following diagram identifies:

1. The components associated with the mandatory and informative risk management mechanisms; and
2. The location within this summary that presents their corresponding bushfire protection measures as:
    a) Those currently not fully implemented that must be implemented; and
    b) Those that are recommended to be implemented.



4.2 INFORMATIVE MECHANISMS – RECOMMENDED ACTIONS

4.2.1 ADDITIONAL BUSHFIRE PROTECTION MEASURES - RECOMMENDED BY THE BUSHFIRE CONSULTANT

4.2.1.1 THREAT REDUCING MEASURES - BUSHFIRE HAZARD

BUSHFIRE HAZARD THREAT REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]
Prevent bushfire ignition by managing heat energy sources	1.9	**Layout and Design** Management of Planned Revegetation	Where vegetation screening is <10m width and continuous with pasture only, vegetation classification should not exceed Class D Scrub. Where vegetation screening is <10m in width and isolated from significant vegetation, exclusion as a 'nature strip' may be appropriate. This will be reflected within the associated 'planning' Bushfire Management Plan for the Development Application.	Medium
	1.10	**Procedures & Ongoing Management** Robust and effective site operational procedures	The following procedures should be completed prior to the bushfire season (see the Shire of Kojonup Prohibited Burning Period): • Scheduled maintenance to assets, emergency equipment, or fire detection/prevention systems. • The ongoing requirements outlined in the Bushfire Management Plan. • Scheduled housekeeping inspections including: o Hazard identification - ensuring that infrastructure, plant, equipment, vehicles and safety/warning signs show no signs of damage or dilapidation. o Facility access - ensuring all vehicle site access points, including emergency access points, are clear and accessible. o Fire protection systems and equipment – ensuring that all equipment is unobstructed, clearly identifiable, in-service and performing optimally. o Vegetation management - ensuring that any accumulation of combustible materials is cleared from infrastructure, buildings and fire breaks, and removed from the site. o Security measures - ensuring that fences, gates, and security cameras are inspected for damage, and that any damage is immediately actioned (e.g., repaired or replaced).	Medium

BUSHFIRE HAZARD THREAT REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]
			• Ad-hoc or annual invitations extended to the local emergency services through the Local Government's Community Emergency Services Manager to offer a familiarisation visit and explanation of emergency procedures, access, hazards, and fire detection and suppression systems.	

[1] The full description of each bushfire protection measure and the detail of the assessment is presented in Section 5.1.4.

[2] Refer to Appendix A1.3.5 for implementation priority rating explanation.

4.2.1.2 EXPOSURE REDUCING MEASURES – ALL STRUCTURES

ALL STRUCTURES EXPOSURE REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]

Establish sufficient separation from relevant bushfire hazard threats	4.3
	5.2
	6.3
	8.3
		Procedures & Ongoing Management
		Landscaping - asset protection zone (APZ)
			An APZ must be installed around all identified assets. The dimensions are provided below.
			
			<10kW/m2 (calculated at 1200K flame temperature):
			• Operations and Maintenance Buildings (Class 1-9)
			
			<10kW/m2 (calculated at 1090K flame temperature):
			• Critical Class 10 Buildings
			• BESS units and PCS
			  o The 10m portion of the APZ immediately around BESS units must be entirely and permanently non-vegetated (sealed, compacted limestone, gravel, mineral earth etc). BESS units are recommended to be sited on concrete slabs or other sealed, non-combustible surface.
			
			<19kW/m2 (BAL-19):
			• Substations
			
			<29kW/m2 (BAL-29):
			• Laydown Areas
			  o Outdoor material storage areas are recommended to have surfacing applied, extending 2m beyond the storage area.
			• Construction Compounds
			• Other Class 1-10 Buildings
			• Water Tanks
				Highest

ALL STRUCTURES EXPOSURE REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]
	4.4 6.4 8.4	**Layout and Design** Landscaping - tree location	Any future Landscape Management Plan should be reviewed by the Bushfire Consultant to provide additional advice on vegetation location, demographics, and structure. Trees over 6m tall are not recommended to be planted within 10m of assets to reduce the capacity for ongoing fuel accumulation or tree strike.	Lowest
	4.7 5.4 6.7 8.7	**Layout and Design** **Procedures & Ongoing Management** Separation from stored and constructed combustible items (consequential fire fuels)	All non-structural combustible materials are to be removed within 10m of assets. This includes but is not limited to; waste, leaf litter, machinery, grasses, vehicles, fuel, furniture, and timber. When storage of flammable items or materials are stored on site temporarily (for maintenance etc), separation distances must be complied with. This requirement is to be included in the Site Operating Procedures document. The product datasheet or manufacturer is likely to specify a setback between BESS units. Where this is not provided, a setback of >1m on the shorter and >3m on the longer side is recommended. Where the product datasheet or manufacturer specification does not specify a distance between battery containers and other constructed combustible/critical assets, the applied distance should be 15m (based on >1 hour intervention). This does not apply to any constructed asset required to be reasonably adjacent. For outdoor storage areas, higher flammability or dangerous materials should be positioned toward the centre of the storage areas, to limit the exposure to direct bushfire impacts. Note this may include materials such as tarpaulin.	High
Establish shielding from relevant bushfire hazard threats	4.12 6.12 8.12	**Construction** Shield operation critical non-structural elements	Electrical cabling associated with built assets (not transmission lines) which are beyond the >10kW/m2 setback (thus subject to radiant heat fluxes >10kW/m^2), or beyond footprint of buildings or constructed assets, are recommended to be installed underground, or shielded with non-combustible material (or enclosed) where practical.	Medium

[1] The full description of each bushfire protection measure, the detail of the assessment and any recommendation, is presented in Sections 5.3.3 & 5.3.4 & 5.3.5 & 5.3.6.

[2] Refer to Appendix A1.3.5 for implementation priority rating explanation.

4.2.1.3 VULNERABILITY REDUCING MEASURES - PERSONS

PERSONS VULNERABILITY REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]
Provision of bushfire emergency information and education	9.3	**Emergency Planning** Develop a bushfire emergency plan	The following details have been identified for inclusion within the Emergency Management Plan (and/or the Site Operating Procedures, as appropriate to the document structure): **Details and Information** • A summary of fire hazards and risks to and from the site, specific to its location, infrastructure, activities and occupancy. • A facility description, including infrastructure details, operations, number of personnel, and operating hours. • A site plan depicting structures/built assets, operational areas, site access points and internal roads, firefighting infrastructure, drainage (as applicable), and neighbouring properties. • Up-to-date contact details for facility personnel, including for at least two persons who may be able to provide information or support during emergencies (24 hours a day). Update contact information when necessary. • Details of emergency resources, including fire detection and suppression systems and equipment; gas detection; emergency eye-wash and shower facilities; spill containment systems and equipment; emergency warning systems; communication systems; personal protective equipment; first aid. • Contact information for 24/7/365 specialist technical support for the battery energy storage system. • Specifications for safe operating conditions for temperature. • Schematics and technical data for battery energy storage system containers/enclosures, the number of containers/enclosures on-site, and the number of battery racks or modules within each container/enclosure. • Details of the hazards for the battery energy storage system, including thermal events/runaway, electrical safety hazards, explosion hazards, dangerous goods hazards (including off-gassing), and the effects of fire on the battery energy storage system (eg., explosion, release of toxic gases). • Details of all provided battery failure/safety and protective systems, including a description, the activation process/automatic trigger, and any hazards associated with these systems.	High

PERSONS VULNERABILITY REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]
			Procedures **Prevention** • Smoking restrictions or designated smoking locations. • Procedures regarding vegetation management and accidental ignition prevention. • The specifications of Schedule 1 of the Planning for Bushfire Guidelines and the Shire of Kojonup Section 33 Notice can be achieved via livestock grazing. If grazing is used, the vegetation must continue to be monitored for compliance with Schedule 1, and additional vegetation management works undertaken as required. • Heavy equipment is not to be operated where long grass (>100mm) or heavy leaf litter is present, particularly during the bushfire season (see the Local Government Prohibited Burning Period). • Servicing of battery energy storage systems should not take place on days of High, Extreme or Catastrophic Fire Danger Rating, except where the system is experiencing malfunction or abnormal behaviour. • Bushfire response training should be provided to all permanent staff. Training should be scheduled at appropriate intervals, accounting for staff turnover and the complexity of firefighting equipment. **Preparedness** • Annual emergency exercises should be conducted. Contact the local emergency control agencies; the Shire Emergency Management Coordinator (CBFCO) for input/inclusion. Emergency exercises should include bushfire as a potential emergency scenario. • Evacuation and shelter-in-place triggers and procedures, unless included within a Bushfire Emergency Plan. • Procedures for review of the Emergency Management Plan, including the ongoing effectiveness of control measures. • An ongoing schedule to contact the local emergency control agencies; Shire of Kojonup Emergency Services Manager and Chief Bush Fire Control Officer (CBFCO) prior to the bushfire season.	

PERSONS VULNERABILITY REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]

			• The Emergency Management Plan and any Emergency Response Guide (FES-ERG) should contain procedures for isolation, shut-down, fail safe or management of critical/high-risk plant, equipment, and utilities, and their advised triggers.
			• Visitors must provide mobile phone numbers to site management. Within the Emergency Management Plan, a key response will be to contact and advise all persons onsite. Site vehicles are required to have a secondary communication system installed (e.g. two-way radio).
			• A bushfire monitoring procedure for the Restricted/Prohibited Burning Period (see Shire of Kojonup Section 33 Notice), including:
			  o Nominating a person/role in your Emergency Control Organisation to be responsible for identifying, responding to, and communicating Fire Danger Ratings in advance.
			  o Identifying bushfire activity within 10km of the facility.
			  o Communicating this information to everyone likely to be present on-site, and relevant off-site personnel.
			  o An outline of site activities to be modified or cease as a response (if any).
			Response
			DFES Comcen should immediately be notified of:
			• Any shorts, faults, temperature increases above normal parameters (eg. precursor to thermal events/runaway).
			• Equipment failures with the potential to ignite or propagate fire.
			• Off-gassing, smoke or fire.
			• The monitoring personnel can determine if Emergency Services response is necessary. The notification is for awareness.
			Bushfire emergency response procedures must include:
			• Evacuation and shelter-in-place triggers and procedures, unless included within a Bushfire Emergency Plan.	

PERSONS VULNERABILITY REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]
			• Response procedures by Emergency Services (including Bushfire Brigades) should include the safe distances from asset fire to establish a containment perimeter to monitor and respond to potential bushfire ignition. • A specific action to notify (or verify notification) the Emergency Services, at the earliest possible stage of the emergency. • The person or role responsible for making or verifying the notification. • The '000' number in the procedure. • Communicating with site personnel and supporting their physical relocation. Bushfire alerts within a 10km radius should be communicated to persons onsite. • Ensuring all buildings and plant are adequately secured. • Initiating any bushfire protection measures such as activating sprinkler or deluge systems or pre-emptive shut-down, prior to the arrival of the fire front. • Liaising with the emergency services where possible. • Consideration of arc flash risk due to bushfire smoke (transmission lines, substations).	
	9.6	**Emergency Planning** Direct to persons emergency messaging system	Site personnel should download the EmergencyWA app (or equivalent), be trained in its use and information provided in the app. The app should be referred to prior to travelling to or from the sites.	Medium
	9.10	**Emergency Planning** Build community resilience through education	An information package detailing emergency considerations and response should be provided to landowners leasing land for the proposed development. The proponent may consider extending this information to neighbouring landowners or the local community, recognising the potential for adverse community attitudes.	Medium
	9.15	**Emergency Planning** External Emergency Response Services Available	Contact the local emergency control agencies; Shire of Kojonup Emergency Services Manager and Chief Bushfire Control Officer (CBFCO) prior to commissioning and offer a familiarisation visit and explanation of emergency procedures, access, hazards, and fire detection and suppression systems. Local Volunteer Fire and Rescue Services (VFRS) and Bush Fire Brigades (BFB) may be invited through the Shire Emergency Management Coordinator (CBFCO). The particular services should be determined by the CBFCO. Establish an ongoing schedule to contact the Shire Emergency Services Manager and/or CBFCO prior to the bushfire season.	High

PERSONS VULNERABILITY REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]
Lower risk road construction (design and materials)	Persons on Access / Egress Routes in Vehicles			
	10.7	**Construction** Interconnected road network to provide route options	Access points will be gated but should be openable in the same manner (the same key, keycard, access code, remote etc). Internal roads (driveways) accessing site assets are to comply, at a minimum, with the specifications for Private Driveways within the *Planning for Bushfire Guidelines*.	Medium
[1] The full description of each bushfire protection measure, the detail of the assessment and any recommendation, is presented in Section 5.4.1 and Section 5.4.2. [2] Refer to Appendix A1.2.5 for implementation priority rating explanation.				

4.2.1.4 VULNERABILITY REDUCING MEASURES – ALL STRUCTURES

ALL STRUCTURES VULNERABILITY REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]
Construction design and materials	11.1	**Construction** Construct to AS 3959:2018	All permanent Class 1-9 buildings are required to apply bushfire resistant construction following their assessed BAL under AS 3959. The standard of construction may align with AS 3959 (to a minimum of BAL-12.5) or NASH Steel Framed Construction in Bushfire Prone Areas. See Figure 3.2 of the associated Bushfire Management Plan. The Operations and Maintenance Building has been designated as an on-site shelter building and must be constructed to AS 3959 requirements for BAL-29 and have a minimum internal floor area equal to 1m^2 per proposed person (e.g. 24m^2 for 24 workers).	Highest
	11.3 13.3	**Construction** Construction materials for external and internal cavity building elements	For any future Class 1-10 buildings, include non-combustible structural elements where practical. In particular, avoid: polycarbonate (sheeting and skylights), softwoods (<650 kg/m3 density at 12% moisture content), and fibrous materials.	Lowest

ALL STRUCTURES VULNERABILITY REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]
			Review compliance of the selected BESS product against NFPA 855 - Standard for the Installation of Stationary Energy Storage Systems (2023) noting that as a North American planning standard, all requirements may not be applicable.	
	11.8 13.8 15.8	**Construction** Minimise re-entrant detail to minimise debris and ember accumulation	Where electrical cabling, or gas or liquid piping, contacts the ground or any arrangement of associated structures creates a 'pocket' for accumulation of debris, this should be rectified by design or filling with non-combustible material such as mineral earth. Consideration should be given to making the arrangement self-cleaning through wind action to the greatest extent possible. These measures will reduce accumulation and/or make the management (clearing) of accumulated debris easier. E.g. cable raking to be 100mm above ground.	Lowest
	11.11 13.11 15.11	**Construction** Minimise construction cavities to minimise debris and ember accumulation	Any subfloor cavities must have exposed subfloor spaces enclosed, sealed with non-combustible material, or be ember screened. Ember screening mesh is to be maximum 2mm aperture and composed of corrosion-resistant steel, bronze, or aluminium. This includes ramps/stairs to the building entry.	Highest
	11.12 13.12 15.12	**Construction** Minimise external openings to limit flame / radiant heat / ember / debris entry	Review the design of warehouse/workshop buildings to ensure they can be fully enclosed.	Medium
	11.13 13.13 15.13	**Construction** Screen and seal gaps and penetrations	<u>Workshop/warehouse buildings</u> Recommended to have ember screening/sealants installed on any gaps, penetrations, and external glazed elements. Ember screening mesh is to be maximum 2mm aperture and composed of corrosion-resistant steel, bronze, or aluminium. <u>Substations</u> Consider application of ember screening to the external vent interface of the control room, switch room, terminal boxes etc. The intention is to prevent both ember ingress and debris accumulation. Ember screening mesh is to be maximum 2mm aperture and composed of corrosion-resistant steel, bronze, or aluminium.	Medium

ALL STRUCTURES VULNERABILITY REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]
	11.15 13.15 15.15	**Construction** Shutter external doors and windows	External doors (if present) to BESS units should be self-closing.	Lowest
	13.16 15.16	**Construction** Construction materials for critical non-structural elements	Review *FM Global Property Loss Prevention Data Sheet 5-33 (2020) Electrical Energy Storage Systems* for additional measures applicable to the development.	Lowest

Availability of a firefighting response capability	11.16
	12.2
	13.17
	15.17
		Construction
		Firefighting water supply
			The firefighting water supply requirements for the proposal are as follows:
			<u>Access</u>
			• Firefighting water access points (hydrants, hard suction, or drafting) must be clearly identifiable, visible from internal roads, and unobstructed.
			• Signage must be provided at each vehicle entrance to the facility, indicating the direction to the nearest firefighting water access point.
			• An all-weather hardstand turnaround area meeting the requirements of the *Planning for Bushfire Guidelines* (Figure 30) must be provided within 4 metres static water storage tank(s) and any independent hard suction points (hydrants).
			• Site Operating Procedures must include that access routes must be unobstructed at all times.
			<u>Siting and Capacity</u>
			• The BESS development requires a minimum 288,000L firefighting water tank. This is to account for both bushfire and asset fire.
			  o Where another firefighting water supply is determined elsewhere (for asset fire etc), the greater volume is to apply.
			  o The required water supply in compliance with AS 2419.1 will be determined based on the final footprint of the BESS development. A footprint exceeding 9000m2 will require additional water supply (per AS 2419.1).
			• All BESS units must be wholly within 70m of a water outlet.
			• Water tanks must be positioned >15m from BESS units and PCUs.
				Highest

ALL STRUCTURES VULNERABILITY REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]
			• Water tanks should apply a BAL-29 dimensioned APZ at a minimum. <u>Construction</u> • Static water storage tanks must be an above-ground water tank constructed of concrete or steel. • An external water level indicator must be installed on static water storage tanks and be visible from internal roads and the adjoining turnaround area. • Signage indicating 'FIRE WATER' and the tank capacity must be fixed to each tank. Couplings at hard suction points are required to be 125mm Storz fittings (*Guidelines B.4.1.2*). DFES Built Environment and the local emergency services should be contacted for input on appropriate couplings and adaptors.	
	11.17 12.3 13.18 15.18	**Emergency Planning** Firefighting equipment actively operated	Two suitable fire extinguishers should be provided within 20m of each PCU.	Medium
	11.18 13.19 15.19	**Construction** Firefighting equipment passively operated	Automatic fire detection and suppression systems should be installed and maintained, as appropriate to the BESS details and recommended by the manufacturer.	Highest
	11.19 13.20 15.20	**Construction** Firefighting equipment operability maintained	All firefighting water tanks, pumps, connections, couplings, and pipes are to be metal or else non-combustible.	High
Manage and maintain effectiveness of applied protection measures	11.21 12.7 13.22 15.22	**Procedures & Ongoing Management** Formal documents created to guide and enforce management	The decision maker should note that multiple international standards and guidelines exist, and full compliance with all may not be achievable. Australia lacks a guiding standard, as discussed in the *Battery Energy Storage Systems Guidance Report* (GHD March 2023, prepared for the Australian Energy Council). The decision maker may choose to review this report for an overview of context, concerns, and outcomes, for the construction and installation of BESS proposals. Ongoing requirements established in this Risk Assessment must be included in operational documents. Site Operating Procedures must include the following information: <u>Maintenance</u>	Medium

ALL STRUCTURES VULNERABILITY REDUCTION RECOMMENDED ADDITIONAL BUSHFIRE PROTECTION MEASURES				
The Protection Mechanism	Ref No	Brief Description [1]	Recommendation Details	Implementation Priority Rating [2]

			• Maintenance intervals. Scheduling can be detailed within a supporting document.
			• Assigned responsibilities of staff.
			• Maintenance procedures and servicing to manufacturer's specifications.
			• Testing procedures of the firefighting water supply and equipment.
			<u>Inspections</u>
			• Inspection intervals. Frequency of inspections are recommended to be increased during the bushfire season (see the Local Government Prohibited Burning Period) where practical.
			• Inspection triggers, including extreme weather events or seismic activity.
			• Established inspection criteria, including:
			  o Accumulation of debris and vegetative material within 10m of battery modules.
			  o Mechanical damage to exterior elements.
			  o Vegetation regrowth within the APZ, particularly immediately prior to and during bushfire season (see the Local Government Prohibited Burning Period).
			  o Obstruction of access routes including firebreaks.
			  o Volume of the firefighting water supply.	

[1] The full description of each bushfire protection measure, the detail of the assessment and any recommendation, is presented in Sections 5.4.3 & 5.4.4 & 5.4.5 & 5.4.6.

[2] Refer to Appendix A1.2.5 for implementation priority rating explanation.

4.2.2 ADDITIONAL ISSUES AND ADVICE FOR CONSIDERATION

This section presents items the bushfire consultant has identified as being:

- Issues that are additional to or not specifically addressed within the assessment of bushfire risk management conducted in Section 6; and
- Advice for dealing with these issues or other issues that require emphasising, for consideration by management.

The *Guidelines and Model Requirements – Renewable Energy Facilities v4* (Victorian Country Fire Authority June 2025) has been considered in the construction of this Bushfire Risk Report. Some considerations are outside the scope of bushfire assessment.

Consider the following criteria for inclusion within the Emergency Management Plan, to be prepared prior to commercial operation. All criteria are for consideration only, being non-bushfire measures identified within *Design Guidelines*.

- Emergency procedures based on identified risks and hazards of the battery energy storage system and related infrastructure, including but not limited to:
    - Electrical infrastructure faults and fire.
    - Battery energy storage system damage or faults, including battery monitoring faults, temperature increases above normal operating parameters, electrical faults, chemical spills or reactions, off-gassing, thermal events/runaway, smoke and fire.
    - The management of fire water runoff.
- A plan for partial and full decommissioning of the battery energy storage system in the event of an emergency incident that renders the facility inoperable or unsafe, prior to its anticipated end-of-life.
- The shut down and/or isolation procedures if the batteries are involved in fire, and appropriate personnel contact details for verifying that the battery enclosure/container system has been isolated/shut-down and de-energised during emergencies.

Within the *Design Guidelines*, s4.2.6.4 Management of Fire Water Runoff states:

> *CFA recommends that infrastructure is provided for the containment and management of contaminated fire water runoff from battery energy storage systems.*
>
> *Infrastructure may include bunding, sumps and/or purpose-built, impervious retention facilities. A fire water management plan may consist of the containment and disposal of contaminated fire water.*
>
> *CFA recommends a containment and management capacity equivalent to the on-site fire protection system. Containment is to be provided as per AS 4681- 2000: The storage and handling of class 9 dangerous goods, Section 7.3.9: Control of run-off.*

A detention basin is included within the submitted design, to the east of the development. The dimensions and capacity of the basins will be confirmed within the civil engineering design. This measure does not directly influence fire risk to/from the site, so is not addressed in this report. The inclusion of this comment is to confirm the consideration has been included in design.

5 BUSHFIRE RISK ASSESSMENT

5.1 THE SURROUNDING LANDSCAPE - BUSHFIRE HAZARD THREAT LEVEL ASSESSMENT

INFORMATION TO ASSIST INTERPRETATION

AREA OF LAND TO BE ASSESSED AS THE SURROUNDING LANDSCAPE

The assessment for this report considers the surrounding landscape to be comprised of two parts:

1. The Project and all land surrounding the subject land extending out to 150 metres as the 'Subject Land + 150m Extent'; and
2. The land surrounding the 'Subject Land + 150m Extent' extending out to the maximum distance that will be established by one or more of the following factors:
    - The distance away from the subject land that will result in an area of land that, when supporting bushfire prone vegetation, is of sufficient size such that a large-scale bushfire can develop (landscape scale fire);
    - The distance away from the subject land from which the bushfire direct attack mechanism of embers/ burning debris may reasonably be expected impact the subject land. This is highly dependent on the 'category' of vegetation present regarding its potential ember/burning debris threat (refer to Appendix 2 for explanatory information); and/or
    - The distance away from the subject land that contains the road network that persons in vehicles (including emergency services) would traverse in evacuating or accessing the subject land in the event of a bushfire.

To achieve the required assessment outcomes a maximum distance of 5 km from the subject land is likely to be considered sufficient, with this distance being reduced when the vegetation categories presenting the higher ember/burning debris threat level do not exist.

ASSESSMENT PURPOSE - EXISTENCE OF RELEVANT PHYSICAL FACTORS

To identify whether the land surrounding the existing or proposed development and its use contains the physical factors necessary for any of the following scenarios to exist:

1. The potential exists for the bushfire hazard threat of embers/burning debris to impact elements at risk on the subject land. It is particularly important this threat is identified when any vegetation planned to be retained and/or established on the subject land and within 100 metres (the 'Subject Land + 150m Extent') may not present this threat - or at least not to the same level. Refer to Appendices A1.3 and A1.6 for additional information.

   Note: Scientific research indicates that at least 80% of building losses from past Australian bushfires can be attributed to ember/firebrand attack (mostly in isolation but also in combination with radiant heat), and the resultant consequential fires. It is a very important threat to be identified; and/or

2. The potential exists for development of a large-scale bushfire event(s) that can impact the subject land because the necessary extent of bushfire prone vegetation exists. Such events may increase the severity of bushfire behaviour within the 'Subject Land + 150m Extent' vegetation, consequently increasing the levels of all bushfire hazard threats impacting elements at risk; and/or
3. The potential exists for development of dynamic fire behaviours and deep flaming that are associated with extreme bushfire events (including pyroconvective events). Dynamic fire propagation arises from complex interactions between the terrain, the atmosphere, and the fire (refer to Appendix 3 for additional information).

   Extreme bushfire events have the potential to impact subject land through generating fire driven strong winds, increasing erratic fire behaviour and increasing the levels of all bushfire hazard threats impacting elements at risk; and/or
4. The potential exists for increased levels of bushfire hazard threats, to persons in vehicles who need to move through this area of land (i.e., persons evacuating from the subject land and emergency services), thereby increasing level of risks associated with bushfire.

5.1.1 DETERMINATION OF THE ASSESSMENT EXTENT TO BE APPLIED

THE SURROUNDING LANDSCAPE ASSESSMENT EXTENT	
BASIS FOR DETERMINATION	
The vegetation categories identified surrounding the subject land include significant extents and continuity of those that contain trees with bark hazards. These present the potential for developing significant ember/burning debris threat levels. These threats are either medium (up to 5km) and/or long distance (greater than 5km) spotting. [1]	
The vegetation categories identified surrounding the subject land only include those that have the potential for shorter distance spotting (ember/burning debris attack) of up to 500-750m. [1]	✓
The distance away from the subject land that contains the road network that persons in vehicles would traverse in evacuating or accessing the subject land in the event of a bushfire, has determined the assessment extent.	
Assessment Comments: The dominant vegetation in the region is unlikely to generate moderate or long-range ember attack during a bushfire. No significant vegetation assemblages with spotting distances exceeding 700m were noted. However, a 2km extent was considered to make this determination. Overall, the vegetation types present are not conducive to the production of significant long-distance embers. Ribbon and candle bark species, which are known to generate longer-range embers due to their structure and burn characteristics, are uncommon in the area. The vegetation tends to include smooth and platy/papery barks which pose a lesser threat or fibrous barks which typically produce embers with shorter burnout times and limited travel distance, thereby reducing the potential ember threat to assets located further from the fire front.	
The extent of land surrounding the subject land that is to be considered as being the surrounding landscape for assessment purposes:	**Approximately 2 km**
Note 1: Refer to Appendix 2 and Appendix 3 for additional information.	

5.1.2 IDENTIFICATION OF VEGETATION CATEGORIES PRESENT AND RANGE OF POTENTIAL THREAT LEVELS

INFORMATION TO ASSIST INTERPRETATION

Vegetation categories are established to enable a comprehensive assessment of the type and severity of the direct bushfire attack mechanisms (i.e., the bushfire threats – refer to Appendix 2), potentially generated by bushfire prone vegetation on surrounding land. This enables variations in vegetation composition and structure to be more appropriately accounted for in the determination of the levels of risk associated with a local bushfire event.

The potential threat level ranges assigned to each vegetation category in the table below are the result of these variations in vegetation composition.

The vegetation 'Categories' applied are necessarily different to the vegetation 'Classifications' applied in the BAL determination methodology of AS 3959:2018. This building Standard primarily considers the flame contact and radiant heat attack mechanisms to inform construction requirements to resist the bushfire itself.

The BAL determination methodology does not fully address ember/firebrand attack with respect to spotting range and density associated with the types of available fuel (or any other threats from direct or indirect attack mechanisms).

Higher levels of ember/firebrand threat have implications for the initiation of consequential fire as a very significant bushfire indirect attack mechanism that can subject elements at risk to flame contact and high levels of radiant heat, even though the bushfire itself is not close and could be kilometres away. It is important not to overlook this threat.

VEGETATION CATEGORIES IDENTIFIED IN THE SURROUNDING LANDSCAPE (AND CORRESPONDING POTENTIAL THREAT LEVEL RANGES)

Vegetation Category [1 & 2]	Assessment Comments	Potential Threat Level Range [2]
Tree-1	Substantial remnant banksia woodlands within the local area, and pockets of marri trees either within these areas or isolated within pasture areas. Very low density areas of low eucalypts have been included within this category due to the bark type, however the fire intensity in such areas is unlikely to dislodge significant embers or form a pyroconvective column to create an attack vector.	Moderate to Extreme
Tree-2	Not Present	Moderate to Extreme
Tree/Shrub	Scrubby heathland areas common throughout the region, and treed areas with inconsistent or lower hazard bark types (smooth/flaky/spongy) such as melaleuca and whitegums. Tree/Shrub functionally applies to non-grassland vegetation assemblages with limited bark hazards.	Moderate to Very High
Shrub	Not Present	Low to Moderate
Grass	Pasture consistent with the region. Pasture areas display regular grazing or slashing.	Low to Moderate
No / Low Threat	Not Present	None to Low

Note 1: Refer to Figure 5.1: Surrounding landscape – the identified vegetation categories.

Note 2: Refer to Appendix 5 for a description of the criteria that establish the vegetation categories, the base bushfire hazard scenario and the potential threat levels and the application of these levels.

Figure 5.1

Vegetation Categories Map

Lot 3194 on Plan 227649, Area : 97.29 ha
Collie-Changerup Road
KOJONUP
SHIRE OF KOJONUP

BELL RD
ALBANY HWY
COLLIE-CHANGERUP RD
LUZ RD
TUNNEY RD
NORRISH DR
MATHER RD

------ LEGEND ------

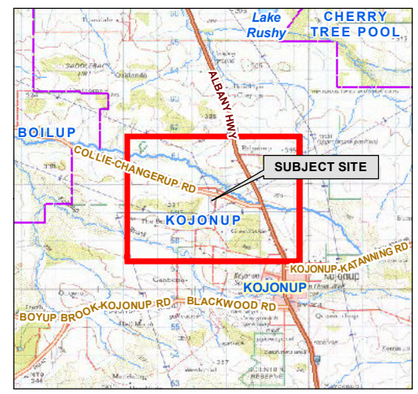
- Development Extent
- 2km from Development

Vegetation Categories

- Tree-1
- Tree/Shrub
- Grass

0 250 500 750 1,000
Metres

------ LOCALITY ------



Aerial Imagery : Landgate/SLIP
Image Date : Nov 2024

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Neil Stoney 6/01/2026
Map updated by: Neil Stoney 6/01/2026
A3 Scale 1:15,800

BUSHFIRE PRONE PLANNING

Map Document Path / Name: K:\Projects\Jobs 2024\241243 - 3680 Collie - Changerup Rd, Kojonup (BRMP)\Mapping\MXD\241243_Fig5-1_CAT.mxd

5.1.3 DETERMINING THE POTENTIAL THREAT LEVEL TO APPLY - EXISTENCE OF RELEVANT PHYSICAL FACTORS

5.1.3.1 VEGETATION EXTENT AND CONTINUITY FACTORS

THE EXISTENCE OF RELEVANT PHYSICAL FACTORS AND THEIR LIKELY IMPACT ON THE BASE POTENTIAL THREAT LEVEL (VEGETATION EXTENT AND CONTINUITY OF IDENTIFIED VEGETATION CATEGORIES)						
Relevant Physical Factors [1,4 & 6]	Vegetation Location Within the Surrounding Landscape [2]	Vegetation Classification AS 3959:2018 [3]	Vegetation Category [4]	Existence of Physical Factor	Assessment Comments (As Needed)	Resultant Modification of the Threat Level [4 & 5]
The extent of vegetation is sufficient to support a fully developed bushfire but insufficient to result in an extreme bushfire event. [4] Note: Vegetation within the 'Subject Land + 150m Extent' is only assessed independently of the surrounding vegetation when it is sufficiently isolated. If the relevant area of vegetation is not isolated or can support an extreme bushfire event (see next physical factor) the assessment response will be N/A.	N/A Vegetation within the 150 metre assessment area is not isolated from other external vegetation areas.					

THE EXISTENCE OF RELEVANT PHYSICAL FACTORS AND THEIR LIKELY IMPACT ON THE BASE POTENTIAL THREAT LEVEL (VEGETATION EXTENT AND CONTINUITY OF IDENTIFIED VEGETATION CATEGORIES)						
Relevant Physical Factors [1,4 & 6]	Vegetation Location Within the Surrounding Landscape [2]	Vegetation Classification AS 3959:2018 [3]	Vegetation Category [4]	Existence of Physical Factor	Assessment Comments (As Needed)	Resultant Modification of the Threat Level [4 & 5]
The extent of vegetation is sufficient to support large active flaming zones (landscape scale fire). This presents one of the physical factors required for the development of an extreme bushfire event. [6]	The 'Subject Land + 150m Extent'.	A. FOREST	Tree-1	Does Not Exist	Not present within the assessment extent.	Major Decrease
		B. WOODLAND				
		A. FOREST	Tree/Shrub	Insignificant / Unlikely to Occur	Limited to road verge vegetation only.	Major Decrease
		B. WOODLAND				
		D. SCRUB				
		G. GRASSLAND	Grass	Substantially Exists	Grassland is of substantial extent.	Neutral
	The Land Surrounding the 'Subject Land + 150m Extent'		Tree-1	Partially Exists	Continuous large extents are present to the south-east, >500m from the site.	Neutral
			Tree/Shrub	Partially Exists	Often irregularly shaped or smaller areas, but do exist to the west and north.	Minor Decrease
			Grass	Partially Exists	Cleared pasture areas are common locally.	Neutral
The bushfire fuels are continuous. Fire can spread uninterrupted and not be slowed by the intermittent absence of fuels. This presents one of the physical factors required for the development of an extreme bushfire event. [6]	The 'Subject Land + 150m Extent'.	A. FOREST	Tree-1	Does Not Exist	Not present within the assessment extent.	Major Decrease
		B. WOODLAND				
		A. FOREST	Tree/Shrub	Does Not Exist	Road verge vegetation is limited and fragmented by roads and pasture.	Major Decrease
		B. WOODLAND				
		D. SCRUB				
		G. GRASSLAND	Grass	Substantially Exists	Access tracks and external roads fragments the vegetation to a limited extent.	Minor Decrease
	The Land Surrounding the 'Subject Land + 150m Extent'		Tree-1	Substantially Exists	The fuels within these areas are continuous, and the area to the south-east is of sufficient extent that fire spread would be uninterrupted.	Minor Increase

THE EXISTENCE OF RELEVANT PHYSICAL FACTORS AND THEIR LIKELY IMPACT ON THE BASE POTENTIAL THREAT LEVEL (VEGETATION EXTENT AND CONTINUITY OF IDENTIFIED VEGETATION CATEGORIES)						
Relevant Physical Factors [1,4 & 6]	Vegetation Location Within the Surrounding Landscape [2]	Vegetation Classification AS 3959:2018 [3]	Vegetation Category [4]	Existence of Physical Factor	Assessment Comments (As Needed)	Resultant Modification of the Threat Level [4 & 5]
			Tree/Shrub	Partially Exists	Occasional fragmentation only.	Minor Decrease
			Grass	Partially Exists	Access tracks and external roads fragments the vegetation to a limited extent.	Minor Decrease

Note 1: Refer to Appendix 2 for additional information.

Note 2: Refer to Figure 5.1 Surrounding landscape – the identified vegetation categories.

Note 3: Refer to Appendix A6.4.2 for the map of classified (AS 3959:2018) bushfire prone vegetation and topography within the 'Subject Land + 150m Extent'. The identified classified vegetation that best corresponds to the categorised vegetation will be specific to the subject land and its surrounds and is identified in this column.

Note 4: Refer to Appendix 5 for a description of the criteria that establish the vegetation categories and their potential threat level range.

Note 5: The modification rating is derived for the identified area of vegetation/land after conducting a qualitative assessment of the existence of the relevant physical factor. It is applied to deriving a 'Potential Threat Level' from the 'Potential Threat Level Range' associated with each vegetation category.

Note there is a base bushfire fuels, terrain and fire weather assumption that has been applied in establishing the 'Potential Threat Level' ranges. It is a scenario of a sufficiently large area of bushfire prone vegetation, with continuous fuels, on flat to undulating terrain with no slopes greater than ten degrees, that can support a fully developed bushfire. It is also assumed to be possible for the most adverse (catastrophic) fire weather to occur. This scenario establishes the midpoint of the 'Potential Threat Level Range'. Refer to Appendix 5 for additional explanatory and supporting information.

Note 6: A physical factor with identified links (from bushfire research) to dynamic bushfire propagation and subsequent development of extreme bushfire events, including the development of pyroconvective, coupled atmosphere events. Refer to Appendix 3 for additional information.

5.1.3.2 VEGETATION FUEL LOAD/ARRANGEMENT/BARK HAZARD FACTORS

THE EXISTENCE OF RELEVANT PHYSICAL FACTORS AND THEIR LIKELY IMPACT ON THE BASE POTENTIAL THREAT LEVEL (FUEL LOAD/ARRANGEMENT/BARK HAZARD OF IDENTIFIED VEGETATION CATEGORIES)						
Relevant Physical Factors [1 & 6]	Vegetation Location Within the Surrounding landscape [2]	Vegetation Classification AS 3959:2018 [3]	Vegetation Category [4]	Existence of Physical Factor	Assessment Comments (As Needed)	Resultant Modification of the Potential Threat Level [4 & 5]
Managed Fuel Loads Evidence that management of fuel loads is planned, conducted regularly and enforced. Includes prescribed burning programs.	The 'Subject Land + 150m Extent'.	A. FOREST	Tree-1	N/A	Not present within the assessment extent.	Major Decrease
		B. WOODLAND				
		A. FOREST	Tree/Shrub	Does Not Exist	Road verges are not managed.	Neutral
		B. WOODLAND				
		D. SCRUB				
		G. GRASSLAND	Grass	Partially Exists	Grassed areas are often grazed or cropped short. This is not a planned or conducted measure.	Minor Decrease
	The Land Surrounding the 'Subject Land + 150m Extent'		Tree-1	Does Not Exist	-	Neutral
			Tree/Shrub	Partially Exists	Many such areas have heavily grazed understory.	Minor Decrease
			Grass	Partially Exists	Grassed areas are often grazed or cropped short. This is not a planned or conducted measure.	Minor Decrease
Adverse Fuel Loads and Arrangement [6] Fuel loads heavier than a normal range for the category or are uncharacteristic for the category; and/or	The 'Subject Land + 150m Extent'.	A. FOREST	Tree-1	N/A	Not present within the assessment extent.	Major Decrease
		B. WOODLAND				
		A. FOREST	Tree/Shrub	Substantially Exists	Road verges are scrub/grass with significant surface, near-surface, and elevated fuels.	Neutral
		B. WOODLAND				
		D. SCRUB				
		G. GRASSLAND	Grass	Limited	Grassed areas are often grazed or cropped short.	Significant Decrease

THE EXISTENCE OF RELEVANT PHYSICAL FACTORS AND THEIR LIKELY IMPACT ON THE BASE POTENTIAL THREAT LEVEL (FUEL LOAD/ARRANGEMENT/BARK HAZARD OF IDENTIFIED VEGETATION CATEGORIES)						
Relevant Physical Factors [1 & 6]	Vegetation Location Within the Surrounding landscape [2]	Vegetation Classification AS 3959:2018 [3]	Vegetation Category [4]	Existence of Physical Factor	Assessment Comments (As Needed)	Resultant Modification of the Potential Threat Level [4 & 5]
Worst case fuel arrangement exists. [Where heavy forest fuel types with loads more than 15-20 t/ha exist, the potential for vorticity-driven lateral spread exists (as a dynamic fire behaviour) if the required terrain characteristics are present].	The Land Surrounding the 'Subject Land + 150m Extent'		Tree-1	Partially Exists	The fuel load arrangements in Tree-1 areas are that of dense scrub/forest, and approximate the expected fuel loads.	Neutral
			Tree/Shrub	Limited	Most areas have reduced available elevated fuels due to grazing.	Significant Decrease
			Grass	Partially Exists	Grassed areas are often grazed or cropped short.	Significant Decrease
Bark Hazard The presence of high threat level bark hazards with potential for high levels of ember/burning debris production (spotting density) and long burnout times (travel distance). Refer to photo evidence in Appendix A6.3.	The 'Subject Land + 150m Extent'.	A. FOREST	Tree-1	Does Not Exist	Not present within the assessment extent.	Major Decrease
		B. WOODLAND				
		A. FOREST	Tree/Shrub	Limited	The limited scrub areas do not contain barks which pose a significant ember hazard.	Significant Decrease
		B. WOODLAND				
		D. SCRUB				
		G. GRASSLAND	Grass	Does Not Exist	-	Significant Decrease
	The Land Surrounding the 'Subject Land + 150m Extent'		Tree-1	Partially Exists	The bark types within Tree-1 have higher ember generation potential (finely fibrous barks) with short distance spotting (shorter burnout times). Flooded gum and casuarina has very short spotting distances, but jarrah bark is both longer distance and substantially more intense.	Significant Decrease
			Tree/Shrub	Limited	The bark types within Tree/Shrub areas is greatly variable, but longer distance spotting is unlikely. Platy, smooth, papery, and fibrous barks are all present.	Significant Decrease

THE EXISTENCE OF RELEVANT PHYSICAL FACTORS AND THEIR LIKELY IMPACT ON THE BASE POTENTIAL THREAT LEVEL (FUEL LOAD/ARRANGEMENT/BARK HAZARD OF IDENTIFIED VEGETATION CATEGORIES)						
Relevant Physical Factors [1 & 6]	Vegetation Location Within the Surrounding landscape [2]	Vegetation Classification AS 3959:2018 [3]	Vegetation Category [4]	Existence of Physical Factor	Assessment Comments (As Needed)	Resultant Modification of the Potential Threat Level [4 & 5]
			Grass	Does Not Exist	-	Significant Decrease

Note 1: Refer to Appendix 2 for additional information.

Note 2: Refer to Figure 5.1 Surrounding landscape – the identified vegetation categories.

Note 3: Refer to Appendix A6.4.2 for the map of classified (AS 3959:2018) bushfire prone vegetation and topography within the 'Subject Land + 150m Extent'. The identified classified vegetation that best corresponds to the categorised vegetation will be specific to the subject land and its surrounds and is identified in this column.

Note 4: Refer to Appendix 5 for a description of the criteria that establish the vegetation categories and their potential threat level range.

Note 5: The modification rating is derived for the identified area of vegetation/land after conducting a qualitative assessment of the existence of the relevant physical factor. It is applied to deriving an 'Potential Threat Level' from the 'Potential Threat Level Range' associated with each vegetation category.

Note there is a base bushfire fuels, terrain and fire weather assumption that has been applied in establishing the 'Potential Threat Level' ranges. It is a scenario of a sufficiently large area of bushfire prone vegetation, with continuous fuels, on flat to undulating terrain with no slopes greater than ten degrees, that can support a fully developed bushfire. It is also assumed to be possible for the most adverse (catastrophic) fire weather to occur. This scenario establishes the midpoint of the 'Potential Threat Level Range'. Refer to Appendix 5 for additional explanatory and supporting information.

Note 6: A physical factor with identified links (from bushfire research) to dynamic bushfire propagation and subsequent development of extreme bushfire events, including the development of pyroconvective, coupled atmosphere events. Refer to Appendix 3 for additional information.

5.1.3.3 TERRAIN FACTORS

THE EXISTENCE OF RELEVANT PHYSICAL FACTORS AND THEIR LIKELY IMPACT ON THE BASE POTENTIAL THREAT LEVEL (GROUND SLOPE AND SLOPE LENGTH UNDER IDENTIFIED VEGETATION CATEGORIES)						
Relevant Physical Factors [1 & 6]	Vegetation Location Within the Surrounding landscape [2]	Vegetation Classification AS 3959:2018 [3]	Vegetation Category [4]	Existence of Physical Factor	Assessment Comments (As Needed)	Resultant Modification of the Potential Threat Level [4 & 5]
Effective Slopes ≥ 10 Degrees Vegetation exists, at least partially, on terrain of 10 degrees or greater ground slope and of sufficient length (see slope length factor), that will increase fire rates of spread and consequent fire intensity.	The 'Subject Land + 150m Extent'.	A. FOREST	Tree-1	Does Not Exist	Local slopes are largely flat or up to 5 degrees. See Figure 5.3.	Minor Decrease
		B. WOODLAND				
		A. FOREST	Tree/Shrub			
		B. WOODLAND				
		D. SCRUB				
		G. GRASSLAND	Grass			
	The Land Surrounding the 'Subject Land + 150m Extent'		Tree-1			Minor Decrease
			Tree/Shrub			
			Grass			
Effective Slopes ≥ 20 Degrees [6] Vegetation exists, at least partially, on steep terrain of 20 degrees or greater ground slope and of sufficient length (see slope length factor). The presence of ridges able to present steep leeward slopes to exposed elements is an additional	The 'Subject Land + 150m Extent'.	A. FOREST	Tree-1	Does Not Exist		Minor Decrease
		B. WOODLAND				
		A. FOREST	Tree/Shrub			
		B. WOODLAND				
		D. SCRUB				
		G. GRASSLAND	Grass			
	The Land Surrounding the 'Subject Land + 150m Extent'		Tree-1			
			Tree/Shrub			
			Grass			

THE EXISTENCE OF RELEVANT PHYSICAL FACTORS AND THEIR LIKELY IMPACT ON THE BASE POTENTIAL THREAT LEVEL (GROUND SLOPE AND SLOPE LENGTH UNDER IDENTIFIED VEGETATION CATEGORIES)						
Relevant Physical Factors [1 & 6]	Vegetation Location Within the Surrounding landscape [2]	Vegetation Classification AS 3959:2018 [3]	Vegetation Category [4]	Existence of Physical Factor	Assessment Comments (As Needed)	Resultant Modification of the Potential Threat Level [4 & 5]
component of this factor.						
Sufficient Length of Steep Slopes The identified 20 degree and greater slopes can support the entire flame depth of a fully developed fire.	The 'Subject Land + 150m Extent'.	A. FOREST	Tree-1	Does Not Exist	No slopes >20 degrees exist for longer slopes to apply.	Minor Decrease
		B. WOODLAND				
		A. FOREST	Tree/Shrub			
		B. WOODLAND				
		D. SCRUB				
		G. GRASSLAND	Grass			
	The Land Surrounding the 'Subject Land + 150m Extent'		Tree-1			
			Tree/Shrub			
			Grass			

Note 1: Refer to Appendix 2 for additional information.

Note 2: Refer to Figure 5.1 Surrounding landscape – the identified vegetation categories.

Note 3: Refer to Appendix A6.4.2 for the map of classified (AS 3959:2018) bushfire prone vegetation and topography within the 'Subject Land + 150m Extent'. The identified classified vegetation that best corresponds to the categorised vegetation will be specific to the subject land and its surrounds and is identified in this column.

Note 4: Refer to Appendix 5 for a description of the criteria that establish the vegetation category and its potential threat level range.

Note 5: The modification rating is derived for the identified area of vegetation/land after conducting a qualitative assessment of the existence of the relevant physical factor. It is applied to deriving an 'Potential Threat Level' from the 'Potential Threat Level Range' associated with each vegetation category.

Note there is a base bushfire fuels, terrain and fire weather assumption that has been applied in establishing the 'Potential Threat Level' ranges. It is a scenario of a sufficiently large area of bushfire prone vegetation, with continuous fuels, on flat to undulating terrain with no slopes greater than ten degrees, that can support a fully developed bushfire. It is also assumed to be possible for the most adverse (catastrophic) fire weather to occur. This scenario establishes the midpoint of the 'Potential Threat Level Range'. Refer to Appendix 5 for additional explanatory and supporting information.

Note 6: A physical factor with identified links (from bushfire research) to dynamic bushfire propagation and subsequent development of extreme bushfire events, including the development of pyroconvective, coupled atmosphere events. Refer to Appendix 3 for additional information.

Note 7: Refer to Figure 5.3: Surrounding landscape - terrain slope map.

Figure 5.2

Surrounding Landscape Terrain Elevation Map

Lot 3194 on Plan 227649, Area : 97.29 ha
Collie-Changerup Road
KOJONUP
SHIRE OF KOJONUP

BELL RD
ALBANY HWY
COLLIE-CHANGERUP RD
LUZ RD
NORRISH DR
TUNNEY RD
MATHER RD

Key

Elevation (m)

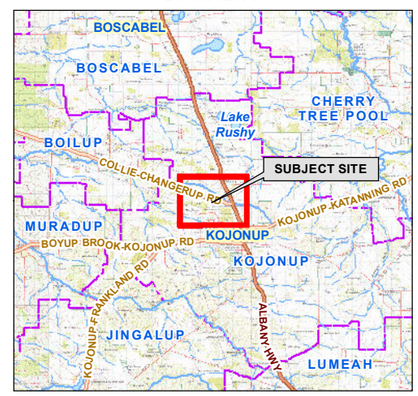
- 270 - 280
- 280 - 290
- 290 - 300
- 300 - 310
- 310 - 320
- 320 - 330
- 330 - 340
- 340 - 350
- 350 - 360
- 360 - 370

------ **LEGEND** ------

- Development Extent
- 2km from Development

0 250 500 750 1,000
Meters

------ **LOCALITY** ------



N

BUSHFIRE PRONE PLANNING

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Ian Ross 6/01/2026
Map updated by: Neil 6/01/2026
A3 Scale 1:15,800

Map Document Path / Name: K:\Projects\Jobs 2024\241243 - 3680 Collie - Changerup Rd, Kojonup (BRMP)\Mapping\MXD\241243_Fig5-2_DEM.mxd

Figure 5.3

Surrounding Landscape Terrain Slope Map

Lot 3194 on Plan 227649, Area : 97.29 ha
Collie-Changerup Road
KOJONUP
SHIRE OF KOJONUP

BELL RD
ALBANY HWY
COLLIE-CHANGERUP RD
LUZ RD
NORRISH DR
TUNNEY RD
MATHER RD

Key

Slope (Degrees)

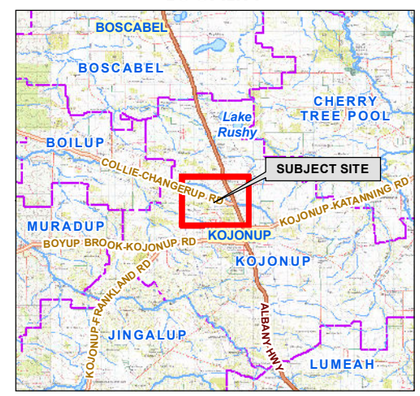
- 0 - 1
- 1 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20+

------ **LEGEND** ------

- Development Extent
- 2km from Development

0 250 500 750 1,000
Meters

------ **LOCALITY** ------



N

BUSHFIRE PRONE PLANNING

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Ian Ross 6/01/2026
Map updated by: Neil 6/01/2026
A3 Scale 1:15,800

Map Document Path / Name: K:\Projects\Jobs 2024\241243 - 3680 Collie - Changerup Rd, Kojonup (BRMP)\Mapping\MXD\241243_Fig5-3_SLOPE.mxd

5.1.3.4 FIRE WEATHER FACTORS

The purpose of including consideration of fire weather factors in the surrounding landscape assessment is to be able to account for those scenarios in which the most adverse (catastrophic) fire weather conditions are either (a) cannot occur; or (b) highly unlikely to occur and this can be fully justified. Otherwise, such conditions are accounted for in the 'Potential Threat Level' ranges stated for each category of vegetation in Appendix 5.

THE EXISTENCE OF RELEVANT PHYSICAL FACTORS AND THEIR LIKELY IMPACT ON THE BASE POTENTIAL THREAT LEVEL - FIRE WEATHER CONSIDERATIONS			
Relevant Physical Factor	Existence of Physical Factor	Assessment Comments (As Needed)	Resultant Modification of the Potential Threat Level [1]
Associated with intensification of fire behaviour			
Location has persistent strong synoptic winds (i.e., not fire driven)	Likely to Occur	The nearest weather station is Katanning. The prevailing wind directions are easterly and southerly. Wind speeds are historically gentle to moderate, with speeds exceeding 30kmh being <5% frequency.	Significant Decrease
Very low relative humidity and very high ambient air temperature	Likely to Occur	Common during the bushfire season, with extended periods without rain. The region frequently has very low relative humidity due to the expansive cleared areas and wind action.	Minor Increase
Associated with development of dynamic fire propagation behaviours, intensification of fire behaviour, and development of extreme bushfire events. [2]			
Wind speeds in excess of approximately 20 km/hr and wind direction within 30-40 degrees of ridge/scarp features – increasing the potential for vorticity-driven lateral spread.	N/A	Ridges/scarps are not present within the region.	N/A
Due to weather factors, fuel moisture contents can dry to around 5% or less.	Possible to Occur	Due to the drying climate and increasing temperatures, these factors may be possible. Pasture will often reach 5% fuel moisture and the limited overstory in many areas limits the ability for shading to increase humidity.	Neutral
Atmospheric instability creating opportunity for atmospheric coupling and violent pyroconvection. [3]	Possible to Occur	Atmospheric instability occurs where air higher in the atmosphere is cool relative to the surface (>9.8°C per vertical kilometre differential). This weather condition is always possible to occur.	Neutral
Note 1: The modification rating is derived for the identified area of vegetation/land after conducting a qualitative assessment of the existence of the relevant physical factor. It is applied to deriving an 'Potential Level' from the 'Potential Threat Level Range' associated with each vegetation category.			

Note there is a base bushfire fuels, terrain and fire weather assumption that has been applied in establishing the 'Potential Threat Level' ranges. It is a scenario of a sufficiently large area of bushfire prone vegetation, with continuous fuels, on flat to undulating terrain with no slopes greater than ten degrees, that can support a fully developed bushfire. It is also assumed to be possible for the most adverse (catastrophic) fire weather to occur. This scenario establishes the midpoint of the 'Potential Threat Level Range'. Refer to Appendix 5 for additional explanatory and supporting information.

Note 2: Refer to Appendix 3 for additional information.

Note 3: Regarding the potential for a pyroconvective fire event to occur, the default assumption is that most locations will have the potential for vertical movement of air without any resistance to that movement (e.g. temperature inversion), as one of the typical requirements for such an event to occur.

It is not sufficiently risk averse to assume that atmospheric instability is unlikely to exist. Different temperature air masses can always interact as a consequence of the passage of different weather systems at any location. Justifying a variation to this is outside the scope of this assessment.

5.1.3.5 OUTCOME OF RELEVANT PHYSICAL FACTOR ASSESSMENT – THE BASE POTENTIAL THREAT LEVEL

THE BUSHFIRE HAZARD OF THE SURROUNDING LANDSCAPE – SUMMARY OF HOW THE POTENTIAL THREAT LEVEL IS DERIVED							
Vegetation Location Within the Surrounding Landscape	Identified Vegetation Categories	Potential Threat Level Range	Assessed Potential for the Modification of the Threat Level by Each Stated Physical Factor				The Derived Potential Threat Level of Each Vegetation Category
			Vegetation Extent and Continuity	Fuel Load / Arrangement and Bark Hazard	Terrain - Ground Slope and Slope Length	Fire Weather	
(Section 5.1)	(Figure 5.1 & Appendix 5)	(Appendix 5)	(Section 5.1.3.1)	(Section 5.1.3.2)	(Section 5.1.3.3)	(Section 5.1.3.4)	
The 'Subject Land + 150m Extent'	Tree-1	Moderate to Extreme	Major Decrease	Major Decrease	Minor Decrease	Minor Decrease	N/A
	Tree/Shrub	Moderate to High	Significant Decrease	Minor Decrease			Moderate
	Grass	Low to Moderate	Minor Decrease	Significant Decrease			Low
The Land Surrounding the 'Subject Land + 150m Extent'	Tree-1	Moderate to Extreme	Minor Increase	Minor Decrease			Moderate
	Tree/Shrub	Moderate to High	Minor Decrease	Significant Decrease			Moderate
	Grass	Low to Moderate	Minor Decrease	Significant Decrease			Low
THE BASE BUSHFIRE HAZARD POTENTIAL THREAT LEVEL TO APPLY TO THE SITE [1]			Very Low ☐	Low ☒	Moderate ☐	High ☐	**Extreme** ☐
Note 1: Derived qualitatively by considering the assessed potential threat level for each identified category of vegetation and the relative extents of each category. The highest level will be applied unless it is associated with a less significant extent of vegetation.							

ASSESSMENT SUMMARY COMMENTS

The immediate bushfire threat is grassland only and the regional threats are 'Moderate' whilst posing a reduced ember hazard. A threat level of 'Low' is appropriate.

5.1.4 THREAT LEVEL ASSESSMENT – BUSHFIRE PROTECTION MEASURE ANALYSIS

For each identified bushfire hazard, an assessment is conducted that considers the effectiveness and application status of all available threat reducing bushfire protection measures that are listed under their applicable bushfire protection mechanism. This information is subsequently applied to deriving threat levels applied to deriving risk levels.

5.1.4.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE THREAT LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
THE PROTECTION MECHANISM – PREVENT BUSHFIRE IGNITION AND/OR SEVERITY BY MANAGING FUEL LOADS: Eliminate or reduce vegetation fuel loads, modify their properties (vegetation types and fuel arrangement). Maintain the measures over time to eliminate bushfire or lower the severity of fire behaviours and the consequent threat levels. Desired and mandatory environmental conservation will likely always be the most significant limitation to applying the mechanism.						
1.1	**Remove Offsite Bushfire Fuel:** Remove fuel permanently by clearing bushfire prone vegetation - only when permission and relevant agreements for removal have been established with the landowner and relevant authorities.	Very High	N/A	N/A	N/A	N/A
Assessment Comments: Not environmentally acceptable and beyond the control of the proponent. ***Recommendation Details:*** Not Applicable						
1.2	**Reduce Offsite Bushfire Fuel - Prescribed Burning:** Planned hazard reduction when permission and relevant agreements to conduct and maintain have been established with the landowner and relevant authorities.	High	N/A	N/A	N/A	N/A
Assessment Comments: Prescribed offsite burning is unlikely to be supported by the management authorities of neighbouring lots in support of the proposed development. ***Recommendation Details:*** Not Applicable						
1.3	**Reduce Offsite Bushfire Fuel - Mechanical:** Modify composition of vegetation types and/or the arrangement of fuels and maintain the modification over time e.g. reduce canopy, limit higher threat bark types (e.g. stringy, ribbon), minimise 'ladder' fuels'. Will likely require permission and relevant agreements to conduct and maintain from the landowner and relevant authorities.	High	N/A	N/A	N/A	N/A
Assessment Comments: Not environmentally acceptable and beyond the control of the proponent. ***Recommendation Details:*** Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE THREAT LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
1.4	**Remove Onsite Bushfire Fuel:** Remove fuel permanently by clearing bushfire prone vegetation – only after the necessary approvals from relevant authorities have been obtained.	Very High	Yes	No	Partly	Yes
Assessment Comments: Vegetation clearing will occur for required APZs and development but not to reduce regional bushfire hazard. The groundworks and minimum 'BAL-29 Planning' APZ considered 'Planned' and the APZs applicable to different assets is 'Additionally Recommended.' ***Recommendation Details:*** **See Measure 6.3**.						
1.5	**Reduce Onsite Bushfire Fuel - Prescribed Burning:** Planned hazard reduction only after the necessary approvals from relevant authorities have been obtained.	High	Yes	No	Unknown	No
Assessment Comments: Based on the relative location of non-grassland fuels, the potential reduced fire intensity is not sufficient justification for imposing a prescribed burning schedule. ***Recommendation Details:*** Not Applicable						
1.6	**Reduce Onsite Bushfire Fuel - Mechanical:** Modify composition of vegetation types and/or the arrangement of fuels and maintain the modification over time e.g. reduce canopy, limit higher threat bark types (e.g. stringy, ribbon), minimise 'ladder' fuels'. Approvals from relevant authorities regarding environmental considerations may be required.	High	Yes	No	Unknown	Yes
Assessment Comments*:* Mechanical fuel reduction will not be applied due to the scale and frequency of maintenance required. Vegetation classifications applied are already conservative. ***Recommendation Details***: **See Measure 1.10.**						
1.7	**Reduce Road Verge Fuel:** Road verges of designated evacuation routes are subject to fuel load reduction, tree management and ongoing maintenance when an authority exists to conduct and maintain.	Medium	No	No	No	No
Assessment Comments*:* Verge fuel reduction following the local road network would require support from the Local Government Authority (Shire of Kojonup). The site is 97.3ha comprise a very limited proportion of the bushfire hazard. Road verge fuel reduction may be entertained where the verge impacts a specific asset, but not across the entire site or for evacuation safety. ***Recommendation Details****:* Not Applicable						

	PROTECTION MEASURES AVAILABLE TO REDUCE THREAT LEVELS	Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
1.8	**Enforce Compliance with Local Government Property Management Directives:** Inform landowners of the high level of enforcement that will be applied by the relevant authority.	High	Yes	Yes	No	No
Assessment Comments: The Firebreak Notice does not require property fuel reduction for the zoning/lot sizes. APZs required under the Firebreak Notice not associated with the development do not impact the bushfire risk from/to the development. The Firebreak Notice is enforceable by law, at the discretion of the Local Government Authority. ***Recommendation Details:*** Not Applicable						
1.9	**Management of Planned Revegetation:** Planned revegetation includes environmental offsets, landscape screening, windbreaks, water table management, sprayfields etc. Revegetation works consider potential bushfire and consequential fire hazards, through: • Species selection; • Dimensions and alignment; • Location relative to other vegetation hazards; • Separation between revegetation areas to avoid continuous fire spread, and; • Initial or ongoing management works to limit the bushfire hazard.	Very High	Yes	No	Yes	Yes
Assessment Comments: Renewable energy infrastructure is frequently sited in large vacant allotments or farmland where the necessary infrastructure and sufficient space is available. This results in potential visual and noise amenity impacts. Revegetation to provide vegetation screening is a very common requirement for such proposals. Vegetation screening is required where the existing vegetation is insufficient to block the development from receptors, and so is generally not connected to substantive vegetation. In general, such areas will be continuous with open pasture, windbreaks, or nature strips within road reserves. <u>Exclusion from Classification</u> *AS 3959-2018* appropriately provides for exclusion of isolated, narrow, and/or disconnected vegetation through exclusion clauses 2.2.3.2 (b), (c), and (d), and the clause (f) provision for windbreaks and nature strips. The exclusions attempt to provide for the principle that fire spread will not be continuous between sufficiently separated pockets of vegetation- it will need to spot (through embers or detached flame) and re-develop. Any fire in such a pocket will be a developing fire without presenting significant threat to assets which are sufficiently separated from the vegetation. Vegetation screens are often isolated, narrow pockets which do not meet the prescribed >20m setbacks of clauses 2.2.3.2 (c) and (d), despite the intent being applicable. For example, a pasture fire (modelled flame length <8m) cannot spread uninterrupted across a >12m road carriageway (noting spotting and re-establishment may occur as above). Clauses 2.2.3.2 (c) or (d) cannot be applied to vegetation on the opposing verge due to the <20m separation.					

PROTECTION MEASURES AVAILABLE TO REDUCE THREAT LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Modification of Classification *AS 3959-2018* does not provide for modified classification (e.g. Class A Forest to Class D Scrub) where the same principles as for exclusion apply. This oversight has direct implication on vegetation screening, which must necessarily be sited relatively near the development and at a sufficient depth and height to function as a screen. Within the 'Planning' BMP (*241243 - Kojonup BESS (BMP*) prepared to support the proposal, vegetation must be classified in accordance with AS 3959. For the purposes of this risk assessment, the gaps in this methodology should be considered. A landscape-scale fire running through pasture, windbreaks, and road reserves impacting a <10m wide band of vegetation will increase in intensity. Thus, classification of this vegetation is appropriate. However, in treed vegetation (forest/woodland), it is highly unlikely to develop/establish into a crowning fire- where the canopy is fully involved in the fire. The behaviour would not be a developing fire but would be limited to the elevated fuels only. Further, where the vegetation is surrounded by pasture, wind action is a far more relevant consideration as continuous trees are not present to limit wind impact. A fully established bushfire where elevated (but not canopy) fuels are consumed and placing emphasis on wind action, is the modelling for Shrub, Scrub, and Mallee/Mulga fuel types in Table B4 of *AS 3959-2018* (Catchpole et al. 1998). This is the appropriate fire model to apply. Summary 1. Class A Forest/Class B Woodland classification does not appropriately represent the expected or modelled fire behaviour for narrow bands of vegetation screening vegetation which are either isolated or continuous with pasture. Class D Scrub (Catchpole et al. fire model) is the appropriate classification to apply in these scenarios. 2. It may be appropriate to exclude narrow bands of screening vegetation which are disconnected from continuous fire runs by non-vegetated or low fuel areas (roads, hardstand, APZs etc), in alignment with but not strictly meeting AS 3959 clause 2.2.3.2 (c) or (d). ***Recommendation Details***: Where vegetation screening is <10m width and continuous with pasture only, vegetation classification should not exceed Class D Scrub. Where vegetation screening is <10m in width and isolated from significant vegetation, exclusion as a 'nature strip' may be appropriate. This will be reflected within the associated Bushfire Management Plan for the Development Application.						
THE PROTECTION MECHANISM – PREVENT BUSHFIRE IGNITION BY MANAGING HEAT ENERGY SOURCES: The use of measures that control the existence of potential ignition sources. This includes human actions and/or faulty or poorly designed equipment. Natural causes of ignition (lightning) cannot be controlled and will remain an unmanageable limitation.						
1.10	**Robust and Effective Site Operational Procedures:** Apply fire safe principles to site operation procedures including: • Eliminating or reducing the potential for open air creation of fire, embers or sparks; and • Closing identified high risk operations when a bushfire event exists. • Ensure safe practices are carried out via appropriate guidelines, protocols, signage and education.	Medium	Yes	No	Partly	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE THREAT LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Assessment Comments: Compliance with any Dangerous Goods Licences is a regulatory requirement and will include recommendations for operational procedures. Operating procedures document has not yet been prepared. ***Recommendation Details:*** The following procedures should be completed prior to the bushfire season (see the Shire of Kojonup Prohibited Burning Period): • Scheduled maintenance to assets, emergency equipment, or fire detection/prevention systems. • The ongoing requirements outlined in the Bushfire Management Plan. • Scheduled housekeeping inspections including: o Hazard identification - ensuring that infrastructure, plant, equipment, vehicles and safety/warning signs show no signs of damage or dilapidation. o Facility access - ensuring all vehicle site access points, including emergency access points, are clear and accessible. o Fire protection systems and equipment – ensuring that all equipment is unobstructed, clearly identifiable, in-service and performing optimally. o Vegetation management - ensuring that any accumulation of combustible materials is cleared from infrastructure, buildings and fire breaks, and removed from the site. o Security measures - ensuring that fences, gates, and security cameras are inspected for damage, and that any damage is immediately actioned (e.g., repaired or replaced). • Ad-hoc or annual invitations extended to the local emergency services through the Local Government's Community Emergency Services Manager to offer a familiarisation visit and explanation of emergency procedures, access, hazards, and fire detection and suppression systems.					
1.11	**Develop Planning and Management Procedures for Prescribed Burning:** Ensure proper management of hazard reduction burning to prevent ignition of unintended fuels.	Medium	No	No	No	No
Assessment Comments: Local burns by the volunteer Bushfire Brigades will not be undertaken near hazardous or flammable materials (non-vegetation). Burns will not be conducted by development staff. ***Recommendation Details:*** Not Applicable						
1.12	**Design and Construct Equipment to Prevent Airborne Ignition:** Apply fire safe design principles to equipment, vehicles, and energy transmission etc. Design to control rate of energy release and eliminate/reduce potential for open air creation of fire, embers or sparks.	Very High	Yes	No	Yes	No
Assessment Comments: All equipment must meet minimum national and state standards and guidelines. Due to the nature of the site, control of ignition sources will be stringent.						

PROTECTION MEASURES AVAILABLE TO REDUCE THREAT LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
A bushfire consultant cannot provide additional design measures to prevent accidental ignition (due to faults/failure of the asset or equipment), so this scenario is assumed in determining bushfire protection measures. Accidental ignition is instead managed through operating procedures (Measure 1.10). ***Recommendation Details***: Not Applicable						
1.13	**Actively Enforce Activity Restrictions:** Impose restrictions on source of ignition operations by enforcing Total Fire Bans (TFB)	Medium	Yes	Yes	No	Yes
Assessment Comments: Total fire bans will be complied with. Total fire ban exemptions will be applied for, if necessary for site functionality. ***Recommendation Details***: **See Measure 1.10**.						
1.14	**Monitor and Penalise Illegal Activity:** Reduce arson events as sources of ignition by monitoring and publicising enforcement of penalties.	Medium	N/A	N/A	N/A	N/A
Assessment Comments: The subject site is private property. Illegal ignition offsite is not under the control of the proponent /occupier. ***Recommendation Details***: Not Applicable						
1.15	**Bushfire Awareness and 'Good Practices' Education:** Educate persons to reduce the occurrence of accidental ignitions in vegetation by persons and/or vehicles, including in road reserves.	Medium	Yes	No	Yes	Yes
Assessment Comments: Activities which may result in fire are prohibited onsite. Contractors and staff are required to complete inductions and/or be escorted and follow the operating procedures per Measure 1.10. ***Recommendation Details***: See Measure 1.10.						
THE PROTECTION MECHANISM - PREVENT BUSHFIRE IGNITION BY MANAGING INTERACTIONS OF HEAT ENERGY SOURCES AND FUELS: The use of measures that control the interaction of heat sources and fuels.						
1.16	**Barriers (Shielding) between Ignition Sources and Fuels:** Utilise physical barriers (shielding) between bushfire fuels and heat energy sources such as electricity generation / transmission, fuel supplies, stored flammable products etc. Examples include appropriate walls, enclosures, and underground transmission of electricity or liquid/gas fuels.	Medium	Yes	No	No	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE THREAT LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Assessment Comments: Site assets will be required to have a sufficient APZ installed to avoid flame contact and excessive radiant heat. This has been addressed in **Measure 6.3**. Any ignition of offsite vegetation would likely be due to embers or flaming debris/firebrands, which shielding is not effective against. Ember screening of battery cabinets is required through **Measure 13.13** which will reduce the capacity for such embers to escape a compromised battery cabinet. ***Recommendation Details***: **See Measures 6.3 & 13.13**.						
1.17	**Equipment Design and Construction to Reduce Heat Transfer:** Through design (e.g., insulation) and materials, control heat energy transfer via conduction, convection and radiation.	Medium	Yes	No	Yes	Yes
Assessment Comments: All equipment must meet minimum national and state standards and guidelines. Due to the nature of the site, control of ignition sources will be stringent. ***Recommendation Details:*** See **Measure 13.16.**						
1.18	**Separation Distance Between Ignition Sources and Fuels:** Establish sufficient separation distance between bushfire fuels and heat energy sources such as electricity generation / transmission, fuel supplies, stored flammable products etc.	Medium	Yes	No	Yes	Yes
Assessment Comments: Radiant heat flux in battery fires is relatively low; the Victorian Big Battery Fire (July 2021) required only a 20m exclusion zone for personnel (such an exclusion zone would generally be <4kW/m2 radiant heat flux). The <10kW/m2 APZ proposed is 25m. Therefore, in the reasonable worst-case scenario, flame contact and radiant heat flux will be insufficient to ignite a bushfire in the surrounding vegetation. Grasses require approximately 250-degree temperature to ignite with no pilot- thus the setback required to minimise the capacity for flame contact is the relevant concern as compared to heat flux. Embers can travel beyond any applicable APZ. Onsite fine and heavy fuel sources are required to be eliminated in project design and strictly controlled in ongoing operation to prevent the capacity for embers to be generated. This has been addressed in Measure 6.3. ***Recommendation Details***: **See Measure 6.3.**						

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining.

Note 2: Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use.
- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Currently Planned:** Protection measures that:
    - Are incorporated into the site plans;

PROTECTION MEASURES AVAILABLE TO REDUCE THREAT LEVELS	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend

- Exist in an approved Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), alternative solutions and any additional recommended protection measures - for which a responsibility for their implementation has been created and approved; and/or
- Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).

- **Additionally Recommend:** Protection measures that:
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or
  - Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP.

These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).

5.1.4.2 PROTECTION MEASURE ANALYSIS - EFFECTIVENESS AND NUMBER APPLIED

For the identified bushfire hazard, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing threat levels is stated. This information is subsequently applied to assess the ability of applied protection measures to reduce threat levels. Refer to Appendix 1 for explanatory and supporting information.

THREAT REDUCING PROTECTION MEASURE ANALYSIS								
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures						
		Total Available	Application Status [2]					
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend	
Prevent Bushfire Ignition and/or Severity by Managing the Fuels	Very High	3	2			2	2	
	High	5	3	2			1	
	Medium	1						
	Not Relevant							
Prevent Bushfire Ignition by Managing Heat Energy Sources	Very High	1	1			1		
	High							
	Medium	5	3	1		2	3	
	Not Relevant							
Prevent Bushfire Ignition by Managing Interactions of Heat Energy Sources and Fuels	Very High							
	High							
	Medium	3	3			2	3	
	Not Relevant							
Number Analysis	Very High	4	3			3	2	
	High	5	3	2			1	
	Medium	9	6	1		4	6	
	Not Relevant							
	Totals	18	12	3		7	9	

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.1.4.3 PROTECTION MEASURE ANALYSIS - POTENTIAL TO REDUCE THREAT LEVELS

For the identified bushfire hazard, the potential for applied bushfire protection measures to reduce threat levels is assessed as a function of:

- The number of bushfire protection measures that can be applied compared to the number available; and
- The weighting applied to each protection measure that indicates how effective it can be at reducing hazard threat levels.

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE BUSHFIRE HAZARD THREAT LEVELS [1]			
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]			
Bushfire Direct Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind
Significant	Minimal	Moderate	Significant
Moderate			
WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]			
Bushfire Direct Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind
Significant	Moderate	Moderate	Significant
Significant			

Note 1: Refer to Appendix A1.2 for explanatory and supporting information.

Note 2: This threat reducing potential will be applied to deriving the inherent threat level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This threat reducing potential will be applied to deriving the residual threat level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 4: Refer to Appendix 2 for explanatory and supporting information.

5.1.5 OUTCOME OF THE BUSHFIRE HAZARD POTENTIAL THREAT LEVEL ASSESSMENT

Inherent and residual threat levels (each referring to a different stage of bushfire protection measure application), are derived from preceding bushfire hazard assessments of:

1. The bushfire hazard potential threat level that has accounted for the identified vegetation categories in the surrounding landscape and the existence (or otherwise) of relevant physical factors that can intensify bushfire behaviour resulting in increased threat levels; and
2. The assessed potential impact of applied bushfire protection measures in reducing potential threat levels.

The resulting inherent and residual potential threat levels are derived through a qualitative assessment process (refer to Appendices A1.3.1 and A1.3.2 for explanatory and supporting information).

These threat levels, in combination with the corresponding assessed exposure and vulnerability levels for each of the assessed elements at risk, are later applied to deriving the inherent and residual bushfire risk levels (on an 'indicative' basis).

BUSHFIRE HAZARD POTENTIAL THREAT LEVEL ASSESSMENT OUTCOMES [1]					
THE IDENTIFIED BUSHFIRE HAZARD - VEGETATION CATEGORIES AND POTENTIAL THREAT LEVEL RANGES [2]					
Tree-1	Tree-2	Tree/Shrub	Shrub	Grass	No/Low Threat
Moderate to Extreme	Moderate to Extreme	Moderate to Very High	Low to Moderate	Low to Moderate	None to Low
THE BASE BUSHFIRE HAZARD POTENTIAL THREAT LEVEL TO APPLY TO THE SITE [3]					
Very Low ☐	Low ☒	Moderate ☐	High ☐	**Extreme** ☐	
THE ABILITY FOR APPLIED PROTECTION MEASURES TO REDUCE BASE THREAT LEVELS [4]					
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED			WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED		
Moderate			Significant		
THE ASSESSED BUSHFIRE HAZARD POTENTIAL THREAT LEVELS					
RESULTANT INHERENT THREAT LEVEL [5] (Current State)			RESULTANT RESIDUAL THREAT LEVEL [5] (Potential Future State)		
Low			Low		

Note 1: Refer to Appendix 1 for explanatory information.

Note 2: Assessment detail is presented in Section 5.1.2.

Note 3: After the consideration of the surrounding landscape and existence of relevant physical factors. Assessment detail is in Section 5.1.3.

Note 4: Assessment detail is presented in Section 5.1.4.

Note 5: Refer to A1.3.3 for explanatory information.

Assessment Comments: The existing and planned protection measures are partly considered in the base bushfire hazard threat level (e.g. local grazing intensity). The existing/planned and additional measures are insufficient to reduce the threat level.

5.2 THE IDENTIFIED ELEMENTS AT RISK

THE IDENTIFIED ELEMENTS AT RISK AND SUBJECT TO ASSESSMENT			
Possible Types	Exists on Subject Site and is Exposed to Bushfire Hazard Threats	Bushfire Risk Report Objectives Establish Requirement to Assess	Description
Persons located onsite and temporarily offsite as part of site operations - includes occupants, staff, visitors and persons on day trips offsite (e.g. tourism)	✓		The site is proposed to be unstaffed. Persons on access/egress routes has been assessed for Emergency Services and any staff temporarily onsite for maintenance etc.
Persons on access/egress routes (roads, driveways, access ways) in vehicles:	✓		Internal access roads and driveways are the primary focus to ensure safe movement between asset locations and major external roads. External public roads are considered for Emergency Services, and if full evacuation is required.
Buildings - NCC Classes 1 to 9 - residential, offices, shops (retail/services), warehouses, carparks, factories, workshops, laboratories, public buildings.	✓		Operations and Maintenance Building. The potential for warehouses and workshops are considered.
Buildings or Structures – NCC Class 10 - non-habitable – shed, carport, garage, fence, retaining wall etc.		✓	The assessment considers maintenance and storage sheds which may be present onsite.
Built Infrastructure Assets – structures associated with telecommunications / power generation / transport / water supply etc.	✓		BESS units and Associated Infrastructure.
			Substation.
Materials Stockpiled Outdoors – as part of recycling and/or waste management operations.	✓		Laydown Areas may be temporary or permanent, and contain a range of materials which may be of greater or lesser importance. These areas will not be occupied.

5.3 EXPOSURE LEVEL ASSESSMENT – BUSHFIRE PROTECTION MEASURE ANALYSIS

For each stated element at risk and each relevant bushfire hazard, an assessment is conducted that considers the effectiveness and application status of all available exposure reducing bushfire protection measures that are listed under their applicable bushfire protection mechanism. This information is subsequently applied to deriving exposure levels.

5.3.1 PERSONS ONSITE AND TEMPORARILY OFFSITE

5.3.1.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons Onsite and Temporarily Offsite					
THE PROTECTION MECHANISM – ESTABLISH SUFFICIENT SEPARATION FROM RELEVANT BUSHFIRE HAZARD THREATS: To ensure that the persons are located or re-located at a sufficient distance from the bushfire hazard to ensure the level of exposure to the threats, and the associated risk of persons death or injury, is contained within acceptable parameters.						
2.1	**Stay Away from the Subject Site:** Prevent access to, occupancy or operation of the subject site (i.e. closure of use) in response to a pre-determined fire danger rating (FDR) or fire behaviour index (FBI) and/or activity restriction (e.g., total fire ban) or a defined period of the year (highest risk). The relevant conditions and the requirement to stay away will be established through relevant site operational documents such as a Bushfire Emergency Plan or Site Emergency Plan/Guide.	Very High	Yes	No	No	No
Assessment Comments: Permanent staffing is not proposed, however intermittent occupation will occur during maintenance, inspections, etc. It is possible this will occur during fire danger periods. Hot works will be restricted during Total Fire Bans. Attendance for other reasons, particularly to investigate potential issues, will occur regardless of (and potentially due to) fire weather conditions. ***Recommendation Details:*** Not Applicable						
2.2	**Remote Tourism Sites - Stay Within the Subject Site:** Relevant when tourism operations are moving persons offsite as part of operations e.g., tourism day trips. All associated persons (staff, guests, visitors), in response to a pre-determined fire danger rating (FDR) or fire behaviour index (FBI) and/or activity restriction (e.g., total fire ban), will remain on-site as better communication and sheltering options exist on-site compared to travelling in a remote area – if possible. The relevant conditions and the requirement to stay will be established through relevant site operational documents such as a Bushfire Emergency Plan or Site Emergency Guide.	High	N/A	N/A	N/A	N/A

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons Onsite and Temporarily Offsite					
Assessment Comments: Not Required ***Recommendation Details:*** Not Applicable						
2.3	**Remote Tourism Sites - Relocate to Designated Safer Offsite Location:** Relevant when tourism operations are moving persons offsite as part of operations e.g., tourism day trips. A suitable offsite alternative safer location(s) is identified as a destination should the subject site and/or the route back to the subject site, be impacted by a bushfire event during the time away from the site.	High	N/A	N/A	N/A	N/A
Assessment Comments: Not Required ***Recommendation Details:*** Not Applicable						
2.4	**Relocate (Evacuate) to Designated Safer Offsite Location(s):** A building, area or general location is identified and accessible from the subject site as an evacuation destination. The offsite location exists at a sufficient distance away ensuring that the destination and the subject site are not likely to be simultaneously impacted by a bushfire event.	High	No	No	Yes	No
Assessment Comments: The site is relatively close to the Kojonup townsite (approx. 4.2 km driving). Any staff onsite will not be vulnerable requiring assistance or facilities at a destination. They will self-evacuate to Kojonup, selecting the appropriate route based on location of the bushfire threat. If all routes to Kojonup are compromised, continuous access in other directions is available. Evacuation procedures and directions will be established within the Emergency Management Plan required prior to commercial operation. ***Recommendation Details:*** Not Applicable						
2.5	**Relocate to Safer Onsite Open Area:** Provide an accessible area located in the open (i.e. not in an enclosed building), within the subject site and on which persons can assemble and that will not be subject to radiant heat flux in excess of 2 kW/m^2 (determined using a flame temperature of 1200 K). Consideration must also be given to potential exposure to embers, adverse weather, availability of water / facilities and the relative importance of these to the specific use proposal.	High	No	No	Yes	No
Assessment Comments: Low threat areas subject to >2kw/m2 radiant heat flux will be available within the site. However, open sheltering is not intended as appropriate buildings will be available within the O&M area. **See Measure 2.11**. ***Recommendation Details:*** Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons Onsite and Temporarily Offsite					
2.6	**Safer Pathways for Onsite Movement:** To ensure lower risk movement (walking) of persons and firefighters on the site, heavy fuels are excluded from areas adjacent to pathways used to access designated safer locations onsite. The required minimum separation distances are [13] [31]: • At least 4m from stored heavy fuels (refer to Appendix 2). • At least 6m from stored and constructed large heavy fuels (refer to Appendix 2). • At least 12m from constructed large heavy fuels that are buildings/structures. Additionally: • The pathway/route is constructed of non-combustible materials; • No gas cylinders are venting towards the pathway/route; and • Shrubs are separated from the pathway/route corresponding to a distance to minimise the threats to persons on foot with consideration of their flammability and height.	Medium	Yes	No	Yes	No
Assessment Comments: There may be fuels with the Operations and Maintenance Building. Stored heavy fuels may be present around the facility, and persons may be moving from any given location within the facility across the hardstand. Fuels are required to be maintained >10m from assets (including buildings) in **Measure 6.7**. Therefore, a person traversing between areas should not encounter significant stored fuels where the buildings are reasonably adjacent. ***Recommendation Details:*** Not Applicable						
2.7	**Pre-Emptively Relocate to Designated Safer Offsite Location(s):** In response to a pre-determined fire danger rating (FDR) or fire behaviour index (FBI) and/or activity restriction (e.g., total fire ban) or other established condition, all persons onsite will pre-emptively relocate offsite for the duration of the existence of the conditions. The relevant conditions and the requirement to pre-emptively relocate will be established through relevant site operational documents such as a Bushfire Emergency Plan or FES-ERG.	High	Yes	No	No	No
Assessment Comments: Permanent staffing is not proposed, however intermittent occupation will occur during maintenance, inspections, etc. It is possible this will occur during fire danger periods. Hot works will be restricted during Total Fire Bans. Attendance for other reasons, particularly to investigate potential issues, will occur regardless of (and potentially due to) fire weather conditions. ***Recommendation Details:*** Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons Onsite and Temporarily Offsite					
THE PROTECTION MECHANISM – ESTABLISH SHIELDING FROM RELEVANT BUSHFIRE HAZARD THREATS: To utilise constructed or natural shielding to reduce the exposure of persons to the flame, radiant heat, and ember attack from bushfire and consequential fire.						
2.8	**On-site Shelter Building – Community Bushfire Refuge Standard [20]:** Applicable to use by 'vulnerable' persons (refer to Glossary). Provide a building which is constructed in accordance with the NCC and the ABCB Design and Construction of Community Bushfire Refuges – Information Handbook [20]. Note: The minimum requirement for floor area per person of 0.75 m^2 may be increased by relevant authorities in specific jurisdictions (e.g., to 1.0 m^2 in WA, Guidelines v1.4 [22]).	High	N/A	N/A	N/A	N/A
Assessment Comments: Not Required ***Recommendation Details:*** Not Applicable						
2.9	**On-site Shelter Building – Limit Radiant Heat Exposure Only:** Applicable to use by 'vulnerable' persons (refer to Glossary) where accommodation is not part of the site use. Provide a building that will not be subject to radiant heat flux in excess of 10 kW/m^2 (determined using AS 3959 BAL determination methodology [4] and applying a flame temperature of 1200 K) and constructed to the bushfire standard corresponding to the BAL-29 rating (to provide greater resistance to consequential fire threats).	High	N/A	N/A	N/A	N/A
Assessment Comments: Not Required ***Recommendation Details:*** Not Applicable						
2.10	**On-site Shelter Building – Resilient to Potential Bushfire Impacts to the Degree Necessary:** Provide a building that incorporates design and construction protection measures to reduce the building's vulnerability to bushfire and consequential fire threats to the degree necessary. Refer to the section of this report that identifies bushfire protection measures to reduce the vulnerability of buildings/structures). Alternatively, provide a building that will not be subject to radiant heat flux in excess of 10 kW/m^2 (determined using AS 3959 BAL determination methodology [4] and applying a flame temperature of 1200 K) and constructed to the bushfire standard corresponding to the BAL-29 rating (to provide greater resistance to consequential fire threats).	High	N/A	N/A	N/A	N/A
Assessment Comments: Not Required ***Recommendation Details:*** Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons Onsite and Temporarily Offsite					
2.11	**On-site Shelter Structure – Class 10c:** Provide a private bushfire shelter (Class 10c building) constructed in accordance with the NCC and the *Performance Standard – The design and construction of private bushfire shelter (ABCB 2014).* This is not a standalone measure but an additional measure as a last resort.	High	Yes	No	No	Yes

Assessment Comments: The Operations and Maintenance Building will be nominated as an on-site shelter building. The building is to be constructed to AS 3959 requirements for BAL-29 and have a minimum internal floor area equal to 1m^2 per proposed person (e.g. 10m^2 for 10 workers).

The *Performance Standard – The design and construction of private bushfire shelter (ABCB 2014)* (the 'ABCB Handbook') Section 1.2 advises the '*benefits of developing a performance-based Handbook capable of* ***producing a site-specific outcome****, rather than developing a prescriptive Handbook that would produce a generic outcome.*'

Section 2.3 "*A community bushfire refuge must be designed and constructed to provide a tenable environment for occupants during the passage of untenable conditions arising from a bushfire even,* ***appropriate to the**** –

a) Location of the refuge relative to the fire hazards including-

I. Predominant vegetation; and

II. Adjacent buildings, structures and movable objects; and

III. Car parking area/s and allotment boundaries; and

IV. *Other combustible materials…*"

*****(emphasis added)

As discussed in Measure 1.9, vegetation screening proposed at the perimeter of the facility may not meet clause 2.2.3.2 of AS 3959. However, it meets the intent of the isolated vegetation pockets considered- being sufficiently disconnected to prevent continuous fire spread and sufficiently limited to prevent fire fully re-establishing. This vegetation poses a very limited threat to assets sufficiently separated from the pocket (stipulated as 20m per AS 3959 clause 2.2.3.2 c and d).

Screening vegetation must be assessed in accordance with AS 3959 for the purposes of planning documentation. This Risk Assessment recognises that based on predicted fire behaviour, the intent of AS 3959 clause 2.2.3.2 can be applied rather than strict text, in providing risk-based protection measures.

On this basis, the northern screening vegetation is excluded for the purposes of calculating the 10kW/m2 setback for on-site shelter provisions. The Operations and Maintenance Building has been specifically sited to allow installation of the required APZ (<10kW/m2 radiant heat flux calculated at 1200K flame temperature).

Compliance with AS 3959 construction standards for BAL-29 is a suitable level of protection for the bushfire impact and duration on the shelter building.

Moveable objects and combustible materials are managed through Operating Procedures, applied in **Measure 6.7**.

Car parking areas and adjacent buildings can be sited 10m from the building through layout design, in accordance with the Acceptance Criteria (*ABCB Handbook* Table 1).

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons Onsite and Temporarily Offsite					
Recommendation Details: See **Measure 11.1.**						
2.12	**Constructed Barrier – Shield Persons in the Open:** Construct walls / fences / landforms as shielding structures that are not buildings, applying appropriate fire resistant / non-combustible construction materials (e.g. masonry, steel, earthworks). These are to withstand the impact of direct bushfire attack mechanisms for the required period of time and provide the required reduction in threat levels to persons in the open. Construction requirements will correspond, as a minimum, to the BAL-FZ requirements for walls as established by AS 3959:2018 [4] and/or the NASH Standard [33] and additionally informed by the research report 'Research and Investigation into the Performance of Residential Boundary Fencing Systems in Bushfires' [29].	Medium	Yes	No	No	No
Assessment Comments: Structures will be present onsite and will provide a measure of shielding. A calculation is not available to measure the impact of this shielding. ***Recommendation Details***: Not Applicable						
2.13	**Natural Barrier – Shield Persons in the Open:** Utilise natural landforms that have the potential to shield persons from the bushfire and consequential fire threats.	Medium	N/A	N/A	N/A	N/A
Assessment Comments: No landforms exist in appropriate locations. ***Recommendation Details***: Not Applicable						
2.14	**Constructed/Natural Barrier – Shielding for Persons on Pathways to Safer Onsite Area/Building:** Where possible, alongside pathways to an on-site shelter building/area, utilise walls / fences / landforms as shielding structures constructed using fire resistant / non-combustible construction materials (e.g. masonry, steel, earthworks). These are to withstand the impact of direct bushfire attack mechanisms for the required period of time and provide the required reduction in threat levels to persons (including firefighters) traversing the pathway. Construction can be informed by the BAL-FZ requirements for walls as established by AS 3959:2018 [4] and/or the NASH Standard [33] and additionally informed by the research report 'Research and Investigation into the Performance of Residential Boundary Fencing Systems in Bushfires' [29].	Medium	Yes	No	No	No
Assessment Comments: The Operations and Maintenance Building may be used as a shelter of last resort. The BESS units and the building itself will provide some measure of shielding, ***Recommendation Details:*** Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons Onsite and Temporarily Offsite					

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining.

Note 2: Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use.
- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Currently Planned:** Protection measures that:
    - Are incorporated into the site plans;
    - Exist in an approved Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), alternative solutions and any additional recommended protection measures - for which a responsibility for their implementation has been created and approved; and/or
    - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

  These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Additionally Recommend:** Protection measures that:
    - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or
    - Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP.

  These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).

5.3.1.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing exposure levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the exposure of the relevant element at risk to bushfire hazard threats.

EXPOSURE REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Persons Onsite and Temporarily Offsite						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Establish Sufficient Separation from Relevant Bushfire Hazard Threats	Very High	1	1				
	High	5	1			2	
	Medium	1	1			1	
	Not Relevant						
Establish Shielding from Relevant Bushfire Hazard Threats	Very High						
	High	4	1				1
	Medium	3	2				
	Not Relevant						
Number Analysis	Very High	1	1				
	High	9	2			2	1
	Medium	4	3			1	
	Not Relevant						
	Totals	14	6			3	1

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.3.1.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE EXPOSURE

From the information presented in the previous section, the exposure reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce exposure (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE EXPOSURE TO BUSHFIRE HAZARD THREATS [1]							
Element at Risk	Persons Onsite and Temporarily Offsite						
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Moderate	Minimal	Minimal	Moderate	Significant	Minimal	Significant	Minimal
Minimal				Moderate			
WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Significant	Significant	Significant	Significant	Significant	Significant	Significant	Moderate
Significant				Significant			

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This exposure reducing potential will be applied to deriving the inherent exposure level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This exposure reducing potential will be applied to deriving the residual exposure level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 4: Refer to Appendix 2 for explanatory and supporting information.

Assessment Comments: Regular staffing is not proposed, and any persons onsite will have vehicles immediately available to move within or away from the site. Pre-emptive closure is not proposed, as inspection/monitoring may be more important during fire danger weather conditions.

The Operations and Maintenance Building may be used as an appropriate On-site Shelter Building. Safe (early) Evacuation remains the primary response procedure.

5.3.1.4 DERIVED EXPOSURE LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual exposure levels.

In combination with the corresponding assessed threat and vulnerability levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL EXPOSURE LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]							
ELEMENT AT RISK		Persons Onsite and Temporarily Offsite					
BUSHFIRE ATTACK MECHANISMS [2]		INHERENT EXPOSURE LEVEL (CURRENT STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	Moderate
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
BUSHFIRE ATTACK MECHANISMS [2]		RESIDUAL EXPOSURE LEVEL (POTENTIAL FUTURE STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	Low
DIRECT	Radiant Heat	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: Refer to Appendix 2 for explanatory and supporting information.

Note 3: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

5.3.2 PERSONS ON ACCESS/EGRESS ROUTES IN VEHICLES

5.3.2.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons on Access / Egress Routes in Vehicles	Access Route Description	Local road network including internal roads			
THE PROTECTION MECHANISM - ESTABLISH SUFFICIENT SEPARATION FROM RELEVANT BUSHFIRE HAZARD THREATS: To utilise distance away from relevant bushfire hazard threats (primarily flames, radiant heat and tree strike/obstruction) while traversing an access/egress route in a vehicle to lower the exposure of persons for the expected time on the route.						
3.1	**Locate Access/Egress Routes Away from Adjacent Hazards:** Existing or to be installed vehicular access/egress route components (roads, access ways, and driveways) are positioned to maximise the distance away from any adjacent bushfire prone vegetation where possible.	High	No	Yes	No	No
Assessment Comments: Internal access is separated from major bushfire hazard areas (non-pasture), except where reaching the crossover to public roads. The external routes are generally bounded by pasture. ***Recommendation Details:*** Not Applicable						
3.2	**Egress Routes Located to Ensure Driving Away from Hazard:** Existing or to be installed vehicular access/egress route components (roads, access ways, and driveways) are positioned so that the direction of egress is away from the hazard into lower threat areas.	Very High	No	Yes	No	No
Assessment Comments: Collie-Changerup Road provides effective access in opposite directions. Tunney Road provides secondary through access via the secondary access point (eastern gate). ***Recommendation Details:*** Not Applicable						
3.3	**Greater Road Width:** Wider roads will allow for a greater separation distance between traversing vehicles and the bushfire hazard. The incorporation of non-vegetated and trafficable road verges/shoulders and adjacent footpaths can also safely increase effective separation for slower moving vehicles.	High	No	Yes	Partly	No
Assessment Comments: Collie-Changerup Road is generally 8m wide, with a non-vegetated clearance of >12m including shoulders. Tunney Road is approximately 6m wide and has vegetated shoulders, so does not provide additional clearance.						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons on Access / Egress Routes in Vehicles	Access Route Description	Local road network including internal roads			
Recommendation Details: Not Applicable						
3.4	**Reduce and Maintain Road Verge Fuel to a Low Threat State:** Road verges, or part off, support low threat vegetation or vegetation is removed or reduced and maintained to a minimal fuel condition to increase the separation distance from the bushfire hazard. This is practical when an authority exists to conduct the management and will have greater threat reducing impact as a protection measure, if there is certainty it will be carried out.	Medium	No	Partly	No	No
Assessment Comments: Verges offsite have a reduced fuel (but not low threat) condition. ***Recommendation Details***: Not Applicable						
THE PROTECTION MECHANISM – ESTABLISH SHIELDING FROM RELEVANT BUSHFIRE HAZARD THREATS: To utilise constructed or natural shielding to reduce the exposure of persons, traversing the access/egress routes, to relevant bushfire threats (primarily flames, radiant heat and embers). To assist with ensuring the level of exposure to the threats is survivable for the expected time on the route while travelling in a vehicle.						
3.5	**Ensure Evacuation Vehicle Types Provide a Degree of Protection:** People can only tolerate low levels of radiant heat without some protection. Vehicles provide some protection from low intensity fires (if they stay on cleared area and remain in the vehicle) but they will not protect people in moderate to intense grass fires or in any location where scrub or forest adjoin the road. Protection provided by vehicles with predominantly metal bodies (including roof) and able to be enclosed (glass window), while limited is also still significant. It is particularly significant when compared to other potentially available modes of transport on roads (e.g. open top/backed vehicles, motorbikes, bicycles and being on foot). The availability such vehicles of required capacity can contribute to reduced exposure to the bushfire threats for persons on access/egress routes.	Medium	Yes	Yes	No	No
Assessment Comments: Staff and contractors will have enclosed vehicles for traversing the site. Vehicles accessing the site in a bushfire event will be Emergency Services, with vehicles which provide a measure of protection. ***Recommendation Details***: Not Applicable						
Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining. **Note 2: Protection Measure Application Status:** • **Possible:** Protection measures that can potentially be applied to the proposed development/use.						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS				Effectiveness Rating [1]	Application Status [2]			
					Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons on Access / Egress Routes in Vehicles	Access Route Description	Local road network including internal roads					

- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Currently Planned:** Protection measures that:
  - Are incorporated into the site plans;
  - Exist in an approved Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), alternative solutions and any additional recommended protection measures - for which a responsibility for their implementation has been created and approved; and/or
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

  These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Additionally Recommend:** Protection measures that:
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or
  - Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP.

  These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).

5.3.2.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing exposure levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the exposure of the relevant element at risk to bushfire hazard threats.

EXPOSURE REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Persons on Access / Egress Routes in Vehicles						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Establish Sufficient Separation from Relevant Bushfire Hazard Threats	Very High	1		1			
	High	2		2			
	Medium	1			1		
	Not Relevant						
Establish Shielding from Relevant Bushfire Hazard Threats	Very High						
	High						
	Medium	1	1	1			
	Not Relevant						
Number Analysis	Very High	1		1			
	High	2		2			
	Medium	2	1	1	1		
	Not Relevant						
	Totals	5	1	4	1		

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.3.2.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE EXPOSURE

From the information presented in the previous section, the exposure reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce exposure (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE EXPOSURE TO BUSHFIRE HAZARD THREATS [1]							
Element at Risk	Persons On Access/Egress Routes in Vehicles						
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Significant	Moderate	Moderate	Moderate	N/A	Very Significant	Significant	Very Significant
Moderate				Very Significant			
WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Significant	Moderate	Moderate	Moderate	N/A	Very Significant	Significant	Very Significant
Moderate				Very Significant			

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This exposure reducing potential will be applied to deriving the inherent exposure level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This exposure reducing potential will be applied to deriving the residual exposure level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 4: Refer to Appendix 2 for explanatory and supporting information.

Assessment Comments: No recommendations are applicable. The inherent and residual risk are the same. As the site is intended to be unstaffed, the relevant persons on access routes are Emergency Services.

The site is close to two public roads providing effective access with reduced fuel shoulders and a generally pasture landscape.

5.3.2.4 DERIVED EXPOSURE LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual exposure levels.

In combination with the corresponding assessed threat and vulnerability levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL EXPOSURE LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]							
ELEMENT AT RISK		Persons on Access/Egress Routes in Vehicles					
BUSHFIRE ATTACK MECHANISMS [2]		INHERENT EXPOSURE LEVEL (CURRENT STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	Low
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
BUSHFIRE ATTACK MECHANISMS [2]		RESIDUAL EXPOSURE LEVEL (POTENTIAL FUTURE STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	Low
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: Refer to Appendix 2 for explanatory and supporting information.

Note 3: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

5.3.3 BUILDINGS AND STRUCTURES - NCC CLASSES 1-10

5.3.3.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Buildings/Structures - NCC Classes 1-10					
THE PROTECTION MECHANISM – ESTABLISH SUFFICIENT SEPARATION FROM RELEVANT BUSHFIRE HAZARD THREATS: To reduce exposure to the relevant direct and indirect attack mechanisms of bushfire by locating buildings and attached/adjacent structures at sufficient distances away from the bushfire hazard and consequential fire fuels. The required distances will be dependent on the assessed threat levels and the degree of bushfire resilience that exists or is planned to be incorporated into the exposed elements through design and construction.						
4.1	**Siting of Buildings/Structures Considering Potential High Wind Exposure:** Site buildings and attached/adjacent structures in locations that have less exposure to terrain influenced prevailing synoptic winds, and particularly those locations with potential for significant terrain/bushfire threat intensification interactions (refer to Appendix 3). Avoid the top and sides of ridges. Strong winds can directly or indirectly (airborne materials/debris) cause damage to the external building envelope, potentially allowing flame, radiant heat and ember entry.	High	No	Yes	No	No
Assessment Comments: The siting of the proposal considers a number of impacts other than wind. The predominant vegetation (pasture) within 150m of the development area will not generate significant fire-driven winds, and it is thus not a relevant consideration. Road verge and vegetation screening scrub are narrow bands which will not intensify fire behaviour sufficiently to generate fire-driven wind- and are more likely to reduce wind impacts. ***Recommendation Details:*** Not Applicable						
4.2	**Designed Location of Non-Vegetated Areas and/or Managed Open Space:** Non-vegetated land uses include footpaths, paved areas, roads, parking, open drainage channels, and major services delivery (power, water, gas) installed in common corridors. Managed open space is land for public or private use on which the vegetation is either low threat due to type or situation or is continually managed in a minimal fuel condition. This can include public open space providing recreation facilities. Use these design elements to create or increase separation from any bushfire prone vegetation by positioning them adjacent to the bushfire hazard.	Very High	Yes	Yes	No	No
Assessment Comments: No managed open spaces exist. The buildings will be positioned on a non-vegetated hardstand.						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Buildings/Structures - NCC Classes 1-10					
Recommendation Details: Not Applicable						
4.3	**Landscaping - Asset Protection Zone (APZ):** Ensure an APZ is established surrounding the relevant element(s) at risk to create the required separation distance from the bushfire hazard to protect against the direct attack mechanisms of flame contact and radiant heat and reduce exposure to embers. ***In addition to providing separation from the direct bushfire attack mechanisms, the nature of the APZ design and management requirements is intended to minimise the potential impact of the indirect bushfire attack mechanisms of surface fire attack, debris production and accumulation, tree strike and consequential fire (refer to Appendix 2).*** This is achieved by ensuring the APZ contains low threat vegetation; and/or has potential fire fuels managed in a minimal fuel condition; and/or contains non-vegetated areas (e.g. footpaths, paved areas, driveways, parking, swimming pools etc) and/or limits the presence/location of constructed/stored combustible items. For different States and local government areas, APZ establishment and maintenance guides ideally need to be local environment specific. Some authorities establish general requirements while specific requirements may also be established through site specific management documents (e.g. bushfire management plan). The required dimensions of the APZ will correspond to the maximum level of radiant heat the exposed element is to be exposed to – or a greater distance if it is stipulated by a relevant authority. As a minimum avoid dimensions (separation distances) that correspond to BAL-FZ and BAL-40 ratings for any given site/vegetation combination of relevant parameters. This will also apply to BAL-29 separation distances if flame length modelling indicates potential contact due to specific site and effective slope configurations. The location of an APZ should be entirely within the boundaries of each lot so that landowners can have control and responsibility for its implementation and maintenance. Exceptions exist for instances where adjoining land is not vegetated or it can be justified that the fire fuels will be managed in a minimal fuel, low threat state on an ongoing basis, in perpetuity.	Very High	Yes	No	Yes	Yes
Assessment Comments: No vegetation landscaping (gardens) are proposed within the APZ, and the surface will be either hardstand or slashed grasses only. Vulnerability of buildings is assessed in Section 5.4.3. Buildings will require an APZ. The Operations and Maintenance Building has been designated as an on-site shelter location, and requires an exposure of <10kW/m2 radiant heat flux (calculated at 1200K flame temperature).						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend
Element at Risk: Buildings/Structures - NCC Classes 1-10					

Buildings not associated with the Operations and Maintenance Building may be workshops, storage sheds, etc. A BAL-29 dimensioned APZ is appropriate for these structures to limit the potential for flame contact as their construction will be largely non-combustible.

Some structures may contain flammable/HAZMAT materials, or materials which is otherwise of greater value such as replacement parts. This is not known at planning submission, but the occupier can consider a greater dimensioned APZ to protect these assets. As a 10kW/m2 threshold has been applied to other assets due to vulnerable components, these components can then be assumed in storage, and apply a consistent 10kW/m2 APZ.

Recommendation Details:

An APZ must be installed around all identified assets. The dimensions of the APZ are associated with the maximum acceptable radiant heat flux exposure of that asset. All asset APZs are provided within this measure for application. The assessment for each asset type is provided in Measure 4.3, 5.3, 5.3, and 8.3.

<10kW/m2 (calculated at 1200K flame temperature):

- Operations and Maintenance Buildings (Class 1-9)

<10kW/m2 (calculated at 1090K flame temperature):

- Critical Class 10 Buildings
- BESS units and PCS
    - The 10m portion of the APZ immediately around BESS units must be entirely and permanently non-vegetated (sealed, compacted limestone, gravel, mineral earth etc). BESS units are recommended to be sited on concrete slabs or other sealed, non-combustible surface.

<19kW/m2 (BAL-19):

- Substations

<29kW/m2 (BAL-29):

- Laydown Areas
    - Outdoor material storage areas are recommended to have surfacing applied, extending 2m beyond the storage area.
- Construction Compounds
- Other Class 1-10 Buildings
- Water Tanks

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Buildings/Structures - NCC Classes 1-10					
4.4	**Landscaping - Tree Location:** Use separation to minimise the potential for debris accumulation and tree strike damage to the building/structures that will allow flame, radiant heat and ember entry to internal spaces. Principles to apply are: • The buildings/structures are separated from trees (or trees from buildings) by a distance of at least 1.5 times the height of the tallest tree; and • Trees that produce significant quantities of debris (fine fuels) during the bushfire season should be located a sufficient distance away from vulnerable exposed elements to ensure debris cannot drop and accumulate within at least 4m of buildings/structures or be likely to be relocated by wind to closer than 4m to buildings / structures. Avoid planting trees with ribbon or stringy bark (ember/firebrand production). • If the minimum distance cannot be achieved with an existing tree either remove the tree or at least ensure tree branches are sufficiently separated from buildings and attached/adjacent structures (at a minimum to not overhang) to ensure branches cannot fall onto or be blown onto the buildings/structures.	Medium	Yes	Yes	Unknown	Yes
Assessment Comments: The development is proposed toward the north-eastern extent of a large rural lot and is expected to require planting of vegetated vegetation screening. Vegetation screening is intended to meet Class D Scrub structure, however some trees may be present within the screen. The vegetation screen is >13.5m from buildings. A maximum tree height of 9m will meet the above specification. This will generally be met- it is possible a single tree will be within the 1.5x height distance. ***Recommendation Details***: See **Measure 6.4.**						
4.5	**Separation from Stored Flammable Products - Gas in Cylinders:** To reduce the potential for gas flaring or explosion (consequential fire), installation of LPG cylinders is to apply as a minimum, the principles and requirements established in AS 1596 'The Storage and Handling of LP Gas'. Readily available guidance is provided by CSIRO Best Practice Bushfire Guide (https://research.csiro.au/bushfire/new-builds/water-electricity-gas/) and WA Dept. Mines, Industry, Regulation and Safety 'LP Gas cylinder safety in bushfire prone areas' (https://www.commerce.wa.gov.au/publications/lp-gas-cylinder-safety-bushfire-prone-areas). Otherwise, the required separation distance is 6m from any combustible materials. Heat from bushfire or consequential fire can be sufficient to cause cylinder pressure to reach critical levels and the pressure relief valve release large quantities of gas (flare). If the cylinder falls over the pressure relief valve may not function correctly, and the cylinder may rupture (explosion).	Medium	Yes	No	Yes	No
Assessment Comments: Any LPG will be stored in compliance with AS 1596. ***Recommendation Details***: Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Buildings/Structures - NCC Classes 1-10					
4.6	**Separation from Stored Flammable Products – Fuels / Other Hazardous Materials (Consequential Fire Fuels):** Establish sufficient separation distance between these consequential fire fuels and buildings/structures. The required separation distance will be dependent on the fuel and storage type.	High	Yes	Yes	No	Yes
Assessment Comments: Workshops/warehouses are likely to have various consequential fuels stored inside or around the perimeter. This will be managed by operational and emergency procedures. ***Recommendation Details***: See **Measure 6.7.**						
4.7	**Separation from Stored and Constructed Combustible Items (Consequential Fire Fuels):** These consequential fire fuels include: • Stored Combustible Items - Heavy Fuels (>6mm diameter) e.g. building materials, packaging materials, firewood, branches, sporting/playground equipment, outdoor furniture, rubbish bins etc; • Stored Combustible Items – Large Heavy Fuels e.g. vehicles, caravans, boats and large quantities of dead vegetation materials stored as part of site use; • Constructed Combustible Items – Heavy Fuels e.g. landscaping structures including fences, screens, walls, plastic water tanks; and • Constructed Combustible Items – Large Heavy Fuels e.g. adjacent buildings/structures including houses, sheds, garages, carports. (Note: If the adjacent structure is constructed to BAL-29 requirements or greater and can implement a significant number of additional bushfire protection measures associated with reducing exposure and vulnerability, these minimum separation distances could be reduced by 30%) [31]. *Apply the rule of thumb [13] "assume flames produced from a consequential fire source will be twice as high as the object itself … where the consequential fire source is a structure, then the maximum eave height is a reasonable measure of maximum height".* Apply the following separation distances from the subject building/structure as a multiple of the height of the consequential fire source and dependent on the bushfire construction standard applied to the building/structure [13 and 31]: • At least six times the height when the building/structure construction incorporates design and materials that is only intended to resist low levels of radiant heat up to 12.5 kW/m^2) and no flame contact;	High	Yes	No	Yes	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Buildings/Structures - NCC Classes 1-10					
	• Between 4 and 6 six times the height when the building/structure construction incorporates design and materials intended to resist radiant heat up to 29 kW/m^2 and no flame contact. • Between 2 and 4 times the height when the building/structure construction incorporates design and materials intended to resist up to 40kW/m^2 and potential flame contact. • Less than 2 times the height when the building/structure construction incorporates design and materials intended to resist extreme levels of radiant heat and flame contact. • Zero separation distance is required if the building/structure is separated by a non-combustible FRL 60/60/60 rated wall, or the potential consequential fire source is fully enclosed by the building/structure.					
Assessment Comments: The Operations and Maintenance Building is required to comply with a minimum of BAL-29 construction. Any warehouses/workshops may be unable to comply with AS 3959 but will be composed of non-combustible materials and thus <12.5kW/m^2 radiant heat level construction is considered. The Operations and Maintenance Building is proposed >12m from BESS units, which are approximately 2.6m tall (thus 4x separation). BAL-29 construction is appropriate. The setback of assets from substations will be informed by the relevant design standard, as substations are an established (known) technology. Vehicles (small buses and 4wds) are approximately 2.5m tall and would require a 10m separation. Greater separation distances would substantially increase the footprint of the development and is not applied. ***Recommendation Details:*** See **Measure 6.7.**						
THE PROTECTION MECHANISM – ESTABLISH SHIELDING FROM RELEVANT BUSHFIRE HAZARD THREATS: Reduce exposure the direct bushfire attack mechanisms of flame, radiant heat, surface migration of embers and to a potentially limited extent, fire driven wind - by shielding buildings and attached/adjacent structures or other consequential fire fuels. To also reduce exposure to the indirect attack mechanism of debris accumulation against buildings/structures and other consequential fire fuels.						
4.8	**Constructed Barrier – Shielding from Bushfire:** Walls, fences and/or landforms to shield the subject building/structure from direct and indirect bushfire attack mechanisms and reduce the potential impact. Must be constructed using appropriate fire resistant / non-combustible construction materials (e.g. masonry, steel, earthworks). These are to withstand the impact of direct bushfire attack mechanisms for the required period of time. Apply the bushfire construction standards for external walls subject to the assessed level of radiant heat or flame contact to which the barrier will be exposed (or otherwise to BAL-FZ requirements). These are established by AS 3959:2018 [4] and/or the NASH Standard [33] and additionally informed by the research report 'Research and Investigation into the Performance of Residential Boundary Fencing Systems in Bushfires.' [29]	High	Yes	No	No	No
Assessment Comments: A greater APZ can be established without environmental impact through appropriate siting.						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Buildings/Structures - NCC Classes 1-10					
Recommendation Details: Not Applicable						
4.9	**Constructed Barrier - Shielding from Consequential Fire:** Applicable to all consequential fire fuel sources. Install a non-combustible barrier (including complete enclosure when appropriate), of required robustness, that can perform the following as relevant: • Reduce the exposure of the subject building/structure to the threats of consequential fire; and/or • Reduce the exposure of the consequential fire fuels to the bushfire hazard.	High	Yes	No	No	No
Assessment Comments: Consequential fire sources are addressed in **Measure 6.7.** ***Recommendation Details***: Not Applicable						
4.10	**Natural Landforms Barrier:** Use existing natural landforms to reduce buildings/structures exposure to radiant heat, and lower wind speeds (prevailing synoptic and/or fire driven).	High	No	No	No	No
Assessment Comments: No appropriate landforms exist. ***Recommendation Details***: Not Applicable						
4.11	**Planted Vegetation Barrier:** Use appropriate species (lower flammability) of hedges and trees strategically to reduce (to varying extents) buildings/structures exposure to radiant heat, to filter/trap embers and firebrands, and to lower wind speeds (prevailing synoptic and/or fire driven).	Medium	Yes	No	No	No
Assessment Comments: Landscaped vegetation is not recommended within the APZ to remove the capacity for surface fire and production of debris (leaf litter etc). ***Recommendation Details***: Not Applicable						
4.12	**Shield Operation Critical Non-Structural Elements:** These are vulnerable elements essential to the continued operation of the building/structure which are potentially exposed to the attack mechanisms of both bushfire and consequential fire. These elements include cabling and plumbing associated with power delivery, data transmission, fuel and water transport. When the use of fire rated materials to the degree necessary is not possible or practical, the application of non-combustible shielding can be applied to reduce exposure to the threats. Shielding includes underground installation.	Medium	Yes	No	No	Yes
Assessment Comments: The only critical elements of the buildings are associated with site communications. The site has strong mobile phone reception and this is a minor concern.						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend
Element at Risk: Buildings/Structures - NCC Classes 1-10					
Recommendation Details: See **Measure 6.12.**					

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining.

Note 2: Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use.
- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Currently Planned:** Protection measures that:
    - Are incorporated into the site plans;
    - Exist in an approved Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), alternative solutions and any additional recommended protection measures - for which a responsibility for their implementation has been created and approved; and/or
    - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

  These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Additionally Recommend:** Protection measures that:
    - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or
    - Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP.

  These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).

5.3.3.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing exposure levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the exposure of the relevant element at risk to bushfire hazard threats.

EXPOSURE REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Establish Sufficient Separation from Relevant Bushfire Hazard Threats	Very High	2	2	1		1	1
	High	3	2	2		1	2
	Medium	2	2	1		1	1
	Not Relevant						
Establish Shielding from Relevant Bushfire Hazard Threats	Very High						
	High	3	2				
	Medium	2	2				1
	Not Relevant						
Number Analysis	Very High	2	2	1		1	1
	High	6	4	2		1	2
	Medium	4	4	1		1	2
	Not Relevant						
	Totals	12	10	4		3	5

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding Section.

5.3.3.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE EXPOSURE

From the information presented in the previous section, the exposure reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce exposure (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE EXPOSURE TO BUSHFIRE HAZARD THREATS [1]							
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.						
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Significant	Moderate	Minimal	Significant	Significant	Minimal	Moderate	Minimal
Moderate				Moderate			
WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Very Significant	Moderate	Moderate	Very Significant	Very Significant	Moderate	Significant	Significant
Significant				Significant			

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This exposure reducing potential will be applied to deriving the inherent exposure level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This exposure reducing potential will be applied to deriving the residual exposure level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 4: Refer to Appendix 2 for explanatory and supporting information.

Assessment Comments: Most measures relate to the size and standard of maintenance of the APZ, and separations from and between hazards. The separation between buildings and stored or constructed consequential fire hazards is applied to a practical extent.

5.3.3.4 DERIVED EXPOSURE LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual exposure levels.

In combination with the corresponding assessed threat and vulnerability levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL EXPOSURE LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]							
ELEMENT AT RISK		Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
BUSHFIRE ATTACK MECHANISMS [2]		INHERENT EXPOSURE LEVEL (CURRENT STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	High
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☒	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
BUSHFIRE ATTACK MECHANISMS [2]		RESIDUAL EXPOSURE LEVEL (POTENTIAL FUTURE STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	Low
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: Refer to Appendix 2 for explanatory and supporting information.

Note 3: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

5.3.4 MATERIALS STOCKPILED OUTDOORS - LAYDOWN AREAS

5.3.4.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Materials Stockpiled Outdoors – Laydown Areas					
THE PROTECTION MECHANISM – ESTABLISH SUFFICIENT SEPARATION FROM RELEVANT BUSHFIRE HAZARD THREATS: To reduce exposure to the relevant direct and indirect attack mechanisms of bushfire by locating buildings and attached/adjacent structures at sufficient distances away from the bushfire hazard and consequential fire fuels. The required distances will be dependent on the assessed threat levels and the degree of bushfire resilience that exists or is planned to be incorporated into the exposed elements through design and construction.						
5.1	**Designed Location of Non-Vegetated Areas and/or Managed Open Space:** Non-vegetated land uses include footpaths, paved areas, roads, parking, open drainage channels, and major services delivery (power, water, gas) installed in common corridors. Managed open space is land for public or private use on which the vegetation is either low threat due to type or situation or is continually managed in a minimal fuel condition. This can include public open space providing recreation facilities. Use these design elements to create or increase separation from any bushfire prone vegetation by positioning them adjacent to the bushfire hazard.	Very High	Yes	No	No	Yes
Assessment Comments: Laydown areas will be sited on cleared areas beside accessways. They may not be surfaced. ***Recommendation Details***: See **Measure 4.3**.						
5.2	**Landscaping - Asset Protection Zone (APZ):** Ensure an APZ is established surrounding the relevant element(s) at risk to create the required separation distance from the bushfire hazard to protect against the direct attack mechanisms of flame contact and radiant heat and reduce exposure to embers. ***In addition to providing separation from the direct bushfire attack mechanisms, the nature of the APZ design and management requirements is intended to minimise the potential impact of the indirect bushfire attack mechanisms of surface fire attack, debris production and accumulation, tree strike and consequential fire (refer to Appendix 2).*** This is achieved by ensuring the APZ contains low threat vegetation; and/or has potential fire fuels managed in a minimal fuel condition; and/or contains non-vegetated areas (e.g. footpaths, paved areas, driveways, parking, swimming pools etc) and/or limits the presence/location of constructed/stored combustible items.	Very High	Yes	No	No	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Materials Stockpiled Outdoors – Laydown Areas					
	For different States and local government areas, APZ establishment and maintenance guides ideally need to be local environment specific. Some authorities establish general requirements while specific requirements may also be established through site specific management documents (e.g. bushfire management plan). The required dimensions of the APZ will correspond to the maximum level of radiant heat the exposed element is to be exposed to – or a greater distance if it is stipulated by a relevant authority. As a minimum avoid dimensions (separation distances) that correspond to BAL-FZ and BAL-40 ratings for any given site/vegetation combination of relevant parameters. This will also apply to BAL-29 separation distances if flame length modelling indicates potential contact due to specific site and effective slope configurations. The location of an APZ should be entirely within the boundaries of each lot so that landowners can have control and responsibility for its implementation and maintenance. Exceptions exist for instances where adjoining land is not vegetated or it can be justified that the fire fuels will be managed in a minimal fuel, low threat state on an ongoing basis, in perpetuity.					
Assessment Comments: Laydown areas will contain a range materials which may be of greater or lesser importance. Some materials may be combustible, flammable, or hazardous. Any materials will have a range of radiant heat flux thresholds for damage; however ignition is the primary concern rather than potential damage to a single material type. Combustible materials require conditions to be met (moisture content and temperature) and a pilot flame for pyrolysis. Flame contact is the most practical condition to avoid. AS 3959 BAL-29 setbacks all exceed the modelled flame lengths for the associated design bushfire- and therefore a BAL-29 dimensioned APZ limits the potential for flame contact. ***Recommendation Details:*** See **Measure 4.3.**						
5.3	**Separation from Stored Flammable Products – Fuels / Other Hazardous Materials (Consequential Fire Fuels):** Establish sufficient separation distance between these consequential fire fuels and the stored materials. The required separation distance will be dependent on the fuel and storage type.	High	No	No	No	No
Assessment Comments: Various fuel sources will be associated with laydown areas, as this is the designated storage location. ***Recommendation Details:*** Not Applicable.						
5.4	**Separation from Stored and Constructed Combustible Items (Consequential Fire Fuels):** Apply a separation distance of at least six times the height of the stored and constructed combustible items. These consequential fire fuels include: • Stored Combustible Items - Heavy Fuels e.g. building materials, packaging materials, rubbish bins etc;	High	Yes	No	No	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Materials Stockpiled Outdoors – Laydown Areas					
	• Stored Combustible Items – Large Heavy Fuels e.g. vehicles, caravans etc; • Constructed Combustible Items – Heavy Fuels e.g. landscaping structures including fences, screens, walls, plastic water tanks; and • Constructed Combustible Items – Large Heavy Fuels e.g. adjacent buildings/structures such as sheds and offices. *Apply the rule of thumb [13] "assume flames produced from a consequential fire source will be twice as high as the object itself … where the consequential fire source is a structure, then the maximum eave height is a reasonable measure of maximum height".*					
Assessment Comments: Various fuel sources will be associated with laydown areas, as this is the designated storage location. ***Recommendation Details:*** Higher flammability or dangerous materials should be positioned toward the centre of storage areas, to limit the exposure to direct bushfire impacts. Note this may include materials such as tarpaulins.						
THE PROTECTION MECHANISM – ESTABLISH SHIELDING FROM RELEVANT BUSHFIRE HAZARD THREATS: To shield buildings and attached/adjacent structures (or other consequential fire fuels) from the direct bushfire attack mechanisms of flame, radiant heat, surface fire and surface migration of embers. To also reduce exposure to the indirect attack mechanism of debris accumulation against buildings/structures and other consequential fire fuels and wind attack.						
5.5	**Constructed Barrier – Shielding from Bushfire:** Walls, fences and/or landforms to shield the stored materials from direct and indirect bushfire attack mechanisms and reduce the potential impact of these threats. Must be constructed using appropriate fire resistant / non-combustible construction materials (e.g. masonry, steel, earthworks). These are to withstand the impact of direct bushfire attack mechanisms for the required period of time. Apply the bushfire construction standards for external walls subject to the assessed level of radiant heat or flame contact to which the barrier will be exposed (or otherwise to BAL-FZ requirements). These are established by AS 3959:2018 [4] and/or the NASH Standard [33] and additionally informed by the research report 'Research and Investigation into the Performance of Residential Boundary Fencing Systems in Bushfires.' [29]	High	No	No	No	No
Assessment Comments: Shielding is not practical to install around the perimeter of material storage areas. Any material stored outdoors rather than within a building must have some level of resistance to weather exposure (including heat). ***Recommendation Details:*** Not Applicable						
5.6	**Constructed Barrier - Shielding from Consequential Fire:** Applicable to all consequential fire fuel sources. Install a non-combustible barrier (including complete enclosure when appropriate), of required robustness, that can perform the following as relevant:	High	No	No	No	No

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Materials Stockpiled Outdoors – Laydown Areas					
	• Reduce the exposure of the stored materials to the threats of consequential fire; and/or • Reduce the exposure of the consequential fire fuels to the bushfire hazard.					
Assessment Comments: Various fuel sources will be associated with laydown areas, as this is the designated storage location. ***Recommendation Details:*** Not Applicable						
5.7	**Natural Landforms Barrier:** Use existing natural landforms to reduce stored materials exposure to radiant heat, and lower wind speeds (prevailing synoptic and/or fire driven).	High	No	No	No	No
Assessment Comments: No appropriate landforms exist. ***Recommendation Details:*** Not Applicable						
5.8	**Planted Vegetation Barrier:** Use appropriate hedges and trees strategically to reduce (to varying extents) stored materials exposure to radiant heat, to filter/trap embers and firebrands, and to lower wind speeds (prevailing synoptic and/or fire driven).	Medium	Yes	No	No	No
Assessment Comments: Vegetation screening can reduce radiant heat flux impact, however the screen cannot be maintained whilst functioning as a screen. There is the possibility of vegetation screens being involved in fire. ***Recommendation Details:*** Not Applicable						

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining.

Note 2: Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use.
- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Currently Planned:** Protection measures that:
  - Are incorporated into the site plans;
  - Exist in an approved Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), alternative solutions and any additional recommended protection measures - for which a responsibility for their implementation has been created and approved; and/or

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Materials Stockpiled Outdoors – Laydown Areas					

- Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).

- **Additionally Recommend:** Protection measures that:
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or
  - Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP.

These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).

5.3.4.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing exposure levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the exposure of the relevant element at risk to bushfire hazard threats.

EXPOSURE REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Materials Stockpiled Outdoors						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Establish Sufficient Separation from Relevant Bushfire Hazard Threats	Very High	2	2				2
	High	2	1				1
	Medium						
	Not Relevant						
Establish Shielding from Relevant Bushfire Hazard Threats	Very High						
	High	3					
	Medium	1					
	Not Relevant						
Number Analysis	Very High	2	2				2
	High	5	1				1
	Medium	1					
	Not Relevant						
	Totals	8	3				3

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.3.4.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE EXPOSURE

From the information presented in the previous section, the exposure reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce exposure (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE EXPOSURE TO BUSHFIRE HAZARD THREATS [1]							
Element at Risk	Materials Stockpiled Outdoors – Laydown Areas						
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
None	None	None	Minimal	Minimal	Minimal	Significant	Minimal
None				Minimal			
WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Significant	Moderate	Minimal	Moderate	Moderate	Significant	Significant	Significant
Moderate				Significant			

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This exposure reducing potential will be applied to deriving the inherent exposure level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This exposure reducing potential will be applied to deriving the residual exposure level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 4: Refer to Appendix 2 for explanatory and supporting information.

Assessment Comments: Management measures are to avoid pilot flame contact on stored materials, through direct flame contact and surface fire. The material itself is the consequential fire source.

5.3.4.4 DERIVED EXPOSURE LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual exposure levels.

In combination with the corresponding assessed threat and vulnerability levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL EXPOSURE LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]							
ELEMENT AT RISK		Materials Stockpiled Outdoors – Laydown Areas					
BUSHFIRE ATTACK MECHANISMS [2]		INHERENT EXPOSURE LEVEL (CURRENT STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☒	Extreme
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☒	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☒	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☒	
INDIRECT	Surface Fire	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☒	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☒	
BUSHFIRE ATTACK MECHANISMS [2]		RESIDUAL EXPOSURE LEVEL (POTENTIAL FUTURE STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	High
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: Refer to Appendix 2 for explanatory and supporting information.

Note 3: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

5.3.5 BUILT INFRASTRUCTURE ASSETS – BESS UNITS

5.3.5.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
THE PROTECTION MECHANISM – ESTABLISH SUFFICIENT SEPARATION FROM RELEVANT BUSHFIRE HAZARD THREATS: To reduce exposure to the relevant direct and indirect attack mechanisms of bushfire by locating buildings and attached/adjacent structures at sufficient distances away from the bushfire hazard and consequential fire fuels. The required distances will be dependent on the assessed threat levels and the degree of bushfire resilience that exists or is planned to be incorporated into the exposed elements through design and construction.						
6.1	**Siting of Buildings/Structures Considering Potential High Wind Exposure:** Site buildings and attached/adjacent structures in locations that have less exposure to terrain influenced prevailing synoptic winds, and in particular, those locations with potential for significant terrain/bushfire threat intensification interactions (refer to Appendix 3). Avoid the top and sides of ridges. Strong winds can directly or indirectly (airborne materials/debris) cause damage to the external building envelope, potentially allowing flame, radiant heat and ember entry.	High	No	Yes	No	No
Assessment Comments: The siting of the proposal considers a number of impacts other than wind. The relevant vegetation (pasture) within 150m of the development area will not generate significant fire-driven winds, and it is thus not a relevant consideration. The BESS footprint is within a less vegetated portion of the site, and is required to have a <10kW/m2 APZ installed, which will greatly reduce the exposure to any fire-driven wind. ***Recommendation Details***: Not Applicable						
6.2	**Designed Location of Non-Vegetated Areas and/or Managed Open Space:** Non-vegetated land uses include footpaths, paved areas, roads, parking, open drainage channels, and major services delivery (power, water, gas) installed in common corridors. Managed open space is land for public or private use on which the vegetation is either low threat due to type or situation or is continually managed in a minimal fuel condition. This can include public open space providing recreation facilities. Use these design elements to create or increase separation from any bushfire prone vegetation by positioning them adjacent to the bushfire hazard.	Very High	Yes	No	Yes	Yes
Assessment Comments: There are no such areas existing. The non-vegetated areas will be the internal access roads and carparks, 10m non-vegetated area around the BESS development (applied in **Measure 6.3**), and surfaced hardstand of the BESS and Substation footprints.						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
***Recommendation Details:* See Measure 6.3.**						
6.3	**Landscaping - Asset Protection Zone (APZ):** Ensure an APZ is established surrounding the relevant element(s) at risk to create the required separation distance from the bushfire hazard to protect against the direct attack mechanisms of flame contact and radiant heat and reduce exposure to embers. ***In addition to providing separation from the direct bushfire attack mechanisms, the nature of the APZ design and management requirements is intended to minimise the potential impact of the indirect bushfire attack mechanisms of surface fire attack, debris production and accumulation, tree strike and consequential fire (refer to Appendix 2).*** This is achieved by ensuring the APZ contains low threat vegetation; and/or has potential fire fuels managed in a minimal fuel condition; and/or contains non-vegetated areas (e.g. footpaths, paved areas, driveways, parking, swimming pools etc) and/or limits the presence/location of constructed/stored combustible items. For different States and local government areas, APZ establishment and maintenance guides ideally need to be local environment specific. Some authorities establish general requirements while specific requirements may also be established through site specific management documents (e.g. bushfire management plan). The required dimensions of the APZ will correspond to the maximum level of radiant heat the exposed element is to be exposed to – or a greater distance if it is stipulated by a relevant authority. As a minimum avoid dimensions (separation distances) that correspond to BAL-FZ and BAL-40 ratings for any given site/vegetation combination of relevant parameters. This will also apply to BAL-29 separation distances if flame length modelling indicates potential contact due to specific site and effective slope configurations. The location of an APZ should be entirely within the boundaries of each lot so that landowners can have control and responsibility for its implementation and maintenance. Exceptions exist for instances where adjoining land is not vegetated or it can be justified that the fire fuels will be managed in a minimal fuel, low threat state on an ongoing basis, in perpetuity.	Very High	Yes	No	Yes	Yes
Assessment Comments:						
The APZ applicable to a development should be commensurate to the vulnerabilities and maximum thresholds of that asset. The *Planning for Bushfire Guidelines* do not require an APZ for assets other than habitable buildings, regardless of asset type, use, construction, and any critical (or possibly sacrificial) nature.						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					

The exterior and structural components of battery cabinets are non-combustible, generally being metal, fibrous cement, mineral wool etc. A Battery Energy Storage System 'unit' is an approximately sea container sized cabinet with a series of battery racks installed. A single battery rack consists of battery cells (each cell connected into a module), and a control box with chiller. Power and computer cabling is associated within and between racks. These are the relevant components regarding potential for fire.

- Individual batteries have been found to be highly resistant to conductive heat. Applied temperatures exceeding 400 degrees Celsius destroyed, but did not ignite, running battery cells. See UL *9540A Test Method for Evaluating Thermal Runaway Fire Propagation in Cell Energy Storage Systems, Third Edition* (UL LLC; 8 July 2020). Other trigger/failure conditions must be met for battery cells to ignite (mechanical rupture, flame contact, product failure etc).
- Control boxes are computers which will apply thermal throttling and thermal shutdown if internal temperatures exceed a determined threshold. Once a computer system is shut down in this scenario, the threshold is expected to be that of the cabling (below).
- Associated cabling (both power transmission and computer). Common electrical cabling reaches its critical point at >12kW/m^2 (Kaczorek-Chrobak et al. 2021) [49]. Electrical cabling and components are expected to exceed this standard, being industrial and high capacity, however the 12kW threshold is adopted for the highest potential vulnerability.

Heat Flux Thresholds

BESS technologies are continuing to develop, and the critical heat flux thresholds of assets may vary between engineering designs.

Heat flux thresholds are not available for any BESS product. Thresholds can occasionally be found for components of various assets other than Class 1-10 buildings. However, these specifications understate the tolerance to high heat fluxes as they test major asset fire, which have far longer residence periods as compared to bushfire.

The following document was found to be relevant in the assessment of proposed substations: *NS187 Passive Fire Mitigation Design of Major Substations - Internal Document No. NW000-S0007* (Ausgrid 2020). Ausgrid Pty Ltd is Australia's largest electricity distributor (in terms of customers and energy load), and the document referenced is an internal network standard. The below table is sourced from Section 12 of the network standard.

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					

Table 3 – Radiant Heat Exposure Limits for Bushfires

Item	Maximum allowable radiant heat flux (kW/m^2)	Comment
Cable	12.5 20	PVC Cables begin to distort and may ignite. Ignition of XLPE cables between 85 and 550 seconds.
Steel support structure	35	To 60% of yield strength after a maximum duration of 5 minutes. Applies where elastic deflections due to elevated temperatures are not critical.
Porcelain bushing/Insulators	>30	Damage may occur requiring replacement or in extreme case resulting in catastrophic failure. See Note 2.
Polymeric bushing/insulators	>30	Damage may occur requiring replacement or in extreme case resulting in catastrophic failure. See Note 2.
Aluminium busbar	20	Based on 250°C after a maximum duration of 5 minutes. Comparable to withstand temperature under fault conditions.
Copper busbar	25	Busbars may undergo significant distortion and impose significant stresses on rigid insulators.
Transformer tank	>35 (see Note 1)	Refer to above regarding bushings and cables.
Combustibles	12.5	Piloted ignition may occur on timber.

Note 1. Transformers always have some more vulnerable components such as bushings and cables etc. Refer to Clause 7.2.

'Combustibles' in this description are consequential fire hazards for the purposes of the bushfire assessment: packing materials, pallets, waste, and other assorted debris. These should not be present within the immediate siting and where necessary should be positioned away from infrastructure components, applied in Measure 6.7.

This leaves cables as the relevant consideration, with a maximum allowable heat flux comparable to the findings of (Kaczorek-Chrobak et al. 2021) [49], which found common electrical cabling reaches its critical point at >12kW/m^2. Electrical cabling and components may exceed this standard, being industrial and high capacity, however the 12kW threshold is adopted for the highest potential vulnerability.

Associated cabling (both power transmission and computer) will be present both internally and externally connecting to associated infrastructure through to the electricity network.

Control boxes are computers which will apply thermal throttling and thermal shutdown if internal temperatures exceed a determined threshold. Once a computer system is shut down in this scenario, the threshold is expected to be that of the cabling (above).

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					

Exposed cabling (not shielded or buried underground) positioned beyond a <12kW zone may be damaged/destroyed in a bushfire event and require replacement. The manufacturer/ proponent should identify where any such exposed cabling can be sacrificed and replaced, and if de-powering/disconnection from the grid etc is required for this to be appropriate. Critical cabling should be installed within structures, underground, or shielded with appropriate sheaths.

Temperature Thresholds

The thermal insulation of the battery cabinet is not readily available and may be specified within the standards with which the cabinet is compliant (being purchase-only). The construction, cladding, and insulation may meet or exceed the requirements for BAL-29, NASH, or the *ABCB Handbook*.

Radiant heat from a bushfire or other source against the battery cabinet can heat the interior, however direct calculations between radiant heat and ambient temperature within an enclosure are not available. Testing has been conducted, but only directional heat exposure (nearby asset fire or heating elements).

A critical consideration is that the full duration for the passage of a fire front is brief relative to structural fires. AS 3959 assumes a peak heat flux phase of 2 minutes. The pre-heating and flaming phase is generally <10 minutes. Residual heat (through ongoing combustion of heavy fuels) may continue for >1 hour with lower heat fluxes. For grassland vegetation and other fine fuels, the entire exposure duration may be <30 seconds.

The individual batteries have been found to be highly resistant to conductive heat. Applied temperatures exceeding 400 degrees Celsius destroyed, but not ignite, running battery cells. See *UL 9540A Test Method for Evaluating Thermal Runaway Fire Propagation in Cell Energy Storage Systems, Third Edition* (UL LLC; 8 July 2020). Other trigger/failure conditions must be met for battery cells to ignite (mechanical rupture, flame contact, product failure etc).

The maximum storage and design temperatures vary on the manufacturer specifications of the specific product. The lowest maximums found are:

- Switchgear: 105°C
- Transformer: 130°C
- Cables: 130°C
- Liquid cooling rack: 60°C
- Battery cell: 55°C for 12 months / 60°C 24 hours.

The product is required to comply with UN 38.3 under s2.9.4 of the *Australian Code for the Transport of Dangerous Goods by Road & Rail* v7.9 (Australian National Transport Commission 2024). UN 38.3.4.2 *Test T.2: Thermal test* which requires cells and batteries to be tested to 72C ± 2°C for 6 hours, with 10 repeats of the same set of cells or batteries. As shown above, it must be considered that battery cells and associated infrastructure/equipment are tested to be able to withstand an environment of sustained high temperatures beyond human endurance.

- The *ABCB Handbook* requires refuge structures for a tenable human environment be subject to <10kw/m2 radiant heat flux, and a maximum mean internal temperature <39°C for 1 hour (and peak of 45°C).

This 'tenable environment' for battery infrastructure within the BESS units should be adopted as 60°C for a period of 6 hours.

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					

Emergency Response

The *ABCB Handbook* (and referenced through the *Planning for Bushfire Guidelines*) consider that emergency responders with suitable PPE are able to operate within areas subject to <10kW/m^2 radiant heat flux for limited periods. The BESS Infrastructure and the substation will be subject to <10kW/m^2 radiant heat flux, and thus align to these documents.

Note that as the development does not include persons sheltering, the applied flame temperature would be 1090K rather than 1200K.

View Factor Adjustment – Application of a Radiant Heat Barrier

The following is ***not*** a Method 2 calculation of a View Factor Adjustment.

All assumptions within the View Factor Adjustment are met as the battery cabinet is a full enclosure (e.g. barrier height against the emitting radiant heat panel), or not relevant (e.g. flame deflection, as the APZ applied exceeds BAL-29- which based on modelled solid flame lengths).

A constructed barrier must consist of solid non-combustible materials. The quality of materials and construction (including quantity and quality of fixings) must be able to withstand the expected amount of radiation and its duration (as associated with the type of vegetation present), and any other reasonably expected potential impacts.

Effective barrier materials and construction include barriers that can comply with the requirements established by AS 3959:2018 clause 9.4.1 for walls subject to BAL-FZ (FRL -/60/60 or 60/60/60 if load bearing).

The insulation period is the critical measure (e.g. FRL 60/60/**60**), as this accounts for the radiant heat on the external element transferring through conduction to the internal panel and thus heating the internal environment- and thus impacting the 'tenability' above.

The barrier (battery enclosure) will not assume flame contact at <10kW/m^2 radiant heat flux exposure, and the duration of pre-heating, flaming phase, and residual heat will be <60 minutes for the associated vegetation. Therefore, the duration applied for BAL-FZ construction can justifiably be reduced.

As a reference of materials and effectiveness, findings from the project '*Research and Investigation into the Performance of Residential Boundary Fencing Systems in Bushfires*' (2006) conducted by BlueScope Steel Limited, CSIRO Bushfire Research and the Bushfire CRC, established the following as a key output:

> *"COLORBOND steel had the best performance as it is a non-combustible material, it maintained structural integrity as a heat barrier under all experimental exposure conditions, and it did not spread flame laterally or contribute to the fire intensity during exposure. The fencing reduced radiation levels within the fencing boundary to below 5 kW/m^2 immediately behind the fencing system during all radiation exposures and reduced the radiant heat exposure on a structure 9 m from the fencing by at least a factor of two".*

This is to provide evidence that effective radiant heat shielding exists and can be applied, however direct calculations do not exist.

The technical report 21-*0010 IHE Safety Distance* (SAFT Engineering Department 14/1/2021) tested a forced fire propagation via thermal runaway of a battery module within a container on an adjoining container. This report is based on older battery chemistry. Flame ignited after 3 hours of abuse, with a duration of approximately 2 hours, and peak flame temperature of approximately 800 degrees (note- bushfire modelling applies a standard flame temperature of 1090 degrees). The impact on the neighbouring cabinet within 3m

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
was to increase the external panel to 55 degrees, with the internal environment increasing by 20 degrees only. The inputs cannot be compared to a bushfire. However, the shielding effect of the cabinet is substantial. The impact of shielding is not applied, as calculations are not available. However, the APZs applied are based on assets being entirely exposed, when in reality a significant measure of shielding will exist and reduce the exposure to the asset. ***Recommendation Details***: See **Measure 4.3.**						
6.4	**Landscaping - Tree Location:** Use separation to minimise the potential for debris accumulation and tree strike damage to the building envelop potentially allowing flame, radiant heat and ember entry to internal spaces. • The buildings/structures are separated from trees (or trees from buildings) by a distance of at least 1.5 times the height of the tallest tree. • Trees that produce significant quantities of debris (fine fuels) during the bushfire season should be located a sufficient distance away from vulnerable exposed elements to ensure debris cannot drop and accumulate within at least 4m of buildings/structures or be likely to be relocated by wind to closer than 4m to buildings / structures. • If the minimum distances cannot be achieved with an existing tree either remove the tree or at least ensure tree branches are sufficiently separated from buildings and attached/adjacent structures (at a minimum to not overhang) to ensure branches cannot fall onto or be blown onto the buildings/structures.	Medium	Yes	Partly	Yes	Yes
Assessment Comments: The BESS development requires a minimum 10m non-vegetated APZ through Measure 4.3. The development is proposed toward the north-eastern extent of a large rural lot and is expected to require planting of vegetated vegetation screening. Vegetation screening is intended to meet Class D Scrub structure, however some trees may be present within the screen. The vegetation screen is >20m from BESS units. A maximum tree height of 13.3m will meet the above specification. ***Recommendation Details***: Any future Landscape Management Plan should be reviewed by the Bushfire Consultant to provide additional advice on vegetation location, demographics, and structure. Trees over 6m tall are not recommended to be planted within 10m of assets to reduce the capacity for ongoing fuel accumulation or tree strike.						
6.5	**Separation from Stored Flammable Products - Gas in Cylinders:** To reduce the potential for gas flaring or explosion (consequential fire), installation of LPG cylinders is to apply as a minimum, the principles and requirements established in AS 1596 'The Storage and Handling of LP Gas'. Readily available guidance is provided by CSIRO Best Practice Bushfire Guide (https://research.csiro.au/bushfire/new-builds/water-electricity-gas/) and WA Dept. Mines, Industry, Regulation	Medium	N/A	N/A	N/A	N/A

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
	and Safety 'LP Gas cylinder safety in bushfire prone areas' (https://www.commerce.wa.gov.au/publications/lp-gas-cylinder-safety-bushfire-prone-areas). Otherwise, the required separation distance is 6m from any combustible materials. Heat from bushfire or consequential fire can be sufficient to cause cylinder pressure to reach critical levels and the pressure relief valve release large quantities of gas (flare). If the cylinder falls over the pressure relief valve may not function correctly, and the cylinder may rupture (explosion).					
Assessment Comments: Gas storage is not proposed on site. Any LPG will be stored in compliance with AS 1596. ***Recommendation Details***: Not Applicable						
6.6	**Separation from Stored Flammable Products – Fuels / Other Hazardous Materials (Consequential Fire Fuels):** Establish sufficient separation distance between these consequential fire fuels and buildings/structures. The required separation distance will be dependent on the fuel and storage type.	High	Yes	No	Yes	Yes
Assessment Comments: All infrastructure will be installed to manufacturers specification, including separation distances. Fuel and other hazardous material will not be stored on site. Both flammable and combustible materials are required to be positioned and maintained >10m from assets by Measure 6.7. ***Recommendation Details***: **See Measure 6.7.**						
6.7	**Separation from Stored and Constructed Combustible Items (Consequential Fire Fuels):** These consequential fire fuels include: • Stored Combustible Items - Heavy Fuels e.g. building materials, packaging materials, rubbish bins etc; • Stored Combustible Items – Large Heavy Fuels e.g. vehicles, caravans and large quantities of dead vegetation materials stored as part of site use; • Constructed Combustible Items – Heavy Fuels e.g. landscaping structures including fences, screens, walls, plastic water tanks; and • Constructed Combustible Items – Large Heavy Fuels e.g. adjacent buildings/structures including houses, sheds, garages, carports. (Note: If the adjacent structure is constructed to BAL-29 requirements or greater and can implement a significant number of additional bushfire protection measures associated with reducing exposure and vulnerability, these minimum separation distances could be reduced by 30%) [31].	High	Yes	No	Yes	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend
Element at Risk: Built Infrastructure Assets - BESS units and Associated Infrastructure.					
Apply the rule of thumb [13] "assume flames produced from a consequential fire source will be twice as high as the object itself … where the consequential fire source is a structure, then the maximum eave height is a reasonable measure of maximum height". Apply the following separation distances from the subject building/structure as a multiple of the height of the consequential fire source and dependent on the construction standard applied to the building/structure [13 and 31]: • At least six times the height when the building/structure construction incorporates design and materials that is only intended to resist low levels of radiant heat up to 12.5 kW/m^2) and no flame contact; • Between 4 and 6 six times the height when the building/structure construction incorporates design and materials intended to resist radiant heat up to 29 kW/m^2 and no flame contact. • Between 2 and 4 times the height when the building/structure construction incorporates design and materials intended to resist up to 40kW/m^2 and potential flame contact. • Less than 2 times the height when the building/structure construction incorporates design and materials intended to resist extreme levels of radiant heat and flame contact. • Zero separation distance is required if the building/structure is separated by a non-combustible FRL 60/60/60 rated wall, or the potential consequential fire source is fully enclosed by the building/structure.					

***Assessment Comments**:* The design and layout of the facility has been determined by the relevant designer/engineer and are assumed to be appropriate in reducing the risk of structure-to-structure (or asset) fire. Required separation distances are different for each supplier (and equipment model) depending on the results from the large-scale fire test and UL9540. As such, once a supplier has been selected a final layout will be prepared prior to construction. This will be confirmed in the updated Risk Management Plan. The recommended CFA conditions require the updated Risk Management Plan to specify the separation distance, based on radiant heat flux (output) as an ignition source (an output from the large-scale fire test). It is also anticipated that it will be shown on Development Plans to the satisfaction of the Minister for Planning.

The minimum separations within this Bushfire Risk Report should be applied where the selected product does not specify an alternative setback.

These separation distances between assets are based on a >1 hour intervention due to the remoteness of the site.

***Recommendation Details**:* All non-structural combustible materials are to be removed within 10m of assets. This includes but is not limited to; waste, leaf litter, machinery, grasses, vehicles, fuel, furniture, and timber. When storage of flammable items or materials are stored on site temporarily (for maintenance etc), separation distances must be complied with. This requirement is to be included in the Site Operating Procedures document.

The product datasheet or manufacturer is likely to specify a setback between BESS units. Where this is not provided, a setback of >1m on the shorter and >3m on the longer side is recommended.

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
Where the product datasheet or manufacturer specification does not specify a distance between battery containers and other constructed combustible/critical assets, the applied distance should be 15m (based on >1 hour intervention). This does not apply to any constructed asset required to be reasonably adjacent.						
THE PROTECTION MECHANISM – ESTABLISH SHIELDING FROM RELEVANT BUSHFIRE HAZARD THREATS: To shield buildings and attached/adjacent structures (or other consequential fire fuels) from the direct bushfire attack mechanisms of flame, radiant heat, surface fire and surface migration of embers. To also reduce exposure to the indirect attack mechanism of debris accumulation against buildings/structures and other consequential fire fuels and wind attack.						
6.8	**Constructed Barrier – Shielding from Bushfire:** Walls, fences and/or landforms to shield the subject building/structure from direct and indirect bushfire attack mechanisms and reduce the potential impact of these. Must be constructed using appropriate fire resistant / non-combustible construction materials (e.g. masonry, steel, earthworks). These are to withstand the impact of direct bushfire attack mechanisms for the required period of time. Apply the bushfire construction standards for external walls subject to the assessed level of radiant heat or flame contact to which the barrier will be exposed (or otherwise to BAL-FZ requirements). These are established by AS 3959:2018 [4] and/or the NASH Standard [33] and additionally informed by the research report 'Research and Investigation into the Performance of Residential Boundary Fencing Systems in Bushfires.' [29]	High	Yes	No	No	No
Assessment Comments: A radiant heat barrier could be applied, however a greater APZ can be established without environmental impact due to the pasture vegetation. ***Recommendation Details:*** Not Applicable						
6.9	**Constructed Barrier - Shielding from Consequential Fire:** Applicable to all consequential fire fuel sources. Install a non-combustible barrier (including complete enclosure when appropriate), of required robustness, that can perform the following as relevant: • Reduce the exposure of the subject building/structure to the threats of consequential fire; and/or • Reduce the exposure of the consequential fire fuels to the bushfire hazard.	High	Yes	No	No	No
Assessment Comments: Consequential fire sources are addressed in **Measure 6.7**. ***Recommendation Details:*** Not Applicable						
6.10	**Natural Landforms Barrier:** Use existing natural landforms to reduce buildings/structures exposure to radiant heat, and lower wind speeds (prevailing synoptic and/or fire driven).	High	No	No	No	No
Assessment Comments: No appropriate landforms exist.						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
Recommendation Details: Not Applicable						
6.11	**Planted Vegetation Barrier:** Use appropriate hedges and trees strategically to reduce (to varying extents) buildings/structures exposure to radiant heat, to filter/trap embers and firebrands, and to lower wind speeds (prevailing synoptic and/or fire driven).	Medium	Yes	No	No	No
***Assessment Comments**:* Landscaped vegetation is not recommended within the APZ to remove the capacity for surface fire and production of debris (leaf litter etc). ***Recommendation Details**:* Not Applicable						
6.12	**Shield Operation Critical Non-Structural Elements:** These are vulnerable elements essential to the continued operation of the building/structure which are potentially exposed to the attack mechanisms of both bushfire and consequential fire. These elements include cabling and plumbing associated with power delivery, data transmission, fuel and water transport. When the use of fire rated materials to the degree necessary is not possible or practical, the application of non-combustible shielding can be applied to reduce exposure to the threats. Shielding includes underground installation.	Medium	Yes	Unknown	No	Yes
***Assessment Comments**:* All high-risk components will be positioned such that they are subject to a maximum 10kW/m2 radiant heat flux. ***Recommendation Details**:* Electrical cabling associated with built assets (not transmission lines) which are beyond the >10kW/m^2 setback (thus subject to radiant heat fluxes >10kW/m^2), or beyond footprint of buildings or constructed assets, are recommended to be installed underground, or shielded with non-combustible material (or enclosed) where practical.						

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining.

Note 2: Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use.
- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Currently Planned:** Protection measures that:
  - Are incorporated into the site plans;
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Planning for Bushfire Guidelines', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					

These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).

- **Additionally Recommend:** Protection measures that:
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or
  - Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP.

These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).

5.3.5.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing exposure levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the exposure of the relevant element at risk to bushfire hazard threats.

EXPOSURE REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Establish Sufficient Separation from Relevant Bushfire Hazard Threats	Very High	2	2			2	2
	High	3	2	1		2	2
	Medium	2	1		1	1	1
	Not Relevant						
Establish Shielding from Relevant Bushfire Hazard Threats	Very High						
	High	3	2				
	Medium	2	2				1
	Not Relevant						
Number Analysis	Very High	2	2			2	2
	High	6	4	1		2	2
	Medium	4	3		1	1	2
	Not Relevant						
	Totals	12	9	1	1	5	6

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.3.5.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE EXPOSURE

From the information presented in the previous section, the exposure reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce exposure (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE EXPOSURE TO BUSHFIRE HAZARD THREATS [1]							
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.						
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Significant	Moderate	Minimal	Significant	Significant	Minimal	Significant	Moderate
Moderate				Moderate			
WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Very Significant	Very Significant	Moderate	Very Significant	Very Significant	Very Significant	Significant	Significant
Very Significant				Significant			

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This exposure reducing potential will be applied to deriving the inherent exposure level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This exposure reducing potential will be applied to deriving the residual exposure level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 4: Refer to Appendix 2 for explanatory and supporting information.

Assessment Comments: Most measures relate to the increased size and standard of maintenance of the APZ, separations from and between hazards, and between assets.

5.3.5.4 DERIVED EXPOSURE LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual exposure levels.

In combination with the corresponding assessed threat and vulnerability levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL EXPOSURE LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]							
ELEMENT AT RISK		Built Infrastructure Assets - BESS units and Associated Infrastructure.					
BUSHFIRE ATTACK MECHANISMS [2]		INHERENT EXPOSURE LEVEL (CURRENT STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	Moderate
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☒	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
BUSHFIRE ATTACK MECHANISMS [2]		RESIDUAL EXPOSURE LEVEL (POTENTIAL FUTURE STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	Very Low
DIRECT	Radiant Heat	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: Refer to Appendix 2 for explanatory and supporting information.

Note 3: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

5.3.6 BUILT INFRASTRUCTURE ASSETS – SUBSTATION

5.3.6.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
THE PROTECTION MECHANISM – ESTABLISH SUFFICIENT SEPARATION FROM RELEVANT BUSHFIRE HAZARD THREATS: To reduce exposure to the relevant direct and indirect attack mechanisms of bushfire by locating buildings and attached/adjacent structures at sufficient distances away from the bushfire hazard and consequential fire fuels. The required distances will be dependent on the assessed threat levels and the degree of bushfire resilience that exists or is planned to be incorporated into the exposed elements through design and construction.						
8.1	**Siting of Buildings/Structures Considering Potential High Wind Exposure:** Site buildings and attached/adjacent structures in locations that have less exposure to terrain influenced prevailing synoptic winds, and in particular, those locations with potential for significant terrain/bushfire threat intensification interactions (refer to Appendix 3). Avoid the top and sides of ridges. Strong winds can directly or indirectly (airborne materials/debris) cause damage to the external building envelope, potentially allowing flame, radiant heat and ember entry.	High	No	Partly	No	No
Assessment Comments: The siting of the proposal considers a number of impacts other than wind. The relevant vegetation (pasture) within 150m of the development area will not generate significant fire-driven winds, and it is thus not a relevant consideration. The development footprint is within a less vegetated portion of the site, and is required to have a BAL-19 dimensioned APZ installed, which will reduce the exposure to any fire-driven wind. ***Recommendation Details***: Not Applicable						
8.2	**Designed Location of Non-Vegetated Areas and/or Managed Open Space:** Non-vegetated land uses include footpaths, paved areas, roads, parking, open drainage channels, and major services delivery (power, water, gas) installed in common corridors. Managed open space is land for public or private use on which the vegetation is either low threat due to type or situation or is continually managed in a minimal fuel condition. This can include public open space providing recreation facilities. Use these design elements to create or increase separation from any bushfire prone vegetation by positioning them adjacent to the bushfire hazard.	Very High	Yes	Partly	Yes	Yes
Assessment Comments: There are no such areas existing. The non-vegetated areas will be the internal access roads and carparks, 10m non-vegetated area around the BESS development (applied in **Measure 6.3**), and surfaced hardstand of the BESS and Substation, footprints.						

PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
***Recommendation Details:* See Measure 6.3.**						
8.3	**Landscaping - Asset Protection Zone (APZ):** Ensure an APZ is established surrounding the relevant element(s) at risk to create the required separation distance from the bushfire hazard to protect against the direct attack mechanisms of flame contact and radiant heat and reduce exposure to embers. ***In addition to providing separation from the direct bushfire attack mechanisms, the nature of the APZ design and management requirements is intended to minimise the potential impact of the indirect bushfire attack mechanisms of surface fire attack, debris production and accumulation, tree strike and consequential fire (refer to Appendix 2).*** This is achieved by ensuring the APZ contains low threat vegetation; and/or has potential fire fuels managed in a minimal fuel condition; and/or contains non-vegetated areas (e.g. footpaths, paved areas, driveways, parking, swimming pools etc) and/or limits the presence/location of constructed/stored combustible items. For different States and local government areas, APZ establishment and maintenance guides ideally need to be local environment specific. Some authorities establish general requirements while specific requirements may also be established through site specific management documents (e.g. bushfire management plan). The required dimensions of the APZ will correspond to the maximum level of radiant heat the exposed element is to be exposed to – or a greater distance if it is stipulated by a relevant authority. As a minimum avoid dimensions (separation distances) that correspond to BAL-FZ and BAL-40 ratings for any given site/vegetation combination of relevant parameters. This will also apply to BAL-29 separation distances if flame length modelling indicates potential contact due to specific site and effective slope configurations. The location of an APZ should be entirely within the boundaries of each lot so that landowners can have control and responsibility for its implementation and maintenance. Exceptions exist for instances where adjoining land is not vegetated or it can be justified that the fire fuels will be managed in a minimal fuel, low threat state on an ongoing basis, in perpetuity.	Very High	Yes	No	Yes	Yes

Assessment Comments:

Substations and Switchyards

AS 2067-2016 *Substations and high voltage installations exceeding 1 kV a.c.* does not provide radiant heat or flame exposure thresholds, nor any general bushfire protection measures. 'Consideration of the area surrounding the installation should also be included, in particular the effect of fire on or from surrounding vegetation.' (AS 2067-2016 s6.7.1.2).

Standard vegetation clearances are provided in *Western Australian Distribution Connections Manual 2015* (Western Power 2015).

The following document was found to be relevant in the assessment of proposed substations: *NS187 Passive Fire Mitigation Design of Major Substations* - Internal Document No. NW000-S0007 (Ausgrid 2020). Ausgrid Pty Ltd is Australia's largest electricity distributor (in terms of customers and energy load), and the document referenced is an internal network standard. The below table is sourced from Section 12 of the network standard.

Table 3 – Radiant Heat Exposure Limits for Bushfires

Item	Maximum allowable radiant heat flux (kW/m^2)	Comment
Cable	12.5	PVC Cables begin to distort and may ignite.
	20	Ignition of XLPE cables between 85 and 550 seconds.
Steel support structure	35	To 60% of yield strength after a maximum duration of 5 minutes. Applies where elastic deflections due to elevated temperatures are not critical.
Porcelain bushing/Insulators	>30	Damage may occur requiring replacement or in extreme case resulting in catastrophic failure. See Note 2.
Polymeric bushing/insulators	>30	Damage may occur requiring replacement or in extreme case resulting in catastrophic failure. See Note 2.
Aluminium busbar	20	Based on 250°C after a maximum duration of 5 minutes. Comparable to withstand temperature under fault conditions.
Copper busbar	25	Busbars may undergo significant distortion and impose significant stresses on rigid insulators.
Transformer tank	>35 (see Note 1)	Refer to above regarding bushings and cables.
Combustibles	12.5	Piloted ignition may occur on timber.

Note 1. Transformers always have some more vulnerable components such as bushings and cables etc. Refer to Clause 7.2.

'Combustibles' in this description are consequential fire hazards for the purposes of the bushfire assessment: packing materials, pallets, waste, and other assorted debris. These should not be present within the substation footprint and where necessary should be positioned away from infrastructure components, applied in **Measure 6.7**.

<table>
<tr><td colspan="7">The internal network standard aligns with (Suzuki et al 2007)[1]; (Zhenhua et al 2018)[2]; (Ausgrid 2020)[3] in identifying Transformer Oil as being a consequential fire source (within the context of bushfire assessments). This is a flammable material with a low flash point of 135°C, and a radiant heat flux threshold of 4.5-5.8kW/m^2 varying on period of exposure. The network standard considers radiant heat impact from asset fires on transformer oil but not bushfires, which appears to be due to the greatly reduced residence period and the transformer oil being contained within the transformer tank, which provides shielding/insulation to the contents to prevent the flash point being reached. As an appropriate heat flux for the short residence period of a bushfire is not available, the capacity for this risk to be managed is dependent on the proponent recognising the issue and ensuring that the design/procedures that are applied to manage transformer oil fires, also consider the possibility of external bushfire impact igniting the oil (either through piloted ignition from embers or radiant heat only).

[1] Suzuki K, Sugawa O, Yamagishi A, Miyagi K, Kamiya K (2007). Experimental study on ignition and combustion behaviors of insulation fluids for transformer using cone calorimeter. *IEEJ Transactions on Power and Energy*, 127(7), 797-802.
[2] Zhenhua W, You F, Rein G, Juncheng J, Xuefeng H, Junhua H, Wei S (2018). Flammability hazards of typical fuels used in wind turbine nacelle. *Fire and Materials*, 42(2), 1-12.
[3] Ausgrid (2020). NS187 Passive Fire Mitigation Design of Major Substations. *Network Standard NW000-S0007 Amendment 2*.

PVC cables should be either enclosed within structures or installed underground where practical. Any exposed cabling (not shielded or buried underground) subject to >12kW/m^2 radiant heat flux may be damaged/destroyed in a bushfire event and require replacement. Automated isolation and shutdown of affected systems are applied in substation design, to prevent any such fire spread. It may be possible to identify sacrificial cabling for the Substation/Switchyard.
A <10kW/m^2 APZ is ideal, however the requirement for vegetation screening conflicts with the APZ dimension. A BAL-19 APZ can be achieved for the substation which significantly exceeds Western Power vegetation clearances and aligns to the thresholds of busbars and XLPE cables in the table above.

Recommendation Details: See **Measures 4.3.**</td></tr>
<tr><td>8.4</td><td>Landscaping - Tree Location: Use separation to minimise the potential for debris accumulation and tree strike damage to the building envelope potentially allowing flame, radiant heat and ember entry to internal spaces.
The buildings/structures are separated from trees (or trees from buildings) by a distance of at least 1.5 times the height of the tallest tree.
Trees that produce significant quantities of debris (fine fuels) during the bushfire season should be located a sufficient distance away from vulnerable exposed elements to ensure debris cannot drop and accumulate within at least 4m of buildings/structures or be likely to be relocated by wind to closer than 4m to buildings / structures.
If the minimum distances cannot be achieved with an existing tree either remove the tree or at least ensure tree branches are sufficiently separated from buildings and attached/adjacent structures (at a minimum to not overhang) to ensure branches cannot fall onto or be blown onto the buildings/structures.</td><td>Medium</td><td>Yes</td><td>Yes</td><td>No</td><td>Yes</td></tr>
<tr><td colspan="7">Assessment Comments: The development is proposed toward the north-eastern extent of a large rural lot and is expected to require planting of vegetated vegetation screening.

Vegetation screening is intended to meet Class D Scrub structure, however some trees may be present within the screen. The vegetation screen is >20m from the substation footprint. A maximum tree height of 13.3m will meet the above specification.</td></tr>
</table>

Vegetation clearances will follow *Vegetation Clearances for the Construction of Overhead Powerlines* (Western Power Standard - Internal Document - DM#9288088). ***Recommendation Details***: See **Measure 6.4.**						
8.5	**Separation from Stored Flammable Products - Gas in Cylinders:** To reduce the potential for gas flaring or explosion (consequential fire), installation of LPG cylinders is to apply as a minimum, the principles and requirements established in AS 1596 'The Storage and Handling of LP Gas'. Readily available guidance is provided by CSIRO Best Practice Bushfire Guide (https://research.csiro.au/bushfire/new-builds/water-electricity-gas/) and WA Dept. Mines, Industry, Regulation and Safety 'LP Gas cylinder safety in bushfire prone areas' (https://www.commerce.wa.gov.au/publications/lp-gas-cylinder-safety-bushfire-prone-areas). Otherwise, the required separation distance is 6m from any combustible materials. Heat from bushfire or consequential fire can be sufficient to cause cylinder pressure to reach critical levels and the pressure relief valve release large quantities of gas (flare). If the cylinder falls over the pressure relief valve may not function correctly, and the cylinder may rupture (explosion).	Medium	N/A	N/A	N/A	N/A
Assessment Comments: Gas storage is not proposed on site. Any LPG will be stored in compliance with AS 1596. ***Recommendation Details***: Not Applicable						
8.6	**Separation from Stored Flammable Products – Fuels / Other Hazardous Materials (Consequential Fire Fuels):** Establish sufficient separation distance between these consequential fire fuels and buildings/structures. The required separation distance will be dependent on the fuel and storage type.	High	Yes	No	Yes	Yes
Assessment Comments: All infrastructure will be installed to manufacturers specification, including separation distances. Fuel and other hazardous material will not be stored on site. Both flammable and combustible materials are required to be positioned and maintained >10m from assets by **Measure 6.7.** ***Recommendation Details***: See **Measure 6.7.**						
8.7	**Separation from Stored and Constructed Combustible Items (Consequential Fire Fuels):** These consequential fire fuels include: • Stored Combustible Items - Heavy Fuels e.g. building materials, packaging materials, rubbish bins etc; • Stored Combustible Items – Large Heavy Fuels e.g. vehicles, caravans and large quantities of dead vegetation materials stored as part of site use; • Constructed Combustible Items – Heavy Fuels e.g. landscaping structures including fences, screens, walls, plastic water tanks; and • Constructed Combustible Items – Large Heavy Fuels e.g. adjacent buildings/structures including houses, sheds, garages, carports. (Note: If the adjacent structure is constructed to BAL-29 requirements or greater and can implement a significant number of additional bushfire protection measures associated with reducing exposure and vulnerability, these minimum separation distances could be reduced by 30%) [31].	High	Yes	No	Yes	Yes

	Apply the rule of thumb [13] "assume flames produced from a consequential fire source will be twice as high as the object itself … where the consequential fire source is a structure, then the maximum eave height is a reasonable measure of maximum height". Apply the following separation distances from the subject building/structure as a multiple of the height of the consequential fire source and dependent on the construction standard applied to the building/structure [13 and 31]: • At least six times the height when the building/structure construction incorporates design and materials that is only intended to resist low levels of radiant heat up to 12.5 kW/m^2) and no flame contact; • Between 4 and 6 six times the height when the building/structure construction incorporates design and materials intended to resist radiant heat up to 29 kW/m^2 and no flame contact. • Between 2 and 4 times the height when the building/structure construction incorporates design and materials intended to resist up to 40kW/m^2 and potential flame contact. • Less than 2 times the height when the building/structure construction incorporates design and materials intended to resist extreme levels of radiant heat and flame contact. • Zero separation distance is required if the building/structure is separated by a non-combustible FRL 60/60/60 rated wall, or the potential consequential fire source is fully enclosed by the building/structure.					
Assessment Comments**:* **Measure 6.7** requires a 10m separation of BESS units from other assets (including the Substation), where another distance is not specified in the BESS product specifications. The separation from buildings will be per *AS 2067 - Substations and high voltage installations exceeding 1 kV a.c* (Standards Australia 2016). ***Recommendation Details: See **Measure 6.7.**						
THE PROTECTION MECHANISM – ESTABLISH SHIELDING FROM RELEVANT BUSHFIRE HAZARD THREATS: To shield buildings and attached/adjacent structures (or other consequential fire fuels) from the direct bushfire attack mechanisms of flame, radiant heat, surface fire and surface migration of embers. To also reduce exposure to the indirect attack mechanism of debris accumulation against buildings/structures and other consequential fire fuels and wind attack.						
8.8	**Constructed Barrier – Shielding from Bushfire:** Walls, fences and/or landforms to shield the subject building/structure from direct and indirect bushfire attack mechanisms and reduce the potential impact of these. Must be constructed using appropriate fire resistant / non-combustible construction materials (e.g. masonry, steel, earthworks). These are to withstand the impact of direct bushfire attack mechanisms for the required period of time. Apply the bushfire construction standards for external walls subject to the assessed level of radiant heat or flame contact to which the barrier will be exposed (or otherwise to BAL-FZ requirements). These are established by AS 3959:2018 [4] and/or the NASH Standard [33] and additionally informed by the research report 'Research and Investigation into the Performance of Residential Boundary Fencing Systems in Bushfires.' [29]	High	Yes	No	No	No
***Assessment Comments**:* A radiant heat barrier could be applied, however a greater APZ can be established without environmental impact due to the pasture vegetation. ***Recommendation Details**:* Not Applicable						

8.9	**Constructed Barrier - Shielding from Consequential Fire:** Applicable to all consequential fire fuel sources. Install a non-combustible barrier (including complete enclosure when appropriate), of required robustness, that can perform the following as relevant: • Reduce the exposure of the subject building/structure to the threats of consequential fire; and/or • Reduce the exposure of the consequential fire fuels to the bushfire hazard.	High	Yes	No	No	No
Assessment Comments: Consequential fire sources are addressed in **Measure 6.7.** ***Recommendation Details:*** Not Applicable						
8.10	**Natural Landforms Barrier:** Use existing natural landforms to reduce buildings/structures exposure to radiant heat, and lower wind speeds (prevailing synoptic and/or fire driven).	High	No	No	No	No
Assessment Comments: No appropriate landforms exist. ***Recommendation Details:*** Not Applicable						
8.11	**Planted Vegetation Barrier:** Use appropriate hedges and trees strategically to reduce (to varying extents) buildings/structures exposure to radiant heat, to filter/trap embers and firebrands, and to lower wind speeds (prevailing synoptic and/or fire driven).	Medium	Yes	No	No	No
Assessment Comments: Landscaped vegetation is not recommended within the APZ to remove the capacity for surface fire and production of debris (leaf litter etc). ***Recommendation Details:*** Not Applicable						
8.12	**Shield Operation Critical Non-Structural Elements:** These are vulnerable elements essential to the continued operation of the building/structure which are potentially exposed to the attack mechanisms of both bushfire and consequential fire. These elements include cabling and plumbing associated with power delivery, data transmission, fuel and water transport. When the use of fire rated materials to the degree necessary is not possible or practical, the application of non-combustible shielding can be applied to reduce exposure to the threats. Shielding includes underground installation.	Medium	Yes	No	No	Yes
Assessment Comments: Conductors will be underground. Switches will be within structures or cabinets. ***Recommendation Details:*** See **Measure 6.12.**						

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining.

Note 2: Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use.
- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).

- **Currently Planned:** Protection measures that:
  - Are incorporated into the site plans;
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Planning for Bushfire Guidelines', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

  These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Additionally Recommend:** Protection measures that:
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or
  - Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP.

  These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).

5.3.6.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing exposure levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the exposure of the relevant element at risk to bushfire hazard threats.

EXPOSURE REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Substation						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Establish Sufficient Separation from Relevant Bushfire Hazard Threats	Very High	2	2		1	2	2
	High	3	2		1	2	2
	Medium	2	1	1			1
	Not Relevant						
Establish Shielding from Relevant Bushfire Hazard Threats	Very High						
	High	3	2				
	Medium	2	2				1
	Not Relevant						
Number Analysis	Very High	2	2		1	2	2
	High	6	4		1	2	2
	Medium	4	3	1			2
	Not Relevant						
	Totals	12	9	1	2	4	6

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.3.6.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE EXPOSURE

From the information presented in the previous section, the exposure reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce exposure (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE EXPOSURE TO BUSHFIRE HAZARD THREATS [1]							
Element at Risk	Substation						
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Significant	Moderate	Minimal	Significant	Significant	Minimal	Significant	Moderate
Moderate				Moderate			
WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Significant	Significant	Moderate	Significant	Significant	Significant	Significant	Very Significant
Significant				Significant			

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This exposure reducing potential will be applied to deriving the inherent exposure level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This exposure reducing potential will be applied to deriving the residual exposure level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 4: Refer to Appendix 2 for explanatory and supporting information.

Assessment Comments: The Substation will apply an APZ to limit radiant heat flux exposure to <19kW/m^2 (BAL-19). Separation between consequential fire hazards (including adjacent structures) will be established.

5.3.6.4 DERIVED EXPOSURE LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual exposure levels.

In combination with the corresponding assessed threat and vulnerability levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL EXPOSURE LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]							
ELEMENT AT RISK		Substation					
BUSHFIRE ATTACK MECHANISMS [2]		INHERENT EXPOSURE LEVEL (CURRENT STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	Moderate
	Radiant Heat	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☒	
	High/Erratic Fire Driven Wind	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
	Surface Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
	Tree Strike / Obstruction	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
	Consequential (Secondary) Fire	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
BUSHFIRE ATTACK MECHANISMS [2]		RESIDUAL EXPOSURE LEVEL (POTENTIAL FUTURE STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	Low
	Radiant Heat	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
	High/Erratic Fire Driven Wind	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
	Surface Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
	Tree Strike / Obstruction	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
	Consequential (Secondary) Fire	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: Refer to Appendix 2 for explanatory and supporting information.

Note 3: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

5.4 VULNERABILITY LEVEL ASSESSMENT – BUSHFIRE PROTECTION MEASURE ANALYSIS

For each stated element at risk an assessment is conducted that considers the effectiveness and application status of all available vulnerability reducing bushfire protection measures that are listed under their applicable bushfire protection mechanism. This information is subsequently applied to deriving vulnerability levels.

5.4.1 PERSONS ONSITE AND TEMPORARILY OFFSITE

5.4.1.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Persons Onsite and Temporarily Offsite					
THE PROTECTION MECHANISM – TRANSPORT AND MULTIPLE EVACUATION DESTINATIONS AND ROUTES AVAILABLE						
9.1	**Sufficient Evacuation Transport Available:** Ensure that all persons likely to be on site have access to transport. This can be through own vehicles, facility vehicles, a formal arrangement with an external provider or a combination of these.	Very High	Yes	Yes	No	No
Assessment Comments: Occupants will have site or personal vehicles available. The site does not have public transport access and is too remote for practical walking access (1 hr walk from Kojonup). Bicycle access is possible, but evacuation would remain possible due to the short distance (15 min travel to Kojonup). ***Recommendation Details:*** Not Applicable						
9.2	**Multiple Safer Offsite Locations Available:** Increasing the route and destination options decreases vulnerability of persons as the exposed element. Multiple buildings/areas are accessible from the subject site as evacuation destinations. The offsite locations exist at a sufficient distance from the subject site ensuring that the destination and the subject site are very unlikely to be simultaneously impacted by a bushfire event. For the most robust scenario: • Multiple access/egress route are available to the safer locations from the subject site; • The entirety of at least two routes is unlikely to be simultaneously impacted by a bushfire event; and • The availability of water and amenities corresponding to person numbers increases the effectiveness of the measure.	Very High	No	Yes	No	No
Assessment Comments: The site has immediate access to Collie-Changerup Road and through to Albany Highway. Tunney Road provides alternative access to the south.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Persons Onsite and Temporarily Offsite					
The site is relatively close to the Kojonup townsite (approx. 4.2 km). Staff will self-evacuate to Kojonup, selecting the appropriate route based on location of the bushfire threat. If all routes to Kojonup are compromised, continuous access in other directions is available. Evacuation procedures and directions will be established within the Emergency Management Plan required prior to commercial operation. ***Recommendation Details:*** Not Applicable						
THE PROTECTION MECHANISM – PROVISION OF BUSHFIRE EMERGENCY INFORMATION AND EDUCATION						
9.3	**Develop a Bushfire Emergency Plan:** This will provide operational guidance for the implementation of prevention, preparation, response and recovery procedures and their associated actions. The format and content of the plan documents will be aligned with the specific needs of the site and its use. Development of the Plan considers site specific information that includes: • The site's use and the numbers and types of persons who will be on the site at any time; • The physical characteristics of the site and its structures; and • The surrounding topography and bushfire prone vegetation; and • The surrounding human settlement and road networks. It is produced for use by the site owners, managers, operators and occupants (as relevant).	High	Yes	No	Yes	Yes
Assessment Comments: A comprehensive Emergency Management Plan is to be prepared for the facility. This is to outline Prevention, Preparedness, Response, and Recovery (PPRR) procedures for potential emergencies, of which bushfire is one component. ***Recommendation Details:*** The following details have been identified for inclusion within the Emergency Management Plan (and/or the Site Operating Procedures, as appropriate to the document structure): **Details and Information** • A summary of fire hazards and risks to and from the site, specific to its location, infrastructure, activities and occupancy. • A facility description, including infrastructure details, operations, number of personnel, and operating hours. • A site plan depicting structures/built assets, operational areas, site access points and internal roads, firefighting infrastructure, drainage (as applicable), and neighbouring properties.					

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Persons Onsite and Temporarily Offsite					

- Up-to-date contact details for facility personnel, including for at least two persons who may be able to provide information or support during emergencies (24 hours a day). Update contact information when necessary.
- Details of emergency resources, including fire detection and suppression systems and equipment; gas detection; emergency eye-wash and shower facilities; spill containment systems and equipment; emergency warning systems; communication systems; personal protective equipment; first aid.
- Contact information for 24/7/365 specialist technical support for the battery energy storage system.
- Specifications for safe operating conditions for temperature.
- Schematics and technical data for battery energy storage system containers/enclosures, the number of containers/enclosures on-site, and the number of battery racks or modules within each container/enclosure.
- Details of the hazards for the battery energy storage system, including thermal events/runaway, electrical safety hazards, explosion hazards, dangerous goods hazards (including off-gassing), and the effects of fire on the battery energy storage system (eg., explosion, release of toxic gases).
- Details of all provided battery failure/safety and protective systems, including a description, the activation process/automatic trigger, and any hazards associated with these systems.

Procedures

Prevention

- Smoking restrictions or designated smoking locations.
- Procedures regarding vegetation management and accidental ignition prevention.
- The specifications of Schedule 1 of the *Planning for Bushfire Guidelines* and the Shire of Kojonup Section 33 Notice can be achieved via livestock grazing. The vegetation must continue to be monitored for compliance with Schedule 1, and additional vegetation management works undertaken as required.
- Heavy equipment is not to be operated where long grass (>100mm) or heavy leaf litter is present, particularly during the bushfire season (see the Local Government Prohibited Burning Period).
- Servicing of battery energy storage systems should not take place on days of High, Extreme or Catastrophic Fire Danger Rating, except where the system is experiencing malfunction or abnormal behaviour.
- Bushfire response training should be provided to all permanent staff. Training should be scheduled at appropriate intervals, accounting for staff turnover and the complexity of firefighting equipment.

Preparedness

- Annual emergency exercises should be conducted. Contact the local emergency control agencies; the Shire Emergency Management Coordinator (CBFCO) for input/inclusion. Emergency exercises should include bushfire as a potential emergency scenario.

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Persons Onsite and Temporarily Offsite					

- Evacuation and shelter-in-place triggers and procedures, unless included within a Bushfire Emergency Plan.
- Procedures for review of the Emergency Management Plan, including the ongoing effectiveness of control measures.
- An ongoing schedule to contact the local emergency control agencies; Shire of Kojonup Emergency Services Manager and Chief Bush Fire Control Officer (CBFCO) prior to the bushfire season.
- The Emergency Management Plan and any Emergency Response Guide (FES-ERG) should contain procedures for isolation, shut-down, fail safe or management of critical/high-risk plant, equipment, and utilities, and their advised triggers.
- Visitors must provide mobile phone numbers to site management. Within the Emergency Management Plan, a key response will be to contact and advise all persons onsite. Site vehicles are required to have a secondary communication system installed (e.g. two-way radio).
- A bushfire monitoring procedure for the Restricted/Prohibited Burning Period (see Shire of Kojonup Section 33 Notice), including:
    - Nominating a person/role in your Emergency Control Organisation to be responsible for identifying, responding to, and communicating Fire Danger Ratings in advance.
    - Identifying bushfire activity within 10km of the facility.
    - Communicating this information to everyone likely to be present on-site, and relevant off-site personnel.
    - An outline of site activities to be modified or cease as a response (if any).

Response

DFES Comcen should immediately be notified of:

- Any shorts, faults, temperature increases above normal parameters (eg. precursor to thermal events/runaway).
- Equipment failures with the potential to ignite or propagate fire.
- Off-gassing, smoke or fire.
- The monitoring personnel can determine if Emergency Services response is necessary. The notification is for awareness.

Bushfire emergency response procedures must include:

- Evacuation and shelter-in-place triggers and procedures, unless included within a Bushfire Emergency Plan.
- Response procedures by Emergency Services (including Bushfire Brigades) should include the safe distances from asset fire to establish a containment perimeter to monitor and respond to potential bushfire ignition.
- A specific action to notify (or verify notification) the Emergency Services, at the earliest possible stage of the emergency.

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Persons Onsite and Temporarily Offsite					
• The person or role responsible for making or verifying the notification. • The '000' number in the procedure. • Communicating with site personnel and supporting their physical relocation. Bushfire alerts within a 10km radius should be communicated to persons onsite. • Ensuring all buildings and plant are adequately secured. • Initiating any bushfire protection measures such as activating sprinkler or deluge systems or pre-emptive shut-down, prior to the arrival of the fire front. • Liaising with the emergency services where possible. • Consideration of arc flash risk due to bushfire smoke (transmission lines, substations).						
9.4	**Operational Documents are to Contain the Bushfire Protection Measures to be Implemented:** The documents include the 'planning' or 'operational' Bushfire Management Plan (BMP), the Bushfire Emergency Plan (BEP), the Site Emergency Plan and any relevant documents associated with a projects design phase. The purpose of this measure is to ensure the application of applicable protection measures identified in this Report, will be acted upon through responsibilities created within the operational documents.	High	Yes	No	Yes	Yes
Assessment Comments: A 'planning' Bushfire Management Plan has been prepared alongside this Bushfire Risk Report. Requirements for the Emergency Management Plan are provided in **Measure 9.3**. ***Recommendation Details:*** See **Measure 13.22**						
9.5	**Prominent Display of Bushfire Emergency Information:** The relevant format and content of the site-specific bushfire emergency response information, taken from the planning developed for a bushfire emergency, is made readily available to all persons on site.	Medium	Yes	No	Yes	No
Assessment Comments: Staff and contractors will move throughout the site but will be contactable through the messaging system in **Measure 9.6**. Staff within the Operations and Maintenance Building will have access to and training in the Site Emergency Plan. General emergency information will be displayed, not specifically bushfire. ***Recommendation Details:*** Not Applicable						
9.6	**Direct to Persons Emergency Messaging System:** Have a process and system (e.g. SMS) for site managers to provide persons onsite and temporarily offsite with emergency information as necessary. Consideration will need to be given to availability and reliability of the infrastructure that is to facilitate this system.	Medium	Yes	Yes	Yes	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Persons Onsite and Temporarily Offsite					
Assessment Comments: Vulnerability and exposure of persons remote from the Operations and Maintenance Building (inspection/maintenance) can be managed through appropriate communication and emergency procedures. Staff, contractors, and visitors must provide mobile phone numbers to site management. Within the Emergency Management Plan, a key response will be to contact and advise all persons onsite. Bushfire alerts within a 10km radius should be communicated to persons onsite. ***Recommendation Details:*** Site personnel should download the EmergencyWA app, be trained in its use and information provided in the app. The app should be referred to prior to travelling to or from the site.						
9.7	**An Alternative Internet and Mobile Phone System is Available:** Establish and maintain an appropriate alternative system to ensure the required capabilities for emergency communication and access to emergency information will be retained if there is an outage of the primary communication system. This includes direct to satellite connections for voice and data.	Medium	Yes	No	No	No
Assessment Comments: **Measure 9.6** ensures persons onsite will be contactable. ***Recommendation Details:*** Not Applicable						
9.8	**Egress Pathway Signage:** Where pathways exist onsite for occupants to relocate to an identified safer onsite location, appropriate signage to guide unfamiliar persons can reduce their vulnerability.	Medium	Yes	No	No	No
Assessment Comments: Any persons onsite will have rapid vehicle access and are likely to be familiar with the site. Persons will proceed to the Operations and Maintenance Building to shelter or site access point to evacuate. ***Recommendation Details:*** Not Applicable						
9.9	**Personnel are Trained to Implement the Bushfire Emergency Plan:** Operational persons (staff) are provided with appropriate training, aligned with the subject site's prepared Bushfire Emergency Plan (BEP). The process will also identify specific roles and persons to fill those roles.	High	Yes	No	Yes	No
Assessment Comments: All staff are required to be familiar with the site Emergency Management Plan. The limited staffing does not necessitate specific roles beyond Chief Warden. ***Recommendation Details:*** Not Applicable						
9.10	**Build Community Resilience Through Education:** When relevant to the type and scale of proposed development/use, the delivery of effective community education programs, to ensure information is acted upon and packages of protection measures are put in place, will result in lowering the vulnerability of the community to a bushfire event.	High	Yes	No	Unknown	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Persons Onsite and Temporarily Offsite					
	Local government develops an ongoing program of innovative and leading-edge community and landowner education that builds on the information presented within this Report. Implementation of recommended/required protection measures can be encouraged through legislation, education, audits, enforcement, and penalties as appropriate. Examples of such community education programs exist in various jurisdictions. The CSIRO (2020) Climate and Disaster Resilience Overview Report in 'Recommendation No. 5' [18] encourages collaboration with research agencies on the issue of building community resilience.					
Assessment Comments: Community attitudes towards the proposed development may be impacted where the proponent attempts to provide community education on potential emergencies. Additional education will be provided to local Emergency Services in Measure 9.3. ***Recommendation Details***: An information package detailing emergency considerations and response should be provided to landowners (lessors) for the Project. The proponent may optionally consider extending this information to neighbouring landowners or the local community.						
9.11	**Encourage 'Property Bushfire Resilience Assessments'**: Local government to promote (and potentially incentivise) the conducting of these assessments and the implementation of any recommendations. These assessments address bushfire hazard threat levels and the level of exposure and vulnerability of specific buildings and persons. It identifies appropriate protection measures that can be implemented to increase bushfire resilience.	High	No	Partly	No	No
Assessment Comments: Not relevant to a commercial operation. Bushfire resilience of private dwellings can be applied through the contents and enforcement of the Shire of Kojonup Section 33 Notice. ***Recommendation Details***: Not Applicable						
9.12	**Locations of Vulnerable Persons are Registered:** Relevant department of local government and their emergency services maintains a register of the location of land uses that are likely to result in a number of 'vulnerable' persons (see Glossary) residing onsite, so that their needs can be addressed as a priority in a bushfire emergency. The subject development/use would exist on that register.	Medium	N/A	N/A	N/A	N/A
Assessment Comments: No 'vulnerable' persons will be onsite. ***Recommendation Details***: Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Persons Onsite and Temporarily Offsite					
THE PROTECTION MECHANISM – ONSITE PERSONS CAPABLE OF MANAGING A BUSHFIRE EMERGENCY ARE AVAILABLE						
9.13	**Onsite Persons Available to Manage Bushfire Emergency Procedures:** Different categories of persons can perform this role in different scenarios, with potentially varying levels of expertise and effectiveness. These include: • Appropriately trained person(s) will be onsite at all times, or able to be onsite at short notice. They are trained in bushfire emergency procedures in general and have specific knowledge of the site's Bushfire Emergency Plan, and the environment in which the development/use exists. This person(s) may have the official title of fire warden. • An untrained person familiar with the local area will be onsite at all times. They have knowledge and instruction gained from the site's Bushfire Emergency Plan and can implement the required procedures. They can guide and assist persons onsite.	High	Yes	No	Yes	Yes
Assessment Comments: Emergency management arrangements are discussed in **Measure 9.3.** All staff are required to be familiar with the site Emergency Management Plan. The limited staffing does not necessitate specific roles beyond Chief Warden. ***Recommendation Details:*** See **Measure 9.3**.						
9.14	**Onsite Persons Can Operate Firefighting Equipment:** Such person(s) is suitably capable of maintaining and operating any installed firefighting water supply and associated pumps, hoses/nozzles and sprinklers.	Medium	Yes	No	Yes	No
Assessment Comments: Through the Emergency Management Plan, all facility team members are required to be trained in the use of fire extinguishers and firefighting equipment. ***Recommendation Details:*** Not Applicable						
9.15	**External Emergency Response Services Available:** An emergency service with a bushfire response capability is located within a realistic operational distance of the subject development/use. This includes services provided by government (e.g., career fire and rescue services or other agencies) and volunteer services. Note: The services of these limited resources should not be relied upon, as their availability for a given event can be compromised by other obligations at the crucial time. *Bushfire Verification Method – Handbook s6.6 [14] states "During significant bushfires, there will be conflicting demands on fire brigade resources and reliance should not be placed on fire brigade intervention to protect a specific property.* *Prior to the 2009 Black Saturday fires, an early evacuation or stay and defend policy was in place and data from major fires indicated that the presence of occupants significantly increased the probability of house survival (refer Table 7.1). However, in response to the subsequent Royal Commission findings there is now a greater emphasis on early evacuation.*	Medium	Yes	Yes	No	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Persons Onsite and Temporarily Offsite					
	Whilst this is expected to reduce fatalities by reducing the numbers of people at risk, a negative consequence will be an increase in property losses for buildings constructed to similar standards. It should therefore be assumed that there will be no fire brigade or occupant intervention with respect to protecting a specific property."					

***Assessment Comments**:* The site is near Kojonup townsite, and thus local bushfire brigades may attend during an emergency. Career emergency services may not attend due to the distance from career FRS.

***Recommendation Details**:* Contact the local emergency control agencies; Shire of Kojonup Emergency Services Manager and/or Chief Bushfire Control Officer (CBFCO) prior to commissioning and offer a familiarisation visit and explanation of emergency procedures, access, hazards, and fire detection and suppression systems.

Local VFRS and BFB may be invited through the Shire Emergency Management Coordinator (CBFCO). The particular services should be determined by the CBFCO. Establish an ongoing schedule to contact the Shire Emergency Services Manager and/or CBFCO prior to the bushfire season.

Contact DFES Built Environment Branch to determine if an Emergency Response Guide (FES-ERG) is required.

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining.

Note 2: Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use.
- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Currently Planned:** Protection measures that:
    - Are incorporated into the site plans;
    - Exist in an approved Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), alternative solutions and any additional recommended protection measures - for which a responsibility for their implementation has been created and approved; and/or
    - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

  These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Additionally Recommend:** Protection measures that:
    - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk:	Persons Onsite and Temporarily Offsite					
• Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP. These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).						

5.4.1.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing vulnerability levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the vulnerability of the relevant element at risk to bushfire hazard threats.

VULNERABILITY REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Persons Onsite and Temporarily Offsite						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Transport and multiple evacuation destinations and routes available	Very High	2	1	2			
	High						
	Medium						
	Not Relevant						
Provision of bushfire emergency information and education	Very High						
	High	5	4		1	3	3
	Medium	5	4	1		2	1
	Not Relevant						
Onsite Persons Capable of Managing a Bushfire Emergency Are Available	Very High						
	High	1	1			1	1
	Medium	2	2	1		1	1
	Not Relevant						
Number Analysis	Very High	2	1	2			
	High	6	5		1	4	4
	Medium	7	6	2		3	2
	Not Relevant						
	Totals	15	12	4	1	7	6

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.4.1.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE VULNERABILITY

From the information presented in the previous section, the vulnerability reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce vulnerability (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE VULNERABILITY TO BUSHFIRE HAZARD THREATS [1]	
Element at Risk	Persons Onsite and Temporarily Offsite
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]	WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]
Significant	Very Significant

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This vulnerability reducing potential will be applied to deriving the inherent vulnerability level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This vulnerability reducing potential will be applied to deriving the residual vulnerability level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Assessment Comments: Persons are vulnerable to radiant heat, flame contact, and smoke exposure only. Staff will be trained in emergency procedures and response as a 'Planned' measure.

The recommended measures include communication and awareness.

5.4.1.4 DERIVED VULNERABILITY LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual vulnerability levels.

In combination with the corresponding assessed threat and exposure levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL VULNERABILITY LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]				
ELEMENT AT RISK	Persons Onsite and Temporarily Offsite			
INHERENT VULNERABILITY LEVEL (CURRENT STATE) [2]				
Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐
THE RESIDUAL VULNERABILITY LEVEL (POTENTIAL FUTURE STATE) [2]				
Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

5.4.2 PERSONS ON ACCESS/EGRESS ROUTES IN VEHICLES

5.4.2.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons on Access/Egress Routes in Vehicles	Access/Egress Route ID	Local road network including internal roads			
THE PROTECTION MECHANISM – LOWER RISK ROAD CONSTRUCTION (DESIGN AND MATERIALS): The application of as many of the following protection measures as possible ensures a greater level of safety for users and lowers the associated risk when roads need to be used to evacuate to a safer offsite location in potentially high stress situations within a threatening environment. Safety for persons using the route is increased through reducing the likelihood of vehicle/terrain or vehicle/vehicle accidents and the ability to maintain travelling speed.						
10.1	**Greater Road Width:** Ensure appropriate width roads are installed. Wider roads allow safer passing of the anticipated traffic that can be travelling in both directions (e.g. emergency services travelling towards the emergency event). The effectiveness of road width to reduce vulnerability is also a function of the required carriage capacity - which may be increased by the proposed development/use when it will increase traffic intensity. The incorporation of non-vegetated and trafficable road verges/shoulders and adjacent footpaths can also be considered to increase effective width for slower moving vehicles (providing additional separation from the hazard and passing opportunities).	High	Yes	No	Yes	No
***Assessment Comments**:* Collie-Changerup Road is generally 8m wide, with a with a non-vegetated clearance of >12m including shoulders. Tunney Road is approximately 6m wide and has vegetated shoulders, so does not provide additional clearance. Internal access will be constructed to 4m wide with passing bays installed in compliance with the Planning for Bushfire Guidelines. These roads will be bounded by cleared areas (pasture) and thus the verge will frequently be traversable. Additional width has not been applied due to the limited occupancy of the site. ***Recommendation Details**:* Not Applicable						
10.2	**Lower Road Gradient:** Ensure appropriate road gradients are available. Lower gradients help ensure traction and speed can be maintained. Steep gradients can also be associated with driver visibility. Appropriate gradients will depend on the constructed surface materials and the weights and tractive capability of expected vehicle types.	Medium	No	Yes	No	No
***Assessment Comments**:* External public roads and the subject site (with internal roads to be constructed) would rarely exceed 5 degrees, if at all. See Figure 5.3. ***Recommendation Details**:* Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons on Access/Egress Routes in Vehicles	Access/Egress Route ID	Local road network including internal roads			
10.3	**Greater Road Clearance:** Ensure appropriate clearance can exist and is established. Sufficient horizontal and vertical clearances from obstructions ensure unhindered movement of all possible vehicle types;	Medium	Partly	Partly	No	Yes
Assessment Comments: Trees will not bound the internal access except toward the site access point. There are no expected obstructions, and the surrounds is trafficable pasture. The road verge externally has >1m shoulders providing ample carriageway clearance. ***Recommendation Details:*** See **Measure 13.17.**						
10.4	**Stable Road Surfaces:** Ensure that roads are constructed of materials that will provide the necessary traction (also a function of gradient), can support the weight of all expected vehicle types and remain operational in all weather. The required supportive capacity also applies to associated structures such as bridges.	Medium	Yes	Yes	Yes	No
Assessment Comments: Collie-Changeroup Road is sealed major road and Albany Highway is a national highway. Tunney Road is unsealed and maintained in fair condition and with relatively flat surface. Internal roads will be all-weather surfaces, which may not be sealed. The internal roads will be constructed to exceed the 15-tonne weight capacity within the *Planning for Bushfire Guidelines* to support the delivery of site assets. ***Recommendation Details:*** Not Applicable						
10.5	**Driver Visibility and Road Ahead Signage:** Ensure that road design provides high levels of visibility ahead (in the absence of smoke and embers) and informative signage indicating relevant 'up ahead' route information (includes information stating distance to turnaround area for narrow roads in more remote locations). Good visibility is associated with the avoidance of 'blind' corners and crests to the greatest extent possible.	Medium	No	Yes	No	No
Assessment Comments: Collie-Changeroup Road and Albany Highway are largely straight with gentle curves. Tunney Road has more curves with straight sections no less than 150m long. Road ahead signage is common. Trees follow roads closely and can obstruct visibility to the periphery. All major roads are sealed. Obscuring dust may be a consideration for Tunney Road, however Collie-Changeroup Road is the primary evacuation route. ***Recommendation Details:*** Not Applicable						
10.6	**Shorter Road Length:** Shorter distances to safer locations reduce the length of time persons remain vulnerable to bushfire threats.	High	No	Yes	No	No
Assessment Comments: Collie-Changeroup Road and Albany Highway provide highly effective egress from the immediate area. The Kojonup townsite is approximately 4.2km from the site.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons on Access/Egress Routes in Vehicles	Access/Egress Route ID	Local road network including internal roads			
Recommendation Details: Not Applicable						
10.7	**Interconnected Road Network to Provide Route Options:** Ensuring that the design of the road network provides through roads and avoids dead-end roads, provides the choice of alternative routes to for minimising close contact with a bushfire event. Otherwise, vehicles and persons can be trapped.	Very High	No	No	Yes	Yes
Assessment Comments: The local road network has alternative access options immediately available. The *CFA Guidelines* Section 4.2 recommends provision of 2 access points into each part of the facility. An access point onto both Collie-Changerup Road (north) and Tunney Road (east) are included within the submitted design. ***Recommendation Details:*** Access points will be gated but should be openable in the same manner (the same key, keycard, access code, remote etc). Internal roads (driveways) accessing site assets are to comply, at a minimum, with the specifications for Private Driveways within the *Planning for Bushfire Guidelines.*						
THE PROTECTION MECHANISM – EVACUEES ARE SELF-SUFFICIENT AND HAVE LOCAL AWARENESS AND OWN TRANSPORT: The 'type' of persons that will be present on the site of the proposed development/use influences their degree of vulnerability to both bushfire threats and to risk associated with vehicular accidents in a stressful environment. Persons that have local knowledge, are self-supportive, have their own transport and are physically and mentally capable present the lowest degree of vulnerability for this factor. This contrasts with persons who can be considered 'vulnerable' and are likely to be less capable or effective at making the required decisions and carrying out the required actions in the timeframe required. They are likely to be dependent on others for both information and transport and will not have any local knowledge.						
10.8	**Self Sufficient Persons with Local Awareness:** The site use and location increase the likelihood these are the type of persons that will be present on the site.	High	Yes	Yes	No	No
Assessment Comments: Staff will be familiar with the local area. Contractors or visitors may have limited awareness, however the site access and contextual location are simple and clear. ***Recommendation Details***: Not Applicable.						
10.9	**Onsite Persons Have Own Transport:** There is no need to have arrangements in place for external provision of evacuation vehicles. Transport will always be available.	High	Yes	Yes	No	No
Assessment Comments: Occupants will have site or personal vehicles available. The site does not have public transport access and is too remote for practical walking access (1 hr walk from Kojonup). Bicycle access is possible, but evacuation would remain possible due to the short distance (15 min travel to Kojonup). ***Recommendation Details***: Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS				Effectiveness Rating [1]	Application Status [2]			
					Possible	Exists	Planned	Additionally Recommend
Element at Risk	Persons on Access/Egress Routes in Vehicles	Access/Egress Route ID	Local road network including internal roads					

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining.

Note 2: Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use.
- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Currently Planned:** Protection measures that:
    - Are incorporated into the site plans;
    - Exist in an approved Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), alternative solutions and any additional recommended protection measures - for which a responsibility for their implementation has been created and approved; and/or
    - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

  These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Additionally Recommend:** Protection measures that:
    - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or
    - Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP.

  These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).

5.4.2.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing vulnerability levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the vulnerability of the relevant element at risk to bushfire hazard threats.

VULNERABILITY REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Persons on Access/Egress Routes in Vehicles						
Access/Egress Route ID	Local road network including internal roads						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Lower Risk Road Construction (Design and Materials)	Very High	1		1		2	1
	High	2	1	1			
	Medium	4	2	3	1	1	1
	Not Relevant						
Evacuees are Self-Sufficient and Have Local Awareness and Own Transport	Very High						
	High	2	2	2			
	Medium						
	Not Relevant						
Number Analysis	Very High	1		1		2	1
	High	4	3	3			
	Medium	4	2	3	1	1	1
	Not Relevant						
	Totals	9	5	7	1	3	2

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.
Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.4.2.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE VULNERABILITY

From the information presented in the previous section, the vulnerability reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce vulnerability (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE VULNERABILITY TO BUSHFIRE HAZARD THREATS [1]	
Element at Risk	Persons on Access/Egress Routes in Vehicles
Access/Egress Route ID	Local road network including internal roads
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]	WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]
Significant	Very Significant

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This vulnerability reducing potential will be applied to deriving the inherent vulnerability level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This vulnerability reducing potential will be applied to deriving the residual vulnerability level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Assessment Comments: Persons and vehicle types are of relatively low vulnerability. The road network provides highly effective access/egress options. The Kojonup townsite is close to the site, and alternative options are available by continuing through the public road network.

5.4.2.4 DERIVED VULNERABILITY LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual vulnerability levels.

In combination with the corresponding assessed threat and exposure levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL VULNERABILITY LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]				
ELEMENT AT RISK	Persons on Access/Egress Routes in Vehicles			
Access/Egress Route ID	Local road network including internal roads			
INHERENT VULNERABILITY LEVEL (CURRENT STATE) [2]				
Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐
THE RESIDUAL VULNERABILITY LEVEL (POTENTIAL FUTURE STATE) [2]				
Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐

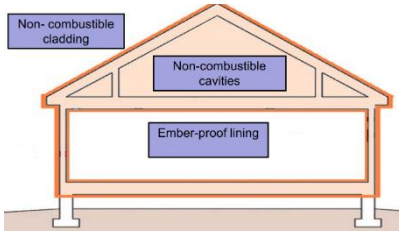
Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

5.4.3 BUILDINGS AND STRUCTURES (NCC CLASSES 1-10)

5.4.3.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
THE PROTECTION MECHANISM – CONSTRUCTION DESIGN AND MATERIALS: Increase bushfire resilience through the application of beneficial design and construction, including using non-combustible materials and minimising the use of vulnerable materials, to the greatest extent possible. Practicality and cost will be key considerations in determining the viability of applying protection measures in differing scenarios, but this should be determined with due consideration of threat levels and the importance of the elements at risk. The constructed systems should utilise the following properties to the greatest extent possible: **reliability** (which requires their durability over time, low maintenance and being unlikely to change over time), **robustness** (which limits damage spread from minor sources, continues to protect when thermally loaded and protects vulnerable elements), **resilience** (which enables their return to a functional state following an overload) and **redundancy** (which ensures the fate of the subject building/structure is not reliant on the effective performance of a single element). Refer to the glossary for additional explanation. The mechanism is also applicable to constructed consequential fire fuels.						
11.1	**Construct to AS 3959:2018 [4]:** Apply the specified requirements to construction. These are intended to reduce the risk of building ignition from bushfire direct attack mechanisms. Note that the indirect attack mechanisms and the threats presented by consequential fire fuels are not specifically considered. *"The standard is primarily concerned with improving the ability of buildings … to better withstand attack from bushfire thus giving a measure of protection to the building occupants (until the fire front passes), as well as to the building itself".* The AS 3959 approach adopts a strategy that relies on the integrity of the building's exterior envelope (i.e., the cladding of roof/wall/eaves, floor supporting structures/flooring and all penetrations) to resist all bushfire exposure conditions and environmental actions thereby protecting all structural construction elements behind it, including allowable combustible materials. It provides protection by: • Using specified materials that provide ignition resistance (tolerance of radiant heat and flames). Higher BAL ratings impose increased construction requirements for these exterior envelope materials; • Specifying precise gap control (applicable to all bushfire attack levels) for the exterior envelope of the building to prevent ember entry); and • Attached and adjacent structures (within 6m) must also comply with the Standard.	High	Yes	No	No	Yes
***Assessment Comments**:* Warehouses/workshops may be unable to comply with AS 3959 construction.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
Class 4-9 buildings are not required to apply bushfire resistant construction via part G5 or H7 of the NCC. However, it is recommended that these buildings comply with AS 3959 or NASH where it is possible for the building type to comply. The provisions for the on-site shelter building is assessed in Measure 2.11. ***Recommendation Details:*** All permanent Class 1-9 buildings are required to apply bushfire resistant construction following their assessed BAL under AS 3959. The standard of construction may align with AS 3959 (to a minimum of BAL-12.5) or NASH Steel Framed Construction in Bushfire Prone Areas. See Figure 3.2 of the associated Bushfire Management Plan. The Operations and Maintenance Building has been designated as an on-site shelter building and must be constructed to AS 3959 requirements for BAL-29 and have a minimum internal floor area equal to 1m^2 per proposed person (e.g. 24m^2 for 24 workers).						
11.2	**Construct to NASH Standard [33]:** Apply the specified requirements to construction. The Standard: *"Sets out acceptable construction requirements for residential and low-rise buildings in bushfire prone areas to reduce the risk of ignition from bushfire attack involving embers, radiant heat and direct flame impingement using non-combustible materials. Buildings constructed in accordance with this Standard are intended to provide a sheltering envelope during the passage of a bushfire flame front. They do not constitute 'last resort' private bushfire shelters as defined in the NCC. The Standard is based on achieving ignition resistance through non-combustible construction using conventional building materials and a level of redundancy to provide a high level of performance in extreme bushfire events and an increased probability that unattended buildings will survive such events."* Key attributes of the Standard include: • Materials used anywhere on the building envelope (see shaded part of diagram below), must be non-combustible except for a small amount allowed externally that includes flooring, window frames, doors and external decorative trim. The building envelope is comprised of a framed roof/ceiling system, an external wall system and a floor system;  	Very High	No	No	No	No

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
	• The same construction requirements apply for all BAL ratings up to BAL-40 (except for external doors and windows which apply AS 3959 requirements). An additional benefit of this is the built in resistance to the direct attack mechanisms of consequential fire when lower BAL ratings apply. • It does not rely on eliminating ember entry to the roof space, wall cavities and floor system as these are non-combustible construction. Embers only need to be kept from entering the internal living/operating spaces. • It is ember tolerant without unrealistic workmanship, supervision and maintenance requirements; • The combination of a non-combustible cladding and cavities is a robust solution that enables the building to be configured so that failure or damage to one element does not lead to the inevitable failure of the building or a breach of the habitable envelope; and • Attached and adjacent structures (within 6m) must also comply with the Standard.					
Assessment Comments: NASH may be considered as an alternative standard for steel-framed construction rather than AS 3959. ***Recommendation Details:*** Not Applicable						
11.3	**Construction Materials for External and Internal Cavity Building Elements:** Except for internal living or operation spaces, to the degree necessary, utilise materials resistant to fire attack mechanisms of flame and radiant heat (preferably non-combustible) for all relevant building elements, including wall, roof, floor, supporting structures and framing systems.	Very High	Yes	No	Unknown	Yes
Assessment Comments: Any workshops/warehouses will be steel framed and entirely non-combustible (likely masonry, steel, aluminium, and cement sheeting) ***Recommendation Details:*** For any future Class 1-10 buildings, include non-combustible structural elements where practical. In particular, avoid: polycarbonate (sheeting and skylights), softwoods (<650 kg/m3 density at 12% moisture content), and fibrous materials.						
11.4	**Construction Materials for Consequential Fire Fuels:** For constructed large consequential fire fuels, use non-combustible materials to the fullest extent possible. Potential fuels include: • Landscaping items – fences, screens, retaining walls, gazebos, plastic water tanks etc; • Attached structures - decks, verandahs, stairs, carports, garages, pergolas, patios, etc; • Adjacent structures – other houses, sheds, garages, carports, etc. Post bushfire event assessments identify structure to structure fire as a common cause of overall building loss [9].	High	Yes	Partly	No	No

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
Assessment Comments: Potential large fuels are not known (other than assets assessed in Report) and are unlikely to be present due to the proposed use. Potential large, constructed fuels are assessed in **Measure 4.7**. ***Recommendation Details***: Not Applicable						
11.5	**Construction Design / Materials Resistant To High Wind Damage:** Apply construction measures to prevent the type of building damage from wind that will open or create gaps (from the wind itself or carried projectiles) and allow the entry of embers, radiant heat and flames. This type of damage is typically superficial damage. Building codes relating to wind (e.g., cyclones) do not necessarily address this superficial type of impact. Additional fixings for building envelope claddings and protection of the most vulnerable elements, such as glazing, from debris impact, are key considerations. Consider applying the principles of the NASH Standard [33] design solution to construction. "Potential wind effects directly associated with bushfire events have been considered in this Standard. Wind actions may affect buildings subject to a bushfire attack in various ways including: • The intensity of flame front activity may produce locally high wind pressures on parts of the building; • In the post fire phase, some weakened components on the building envelope may be vulnerable to normal design pressures; and • Wind can drive embers into the building envelope." Most applicable when the physical requirements exist for the development of an extreme bushfire event within the surrounding landscape.	Medium	Yes	Partly	No	No
Assessment Comments: Wind is unlikely to cause sufficient damage to create a vulnerability to embers given the setback from vegetation. Increased structural requirements to account for high wind have not been applied, as Class 1-9 buildings are required to comply with the NCC and Class 10 buildings do not have practical measures available to reduce this vulnerability. ***Recommendation Details***: Not Applicable						
11.6	**Construction of Gas Supply:** All gas cylinders are installed and maintained in accordance with AS 1596 (for domestic house supply) as a guide. The requirement of the standard includes: • Safety release valve shall be directed away from the building and persons access/egress routes;	Medium	Yes	No	Yes	No

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
	• Metal piping and fittings shall be used on all piping inside the building's cavities and enclosable occupied spaces and the high-pressure side of any gas regulators; and • Tethers securing cylinders are to be non-combustible. The objective is to reduce the risk of consequential (secondary) fire against a building and reduce the risk of death or injury, from gas flaring or explosion. The rationale is gas cylinders which have either flared or ruptured are commonly found in post bushfire surveys [9]. The heat from the bushfire or consequential (secondary) fire has been sufficient to cause their pressure to reach critical levels beyond which their pressure release valve releases large quantities of LP gas. If these gas cylinders fall over, this pressure release valve may no longer function correctly, meaning that the gas cylinder may continue to increase in pressure with continued heating until the cylinder ruptures. The resulting explosion includes a pressure wave and large ball of flame which can threaten nearby life and buildings. Readily available guidance is provided by CSIRO Best Practice Bushfire Guide (https://research.csiro.au/bushfire/new-builds/water-electricity-gas/) and WA Dept. Mines, Industry, Regulation and Safety 'LP Gas cylinder safety in bushfire prone areas' (https://www.commerce.wa.gov.au/publications/lp-gas-cylinder-safety-bushfire-prone-areas).					
Assessment Comments: Any gas cylinders will be stored in compliance with AS 1596. ***Recommendation Details***: Not Applicable						
11.7	**Construction of Electricity Supply:** Cabling to be shielded (includes installing underground within subject property boundary) from applicable bushfire attack mechanisms. The objective is to assist with continuity of supply for essential site operations and/or electrically driven firefighting pumps. It also reduces the risk of electrocution to any persons onsite and reduces potentially additional sources of fire ignition. It is common in bushfires for power infrastructure to burn and collapse or be impacted by falling trees or branches while power lines are still live. Removing this risk may be appropriate for some sites.	Medium	Yes	Yes	No	No
Assessment Comments: The site is for energy storage for use during power outages- the facility therefore is designed to operate regardless of interruptions to external electricity supply. The failure of external electricity would be due to impacts on transmission lines offsite rather than within the facility APZs. The only critical elements of the buildings are associated with site communications. The site has strong mobile phone reception and this is a minor concern. ***Recommendation Details***: Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
11.8	**Minimise Re-entrant Detail to Minimise Debris and Ember Accumulation:** Avoid or limit the accumulation of unburnt debris and embers by minimising re-entrant details and/or adopting aerodynamic forms that will self-shed windblown debris and embers. For example: • Simple building/structure footprints that avoid re-entrant corners in access ways, at wall/floor, wall/ground, roof/wall junctions and around doors, vents, windows; and • Simple roof layouts that avoid valleys and minimise the number of ridges that need protection details (e.g. skillion roofs).	Medium	Yes	Yes	No	Yes
Assessment Comments: Buildings will be simple rectangular structures without complex features. The Operations and Maintenance Building is likely to be a transportable building including wall-mounted rather than ground air conditioners. Access ramps may allow for debris accumulation. ***Recommendation Details:*** See **Measure 13.11.**						
11.9	**Minimise Debris and Ember Trapping Surfaces:** Avoid or minimise the use of exposed combustible surfaces that can trap and accumulate debris and embers. These include: • Horizontal, or shallow angle surfaces e.g. exposed wall/roof framework, roofs, decking, verandahs, steps, windowsills; and • Vertical surfaces with rough textured cladding (e.g. sawn timber).	Medium	Yes	Yes	No	No
Assessment Details: Shallow angle surfaces are unlikely to be present on steel-framed class 10a or transportable structures. Where present, these will not be combustible. ***Recommendation Details***: Not Applicable						
11.10	**Protect Roof Plumbing to Minimise Debris and Ember Accumulation:** All roof plumbing (gutters, valleys) is protected from the accumulation of debris and embers that can result in direct fire attack mechanisms immediately adjacent to any combustible elements within the roof cavity.	Medium	N/A	N/A	N/A	N/A
Assessment Comments: **Measure 4.4** establishes trees >6m tall should not be retained/planted within 10 of assets. There will be no debris to protect roof plumbing from. ***Recommendation Details***: Not Applicable						
11.11	**Minimise Construction Cavities to Minimise Debris and Ember Accumulation:** Apply designs that lower the potential for accumulation of embers and debris within cavity spaces of buildings/structures. Examples include concrete floor slab on the ground and solid masonry walls.	Medium	Yes	Yes	No	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
Assessment Comments: Buildings will be simple rectangular structures without complex features. ***Recommendation Details:*** **See Measure 13.11**						
11.12	**Minimise External Openings to Limit Flame/Radiant Heat/Ember/Debris Entry:** Limit potential sites for threat entry through the external building envelope to internal spaces containing combustible materials (consequential fire fuels). Examples include reducing windows/doors on elevations facing the bushfire hazard and apply design to limit gaps and penetrations that will require screening.	Medium	Yes	Partly	No	Yes
Assessment Comments: Warehouse/workshop buildings (if required) will likely have numerous entries and roller doors. The Operations and Maintenance Building (transportable building) will likely have 1-3 external doors and numerous windows. ***Recommendation Details:*** Review the design of warehouse/workshop buildings to ensure they can be fully enclosed.						
11.13	**Screen and Seal Gaps and Penetrations:** Apply fire rated sealants and/or install metal screening (corrosion resistant steel, bronze, aluminium <2mm aperture). All external construction and penetration gaps with apertures greater than 2mm will allow ember entry (and potentially debris) to internal cavities and combustible materials within (as consequential fire fuels). This includes gaps in roofs, walls, doors, windows and their surrounding trims – including those associated with penetrations, vents, weepholes, poor workmanship and material deterioration and movement over time (maintenance). Internal fire is difficult to see and extinguish.	Medium	Yes	No	Yes	Yes
Assessment Comments: The measure is applied through construction to AS 3959 in **Measure 11.1.** ***Recommendation Details:*** Workshop/warehouse buildings (if required) are recommended to have ember screening/sealants installed on any gaps, penetrations, and external glazed elements. Ember screening mesh is to be maximum 2mm aperture and composed of corrosion-resistant steel, bronze, or aluminium.						
11.14	**Screen External Doors and Windows**: Metal screens (corrosion resistant steel, bronze, aluminium <2mm aperture) installed over non-openable and/or openable parts of windows and doors to prevent ember entry to internal spaces containing combustible materials (consequential fire fuels) and reduce radiant heat load on vulnerable surfaces.	Medium	Yes	No	Yes	No
Assessment Comments: Screening will only be applied where required by AS 3959 construction standards. ***Recommendation Details:*** Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
11.15	**Shutter External Doors and Windows**: Fire rated shutters are installed to significantly increase bushfire resistance of the vulnerable building elements.	Medium	Yes	No	No	No
Assessment Comments: Screening will be applied rather than shutters (BAL-12.5 or 29 construction). ***Recommendation Details:*** Not Applicable						
THE PROTECTION MECHANISM – AVAILABILITY OF A FIREFIGHTING RESPONSE CAPABILITY: Provide sufficient and reliable dedicated firefighting water supply and delivery capability as necessary for installed active and/or passive systems.						
11.16	**Firefighting Water Supply:** Have a dedicated static supply of firefighting water for the protection of buildings/structures before and after the passage of a bushfire front. Adequate water supply is critical for any firefighting operation, particularly where property protection is the intent. This is necessary when: • A water supply additional to a reticulated water supply is required to counter the loss of firefighting water as a protection measure, should the reticulated supply be interrupted; and • It is the only source of firefighting water. All tanks shall be non-combustible. Aside from losing water, failure of combustible tank can provide an additional heat or load to a vulnerable building element. Metal piping and fittings shall be used for any above ground components. The limitation to the effectiveness of the measure is the requirement for persons to be present and have the minimum required operational knowledge and/or access to appropriate information.	High	Yes	No	Yes	Yes
Assessment Comments: The Operations and Maintenance Building will require a firefighting water supply calculated following the *Planning for Bushfire Guidelines*, based on number of buildings and floor area. The Operations and Maintenance Building will be supplied through the same water capacity required for the BESS development. ***Recommendation Details:*** The aggregate water supply requirements for the proposal have been applied within a single measure. **See Measure 13.17.**						
11.17	**Firefighting Equipment Actively Operated:** In addition to a dedicated water supply, appropriate mobile firefighting appliances are available quickly and/or fixed firefighting equipment is installed (pumps, hoses, sprinklers etc). Where equipment is installed, this will be resilient to bushfire impact, to the extent necessary, through the application of appropriate equipment materials and protection (shielding or separation from the hazard). The limitation to the effectiveness of the measure is the requirement for persons to be present and have the minimum required operational knowledge and/or access to appropriate information.	High	Yes	No	Yes	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
Assessment Comments: The firefighting operations for the proposal have been assessed and discussed within a single measure. ***Recommendation Details:*** See **Measure 13.18.**						
11.18	**Fire Fighting Equipment Passively Operated:** In addition to a dedicated water supply, appropriate water dispensing apparatus are installed (e.g. pumps, plumbing and sprinklers) that are automatically activated. These will be resilient to bushfire impact, to the extent necessary, through the application of appropriate equipment materials and protection (shielding or separation from the hazard).	High	Yes	No	Unknown	No
Assessment Comments: Passive fire protection is possible; however the Operations and Maintenance Building is required to be constructed to AS 3959 and any workshops/warehouse buildings will be of non-combustible construction, and both require an APZ appropriate to their design/use (BAL-29 or <10kW/m^2). There will be few vulnerable components where passive fire protection would be appropriate. ***Recommendation Details:*** Not Applicable						
11.19	**Fire Fighting Equipment Operability Maintained:** Where water pumps, shutters or other active/passive protection measures rely on the continued supply of electricity, establish barriers (shielding) or separation from potential damaging factors (e.g. falling trees/branches, fire, or other impact sources). For example, bury transmission systems to the greatest extent possible.	High	Yes	No	Unknown	Yes
Assessment Comments: *DFES Guidance Note: Firefighting Water Supply Considerations for Special Hazard & Dangerous Goods Sites* has been considered in the design of the firefighting water supply. The site will have an independent power supply through either the onsite BESS or generators. ***Recommendation Details:*** See **Measure 13.20.**						
11.20	**Access via Firebreaks Provided:** Installation and maintenance of firebreaks to facilitate firefighting access / backburning (and limiting surface fire progression).	Medium	Yes	Yes	Yes	Yes
Assessment Comments: Direct access to classified vegetation areas will be available via the internal access network. Early engagement with DFES recommended fire service access between the western vegetation screen and the power line easement. The Operations and Maintenance Building will have access roads installed, and the BESS and Substation footprint will be a trafficable hardstand. The Operations and Maintenance Building will likely (but is not required) to be installed on a hardstand. Firebreaks are required by the Shire of Kojonup Section 33 Notice. Some firebreaks may be upgraded to function as part of the internal road network.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
Recommendation Details: Not Applicable						
THE PROTECTION MECHANISM – MANAGE AND MAINTAIN EFFECTIVENESS OF APPLIED PROTECTION MEASURES: To ensure the retention of the level of bushfire resilience that has been established through the implementation of appropriate bushfire protection measures, formal and enforceable responsibilities are created.						
11.21	**Formal Documents Created to Guide and Enforce Management:** Through relevant site operations document(s) and/or an enforceable agreement, regulation or standard, a mechanism is put in place to ensure that: • The required management and maintenance of applied bushfire protection measures is conducted on a regular basis – with the interval dependent on the necessary frequency that will maintain full effectiveness; • The relevant protection measures are known and understood; and • Responsibilities are created.	High	Yes	Partly	Yes	Yes
Assessment Comments: The documents have been or will be produced. Section 6.1 of this Bushfire Risk Report includes the operational documents to include bushfire protection measures. ***Recommendation Details***: See **Measure 13.22.**						

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining.

Note 2: Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use.
- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Currently Planned:** Protection measures that:
  - Are incorporated into the site plans;
  - Exist in an approved Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), alternative solutions and any additional recommended protection measures - for which a responsibility for their implementation has been created and approved; and/or
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

  These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Additionally Recommend:** Protection measures that:

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
• Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or • Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP. These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).						

5.4.3.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing vulnerability levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the vulnerability of the relevant element at risk to bushfire hazard threats.

VULNERABILITY REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Construction Design and Materials	Very High	2	1				1
	High	2	2				1
	Medium	11	10	4	2	3	4
	Not Relevant						
Availability of a Firefighting Response Capability	Very High						
	High	4	4			2	4
	Medium	1	1	1		1	
	Not Relevant						
Manage and Maintain Effectiveness of Applied Protection Measures	Very High						
	High	1	1		1	1	1
	Medium						
	Not Relevant						
Number Analysis	Very High	2	1				1
	High	7	7		1	3	6
	Medium	12	11	5	2	4	4
	Not Relevant						
	Totals	21	19	5	3	7	11

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.4.3.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE VULNERABILITY

From the information presented in the previous section, the vulnerability reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce vulnerability (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE VULNERABILITY TO BUSHFIRE HAZARD THREATS [1]							
Element at Risk	Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.						
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Moderate	Significant
Minimal				Moderate			
WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Significant	Very Significant	Very Significant	Significant	Very Significant	Moderate	Moderate	Very Significant
Very Significant				Significant			

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This vulnerability reducing potential will be applied to deriving the inherent vulnerability level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This vulnerability reducing potential will be applied to deriving the residual vulnerability level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 4: Refer to Appendix 2 for explanatory and supporting information.

Assessment Comments: The Operations and Maintenance Building would not be required to construct to AS 3959 through 'Planned' measures and has been established as an additional measure. Enclosing subfloor cavities is a measure which improves the vulnerability against multiple mechanisms. Availability of firefighting water improves the vulnerability against consequential fires, radiant heat, and flame contact.

5.4.3.4 DERIVED VULNERABILITY LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual vulnerability levels.

In combination with the corresponding assessed threat and exposure levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL VULNERABILITY LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]							
ELEMENT AT RISK		Operations and Maintenance Building, Warehouses/Workshops, and standalone Class 10a buildings.					
BUSHFIRE ATTACK MECHANISMS [2]		INHERENT VULNERABILITY LEVEL (CURRENT STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	High
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
BUSHFIRE ATTACK MECHANISMS [2]		RESIDUAL VULNERABILITY LEVEL (POTENTIAL FUTURE STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	Low
DIRECT	Radiant Heat	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: Refer to Appendix 2 for explanatory and supporting information.

Note 3: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

5.4.4 MATERIALS STOCKPILED OUTDOORS – LAYDOWN AREAS

5.4.4.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Materials Stockpiled Outdoors – Laydown Areas					
THE PROTECTION MECHANISM – CONSTRUCTION DESIGN AND MATERIALS: Increase bushfire resilience through the application of beneficial design and construction, including using non-combustible materials and minimising the use of vulnerable materials, to the greatest extent possible. Practicality and cost will be key considerations in determining the viability of applying protection measures in differing scenarios, but this should be determined with due consideration of threat levels and the importance of the elements at risk. The constructed systems should utilise the following properties to the greatest extent possible: **reliability** (which requires their durability over time, low maintenance and being unlikely to change over time), **robustness** (which limits damage spread from minor sources, continue to protect when thermally loaded and protects vulnerable elements), **resilience** (which enables their return to a functional state following an overload) and **redundancy** (which ensures the fate of the subject building/structure is not reliant on the effective performance of a single element). Refer to the glossary for additional explanation. The principle is also applicable to constructed consequential fire fuels.						
12.1	**Construction Materials for Consequential Fire Fuels:** For constructed large consequential fire fuels, use non-combustible materials to the fullest extent possible. Potential fuels include adjacent structures and surrounding landscaping items (fences, screens, retaining walls etc.).	High	N/A	N/A	N/A	N/A
Assessment Comments: Laydown areas do not include constructed features. ***Recommendation Details***: Not Applicable						
THE PROTECTION MECHANISM – AVAILABILITY OF A FIREFIGHTING RESPONSE CAPABILITY: Provide sufficient and reliable dedicated firefighting water supply and delivery capability as necessary for installed active and/or passive systems.						
12.2	**Firefighting Water Supply:** Have a dedicated static supply of firefighting water for the protection of buildings/structures before and after the passage of a bushfire front. Adequate water supply is critical for any firefighting operation, particularly where property protection is the intent. This is necessary when: • A water supply additional to a reticulated water supply is required to counter the loss of firefighting water as a protection measure, should the reticulated supply be interrupted; and • It is the only source of firefighting water. All tanks shall be non-combustible. Aside from losing water, failure of combustible tank can provide an additional heat load to a vulnerable building element. Metal piping and fittings shall be used for any above ground components.	High	Yes	No	No	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Materials Stockpiled Outdoors – Laydown Areas					
	The limitation to the effectiveness of the measure is the requirement for persons to be present and have the minimum required operational knowledge and/or access to appropriate information.					
Assessment Comments: Laydown areas will be supplied through the same water capacity required for the BESS development. ***Recommendation Details:*** The aggregate water supply requirements for the proposal have been applied within a single measure. See **Measure 13.17.**						
12.3	**Firefighting Equipment Actively Operated:** In addition to a dedicated water supply, appropriate mobile firefighting appliances are available quickly and/or fixed firefighting equipment is installed (pumps, hoses, sprinklers etc). Where equipment is installed, this will be resilient to bushfire impact, to the extent necessary, through the application of appropriate equipment materials and protection (shielding or separation from the hazard). The limitation to the effectiveness of the measure is the requirement for persons to be present and have the minimum required operational knowledge and/or access to appropriate information.	High	Yes	No	No	Yes
Assessment Comments: Laydown areas are relatively lower priority assets for active defence. ***Recommendation Details:*** The firefighting operations have been assessed and discussed within a single measure. See **Measure 9.3.**						
12.4	**Fire Fighting Equipment Passively Operated:** In addition to a dedicated water supply, appropriate water dispensing apparatus are installed (e.g. pumps, plumbing and sprinklers) that are automatically activated. These will be resilient to bushfire impact, to the extent necessary, through the application of appropriate equipment materials and protection (shielding or separation from the hazard).	High	Yes	No	No	No
Assessment Comments: Passive firefighting measures are not practical for remote material storage. ***Recommendation Details:*** Not Applicable						
12.5	**Fire Fighting Equipment Operability Maintained:** Where water pumps, shutters or other active/passive protection measures rely on the continued supply of electricity, establish barriers (shielding) or separation from potential damaging factors (e.g. falling trees/branches, fire, or other impact sources). For example, bury transmission systems to the greatest extent possible.	High	N/A	N/A	N/A	N/A
Assessment Comments: Active firefighting equipment is not associated with material storage, they are independent of these locations. ***Recommendation Details:*** Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Materials Stockpiled Outdoors – Laydown Areas					
12.6	**Access via Firebreaks Provided:** Installation and maintenance of firebreaks to facilitate firefighting access / backburning (and also limiting surface fire progression).	Medium	Yes	Yes	Yes	No
Assessment Comments: Laydown areas are accessed via the internal access network, which adjoin classified vegetation areas. Laydown areas will be a trafficable hardstand, though with obstructions (the stored material). Firebreaks are required by the Shire of Kojonup Section 33 Notice. Some firebreaks may be upgraded to function as part of the internal road network. ***Recommendation Details:*** Not Applicable						
THE PROTECTION MECHANISM – MANAGE AND MAINTAIN EFFECTIVENESS OF APPLIED PROTECTION MEASURES: To ensure the retention of the level of bushfire resilience that has been established through the implementation of appropriate bushfire protection measures, formal and enforceable responsibilities are created.						
12.7	**Formal Documents Created to Guide and Enforce Management:** Through relevant site operations document(s) and/or an enforceable agreement, regulation or standard, a mechanism is put in place to ensure that: • The required management and maintenance of applied bushfire protection measures is conducted on a regular basis – with the interval dependent on the necessary frequency that will maintain full effectiveness; • The relevant protection measures are known and understood; and • Responsibilities are created.	High	Yes	No	Yes	Yes
Assessment Comments: The documents have been or will be produced. Section 6.1 of this Bushfire Risk Report includes the operational documents to include bushfire protection measures. ***Recommendation Details:*** See **Measure 13.22.**						
Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining. **Note 2: Protection Measure Application Status:** • **Possible:** Protection measures that can potentially be applied to the proposed development/use. • **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary). • **Currently Planned:** Protection measures that: • Are incorporated into the site plans;						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Materials Stockpiled Outdoors – Laydown Areas					

- Exist in an approved Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), alternative solutions and any additional recommended protection measures - for which a responsibility for their implementation has been created and approved; and/or
- Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).

- **Additionally Recommend:** Protection measures that:
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or
  - Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP.

These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).

5.4.4.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing vulnerability levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the vulnerability of the relevant element at risk to bushfire hazard threats.

VULNERABILITY REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Materials Stockpiled Outdoors						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Construction Design and Materials	Very High						
	High						
	Medium						
	Not Relevant						
Availability of a Firefighting Response Capability	Very High						
	High	4	3				2
	Medium	1	1	1		1	
	Not Relevant						
Manage and Maintain Effectiveness of Applied Protection Measures	Very High						
	High	1	1			1	1
	Medium						
	Not Relevant						
Number Analysis	Very High						
	High	5	4			1	3
	Medium	1	1	1		1	
	Not Relevant						
	Totals	6	5	1		2	3

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.4.4.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE VULNERABILITY

From the information presented in the previous section, the vulnerability reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce vulnerability (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE VULNERABILITY TO BUSHFIRE HAZARD THREATS [1]							
Element at Risk	Materials Stockpiled Outdoors – Laydown Areas						
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Minimal	Moderate	Minimal	Moderate	Minimal	Minimal	Significant	Minimal
Minimal				Minimal			
WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Moderate	Moderate	Minimal	Moderate	Minimal	Moderate	Significant	Moderate
Moderate				Moderate			

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This vulnerability reducing potential will be applied to deriving the inherent vulnerability level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This vulnerability reducing potential will be applied to deriving the residual vulnerability level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 4: Refer to Appendix 2 for explanatory and supporting information.

Assessment Comments: Materials have widely variable vulnerabilities. Firefighting response is possible, but these assets are a lower priority during a larger-scale fire.

5.4.4.4 DERIVED VULNERABILITY LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual vulnerability levels.

In combination with the corresponding assessed threat and exposure levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL VULNERABILITY LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]							
ELEMENT AT RISK		Materials Stockpiled Outdoors – Laydown Areas					
BUSHFIRE ATTACK MECHANISMS [2]		INHERENT VULNERABILITY LEVEL (CURRENT STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☒	High
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☐	Moderate ☐	High ☐	Extreme ☒	
BUSHFIRE ATTACK MECHANISMS [2]		RESIDUAL VULNERABILITY LEVEL (POTENTIAL FUTURE STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	Moderate
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	

Note 1: Refer to Appendix 1 for explanatory and supporting information.

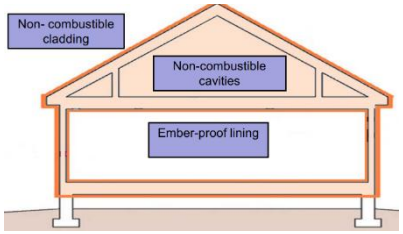
Note 2: Refer to Appendix 2 for explanatory and supporting information.

Note 3: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

5.4.5 BUILT INFRASTRUCTURE ASSETS – BESS UNITS

5.4.5.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
THE PROTECTION MECHANISM – CONSTRUCTION DESIGN AND MATERIALS: Increase bushfire resilience through the application of beneficial design and construction, including using non-combustible materials and minimising the use of vulnerable materials, to the greatest extent possible. Practicality and cost will be key considerations in determining the viability of applying protection measures in differing scenarios, but this should be determined with due consideration of threat levels and the importance of the elements at risk. The constructed systems should utilise the following properties to the greatest extent possible: **reliability** (which requires their durability over time, low maintenance and being unlikely to change over time), **robustness** (which limits damage spread from minor sources, continue to protect when thermally loaded and protects vulnerable elements), **resilience** (which enables their return to a functional state following an overload) and **redundancy** (which ensures the fate of the subject building/structure is not reliant on the effective performance of a single element). Refer to the glossary for additional explanation. The principle is also applicable to constructed consequential fire fuels.						
13.1	**Construct to AS 3959:2018 [4]:** Use the principles and requirements established in the Standard, for buildings in general, and apply to the infrastructure assets where they have merit. These are intended to reduce the risk of building ignition from bushfire direct attack mechanisms. Note that the indirect attack mechanisms and the threats presented by consequential fire fuels are not specifically considered. Key attributes of the Standard that may have relevance to other built assets include: • The AS 3959 strategy that relies on the integrity of the building's exterior envelope (i.e., the cladding of roof/wall/eaves, floor supporting structures/flooring and all penetrations) to resist all bushfire exposure conditions and environmental actions thereby protecting all structural construction elements behind it, including allowable combustible materials. • Using specified materials that provide ignition resistance (tolerance of radiant heat and flames). Higher BAL ratings impose increased construction requirements for these exterior envelope materials; • Specifying precise gap control (applicable to all bushfire attack levels) for the exterior envelope of the building to prevent ember entry); and • Attached and adjacent structures (within 6m) must also comply with the Standard.	High	N/A	N/A	N/A	N/A
13.2	**Construct to NASH Standard [33]:** Use the principles and requirements established in the Standard, for residential and low-rise buildings, and apply to the infrastructure assets where they have merit. Key attributes of the Standard that may have relevance to other built assets include:	Very High	N/A	N/A	N/A	N/A

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
	• Materials used anywhere on the building envelope (see shaded part of diagram below), must be non-combustible (except for a small number of smaller building elements). The building envelope is comprised of a framed roof/ceiling system, an external wall system and a floor system;  • The same construction requirements apply for all BAL ratings up to BAL-40 (except for external doors and windows which apply AS 3959 requirements). An additional benefit of this is the built in resistance to the direct attack mechanisms of consequential fire when lower BAL ratings apply. • It does not rely on eliminating ember entry to the roof space, wall cavities and floor system as these are non-combustible construction. Embers only need to be kept from entering the internal living/operating spaces. • It is ember tolerant without unrealistic workmanship, supervision and maintenance requirements; • The combination of a non-combustible cladding and cavities is a robust solution that enables the building to be configured so that failure or damage to one element does not lead to the inevitable failure of the building or a breach of the habitable envelope; and • Attached and adjacent structures (within 6m) must also comply with the Standard.					
Assessment Comments: Assets do not have a design to which AS3959 or NASH applies. ***Recommendation Details***: Not Applicable.						
13.3	**Construction Materials for External and Internal Cavity Building Elements:** Except for internal living or operation spaces, to the degree necessary, utilise materials resistant to fire attack mechanisms of flame and radiant heat (preferably non-combustible) for all relevant building elements, including wall, roof, floor, supporting structures and framing systems.	Very High	Yes	Yes	No	Yes
Assessment Comments: Battery modules will be self-contained through highly insulated steel casing used to encapsulate modules. Installation of thermally insulated steel vents within the thermal roof protecting the units from flame impingements and hot gas intrusion. There is no Australian Standard applicable to large-scale BESS installations.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
Recommendation Details: Review compliance against NFPA 855 - Standard for the Installation of Stationary Energy Storage Systems (2023) noting that as a North American planning standard, all requirements may not be applicable.						
13.4	**Construction Materials for Consequential Fire Fuels:** For constructed large consequential fire fuels, use non-combustible materials to the fullest extent possible. Potential fuels include attached structures, adjacent structures and surrounding landscaping items (fences, screens, retaining walls etc.).	High	Yes	No	Unknown	No
Assessment Comments: No combustible structural elements have been identified. They will likely be primarily masonry, steel, aluminium and cement sheeting. ***Recommendation Details***: Not Applicable						
13.5	**Construction Design / Materials Resistant To High Wind Damage:** Apply construction measures to prevent the type of building damage from wind that will open or create gaps (from the wind itself or carried projectiles) and allow the entry of embers, radiant heat and flames. This type of damage is typically superficial damage. Building codes relating to wind (e.g., cyclones) do not necessarily address this superficial type of impact. Additional fixings for building envelope claddings and protection of the most vulnerable elements, such as glazing, from debris impact, are key considerations. Consider applying the principles of the NASH Standard [33] design solution to construction. "Potential wind effects directly associated with bushfire events have been considered in this Standard. Wind actions may affect buildings subject to a bushfire attack in various ways including: • The intensity of flame front activity may produce locally high wind pressures on parts of the building; • In the post fire phase, some weakened components on the building envelope may be vulnerable to normal design pressures; and • Wind can drive embers into the building envelope." Most applicable when the physical requirements exist for the development of an extreme bushfire event within the surrounding landscape.	Medium	Yes	Yes	No	No
Assessment Comments: Assets will include components installed underground, fixed to the ground (concrete or buried support pillars), and else will be metal and heavily weighted. Wind is unlikely to cause sufficient damage to create a vulnerability to embers. ***Recommendation Details***: Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
13.6	**Construction of Gas Supply:** All gas cylinders are installed and maintained in accordance with AS 1596 (for domestic house supply) as a guide. The requirement of the standard includes: • Safety release valve shall be directed away from the building and persons access/egress routes; • Metal piping and fittings shall be used on all piping inside the building's cavities and enclosable occupied spaces and the high pressure side of any gas regulators; and • Tethers securing cylinders are to be non-combustible. The objective is to reduce the risk of consequential (secondary) fire against a building and reduce the risk of death or injury, from gas flaring or explosion. The rationale is gas cylinders which have either flared or ruptured are commonly found in post bushfire surveys [9]. The heat from the bushfire or consequential (secondary) fire has been sufficient to cause their pressure to reach critical levels beyond which their pressure release valve releases large quantities of LP gas. If these gas cylinders fall over, this pressure release valve may no longer function correctly, meaning that the gas cylinder may continue to increase in pressure with continued heating until the cylinder ruptures. The resulting explosion includes a pressure wave and large ball of flame which can threaten nearby life and buildings. Readily available guidance is provided by CSIRO Best Practice Bushfire Guide (https://research.csiro.au/bushfire/new-builds/water-electricity-gas/) and WA Dept. Mines, Industry, Regulation and Safety 'LP Gas cylinder safety in bushfire prone areas' (https://www.commerce.wa.gov.au/publications/lp-gas-cylinder-safety-bushfire-prone-areas).	Medium	N/A	N/A	N/A	N/A
Assessment Comments: Gas storage is not proposed on site. Any LPG will be stored in compliance with AS 1596. ***Recommendation Details***: Not Applicable						
13.7	**Construction of Electricity Supply:** Cabling to be shielded (includes installing underground within subject property boundary) from applicable bushfire attack mechanisms. The objective is to assist with continuity of supply for essential site operations and/or electrically driven firefighting pumps. It also reduces the risk of electrocution to any persons onsite and reduces potentially additional sources of fire ignition. It is common in bushfires for power infrastructure to burn and collapse or be impacted by falling trees or branches while power lines are still live. Removing this risk may be appropriate for some sites.	Medium	Yes	No	Yes	Yes
Assessment Comments: Cabling associated with BESS will be enclosed within the cabinet, with some lines potentially running between systems or to the O&M buildings or Substation. The critical threshold for electrical cabling applied in Measure 6.3 is 12kW/m^2, with the APZ being 10kW/m^2 to ensure this threshold is not exceeded.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
Recommendation Details: See **Measure 6.12**.						
13.8	**Minimise Re-entrant Detail to Minimise Debris and Ember Accumulation:** Avoid or limit the accumulation of unburnt debris and embers by minimising re-entrant details and/or adopting aerodynamic forms that will self-shed windblown debris and embers. For example: • Simple building/structure footprints that avoid re-entrant corners in access ways, at wall/floor, wall/ground, roof/wall junctions and around doors, vents, windows; and • Simple roof layouts that avoid valleys and minimise the number of ridges that need protection details (e.g. skillion roofs).	Medium	Yes	Yes	Unknown	Yes
Assessment Comments: The structure design and construction allow for little debris accumulation. No trees are proposed to be planted or retained within the 10kW/m^2 APZ and thus accumulation of debris will be unlikely and, where any occurs, will occur slowly. **Recommendation Details**: Where electrical cabling, or gas or liquid piping, contacts the ground or any arrangement of associated structures creates a 'pocket' for accumulation of debris, this should be rectified by design or filling with non-combustible material such as mineral earth. Consideration should be given to making the arrangement self-cleaning through wind action to the greatest extent possible. These measures will reduce accumulation and/or make the management (clearing) of accumulated debris easier. E.g. cable raking to be 100mm above ground.						
13.9	**Minimise Debris/Ember Trapping Surfaces:** Avoid or minimise the use of exposed combustible surfaces that can trap and accumulate debris and embers. These include: • Horizontal, or shallow angle surfaces e.g. exposed wall/roof framework, roofs, decking, verandahs, steps, windowsills; and • Vertical surfaces with rough textured cladding (e.g. sawn timber).	Medium	Yes	Yes	Unknown	No
Assessment Comments: BESS units are rectangular and not expected to include the above features. Horizontal surfaces may exist but will be open-air and will be self-clearing through wind. No rough textured vertical surfaces will exist as assets will be metal, concrete, or tilt-up panels. No trees are proposed to be planted or retained within the 10kW/m^2 APZ and thus accumulation of debris will be unlikely and, where any occurs, will occur slowly. ***Recommendation Details***: Not Applicable						
13.10	**Protect Roof Plumbing to Minimise Debris and Ember Accumulation:** All roof plumbing (gutters, valleys) is protected from the accumulation of debris and embers that can result in direct fire attack mechanisms immediately adjacent to any combustible elements within the roof cavity.	Medium	N/A	N/A	N/A	N/A

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
Assessment Comments: BESS units will not have roof plumbing. ***Recommendation Details:*** Not Applicable						
13.11	**Minimise Construction Cavities to Minimise Debris and Ember Accumulation:** Apply designs that lower the potential for accumulation of embers and debris within cavity spaces of buildings/structures. Examples include concrete floor slab on the ground and solid masonry walls.	Medium	Yes	Yes	No	Yes
Assessment Comments: The internal spaces of assets will be entirely enclosed. BESS units may have exposed subfloors (as containers placed on the ground). BESS units are recommended to be sited on concrete slabs or other sealed, non-combustible surface in **Measure 6.3**. ***Recommendation Details:*** Any subfloor cavities must have exposed subfloor spaces enclosed, sealed with non-combustible material, or be ember screened. Ember screening mesh is to be maximum 2mm aperture and composed of corrosion-resistant steel, bronze, or aluminium.						
13.12	**Minimise External Openings to Limit Flame/Radiant Heat/Ember/Debris Entry:** Limit potential sites for threat entry to through the external building envelope to internal spaces containing combustible materials (consequential fire fuels). Examples include reducing windows/doors on elevations facing the bushfire hazard and apply design to limit gaps and penetrations that will require screening.	Medium	Yes	Yes	No	Yes
Assessment Comments: BESS units include intake/extraction/air conditioning vents. Assets will otherwise be sealed against weather impacts with an appropriate IP rating. ***Recommendation Details:*** See **Measures 13.11** and **13.13.**						
13.13	**Screen and Seal Gaps and Penetrations:** Apply fire rated sealants and/or install metal screening (corrosion resistant steel, bronze, aluminium <2mm aperture). All external construction and penetration gaps with apertures greater than 2mm will allow ember entry (and potentially debris) to internal cavities and combustible materials within (as consequential fire fuels). This includes gaps in roofs, walls, doors, windows and their surrounding trims – including those associated with penetrations, vents, weepholes, poor workmanship and material deterioration and movement over time (maintenance). Internal fire is difficult to see and extinguish.	Medium	Yes	Yes	No	No
Assessment Comments: Battery Units are designed to eliminate the ingress of dust, spiders and other insects. This will also prevent any embers from fires in the surrounding area entering the Battery Unit. The chosen Battery Unit will have a suitable Ingress Protection (IP) rating. This will be confirmed prior to construction once a battery supplier and model has been selected.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
Recommendation Details: Not Applicable.						
13.14	**Screen External Doors and Windows**: Metal screens (corrosion resistant steel, bronze, aluminium <2mm aperture) installed over non-openable and/or openable parts of windows and doors to prevent ember entry to internal spaces containing combustible materials (consequential fire fuels) and reduce radiant heat load on vulnerable surfaces.	Medium	N/A	N/A	N/A	N/A
Assessment Comments: Assets will not have windows. Doors will be a solid metal panel. ***Recommendation Details***: Not Applicable.						
13.15	**Shutter External Doors and Windows**: Fire rated shutters are installed to significantly increase bushfire resistance of the vulnerable building elements.	Medium	Yes	Unknown	No	Yes
Assessment Comments: Assets will not have windows. ***Recommendation Details***: External doors (if present) should be self-closing.						
13.16	**Construction Materials for Critical Non-Structural Elements:** Utilise fire/radiant heat rated products (rated to the level determined necessary), for the construction of non-structural elements that are essential to the continued operation of the built asset, and which are potentially exposed to the attack mechanisms of both bushfire and consequential fire. These vulnerable elements include cabling and plumbing associated with power (delivery) inputs and outputs, data transmission, liquid/gas transport (fuel/water) etc.	High	Yes	Yes	Yes	Yes
Assessment Comments: The materials identified as critical are discussed in **Measure 6.3** in determining the appropriate APZ. These components are integral to the design and cannot be replaced with materials more resistant to fire attack mechanisms. Asset fire is the major concern for the risks associated with BESS technologies and the engineer/manufacturer is assumed to have applied fire risk reduction in material selection to the maximum practical extent. No constructed assets or infrastructure are expected to include flammable or otherwise vulnerable materials. ***Recommendation Details***: Review *FM Global Property Loss Prevention Data Sheet 5-33 (2020) Electrical Energy Storage Systems* for additional measures applicable to the development.						
THE PROTECTION MECHANISM – AVAILABILITY OF A FIREFIGHTING RESPONSE CAPABILITY: Provide sufficient and reliable dedicated firefighting water supply and delivery capability as necessary for installed active and/or passive systems.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
13.17	**Firefighting Water Supply:** Have a dedicated static supply of firefighting water for the protection of buildings/structures before and after the passage of a bushfire front. Adequate water supply is critical for any firefighting operation, particularly where property protection is the intent. This is necessary when: • A water supply additional to a reticulated water supply is required to counter the loss of firefighting water as a protection measure, should the reticulated supply be interrupted; and • It is the only source of firefighting water. All tanks shall be non-combustible. Aside from losing water, failure of combustible tank can provide an additional heat load to a vulnerable building element. Metal piping and fittings shall be used for any above ground components. The limitation to the effectiveness of the measure is the requirement for persons to be present and have the minimum required operational knowledge and/or access to appropriate information.	High	Yes	No	Yes	Yes

***Assessment Comments**:* The *Planning for Bushfire Guidelines* does not establish a firefighting water supply for non-habitable structures, including large-scale uses such as renewable energies.

The State of Victoria Country Fire Authority *Design Guidelines and Model Requirements – Renewable Energy Facilities* v4 (CFA June 2025) provides guidance for commercial-scale BESS facilities.

The BESS development will require a water supply calculated following AS 2419.1 (Open Yards), to a minimum of 288,000L. Where a firefighting water supply for the BESS development is determined elsewhere, the greater volume is to apply.

A summary of applicable measures to align with the *Design Guidelines*, as well as modifications for bushfire risk outcomes, and to meet the Western Australian planning requirements, are provided below.

***Recommendation Details**:* The firefighting water supply requirements for the proposal are as follows:

Access

- Firefighting water access points (hydrants, hard suction, or drafting) must be clearly identifiable, visible from internal roads, and unobstructed.
- Signage must be provided at each vehicle entrance to the facility, indicating the direction to the nearest firefighting water access point.
- An all-weather hardstand turnaround area meeting the requirements of the *Planning for Bushfire Guidelines* (Figure 30) must be provided within 4 metres static water storage tank(s) and any independent hard suction points (hydrants).
- Site Operating Procedures must include that access routes must be unobstructed at all times.

Siting and Capacity

- The BESS development requires a minimum 288,000L firefighting water tank. This is to account for both bushfire and asset fire.

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
	○ Where another firefighting water supply is determined elsewhere (for asset fire etc), the greater volume is to apply. ○ The required water supply in compliance with AS 2419.1 will be determined based on the final footprint of the BESS development. A footprint exceeding 9000m2 will require additional water supply. • All BESS units must be wholly within 70m of a water outlet. • Water tanks must be positioned >15m from BESS units and PCUs. • Water tanks should apply a BAL-29 dimensioned APZ at a minimum. <u>Construction</u> • Static water storage tanks must be an above-ground water tank constructed of concrete or steel. • An external water level indicator must be installed on static water storage tanks and be visible from internal roads and the adjoining turnaround area. • Signage indicating 'FIRE WATER' and the tank capacity must be fixed to each tank. • Couplings at hard suction points are required to be 125mm Storz fittings (*Guidelines B.4.1.2*). DFES Built Environment and the local emergency services should be contacted for input on appropriate couplings and adaptors.					
13.18	**Firefighting Equipment Actively Operated:** In addition to a dedicated water supply, appropriate mobile firefighting appliances are available quickly and/or fixed firefighting equipment is installed (pumps, hoses, sprinklers etc). Where equipment is installed, this will be resilient to bushfire impact, to the extent necessary, through the application of appropriate equipment materials and protection (shielding or separation from the hazard). The limitation to the effectiveness of the measure is the requirement for persons to be present and have the minimum required operational knowledge and/or access to appropriate information.	High	Yes	No	Unknown	Yes
Assessment Comments: Through the Emergency Management Plan, an Emergency Response Team will be designated and trained in firefighting operation. Ensure the Site Emergency Plan and training for the Emergency Response Team considers bushfire as well as asset fires. See **Measure 9.3** ***Recommendation Details***: Two suitable fire extinguishers should be provided within 20m of each PCU.						
13.19	**Fire Fighting Equipment Passively Operated:** In addition to a dedicated water supply, appropriate water dispensing apparatus are installed (e.g. pumps, plumbing and sprinklers) that are automatically activated. These will be resilient to bushfire impact, to the extent necessary, through the application of appropriate equipment materials and protection (shielding or separation from the hazard).	High	Yes	No	Yes	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
Assessment Comments: The BESS units have active monitoring and electrical fault safety devices which ensure the units only remain operational within their intended operating environment, with an automated shut-down system. Fire detection and suppression systems depend on the asset type and its design, there is no 'one size fits all' solution. As BESS units are delivered fully constructed (plug in and play) the detection/suppression systems will be functional immediately. ***Recommendation Details:*** Automatic fire detection and suppression systems should be installed and maintained, as appropriate to the BESS details and recommended by the manufacturer.						
13.20	**Fire Fighting Equipment Operability Maintained:** Where water pumps, shutters or other active/passive protection measures rely on the continued supply of electricity, establish barriers (shielding) or separation from potential damaging factors (e.g. falling trees/branches, fire, or other impact sources). For example, bury transmission systems to the greatest extent possible.	High	Yes	No	Unknown	Yes
Assessment Comments: *DFES Guidance Note: Firefighting Water Supply Considerations for Special Hazard & Dangerous Goods Sites* has been considered in the design of the firefighting water supply. The site will have an independent power supply through either the onsite BESS or generators. Firefighting water tanks must install a BAL-29 dimensioned APZ. The Operations and Maintenance Building and Substation will be reasonably adjacent to the BESS and will be serviced with the same water supply. Model Requirement 4.4.2(e) of the *Design Guidelines* require the water tank to be at the site access point and not aligned to the prevailing wind, which are potentially contradictory. For the proposed layout, the water tanks are proposed to the north of the development, which meets both requirements (the prevailing wind direction being eastern and southerly). ***Recommendation Details:*** All firefighting water tanks, pumps, connections, couplings, and pipes are to be metal or else non-combustible.						
13.21	**Access via Firebreaks Provided:** Installation and maintenance of firebreaks to facilitate firefighting access / backburning (and also limiting surface fire progression).	Medium	Yes	Yes	Yes	Yes
Assessment Comments: Direct access to classified vegetation areas (vegetation screening and pasture) will be via the internal access network. The Operations and Maintenance Building will have access roads installed, and the BESS and Substation footprint will be a trafficable hardstand. The Operations and Maintenance Building buildings will likely (but is not required) to be installed on a hardstand. Firebreaks are required by the Shire of Kojonup Section 33 Notice. Some firebreaks may be upgraded to function as part of the internal road network. ***Recommendation Details:*** Not Applicable						
THE PROTECTION MECHANISM – MANAGE AND MAINTAIN EFFECTIVENESS OF APPLIED PROTECTION MEASURES: To ensure the retention of the level of bushfire resilience that has been established through the implementation of appropriate bushfire protection measures, formal and enforceable responsibilities are created.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
13.22	**Formal Documents Created to Guide and Enforce Management:** Through relevant site operations document(s) and/or an enforceable agreement, regulation or standard, a mechanism is put in place to ensure that: • The required management and maintenance of applied bushfire protection measures is conducted on a regular basis – with the interval dependent on the necessary frequency that will maintain full effectiveness; • The relevant protection measures are known and understood; and • Responsibilities are created.	High	Yes	No	Yes	Yes

***Assessment Comments**:* The documents have been or will be produced.

***Recommendation Details**:* There is no Australian Standard applicable to large-scale BESS installations. The absence of consistent guidance is discussed in the *Battery Energy Storage Systems Guidance Report* (GHD March 2023, prepared for the Australian Energy Council). The decision maker may choose to review this report for an overview of context, concerns, and outcomes, for the construction and installation of BESS proposals.

AS/NZS 5139:2019 Electrical installations - Safety of battery systems for use with power conversion equipment provides considerations in a general sense, but largely refers to the manufacturers' information.

Ongoing requirements established in this Risk Assessment, must be included in the relevant ongoing operational documents.

Site Operating Procedures must include the following information:

<u>Maintenance</u>

- Maintenance intervals. Scheduling can be detailed within a supporting document.
- Assigned responsibilities of staff.
- Maintenance procedures and servicing to manufacturer's specifications.
- Testing procedures of the firefighting water supply and equipment.

<u>Inspections</u>

- Inspection intervals. Frequency of inspections are recommended to be increased during the bushfire season (see the Local Government Prohibited Burning Period) where practical.
- Inspection triggers, including extreme weather events or seismic activity.
- Established inspection criteria, including:
    - Accumulation of debris and vegetative material within 10m of battery modules.

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.					
	o Mechanical damage to exterior elements. o Vegetation regrowth within the APZ, particularly immediately prior to and during bushfire season (see the Local Government Prohibited Burning Period). o Obstruction of access routes including firebreaks. o Volume of the firefighting water supply.					

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining.

Note 2: Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use.
- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Currently Planned:** Protection measures that:
  - Are incorporated into the site plans;
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Planning for Bushfire Guidelines', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

  These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Additionally Recommend:** Protection measures that:
  - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or
  - Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP.

  These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).

5.4.5.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing vulnerability levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the vulnerability of the relevant element at risk to bushfire hazard threats.

VULNERABILITY REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Construction Design and Materials	Very High	2	1	1			1
	High	3	2	1		1	2
	Medium	11	8	5		1	6
	Not Relevant						
Availability of a Firefighting Response Capability	Very High						
	High	4	4			2	4
	Medium	1	1	2		1	
	Not Relevant						
Manage and Maintain Effectiveness of Applied Protection Measures	Very High						
	High	1	1			1	1
	Medium						
	Not Relevant						
Number Analysis	Very High	2	1	1			1
	High	8	7	1		4	7
	Medium	12	9	7		2	6
	Not Relevant						
	Totals	22	17	9		6	14

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.4.5.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE VULNERABILITY

From the information presented in the previous section, the vulnerability reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce vulnerability (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE VULNERABILITY TO BUSHFIRE HAZARD THREATS [1]							
Element at Risk	Built Infrastructure Assets - BESS units and Associated Infrastructure.						
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Moderate	Significant	Moderate	Significant	Significant	Very Significant	Moderate	Minimal
Moderate				Moderate			
WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Very Significant	Very Significant	Significant	Significant	Significant	Very Significant	Significant	Very Significant
Very Significant				Very Significant			

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This vulnerability reducing potential will be applied to deriving the inherent vulnerability level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This vulnerability reducing potential will be applied to deriving the residual vulnerability level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 4: Refer to Appendix 2 for explanatory and supporting information.

Assessment Comments: The vulnerability reducing protection measures are associated with:

- Ensuring that the design and construction of the assets can limit locations for accumulation of debris and facilitates self-cleaning by the wind.
- Having firefighting resources available of an appropriate design and capacity to extinguish consequential fires and cool battery cabinets.
- Having the BESS units fitted with active monitoring and electrical fault safety devices which ensure the units only remain operational within their intended operating environment, with an automated shut-down system.

5.4.5.4 DERIVED VULNERABILITY LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual vulnerability levels.

In combination with the corresponding assessed threat and exposure levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL VULNERABILITY LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]							
ELEMENT AT RISK		Built Infrastructure Assets - BESS units and Associated Infrastructure.					
BUSHFIRE ATTACK MECHANISMS [2]		INHERENT VULNERABILITY LEVEL (CURRENT STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	Moderate
DIRECT	Radiant Heat	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
BUSHFIRE ATTACK MECHANISMS [2]		RESIDUAL VULNERABILITY LEVEL (POTENTIAL FUTURE STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	Low
DIRECT	Radiant Heat	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	

Note 1: Refer to Appendix 1 for explanatory and supporting information.

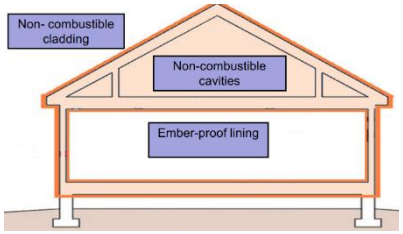
Note 2: Refer to Appendix 2 for explanatory and supporting information.

Note 3: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

5.4.6 BUILT INFRASTRUCTURE ASSETS – SUBSTATION

5.4.6.1 PROTECTION MEASURE ANALYSIS - IDENTIFICATION AND APPLICATION STATUS

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
THE PROTECTION MECHANISM – CONSTRUCTION DESIGN AND MATERIALS: Increase bushfire resilience through the application of beneficial design and construction, including using non-combustible materials and minimising the use of vulnerable materials, to the greatest extent possible. Practicality and cost will be key considerations in determining the viability of applying protection measures in differing scenarios, but this should be determined with due consideration of threat levels and the importance of the elements at risk. The constructed systems should utilise the following properties to the greatest extent possible: **reliability** (which requires their durability over time, low maintenance and being unlikely to change over time), **robustness** (which limits damage spread from minor sources, continue to protect when thermally loaded and protects vulnerable elements), **resilience** (which enables their return to a functional state following an overload) and **redundancy** (which ensures the fate of the subject building/structure is not reliant on the effective performance of a single element). Refer to the glossary for additional explanation. The principle is also applicable to constructed consequential fire fuels.						
15.1	**Construct to AS 3959:2018 [4]:** Use the principles and requirements established in the Standard, for buildings in general, and apply to the infrastructure assets where they have merit. These are intended to reduce the risk of building ignition from bushfire direct attack mechanisms. Note that the indirect attack mechanisms and the threats presented by consequential fire fuels are not specifically considered. Key attributes of the Standard that may have relevance to other built assets include: • The AS 3959 strategy that relies on the integrity of the building's exterior envelope (i.e., the cladding of roof/wall/eaves, floor supporting structures/flooring and all penetrations) to resist all bushfire exposure conditions and environmental actions thereby protecting all structural construction elements behind it, including allowable combustible materials. • Using specified materials that provide ignition resistance (tolerance of radiant heat and flames). Higher BAL ratings impose increased construction requirements for these exterior envelope materials; • Specifying precise gap control (applicable to all bushfire attack levels) for the exterior envelope of the building to prevent ember entry); and • Attached and adjacent structures (within 6m) must also comply with the Standard.	High	N/A	N/A	N/A	N/A
15.2	**Construct to NASH Standard [33]:** Use the principles and requirements established in the Standard, for residential and low-rise buildings, and apply to the infrastructure assets where they have merit. Key attributes of the Standard that may have relevance to other built assets include:	Very High	N/A	N/A	N/A	N/A

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
	• Materials used anywhere on the building envelope (see shaded part of diagram below), must be non-combustible (except for a small number of smaller building elements). The building envelope is comprised of a framed roof/ceiling system, an external wall system and a floor system;  • The same construction requirements apply for all BAL ratings up to BAL-40 (except for external doors and windows which apply AS 3959 requirements). An additional benefit of this is the built in resistance to the direct attack mechanisms of consequential fire when lower BAL ratings apply. • It does not rely on eliminating ember entry to the roof space, wall cavities and floor system as these are non-combustible construction. Embers only need to be kept from entering the internal living/operating spaces. • It is ember tolerant without unrealistic workmanship, supervision and maintenance requirements; • The combination of a non-combustible cladding and cavities is a robust solution that enables the building to be configured so that failure or damage to one element does not lead to the inevitable failure of the building or a breach of the habitable envelope; and • Attached and adjacent structures (within 6m) must also comply with the Standard.					
Assessment Comments: Assets do not have a design to which AS3959 or NASH applies. ***Recommendation Details:*** Not Applicable.						
15.3	**Construction Materials for External and Internal Cavity Building Elements:** Except for internal living or operation spaces, to the degree necessary, utilise materials resistant to fire attack mechanisms of flame and radiant heat (preferably non-combustible) for all relevant building elements, including wall, roof, floor, supporting structures and framing systems.	Very High	Yes	Yes	No	No
Assessment Comments: The control room, switch room, and terminal boxes will have internal cavities. The structural components of a substation are entirely non-combustible (generally steel). ***Recommendation Details:*** Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
15.4	**Construction Materials for Consequential Fire Fuels:** For constructed large consequential fire fuels, use non-combustible materials to the fullest extent possible. Potential fuels include attached structures, adjacent structures and surrounding landscaping items (fences, screens, retaining walls etc.).	High	No	Yes	Yes	No
Assessment Comments: No constructed fuels have been identified except the external electrical components (insulators, conductors etc). The substation will be designed in compliance with the relevant Australian Standards. AS 2067-2016 *Substations and high voltage installations exceeding 1 kV a.c.* and AS/NZS 7000:2016 *Overhead Line Design* consider asset-to-asset fire, or fire spread within the asset, to be a critical issue. Note these Australian Standards only consider bushfire in a general sense, and the measures within this Report intend to limit the interaction between bushfire and energised infrastructure to an appropriate level. ***Recommendation Details:*** Not Applicable						
15.5	**Construction Design / Materials Resistant To High Wind Damage:** Apply construction measures to prevent the type of building damage from wind that will open or create gaps (from the wind itself or carried projectiles) and allow the entry of embers, radiant heat and flames. This type of damage is typically superficial damage. Building codes relating to wind (e.g., cyclones) do not necessarily address this superficial type of impact. Additional fixings for building envelope claddings and protection of the most vulnerable elements, such as glazing, from debris impact, are key considerations. Consider applying the principles of the NASH Standard [33] design solution to construction. "Potential wind effects directly associated with bushfire events have been considered in this Standard. Wind actions may affect buildings subject to a bushfire attack in various ways including: • The intensity of flame front activity may produce locally high wind pressures on parts of the building; • In the post fire phase, some weakened components on the building envelope may be vulnerable to normal design pressures; and • Wind can drive embers into the building envelope." Most applicable when the physical requirements exist for the development of an extreme bushfire event within the surrounding landscape.	Medium	Yes	Yes	No	No
Assessment Comments: The reliability of substations against wind damage are a major design consideration internationally due to severe storm events. High wind impacts are assumed to be addressed within the relevant guidance/regulatory material. ***Recommendation Details:*** Not Applicable						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
15.6	**Construction of Gas Supply:** All gas cylinders are installed and maintained in accordance with AS 1596 (for domestic house supply) as a guide. The requirement of the standard includes: • Safety release valve shall be directed away from the building and persons access/egress routes; • Metal piping and fittings shall be used on all piping inside the building's cavities and enclosable occupied spaces and the high pressure side of any gas regulators; and • Tethers securing cylinders are to be non-combustible. The objective is to reduce the risk of consequential (secondary) fire against a building and reduce the risk of death or injury, from gas flaring or explosion. The rationale is gas cylinders which have either flared or ruptured are commonly found in post bushfire surveys [9]. The heat from the bushfire or consequential (secondary) fire has been sufficient to cause their pressure to reach critical levels beyond which their pressure release valve releases large quantities of LP gas. If these gas cylinders fall over, this pressure release valve may no longer function correctly, meaning that the gas cylinder may continue to increase in pressure with continued heating until the cylinder ruptures. The resulting explosion includes a pressure wave and large ball of flame which can threaten nearby life and buildings. Readily available guidance is provided by CSIRO Best Practice Bushfire Guide (https://research.csiro.au/bushfire/new-builds/water-electricity-gas/) and WA Dept. Mines, Industry, Regulation and Safety 'LP Gas cylinder safety in bushfire prone areas' (https://www.commerce.wa.gov.au/publications/lp-gas-cylinder-safety-bushfire-prone-areas).	Medium	N/A	N/A	N/A	N/A
Assessment Comments: Gas storage is not proposed on site. Any LPG will be stored in compliance with AS 1596. ***Recommendation Details***: Not Applicable						
15.7	**Construction of Electricity Supply:** Cabling to be shielded (includes installing underground within subject property boundary) from applicable bushfire attack mechanisms. The objective is to assist with continuity of supply for essential site operations and/or electrically driven firefighting pumps. It also reduces the risk of electrocution to any persons onsite and reduces potentially additional sources of fire ignition. It is common in bushfires for power infrastructure to burn and collapse or be impacted by falling trees or branches while power lines are still live. Removing this risk may be appropriate for some sites.	Medium	Yes	Yes	Unknown	Yes
Assessment Comments: The following document was found to be relevant in the assessment of proposed substations: *NS187 Passive Fire Mitigation Design of Major Substations* - Internal Document No. NW000-S0007 (Ausgrid 2020). Ausgrid Pty Ltd is Australia's largest electricity distributor (in terms of customers and energy load), and the document referenced is an internal network standard. The below table is sourced from Section 12 of the network standard.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					

Table 3 – Radiant Heat Exposure Limits for Bushfires

Item	Maximum allowable radiant heat flux (kW/m^2)	Comment
Cable	12.5 20	PVC Cables begin to distort and may ignite. Ignition of XLPE cables between 85 and 550 seconds.
Steel support structure	35	To 60% of yield strength after a maximum duration of 5 minutes. Applies where elastic deflections due to elevated temperatures are not critical.
Porcelain bushing/Insulators	>30	Damage may occur requiring replacement or in extreme case resulting in catastrophic failure. See Note 2.
Polymeric bushing/insulators	>30	Damage may occur requiring replacement or in extreme case resulting in catastrophic failure. See Note 2.
Aluminium busbar	20	Based on 250°C after a maximum duration of 5 minutes. Comparable to withstand temperature under fault conditions.
Copper busbar	25	Busbars may undergo significant distortion and impose significant stresses on rigid insulators.
Transformer tank	>35 (see Note 1)	Refer to above regarding bushings and cables.
Combustibles	12.5	Piloted ignition may occur on timber.

Note 1. Transformers always have some more vulnerable components such as bushings and cables etc. Refer to Clause 7.2.

'Combustibles' in this description are consequential fire hazards for the purposes of the bushfire assessment: packing materials, pallets, waste, and other assorted debris. These should not be present within the substation footprint and where necessary should be positioned away from infrastructure components, applied in **Measure 6.7**.

The materials identified as critical are discussed in **Measure 8.3** in determining the appropriate APZ.

Tree strike is considered in **Measures 6.4** and **8.4**.

Recommendation Details: See **Measure 8.3**

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
15.8	**Minimise Re-entrant Detail to Minimise Debris and Ember Accumulation:** Avoid or limit the accumulation of unburnt debris and embers by minimising re-entrant details and/or adopting aerodynamic forms that will self-shed windblown debris and embers. For example: • Simple building/structure footprints that avoid re-entrant corners in access ways, at wall/floor, wall/ground, roof/wall junctions and around doors, vents, windows; and • Simple roof layouts that avoid valleys and minimise the number of ridges that need protection details (e.g. skillion roofs).	Medium	Yes	Yes	Yes	No
Assessment Comments: All substation components are mounted on concrete slabs and elevated from the ground, with only flat/rounded surfaces with through wind action possible. Features above ground level are more complex but are fully exposed to wind action. Fencing is the only identified feature which can trap significant quantities of debris. Debris (leaf litter) can accumulate against fence lines. Any fence will be set back from the closest substation component by >2m. Debris may be blown from the fence line and distribute the material to be a minor hazard (individual firebrands vs no directly flammable components). The fencing itself will be entirely non-combustible and may be brick, weldmesh, palisade etc. ***Recommendation Details:*** Not Applicable						
15.9	**Minimise Debris/Ember Trapping Surfaces:** Avoid or minimise the use of exposed combustible surfaces that can trap and accumulate debris and embers. These include: • Horizontal, or shallow angle surfaces e.g. exposed wall/roof framework, roofs, decking, verandahs, steps, windowsills; and • Vertical surfaces with rough textured cladding (e.g. sawn timber).	Medium	No	Yes	No	No
Assessment Comments: Horizontal surfaces are present but fully exposed to wind action, so debris will not accumulate. Fencing can allow debris to accumulate. Perimeter fencing will be present around the Project but will be set back several metres from infrastructure components. ***Recommendation Details:*** Not Applicable						
15.10	**Protect Roof Plumbing to Minimise Debris and Ember Accumulation:** All roof plumbing (gutters, valleys) is protected from the accumulation of debris and embers that can result in direct fire attack mechanisms immediately adjacent to any combustible elements within the roof cavity.	Medium	N/A	N/A	N/A	N/A
Assessment Comments: The substation will not have roof plumbing.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
Recommendation Details: Not Applicable						
15.11	**Minimise Construction Cavities to Minimise Debris and Ember Accumulation:** Apply designs that lower the potential for accumulation of embers and debris within cavity spaces of buildings/structures. Examples include concrete floor slab on the ground and solid masonry walls.	Medium	No	Yes	No	No
Assessment Comments: The substation will be externally sealed and mounted on concrete slabs, so there will be no construction cavities. ***Recommendation Details***: Not Applicable						
15.12	**Minimise External Openings to Limit Flame/Radiant Heat/Ember/Debris Entry:** Limit potential sites for threat entry to through the external building envelope to internal spaces containing combustible materials (consequential fire fuels). Examples include reducing windows/doors on elevations facing the bushfire hazard and apply design to limit gaps and penetrations that will require screening.	Medium	No	Partly	No	No
Assessment Comments: The control room, switch room, and terminal boxes will have internal cavities. These will have a single door and no windows. Vents will be installed where required, so the design cannot be altered to reduce the capacity for ember intrusion. ***Recommendation Details***: Not Applicable						
15.13	**Screen and Seal Gaps and Penetrations:** Apply fire rated sealants and/or install metal screening (corrosion resistant steel, bronze, aluminium <2mm aperture). All external construction and penetration gaps with apertures greater than 2mm will allow ember entry (and potentially debris) to internal cavities and combustible materials within (as consequential fire fuels). This includes gaps in roofs, walls, doors, windows and their surrounding trims – including those associated with penetrations, vents, weepholes, poor workmanship and material deterioration and movement over time (maintenance). Internal fire is difficult to see and extinguish.	Medium	Yes	No	Unknown	Yes
Assessment Comments: The control room, switch room, and terminal boxes may have external vents. ***Recommendation Details***: Consider application of ember screening to the external vent interface of the control room, switch room, terminal boxes etc. The intention is to prevent both ember ingress and debris accumulation. Ember screening mesh is to be maximum 2mm aperture and composed of corrosion-resistant steel, bronze, or aluminium.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
15.14	**Screen External Doors and Windows**: Metal screens (corrosion resistant steel, bronze, aluminium <2mm aperture) installed over non-openable and/or openable parts of windows and doors to prevent ember entry to internal spaces containing combustible materials (consequential fire fuels) and reduce radiant heat load on vulnerable surfaces.	Medium	No	No	No	No
Assessment Comments: Screening will not be applied to doors. ***Recommendation Details***: Not Applicable						
15.15	**Shutter External Doors and Windows**: Fire rated shutters are installed to significantly increase bushfire resistance of the vulnerable building elements.	Medium	No	No	No	No
Assessment Comments: Assets will not have windows. Shutters are not applied to doors of the same construction as the enclosure. ***Recommendation Details***: Not Applicable						
15.16	**Construction Materials for Critical Non-Structural Elements:** Utilise fire/radiant heat rated products (rated to the level determined necessary), for the construction of non-structural elements that are essential to the continued operation of the built asset, and which are potentially exposed to the attack mechanisms of both bushfire and consequential fire. These vulnerable elements include cabling and plumbing associated with power (delivery) inputs and outputs, data transmission, liquid/gas transport (fuel/water) etc.	High	Yes	Yes	No	Yes
Assessment Comments: The materials identified as critical are discussed in **Measure 8.3** in determining the appropriate APZ. These components are integral to the design and cannot be replaced with materials more resistant to fire attack mechanisms. ***Recommendation Details:*** See **Measure 8.3**						
THE PROTECTION MECHANISM – AVAILABILITY OF A FIREFIGHTING RESPONSE CAPABILITY: Provide sufficient and reliable dedicated firefighting water supply and delivery capability as necessary for installed active and/or passive systems.						
15.17	**Firefighting Water Supply:** Have a dedicated static supply of firefighting water for the protection of buildings/structures before and after the passage of a bushfire front. Adequate water supply is critical for any firefighting operation, particularly where property protection is the intent. This is necessary when: • A water supply additional to a reticulated water supply is required to counter the loss of firefighting water as a protection measure, should the reticulated supply be interrupted; and • It is the only source of firefighting water.	High	Yes	No	Yes	Yes

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
	All tanks shall be non-combustible. Aside from losing water, failure of combustible tank can provide an additional heat load to a vulnerable building element. Metal piping and fittings shall be used for any above ground components. The limitation to the effectiveness of the measure is the requirement for persons to be present and have the minimum required operational knowledge and/or access to appropriate information.					
Assessment Comments**:* The Substation will be reasonably adjacent to the BESS and will be serviced with the same water supply. ***Recommendation Details: See **Measure 13.17.**						
15.18	**Firefighting Equipment Actively Operated:** In addition to a dedicated water supply, appropriate mobile firefighting appliances are available quickly and/or fixed firefighting equipment is installed (pumps, hoses, sprinklers etc). Where equipment is installed, this will be resilient to bushfire impact, to the extent necessary, through the application of appropriate equipment materials and protection (shielding or separation from the hazard). The limitation to the effectiveness of the measure is the requirement for persons to be present and have the minimum required operational knowledge and/or access to appropriate information.	High	Yes	No	No	Yes
Assessment Comments**:* The firefighting operations for the proposal have been assessed and discussed within a single measure. Through the Site Emergency Plan, an Emergency Response Team will be designated and trained in firefighting operation. Ensure the Site Emergency Plan and training for the Emergency Response Team considers bushfire as well as asset fires. ***Recommendation Details: See **Measure 9.3.**						
15.19	**Fire Fighting Equipment Passively Operated:** In addition to a dedicated water supply, appropriate water dispensing apparatus are installed (e.g. pumps, plumbing and sprinklers) that are automatically activated. These will be resilient to bushfire impact, to the extent necessary, through the application of appropriate equipment materials and protection (shielding or separation from the hazard).	High	Yes	No	Yes	Yes
Assessment Comments**:* Automatic monitoring and remote control of transmission lines allows for remote shut down in an emergency. Automatic fire protection systems can rapidly disconnect power (80 to 120 milliseconds from detection). Heavy smoke from a bushfire can increase the chance of an arc flash, thus automatic fire protection systems may be applied even where the substation is otherwise resisting the impacts of bushfire. ***Recommendation Details: See **Measure 9.3**						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
15.20	**Fire Fighting Equipment Operability Maintained:** Where water pumps, shutters or other active/passive protection measures rely on the continued supply of electricity, establish barriers (shielding) or separation from potential damaging factors (e.g. falling trees/branches, fire, or other impact sources). For example, bury transmission systems to the greatest extent possible.	High	Yes	No	Unknown	Yes
***Assessment Comments**: DFES Guidance Note: Firefighting Water Supply Considerations for Special Hazard & Dangerous Goods Sites* has been considered in the design of the firefighting water supply. The site will have an independent power supply through either the onsite BESS or generators. ***Recommendation Details**:* See **Measure 13.20.**						
15.21	**Access via Firebreaks Provided:** Installation and maintenance of firebreaks to facilitate firefighting access / backburning (and also limiting surface fire progression).	Medium	Yes	Yes	Yes	No
***Assessment Comments**:* Direct access to classified vegetation areas (vegetation screens and adjacent pasture) will be via the internal access network. The Operations and Maintenance Building will have access roads installed, and the BESS and Substation footprint will be a trafficable hardstand. The Operations and Maintenance Building buildings will likely (but is not required) to be installed on a hardstand. Firebreaks are required by the Shire of Kojonup Section 33 Notice. Some firebreaks may be upgraded to function as part of the internal road network. ***Recommendation Details**:* Not Applicable						
THE PROTECTION MECHANISM – MANAGE AND MAINTAIN EFFECTIVENESS OF APPLIED PROTECTION MEASURES: To ensure the retention of the level of bushfire resilience that has been established through the implementation of appropriate bushfire protection measures, formal and enforceable responsibilities are created.						
15.22	**Formal Documents Created to Guide and Enforce Management:** Through relevant site operations document(s) and/or an enforceable agreement, regulation or standard, a mechanism is put in place to ensure that: • The required management and maintenance of applied bushfire protection measures is conducted on a regular basis – with the interval dependent on the necessary frequency that will maintain full effectiveness; • The relevant protection measures are known and understood; and • Responsibilities are created.	High	Yes	No	Yes	Yes
***Assessment Comments**:* The documents have been or will be produced. Section 6.1 of this Bushfire Risk Report includes the operational documents to include bushfire protection measures.						

PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Element at Risk	Substation					
Recommendation Details: See **Measure 13.22.**						

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.2.4 for explanation and defining.

Note 2: Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use.
- **Fully or Partly Exists**: A current state assessment of protection measures already implemented by existing components of the proposed development/use. The status of current implementation can also be fully or partly. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Currently Planned:** Protection measures that:
    - Are incorporated into the site plans;
    - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and are comprised of the applicable acceptable solutions (established by the 'Planning for Bushfire Guidelines', DPLH as amended), that can be met and for which a responsibility for their implementation can be created in the BMP.

  These planned measures are accounted for in assessing 'inherent' risk levels (refer to Glossary).
- **Additionally Recommend:** Protection measures that:
    - Exist in a concurrently produced Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and comprise alternative solutions and/or additional recommended protection measures (that can and should be implemented in the opinion of the bushfire consultant), and for which a responsibility for their implementation can be created in the BMP; and/or
    - Are developed in the process of producing this risk assessment and management report and for which a responsibility for their implementation can be created in the BMP.

  These additionally recommended measures, along with existing and planned measures, are accounted for in assessing 'residual' risk levels (refer to Glossary).

5.4.6.2 PROTECTION MEASURE ANALYSIS – NUMBER SUMMARY

For the stated element at risk, the numbers of both available and potentially applied bushfire protection measures are summarised and the effectiveness of each measure at reducing vulnerability levels is stated (refer to Appendix 1 for explanatory and supporting information).

This information is applied in the following section of this report to the derivation of the potential for applied bushfire protection measures to reduce the vulnerability of the relevant element at risk to bushfire hazard threats.

VULNERABILITY REDUCING PROTECTION MEASURE ANALYSIS							
Element at Risk	Substation						
The Protection Mechanism	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Fully Exists	Partly Exists	Currently Planned	Additionally Recommend
Construction Design and Materials	Very High	2	1	1			
	High	3	1	2		1	1
	Medium	11	4	5	1	1	2
	Not Relevant						
Availability of a Firefighting Response Capability	Very High						
	High	4	4			2	4
	Medium	1	1	1		1	
	Not Relevant						
Manage and Maintain Effectiveness of Applied Protection Measures	Very High						
	High	1	1			1	1
	Medium						
	Not Relevant						
Number Analysis	Very High	2	1	1			
	High	8	6	2		4	6
	Medium	12	5	6	1	2	2
	Not Relevant						
	Totals	22	12	9	1	6	8

Note 1: Protection Measure Effectiveness Rating: Refer to Appendix A1.3.4 for explanation and defining.

Note 2: Protection Measure Application Status: Refer to table footnotes in the preceding section.

5.4.6.3 PROTECTION MEASURE ANALYSIS – POTENTIAL TO REDUCE VULNERABILITY

From the information presented in the previous section, the vulnerability reducing potential of the applied bushfire protection measures is assessed as a function of:

- The number of bushfire protection measures that can be applied to the subject element at risk and the subject site/use, compared to the number available; and
- The effectiveness rating that is given to each applied protection measure that weights the relative ability of the measure to reduce vulnerability (refer to Appendix A1.3.4 for supporting and explanatory information).

ASSESSED POTENTIAL FOR APPLIED PROTECTION MEASURES TO REDUCE VULNERABILITY TO BUSHFIRE HAZARD THREATS [1]							
Element at Risk	Substation						
WHEN EXISTING AND PLANNED PROTECTION MEASURES ARE APPLIED [2]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Moderate	Moderate	Moderate	Significant	Very Significant	Very Significant	Moderate	Significant
Moderate				Significant			
WHEN EXISTING, PLANNED AND RECOMMENDED PROTECTION MEASURES ARE APPLIED [3]							
Direct Attack Mechanisms [4]				Indirect Attack Mechanisms [4]			
Flame Contact	Radiant Heat	Embers / Burning Debris	High / Erratic Fire Driven Wind	Debris Production / Accumulation	Surface Fire	Tree Strike / Obstruction	Consequential (Secondary) Fire
Moderate	Significant	Very Significant	Significant	Very Significant	Very Significant	Moderate	Significant
Significant				Significant			

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: This vulnerability reducing potential will be applied to deriving the inherent vulnerability level (i.e. the current state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 3: This vulnerability reducing potential will be applied to deriving the residual vulnerability level (i.e. the potential future state). Refer to Appendix A1.3.3 for explanatory and supporting information.

Note 4: Refer to Appendix 2 for explanatory and supporting information.

Assessment Comments: Substations already consider fire impacts within their design and both national standards and state regulations apply. Recommendations are for shielding cabling where possible (including within structures/underground), and ensuring embers cannot enter enclosed spaces (control room, switch room, terminal boxes etc).

5.4.6.4 DERIVED VULNERABILITY LEVEL - INHERENT AND RESIDUAL

The preceding bushfire protection measure analysis has, through a mostly qualitative assessment process, enabled the derivation of the inherent and residual vulnerability levels.

In combination with the corresponding assessed threat and exposure levels, they will subsequently be applied to deriving the inherent and residual bushfire risk levels.

DERIVED POTENTIAL VULNERABILITY LEVELS POST APPLICATION OF EXPOSURE REDUCING BUSHFIRE PROTECTION MEASURES [1]							
ELEMENT AT RISK		Substation					
BUSHFIRE ATTACK MECHANISMS [2]		INHERENT VULNERABILITY LEVEL (CURRENT STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	Moderate
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
BUSHFIRE ATTACK MECHANISMS [2]		RESIDUAL VULNERABILITY LEVEL (POTENTIAL FUTURE STATE) [3]					OVERALL
DIRECT	Flame Contact	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	Low
DIRECT	Radiant Heat	Very Low ☐	Low ☐	Moderate ☒	High ☐	Extreme ☐	
DIRECT	Embers / Burning Debris	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
DIRECT	High/Erratic Fire Driven Wind	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Debris Production / Accumulation	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Surface Fire	Very Low ☒	Low ☐	Moderate ☐	High ☐	Extreme ☐	
INDIRECT	Tree Strike / Obstruction	Very Low ☐	Low ☐	Moderate ☐	High ☒	Extreme ☐	
INDIRECT	Consequential (Secondary) Fire	Very Low ☐	Low ☒	Moderate ☐	High ☐	Extreme ☐	

Note 1: Refer to Appendix 1 for explanatory and supporting information.

Note 2: Refer to Appendix 2 for explanatory and supporting information.

Note 3: Refer to Appendix A1.3.3 for explanatory and supporting information. 'Inherent' accounts for all currently implemented bushfire protection measures and those planned to be implemented. 'Residual' additionally accounts for bushfire protection measures recommended to be implemented by the bushfire consultant.

6 BUSHFIRE RISK MANAGEMENT – PROTECTION MEASURE IMPLEMENTATION ASSESSMENTS

BUSHFIRE RISK MANAGEMENT MECHANISMS

Effective bushfire risk management mechanisms are needed to direct the implementation of required and recommended bushfire protection measures and ensure they continue to be maintained as effective measures.

To assist planners and managers to navigate this space, Bushfire Prone Planning divides the risk management mechanisms into:

- Mandatory mechanisms; and
- Informative mechanisms – although there will be some crossover.

Mandatory Mechanisms: Are those developed by relevant government authorities to establish required minimum protection measures and will require compliance. Some apply to both existing and future operations (use of sites), while others are primarily directed at future development. They include:

- Operating Regulations and Standards where part of the content will have direct relevance to a fire event;
- Construction Standards for buildings in bushfire prone areas; and
- Planning guidelines/overlays establishing certain minimum requirements (including producing a 'Planning' Bushfire Management Plan for planning applications).

Informative Mechanisms: Are those documents that detail the recommended and/or required actions and operational responsibilities as bushfire protection measures to be implemented for a specific site and its use. All bushfire protection measures and their detail, are initially identified through the application of the risk assessment process as:

- Currently existing (fully or partly);
- Required to be implemented;
- Recommended to be implemented; and
- Will have a recommended implementation priority rating.

The Bushfire Risk Report can present the required bushfire protection measure information in two formats:

1. As recommendations and advice at various stages of planning and development to assist with initial planning, initial design, construction, extension, change of use, or just improving on existing resilience to bushfire - as relevant to the identified element(s) at risk; and/or
2. As the specific protection measures that are to be incorporated into required site operations documents and possibly co-ordinated by an overarching 'Operational' Bushfire Management Plan (as distinct from a 'Planning' BMP) when applicable.

Each protection measure will be subject to consideration by the persons responsible for the site and its use regarding their decision to implement it, after evaluating their own required operational outcomes and any operational constraints. The key benefit provided by the bushfire risk report being they can now also evaluate the potential impact of their decisions on the residual bushfire risk. The site operations documents will vary according to site use and management requirements and can include:

- A local government's planning scheme.
- Site Operations Procedures.
- Annual Site Works Program.
- Prescribed Burning Guide.
- Site Emergency Plan / Guide / Evacuation Plan / Bushfire Emergency Plan

6.1 INFORMATIVE MECHANISMS – ASSESSMENT AGAINST NON-MANDATORY GUIDANCE

6.1.1 APPLICABLE PLANNING GUIDELINES (PLANNING STANDARDS)

APPLICABLE PLANNING DOCUMENTS
Design Guidelines and Model Requirements for Renewable Energy Facilities v4.4 Victorian Country Fire Authority – Specialist Risk and Fire Safety Unit (June 2025).

6.1.1.1 COMPLIANCE ASSESSMENT

COMPLIANCE WITH THE RELEVANT ACCEPTABLE SOLUTIONS
The Planning Document/s The applicable planning documents establish packages of bushfire protection measures that are to be applied, each with different sets of specifications and requirements to be satisfied and applied to different types of development or use with appropriate variations. The aim of these is to provide for the protection of human life and minimise impacts on property from the threats of bushfire, while having due regard to development potential, site characteristics and protection of the environment. The bushfire protection measures are typically grouped under a common and specific purpose. Each purpose has: 1. A performance outcome, objective, criteria or intent to be met (satisfied); and 2. Provides for two pathways to satisfy the required performance: a) Prescriptive measures and their requirements as acceptable solutions (approved measures); or b) The ability to develop an alternative solution. **The Compliance Assessment** The assessment will consist of: 1. Identification of the relevant development type/use associated with the subject site. 2. Identify if the Design Advice or Model Requirement criteria is relevant within the context of the Western Australian Planning System. 3. Where a Design Advice or Model Requirement criteria is relevant: a. Determine whether the existing planning or design of the proposed development complies with the criteria or its intent; or b. Provide recommendations for the proposed development to meet the criteria or its intent; or c. Detail why the measure is not or cannot be met. 4. Potential alternative solutions may be provided, but this is applied as a 'Modification' as there is no body or process for consultation/verification that the alternative meets the intent of the criteria.

Following prior requests of DFES Land Use Planning, a separate report provides the assessment of alignment with the *Design Guidelines and Model Requirements for Renewable Energy Facilities v4.4*. See *241243 – Kojonup BESS (CFA) v1.1* (Bushfire Prone Planning, May 2026).

6.2 INFORMATIVE MECHANISMS – GUIDANCE FOR THE APPLICATION OF ALL BUSHFIRE PROTECTION MEASURES

6.2.1 BUSHFIRE HAZARD THREAT REDUCING MEASURES

BUSHFIRE HAZARD **THREAT REDUCING PROTECTION MEASURES [1]** **All Implemented ('Existing' & 'Planned') and 'Additionally Recommended' Protection Measures**			**IDENTIFICATION OF 'ADDITIONALLY RECOMMENDED' (EXTRA) MEASURES AND THEIR IMPLEMENTATION PRIORITY**		**APPLICATION GUIDANCE** **Identification of the Document(s) Recommended to Contain the Applicable Protection Measures**							
			EXTRA MEASURE	**PRIORITY RATING [2]**	**DOCUMENTS REQUIRED FOR PLANNING FUTURE DEVELOPMENT AND/OR RETROFIT**		**OPERATIONAL DOCUMENTS RELEVANT TO SITE USE**					
The Protection Mechanism	Ref No	Brief Description [1]			Bushfire Manage. Plan (Planning)	Inform Design & Construct	External Agreement	Site Operations Procedures	Emergency Services Manifest	Site Emergency Plan/Guide	Site Works	Staff Inductions and Training
Prevent bushfire ignition by managing heat energy sources	1.9	Management of Planned Revegetation	✓	Medium	✓	✓						
	1.10	Robust and effective site operational procedures	✓	Medium				✓			✓	✓

[1] The full description of each bushfire protection measure, the detail of the assessment and any recommendation, is presented in Section 5.1.4.
[2] Refer to Appendix A1.2.5 for implementation priority rating explanation.

6.2.2 EXPOSURE REDUCING MEASURES – ALL STRUCTURES

ALL STRUCTURES EXPOSURE REDUCING PROTECTION MEASURES [1] All Implemented ('Existing' & 'Planned') and 'Additionally Recommended' Protection Measures			IDENTIFICATION OF 'ADDITIONALLY RECOMMENDED' MEASURES AND THEIR IMPLEMENTATION PRIORITY		APPLICATION GUIDANCE Identification of the Document(s) Recommended to Contain the Applicable Protection Measures							
					PLANNING FUTURE DEVELOPMENT		OPERATIONAL – AS RELEVANT TO SITE USE					
The Protection Mechanism	Ref No	Brief Description [1]	EXTRA MEASURE	PRIORITY RATING [2]	Bushfire Manage. Plan (Planning)	Inform Design & Construct	External Agreement	Site Operations Procedures	Emergency Services Manifest	Site Emergency Plan/Guide	Site Works	Staff Inductions and Training
Establish sufficient separation from relevant bushfire hazard threats	4.3 5.2 6.3 8.3	Landscaping - asset protection zone (APZ)	✓	Highest	✓	✓		✓			✓	
	4.4 6.4 8.4	Landscaping - tree location	✓	Lowest		✓					✓	
	4.7 5.3 6.7 8.7	Separation from stored and constructed combustible items	✓	High				✓				✓
Establish shielding from relevant bushfire hazard threats	4.12 6.12 8.12	Shield operation critical non-structural elements	✓	Medium		✓						

[1] The full description of each bushfire protection measure, the detail of the assessment and any recommendation, is presented in Sections 5.3.3 & 5.3.4 & 5.3.5 & 5.3.6.
[2] Refer to Appendix A1.2.5 for implementation priority rating explanation.

6.2.3 VULNERABILITY REDUCING MEASURES – PERSONS

PERSONS VULNERABILITY REDUCING PROTECTION MEASURES [1] All Implemented ('Existing' & 'Planned') and 'Additionally Recommended' Protection Measures			IDENTIFICATION OF 'ADDITIONALLY RECOMMENDED' MEASURES AND THEIR IMPLEMENTATION PRIORITY		APPLICATION GUIDANCE Identification of the Document(s) Recommended to Contain the Applicable Protection Measures							
					PLANNING FUTURE DEVELOPMENT		OPERATIONAL – AS RELEVANT TO SITE USE					
The Protection Mechanism	Ref No	Brief Description [1]	EXTRA MEASURE	PRIORITY RATING [2]	Bushfire Manage. Plan (Planning)	Inform Design & Construct	External Agreement	Site Operations Procedures	Emergency Services Manifest	Site Emergency Plan/Guide	Site Works	Staff Inductions and Training
Provision of bushfire emergency information and education	9.3	Develop a bushfire emergency plan	✓	High					✓	✓		✓
	9.6	Direct to persons emergency messaging system	✓	Medium								✓
	9.10	Build community resilience through education	✓	Medium								
Lower risk road construction (design and materials)	Persons on Access / Egress Routes in Vehicles											
	10.7	Interconnected road network to provide route options	✓	Medium		✓				✓		

[1] The full description of each bushfire protection measure, the detail of the assessment and any recommendation, is presented in s5.4.1 and s5.4.2.
[2] Refer to Appendix A1.2.5 for implementation priority rating explanation.

6.2.4 VULNERABILITY REDUCING MEASURES – ALL STRUCTURES

ALL STRUCTURES VULNERABILITY REDUCING PROTECTION MEASURES [1] All Implemented ('Existing' & 'Planned') and 'Additionally Recommended' Protection Measures			IDENTIFICATION OF 'ADDITIONALLY RECOMMENDED' MEASURES AND THEIR IMPLEMENTATION PRIORITY		APPLICATION GUIDANCE Identification of the Document(s) Recommended to Contain the Applicable Protection Measures							
					PLANNING FUTURE DEVELOPMENT		OPERATIONAL – AS RELEVANT TO SITE USE					
The Protection Mechanism	Ref No	Brief Description [1]	EXTRA MEASURE	PRIORITY RATING [2]	Bushfire Manage. Plan (Planning)	Inform Design & Construct	External Agreement	Site Operations Procedures	Emergency Services Manifest	Site Emergency Plan/Guide	Site Works	Staff Inductions and Training
Construction design and materials	11.1	Construct to AS 3959:2018	✓	High		✓						
	11.3 13.3 15.3	Construction materials for external and internal cavity building elements	✓	Lowest		✓						
	11.5 13.5 15.5	Construction design/materials resistant to high wind damage	✓	Lowest		✓						
	11.11 13.11 15.11	Minimise construction cavities to minimise debris and ember accumulation	✓	Highest		✓						
	11.12 13.12 15.12	Minimise external openings to limit flame / radiant heat / ember / debris entry	✓	Medium		✓						
	11.13 13.13 15.13	Screen and seal gaps and penetrations	✓	Medium		✓						
	11.14 13.14 15.14	Screen external doors and windows	✓	Lowest		✓						

ALL STRUCTURES VULNERABILITY REDUCING PROTECTION MEASURES [1] All Implemented ('Existing' & 'Planned') and 'Additionally Recommended' Protection Measures			IDENTIFICATION OF 'ADDITIONALLY RECOMMENDED' MEASURES AND THEIR IMPLEMENTATION PRIORITY		APPLICATION GUIDANCE Identification of the Document(s) Recommended to Contain the Applicable Protection Measures							
					PLANNING FUTURE DEVELOPMENT		OPERATIONAL – AS RELEVANT TO SITE USE					
The Protection Mechanism	Ref No	Brief Description [1]	EXTRA MEASURE	PRIORITY RATING [2]	Bushfire Manage. Plan (Planning)	Inform Design & Construct	External Agreement	Site Operations Procedures	Emergency Services Manifest	Site Emergency Plan/Guide	Site Works	Staff Inductions and Training
	13.16 15.16	Construction materials for critical non-structural elements	✓	Lowest								
Availability of a firefighting response capability	11.16 12.2 13.17 15.17	Firefighting water supply	✓	Highest	✓	✓			✓	✓	✓	
	11.17 12.3 13.18 15.18	Firefighting equipment actively operated	✓	Medium		✓				✓		✓
	11.18 13.19 15.19	Firefighting equipment passively operated	✓	Highest		✓			✓			✓
	11.19 13.20 15.20	Firefighting equipment operability maintained	✓	High		✓						
Manage and maintain effectiveness of applied protection measures	11.21 12.7 13.22 15.22	Formal documents created to guide and enforce management	✓	Medium				✓				✓
[1] The full description of each bushfire protection measure, the detail of the assessment and any recommendation, is presented in Sections 5.4.3 & 5.4.4 & 5.4.5 & 5.4.6.												

ALL STRUCTURES VULNERABILITY REDUCING PROTECTION MEASURES [1] All Implemented ('Existing' & 'Planned') and 'Additionally Recommended' Protection Measures			IDENTIFICATION OF 'ADDITIONALLY RECOMMENDED' MEASURES AND THEIR IMPLEMENTATION PRIORITY		APPLICATION GUIDANCE Identification of the Document(s) Recommended to Contain the Applicable Protection Measures							
					PLANNING FUTURE DEVELOPMENT		OPERATIONAL – AS RELEVANT TO SITE USE					
The Protection Mechanism	Ref No	Brief Description [1]	EXTRA MEASURE	PRIORITY RATING [2]	Bushfire Manage. Plan (Planning)	Inform Design & Construct	External Agreement	Site Operations Procedures	Emergency Services Manifest	Site Emergency Plan/Guide	Site Works	Staff Inductions and Training
[2] Refer to Appendix A1.2.5 for implementation priority rating explanation.												

APPENDIX 1: THE APPLIED RISK ASSESSMENT PROCESS

A1.1 THE RELEVANT RISK

For this Bushfire Risk Report, the relevant risk is associated with a bushfire event and is the potential for loss of life, injury, or destroyed or damaged assets. The potential outcomes of this risk are personal loss and/or the economic loss associated with the disruption of services and/or the necessary repair or replacement of buildings and infrastructure.

While this risk can be captured by the generic term of 'Bushfire Risk", this term is typically also used to refer to the chance (probability) of a bushfire event occurring and for which consideration of the likelihood of the ignition of vegetation fuels would be required.

However, the risk assessment process adopted in this report does not consider the likelihood of bushfire ignition. Instead, in applying a largely subjective assessment approach, the pragmatic assumption that a bushfire will occur is made. The rationale for this approach is explained in Appendix A1.3.7.

Consequently, in this risk report, the relevant risk will be referred to as the risk associated with a bushfire event.

A1.2 THE RISK ASSESSMENT FRAMEWORK

To conduct the risk assessment, Bushfire Prone Planning (BPP) has adapted the concept for 'Understanding Disaster Risk' as recognised by the United Nations Office for Disaster Risk Reduction [46] and presented in Figure A1.1. This concept is also applied by CSIRO within their Bushfire Best Practice Guide [48].

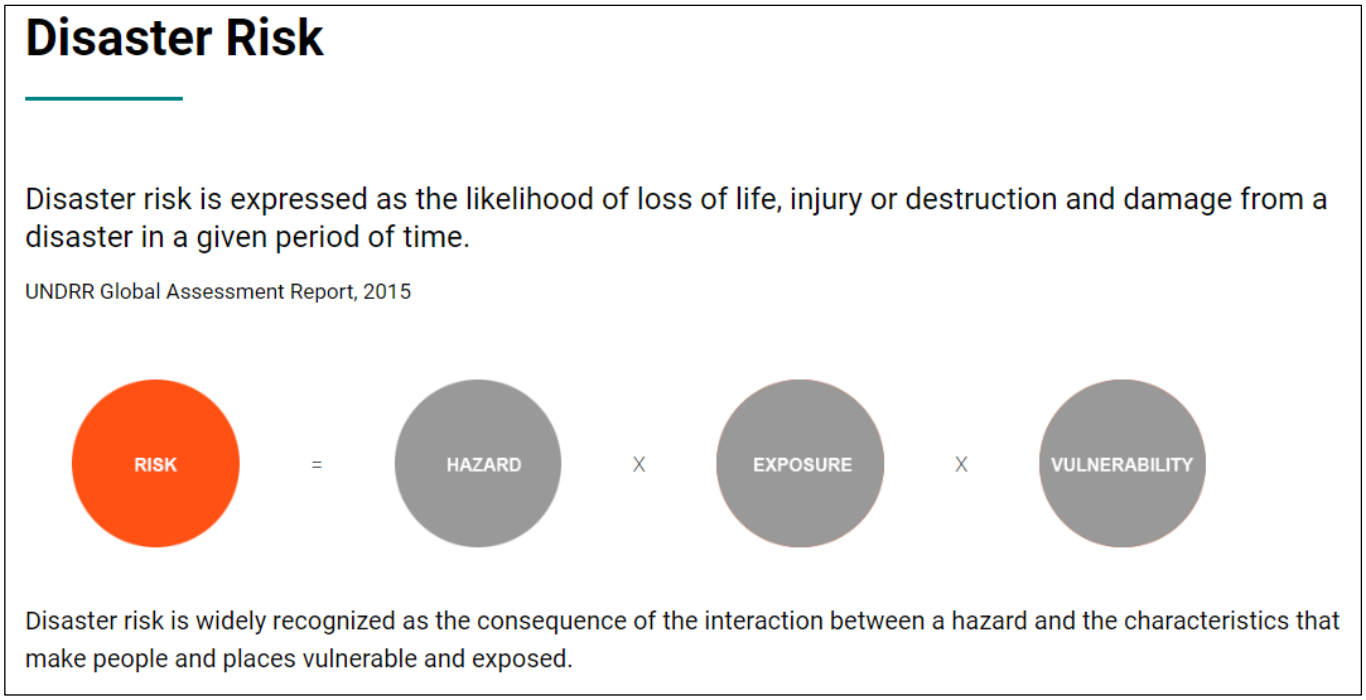


Figure A1.1: Concept for 'Understanding Disaster Risk' as recognised by the UN Office for Disaster Risk Reduction.

In applying this concept, bushfire risk can be considered a consequence of the interaction of bushfire hazard threats and the exposure and vulnerability of the elements at risk from those threats (i.e., the 'exposed elements' which can include various classes of persons and/or property).

The application of available bushfire protection measures will lower the level of risk associated with a bushfire by either:

1. Reducing the number and/or level of hazard threats; and/or
2. Reducing the level of exposure and/or vulnerability of the identified elements at risk.

Additional detail of the application of the risk assessment framework is presented in Figure A1.2 and Figure A1.3 on the following pages. Refer to the glossary for terminology information.

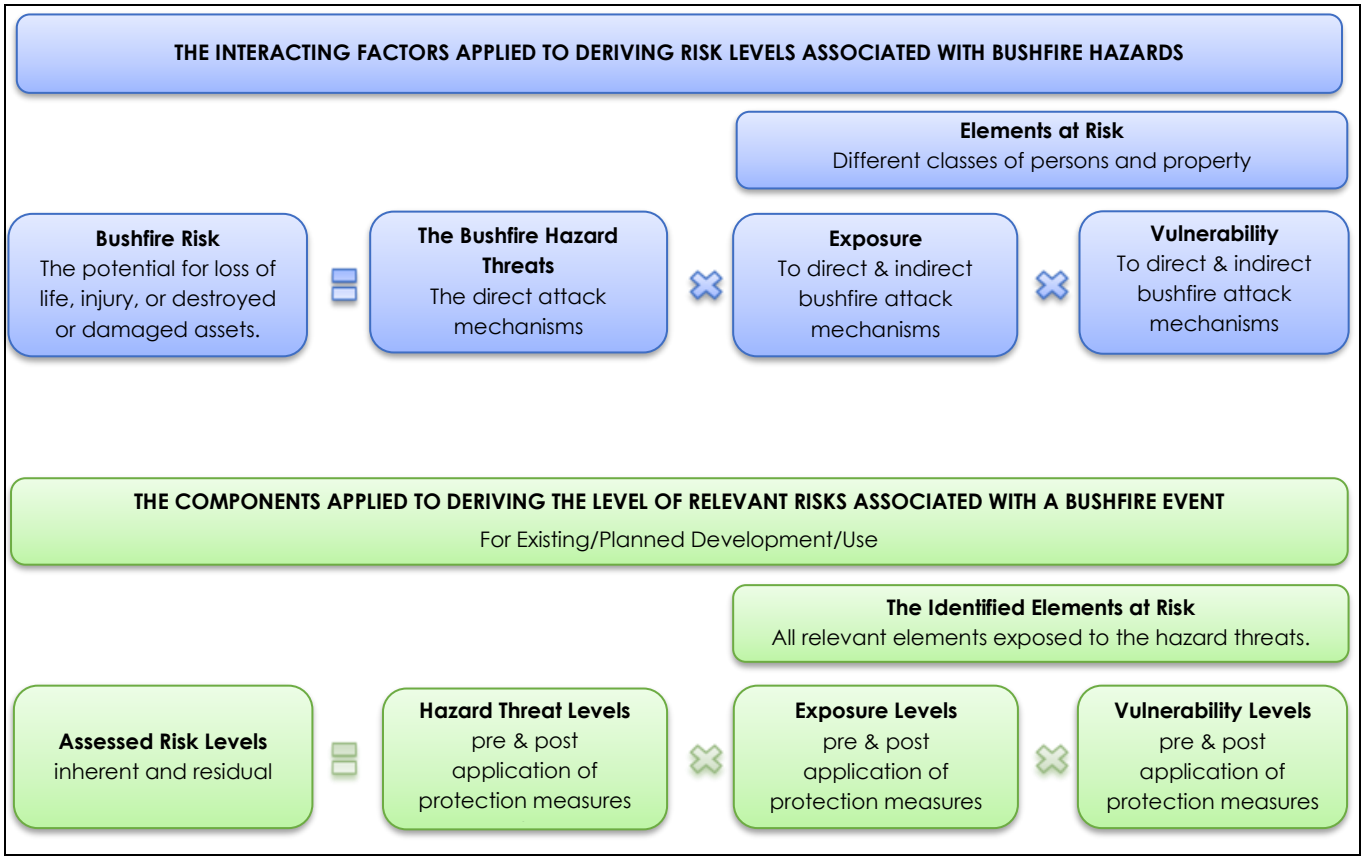


Figure A1.2: The framework of the applied bushfire risk assessment process.

Identify the Bushfire Hazard	Bushfire is a natural hazard and the common term for forest, scrub, shrub, and grass fire. It can exist in any vegetation (identified as the 'hazard') that establishes an ongoing source of readily combustible materials within and surrounding subject land, The bushfire hazard presents threats. These are the direct attack mechanisms (flame contact, radiant heat transfer, ember/burning debris attack, high/erratic fire driven wind) and indirect attack mechanisms (debris production/accumulation, surface fire, tree strike/obstruction, consequential fire). Identify and categorise surrounding vegetation based on a defined set of physical criteria. Each category has an associated 'Potential Threat Level' range.
Assess Hazard Threat Levels	Assess the existence of relevant physical factors in the surrounding landscape that can significantly change bushfire behaviour, intensity and the levels of each bushfire hazard threat and consequently the threat level for each identified category of vegetation. This assessment identifies how the threat level should be 'modified' (i.e., increased or decreased) within its potential range and derives a threat level that is to apply as the 'base' threat level, prior to application of any bushfire protection measures. Conduct a qualitative protection measure analysis that considers how many of all available bushfire protection measures - that can reduce threat levels - are and can be applied. The effectiveness of each measure at reducing threat levels is considered as part of the analysis. Apply the outcome to the derivation of 'Inherent' and 'Residual' threat levels.
Identify the Elements at Risk	Identify all relevant site specific elements 'exposed' to the bushfire hazard. These can include persons in different settings, buildings, structures, temporary accommodation, infrastructure and other physical assets.
Assess Exposure Levels	Conduct a qualitative protection measure analysis that considers how many of all bushfire protection measures available to reduce exposure levels (of an element at risk to bushfire threats), are and can be applied. Consideration of the effectiveness of each measure at reducing exposure levels is part of the analysis. Apply the outcome to the derivation of 'Inherent' and 'Residual" exposure levels.
Assess Vulnerability Levels	Conduct a qualitative protection measure analysis that considers how many of all bushfire protection measures available to reduce vulnerability levels (of an element at risk to bushfire threats), are and can be applied. Consideration of the effectiveness of each measure at reducing vulnerability levels is part of the analysis. Apply the outcome to the derivation of 'Inherent' and 'Residual' vulnerability levels.
Derive the Bushfire Risk Levels	There are potential risks associated with a bushfire hazard and a bushfire event. These include the loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. Derive 'Inherent' and 'Residual' risk levels (for each element at risk) from the derived threat, exposure and vulnerability levels by reference to the risk matrix.
State the Risk Tolerability	Derive the tolerability rating by applying the risk tolerance scale. The tolerability scale is based on the 'As Low as Reasonably Practical' (ALARP) principle.

Figure A1.3: Detail of applied bushfire risk assessment process.

A1.3 RISK ANALYSIS EXPLANATORY GUIDANCE

The risk analysis will derive risk levels as the outcome of the assessment. The risk level analysis can be conducted for either each element at risk separately and/or the proposed or existing development/use overall.

Different labels are applied to reported risk levels to indicate how they have been derived and what they refer to. These labels are:

1. The labels **'Indicative Risk Level'** and **'Determined Risk Level'** are used to identify what methodology has been applied in conducting the risk analysis. (Note: This Bushfire Risk Report **does not** derive 'determined' risk levels (but information is included to explain why this is not possible); and
2. The labels **'Inherent Risk'** and **'Residual Risk'** are used to identify the point in time for which the risk level is being reported i.e., the existing state or a future state.

Additional detail is provided in the following sections and in the Glossary.

A1.3.1 INDICATIVE RISK – APPLICATION JUSTIFICATION AND DERIVATION

Deriving 'Indicative Risk Levels' requires conducting a qualitative assessment. This establishes a subjective understanding of the level of risk that potentially exists and is intended to inform and assist with making planning and operational decisions.

The indicative risk level is derived from a mostly qualitative assessment of the site (some components of the assessment are quantitative in nature), the existing or planned development/use, the assessment of observable physical facts and the knowledge and relevant experience of the bushfire practitioner. The outcome is the provision of an informed and justifiable opinion regarding the levels of risk associated with a bushfire event.

This is an applicable and valuable process when the quantitative information required to derive a 'determined' risk level is either not available or is not possible to generate for practical or economic reasons. Refer to Appendix A1.3.2 for explanatory information.

JUSTIFICATION OF QUALITATIVE ANALYSIS APPROACH

Justification for deriving 'indicative' risk levels is based on the following assumptions:

1. There is a limited number of 'bushfire protection mechanisms' that can be applied to reducing hazard threats and the exposure and vulnerability of at risk elements.
2. There will be a range of individual bushfire protection measures associated with each 'protection mechanism'. The number of available protection measures for each 'protection mechanism' will vary dependent on the specifics of the site and its use, including scale, but effectively these will also have a practical limit.
3. Individual bushfire protection measures will vary in their standalone effectiveness at reducing hazard threat levels and reducing the exposure and vulnerability levels of elements at risk (refer to A1.2.4).
4. The greater the number of effective bushfire protection mechanisms and associated measures that can be applied, the lower the indicative risk level will be.

DERIVATION OF THE INDICATIVE RISK LEVEL

For a given site/development/use, an indication of the level of risk associated with a bushfire event and its tolerability is derived by:

1. Assessing the 'indicative' hazard threat levels and the 'indicative' exposure and vulnerability levels of elements at risk by:
    a) Assessing the potential levels of threat presented by the direct and indirect bushfire attack mechanisms of the identified bushfire hazard;
    b) Assessing how many bushfire protection mechanisms and their associated protection measures are applicable and can be applied, compared to the total available; and
    c) Applying an effectiveness weighting to each protection measure.
2. Derive the indicative risk level by applying the risk matrix presented in Table A1.1;

3. Establish the tolerability of the risk by applying the 'As Low as Reasonably Practicable' (ALARP) principle and associated risk tolerance scale (refer to Appendix A1.2.5).

Table A1.1: Risk matrix for deriving indicative risk levels from the assessed potential hazard threats levels, and the potential exposure and vulnerability levels of elements at risk.

INDICATIVE RISK LEVEL MATRIX						
Potential Threat Level (a)	**Potential Exposure Level (b)**	**Potential Vulnerability Level (c)**				
		Very Low (1)	**Low (2)**	**Moderate (3)**	**High (4)**	**Extreme (5)**
Very Low (1)	**Very Low (1)**	**VL1**	**VL2**	**VL3**	**L4**	**L5**
	Low (2)	**VL2**	**VL3**	**L4**	**L5**	**L6**
	Moderate (3)	**VL3**	**L4**	**L5**	**L6**	**M7**
	High (4)	**L4**	**L5**	**L6**	**M7**	**M8**
	Extreme (5)	**L5**	**L6**	**M7**	**M8**	**H9**
Low (2)	**Very Low (1)**	**VL2**	**VL3**	**L4**	**L5**	**6**
	Low (2)	**VL3**	**L4**	**L5**	**L6**	**M7**
	Moderate (3)	**L4**	**L5**	**L6**	**M7**	**M8**
	High (4)	**L5**	**L6**	**M7**	**M8**	**H9**
	Extreme (5)	**L6**	**M7**	**M8**	**H9**	**H10**
Moderate (3)	**Very Low (1)**	**VL3**	**L4**	**L5**	**L6**	**M7**
	Low (2)	**L4**	**L5**	**L6**	**M7**	**M8**
	Moderate (3)	**L5**	**L6**	**M7**	**M8**	**H9**
	High (4)	**L6**	**M7**	**M8**	**H9**	**H10**
	Extreme (5)	**M7**	**M8**	**H9**	**H10**	**H11**
High (4)	**Very Low (1)**	**L4**	**L5**	**L6**	**M7**	**M8**
	Low (2)	**L5**	**L6**	**M7**	**M8**	**H9**
	Moderate (3)	**L6**	**M7**	**M8**	**H9**	**H10**
	High (4)	**M7**	**M8**	**H9**	**H10**	**H11**
	Extreme (5)	**M8**	**H9**	**H10**	**H11**	**E12**
Extreme (5)	**Very Low (1)**	**L5**	**L6**	**M7**	**M8**	**H9**
	Low (2)	**L6**	**M7**	**8M**	**H9**	**H10**
	Moderate (3)	**M7**	**M8**	**H9**	**H10**	**H11**
	High (4)	**M8**	**H9**	**H10**	**H11**	**E12**
	Extreme (5)	**H9**	**H10**	**H11**	**E12**	**E13**

Risk level key: VL = very low, L = low, M = moderate, H = high, E = extreme.
The qualitative relative levels are assigned a numerical value.
The risk value is calculated as = (a + b + c) – 2 and range from 1 (lowest) to 13 (greatest).
The irisk levels are derived from an assigned a numerical range: very low = 1-3, low = 4-6, moderate = 7-8, high = 9-11, extreme = 12-13.

A1.3.2 DETERMINED RISK – APPLICATION LIMITATIONS

IMPORTANT: THIS BUSHFIRE RISK REPORT DOES NOT DERIVE DETERMINED BUSHFIRE RISK LEVELS.

Deriving 'determined' risk levels requires conducting a quantitative assessment. This establishes an objective understanding of the level of risk that potentially exists and is intended to inform and assist with making planning and operational decisions.

The key difference from an 'indicative' risk level assessment is the requirement to apply a quantitative set of risk factor criteria against which hazard threat levels and the exposure and vulnerability levels of identified elements at risk to these threats can be objectively assessed.

These risk factor criteria would be developed and supported by a relevant government authority (exercising their responsibility), accepted by persons relying on the assessment and be available for the assessor to use. In addition, the corresponding risk level matrix and the risk tolerability scale are required.

It is necessary that:

1. The risk factor criteria reflect society's and/or community's expectations and preparedness/capacity to tolerate risk;
2. The information is standardised to the greatest extent possible so that it provides an accepted basis from which the determined risk level can be derived and be relied upon in making decisions;
3. The corresponding risk level matrix and the risk tolerability scale are developed to derive a risk level and tolerance level from the derived threat, exposure, and vulnerability levels; and
4. Responsibility for development of the reference information is not left to individual assessors who have varied expertise, qualification, and no approved responsibility to provide such information. Such an approach would not result in consistent and reliable assessment outcomes.

Limitations: Where the required reference information (that is researched, effective, functional and acceptable) has not been established and provided by the responsible authorities, determined risk levels cannot be derived.

RISK FACTOR CRITERIA

The required risk factor criteria would need to establish:

- What factors are to define the different 'determined' levels of hazard threats;
- What factors are to define the different 'determined' levels of exposure of elements at risk; and
- What factors are to define the different 'determined' levels of vulnerability of elements at risk.

RISK LEVEL MATRIX

The matrix would need to establish how the 'determined' levels of threat, exposure and vulnerability are to be applied in deriving the 'determined' risk level. Different sets of matrices to account for different development types, uses and scales would likely be required.

Different development types, uses and scales are potentially capable of tolerating different levels of risk and still be considered by the relevant authority (who are reflecting the understood society/community position), to remain acceptable or at least tolerable.

RISK TOLERANCE SCALE

After the 'determined' risk level has been derived after an assessment applying the risk factor criteria and the risk level matrix, a methodology is required to classify the risk level as either unacceptable, tolerable or acceptable.

A1.3.3 INHERENT AND RESIDUAL RISK

In this Bushfire Risk Report, inherent risk is current situation risk after accounting for bushfire protection measures that are either already in place (for existing development/use) and/or are currently planned to be incorporated into the proposed development/use.

Inherent risk levels are derived before the application of any additional protection measures that have been identified and recommended by the bushfire consultant, and which subsequently determines the residual risk. If there are none, the residual risk is the same as the inherent risk. Refer to the Glossary for additional supporting information.

A1.3.4 PROTECTION MEASURE EFFECTIVENESS RATINGS

DERIVING AN EFFECTIVENESS RATING

As part of the qualitative risk assessment process, an effectiveness rating, established by the application of this table, is applied to each bushfire protection measure. The rating weights each bushfire protection measure's ability to reduce a hazard's threat levels or reduce the exposure and/or vulnerability levels of the elements at risk.

The greater the effectiveness the greater the contribution of a protection measure to the reduction in levels of risks associated with a bushfire event. It is also an important factor applied to the determination of the bushfire protection measure's implementation priority.

The effectiveness ratings incorporate the qualities of:

1. **Independent/Dependent:** A qualitative assessment of the extent to which a protection measure can reduce threat, exposure and vulnerability levels as a standalone measure as opposed to only providing an additive reduction by being a part of a package of protection measures; and
2. **Risk Reduction Potential:** A qualitative assessment of a protection measure's capacity to reduce the levels of risks associated with a bushfire event as a standalone risk measure.

The rating methodology assumes the greater the independence and risk reduction potential of a bushfire protection measure, the greater its effectiveness.

DERIVING EFFECTIVENESS RATINGS FOR BUSHFIRE PROTECTION MEASURES	
Rating	Protection Measure Characteristics and Capability
Very High	Very significant risk reduction as an independent (standalone) measure. Impact on risk reduction is immediate and persistent in all scenarios. A priority measure to be implemented wherever possible.
High	Material risk reduction as an independent (standalone) measure;
Medium	Alone the measure will have limited impact on risk reduction. It is dependent on providing additive value when combined with other protection measures to create a 'package' of bushfire protection measures.
Not Relevant	The measure is not relevant to the type of development/use. This is different to not being able to be applied – it is just not relevant to any configuration of the subject development/use.

A1.3.5 PROTECTION MEASURE IMPLEMENTATION PRIORITY RATINGS

The effectiveness of a bushfire protection measure at reducing 'relative' threat, exposure and vulnerability levels, is the primary determinant of the implementation priority rating (refer to Section A1.2.3 for effectiveness rating explanation).

However, the implementation priority rating, corresponding to each effectiveness rating, can be modified with appropriate consideration of factors that may constrain the implementation and ongoing management of the measure. A justifiable weighting for each of the factors may be incorporated into the assessment for differing scenarios, either by the consultant or applied later by the landowner/operator with their greater knowledge of specific factors.

The matrix is applied qualitatively to the determination of the implementation priority rating that will apply to a recommended bushfire protection measure in this Bushfire Risk Report.

DERIVING THE IMPLEMENTATION PRIORITY FOR BUSHFIRE PROTECTION MEASURES									
Derived Implementation Priority Rating	Primary Determinant Effectiveness Rating	Secondary Determinants - Constraints to Implementation and Management [less constraints = potentially higher implementation priority and vice versa]							
		Restrictions from Government / Regulations	Owner / Operator Acceptance	Community Acceptance	Control of Land Restrictions	Financial Cost / Affordability	Knowledge and Ability to Apply Protection Measure	Practicality and Ease of Implementation	Requirement for Ongoing Implementation and Management
Highest	Very High	No Constraints	Likely Alignment with Management Intent & Values	Likely Majority Accept	No Constraints	Likely Within Current Resource Capacity	Past / Current Application Experience	Well Within Existing Capabilities	None - Passive
High	High								
Medium	Medium	Significant Constraints	Likely Strong Conflict with Management Intent & Values	Likely Majority Do Not Accept	Significant Constraints	Unlikely to be Affordable	None – Extensive Education / Training Required	Not Practical	Necessary - Active
Lowest									

A1.3.6 DETERMINATION OF BUSHFIRE RISK LEVEL TOLERANCE

The application of a risk tolerance scale is necessary to:

1. Identify which exposed elements must be given priority for the development and application of bushfire protection measures; and
2. When planning approval is being sought, to identify if the residual risk levels can be considered as tolerable or acceptable and therefore potentially be approved for this factor.

THE APPLIED TOLERANCE SCALE

The risk tolerance scale applied in this Bushfire Risk Report is presented in Table A1.2. It incorporates the application of the 'As Low as Reasonably Practicable' (ALARP) Principle. An overview of this principle and justification for its application is presented on the following pages.

Table A1.2: The applied risk tolerance scale

<table>
<tr><th colspan="4">THE APPLIED RISK TOLERANCE SCALE - INCORPORATING THE ALARP PRINCIPLE</th></tr>
<tr><th>Risk Level</th><th colspan="2">Tolerability Description and Action Required</th><th>Risk Tolerance Level[1]</th></tr>
<tr><td>Extreme</td><td colspan="2">The risks are unacceptable and require immediate implementation of risk management measures to eliminate or reduce risk to tolerable or acceptable levels.

Proposed development giving rise to risks in this region would not be approved unless there are exceptional reasons for the development to proceed.</td><td>Unacceptable</td></tr>
<tr><td rowspan="2">High</td><td rowspan="2">The risks are the most severe that can be tolerated but not unduly high. They require monitoring in the short term as risk management measures are likely to be needed in the short term given the intent should be to drive residual risk lower down the tolerable range where possible.</td><td rowspan="3">Tolerance Regions Subject to ALARP Principle</td><td>Intolerable
- if <u>not</u> ALARP-</td></tr>
<tr><td>Tolerable
- if ALARP -</td></tr>
<tr><td>Moderate</td><td>The risk is approaching an acceptable level. It can be tolerated and requires monitoring in the short to medium term. Need to consider potential changes over time in the risk and/or techniques for reducing/eliminating risk.

Risk management measures may be needed to reduce risk to more acceptable levels where possible – or accept the risk.</td><td>Tolerable
- if <u>not</u> ALARP -</td></tr>
<tr><td>Low</td><td rowspan="2">The risk is accepted as it is generally regarded as insignificant or adequately controlled by existing measures. No additional risk management measures will be required in the short to medium term other than monitoring.</td><td rowspan="2">Acceptable
- if ALARP -</td></tr>
<tr><td>Very Low</td></tr>
<tr><td colspan="4">[1] Refer to the glossary for definitions of the tolerance levels.</td></tr>
</table>

THE ADJUSTMENT OF RESIDUAL BUSHFIRE RISK LEVEL TOLERABILITY

Development/use scenarios can exist where a higher level of residual risk might be considered as tolerable or acceptable. Such a situation may exist when the exposed element is not persons and the economic cost due to the loss or damage of assets and/or disruption of services, is a risk that is retained by the owners as an informed decision.

Consideration of the knock-on risk implications to persons who might be associated with these elements, or other nearby elements at risk, will be part of the tolerability adjustment assessment.

There may also be isolated scenarios where the limits for tolerability of risk need to be established at lower residual risk levels i.e. an additional margin of safety is required. The rationale for any residual risk tolerance adjustment is presented below.

RATIONALE FOR THE ADJUSTMENT OF RISK TOLERANCE FOR PRPOSED DEVELOPMENT	
Relevant Element at Risk [Section 5.2]	Adjustment Rationale
Persons on access/egress routes in vehicles Internal access roads and driveways are the primary focus to ensure safe movement between asset locations and major external roads.	Persons onsite during a bushfire emergency will be Staff, Contractors, and Emergency Services, who will be aware of the local area and have their vehicles immediately available. A designated On-Site Shelter Building will be available, established in **Measure 2.11** and **11.1**. Evacuation is the primary emergency procedure and recommended, but an appropriate shelter location will exist. The tolerability for the residual risk will be adjusted for access/egress as evacuation may not be required.

THE ALARP PRINCIPLE

The 'As Low as Reasonably Practicable' (ALARP) Principle is based on the belief it is not possible to completely eliminate all risk involved, there will always be a certain level of risk remaining known as residual risk. The term is used to express the expected level of residual risk within a system, activity or, relevant to this document, within a proposed development/use, when good practice, judgement and duty of care are applied to decisions and operations.

The origins of the ALARP (As Low as Reasonably Practicable) principle are from United Kingdom case law and their regulatory framework. It is applied by their Health and Safety Executive (HSE) and is used by regulators and companies around the world as it provides a logical basis for managing risks.

The ALARP principle has been defined by the United Kingdom Health and Safety Executive (HSE-UK, 2001) to depict the concept that efforts to reduce risk should be continued until the incremental cost in doing so is grossly disproportionate to the value of the incremental risk reduction achieved (see figure). Incremental cost is defined in terms of time, effort, finance or other expenditure of resources – including loss of natural resources. Usually, each incremental reduction in risk will require a greater expenditure of resources.

This concept is depicted in Figure A3.1 where the triangle represents the decreasing risk and the diminishing proportional benefit as risk is reduced. There are also three regions shown in the figure into which general levels of residual risk can fall. The residual risk should fall either in the broadly acceptable region, or near the bottom of the tolerable region. This approach allows higher levels of safety to be provided where it is feasible.

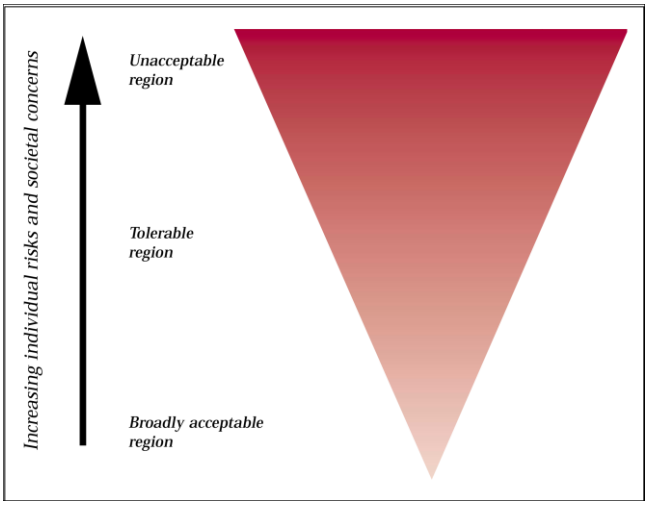


Figure A1.2: HSE framework for the tolerability of risk (source: HSE-UK, 2001)

Moving up the triangle from the region considered broadly acceptable, through a tolerable region (for which a greater range of risk can be considered), to an unacceptable region, represents increasing levels of 'risk' for a particular hazard or hazardous activity (determined through relevant risk analysis). Table A3.1 describes the risks that define each region.

Table A1.3: The risks associated with the risk tolerance regions (adapted from HSE-UK, 2001)

THE ALARP PRINCIPLE – DEFINING THE REGIONS OF RISK TOLERANCE	
Unacceptable Region	For practical purposes, a particular risk falling into this region is regarded as unacceptable whatever the level of benefits associated with the activity. Any activity, practice or use of land giving rise to risks falling in this region would, as a matter of principle, be not approved unless the activity or practice can be modified to reduce the degree of risk so that it falls in one of the regions below, or there are exceptional reasons for the activity, practice or use to be retained.
Tolerable Region	Risks in this region are typical of the risks from activities that people are prepared to tolerate in order to secure benefits, in the expectation that: • The nature and level of the risks are properly assessed, and the results used properly to determine control measures. The assessment of the risks needs to be based on the best available scientific evidence and, where evidence is lacking, on the best available scientific advice; • The residual risks are not unduly high and kept as low as reasonably practicable. This is the region to which the ALARP principle applies; and • The risks are periodically reviewed to ensure that they still meet the ALARP criteria, for example, by ascertaining whether further or new control measures need to be introduced to take into account changes over time, such as new knowledge about the risk or the availability of new techniques for reducing or eliminating risks. • In practice and where possible, the intent should be that residual risk continues to be driven down the tolerable range so that it falls either in the broadly acceptable region or is near the bottom of the tolerable region, in keeping with the duty to ensure health, safety and welfare so far as is reasonably practicable as per the ALARP principal.
Broadly Acceptable Region	Risks falling into this region are generally regarded as insignificant and adequately controlled. Regulators would not usually require further action to reduce risks unless reasonably practicable measures are available. The levels of risk characterising this region are comparable to those that people regard as insignificant or trivial in their daily lives. They are typical of the risk from activities that are inherently

	not very hazardous or from hazardous activities that can be, and are, readily controlled to produce very low risks.
Note: The risk tolerability framework is a conceptual model. The factors and processes that ultimately decide whether a risk is unacceptable, tolerable or broadly acceptable are dynamic in nature and are sometimes governed by the circumstances, time and environment in which the activity, practice or use occurs or is proposed. Standards change and public expectations vary between societies and change with time.	

APPLICATION OF THE ALARP PRINCIPLE IN AUSTRALIA

To contribute to justification for the use of the principle in this bushfire risk report, it is noted that the following Australian guidelines also apply adaptations of the principle:

- Australian Institute for Disaster Resilience, 2020; Land use Planning for Disaster Resilient Communities;
- WA Department of Mines, Industry Regulation and Safety, 2020; Petroleum safety and major hazard facility – guide. ALARP demonstration;
- NOPSEMA (Australia's offshore energy regulator), 2020; ALARP and risk assessment guidance notes;
- Department of Planning Lands and Heritage (DPLH), 2019; Coastal hazard risk management and adaptation planning guidelines;
- Planning Institute of Australia, 2015; National Land Use Planning Guidelines for Disaster Resilient Communities; and
- NERAG 2010, an earlier version of NERAG 2020, applied the ALARP Principle.

The following is taken from the 'National Land Use Planning Guidelines for Disaster Resilient Communities' (Planning Institute of Australia, 2015) and is also referred to in the document 'Land use Planning for Disaster Resilient Communities' (Australian Institute for Disaster Resilience, 2020).

> *Of relevance to planners in the NERAG is the ALARP principle and how it is used in evaluating risks. According to NERAG, the ALARP principle is applied to define boundaries between risks that are generally intolerable, tolerable or broadly acceptable. The ALARP principle will help to prioritise a risk hierarchy and determine which risks require action and which do not. Those that are broadly acceptable naturally require little, if any, action while risks that are at an intolerable level require attention to bring them to a tolerable level.*
>
> *According to NERAG, it is entirely appropriate and accepted practice that risks may be tolerated, provided that the risks are known and managed.*
>
> *The ALARP principle is particularly relevant to planners and other built environment professionals as it provides the means to categorise risks according to their severity, and to assign risk treatment options accordingly.*
>
> *It is important to note that the effect each hazard has on a community and its settlement is different, and therefore land use planning and building responses may not always be appropriate to treat the risk borne by a particular hazard. Equally, the effectiveness or strength of response provided by land use planning or building may not be sufficient to fully address the risk.*
>
> *In addition, it is likely that through a normal natural hazard management process a range of treatment measures will be proposed, tested and implemented to provide a comprehensive approach to risk treatment that may involve other measures working in concert with land use planning or building responses.*
>
> *The manner in which land use planning and building responses are deployed to treat specific instances of natural hazard risk will vary depending on location, information availability, community views, broader development intent for the settlement under analysis and the effect of complementary risk treatment measures.*
>
> *However, the ALARP principle provides a good reference for demonstrating the land use responses for the various ALARP risk categories. Generally speaking, in areas of intolerable risk the strongest land use*

planning and building responses should apply. Conversely, in areas of acceptable risk only minimal controls should apply, if at all.

The most complex risk category for which to prescribe treatment from a land use and building perspective is those areas of tolerable risk. Such risks in existing settlements may not be sufficiently concerning to warrant severe use restrictions or relocation, however they will need treatment over time to ensure the risk does not increase. Treatment options in this instance may include limiting vulnerable uses in this area, restricting significant intensification of development, and promoting resilient urban design. Such areas of tolerable risk are also best avoided from a greenfield perspective to limit increases in future risk and costs associated with infrastructure failure in these locations that could otherwise been avoided.

***

A1.3.7 ADDRESSING THE LIKELIHOOD OF A BUSHFIRE EVENT OCCURRING

USING THE QUALITATIVE RISK ASSESSMENT APPROACH (NOTE: APPLIED IN THIS BUSHFIRE RISK REPORT)

In applying a largely subjective approach, the pragmatic assumption that a bushfire will occur is made. It is assumed a bushfire can occur within any timeframe and could result in loss or life or injury, or unacceptable damage to property and or unacceptable disruption to services.

This approach acknowledges that the requirements for fire of fuel, ignition source and oxygen will always exist. That is:

- The fire fuels being considered will always be there unless physically removed permanently;
- A potential ignition source will always exist through lightning and/or human activities; and
- The potential for adverse fire weather conditions to exist at some point within each year will always be present.

Additionally, the subjective assessment of the site specific potential threat levels of the direct and indirect bushfire attack mechanisms associated with the bushfire hazard, by default and indirectly, effectively incorporate a likelihood component.

Also, consider scenarios when the costs of implementing the required bushfire protection measures to lower indicative risk to acceptable or tolerable levels is not excessive. In such cases a justifiably pragmatic approach is to implement these measures rather than just reduce the assessed and reported risk levels by accounting for a lower likelihood of a bushfire event occurring.

USING THE QUANTITATIVE RISK ASSESSMENT APPROACH (NOTE: <u>NOT</u> APPLIED IN THIS BUSHFIRE RISK REPORT)

A quantitative approach will necessarily be based on the historical record of past bushfire events and determining the mathematical probability of a future event. This approach is problematic to achieving increased bushfire resilience at all stages of existing or proposed development/use for these reasons:

- Historical data may not be available or have enough data sets to be accurate;
- Historical data does not account for future changes in climate that may result in a different occurrence period. Consequently, further assumptions need to be made;
- Siting, design and construction of development to resist bushfire threats is easier, more practical (and likely economical), to incorporate at initial planning stages, rather than the retro-implementation of protection measures, when the considered likelihood of events increases over time for various reasons or tolerance of risk decreases;
- Time spent conducting historical research, performing statistical calculations and modifying risk levels, apart from being costly, is likely better spent assessing potential threat, exposure and vulnerability levels and developing appropriate protection measures; and
- The likelihood of occurrence cannot modify the levels of hazard threats, exposure or vulnerability. It can only be applied to reduce the overall risk level. That is, it would be applied as a modifying factor via the established risk level matrix and not the established risk factor criteria.

  The validity of incorporating such a factor may be indicated when, despite the existence of vegetation that can burn, there are other mitigating physical conditions that exist at the specific site that make the likelihood of ignition and severity of bushfire behaviour very low. How this is applied would need to be established by the authority establishing the relevant risk level matrix.

***

APPENDIX 2: ASSESSING BUSHFIRE HAZARD THREATS

DEFINING THE BUSHFIRE HAZARD AND ITS THREATS

THE BUSHFIRE

For this assessment, a bushfire is the unplanned burning of a fire in vegetation of any type and structure. It is applied as a generic term to refer to forest fires, scrub/shrub fires and grass fires, which have differences of behaviour (dependant on a range of variables), both within and between the vegetation types. Key fire behaviours include residence time, fireline intensities, rates of spread, flame lengths, and spotting i.e., ignition ahead of the fire front by embers/burning debris.

Note that grass fires are significantly different from fire in other vegetation types. This is recognised in the applied threat level assessment.

Compared to the behaviour of bushfires, grass fires are fast moving, have a much shorter duration, the embers produced are smaller and fewer in number (especially compared to forest fires), have a short duration time and consequently are mostly consumed within the grass fire's flame front.

Radiant heat flux levels drop more quickly with distance from the grass fuels. This can be observed in the application of AS 3959:2018 BAL determination methodology where 'Grassland' achieves a BAL-LOW rating at half the separation distance of all other classified vegetation (50m vs 100m).

The following statement encapsulates the different fire behaviours in grass fuels and their impact on threat levels compared to other vegetation types:

> *While pastures, crops and native grasslands often experience fast moving fires, their intensity is usually insufficient to justify a land use planning response (Justin Leonard et al, 2014: A new methodology for State-wide mapping of bushfire prone areas in Queensland, CSIRO, Australia)*

THE BUSHFIRE HAZARD

A bushfire hazard is the natural process/phenomenon of a bushfire event that gives rise to the associated risks of loss of life or injury or destroyed or damaged assets, which results in personal loss and economic loss.

The term bushfire hazard is necessarily applied to both the relevant vegetation as the source of the hazard and the bushfire event itself. This approach is aligned with the definition applied by the United Nations Office for Disaster Risk Reduction.

LAND USE PLANNING AND THE BUSHFIRE HAZARD THREATS TO BE ASSESSED

The bushfire hazard is a potential source of direct and indirect bushfire attack mechanisms (refer to A2.3 for additional information), that present threats to persons and property and give rise to the associated risks of loss of life or injury or destroyed or damaged assets.

Direct Attack Mechanisms: Of most relevance to land use planning are the bushfire threat levels generated by the direct attack mechanisms of:

- Flame contact;
- Radiant heat transfer; and
- Ember/burning debris attack.

Consequently, these are the bushfire hazard threats that are to be considered when assessing the potential bushfire hazard threat levels. Due consideration of winds generated by fire/terrain interactions, is applied when the physical requirements exist for development of landscape scale fire and extreme bushfire events.

Indirect Attack Mechanisms: The indirect attack mechanisms are considered within a risk assessment section of a Bushfire Risk Report when this is required, as the threat levels from these mechanisms is determined by the degree to which available bushfire protection measures are or will be implemented in mitigating risk.

FACTORS INFLUENCING BUSHFIRE BEHAVIOUR

There are three primary factors that influence the intensity, speed and spread of a bushfire. Any increase in these behaviours will result in greater threat levels, to exposed elements, from the bushfire attack mechanisms.

1. **VEGETATION AND OTHER FUELS**

   Key characteristics that will influence fire behaviour include:

   - **Fuel size and shape** – anything less than 6mm diameter/thickness is considered a fine fuel and will ignite and burn quickly. Larger/heavier fuels take longer to ignite but burn for longer, so the threat exists for longer;
   - **Fuel load** – the quantity of available fuel (t/ha) will influence the size of the fire. In particular it is the fine fuel load that determines the intensity of the bushfire and the flame sizes. Vegetation type and period over which it can accumulate will determine fuel loads;
   - **Vegetation type** – this influences the size, shape and quantity of available fuels. For bushfire purposes vegetation types include the classifications of forest, woodland, scrub, shrubland and grassland (with total fuel loads typically decreasing in that order);
   - **Fuel arrangement** – will influence two factors of fire behaviour (1) the speed and intensity of burning and (2) how much of the total fuels are likely to be involved in the fire simultaneously. The first factor is a function of how densely packed or aerated the fuels are with the more available arrangement burning with greater intensity. The second factor is a function of the availability of 'ladder' fuels (i.e. near surface, elevated and bark fuels) to carry fire up the vegetation profile, and the continuity of fuels to carry the fuel across the land; and
   - **Fuel moisture content** – drier fuels will ignite easily and burn quickly. The inherent moisture content of the vegetative fuels is a function of the vegetation type and arrangement and/or the positioning of the vegetation complex near readily available sources of moisture.

   Greater quantities of finer, dryer, aerated and connected fuels will result in more severe behaviours and elevated bushfire threat levels. Large extents of vegetation (surrounding landscape scale) can have additional implications for the development of extreme bushfire events and the consequent increase in bushfire threat levels (refer to Appendix 3 for additional information).

2. **WEATHER**

   Adverse fire weather that results in more severe behaviours and elevated threat levels includes strong winds, high temperatures, low relative humidity and extended periods of these factors.

   Weather events at the surrounding landscape scale can have implications for the development of extreme bushfire events and consequent increase in bushfire threat levels (refer to Appendix 3 for additional information).

3. **TOPOGRAPHY**

   The physical terrain can influence the severity of fire behaviour. At a local scale, it is the influence of ground slope on the rate a fire spreads, that is most relevant. Fire travels faster up slopes (rule of thumb is a doubling of speed for every 10 degrees increase in slope). Greater rates of spread increase fire intensity and the resultant threat levels.

   At the surrounding landscape scale, the impact of topography can be significant and includes establishing the potential for development of certain dynamic fire behaviours that can lead to extreme bushfire events and elevated threat levels (refer to Appendix 3 for additional information).

BUSHFIRE THREATS - DIRECT ATTACK MECHANISMS ORIGINATING FROM THE BUSHFIRE PRONE VEGETATION

FLAME CONTACT

When flames contact buildings/structures they can flow over, under and around – impacting surfaces not directly facing the bushfire. Flames can enter small gaps and crevices resulting in a significant threat to combustible internal parts of buildings/structures.

Flames will be longer when fine fuel loads are higher and will move faster up slopes and generally, slower down slopes.

Flame temperatures are highest in the lower parts of the flame and decrease towards the tip. The flame has two distinct regions - the lower solid body flame and the upper part that is a transitory flame (intermittently present). Both flame regions can damage structures.

Note: AS 3959:2018 *Construction of buildings in bushfire prone areas*, establishes both the construction requirements corresponding to each Bushfire Attack Level (BAL) and the methodology for determining a BAL. For a bushfire modelled using this methodology, the derived flame length only provides an estimate of the solid body flame length.

RADIANT HEAT TRANSFER

This heat is produced from combustion of a fuel source, radiates in all directions from the fire and can potentially be felt from hundreds of meters away.

The amount of heat that a fire can transfer to other objects, through radiation, is influenced by its flame size and flame temperature. These are a function of the characteristics of the fuels being burnt including fuel size, dryness, structure, arrangement and quantity. The bushfire is additionally influenced by weather and topography factors that can intensify fire behaviour (described at start of this section with additional detail provided in Appendix 3).

The radiant heat:

- Can ignite combustible materials such as timber (doors, cladding, external framework), some plastics (which if not ignited will melt and distort (cladding, pipes, gutters, tanks). This breaches the building's envelope allowing flames and embers to enter, increasing the likelihood of damage or destruction;
- Can dry and heat vegetation and other fuels (combustible materials such as timber) to a temperature at which they ignite or are more easily ignited by existing flames or embers; and
- Is an extremely significant threat to persons (occupants, firefighters) when they are not physically shielded. Protective clothing can provide only limited protection.

EMBER / BURNING DEBRIS ATTACK

Note: The importance of establishing protection measures to mitigate the potential impact of consequential fire ignited by the ember attack mechanism, cannot be overstated.

An ember is a small particle of burning material that is transported in the winds that accompany a bushfire (larger particles can exist as firebrands from certain vegetation types). Typically, these consist of plant materials such as bark, leaves and twigs that exist as part of the standing vegetation or have accumulated on the ground. Experimental scientific work has shown that that embers greater than 2mm are effective at igniting combustible materials.

Ember attack is the most common way for buildings/structures to ignite in a bushfire:

Scientific research indicates that at least 80% of building losses from past Australian bushfires can be attributed to ember/firebrand attack (mostly in isolation but also in combination with radiant heat), and the resultant consequential fires. (Leonard J.E. et.al; 2004 – Blanchi R. et.al. 2005 - Blanchi R. et.al. 2006).

Embers are the primary ignition source for consequential fire:

- They accumulate around and on vulnerable parts of structures such as low angle surfaces windows and wherever re-entrant corners exist (e.g., roofs, gutters, doors, windows etc);
- They enter gaps in structure envelopes to vulnerable materials within internal cavities and spaces (e.g., roof, sub-floor, living areas); and

- They ignite surface materials such as walls and decks and any accumulated vegetative debris.

Embers can attack structures for a significant length of time before and after the passage of the fire front, as well as during. This potential length of exposure is an important factor in the consideration of the level of threat embers present.

The importance of bark as an ember source:

(Sources: CSIRO Climate and Disaster Resilience Report 2020 and Overall Fuel Hazard Assessment Guide 4th edition July 2010, Victoria DSE and Cruz, MG (2021) The Vesta Mk 2 rate of fire spread model: a user's guide. CSIRO).

Bark is the primary source of embers and spotting in Australian eucalypt forests due to the key attributes of ease of ignition, extended burnout time and the favourable size to weight ratio and aerodynamic properties. Differences in these attributes strongly influence the spotting potential from different forest types – and therefore the potential hazard rating of the bark.

The type of tree bark will determine the size, shape and number of embers/firebrands which, along with the prevailing fire behaviour and weather conditions will dictate the spotting distances and density of ignitions.

Fine fibrous barks - including stringybarks (e.g. jarrah), have loosely attached fibrous flakes and can produce massive quantities of embers (prolific spotting) for shorter (up to 0.75 km) and medium distances (up to 5 km).

Short distance spotting (including ember showers) are generally the result of embers and firebrands blown directly ahead of the fire with little or no lofting. Density tends to decrease with distance from the fire front.

Medium distance spotting results from embers and firebrands that are lofted briefly in a convection column or blown from an elevated position (e.g., from treetops on ridges). With sufficient density and coalescing spot fires, this can rapidly increase the size of a fire (deep flaming) leading to dynamic fire behaviours and extreme fire events.

Ribbon/candle type barks - have longer burnout time, extended flight paths and are more likely to be responsible for longer distance spotting > 5 km (with up to 30 km having been authenticated). This results from significant lofting of large firebrands (e.g. curled hollow tubes of bark that can burn for 40 minutes) in well-developed convection columns. These develop as separate, independent fires. Very long distance spotting requires Intense fire, maintenance of a strong convection column (to lift firebrands aloft) and strong winds aloft (to transport the firebrands).

Other bark types - that include coarsely fibrous (e.g. marri) / slab or smooth / platy and papery barks - produce lower quantities of embers and shorter distance spotting. Their highest bark hazard ratings are lower than fine fibrous or ribbon barks.

HIGH / ERRATIC FIRE DRIVEN WIND ATTACK

High winds resulting from bushfire / vegetation / terrain / fire weather interactions, can directly damage the external envelope of a building or structure by:

- Positive and negative pressure dislodging building parts; and/or;
- Causing solid materials (e.g., branches or parts of other structures) to break loose and be transported to impact and damage the building's envelope. This provides openings for other bushfire attack mechanisms to enter and ignite internal cavities.

Strong winds are common during serious bushfire events as they are a necessary requirement for bushfires to develop higher intensities and greater severity levels.

Increased wind speeds can be the result of:

1. General weather patterns that will present as strong prevailing winds; and
2. The more complex interactions of prevailing winds along with vegetation types and structures, terrain factors and fire weather factors - that can lead to the development of dynamic fire behaviours resulting in intensification of fire behaviour and generation of local and erratic high winds.

   For highest risk scenarios, the bushfire can couple with the atmosphere as a pyro-convective event resulting in extreme bushfire events and gusty, severe windspeeds (refer to Appendix 3 for more detail).

It is the potential for the interactions and outcomes of the latter that will be considered as a direct bushfire attack mechanism for the relevant bushfire hazard threat level assessment in this report.

BUSHFIRE THREATS - INDIRECT ATTACK MECHANISMS

PRIMARILY ORIGINATING FROM WITHIN AN ASSET PROTECTION ZONE (APZ)

For the following indirect bushfire attack mechanisms to impact relevant exposed elements, certain requirements need to exist within an APZ (i.e., the area immediately surrounding a subject building/structure).

Where these requirements exist, they increase the exposure of the subject building/structure to the indirect bushfire attack mechanisms.

In this Report, it is the exposure component of the risk assessment that will assess the potential impact from the bushfire threat indirect attack mechanisms.

DEBRIS PRODUCTION AND ACCUMULATION

The relevant debris are combustible fine fuels that can accumulate, by falling and/or being windblown to be close to or against buildings, surrounding structures and other heavy fuels.

This makes the ignition of these structures/heavy fuels more likely through flame contact and radiant heat generated by the accumulated debris that has been ignited by embers and/or surface fire attack (i.e. a consequential fire).

This debris can accumulate over long time periods (years) in locations such as:

- On horizontal or close to horizontal surfaces and rough timber surfaces;
- Within re-entrant corners and roof gutters/valleys;
- Against vertical surfaces; and
- Within internal spaces /cavities and under sub-floors when gaps are present.

The threat level of this attack mechanism will be determined by:

- The presence of vegetation types that produce significant quantities of combustible debris and produce this in the driest and hottest part of the year; and
- The extent of the vegetation producing this threat.

SURFACE FIRE

These are low intensity fires with short flames that burn along the ground and are not considered to be part of the 'bushfire' in identified bushfire prone vegetation. They are typically patchy and erratic in their direction, consuming low-lying vegetation, ground litter, mulch and other debris and are short lived (<40 seconds) when burning in the absence of heavier fuels.

Surface fires occur on the land immediately surrounding buildings, associated structures and other heavy consequential fire fuels. Surface fires bring the threats of direct flame contact, higher radiant heat and embers closer to the relevant elements at risk than the bushfire itself can.

To reduce the exposure of relevant elements at risk to this indirect bushfire threat, the area of land typically recognised as an APZ, should be maintained in a minimal fuel / low threat state.

TREE STRIKE/OBSTRUCTION

Branches or trees, subject to strong winds and/or tree burnout, can:

- Damage the envelope of a structure creating openings for direct attack mechanisms of bushfire (or consequential fire) to ignite internal cavities or living space; and/or
- Fall and obstruct access to or egress from, a structure or site being impacted by bushfire.

The threat level of this attack mechanism is determined by the location of relevant trees and their susceptibility to wind damage and/or burnout.

CONSEQUENTIAL (SECONDARY) FIRE

Note: The importance of establishing protection measures to mitigate the potential impact of consequential fire cannot be overstated.

Consequential fire Is the burning of vulnerable (combustible/flammable) materials, items and structures that exist within the area surrounding the subject building or structure. These vulnerable surrounding elements can also include adjacent buildings/structures.

The burning of these surrounding vulnerable elements can result in the subject building/ structure being exposed to the direct fire attack mechanisms (threats) of flame, radiant heat, embers and surface fire from a close distance.

These consequential fire threats are separate from and additional to the threats generated by the bushfire front itself - which can be and often is, a considerable distance away.

Consequential Fire Fine fuels:

- Dead plant material such as leaves grass, bark and twigs thinner than 6mm (or live material less than 3mm thick that can be consumed in a fire involving dead material); and
- Originate from the indirect bushfire attack mechanism of 'debris accumulation' and potentially from other areas of landscaped vegetation.

Consequential Fire Heavy and Large Heavy Fuels:

- Stored combustible / flammable items:
    - Building materials, packaging materials, firewood, sporting/playground equipment, outdoor furniture, matting, rubbish bins etc;
    - Large quantities of dead vegetation materials stored as part of site use;
    - Liquids and gases; and
    - Vehicles, caravans and boats, etc.
- Constructed combustible items:
    - Surrounding landscaping items - fences/screens, retaining walls, gazebos, plastic water tanks etc;
    - Attached structures - decks, verandahs, stairs, carports, garages, pergolas, patios, etc; and
    - Adjacent structures - houses, sheds, garages, carports, etc. Structure to structure fire is a common cause of overall building loss in post bushfire event assessments [9].

The threat level of this attack mechanism is determined by the existence, type and proximity of these fuels.

***

APPENDIX 3: DYNAMIC FIRE BEHAVIOURS AND EXTREME BUSHFIRE EVENTS

The content of this appendix is an overview of information that supports the assessment approach of section 5.2 of this report. It considers the risk implications arising from what is being learnt from the latest research work within the bushfire science of dynamic fire propagation and extreme fire development.

Any potential for extreme fire events to develop in the surrounding landscape surrounding the subject site, will result in increased in bushfire hazard threat levels to exposed elements and must be accounted for in the risk assessment.

The selected compilation of information is taken from various sources including peer reviewed research papers [references 1-3, 12, 15, 21, 27, 28, 41, 42].

RECENT BUSHFIRE RESEARCH

Traditionally, bushfire modelling conducted to determine rates of spread, intensity, flame lengths, radiant heat etc and provide measurements of threat levels, has been based on the quasi-steady fire state (i.e. a fire propagating under constant and uniform fuel, weather and topography – after it has finished its growth phase).

More recent research has provided important insights into the dynamic nature of fire spread in the landscape and identified local drivers of bushfire risk and highlighted the role of environmental factors that are significant for large and extreme fire development.

These environmental factors include aspects of the vertical structure of the atmosphere, meso-scale fire weather processes (e.g., sea breezes, cold fronts, squall lines, convective complexes), interactions between the fire and the atmosphere, and the modification of fire weather and fire behaviour due to the local topography.

From this work, several processes that can contribute significantly to the level of risk posed by a bushfire have been identified. These include:

- Extreme fire weather processes;
- Dynamic fire propagation; and
- Violent pyroconvection and pyrogenic winds.

Of relevance to this risk assessment are the topographic aspects of the surrounding landscape surrounding the subject site and the potential it might present for dynamic fire propagation, development of extreme fire events and therefore increased bushfire hazard threat levels and consequent risk.

DYNAMIC FIRE BEHAVIOURS

Dynamic fire behaviours (DFBs) result from interactions between the physical factors of fuel, terrain, fire weather conditions, atmosphere and different parts of the bushfire itself. They are physical phenomenon that involve rapid changes of fire behaviour and occur under specific conditions.

Certain DFBs occur at various scales and time frames (e.g. spotting), others only at large scales (e.g., conflagrations and pyroconvective events) and others at small scales and short time spans (e.g. junction fires, fire whirls). The following fire behaviours are considered DFBs:

Severe Spotting

The production of embers/firebrands, carried by the wind/convective currents that ignite spot fires ahead of the bushfire front. Under extreme conditions, with the necessary fuels, mass spotting events can occur. Dependent on fuel types, winds and convective currents, embers can be consumed by the fire front itself or travel tens of kilometres. Spot fire occurrence can be so prevalent that spotting becomes the dominant propagation mechanism – with the fire spreading as a cascade of spot fires forming a 'pseudo' front.

Fire Whirl / Tornado

Various sized (<1m - >150m) spinning vortices of ascending hot air and gases that carry smoke, debris, and flame. The intensity of larger whirls compares to tornados. Can induce fire spread contrary to prevailing wind and ignite spot fires away from the fire front.

Junction Fire

Is associated with merging fire fronts that produces very high rates of spread and have the potential to generate fire whirls / tornadoes.

Crown Fire

Types of tree crown fires have been categorised according to their degree of dependence on the surface fire phase - passive, active, independent - with the last two being considered dynamic fire behaviour.

Active crown fire is "a fire in which a solid flame develops in the crowns of trees, but the surface and crown phases advance as a linked unit dependent on each other."

Independent crown fires "advance in the tree crowns alone, not requiring any energy from the surface fire to sustain combustion or movement."

For a crown fire to start, a surface fire of sufficient intensity is first necessary. The distance between the heat source at the ground surface and the canopy-fuel layer will determine how much of the surface fire's energy is dissipated before reaching the fuels at the base of the canopy. The higher the canopy base, the lower the chance of crowning.

The existence of trees themselves, separated from surface fuels, can offer a degree of protection by absorbing radiant heat, trapping embers and shielding from winds. Necessary considerations include:

- Eliminating understorey fuels;
- Species Issue: Understanding the extent to which the trees will contribute to fuels (leaves/bark/twigs etc) that accumulate on the ground and when moved (wind) become involved in consequential fire away from the tree during the fire season. This needs to be considered against the maintenance capability (regular removal of material) of the responsible entity; and
- Species / Positioning Issue: Requirements include not being highly flammable, no loose stringy bark, less able to trap embers, not being prone to branches breaking in high winds potentially causing structural damage to buildings (allowing ember entry) and keeping crowns separated as an additional measure of safety and allow wind to permeate rather than be totally blocked.

Eruptive Fire

Behaviour where the head fire accelerates rapidly on sufficiently steep terrain with sufficiently strong wind – because of fire plume attachment to the surface, bathing it in flames ahead of the front (pre-heating).

Fire Channelling / VLS (vorticity-driven lateral spread)

Behaviour where rapid lateral fire spread, in generated vortices, occurs across a sufficiently steep leeward slope in a direction approximately transverse to the prevailing winds. This results in the rapid increase in width of the fire front. VLS are highly effective at producing mass spotting events.

Conflagrations

These are large, intense, destructive fires. They have a moving front as distinguished from a fire storm (blow up / pyroconvective fire). With sufficient vegetation extent, fuel loads and the development of dynamic fire behaviours, the large amounts of heat and moisture released can cause its plume to rise into the atmosphere and develop large cumulus or cumulonimbus flammagenitus cloud (pyrocumulus or pyrocumulonimbus). Where the extent of vertical development is limited (e.g. a stable atmosphere, or insufficient flaming zone), the fire is likely to remain a surface-based event.

Downbursts

These are strong wind downdrafts associated with convective columns of heated air (and associated cloud forms). The consequent falling columns of cooled air induce an outburst of strong winds on or near the ground that radially spread causing fire spread in directions contrary to the prevailing wind.

Pyroconvective Event

A pyro-convective event is an extreme manifestation of a conflagration that develops in an unstable atmosphere and can transition into a towering pyrocumulus or a pyrocumulonimbus (pyroCb's) that can extend to the upper troposphere or lower stratosphere. With the fire/atmosphere coupling, it has evolved beyond a purely surface based fire into dynamic fire propagation rather than quasi-steady propagation. In the violent pyroconvective system:

- As a fire's plume reaches higher into the atmosphere, larger scale mixing can cause drier and higher-momentum upper air to be transferred back to the surface, thereby further exacerbating the potential for more intense fire behaviour, including fire spread contrary to the prevailing wind direction;
- Pyrogenic winds can cause considerable damage to structures, directly or indirectly, increasing their vulnerability to bushfire attack mechanisms; and

- The pyroCb's carry dense ember loads, fire and other burning debris and generate lightning, all with very little rain or hail that would typically occur with an ordinary thunderstorm.

DRIVERS OF DEEP FLAMING

Deep flaming is the fire condition when the active flaming zone is unusually large and flame-front intensity is simultaneously great, resulting in large quasi-instantaneous energy release.

Deep flaming can be produced by numbers of mechanisms on varying terrain (flat, undulating of rugged) when a large enough area of sufficiently heavy fuels is present. These mechanisms include:

- Very strong winds – so the head fire advances more rapidly than the back of the flaming zone;
- Change in wind direction – so the long flank of a fire is transformed into a fast running head fire;
- Eruptive fire behaviour – where steep slopes can cause a fire to accelerate rapidly;
- Vorticity-driven lateral spread (wind channelling) – where strong winds and steep terrain interact to rapidly drive a fire laterally, accompanied by downwind mass spotting and consequent coalescing of spot fires forming large areas of flame (can include the DFB of 'junction fire').

Research has identified strong links between:

- Eruptive fire behaviour, VLS and the occurrence of deep flaming; and
- The development of deep flaming and extreme bushfire events.

EXTREME BUSHFIRE EVENTS

Extreme bushfire events create disproportionate risks to human and environmental. Their development is affected by dynamic feedback processes that result in unpredictable behaviour, and the worsening of rates of spread and intensities - even when environmental conditions are consistent.

The term 'extreme bushfire' is applied in the recent bushfire science literature in two ways:

1. Where it refers to large, intense bushfires in which one or more DFBs are simultaneously involved; and
2. Where it more specifically refers to a fire that exhibits deep or widespread flaming in an atmospheric environment conducive to the development of violent pyroconvection, often manifesting as towering pyrocumulus (pyroCu) or pyrocumulonimbus (pyroCb) storm(s) – also referred to as blow-up fire event(s).

   A distinguishing feature of these types of fires is that they involve a coupling of the fire with an unstable atmosphere to a much greater vertical extent, well above the mixed layer, which modifies or maintains the fire's propagation (e.g. through mass spotting, blustering winds and lightning);

Relevance to Risk Assessment: Given that this risk assessment is concerned with identifying the potential for the landscape surrounding the subject site to increase bushfire risk, the following common aspects of the two above descriptions are relevant:

- An extreme fire is a large intense fire, so it requires a sufficient area and sufficient fuels in which to develop; and
- An extreme fire of scale requires the formation of deep flaming to develop.

Consequently, the risk assessment is primarily focused on the extent and fuel types/loads of bushfire prone vegetation and the existence of terrain (topography) properties necessary for the relevant dynamic fire behaviours - rather than the potential for adverse fire weather / atmospheric conditions - whose likely occurrence can be assumed as possible.

Note also that the second description requires an unstable atmosphere - to enable deep/violent pyroconvection and subsequent significant cloud formation and latent heat release. This is not essential for the first. Consequently, this identifies a potential difference between the two defined extreme bushfire events to be considered when assessing risk:

- Large, intense bushfires can occur without deep convective column development. These fires remain as surface fires (essentially wind-driven fires), with a greater predictability of behaviour; and
- Large, intense bushfire that couple with an unstable atmosphere are no longer surface based. They are associated with a higher level of energy, chaos, and nonlinearity due to the enhanced (fire-induced)

interaction between the boundary layer and the free troposphere, which may introduce factors that act to maintain or enhance widespread flaming. The fire behaviour is much more unpredictable.

PHYSICAL REQUIREMENTS OF TERRAIN, FUEL LOAD (AND WINDSPEED) FOR DEEP FLAMING

The dynamic fire behaviours of eruptive fire and VLS with associated mass spotting, along with potential for topographically modified winds to develop, are strongly linked with the development of deep flaming, which is a prerequisite for extreme bushfire events.

There are certain environmental thresholds that are required to be met for these dynamic fire behaviours to occur. These are described below and form part of the assessment of the bushfire hazard in Section 5.3.

Eruptive Fire Behaviour

Eruptive fires are characterised by a rapid acceleration of the head fire rate of spread (exponential increases in rate of spread have been observed). It results in a rapid deepening of the flaming zone (larger area of active flame), from which heat is released into the atmosphere.

Eruptive fire results from the interaction between the slope of the terrain and the fire's plume. In the absence of wind, plume attachment can be expected on terrain that is inclined at roughly 24° or more and the effects of wind could cause plume attachment on slopes inclined at angles of 24° or lower. Consequently, the primary topographic requirement for eruptive fire is sufficiently steep terrain and sufficiently strong wind.

"This mode of fire propagation is completely contrary to that expected under the quasi- steady fire spread paradigm … eruptive fire behaviour poses a serious threat to the successful containment of a bushfire and provides a mechanism that can substantially elevate the risk posed by a bushfire in areas that are prone to its occurrence".

Rugged terrain (areas with local topographic relief >300m), is particularly prone to eruptive fire (and dynamic fire behaviours in general).

Fire Channelling (Vorticity-Driven Lateral Spread)

Fire channelling (VLS) exists when a fire exhibits rapid spread in a direction transverse to the synoptic winds as well as in the usual downwind direction. It is characterised by intense lateral and downwind spotting and production of extensive flaming zones.

VLS is highly effective at producing mass spotting events. A link between deep flaming events caused by VLS and the formation of pyroCb has been demonstrated. Under extreme conditions, spot fire occurrence can be so prevalent that spotting becomes the dominant propagation mechanism.

VLS can only be expected to occur on parts of the landscape, and under certain fire weather conditions. VLS occurrence depends critically on the following:

- Leeward slopes greater than 20-25° are required;
- Wind direction must be within 30-40° of the topographic aspect;
- Wind speed in excess of about 20 km h-1 are required;
- Generally, VLS is only observed in heavy forest fuel types with load in excess of 15-20 t ha; and
- Fuel moisture content – dense spotting and downwind extension of the flaming zone are far more likely when fuel moisture contents are around 5% or less.

Topographically Modified Surface Winds - Downslope Winds

In WA the scarp winds are the well-known local occurrence of downslope winds. Similar meteorological phenomena (typically as foehn winds) occur in the lee of mountain ranges in many parts of the world, particularly on ranges with gentle windward and steep leeward slopes.

Scarp winds are nocturnal, strong and gusty winds that develop near the base of the scarp through summer months. The local mechanism is for a synoptic easterly flow, causing air to rise to the top of the scarp from further inland, at which point it is cooler and denser than the surrounding airmass. This produces an unstable situation and consequently the air flows down the scarp as a turbulent density current.

There are implications for enhanced fire activity for a fire located in a region of downslope winds, as they provide a clear mechanism for rapid, irregular direction of fire spread as well as turbulent transport of firebrands and plume development. If a 'hydraulic jump' is also present, the strong vertical motion in the jump region is a mechanism for lofting and dispersal of firebrands further ahead of the bushfire front.

APPENDIX 4: EXPLAINING BUSHFIRE ATTACK LEVEL (BAL)

Bushfire attack levels are determined using the methodology established by AS 3959:2018 Construction of buildings in bushfire prone areas. The Standard defines a bushfire attack level (BAL) as a "means of measuring the severity of a building's exposure to ember attack, radiant heat and direct flame contact, using increments of radiant heat expressed in kW/m^2."

Each BAL rating represents a set range of radiant heat flux (see table below). The amount of radiant heat and flame lengths generated by a bushfire is dependent on many factors that are modelled using the Standard's fire behaviour and flame length models. Key factors include vegetation type, terrain and a range of fire weather factors. The variation that can exist in these factors will result in varying separation distances, away from bushfire prone vegetation, corresponding to a given BAL rating. These distances can be presented as data in a table or illustrated by mapping – the 'BAL Contour Map'.

The different BAL ratings effectively incorporate the threat levels of flame contact, radiant heat transfer and ember/firebrand attack:

- The highest ratings of BAL-FZ and BAL-40 indicate direct or likely exposure to the flame contact threat;
- Each BAL rating represents a defined range (in kW/m^2), of the radiant heat transfer threat, with the threat level increasing from BAL-LOW to BAL-FZ; and
- Each higher BAL rating assumes an increased exposure to the ember/burning debris attack threat. This is based on the practical acknowledgement that the closer the element at risk is to the source of ember production the greater the likely exposure level. In practice, this strong correlation does not exist for all bushfire event scenarios. However, AS 3959 is only intending to apply the same construction response to ember/firebrand attack for each BAL rating above BAL-LOW as consequential fire from any source other than from within the subject structure itself is not being considered by the Standard.

Bushfire Attack Level	**Explanation** [Source AS3959:2018]
BAL – LOW	There is insufficient risk to warrant specific construction requirements but there is still some risk. *Important Note: For AS3959:2018 purposes, BAL-LOW will exist at 100m from classified vegetation (50m for Grassland).* *However, embers/firebrands from certain vegetation types can ignite spot fires ahead of the fire front for significant distances – short range spotting up to 740m, medium range spotting up to 5km and long range spotting has been authenticated up to 30km.*
BAL – 12.5	There is a risk of ember attack. Construction elements are expected to be exposed to heat flux not greater than 12.5 kW/m^2
BAL – 19	There is a risk of ember attack and burning debris ignited by windborne embers and a likelihood of exposure to radiant heat. The construction elements are expected to be exposed to a heat flux not greater than 19 kW/m^2.
BAL – 29	There is an increased risk of ember attack and burning debris ignited by windborne embers and a likelihood of exposure to an increased level of radiant heat. The construction elements are expected to be exposed to a heat flux not greater than 29 kW/m^2.
BAL – 40	There is a much increased risk of ember attack and burning debris ignited by windborne embers, a likelihood of exposure to a high level of radiant heat and some likelihood of direct exposure to flames from the fire front. The construction elements are expected to be exposed to a heat flux not greater than 40kW/m^2.
BAL – FZ (Flame Zone)	There is an extremely high risk of ember attack and burning debris ignited by windborne embers, and a likelihood of exposure to an extreme level of radiant heat and direct exposure to flames from the fire front. The construction elements are expected to be exposed to a heat flux greater than 40 kW/m^2.

APPENDIX 5: THE SURROUNDING LANDSCAPE - VEGETATION CATEGORY AND THREAT LEVEL DETERMINATION CRITERIA

DETERMINATION OF VEGETATION CATEGORIES AND THEIR RANGE OF POTENTIAL THREAT LEVELS

The following criteria are applied to the categorisation of vegetation on the surrounding landscape and deriving potential bushfire threat level ranges from the bushfire hazards present. The assessed threat levels are subsequently applied in the determination of the levels of the risks associated with a bushfire event.

Vegetation Categories

Categories are established to enable a comprehensive assessment of the type and severity of the bushfire attack mechanisms (i.e., the bushfire threats), potentially generated by bushfire prone vegetation on surrounding land. This enables variations in vegetation composition and structure to be more appropriately accounted for in the determination of the levels of the relevant risks.

The variations in the potential threat level ranges assigned to each vegetation category in the table below are the result of these variations in vegetation composition.

The vegetation 'Categories' applied are necessarily different to the vegetation 'Classifications' applied in the BAL determination methodology of AS 3959:2018. This building Standard primarily considers the flame contact and radiant heat attack mechanisms to inform construction requirements to resist the bushfire itself.

The BAL determination methodology does not fully address ember/firebrand attack with respect to spotting range and density associated with the types of available fuel (or any other threats from direct or indirect attack mechanisms).

Higher levels of ember/firebrand threat have implications for the initiation of consequential fire as a very significant bushfire indirect attack mechanism that can subject elements at risk to flame contact and high levels of radiant heat, even though the bushfire itself is not close and could be kilometres away. It is important not to overlook this threat.

Landscape, Fuel Continuity and Fire Weather Factors Applied to Establishing the Mid-Point of Potential Threat Levels

1. The terrain on which the category of vegetation is supported is flat to undulating with no vegetated slopes greater than ten degrees.
2. The fire fuels are continuous.
3. The extent of bushfire prone vegetation is sufficiently large such that a fully developed fire can be supported.

   The parameters applied to the design fire within AS 3959:2018 BAL determination methodology is applied. Specifically:

   - A head fire width of at least 100 metres is physically possible;
   - Sufficient fire run length exists to allow a quasi-steady rate of spread (after the initial growth phase) to be attained and a head fire width of 100 metres to develop from a single point of ignition.
   - Typically, but not in every scenario, this will equate to areas of vegetation greater than 3ha and within which fire runs directly at an element at risk will be greater than 50 -100 metres in length; and
4. It is assumed to be possible for the most adverse fire weather to occur at the subject locality.

The Range of Potential Threat Levels for Each Vegetation Category

The potential threat level range for each category of vegetation is derived from consideration of the degree to which each of the described physical vegetation factors are relevant and present within that category. The assessed threat level will fall within this range and be dependent on the existence of threat modifying physical factors that are presented in Section 5.1.4 of this report.

The Assessed Threat Level Applied

The assessed existence of site specific variations to the threat modifying physical factors described above, will determine the assessed threat level to be applied, within the range applicable to each vegetation category. These variations and their outcome are presented in Section 5.1.4 of this report.

SURROUNDING LANDSCAPE VEGETATION MAPPING - CATEGORY DETERMINATION CRITERIA					
Category Code	Category Description				
	Total Fuel Loads	Most Relevant Fuel [1]	Spotting Range [2]	Spotting Density [2]	Potential Threat Level Range (Property) [3]
Tree-1	Moderate to High	Fine, fibrous, long strand bark	Short to Medium	Very High	Moderate to Extreme
	Trees and Bark Hazard: Tree dominated vegetation including tall species. At least 10% of the trees present have fine, longer strand fibrous barks (stringybarks). "These barks are easily dislodged from the trunk, allowing simultaneously for vertical fire propagation into the overstorey and profuse short to medium range spot fire ignitions." **Spotting Threat:** The fine, longer strand fibrous barks (stringybarks) have the potential to produce the highest short range (up to 500-750 metres) spotting density (quantity) and can spot out to medium ranges (up to 5 km) under conducive fuel, terrain and fire weather conditions. Potential spotting (ember / firebrand attack) threat levels range from moderate to extreme. **Fuel Loads:** Surface and near surface fuel loads (t/ha) range from moderate to very high (note: the worst potential fuel load for the location is applied, regardless of time since last burnt). **Example Eucalyptus Species:** Includes jarrah, messmate stringybark and brown/red stringybark. Marri can be included in this category due to the potential high-density spotting but will be limited to the shorter spotting range.				
Tree-2	Moderate to Very High	Ribbon, candle bark	Short to Long	Moderate	Moderate to Extreme
	Trees and Bark Hazard: Tree dominated vegetation including tall species. Less than 10% of trees present will have fine, longer strand fibrous barks (stringybarks). The predominant trees are smooth bark species where the bark sheds in long ribbons (ribbon/candle barks), and often hangs on the branches. "These bark types provide aerodynamically efficient, firebrand material that can remain alight for long periods and be transported over considerable distances." **Spotting Threat:** These bark types have the longest distance spotting potential (greater than 5 km) due to the long burnout time of the firebrands. However, the potential ember/firebrand density (quantity) will be lower than for fine, longer strand fibrous barks. Potential spotting (ember / firebrand attack) threat levels range from moderate to very high. **Fuel Loads:** Surface and near surface fuel loads (t/ha) range from moderate to very high (note: the worst potential fuel load for the location is applied, regardless of time since last burnt). **Example Eucalyptus Species:** Includes manna gum, blue gum, alpine ash and woollybutt, mallee species. Karri can be included in this category on the basis that while spotting distance is unlikely to be long range (as the bark is shed in short ribbons/small polygonal flakes), the potential for extreme fuel loads is relevant to the categorisation.				
Tree/Shrub	Moderate to High	Smooth, platy, papery, coarsely fibrous bark and/or Shrub fuels	Short	Low to Moderate	Moderate to High
	This category can have the most variation in vegetation types that are present. It can consist of predominantly trees with the stated bark types or be predominately shrub type vegetation or any combination. Can include areas of grass. **Trees and Bark Hazard:** Trees can be of any height. Bark types are more varied and have the characteristics of being tightly held onto the trunk, producing short strands, or producing chunks or				

<table>
<tr><td></td><td colspan="5">small flakes which fall to the ground. These bark types are described as smooth, platy, papery and coarsely fibrous.

Shrub Fuels: Scrub, shrub, heath type fuels of vertically oriented, well aerated, with live and dead vegetation extending from the surface to the top of the vegetation complex and up to 6 metres high.

Spotting Threat: Trees with the stated bark types can produce limited quantities of embers and shorter spotting distances (up to 500-750 metres). Shrub fuels can produce moderate to high quantities of smaller and shorter burn duration embers, resulting in mostly short distance spotting.

Fuel Loads: Surface, near surface and elevated fuel loads (t/ha) range from moderate to high (note: the worst potential fuel load for the location is applied, regardless of time since last burnt).</td></tr>
<tr><td rowspan="2">Shrub</td><td>Low to High</td><td>Shrub fuels</td><td>Short</td><td>Low</td><td>Low to Moderate</td></tr>
<tr><td colspan="5">Shrub Fuels: Scrub, shrub, heath type fuels of smaller sized, vertically oriented, well aerated fuels, with continuous live and dead vegetation extending from the surface to the top of the vegetation complex and up to 2 metres high. Can include areas of grass.

Spotting Threat: Shrub fuels can produce limited quantities of small and short burn duration embers resulting in low density short distance spotting (up to 500-750 metres).

Fuel Loads: Surface, near surface and elevated fuel loads (t/ha) range from moderate to high (note: the worst potential fuel load for the location is applied, regardless of time since last burnt).</td></tr>
<tr><td rowspan="2">Grass</td><td>Low to Moderate</td><td>Fine grass fuels</td><td>Very Short</td><td>Low</td><td>Low to Moderate</td></tr>
<tr><td colspan="5">Fuel Types: Will be varied and includes the following groups that each have similar structural characteristics - tropical grasslands, tussock grasslands, hummock grasslands, and improved pastures / crop lands comprised of species that cure. These fuels are typically much finer than other vegetation types with a low bulk density. Where trees are present, they make up no more than 10% of canopy cover and will have no influence on fire behaviour.

Fuel Loads: Are much lower than other types of vegetation complexes. For example, default total fuel loads applied in AS 3959:2018 BAL determination methodology for Grassland range from 43% to 85% less than other vegetation classifications.

Fire Behaviour: Combustion rates are faster in grasslands than forest fuels due to the finer materials and more aerated structure. This gives rise to the main cause of differences in fire behaviour between grassfires and fires in other fuel types - the residence time is much shorter. This is the period during which flames remain burning over one spot on the ground. Using pastures as an example, the residence time is in the order of 5 seconds in fine light pastures and 10-15 seconds in heavy pastures. This results in grassfires spreading more quickly, reacting very quickly to changes in wind direction and speed and being a shorter duration threat to a specific exposed element.

Spotting Threat: Embers produced by grass fires are smaller and fewer in number than those produced from forest fires and burn for shorter durations. Typically, spotting in grassfires occurs over very short distances and are generally not noticed as they are quickly overrun by the main fire. Potential spotting (ember / firebrand attack) threat levels are low.</td></tr>
<tr><td rowspan="2">No/Low Threat</td><td colspan="4"></td><td>No Threat to Low</td></tr>
<tr><td colspan="5">Areas of land will satisfy this category when the following factors apply:
Low threat vegetation characteristics including low flammability, high moisture content (including non-curing crops) and minimal fuel load. Low threat examples established in AS 3959:2018 include: managed grassland, mangroves/saline wetlands, maintained lawns, golf courses, public reserves/parklands, sporting fields, vineyards, orchards, banana plantations, market gardens, commercial nurseries, nature strips and windbreaks; and
Areas permanently cleared of vegetation, including natural features such as rocky outcrops and manmade infrastructure.</td></tr>
<tr><td colspan="6">Note 1: The fuel type/s that are most relevant for the categorisation of area of vegetation are stated. These have relevance when certain bark types and quantity are a significant component of total fuel loads, resulting in higher</td></tr>
</table>

threat levels for the ember/firebrand direct attack mechanism. Bark fuels are the primary source of fuel for the ember/firebrand attack threat (refer to Appendix 2 for additional information).

Note 2: Understanding and assessing the threat level generated by the ember/firebrand direct attack mechanism (spotting) is important to the management of risks associated with any bushfire hazard. With respect to categorising surrounding landscape vegetation, based on threat levels, the following points identify why the assessment of the spotting threat is important:

- At distances beyond 100 metres from a subject land the direct attack mechanisms of flame contact and radiant heat transfer cannot significantly and directly impact the building elements at risk within that site;
- However, embers/firebrands can impact subject land through the ignition of consequential fire (as an indirect attack mechanism of bushfire), in fuels and structures surrounding, upon and within the relevant elements at risk (e.g., habitable buildings). Consequential fires bring the direct attack mechanisms of flame and radiant heat much closer than the bushfire itself can. Assessments of past bushfire events indicate that ember attack and consequential fire be the cause of 80% or greater of property losses; and
- Spotting can significantly influence the increase scale of the bushfire event and its consequent intensity, both within the surrounding landscape and within the 100 metres surrounding a subject land. From *Cruz M.G. et al (2015): A Guide to Rate of Fire Spread Models for Australian Vegetation. CSIRO, AFAC*). "Spotting is an important, at times dominant, fire propagation process in high intensity fires in eucalypt forests. The type of tree bark will determine the size, shape, and number of firebrands, which the prevailing weather conditions will dictate the spotting distances and density of ignitions." Refer to Appendix 2 for additional information.

Note 3: The stated potential threat levels identify the threat level range that is associated with the stated vegetation category as it applies to constructed property, as opposed to persons in the open or travelling access routes in vehicles, which will be separately assessed.

Subsequent assessment of vegetation, terrain and fire weather factors associated with the surrounding landscape that can increase or decrease the bushfire hazard threat levels, will complete the surrounding landscape assessment for the subject land.

APPENDIX 6: THE IDENTIFIED BUSHFIRE HAZARDS

A6.1 LOCATION OF SUBJECT LAND RELATIVE TO DESIGNATED AREAS OF BUSHFIRE PRONE LAND

A 'Planning' Bushfire Management Plan (BMP) has been prepared alongside this Bushfire Risk Report.

The BMP includes the required assessments following *State Planning Policy 3.7 Bushfire* (WAPC 2024) and the *Planning for Bushfire Guidelines* (WAPC 2024).

This includes a vegetation assessment following *AS 3959:2018* (Standards Australia 2018).

GLOSSARY

APPLIED TERMINOLOGY	
Consequence	The outcome of an event or situation expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain. In the emergency risk management context, consequences are generally described as the effects on persons, society, the environment and the economy. *(Source: DPLH 2019)* An impact on the natural, economic, built or social environments as a result of the hazard. The consequences are influenced by the vulnerability of elements at risk, by the exposure of elements at risk to the hazard, and by the characteristics of the hazard. *(Source: PIA, 2015)*. The outcome of an event that affects objectives. Can be a range of consequences; can be certain or uncertain; can have positive or negative effects; can be expressed qualitatively or quantitatively; can escalate through knock-on effects. *(Source: ISO Guide 73:2009)*
Controls	A measure that maintains and/or modifies risk. Controls include, but are not limited to, any process, policy, device, practice, or other conditions and/or actions which maintain and/or modify risk. *(Source: AIDR Knowledge Hub; Glossary)* A control is any measure or action that modifies or regulates risk. Controls include any policy, procedure, practice, process, technology, technique, method, or device that modifies or regulates risk. Risk treatments become controls, or modify existing controls, once they are implemented. *(Source: Praxiom)* *Note: 'Protection Measures' and 'Risk Treatments' will be alternative terms used in this risk assessment report.*
Decision Maker	The Minister for Planning, State Administrative Tribunal, Western Australian Planning Commission, Development Assessment Panel, any other State decision-making authorities, and/or the relevant local government and their delegates that make decisions regarding the application of this Policy. *(Source: SPP 3.7)* For proposed development or use that is not subject to planning approval, the relevant decision makers are those tasked with the development and management of a development or use. Typically this might be an existing development/use for which an improved bushfire performance is being sought.
Elements At Risk	The population, buildings and civil engineering works economic activities, public services and infrastructure, etc. exposed to hazards. (Australian Institute for Disaster Resilience, 2019)
Exposure	Refers to the people and things in the path of potential hazards. *(Source: AIDR* LUPDRC, *2020)* The elements within a given area that have been, or could be, subject to the impact of a particular hazard. Bushfire exposure can refer to property that may be endangered by a fire burning in another structure or by a bushfire. *(Source: AIDR Knowledge Hub; Glossary)* The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard prone areas. Measures of exposure can include the number of people or types of assets in an area. These can be combined with the specific vulnerability and capacity of the exposed elements to any particular hazard to estimate the quantitative risks associated with that hazard in the area of interest. *(Source: UNDRR, 2017)*

Hazard	A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. Hazards may be natural, anthropogenic or socionatural in origin. • **Natural hazards** are predominantly associated with natural processes and phenomena (note: disasters often follow natural hazards, but there is no such thing a natural disaster); • **Anthropogenic hazards** are human-induced – being induced entirely or predominantly by human activities and choices; • **Socionatural hazards** are associated with a combination of natural and anthropogenic factors, including environmental degradation and climate change. Hazards may be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity or magnitude, frequency and probability. *(Source: UNDRR Terminology 2017)* A source of potential harm or a situation with a potential to cause loss. A potential or existing condition that may cause harm to people, or damage to property or the environment. A source of risk. *(Source: AIDR Knowledge Hub; Glossary)*
Hazardous Event	The manifestation of a hazard in a particular place during a particular period of time. [Severe hazardous events can lead to a disaster as a result of the combination of hazard occurrence and other risk factors.] (Source: *United Nations Office for Disaster Risk Reduction, 2017)*
Hazard Identification	The process of recognising that a hazard exists and defining its characteristics. *(Australian Institute for Disaster Resilience, 2019)*
Hazard - Bushfire	A fuel complex, defined by amount, type condition, arrangement, and location, that determines the degree of hazard. *(Source: AIDR Knowledge Hub; Glossary)* The term 'bushfire hazard' in this assessment report is intended to refer to both bushfire prone vegetation and the associated potential bushfire event itself. The term 'bushfire' is being applied as the common term for forest, scrub, shrub, and grass fire events.
Hazard - Urban Fire	1. Susceptibility of a material to burn. 2. The presence of combustible materials. 3. A process or activity posing a fire risk if not adequately controlled. *(Source: AIDR Knowledge Hub; Glossary)*
Hazardous Material	A substance or material which has been determined by an appropriate authority to be capable of posing an unreasonable risk to health, safety and property. *(Source: AIDR Knowledge Hub; Glossary)*
Impact	Describes as a quantitative or qualitative measure, the relative potential ability of a threat to adversely affect an exposed element or of a protection measure to reduce threat, exposure or vulnerability levels and consequently, risk levels.
Likelihood	Chance of something happening. The likelihood level reflects the probability of **both the emergency event and the estimated consequences** occurring as a result of the event. *(Source: AIDR NERAG, 2020)* In risk management terminology, the word 'likelihood' is used to refer to the chance of something happening, whether defined, measured or determined objectively or subjectively, qualitatively or quantitatively, and described using general terms or mathematically - such as a probability or a frequency over a given time period. *(Source: ISO Guide 73:2009)*

	The chance of an event occurring. Likelihood may be represented as a statistical probability (such as Annual Exceedance Probability), or where this is not possible, it can be represented qualitatively using such measures as 'likely', 'possible', and 'rare'. *(Source: PIA, 2015)*.
Mitigation	The lessening or minimizing of the adverse impacts of a hazardous event. The adverse impacts of hazards, in particular natural hazards, often cannot be prevented fully, but their scale or severity can be substantially lessened by various strategies and actions. Mitigation measures include engineering techniques and hazard-resistant construction as well as improved environmental and social policies and public awareness. *(Source: UNDRR, 2017)*
Reliability	Refers to the expected reliability of a designed solution (protection measure). Over time it will be a function of: • Its Initial likely reliability; • Its durability which may or may not be a function of maintenance; • The level of maintenance required; • The likelihood of solution being modified over time; and • The influence of other adjoining/adjacent structures or stored materials that may be installed after the initial construction. (Adapted from Kelly M. et al; *Structural Design Options for Residential Buildings in Bushfire Areas,* Australasian Structural Engineering Conference November 2016)
Resilience	The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management. (*United Nations Office for Disaster Risk Reduction, 2017)* Is that property of a building, system, or community that facilitates its return to a functional state following an overload. In the context of bushfire damage, resilience will be maximised when: • There is a high probability of an attacked building remaining fit for purpose; and • There is a low time and cost to make badly damaged buildings fit for purpose. (Adapted from Kelly M. et al; *Structural Design Options for Residential Buildings in Bushfire Areas,* Australasian Structural Engineering Conference November 2016)
Robustness	Refers to that property of structural systems that seeks to achieve proportionality of damage to the severity of an overloading event. It will be maximised when bushfire design solutions: • Have few 'weak links' that allow progressive spread of damage from minor sources; • Consist of materials and assemblies that retain physical properties when thermally loaded beyond their design capacity; and • Include protection of inherently vulnerable and brittle elements. Such as openings to internal parts of structures (including doors and windows) and essential services that maintain required functioning (e.g. cabling and plumbing). (Adapted from Kelly M. et al; *Structural Design Options for Residential Buildings in Bushfire Areas,* Australasian Structural Engineering Conference November 2016) As a design principle it means that the design and materials are not easily damaged or compromised, and do not require manual operation or intervention to work (Source: State Government of Queensland, CSIRO, 2020)

Redundancy	Refers to design that ensures the fate of the subject building/structure is not reliant on the effective performance of a single element. (State Government of Queensland, CSIRO, 2020) An example is a roof system that does not rely solely on the roof cladding to resist bushfire threats. It has additional layers of resistance including non-combustible roof/ceiling framing, insulation and ceiling lining, and the sealing/screening of gaps into internal operating spaces.
Risk	Disaster risk is the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity. *(Source: UNDRR, 2017)* Disaster risk is a product of a hazard (a sudden event or shock), exposure (the people and things in the path of potential hazards), vulnerability (the potential for those people and things to be adversely impacted by a hazard) and the capacity (the ability for those people and assets and systems to survive and adapt). *(Source: AIDR LUPDRC, 2020)* Risk is the chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood. In emergency management it is a concept used to describe the likelihood of harmful consequences arising from the interaction of hazards, communities and the environment. *(Source: PIA, 2015)*
Risk Management	Disaster risk management is the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses. *(Source: UNDRR, 2017)* Coordinated activities of an organisation or a government to direct and control risk. The risk management process includes the activities of: • Communication and consultation; • Establishing the context; • Risk Assessment (risk identification, risk analysis, risk evaluation); • Risk Treatment; and • Monitoring and Review. *(Source: AIDR NERAG, 2020)* **Risk management vs. risk mitigation:** Though risk management and risk mitigation are often used interchangeably, the two terms refer to slightly different things. Risk mitigation involves limiting the effect that risks can have (i.e. making less severe). It is a single component of the larger risk management process. Risk management refers to the overall practice of assessing and addressing the relevant risk. (*an explanation of the use of these terms as applied by Bushfire Prone Planning*)
Risk Identification	Process of finding, recognising and describing sources of risks, their causes and their potential consequences. *(Source: ISO Guide 73:2009)* It is a process used to find, recognise, and describe the risks that could affect the achievement of objectives. *(Source: Praxiom)*
Risk Source	An element which, alone or in combination, has the intrinsic potential to give rise to risk. *(Source: ISO Guide 73:2009)*
Risk Assessment	Disaster risk assessment is a qualitative or quantitative approach to determine the nature and extent of disaster risk by analysing potential hazards and evaluating existing conditions of exposure and vulnerability that together could harm people property, services and livelihoods and the environment on which they depend. Assessments include the identification of hazards; a review of the technical characteristics of hazards such as their location, intensity, frequency, and probability; the analysis of exposure and

	vulnerability, including the physical, social, health, environmental and economic dimensions; and the evaluation of the effectiveness of prevailing and alternative coping capacities with respect to likely risk scenarios. *(Source: UNDRR, 2017)* The overall process of risk identification, risk analysis and risk evaluation. *(Source: ISO Guide 73:2009)*
Risk Analysis	The process to comprehend the nature of risk and determine the level of risk. Provides the basis for risk evaluation and decisions about risk treatment. *(Source: ISO Guide 73:2009)* Is a process that is used to understand the nature, sources, and causes of the risks that you have identified and to estimate the level of risk. It is also used to study impacts and consequences and to examine the controls that currently exist. How detailed your risk analysis ought to be will depend upon the risk, the purpose of the analysis, the information you have, and the resources available. *(Source: Praxiom)* In this risk assessment report, risk analysis is the part of the risk assessment process that assesses the hazard threat levels, identifies the protection measures (and their effectiveness) that can be applied and derives the levels of exposure and vulnerability of the identified elements at risk, based on the ability to apply protection measures. From this information indicative risk levels can be derived. Where relevant sets of risk factor criteria and a risk level matrix have been established by the relevant authorities, a determined risk level can be derived. The required risk level analysis can be conducted for either each exposed element separately and/or the proposed or existing development/use overall.
Risk Evaluation	The process used to determine risk management priorities by evaluating and comparing the level of risk against predetermined standards, target risk levels or other criteria. *(Source: PIA, 2015)* In this risk assessment report, it is the process of classifying the acceptability of the levels of risk, derived from the risk analysis, by reference to an established risk tolerance scale. The relevant tolerance scale will be that derived from the application of the 'as low as reasonably practicable' principle – 'ALARP' (refer to Appendix 1 for further information). This process can only be conducted when determined risk levels have been derived.
Risk Factor Criteria	In this risk assessment report, the risk factor criteria establish the parameters that will define the different hazard threat levels, the different levels of exposure of elements at risk and the different levels of vulnerability of elements at risk. Different sets of risk factor criteria can exist corresponding to different development types, uses and scale. They are applied as part of the risk analysis. These criteria are established by the relevant authorities as they must reflect societies preparedness to tolerate risk and be determined by those authorities exercising their responsibilities.
Risk Level Matrix	In this risk assessment report, the risk level matrix establishes how the assessed levels of hazard threats, exposure and vulnerability are to be analysed in deriving a determined risk level. It is applied as part of the risk analysis. The matrix is established by the relevant authorities as they must reflect societies preparedness to tolerate risk and be determined by those authorities exercising their responsibilities.
Risk Tolerance Scale	In this risk assessment report the applied risk tolerance scale defines the acceptability of determined risk levels based on the 'as low as reasonably practical' principle (ALARP). The risk tolerance scale can be applied within the risk assessment report when the required risk factor criteria and risk level matrix are available.

Risk - Inherent	In this risk assessment report, inherent risk is considered to be current risk after accounting for existing and any 'planned' protection measures (controls / risk treatments) but before the application of any additional protection measures that have been identified and recommended by the bushfire consultant – and which subsequently determines the residual risk (this approach is supported by the relevant information sourced from the two references below). 'Planned' protection measures are those that are incorporated into the site development plans and those that exist in an approved Bushfire Management Plan (BMP) and/or Bushfire Emergency Plan (BEP) and for which a responsibility for their implementation has been created. If a BMP or BEP is yet to be developed or is being developed concurrently, the additional protection measures it contains (including any that are part of relevant 'acceptable solutions' established by the 'Guidelines for planning in bushfire prone areas', DPLH as amended), are considered to be additionally recommended protection measures. 1. ***Source: www.fairinstitute.org*** *"Confusion exists between Inherent Risk and Residual Risk … Here are the standard definitions of the two concepts:* • *Inherent risk represents the amount of risk that exists in the absence of controls.* • *Residual risk is the amount of risk that remains after controls are accounted for.* *Sounds straightforward. But these two terms seem to fall apart when put into practice. Applying the above definitions to the clients' scenario uncovered the fact that the 'inherent' risk being described was not a 'no controls' environment, but rather, one that only excluded some controls.* *The flaw with inherent risk is that in most cases, when used in practice, it does not explicitly consider which controls are being included or excluded. A truly inherent risk state, in our example, would assume no employee background checks or interviews are conducted and that no locks exist on any doors. This could lead to almost any risk scenario being evaluated as inherently high. Treating inherent risk therefore can be quite arbitrary. According to Jack Jones, author of Measuring and Managing Information Risk: A FAIR Approach and creator of the FAIR model, much more realistic and useful definitions would be:* • *Inherent risk is current risk level given the existing set of controls rather than the hypothetical notion of an absence of any controls; and* • *Residual risk would then be whatever risk level remain after additional controls are applied."* 2. ***Source: Wikipedia:*** *Inherent risk, in risk management is:* • *an assessed level of raw or untreated risk; that is, the natural level of risk inherent in a process or activity without doing anything to reduce the likelihood or mitigate the severity of a mishap, or the amount of risk before the application of the risk reduction effects of controls; or* • *Another definition is that inherent risk is the current risk level given the existing set of controls, which may be incomplete or less than ideal, rather than an absence of any controls.*
Risk - Residual	In this risk assessment report, residual risk is that which remains after the application of protection measures that are additional to those that already exist or are 'planned' and that establish the inherent risk (see Risk – Inherent in glossary) It is the disaster risk that remains in unmanaged form, even when effective disaster risk reduction measures are in place, and for which emergency response and recovery

	capacities must be maintained. The presence of residual risk implies a continuing need to develop and support effective capacities for emergency services, preparedness, response and recovery, together with socioeconomic policies such as safety nets and risk transfer mechanisms, as part of a holistic approach. *(Source: UNDRR, 2017)* It is the risk left over after you've implemented a risk treatment option. It's the risk remaining after you've reduced the risk, removed the source of the risk, modified the consequences, changed the probabilities, transferred the risk, or retained the risk. *(Source: Praxiom)* It is the risk remaining after any risk treatment has been applied to reduce its potential likelihood and/or its potential consequences. Residual risk can also be any risk that is chosen to be retained rather than treated *(Source: AIDR* LUPDRC*, 2020)* Residual risk can contain unidentified risk. Residual risk can also be known as retained risk. *(Source: ISO Guide 73:2009)*
Risk Level - Determined	Magnitude of a risk or a combination of risks. In this risk assessment report, as an outcome of the risk analysis, a determined risk level is derived from: 1. The determination of threat, exposure and vulnerability levels by reference to an established set of risk factor criteria that corresponds to each risk level (for each factor); and 2. The determination of the risk level by reference to an established risk level matrix that incorporates threat, exposure and vulnerability levels.
Risk Level - Indicative	Magnitude of a risk or a combination of risks. In this risk assessment report, as an outcome of the risk analysis, an indicative risk level is derived from analysis of the number of bushfire protection measures able to be implemented compared to the number of measures available, and the relative effectiveness of each at reducing threat, exposure and/or vulnerability levels. Overall, more applicable and applied measures is better and the measures with a higher effectiveness rating have greater weighting in the analysis.
Risk - Acceptable	Risks that do not need further treatment. The expression acceptable level of risk refers to the level at which it is decided that further restricting or otherwise altering the activity is not worthwhile e.g. additional effort will not result in significant reductions in risk levels. *(Source: DPLH, 2019)* That level of risk that is sufficiently low that society is comfortable with it. Society does not generally consider expenditure in further reducing such risks justifiable. *(Source: AIDR Knowledge Hub)* An acceptable risk is a risk that is sufficiently low to require no new treatments or actions to reduce the risk as communities can live with this level of risk without further action. *(Source: Queensland Government 2019: Natural hazards, risk and resilience – Bushfire: State Planning Policy – state interest guidance material)* Acceptable risk or tolerable risk is an important sub-term (of disaster risk). The extent to which a disaster risk is deemed acceptable or tolerable depends on existing social, economic, political, cultural, technical and environmental conditions. *(Source: UNDRR, 2017)* ***Note:*** *It is generally accepted that nothing can be absolutely free of risk, everything under some circumstance can cause harm. There are differing levels of risk and consequently levels of safety. In practice, attaining zero risk is not possible. Nevertheless, after risk avoidance, reduction/mitigation, transfer or acceptance - the residual risk may be determined as acceptable, as judged by the participants in an activity and decision makers (who apply societies expectations). For certain land uses, the residual risk may exist at higher levels but still be judged by to be acceptable (or tolerable) on this basis.*

Risk - Tolerable	The willingness to live with a risk to secure benefits and achieve objectives, on the understanding that it is being properly controlled. 'Tolerability' does not mean 'acceptability'. Tolerating a risk does not mean that it is regarded as negligible, or something we may ignore, but rather as something that needs to be kept under review and reduced further. *(Source: DPLH, Guidelines v1.4)* Certain levels of risk may be tolerated, provided that the risks are known and managed. *(Source: AIDR LUPDRC, 2020)* A tolerable risk is a risk that is low enough to allow the exposure to a natural hazard to continue while at the same time high enough to require new treatments or actions to reduce risk. Communities can live with level of risk but as much as is reasonably practical should be done to further reduce the risk. *(Source: Queensland Government 2019: Natural hazards, risk and resilience – Bushfire: State Planning Policy – state interest guidance material)* Risk tolerance is defined as the organisations or stakeholder's readiness to bear the risk, after risk treatment, in order to achieve its objectives. Risk tolerance can be influenced by legal or regulatory requirements. *(Source: ISO Guide 73:2009)* A level of risk that defines the ALARP region, as risks that should be driven to the broadly acceptable region. *(Source: PIA, 2015)*
Risk - Intolerable	A level of risk that is so high that require risk treatment measures whatever their cost, or the elimination of the risk. *(Source: PIA, 2015)* Risk that is unacceptable in any circumstances or at any level. *(Source: DPLH, 2019)*
Risk Treatment	Risk treatment options available as part of the risk management process are generally categorised as follows: • Risk Avoidance: Measures taken to avoid risks from natural hazards. Can include avoiding development in hazardous areas, relocating people or assets away from hazardous areas, or developing buffer zones to the hazard; • Risk reduction/mitigation: Measures undertaken to reduce the risks from natural hazards. Includes building control and development controls; • Risk Transfer: Measures taken to transfer the risk from natural hazards from one party to another; and • Risk Acceptance: The acceptance of risk from a natural hazard. Any realised losses will be borne by those parties exposed to the hazard. This is not specifically a treatment option as no action is taken, but it is an option for addressing risk. *(Source: AIDR LUPDRC, 2020)*
Retrofitting	Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards. Retrofitting requires consideration of the design and function of the structure, the stresses that the structure may be subject to from particular hazards or hazard scenarios and the practicality and costs of different retrofitting options. *(Source: UNDRR, 2017)*
Structural and Non-Structural Measures	Structural measures are any physical construction to reduce or avoid possible impacts of hazards, or the application of engineering techniques or technology to achieve hazard resistance and resilience in structures or systems. Non-structural measures are measures not involving physical construction which use knowledge, practice or agreement to reduce disaster risks and impacts, in particular through policies and laws, public awareness raising, training and education.

	Common non-structural measures include building codes, land-use planning laws and their enforcement, research and assessment, information resources and public awareness programmes. *(Source: UNDRR, 2017)*
Threats	The mechanisms by which hazards can impact exposed elements.
Vulnerability	The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards. (*United Nations Office for Disaster Risk Reduction, 2017)* The characteristic or property of a community, system or object that makes it susceptible to the damaging effects of a specific hazard. Can be defined according to the responses of people, houses and assets in mitigating the impacts of a hazard. Specifically, it refers to the extent to which a community, building, services or location is likely to be damaged or disrupted by the impacts of a hazard, such as a bushfire. Building vulnerability refers to weak points in a building caused by its design, construction, use of materials and management (including maintenance). These weak points are identified in the context that they are not able to withstand the level of hazard they are exposed to. Climate and weather may directly influence the buildings vulnerability through several processes including (i) moisture content of combustible elements around and within buildings (ii) gaps between materials that may shrink and expand due to changes in moisture content and temperature (iii) wind action causing damage or dislocation of elements. *(Source: State Government of Queensland, CSIRO, 2020; Bushfire Resilient Building Guidance for Queensland Homes)*
'Vulnerable' Persons	These are persons who are considered to be at-risk members of the community and may be more susceptible to the impacts of bushfire. These persons are likely to present relocation (including evacuation) challenges in the event of a bushfire. Attributes of this group of persons includes: • Less physically or mentally able to relocate themselves; and/or • Are unfamiliar with their surroundings; and/or • Large numbers of persons in a building(s) or in the open, on a single site, such that the numbers present practical challenges.

REFERENCES

[1] Alex Filkov, Tom Duff, Trent Penman: Determining Threshold Conditions for Extreme Fire Behaviour; Annual report 2018-2019 - The Determinants of Crown Fire Runs During Extreme Wildfires in Broadleaf Forests in Australia, University of Melbourne & Bushfire and Natural Hazards CRC

[2] Alexander M.E., Cruz M.G.: The General Nature of Crown Fires (Synthesis on Crown Fire Behaviour in Conifer Forests), Fire Management Today Volume 73 No.4 2014.

[3] Alexander M.E., Cruz M.G.: The Start, Propagation and Spread Rate of Crown Fires (Synthesis on Crown Fire Behaviour in Conifer Forests), Fire Management Today Volume 73 No.4 2014.

[4] AS 3959:2018; Construction of buildings in bushfire prone areas

[5] Australian Government Department of Home Affairs (DHA), 2018; National Disaster Risk Reduction Framework.

[6] Australian Institute for Disaster Resilience (AIDR), 2020; Land use Planning for Disaster Resilient Communities (LUPDRC).

[7] Australian Institute for Disaster Resilience (AIDR), 2020; National Emergency Risk Assessment Guidelines (NERAG).

[8] Australian Institute for Disaster Resilience (AIDR); Knowledge Hub - Glossary

[9] Blanchi R., Leonard J.E. (2005) Investigation of Bushfire Attack Mechanisms Resulting in House Loss in the ACT Bushfire 2003, Bushfire CRC Report – CSIRO MIT Highett, Australia.

[10] Blanchi R., Leonard J., Leicester R.H., (2006) Bushfire risk at the rural–urban interface. In 'Proceedings of Bushfire Conference 2006: Life in a Fire-prone Environment: Translating Science into Practice', 6–9 June 2006, Brisbane, QLD. (Griffith University: Brisbane)

[11] Bowman D. (2021); Asking people to prepare for fire is pointless if they can't afford to do it. It's time we subsidised fire prevention; Article in The Conversation January 12, 2021.

[12] Bushfire Cooperative Research Centre (Melbourne); HighFire Risk Project [http://www.highfirerisk.com.au]

[13] Bushfire Resilient Building Guidance for Queensland Homes (2020); State Government of Queensland and CSIRO.

[14] Bushfire Verification Method - Handbook (ABCB, 2019), © Commonwealth of Australia and States and Territories 2019, published by the Australian Building Codes Board.

[15] Cheney N.P.: Fire behaviour during the Pickering Brook wildfire, January 2005 (Perth Hills Fires 71-80); Conservation Science W. Aust. 7 (3): 451-468 (2010)

[16] Cruz, MG (2021) The Vesta Mk 2 rate of fire spread model: a user's guide; CSIRO, Canberra, ACT. 76pp.

[17] CSIRO (2020) Climate and Disaster Resilience; Technical Report, July 2020

[18] CSIRO (2020) Climate and Disaster Resilience; Overview Report, 30 June 2020

[19] Department of Planning Lands and Heritage (DPLH), 2019; Coastal hazard risk management and adaptation planning guidelines.

[20] Design and Construction of Community Bushfire Refuges – Information Handbook; Australian Building Codes Board and Fire Services Commissioner Victoria, 2014.

[21] Filkov A.I., Duff T.J., Penman T.D. (2020) Frequency of Dynamic Fire Behaviours in Australian Forest Environments // Fire, 2020, 3,1 pp1-17

[22] Guidelines for Planning in Bushfire Prone Areas (Guidelines), Version 1.4, WAPC 2021

[23] Health and Safety Executive (HSE-UK), 2001; Reducing risks protecting people – HSE's decision making process.

[24] Health and Safety Executive (HSE-UK), Guidance - ALARP "at a glance"

[25] Howard T., Burrows N., Smith T., Daniel G., McCaw L. (2020); A framework for prioritising prescribed burning on public land in Western Australia. International Journal of Wildland Fire 2020, 29, 314-325.

[26] ISO Guide 73:2009; Risk Management – vocabulary

[27] Jason J Sharples, University of New South Wales Canberra. Risk Implications of Dynamic Fire Propagation – A Case Study of the Ginninderry Region (Preliminary Report June 2017)

[28] Jason J. Sharples et al. (2016) Natural hazards in Australia: extreme bushfire. Climatic Change (2016) 139:85–99 DOT 10.1007/s10584-016-1811-1

[29] J.E. Leonard, R. Blanchi, N. White, A. Bicknell, A. Sergeant, F. Reisen and M. Cheng (2006); Research and Investigation into the Performance of Residential Boundary Fencing Systems in Bushfires; Bushfire CRC Melbourne.

[30] Leonard J.E., Blanchi R., Bowditch P.A.; (2004) Bushfire Impact from a House's Perspective (CSIRO MIT)

[31] Leonard, J., Short, L. (2016) *Guidelines for Building in Bushfire Prone Areas – Wye River and Separation Creek* (v 2.0).

[32] Leonard et al, Wye River / Separation Creek – Post-bushfire building survey findings (2016) CSIRO Client Report EP16924.

[33] NASH Standard – Steel framed construction in bushfire prone areas. National Association for Steel Framed Housing 2014 (Amendment A 2015)

[34] National Construction Code Series, Volume 2. Australian Building Codes Board. 2015

[35] NOPSEMA (Australia's offshore energy regulator), 2020; ALARP and risk assessment guidance notes.

[36] Peace M, McCaw L, Santos B, Kepert J.D., Burrows N and Fawcett R.J.B.: Meteorological drivers of extreme fire behaviour during the Waroona bushfire, Western Australia, January 2016; Journal of Southern Hemisphere Earth Systems Science (2017) 67:2, 79-106. DOI: 10.22499/3.6702.002

[37] Pearce M., Kepert J.; Extreme Fire Behaviour: Reconstructing the Waroona Fire Pyrocumulonimbus and Ember Storms; Hazard Note Issue 48 June 2018 Bushfire and Natural Hazards CRC

[38] Planning Institute of Australia (PIA), 2015; National Land Use Planning Guidelines for Disaster Resilient Communities.

[39] Praxiom Research Group Limited; ISO 31000 2018 Risk management definitions in plain English.

[40] Prof. Jason J Sharples (School of Science. University of NSW, Canberra) Submission to the Senate Select Committee into Lessons to be Learned in Relation to the Australian Bushfire Season 2019-20

[41] Sharples J.J., McRae R.H.D., and Wilkes S.R.: Wind-terrain effects on the propagation of wildfires in rugged terrain: fire channelling; Article in International Journal of Wildland Fire · May 2012

[42] Sharples J.J., Mills G.A., McRae R.H.D., and Weber R.O.: Foehn-Like Winds and Elevated Fire Danger Conditions in Southeastern Australia; 2010 American Meteorological Society DOI: 10.1175/2010JAMC2219.1

[43] State Planning Policy 3.7 (SPP 3.7); Planning in bushfire prone areas, WAPC, 2015

[44] United Nations Office for Disaster Risk Reduction (UNDRR), 2017; Report on Indicators and terminology relating to disaster risk reduction.

[45] United Nations Office for Disaster Risk Reduction (UNDRR); Global Platform for Disaster Risk Reduction (PreventionWeb) https://www.preventionweb.net/

[46] United Nations Office for Disaster Risk Reduction (UNDRR) – Understanding Disaster Risk. https://www.preventionweb.net/understanding-disaster-risk/component-risk/disaster-risk

[47] WA Department of Mines, Industry Regulation and Safety, 2020; Petroleum safety and major hazard facility – guide. ALARP demonstration.

[48] CSIRO Bushfire Best Practice Guide - https://research.csiro.au/bushfire/