Bushfire management plan/Statement addressing the Bushfire Protection Criteria coversheet

Site address: Northam Solar Farm, Lots 6 and 7 Northam-York Road, Muluckine

Site visit: Yes ☑ No ☐

Date of site visit (if applicable): Day 10 Month November Year 2022

Report author or reviewer: Mike Scott

WA BPAD accreditation level (please circle):

Not accredited ☐ Level 1 BAL assessor ☐ Level 2 practitioner ☐ Level 3 practitioner ☑

If accredited please provide the following.

BPAD accreditation number: 27795 Accreditation expiry: Month February Year 2023

Bushfire management plan version number: 1.0

Bushfire management plan date: Day 08 Month December Year 2022

Client/business name: Infinite Green Energy

	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?	✔	
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the bushfire protection criteria elements)?		✔

Is the proposal any of the following (see SPP 3.7 for definitions)?	Yes	No
Unavoidable development (in BAL-40 or BAL-FZ)		✔
Strategic planning proposal (including rezoning applications)		✔
High risk land-use	✔	
Vulnerable land-use		✔

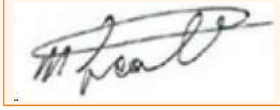
None of the above ☐

Note: Only if one (or more) of the above answers in the tables is yes should the decision maker (e.g. local government or the WAPC) refer the proposal to DFES for comment.

Why has it been given one of the above listed classifications (E.g. Considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

A Method 2 assessment was undertaken to calculate 10kW/m2 setbacks.
The proposal is for a hydrogen production facility and solar farm which are each considered a High Risk Land Use.

The information provided within this bushfire management plan to the best of my knowledge is true and correct:

Signature of report author or reviewer 

Date 08/12/2022

BUSHFIRE PRONE PLANNING

MEG Hydrogen Project
(Northam Solar Farm)

Bushfire Management Plan (BMP)

Produced to meet the relevant requirements of STATE PLANNING POLICY 3.7 Planning in Bushfire Prone Areas & Guidelines

Lots 6 and 7 Northam-York Road, Muluckine

Shire of Northam

Development Application - High Risk Land Use

8 December 2022

Job Reference No:
170545

BPP GROUP PTY LTD T/A BUSHFIRE PRONE PLANNING

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

LEVEL 1, 159-161 JAMES STREET
GUILDFORD WA 6055

PO BOX 388
GUILDFORD WA 6935

08 6477 1144 | admin@bushfireprone.com.au

DOCUMENT CONTROL

PREPARATION		
Author:	Mike Scott (BPAD Level 3 No. 27795)	
Co-Author:	Neil Stoney	

VERSION HISTORY		
Version	Details	Date
1.0	Original	8 December 2022
-	-	

BMP (Master) Template v9.13

DISTRIBUTION					
Destination		Version	No. Copies	Hard Copy	Electronic Copy
Person	Email				
Mick Hutt	mhutt@igeh2.com	1.0		☐	☒
		-		☐	☐

Limitations: *The protection measures that will be implemented based on information presented in this Bushfire Management Plan are 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 required protection measures (including bushfire resistant construction) and any other required or recommended 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

SUMMARY STATEMENTS 3

1 PROPOSAL DETAILS AND THE BUSHFIRE MANAGEMENT PLAN 6

1.1 THE PROPOSED DEVELOPMENT/USE DETAILS, PLANS AND MAPS 6

1.2 THE BUSHFIRE MANAGEMENT PLAN (BMP) 11

1.2.1 COMMISSIONING AND PURPOSE 11

1.2.2 EXISTING DOCUMENTS WITH IMPLICATIONS FOR DEVELOPMENT OF THIS BMP 11

2 ENVIRONMENTAL CONSERVATION (DESKTOP ASSESSMENT) 12

2.1 EXISTING VEGETATION ON PRIVATE LAND 12

2.1.1 DECLARED ENVIRONMENTALLY SENSITIVE AREAS (ESA) 12

2.2 PLANNED LANDSCAPING AND/OR RE-VEGETATION 13

3 BUSHFIRE ATTACK LEVEL (BAL) ASSESSMENT 14

3.1 BAL ASSESSMENT SUMMARY - TABLE FORMAT 15

3.1.1 THE BAL DETERMINATION METHOD(S) APPLIED AND THE LOCATION OF DATA AND RESULTS 15

3.1.2 CLASSIFIED VEGETATION AND TOPOGRAPHY MAP(S) 16

3.1.3 BAL ASSESSMENT MAP(S) 18

4 IDENTIFICATION OF BUSHFIRE HAZARD ISSUES 23

5 ASSESSMENT AGAINST THE BUSHFIRE PROTECTION CRITERIA (GUIDELINES V1.4) 24

5.1 BUSHFIRE PROTECTION CRITERIA ELEMENTS APPLICABLE TO THE PROPOSED DEVELOPMENT/USE 24

5.2 LOCAL GOVERNMENT VARIATIONS TO APPLY 24

5.3 ASSESSMENT STATEMENTS FOR ELEMENT 1: LOCATION 25

5.4 ASSESSMENT STATEMENTS FOR ELEMENT 2: SITING AND DESIGN 26

5.5 ASSESSMENT STATEMENTS FOR ELEMENT 3: VEHICULAR ACCESS 29

5.6 ASSESSMENT STATEMENTS FOR ELEMENT 4: WATER 32

5.7 ADDITIONAL BUSHFIRE PROTECTION MEASURES TO BE IMPLEMENTED 34

5.7.1 ADDITIONAL PROTECTION MEASURES DERIVED FROM ASSOCIATED BUSHFIRE RISK MANAGEMENT DOCUMENTS 34

6 RESPONSIBILITIES FOR IMPLEMENTATION AND MANAGEMENT OF THE BUSHFIRE PROTECTION MEASURES 45

6.1 DEVELOPER / LANDOWNER RESPONSIBILITIES – PRIOR TO OPERATION 45

6.2 LANDOWNER / OCCUPIER RESPONSIBILITIES – ONGOING MANAGEMENT 47

6.3 LOCAL GOVERNMENT RESPONSIBILITIES – ONGOING MANAGEMENT 49

APPENDIX A: DETAILED BAL ASSESSMENT DATA AND SUPPORTING INFORMATION 50

A1: BAL ASSESSMENT INPUTS COMMON TO THE METHOD 1 AND METHOD 2 PROCEDURES 50

A1.1: FIRE DANGER INDICES (FDI/FDI/GFDI) 50

A1.2: VEGETATION ASSESSMENT AND CLASSIFICATION 50
A1.3: EFFECTIVE SLOPE 61
A1.4: SEPARATION DISTANCE 62
A2: BAL ASSESSMENT INPUTS APPLIED USING THE METHOD 2 PROCEDURE 63
A2.1: SUMMARY OF CALCULATION INPUTS APPLIED AND THE LEVEL OF JUSTIFICATION REQUIRED 64
A2.2: FLAME TEMPERATURE 66
A3: BAL CALCULATOR – COPY OF INPUT/OUTPUT VALUES 67
APPENDIX B: ONSITE VEGETATION MANAGEMENT - THE APZ 69
B1: THE DIMENSIONS AND LOCATION OF THE APZ TO BE ESTABLISHED AND MAINTAINED 69
B2: THE STANDARDS FOR THE APZ AS ESTABLISHED BY THE GUIDELINES (DPLH, V1.4) 73
B3: THE STANDARDS FOR THE APZ AS ESTABLISHED BY THE LOCAL GOVERNMENT 75
B4: MAINTAINING LOW THREAT AND NON-VEGETATED AREAS EXCLUDED FROM CLASSIFICATION 76
APPENDIX C: TECHNICAL REQUIREMENTS FOR VEHICULAR ACCESS 77
APPENDIX D: TECHNICAL REQUIREMENTS FOR FIREFIGHTING WATER SUPPLY 78
D1: RETICULATED AREAS – HYDRANT SUPPLY 78
D2: NON-RETICULATED AREAS – STATIC SUPPLY 79
ADDENDUM: BUSHFIRE RISK ASSESSMENT AND MANAGEMENT REPORT 81

LIST OF FIGURES

Figure 1.1: Proposed development plan: Hydrogen Project and Solar Farm Expansion. 7
Figure 1.2: Location map (spatial context) 8
Figure 1.3: Extract from Map of Bushfire Prone Areas (Office of Bushfire Risk Management, DFES) 10
Figure 3.1: Classified vegetation and topography map 16
Figure 3.2.1: BAL Assessment Map: Northern Solar Farm (Lot 6) 18
Figure 3.2.2: BAL Assessment Map: Southern Solar Farm (Lot 7) 19
Figure 3.2.3: BAL Assessment Map: MEG Hydrogen Project (Lot 7) 20

SUMMARY STATEMENTS

THIS DOCUMENT – STATEMENT OF PURPOSE

The Bushfire Management Plan (BMP)

The BMP sets out the required package of bushfire protection measures to lessen the risks associated with a bushfire event. It establishes the responsibilities to implement and maintain these measures.

The BMP also identifies the potential for any negative impact on any environmental, biodiversity and conservation values that may result from the application of bushfire protection measures or that may limit their implementation.

Risks Associated with Bushfire Events

The relevant risks are the potential for loss of life, injury, or destroyed or damaged assets which results in personal loss and economic loss. For a given site, the level of that risk to persons and assets (the exposed elements) is a function of the potential threat levels generated by the bushfire hazard, and the level of exposure and vulnerability of the at risk elements to the threats.

Bushfire Protection Measures

The required package of protection measures is established by *State Planning Policy 3.7 Planning in Bushfire Prone Areas (SPP 3.7)*, its associated *Guidelines* and any other relevant guidelines or position statements published by the Department of Planning, Lands and Heritage. These measures are limited to those considered by the WA planning authorities as necessary to be addressed for the purpose of land use planning. They do not encompass all available bushfire protection measures as many are not directly relevant to the planning approval stage. For example:

- Protection measures to reduce the vulnerability of buildings to bushfire threats is primarily dealt with at the building application stage. They are implemented through the process of applying the Building Code of Australia (Volumes 1 and 2 of the national Construction Code) in accordance with WA building legislation and the application of construction requirements based on a building's level of exposure - determined as a Bushfire Attack Level (BAL) rating); or
- Protection measures to reduce the threat levels of consequential fire (ignited by bushfire and involving combustible materials surrounding and within buildings) and measures to reduce the exposure and vulnerability of elements at risk exposed to consequential fire, are not specifically considered.

The package of required bushfire protection measures established by the Guidelines includes:

- The requirements of the bushfire protection criteria which consist of:
  - Element 1: Location (addresses threat levels).
  - Element 2: Siting and Design of Development (addresses exposure levels of buildings).
  - Element 3: Vehicular Access (addresses exposure and vulnerability levels of persons).
  - Element 4: Water (addresses vulnerability levels of buildings).
  - Element 5: Vulnerable Tourism Land Uses (addresses exposure and vulnerability as per Elements 1-4 but in use specific ways and with additional considerations of persons exposure and vulnerability).
- The requirement to develop Bushfire Emergency Plans / Information for 'vulnerable' land uses for persons to prepare, respond and recover from a bushfire event (this addresses vulnerability levels).
- The requirement to assess bushfire risk and incorporate relevant protection measures into the site emergency plans for 'high risk' land uses (this addresses threat, exposure and vulnerability levels).

Compliance of the Proposed Development or Use with SPP 3.7 Requirements

The BMP assesses the capacity of the proposed development or use to implement and maintain the required 'acceptable' solutions and any additionally recommended bushfire protection measures - or its capacity to satisfy the policy intent through the justified application of additional bushfire protection measures as supportable 'alternative' solutions.

THE PROPOSED DEVELOPMENT/USE – BUSHFIRE PLANNING COMPLIANCE SUMMARY		
Environmental Considerations		**Assessment Outcome**
Will identified environmental, biodiversity and conservation values limit the full application of the required bushfire protection measures?		No
Will identified environmental, biodiversity and conservation values need to be managed in the implementation and maintenance of the bushfire protection measures - but not limit their application?		No
Required Bushfire Protection Measures The Acceptable Solutions of the Bushfire Protection Criteria (Guidelines)		**Assessment Outcome**
Element	The Acceptable Solutions	
1: Location	A1.1 Development location	Fully Compliant
2: Siting and Design of Development	A2.1 Asset Protection Zone (APZ)	Fully Compliant
3: Vehicular Access	A3.1 Public roads	Fully Compliant
	A3.2a Multiple access routes	Fully Compliant
	A3.2b Emergency access way	N/A
	A3.3 Through-roads	Fully Compliant
	A3.4a Perimeter roads	N/A
	A3.4b Fire service access route	N/A
	A3.5 Battle-axe legs	N/A
	A3.6 Private driveways	Fully Compliant
4: Water	A4.1 Identification of future water supply	Select
	A4.2 Provision of water for firefighting purposes	Select
Other Documents Establishing Bushfire Protection Measure Variations or Additions		**Assessment Outcome**
Bushfire Management Plan Guidance for the Dampier Peninsula (DPLH 2021 Rev B)		N/A
Design Guidelines and Model Requirements – Renewable Energy Facilities (Victorian Country Fire Authority March 2022)		Partly Compliant
AS (Australian Standard) 2419-2005: Fire hydrant installations		Fully Compliant

Summary Statement: Protection measures have been drawn from the Victorian CFA Guidelines as relevant to the facility, and discussed in the associated Bushfire Risk Assessment and Management Report). The relevant measures are:

- The solar farm development area is to apply a BAL-29 OR 10m minimum APZ, whichever is greater.
- The firefighting water supply to be applied to the Hydrogen Project is to be calculated from AS 2419.

- Additional measures regarding firefighting water access (in addition to those established in the Guidelines for Planning in Bushfire Prone Areas).

Other 'Bushfire Planning' Documents to Be Produced This necessity for additional documents is determined by the proposed development/use type and the requirements established by SPP 3.7 and the associated Guidelines (as amended). As necessary, relevant outcomes are also captured as responsibilities in this BMP.	**Required**
Bushfire Risk Assessment and Management Report	Yes

Summary Statement: The proposed development is considered a 'high-risk' land use as defined by SPP 3.7 and its associated Guidelines.

This triggers the requirement, through the development of a Risk Assessment and Management Report to:

- Identify the level of exposure and vulnerability of any onsite stored materials and liquids to bushfire attack mechanisms (threats);
- Identify any potential source of ignition threat the use may present to adjoining and/or adjacent bushfire prone vegetation; and
- Recommend protection measures that can be incorporated into the site operations emergency plan as necessary.

The requirement for this report to be developed can be decided by the planning approval decision maker (e.g., the local government). Otherwise, SPP 3.7 states it 'should' be produced.

1 PROPOSAL DETAILS AND THE BUSHFIRE MANAGEMENT PLAN

1.1 The Proposed Development/Use Details, Plans and Maps

The Proposal's Planning Stage For which certain bushfire planning documents are required to accompany the planning application.		Development Application	
Total Area of Subject Lot/Site		317.1 hectares	
Number of Additional Lots Created		N/A	
Primary Proposed Construction	**Type(s)**	Electricity generation	New Building(s)
	NCC Classification	N/A	Class 8 (factory/workshop/laboratory)
Specific 'Bushfire Planning' Land Use Type When applicable, this classification establishes a requirement to conduct assessments and develop documents that are additional to this Bushfire Management Plan.		High Risk Land Use	
Factors Determining the 'Bushfire Planning' Land Use Type		The land use will store combustible materials and/or flammable hazardous materials onsite that may be exposed and vulnerable to ignition from the direct attack mechanisms of bushfire (flame contact, radiant heat and embers). Business operations/activities may include those that are a potential source of ignition for onsite or offsite combustible/flammable materials, including bushfire prone vegetation.	

Description of the Proposed Development/Use

This Bushfire Management Plan has been prepared to support the Development Application for the MEG Hydrogen Project, and an expansion of the existing Northam Solar Farm.

The proposed development includes two components across Lots 6 and 7 Northam-York Road, Muluckine, approximately 1km east of the Northam townsite. Lot 6 contains the existing Northam Solar Farm development. The solar farm is proposed to be expanded, which is proposed to adjoin the perimeter of the existing arrays on Lot 6, and a new development on Lot 7 to the south >250m from the existing solar farm. Both locations are considered.

All potential locations have been addressed within this BMP such that the location of the expansion(s) will be compliant with the bushfire protection measures provided without requiring an additional assessment.

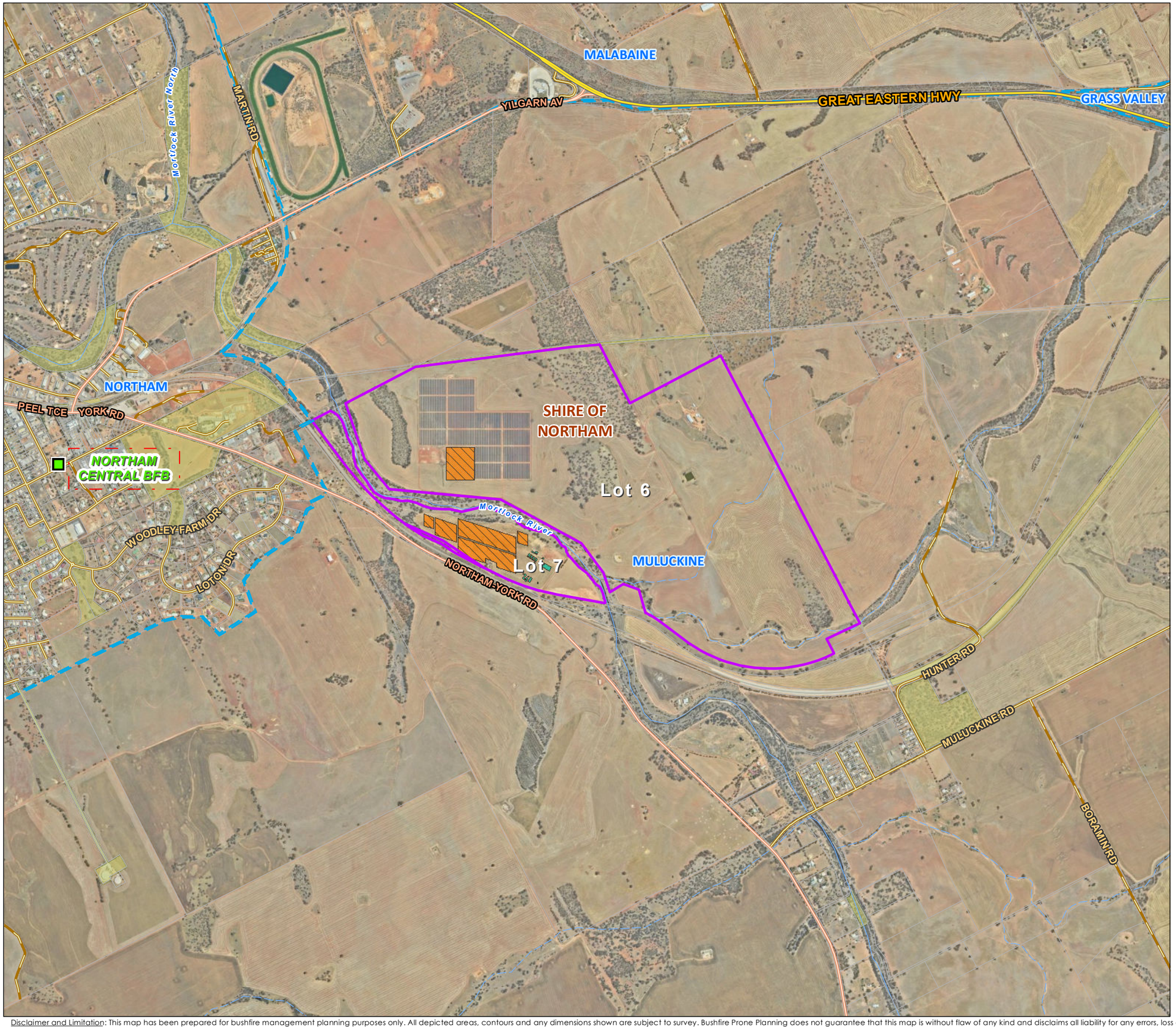
The MEG Hydrogen Project is proposed on Lot 7, which will produce green hydrogen through electrolysis. Stage 1 of the facility will include a total of 10MW of electrolysers. The layout of a potential Stage 2 expansion is not currently known and has not been included within this BMP.

Figure 1.1: Proposed development plan: Hydrogen Project and Solar Farm Expansion.

Figure 1.2

Location Plan

Lots 6 and 7 on Plan 1164, Area : 317.1 ha
Northam-York Road
MULUCKINE
SHIRE OF NORTHAM



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

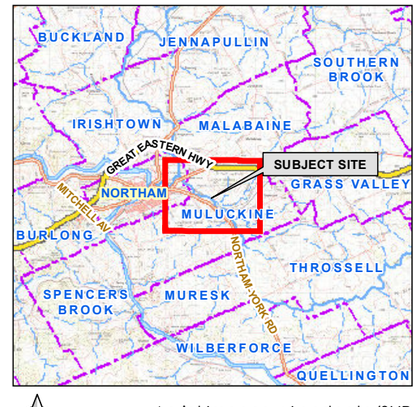
- Subject Site
- Other Lots
- Local Government Authority
- Locality / Suburb
- Bush Fire Brigade
- Reserves

Proposed Building

- MEG Hydrogen (All Structures)
- Solar Arrays

0 250 500 750 1,000
Metres

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



Aerial Imagery : Landgate/SLIP
Image Date : Feb 2021

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Neil Stoney 7/12/2022
Map updated by: Neil Stoney 7/12/2022
A3 Scale 1:20,000

BUSHFIRE PRONE PLANNING

Map Document Path / Name: K:\Projects\Jobs 2017\170545 - Lot 6 (131) Northam-York Road, Muluckine (BMP)\170545 - Hydrogen Production Facility (BMP BRMP) - Aug 2022\Mapping\MXD\170545_Fig1-2_LOC_MEG-Hydrogen.mxd

WHERE SPP 3.7 AND THE GUIDELINES ARE TO APPLY – DESIGNATED BUSHFIRE PRONE AREAS

All higher order strategic planning documents, strategic planning proposals, subdivisions and development applications located in designated bushfire prone areas need to address SPP 3.7 and its supporting Guidelines. This also applies where an area is not yet designated as bushfire prone but is proposed to be developed in a way that introduces a bushfire hazard.

For development applications where only part of a lot is designated as bushfire prone and the proposed development footprint is wholly outside of the designated area, the development application will not need to address SPP 3.7 or the Guidelines. (Guidelines DPLH 2021 v1.4, s1.2).

For subdivision applications, if all the proposed lots have a BAL-LOW indicated, a BMP is not required. (Guidelines DPLH 2021 v1.4, s5.3.1).

Figure 1.3

Bushfire Prone Area

Lots 6 and 7 on Plan 1164, Area : 317.1 ha
Northam-York Road
MULUCKINE
SHIRE OF NORTHAM

MALABAINE
YILGARN AV
NORTHAM
Mortlock River
YORK RD
NORTHAM
Lot 6
SHIRE OF NORTHAM
Lot 7
MULUCKINE
NORTHAM-YORK RD

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

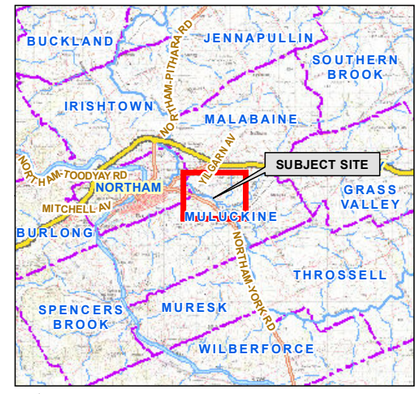
- Subject Site
- Other Lots
- Local Government Authority
- Locality / Suburb
- Bushfire Prone Areas (2021)

Proposed Building

- MEG Hydrogen (All Structures)
- Solar Arrays

0 250 500 750
Metres

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



Aerial Imagery : Landgate/SLIP
Image Date : Feb 2021

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Neil Stoney 7/12/2022
Map updated by: Neil Stoney 7/12/2022
A3 Scale 1:12,000

BUSHFIRE PRONE PLANNING

Map Document Path / Name: K:\Projects\Jobs 2017\170545 - Lot 6 (131) Northam-York Road, Muluckine (BMP)\170545 - Hydrogen Production Facility (BMP BRMP) - Aug 2022\Mapping\MXD\170545_Fig1-3_BPA_MEG-Hydrogen.mxd

1.2 The Bushfire Management Plan (BMP)

1.2.1 Commissioning and Purpose

Proponent:	Infinite Green Energy Pty Ltd
Bushfire Prone Planning commissioned to produce the BMP by:	Geoff Cole
Purpose of the BMP:	To apply the requirements established by State Planning Policy 3.7: Planning in Bushfire Prone Areas (SPP 3.7) and accompany the development application.
BMP to be submitted to:	Shire of Northam

1.2.2 Existing Documents with Implications for Development of this BMP

This section identifies any known assessments, reports or plans that have been conducted and prepared previously, or are being prepared concurrently, and are relevant to the subject site and the proposal/application. They potentially have implications for the assessment of bushfire threats and the implementation of the protection measures that are dealt with in the Bushfire Management Plan.

Table 1.4: Existing documents that may impact threat assessments and protection measure development.

EXISTING RELEVANT DOCUMENTS			
Existing Document	Relevant to the Proposal and the BMP	Copy Provided by Proponent / Developer	Title
Bushfire Risk – Assessment and Management Report	Yes	-	170545 – MEG Hydrogen Project - Bushfire Risk Assessment and Management Report
Implications for the BMP: The Risk Management Plan prepared alongside this BMP identifies the appropriate measures to reduce the risk of onsite and/or offsite ignition, asset damage, and harm to persons, environment, and community.			
Non-jurisdiction Standards	Yes	No	Design Guidelines and Model Requirements – Renewable Energy Facilities (Victorian Country Fire Authority March 2022)
Implications for the BMP: The Guidelines for Planning in Bushfire Prone Areas does not establish a firefighting water supply for non-habitable buildings, including high-risk uses. In the absence of specific requirements at the national or state level for Hydrogen production facilities, a conservative approach is applied in the firefighting water supply for the determination of the appropriate water supply. The facility will achieve simultaneous compliance with multiple sets of guidelines or standards, by applying the most stringent of the components of each			
Landscaping (Revegetation) Plan	Yes	No	Shire of Northam Tree Species List (no title; Shire of Northam)
Implications for the BMP: A visual buffer is intended to be planted between the Hydrogen Project and Northam-York Road. The species of tree will be determined by the Shire of Northam. Where a list is provided by the Shire of Northam, Bushfire Prone Planning will recommend a shortlist of tree species.			

2 ENVIRONMENTAL CONSERVATION (DESKTOP ASSESSMENT)

Important: *This 'desktop' assessment must not be considered as a replacement for a full Environmental Impact Assessment. It is a summary of potential environmental values at the subject site, inferred from information contained in listed datasets and/or reports, which are only current to the date of last modification.*

These data sources must be considered indicative where the subject site has not previously received a site-specific environmental assessment by an appropriate professional.

Many bushfire prone areas also have high biodiversity values. Consideration of environmental priorities within the boundaries of the land being developed can avoid excessive or unnecessary modification or clearing of vegetation. Approval processes (and exemptions) apply at both Commonwealth and State levels.

Any 'modification' or 'clearing' of vegetation to reduce bushfire risk is considered 'clearing' under the ***Environmental Protection Act 1986*** (EP Act) and requires a clearing permit under the ***Environmental Protection (Clearing of Native Vegetation) Regulations 2004*** (Clearing Regulations) – unless for an exempt purpose.

Clearing native vegetation is an offence, unless done under a clearing permit or the clearing is for an exempt purpose. Exemptions are contained in the EP Act or are prescribed in the Clearing Regulations (note: these do not apply in environmentally sensitive areas).

The ***Department of Water and Environmental Regulation*** (DWER) is responsible for issuing 'clearing' permits and the framework for the regulation of clearing. Approvals under other legislation, from other agencies, may also be required, dependent on the type of flora or fauna present.

Local Planning Policy or Local Biodiversity Strategy: Natural areas that are not protected by the above Act and Regulation (or any other National or State Acts) may be protected by a local planning policy or local biodiversity strategy. Permission from the local government will be required for any modification or removal of native vegetation in these Local Natural Areas (LNA's). Refer to the relevant local government for detail.

For further Information refer to Guidelines v1.4, the Bushfire and Vegetation Factsheet - WAPC, Dec 2021 and https://www.der.wa.gov.au/our-work/clearing-permits

2.1 Existing Vegetation on Private Land

2.1.1 Declared Environmentally Sensitive Areas (ESA)

Table 2.1: Identification of relevant ESA.

IDENTIFICATION OF ESA							
ESA Class	Relevant to Proposal	Influence on Bushfire Threat Levels and / or Application of Bushfire Protection Measures	Relevant Dataset	Information Source(s) Applied to Identification of Relevant Vegetation			Further Action Required
				Dataset	Landowner or Developer	Environmental Asset or Vegetation Survey	
Wetlands and their 50m Buffer (Ramsar, conservation category and nationally important)	Yes	No	DBCA-010 and 011, 019, 040, 043, 044	☒	☐	☐	None
Bush Forever	No	No	DPLH-022, SPP 2.8	☒	☐	☐	None
Threatened and Priority Flora + 50m Continuous Buffer	Unlikely	N/A	DBCA-036	Restricted Scale of	☐	☐	Data not obtained -

Threatened Ecological Community	Unlikely	N/A	DBCA-038	Data Available (security)	☐	☐	confirm with relevant agency
Heritage Areas National / World	No	No	Relevant register or mapping	☒	☐	☐	None
Environmental Protection (Western Swamp Tortoise) Policy 2002	No	No	DWER-062	☒	☐	☐	None

DESCRIPTION OF THE IDENTIFIED AREA(S) OF VEGETATION

Onsite vegetation requiring management/removal is largely grassland being either grazed pasture or sown crops (wheat).

Some sections of Class A Forest and Class B Woodland may require management, pending the final locations of the proposed solar farms (see Figure 3.1.2). Within Class A Forest sections requiring management, some mature trees would require removal. No trees or native vegetation would require removal in Class B Woodland sections – management would require slashing of grasses and under-pruning only.

These vegetation management measures will not extend into the 20m riparian buffer following the Mortlock River.

It is extremely unlikely that any ESA classifications apply to the sown pasture onsite.

2.2 Planned Landscaping and/or Re-vegetation

Table 2.5: Identification of land subject to planned vegetation modification.

AREAS OF LAND PLANNED FOR RE-VEGETATION OR LANDSCAPING			
Land with Environmental, Biodiversity, Conservation and Social Values	Relevant to Proposal	Planned Vegetation Modification	Description
Riparian Zones	Yes	N/A	Exists within the assessment area but does not require modification.
Foreshore Areas	No	N/A	
Wetland Buffers	No	N/A	
Legislated Lands	No	N/A	
Public Open Space	No	N/A	
Road Verges	Yes	Landscaping	A portion of the road verge along Northam-York Road will be removed to create the truck entry lane. This land is under the control of the Shire of Northam.
Visual Buffer	Yes	Re-vegetate	Planting of a visual buffer is proposed between the Hydrogen Project and Northam-York Road. The species of tree will be determined by the Shire of Northam. Where a list is provided by the Shire of Northam, Bushfire Prone Planning will recommend a shortlist of tree species.

3 BUSHFIRE ATTACK LEVEL (BAL) ASSESSMENT

BUSHFIRE ATTACK LEVELS (BAL) - UNDERSTANDING THE RESULTS

The transfer (flux/flow) of radiant heat from the bushfire to a receiving object is measured in kW/m^2. The AS 3959:2018 BAL determination methodology establishes the ranges of radiant heat flux that correspond to each bushfire attack level. These are identified as BAL-LOW, BAL-12.5, BAL-19, BAL-29, BAL-40 and BAL-FZ.

The bushfire performance requirements for certain classes of buildings are established by the Building Code of Australia (Vol. 1 & 2 of the NCC). The BAL will establish the bushfire resistant construction requirements that are to apply in accordance with AS 3959:2018 - Construction *of buildings in bushfire prone areas* and the NASH Standard – *Steel framed construction in bushfire areas (NS 300 2021),* whose solutions are deemed to satisfy the NCC bushfire performance requirements.

DETERMINED BAL RATINGS

A BAL Certificate can be issued for a determined BAL. A BAL can only be classed as 'determined' for an existing or future building/structure when:

1. It's final design and position on the lot are known and the stated separation distance from classified bushfire prone vegetation exists and can justifiably be expected to remain in perpetuity; or

2. It will always remain subject to the same BAL regardless of its design or position on the lot after accounting for any regulatory or enforceable building setbacks from lot boundaries as relevant and necessary (e.g., R-codes, restrictive covenants, defined building envelopes) or the retention of any existing classified vegetation either onsite or offsite.

If the BMP derives determined BAL(s), the BAL Certificate(s) required for submission with building applications can be provided, using the BMP as the assessment evidence.

INDICATIVE BAL RATINGS

A BAL Certificate cannot be issued for an indicative BAL. A BAL will be classed as 'indicative' for an existing or future building/structure when the required conditions to derive a determined BAL are not met.

This class of BAL rating indicates what BAL(s) could be achieved and the conditions that need to be met are stated.

Converting the indicative BAL into a determined BAL is conditional upon the currently unconfirmed variable(s) being confirmed by a subsequent assessment and evidential documentation. These variables will include the future building(s) location(s) being established (or changed) and/or classified vegetation being modified or removed to establish the necessary vegetation separation distance. This may also be dependent on receiving approval from the relevant authority for that modification/removal.

BAL RATING APPLICATION – PLANNING APPROVAL VERSUS BUILDING APPROVAL

1. **Planning Approval**: SPP.3.7 establishes that where BAL- LOW to BAL-29 will apply to relevant future construction (or existing structures for proposed uses), the proposed development may be considered for approval (dependent on the other requirements of the relevant policy measures being met). That is, BAL40 or BAL-FZ are not acceptable on planning grounds (except for certain limited exceptions).

   Because planning is looking forward at what can be achieved, as well as looking at what may currently exist, both determined and indicative BAL ratings are acceptable assessment outcomes on which planning decisions can be made (including conditional approvals).

2. **Building Approval:** The Building Code of Australia (Vol. 1 & 2 of the NCC) establishes that relevant buildings in bushfire prone areas must be constructed to the bushfire resistant requirements corresponding to the BAL rating that is to apply to that building. Consequently, a determined BAL rating and the BAL Certificate is required for a building permit to be issued - an indicative BAL rating is not acceptable.

3.1 BAL Assessment Summary - Table Format

3.1.1 The BAL Determination Method(s) Applied and the Location of Data and Results

Procedure Method (AS 3959:2018)	Applied to the BAL Assessment	Location of the Site Assessment Data			Location of the Results
		Classified Vegetation and Topography Map(s)	Calculation Input Variables		Assessed Bushfire Attack Levels and/or Radiant Heat Levels
			Summary Data	Detailed Data with Explanatory and Supporting Information	
Method 1 (Simplified)	Yes	Figures 3.1.1 and 3.1.2	Table 3.1	Appendix A1	Table 3.1
Method 2 (Detailed)	Yes	Figure 3.1.3	Table 3.1	Appendix A2	Table 3.1

Reasons for the Application of the Method 2 Procedure	
1.	To apply the requirement to assume a higher flame temperature of 1200K when determining the availability of suitable onsite sheltering options (Guidelines v1.4 s5.5.3.1.3). This ensures the margin of safety is increased.
2.	A more specific result is sought.

The specific issues associated with the site and/or proposed development that have necessitated the use of the Method 2 procedure:

A <10kW/m2 radiant heat flux APZ (calculated at 1200 K flame temperature) has been applied to all structures within the Hydrogen Project.

This has been applied both for the onsite shelter building, and to allow for active defence of the site by staff or emergency services with suitable PPE.

Figure 3.1.1

Topography & Classified Vegetation

Lots 6 and 7 on Plan 1164, Area : 317.1 ha
Northam-York Road
MULUCKINE
SHIRE OF NORTHAM

AREA : 1
Class (A) Forest
Effective slope: 0°

AREA : 2
Class (B) Woodland
Effective slope: 0°

AREA : 7
Class (B) Woodland
Effective slope: 0°

AREA : 11
Excluded

AREA : 10
Class (G) Grassland
Effective slope: 0°

AREA : 7
Class (B) Woodland
Effective slope: 0°

AREA : 11
Excluded

AREA : 8
Class (G) Grassland
Effective slope: 0°

AREA : 9
Class (G) Grassland
Effective slope: 0°

AREA : 9
Class (G) Grassland
Effective slope: 0°

AREA : 4
Class (G) Grassland
Effective slope: 0°

AREA : 2
Class (B) Woodland
Effective slope: 0°

AREA : 3
Class (B) Woodland
Effective slope: >0° to 5°

AREA : 11
Excluded

AREA : 2
Class (B) Woodland
Effective slope: 0°

AREA : 4
Class (G) Grassland
Effective slope: 0°

AREA : 4
Class (G) Grassland
Effective slope: 0°

Lot 6

Lot 7

Mortlock River

YORK RD

NORTHAM-YORK RD

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

- Subject Site
- Other Lots
- Photo & Direction

Vegetation Assessment Area

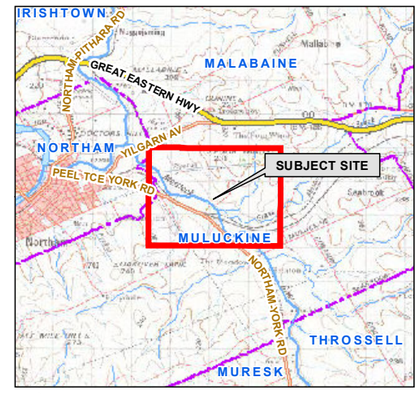
- 150m from Subject Site

Classified Vegetation

- Class (A) Forest
- Class (B) Woodland
- Class (G) Grassland
- Exclusion 2.2.3.2

0 250 500 750
Metres

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



Aerial Imagery : Landgate/SLIP
Image Date : Feb 2021

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Neil Stoney 8/12/2022
Map updated by: Neil Stoney 8/12/2022
A3 Scale 1:10,500

BUSHFIRE PRONE PLANNING

Map Document Path / Name: K:\Projects\Jobs 2017\170545 - Lot 6 (131) Northam-York Road, Muluckine (BMP)\170545 - Hydrogen Production Facility (BMP BRMP) - Aug 2022\Mapping\MXD\170545_Fig3-1-1_VEG_MEG-Hydrogen.mxd

Figure 3.1.2

Topography & Classified Vegetation (Development Level)

Lots 6 and 7 on Plan 1164, Area : 317.1 ha
Northam-York Road
MULUCKINE
SHIRE OF NORTHAM

AREA : 1 Class (A) Forest Effective slope: 0°
AREA : 2 Class (B) Woodland Effective slope: 0°
AREA : 3 Class (B) Woodland Effective slope: >0° to 5°
AREA : 4 Class (G) Grassland Effective slope: 0°
AREA : 5 Class (A) Forest Effective slope: 0°
AREA : 6 Class (A) Forest Effective slope: >0° to 5°
AREA : 7 Class (B) Woodland Effective slope: 0°
AREA : 8 Class (G) Grassland Effective slope: 0°
AREA : 9 Class (G) Grassland Effective slope: 0°
AREA : 10 Class (G) Grassland Effective slope: 0°
AREA : 11 Excluded
Lot 6
Lot 7
Mortlock River
NORTHAM-YORK RD
75 m
36 m
11 m
101 m
109 m
68 m
39 m
60 m
36 m

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

- Subject Site
- Other Lots
- Photo & Direction

Proposed Building

- MEG Hydrogen Project
- Solar Arrays

Vegetation Assessment Area

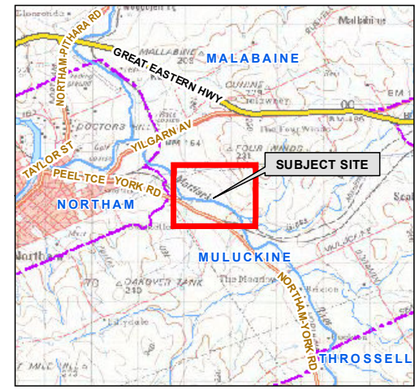
- 150m from Subject Site

Classified Vegetation

- Class (A) Forest
- Class (B) Woodland
- Class (G) Grassland
- Exclusion 2.2.3.2
- Vegetation Distance

0 50 100 150 200 250 300
Metres

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



Aerial Imagery : Landgate/SLIP
Image Date : Feb 2021

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Neil Stoney 8/12/2022
Map updated by: Neil Stoney 8/12/2022
A3 Scale 1:5,500

BUSHFIRE PRONE PLANNING

Map Document Path / Name: K:\Projects\Jobs 2017\170545 - Lot 6 (131) Northam-York Road, Muluckine (BMP)\170545 - Hydrogen Production Facility (BMP BRMP) - Aug 2022\Mapping\MXD\170545_Fig3-1-2_VEG-ZOOM_MEG-Hydrogen.mxd

Figure 3.1.1

Solar Farm Expansion (Northern) Topography & Classified Vegetation (Post Development)

Lots 6 and 7 on Plan 1164, Area : 317.1 ha
Northam-York Road
MULUCKINE
SHIRE OF NORTHAM

AREA : 6
Class (A) Forest
Effective slope: 0°

AREA : 11
Excluded

Lot 6

160 m

155 m

10 m

AREA : 8
Class (G) Grassland
Effective slope: 0°

10 m

AREA : 3
Class (B) Woodland
Effective slope: >0° to 5°

Mortlock River

14 m

AREA : 9
Class (G) Grassland
Effective slope: 0°

AREA : 5
Class (A) Forest
Effective slope: 0°

Lot 7

AREA : 11
Excluded

AREA : 9
Class (G) Grassland
Effective slope: 0°

14 m

AREA : 11
Excluded

AREA : 7
Class (B) Woodland
Effective slope: 0°

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

- Subject Site
- Other Lots

Proposed

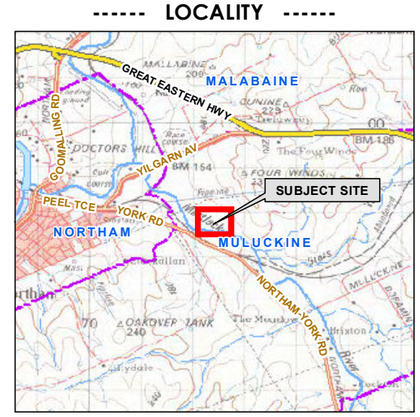
- Solar Arrays

Classified

- Class (A) Forest
- Class (B) Woodland
- Class (G) Grassland
- Exclusion 2.2.3.2
- APZ Distance

0 25 50 75 100 125
Metres

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



Aerial Imagery : Landgate/SLIP
Image Date : Nov 2020

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Neil Stoney 8/12/2022
Map updated by: Neil Stoney 8/12/2022
A3 Scale 1:2,000

BUSHFIRE PRONE PLANNING

Map Document Path / Name: K:\Projects\Jobs 2017\170545 - Lot 6 (131) Northam-York Road, Muluckine (BMP)\170545 - Hydrogen Production Facility (BMP BRMP) - Aug 2022\Mapping\MXD\170545_Fig3-2-1_VEG-POST_Solar-North.mxd

Figure 3.2.2

Solar Farm Expansion (Southern) Topography & Classified Vegetation (Post Development)

Lots 6 and 7 on Plan 1164, Area : 317.1 ha
Northam-York Road
MULUCKINE
SHIRE OF NORTHAM

Lot 6
Lot 7
Mortlock River
NORTHAM-YORK RD

AREA : 8
Class (G) Grassland
Effective slope: 0°

AREA : 3
Class (B) Woodland
Effective slope: >0° to 5°

AREA : 7
Class (B) Woodland
Effective slope: 0°

AREA : 9
Class (G) Grassland
Effective slope: 0°

AREA : 5
Class (A) Forest
Effective slope: 0°

AREA : 4
Class (G) Grassland
Effective slope: 0°

AREA : 2
Class (B) Woodland
Effective slope: 0°

AREA : 11
Excluded

155 m
14 m
10 m
21 m

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

- Subject Site
- Other Lots

Proposed

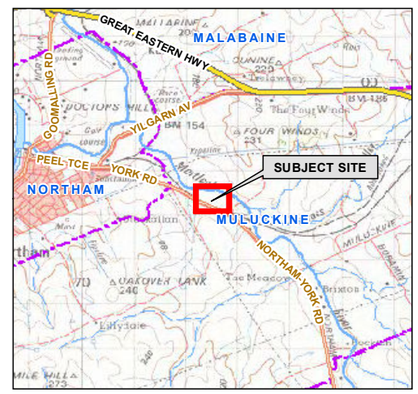
- MEG Hydrogen (All Structures)
- Solar Arrays

Classified

- Class (A) Forest
- Class (B) Woodland
- Class (G) Grassland
- Exclusion 2.2.3.2
- APZ Distance

0 25 50 75 100 125
Metres

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



Aerial Imagery : Landgate/SLIP
Image Date : Nov 2020

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Neil Stoney 8/12/2022
Map updated by: Neil Stoney 8/12/2022
A3 Scale 1:2,000

BUSHFIRE PRONE PLANNING

Map Document Path / Name: K:\Projects\Jobs 2017\170545 - Lot 6 (131) Northam-York Road, Muluckine (BMP)\170545 - Hydrogen Production Facility (BMP BRMP) - Aug 2022\Mapping\MXD\170545_Fig3-2-2_VEG-POST_Solar-South.mxd

Figure 3.2.3

MEG Hydrogen Project Topography & Classified Vegetation (Post Development)

Lots 6 and 7 on Plan 1164, Area : 317.1 ha
Northam-York Road
MULUCKINE
SHIRE OF NORTHAM

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

- Subject Site
- Other Lots

Proposed

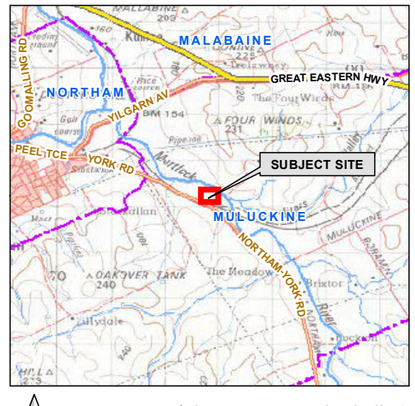
- MEG Hydrogen (All Structures)
- Solar Arrays

Classified

- Class (B) Woodland
- Class (G) Grassland
- Exclusion 2.2.3.2
- APZ Distance

0 20 40 60
Metres

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



Aerial Imagery : Landgate/SLIP
Image Date : Nov 2020

Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Neil Stoney 8/12/2022
Map updated by: Neil Stoney 8/12/2022
A3 Scale 1:1,000

BUSHFIRE PRONE PLANNING

Map Document Path / Name: K:\Projects\Jobs 2017\170545 - Lot 6 (131) Northam-York Road, Muluckine (BMP)\170545 - Hydrogen Production Facility (BMP BRMP) - Aug 2022\Mapping\MXD\170545_Fig3-2-3_VEG-POST_Hydrogen.mxd

Table 3.1: Summary of applied calculation input variables applied in deriving the BAL rating for the identified exposed element (the relevant building/structure).

DATA APPLIED TO THE DERIVATION OF RADIANT HEAT FLUX LEVELS – INCLUDING THOSE STATED AS BUSHFIRE ATTACK LEVELS (BAL) [1]															
Applied BAL Determination Method	METHOD 1 - SIMPLIFIED PROCEDURE (AS 3959:2018 CLAUSE 2.2) AND METHOD 2 - DETAILED PROCEDURE (AS 3959:2018 APPENDIX B)														
The Receiver of Radiant Heat Relevant Building(s) / Structure(s) and Their Location	Calculation Variables Corresponding to the BAL Determination Method														
	Methods 1 and 2		Method 1	Method 2				Method 1 and 2		Method 2						Bushfire Attack Level (BAL)
	Vegetation Classification		FDI	Effective Slope		Site Slope	FFDI or GFDI	Separation Distance (m)		Flame Temp.	Elevation of Receiver	Flame Width	Fireline Intensity	Flame Length	Modified View Factor	
				Applied Range	Measured			Actual	Required							
	Area	Class		degree range	degrees	degrees				K	metres	metres	kW/m	metres	% Reduction	
Northern Solar Farm (Lot 6)	1	(A) Forest	80	Upslope or flat 0	flat 0	-	-	>150	21	-	-	-	-	-	-	BAL-LOW
	2	(B) Woodland	80	Upslope or flat 0	flat 0	-	-	>150	14	-	-	-	-	-	-	BAL-LOW
	3	(B) Woodland	80	d/slope >0-5	d/slope 2	-	-	75	17	-	-	-	-	-	-	BAL-12.5
	4	(G) Grassland	80	Upslope or flat 0	flat 0	-	-	>150	8	-	-	-	-	-	-	BAL-LOW
	5	(A) Forest	80	Upslope or flat 0	flat 0	-	-	>150	21	-	-	-	-	-	-	BAL-LOW
	6	(A) Forest	80	Upslope or flat 0	flat 0	-	-	>150	21	-	-	-	-	-	-	BAL-LOW
	7	(B) Woodland	80	Upslope or flat 0	flat 0	-	-	>150	14	-	-	-	-	-	-	BAL-LOW
	8	(G) Grassland	80	Upslope or flat 0	flat 0	-	-	0	8	-	-	-	-	-	-	BAL-FZ
	9	(G) Grassland	80	Upslope or flat 0	flat 0	-	-	>150	8	-	-	-	-	-	-	BAL-LOW
	10	(G) Grassland	80	Upslope or flat 0	flat 0	-	-	>150	8	-	-	-	-	-	-	BAL-LOW
	11	Excluded cl 2.2.3.2(e & f)	-	-	-	-	-	-	-	-	-	-	-	-	-	BAL-LOW
															Indicative Bushfire Attack Level	BAL-29
Southern Solar Farm (Lot 7)	1	(A) Forest	80	Upslope or flat 0	flat 0	-	-	>150	21	-	-	-	-	-	-	BAL-LOW
	2	(B) Woodland	80	Upslope or flat 0	flat 0	-	-	39	14	-	-	-	-	-	-	BAL-12.5
	3	(B) Woodland	80	d/slope >0-5	d/slope 2	-	-	36	17	-	-	-	-	-	-	BAL-12.5
	4	(G) Grassland	80	Upslope or flat 0	flat 0	-	-	10	8	-	-	-	-	-	-	BAL-29
	5	(A) Forest	80	Upslope or flat 0	flat 0	-	-	11	21	-	-	-	-	-	-	BAL-FZ
	6	(A) Forest	80	Upslope or flat 0	flat 0	-	-	>150	21	-	-	-	-	-	-	BAL-LOW
	7	(B) Woodland	80	Upslope or flat 0	flat 0	-	-	0	14	-	-	-	-	-	-	BAL-FZ
	8	(G) Grassland	80	Upslope or flat 0	flat 0	-	-	101	8	-	-	-	-	-	-	BAL-LOW
	9	(G) Grassland	80	Upslope or flat 0	flat 0	-	-	0	8	-	-	-	-	-	-	BAL-FZ
	10	(G) Grassland	80	Upslope or flat 0	flat 0	-	-	>150	8	-	-	-	-	-	-	BAL-LOW
	11	Excluded cl 2.2.3.2(e & f)	-	-	-	-	-	-	-	-	-	-	-	-	-	BAL-LOW
															Indicative Bushfire Attack Level	BAL-29
MEG Hydrogen Project (all structures)	1	(A) Forest	80	Upslope or flat 0	flat 0	flat 0	80	>150	>63.2	1200 K	Default	Default	Default	Default	Default	BAL-LOW
	2	(B) Woodland	80	Upslope or flat 0	flat 0	flat 0	80	60	>46.1	1200 K	Default	Default	Default	Default	Default	BAL-12.5
	3	(B) Woodland	80	d/slope >0-5	d/slope 2	d/slope 2	80	109	>49.4	1200 K	Default	Default	Default	Default	Default	BAL-LOW
	4	(G) Grassland	80	Upslope or flat 0	flat 0	flat 0	80	36	>29.5	1200 K	Default	Default	Default	Default	Default	BAL-12.5

	5	(A) Forest	80	Upslope or flat 0	flat 0	flat 0	80	>150	>63.2	1200 K	Default	Default	Default	Default	Default	BAL-LOW
	6	(A) Forest	80	Upslope or flat 0	flat 0	flat 0	80	>150	>63.2	1200 K	Default	Default	Default	Default	Default	BAL-LOW
	7	(B) Woodland	80	Upslope or flat 0	flat 0	flat 0	80	68	>46.1	1200 K	Default	Default	Default	Default	Default	BAL-12.5
	8	(G) Grassland	80	Upslope or flat 0	flat 0	flat 0	110	>150	>29.5	1200 K	Default	Default	Default	Default	Default	BAL-LOW
	9	(G) Grassland	80	Upslope or flat 0	flat 0	flat 0	110	0	>29.5	1200 K	Default	Default	Default	Default	Default	BAL-FZ
	10	(G) Grassland	80	Upslope or flat 0	flat 0	flat 0	110	>150	>29.5	1200 K	Default	Default	Default	Default	Default	BAL-LOW
	11	Excluded cl 2.2.3.2(e & f)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
															Indicative Bushfire Attack Level	BAL-12.5

[1] All data and information supporting the determination of the classifications and values stated in this table and any associated justification, is presented in Appendix A. Where the values are stated as 'default' these are either the values stated in AS 3959:2018, Table B1 or the values calculated as intermediate or final outputs through application of the equations of the AS 3959:2018 BAL determination methodology. They are not values derived by the assessor.

4 IDENTIFICATION OF BUSHFIRE HAZARD ISSUES

The Guidelines for Planning in Bushfire Prone Areas (WAPC 2021 v1.4), Appendix 5, establish that the application of this section of the BMP is intended to support ***strategic planning*** proposals. At the strategic planning stage there will typically be insufficient proposed development detail to enable all required assessments, including the assessment against the bushfire protection criteria.

Strategic Planning Proposals

For strategic planning proposals this section of the BMP will identify:

- Issues associated with the level of the threats presented by any identified bushfire hazard;
- Issues associated with the ability to implement sufficient and effective bushfire protection measures to reduce the exposure and vulnerability levels (of elements exposed to the hazard threats), to a tolerable or acceptable level; and
- Issues that will need to be considered at subsequent planning stages.

All Other Planning Proposals

For all other planning stages, this BMP will address what are effectively the same relevant issues but do it within the following sections:

- Section 2 – Environmental Conservation: Assess environmental, biodiversity and conservation values);
- Section 3 – Potential Bushfire Impact: Assess the bushfire threats with the focus on flame contact and radiant heat; and
- Section 5 – Assessment Against the Bushfire Protection Criteria (including the guidance provided by the *Position Statement: 'Planning in bushfire prone areas – Demonstrating Element 1: Location and Element 2'):* Assess the ability of the proposed development to apply the required bushfire protection measures thereby enabling it to be considered for planning approval for these factors.

Is the proposed development a strategic planning proposal?	No

5 ASSESSMENT AGAINST THE BUSHFIRE PROTECTION CRITERIA (GUIDELINES V1.4)

5.1 Bushfire Protection Criteria Elements Applicable to the Proposed Development/Use

APPLICATION OF THE CRITERIA, ACCEPTABLE SOLUTIONS AND PERFORMANCE ASSESSMENT

The criteria are divided into five elements – location, siting and design, vehicular access, water and vulnerable tourism land uses. Each element has an intent outlining the desired outcome for the element and reflects identified planning and policy requirements in respect of each issue.

The example acceptable solutions (bushfire protection measures) provide one way of meeting the element's intent. Compliance with these automatically achieves the element's intent and provides a straightforward pathway for assessment and approval.

Where the acceptable solutions cannot be met, the ability to develop design responses (as alternative solutions that meet bushfire performance requirements) is an alternative pathway that is provided by addressing the applicable performance principles (as general statements of how best to achieve the intent of the element).

A merit based assessment is established by the SPP 3.7 and the Guidelines as an additional alternative pathway along with the ability of using discretion in making approval decisions (sections 2.5, 2.6 and 2.7). This is formally applied to certain development (minor and unavoidable – sections 5.4.1 and 5.7). Relevant decisions by the State Administrative Tribunal have also supported this approach more generally.

Elements 1 – 4 should be applied for all strategic planning proposals, subdivision or development applications, except for vulnerable tourism land uses which should refer to Element 5. Element 5 incorporates the bushfire protection criteria in Elements 1 – 4 but caters them specifically to tourism land uses. (Guidelines DPLH 2021v1.4)

The Bushfire Protection Criteria	Applicable to the Proposed Development/Use
Element 1: Location	Yes
Element 2: Siting and Design	Yes
Element 3: Vehicular Access	Yes
Element 4: Water	Yes
Element 5: Vulnerable Tourism Land Uses	No

5.2 Local Government Variations to Apply

Local governments may add to or modify the acceptable solutions to recognise special local or regional circumstances (e.g., topography / vegetation / climate). These are to be endorsed by both the WAPC and DFES before they can be considered in planning assessments. (Guidelines DPLH 2021v1.4).	
Do endorsed regional or local variations to the acceptable solutions apply to the assessments against the Bushfire Protection Criteria for the proposed development /use?	No

5.3 Assessment Statements for Element 1: Location

LOCATION					
Element Intent	To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure.				
Proposed Development/Use – Relevant Planning Stage	(Do) Development application other than for a single dwelling, ancillary dwelling or minor development				
Element Compliance Statement	The proposed development/use achieves the intent of the element by being fully compliant with all applicable acceptable solutions.				
Pathway Applied to Provide an Alternative Solution	N/A				
Acceptable Solutions - Assessment Statements *All details of acceptable solution requirements are established in the Guidelines for Planning in Bushfire Prone Areas, DPLH v1.4 (Guidelines) and apply the guidance established by the Position Statement: 'Planning in bushfire prone areas – Demonstrating Element 1: Location and Element 2: Siting and design' (WAPC Nov 2019) and the 'Bushfire Management Plan Guidance for the Dampier Peninsula' (WA Department of Planning, Lands and Heritage, 2021 Rev B) as relevant. These documents are available at https://www.wa.gov.au/government/document-collections/state-planning-policy-37-planning-bushfire-prone-areas.*					
Solution Component Check Box Legend	☑ Relevant & met	☒ Relevant & not met	⃠ Not relevant		
A1.1 Development location	**Applicable:**	Yes	**Compliant:**	Yes	
ASSESSMENT AGAINST THE REQUIREMENTS ESTABLISHED BY THE GUIDELINES					
☑ ☐ ☐ The development application is located in an area that is or will, on completion, be subject to either a moderate or low bushfire hazard level, or BAL-29 or below.					
Supporting Assessment Details: The subject site will achieve compliance by ensuring the development area is subject to potential radiant heat from a bushfire not exceeding 29 kW/m^2 (i.e., a BAL rating of BAL-29 or less will apply – refer Figures 3.2: BAL Assessment Maps). This can be achieved by using positioning, design, and appropriate onsite vegetation management.					
ASSESSMENTS APPLYING THE GUIDANCE ESTABLISHED BY THE WAPC ELEMENT 1 & 2 POSITION STATEMENT (2019)					
"Consideration should be given to the site context where 'area' is the land both within and adjoining the subject site. The hazards remaining within the site should not be considered in isolation of the hazards adjoining the site, as the potential impact of a bushfire will be dependent on the wider risk context, including how a bushfire could affect the site and the conditions for a bushfire to occur within the site." **Strategic Planning Proposals:** Consider the threat levels from any vegetation adjoining and within the subject site for which the potential intensity of a bushfire in that vegetation would result in it being classified as an Extreme Bushfire Hazard Level (BHL). Identify any proposed design strategies to reduce these threats. **Structure Plans (lot layout known) and Subdivision Applications:** As for strategic planning proposals but within the subject site the relevant threat levels to consider are the radiant heat levels represented by BAL-FZ and BAL-40 ratings.					
The planning proposal is a development application, consequently the referred to position statement is not applicable to the Element 1 assessment.					

5.4 Assessment Statements for Element 2: Siting and Design

SITING AND DESIGN OF DEVELOPMENT					
Element Intent	To ensure that the siting and design of development minimises the level of bushfire impact. (BPP Note: not building/construction design)				
Proposed Development/Use – Relevant Planning Stage	(Do) Development application other than for a single dwelling, ancillary dwelling or minor development				
Element Compliance Statement	The proposed development/use achieves the intent of the element by being fully compliant with all applicable acceptable solutions.				
Pathway Applied to Provide an Alternative Solution	N/A				
Acceptable Solutions - Assessment Statements *All details of acceptable solution requirements are established in the Guidelines for Planning in Bushfire Prone Areas, DPLH v1.4 (Guidelines) and apply the guidance established by the Position Statement: 'Planning in bushfire prone areas – Demonstrating Element 1: Location and Element 2: Siting and design' (WAPC Nov 2019) and the 'Bushfire Management Plan Guidance for the Dampier Peninsula' (WA Department of Planning, Lands and Heritage, 2021 Rev B) as relevant. These documents are available at https://www.wa.gov.au/government/document-collections/state-planning-policy-37-planning-bushfire-prone-areas.*					
Solution Component Check Box Legend	☑ Relevant & met	☒ Relevant & not met	⃠ Not relevant		
A2.1 Asset Protection Zone (APZ)	**Applicable**: Yes		**Compliant**: Yes		

UNDERSTANDING THE APZ PLANNING ASSESSMENT VERSUS APZ IMPLEMENTATION REQUIREMENTS

Note: Appendix B: 'Onsite Vegetation Management' provides further information regarding the different APZ dimensions that can be referenced, their purpose and the specifications of the APZ that is to be established and maintained.

To reduce risk to buildings (and indirectly to persons) from a bushfire event, a key bushfire protection measure required to be implemented is reducing the exposure of building elements to the direct bushfire threats of flame contact, radiant heat and embers and the indirect threat of consequential fires that result from the subsequent ignition of other combustible materials that may be constructed, stored or accumulate in the area surrounding buildings.

This is achieved by separating existing and/or proposed buildings from areas of classified bushfire prone vegetation. The total area of separation is identified as the Asset Protection Zone (APZ), which exists as an area of minimal fire fuels (or no fuel) and is considered able and likely to remain a low threat and/or be maintained to a low threat state in perpetuity. The required separation distances will vary according to the site specific conditions.

THE APZ PLANNING ASSESSMENT: To achieve planning approval for this factor it must be demonstrated that separation distances that correspond to a maximum level of radiant transfer to a building (29 kW/m^2), either exist or can be established (with certain exceptions). These separation distances are the dimensions of the **'Planning BAL-29' APZ**.

The purpose of this planning assessment is to identify and justify how this low threat area (the Planning BAL-29' APZ) can exist – or not.

THE DIMENSIONS OF THE 'PLANNING BAL-29' APZ MAY EXTEND OUTSIDE SUBJECT LOT BOUNDARIES. THE APZ MAY NOT BE EQUIDISTANT AROUND A BUILDING AS THE REQUIRED SEPARATION DISTANCES DEPEND ON THE TYPE OF VEGETATION PRESENT IN EACH DIRECTION ALONG WITH OTHER SITE VARIABLES.

IT IS IMPORTANT TO UNDERSTAND THAT THE 'PLANNING BAL-29' APZ IS NOT NECESSARILY THE SIZE OF THE APZ THAT MUST BE PHYSICALLY ESTABLISHED AND MAINTAINED BY A LANDOWNER. IT IS A SCREENING TOOL FOR MAKING PLANNING APPROVAL DECISIONS.

THE APZ TO BE IMPLEMENTED: The required dimensions to be established and maintained by the landowner will be those that correspond to the determined BAL rating of a relevant building but limited to the land of the subject lot (with limited exceptions). The requirement for a greater dimension within a lot will only exist if it is required by the relevant local government's annual firebreak / hazard reduction notice or the APZ size is increased as an additional bushfire protection measure as a recommendation of this BMP.

Within this BMP it is the 'Planning BAL-29' APZ that will be identified on maps, diagrams and in tables as necessary.

The exceptions are the data provided in Appendix B part B1 and when a Property Bushfire Management Statement is required to be produced for a development application, in which case the '**Landowner' APZ** dimensions will be shown on the site map (refer to s6.3.1 when relevant).

	ASSESSMENT AGAINST THE REQUIREMENTS ESTABLISHED BY THE GUIDELINES
☑ ☐ ☐	**APZ Width:** The proposed (or a future) habitable building(s) on the lot(s) of the proposed development - or an existing building for a proposed change of use – can be (or is) located within the developable portion of the lot and be surrounded by a 'Planning BAL-29' APZ of the required dimensions (measured from any external wall or supporting post or column to the edge of the classified vegetation), that will ensure their exposure to the potential radiant heat impact of a bushfire does not exceed 29 kW/m^2. Notes: When established by the relevant decision maker, the meeting of this requirement may also apply to proposed non-habitable buildings and other structures.
☐ ☐ ⊘	**Restriction on Building Location:** It has been identified that the current developable portion of a lot(s) provides for the proposed future (or a future) building/structure location that will result in that building/structure being subject to a BA-40 or BAL-FZ rating. Consequently, it may be considered necessary to impose the condition that a restrictive covenant to the benefit of the local government pursuant to section 129BA of the Transfer of Land Act 1893, is to be placed on the certificate(s) of title of the proposed lot(s) advising of the existence of a restriction on the use of that portion of land (refer to Code F3 of Model Subdivision Conditions Schedule, WAPC June 2021 and Guidelines s5.3.2).
☑ ☐ ☐	**APZ Location:** The required dimensions for a 'Planning BAL-29' APZ can be contained solely within the boundaries of the lot(s) on which the proposed (or a future) habitable building(s) - or an existing building(s) for a proposed change of use – is situated.
☐ ☐ ⊘	**APZ Location:** The required dimensions for a 'Planning BAL-29' APZ can be partly established within the boundaries of the lot(s) on which the proposed (or a future) habitable building(s) - or an existing building(s) for a proposed change of use – is situated. The balance of the APZ would exist on adjoining land that satisfies the exclusion requirements of AS 3959:2018 cl 2.2.3.2 for low threat vegetation and non-vegetated areas.
☐ ☐ ⊘	**APZ Location:** It can be justified that any adjoining (offsite) land forming part of a 'Planning BAL-29' APZ will: • If non-vegetated, remain in this condition in perpetuity; and/or • If vegetated, be low threat vegetation managed in a minimal fuel condition in perpetuity.
☑ ☐ ☐	**APZ Management:** The area of land (within each lot boundary), that is to make up the required 'Landowner' APZ dimensions (refer to Appendix B, Part B1), can and will be managed in accordance with the requirements of the Guidelines Schedule 1 'Standards for Asset Protection Zones' (refer to Appendix B).

☐ ☐ ⊘	**Subdivision Staging:** There are undeveloped future stages of subdivision, containing bushfire prone vegetation, that have been taken into consideration for their potentially 'temporary' impact on the ability to establish a 'Planning BAL-29' APZ on adjoining developed lots. A staging plan is developed to manage this.
☑ ☐ ☐	**Firebreak/Hazard Reduction Notice:** Any additional requirements established by the relevant local government's annual notice to install firebreaks and manage fuel loads (issued under s33 of the Bushfires Act 1954), can and will be complied with.

Supporting Assessment Details:

The proposed developments on the subject lots can be surrounded by an APZ that will ensure the potential radiant heat impact of a bushfire does not exceed 29 kW/m^2 (BAL-29). The required APZ specifications of width, location and management can be achieved. The APZs to be installed exceed the minimum BAL-29 required for planning approval. See Section 5.7.

Onsite vegetation requiring management/removal is largely grassland being either grazed pasture or sown crops (wheat). Some sections of Class A Forest and Class B Woodland may require management, pending the final locations of the proposed solar farms (see Figure 3.1.2).

A portion of the APZ will be entirely non-vegetated (sealed, developed, or mineral earth). Any retained vegetation will be managed in accordance with the technical requirements established by the Schedule 1: 'Standards for Asset Protection Zones (Guidelines). The APZ specifications are also detailed in Appendix B and the Shire of Northam may have additional requirements established by their Firebreak Notice.

ASSESSMENTS APPLYING THE GUIDANCE ESTABLISHED BY THE WAPC ELEMENT 1 & 2 POSITION STATEMENT (2019)

Strategic Planning Proposals: "At this planning level there may not be enough detail to demonstrate compliance with this element. The decision-maker may consider this element is satisfied where A1.1 is met."

Structure Plans (lot layout known) and Subdivision Applications: "Provided that Element 1 is satisfied, the decision-maker may consider approving lot(s) containing BAL-40 or BAL-FZ under the following scenarios.

The planning proposal is a development application, consequently the position statement is not applicable to the proposed development.

5.5 Assessment Statements for Element 3: Vehicular Access

VEHICULAR ACCESS	
Element Intent	To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event.
Proposed Development/Use – Relevant Planning Stage	(Do) Development application other than for a single dwelling, ancillary dwelling or minor development
Element Compliance Statement	The proposed development/use achieves the intent of the element by being fully compliant with all applicable acceptable solutions.
Pathway Applied to Provide an Alternative Solution	N/A

Acceptable Solutions - Assessment Statements

All details of acceptable solution requirements are established in the Guidelines for Planning in Bushfire Prone Areas, DPLH v1.4 (Guidelines) and apply the guidance established by the Position Statement: 'Planning in bushfire prone areas – Demonstrating Element 1: Location and Element 2: Siting and design' (WAPC Nov 2019) and the 'Bushfire Management Plan Guidance for the Dampier Peninsula' (WA Department of Planning, Lands and Heritage, 2021 Rev B) as relevant. These documents are available at https://www.wa.gov.au/government/document-collections/state-planning-policy-37-planning-bushfire-prone-areas.

The technical construction requirements for access types and components, and for each firefighting water supply component, are also presented in Appendices 2 and 3. The local government will advise the proponent where different requirements are to apply and when any additional specifications such as those for signage and gates are to apply (these are included in the relevant appendix if requested by the local government).

Solution Component Check Box Legend ☑ Relevant & met ☒ Relevant & not met ⃠ Not relevant

A3.1 Public roads **Applicable**: Yes **Compliant**: Yes

☑ ☐ ☐ The technical construction requirements of vertical clearance and weight capacity (Guidelines, Table 6) can and will be complied with (Refer also to Appendix C in this BMP).

☑ ☐ ☐ All other applicable technical requirements of trafficable width, gradients and curves, are required to be in "accordance with the class of road as specified in the IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Ausroad Standards and/or any applicable standard in the local government area" (Guidelines, Table 6 and E3.1. Refer also to Appendix C in this BMP).

The assessment conducted for the bushfire management plan indicates that it is likely that the proposed development can and will comply with the requirements.

However, the applicable class of road, the associated technical requirements and subsequent proposal compliance, will need to be confirmed with the relevant local government and/or Main Roads WA.

☐ ☐ ⃠ A traversable verge is available adjacent to classified vegetation (Guidelines, E3.1), as recommended.

Supporting Assessment Details: The existing road network surrounding the subject site provides public and emergency vehicles with a suitable trafficable transport route. The construction technical requirements established by the Guidelines and/or the local government have and will be complied with.

A3.2a Multiple access routes **Applicable**: Yes **Compliant**: Yes

☑ ☐ ☐ For each lot, two-way public road access is provided in two different directions to at least two different suitable destinations with an all-weather surface.

☐ ☐ ⊘	The two-way access is available at an intersection no greater than 200m from the relevant boundary of each lot, via a no-through road.
☐ ☐ ⊘	The two-way access is not available at an intersection within 200m from the relevant boundary of each lot. However, the available no-through road satisfies the established exemption for the length limitation in every case. These requirements are: • Demonstration of no alternative access (refer to A3.3 below); • The no-through road travels towards a suitable destination; and • The balance of the no-through road that is greater than 200m from the relevant lot boundary is within a residential built-out area or is potentially subject to radiant heat levels from adjacent bushfire prone vegetation that correspond to the BAL-LOW rating (<12.5 kW/m^2).

Supporting Assessment Details: Northam-York Road provides two directions of continuous travel immediately on leaving the boundary of Lot 6.

Lot 7 does not have public road access, as the driveway access is through Lot 6. Lots 6 and 7 are under the control of the same landowner and this is a common scenario for large rural lots. Lots 6 and 7 are considered the same lot for the purposes of compliance with Element 3.2a.

A3.2b Emergency access way	**Applicable**:	No	**Compliant**:	N/A
A3.3 Through-roads	**Applicable**:	Yes	**Compliant**:	Yes

☑ ☐ ☐	All public roads should be through-roads.
☐ ☐ ⊘	A no-through public road is necessary as no alternative road layout exists due to site constraints.
☐ ☐ ⊘	The no-through public road length does not exceed the established maximum of 200m to an intersection providing two-way access (Guidelines, E3.3).
☐ ☐ ⊘	The no-through public road exceeds 200m but satisfies the exemption provisions of A3.2a as demonstrated in A3.2a above.
☐ ☐ ⊘	The public road technical construction requirements (Guidelines, Table 6 and E3.1. Refer also to Appendix C in this BMP), can and will be complied with as established in A3.1 above.
☐ ☐ ⊘	The turnaround area requirements (Guidelines, Figure 24) can and will be complied with.

Supporting Assessment Details: Northam-York Road is a through-road.

A3.4a Perimeter roads	**Applicable**:	No	**Compliant**:	N/A
A3.4b Fire service access route	**Applicable**:	No	**Compliant**:	N/A
A3.5 Battle-axe access legs	**Applicable**:	No	**Compliant**:	N/A
A3.6 Private driveways	**Applicable**:	Yes	**Compliant**:	Yes

☐ ☐ ⊘	The private driveway to the most distant external part of the development site is within a lot serviced by reticulated water, is accessed via a public road with a speed limit of 70 km/hr or less and has a length is no greater than 70m (measured as a hose lay). No technical requirements need to be met.

☑ ☐ ☐	The technical construction requirements for widths, clearances, capacity, gradients and curves (Guidelines, Table 6 and E3.6. Refer also to Appendix C in this BMP), can and will be complied with.
☑ ☐ ☐	Passing bays can and will be installed every 200m with a minimum length of 20m and a minimum additional trafficable width of 2m.
☑ ☐ ☐	The turnaround area requirements (Guidelines, Figure 28, and within 30m of the habitable building) can and will be complied with.

Supporting Assessment Details: The development area will provide sufficient space, access, passing bays, and turnaround area (within 30m of development site) for any vehicle type. The internal road network proposed includes both perimeter and internal roads which at a minimum meet the specifications for A3.6 Private Driveways.

The Hydrogen Project includes a loop road around the facility, meeting the Explanatory Note of A3.6 for the purposes of a turnaround area.

Additional requirements for internal access have been applied in Section 5.7. This includes the turnaround area to be installed at the site water tanks which will be positioned on the access road, and for the internal roads servicing the Hydrogen Project to have a minimum 6m horizontal clearance. This does not apply to solar farm developments, as these areas are generally unstaffed.

The construction technical requirements established by the Guidelines and/or the local government can and will be complied with. These requirements are set out in Appendix C.

5.6 Assessment Statements for Element 4: Water

FIREFIGHTING WATER					
Element Intent	To ensure water is available to enable people, property and infrastructure to be defended from bushfire.				
Proposed Development/Use – Relevant Planning Stage	(Do) Development application other than for a single dwelling, ancillary dwelling or minor development				
Element Compliance Statement	The proposed development/use achieves the intent of the element by being fully compliant with all applicable acceptable solutions.				
Pathway Applied to Provide an Alternative Solution	N/A				
Acceptable Solutions - Assessment Statements *All details of acceptable solution requirements are established in the Guidelines for Planning in Bushfire Prone Areas, DPLH v1.4 (Guidelines) and apply the guidance established by the Position Statement: 'Planning in bushfire prone areas – Demonstrating Element 1: Location and Element 2: Siting and design' (WAPC Nov 2019) and the 'Bushfire Management Plan Guidance for the Dampier Peninsula' (WA Department of Planning, Lands and Heritage, 2021 Rev B) as relevant. These documents are available at https://www.wa.gov.au/government/document-collections/state-planning-policy-37-planning-bushfire-prone-areas.* *The technical construction requirements for access types and components, and for each firefighting water supply component, are also presented in Appendices 2 and 3. The local government will advise the proponent where different requirements are to apply and when any additional specifications such as those for signage and gates are to apply (these are included in the relevant appendix if requested by the local government).*					
Solution Component Check Box Legend	☑ Relevant & met	☒ Relevant & not met	⊘ Not relevant		
A4.1 Identification of future firefighting water supply	**Applicable**: No		**Compliant**: N/A		
A4.2 Provision of water for firefighting purposes	**Applicable**: Yes		**Compliant**: Yes		
☐ ☐ ⊘	A reticulated water supply is available to the proposed development. The existing hydrant connection(s) are provided in accordance with the specifications of the relevant water supply authority.				
☐ ☐ ⊘	A reticulated water supply will be available to the proposed development. Hydrant connection(s) can and will be provided in accordance with the specifications of the relevant water supply authority.				
☑ ☐ ☐	A static water supply (tank) for firefighting purposes will be installed on the lot(s) that is additional to any water supply that is required for drinking and other domestic purposes.				
☐ ☐ ⊘	A strategic water supply (tank or tanks) for firefighting purposes will be installed within or adjacent to the proposed development that is additional to any water supply that is required for drinking and other domestic purposes. The required land will be ceded free of cost to the local government and the lot or road reserve where the tank is to be located will be identified on the plan of subdivision.				
☐ ☐ ⊘	The strategic static water supply (tank or tanks) will be located no more than 10 minutes travel time from a subject site (at legal road speeds).				
☑ ☐ ☐	The technical requirements (location, number of tanks, volumes, design, construction materials, pipes and fittings), as established by the Guidelines (A4.2, E4 and Schedule 2) and/or the relevant local government, can and will be complied with.				

Supporting Assessment Details: The *Guidelines for Planning in Bushfire Prone Areas v1.4* does not establish a firefighting water supply requirement for non-habitable structures/uses, including High-Risk developments.

The nominal recommended static supply 50,000L for large-scale developments to combat the bushfire and consequential fires.

The Bushfire Risk Assessment and Management Report prepared alongside this BMP, has identified an appropriate water supply and specifications for the proposed development. These requirements have been applied in Section 5.7. The firefighting water supply to be installed is a minimum 1,152,000L.

The firefighting water supply servicing both Lots 6 and 7, will be located on Lot 6. Lots 6 and 7 are under the control of the same landowner and this is a common scenario for large rural lots. Lots 6 and 7 are considered the same lot for the purposes of compliance with Element A4.2.

Refer to information contained in Appendix D for the firefighting water supply specifications and technical requirements established by the *Guidelines for Planning in Bushfire Prone Areas v1.4*.

5.7 Additional Bushfire Protection Measures to be Implemented

The following bushfire protection measures are recommended to be implemented and maintained. They are additional to, or a variation of, those established by the relevant acceptable solutions applied to the proposed development/use within Sections 5 of this BMP (as applicable to the proposed development).

The intent of their application is to improve the bushfire performance of the proposed development/use and reduce residual risk levels to persons and property from a bushfire event.

The development of these additional and/or varied protection measures originates from five potential sources:

1. Out of the relevant merit based assessment when the Section titled 'Non-compliance – Additional Assessments' has been used in this BMP;
2. Out of the relevant performance based assessment when Section titled 'Non-compliance – Additional Assessments' has been used in this BMP;
3. Out of the development of any other required bushfire planning documents. These include a Bushfire Emergency Plan and the Bushfire Risk Assessment and Management Report;
4. Out of any additional bushfire planning guidance documents or position statements issued by the WA Department of Planning, Lands and Heritage; or
5. As a recommendation from the bushfire consultant.

When necessary, the implementation responsibility for these additional protection measures will be stated in Section 6 of this BMP and included in other operational documents as relevant.

5.7.1 Additional Protection Measures Derived from Associated Bushfire Risk Management Documents

For the proposed development, associated risk management documents may exist or be concurrently developed with this BMP. In such instances, these may identify additional protection measures that are to be implemented by the proposed development. Primary sources of these additional protection measures include:

1. A Bushfire Emergency Plan (and the associated supporting information document when its development has been necessary); and/or
2. A Risk Assessment and Management Report.

The relevant protection measures to be applied are stated below. Where the detail is too great, a summary may be provided, and the document referenced as the location of the complete detail.

The responsibilities created by these measures are incorporated into Section 6 of this BMP as necessary.

The following tables summarise the bushfire protection measures within the Risk Assessment and Management Report that may currently exist and/or are recommended to be implemented and that are to be maintained into the future.

The detail of these measures is set out in different protection types;

Hazard Threat Level -
Summarised application of threat reducing protection measures (refer to Section 6 of the BRMP for details).

Exposure -
Summarised application of exposure reducing protection measures for the subject buildings / other structures / infrastructure (refer to Section 7 of the BRMP for detail)

Vulnerability –

Summarised application of vulnerability reducing protection measures for the subject buildings / other structures / infrastructure (refer to Section 8 of the BRMP for detail).

The checklist identifies the operational documents that are recommended to be created to incorporate the requirements and responsibilities into the documents. Refer to the BRMP for further definition and explanation of the protection measures.

SUMMARY OF ADDITIONAL BUSHFIRE PROTECTION MEASURES						
No.	Description of the Protection Measure to Apply to the Proposed Development	The Protection Principle Being Applied		The Assessment or Document Establishing the Application of the Protection Measure	The Element and Associated Acceptable Solution(s) the Measure will Address	Application Status
		Type	Relevant Mode of Action			
1	The Site Office building is to be designated as an Onsite Shelter. The following requirements apply: • The building's exposure to the bushfire hazard threat of radiant heat will be limited to a maximum radiant heat flux of 10 kW/m2 (calculated with an assumed flame temperature of 1200K) by providing the required separation distances from the bushfire hazard. This setback is achieved through the installation of the APZ required for the entirety of the Hydrogen Project facility (not the solar farms). • The building will be built to the bushfire construction requirements corresponding to BAL-29 (as per AS 3959 or the NASH Standard) as a minimum. These specifications meet the requirements of an on-site shelter described in the *Guidelines* Element 5: A5.13c and d.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	Element 3 A3.2a and A3.3	Required and will be established in the responsibilities (Section 6).
		Exposure Reduction	N/A			
		Vulnerability Reduction - Persons	A Bushfire Emergency Firefighting Capability Exists (Response)			
		Vulnerability Reduction – Buildings/Structures	Apply Bushfire Resistant Design and Construction (Materials)			
2	All constructed assets and Class 1-10 buildings of the Hydrogen Project are required to install an APZ which will limit radiant heat flux exposure to<10kW/m2 (calculated at 1200K). In terms of AS3959 this is within BAL-12.5. The reasoning for this APZ, is it exceeds	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	Element 2 A2.1	Required and will be established in the responsibilities (Section 6).
		Exposure Reduction	Separation from All Bushfire Threats			

	planning requirements, far exceeds the thresholds of all assets onsite, and allows for suitably protected Emergency Services personnel (or site personnel with suitable training and PPE) to actively defend the site during the passage of a fire front. These persons can combat consequential fires or provide external cooling to assets if necessary.	Vulnerability Reduction - Persons	N/A			
		Vulnerability Reduction – Buildings/Structures	N/A			
3	Solar arrays are required to install a BAL-29 dimensioned APZ, and additionally a minimum APZ of 10 metres.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	Element 2 A2.1	Required and will be established in the responsibilities (Section 6).
		Exposure Reduction	Separation from All Bushfire Threats			
		Vulnerability Reduction - Persons	N/A			
		Vulnerability Reduction – Buildings/Structures	N/A			
4	The <10kW/m2 radiant heat flux APZ applied to the Hydrogen Project exceeds the 12kW/m2 critical threshold of common electrical cabling. Cabling and plumbing beyond the facility footprint are recommended to be installed underground, or shielded with non-combustible material (or enclosed) where practical.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	N/A	Recommended only. Future inclusion in responsibilities (Section 6) will be dependent on the planning decision maker establishing a condition.
		Exposure Reduction	Shielding from All Bushfire Threats			
		Vulnerability Reduction - Persons	N/A			
		Vulnerability Reduction – Buildings/Structures	N/A			
5	Cabling associated with solar arrays are recommended to be installed underground, or	Threat Reduction	N/A	Bushfire Risk – Assessment and	N/A	Recommended only. Future

	shielded with non-combustible material (or enclosed) where practical.	Exposure Reduction	Shielding from All Bushfire Threats	Management Report		inclusion in responsibilities (Section 6) will be dependent on the planning decision maker establishing a condition.
		Vulnerability Reduction - Persons	N/A			
		Vulnerability Reduction – Buildings/Structures	N/A			
6	It is recommended non-combustible elements are included in structure design/construction where practical.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	N/A	Recommended only. Future inclusion in responsibilities (Section 6) will be dependent on the planning decision maker establishing a condition.
		Exposure Reduction	N/A			
		Vulnerability Reduction - Persons	N/A			
		Vulnerability Reduction – Buildings/Structures	Design and Construction (Materials)			
7	Where a Class 1-10 building is enclosed, it is recommended that the structure applies ember screening to openings to roof, wall, or internal cavities. Screening should have an aperture of <2mm and be corrosion-resistant steel, bronze, or aluminium.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	N/A	Recommended only. Future inclusion in responsibilities (Section 6) will be dependent on the planning decision maker establishing a condition.
		Exposure Reduction	N/A			
		Vulnerability Reduction - Persons	N/A			
		Vulnerability Reduction – Buildings/Structures	Design and Construction (Materials)			
8	Where installed, sprinkler systems are recommended to be automatically activated.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	Element 4 A4.2	Recommended only. Future inclusion in responsibilities (Section 6) will
		Exposure Reduction	N/A			

		Vulnerability Reduction - Persons	N/A			be dependent on the planning decision maker establishing a condition.
		Vulnerability Reduction – Buildings/Structures	Establish/Improve Firefighting Capability			
9	It is recommended that hydrant boosters and other firefighting systems as appropriate, are supported by generators to ensure continued operation.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	Element 4 A4.2	Recommended only. Future inclusion in responsibilities (Section 6) will be dependent on the planning decision maker establishing a condition.
		Exposure Reduction	Separation from All Bushfire Threats			
		Vulnerability Reduction - Persons	N/A			
		Vulnerability Reduction – Buildings/Structures	Establish/Improve Firefighting Capability			
10	Internal access to the MEG Hydrogen Project (not the solar farms) is required to have a minimum 6m trafficable surface to ensure access/egress is available for both staff and responders.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	Element 3 A3.6	Required and will be established in the responsibilities (Section 6).
		Exposure Reduction	N/A			
		Vulnerability Reduction - Persons	Apply Best (Safer) Road Design and Construction (Materials)			
		Vulnerability Reduction – Buildings/Structures	N/A			
11	At the detailed design stage, it is recommended that designs are investigated for: • Roof/building complexities which may trap debris or collect embers • Cabling/piping contacting the ground or any arrangement of associated structures	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	N/A	Recommended only. Future inclusion in responsibilities (Section 6) will be dependent on the planning decision maker
		Exposure Reduction	N/A			
		Vulnerability Reduction - Persons	N/A			

	creating a 'pocket' for accumulation of debris. These complexities are recommended to be removed, enclosed, or filled with non-combustible material (such as mineral earth) where practical. Consideration should be given to making the arrangement self-cleaning through wind action to the greatest extent possible. Functionally this means preventing details which may accumulate leaf litter which will not naturally be cleared by wind.	Vulnerability Reduction – Buildings/Structures	Management And Maintaining Effectiveness Of Applied Protection Measures			establishing a condition.
12	The *Guidelines for Planning in Bushfire Prone Areas* does not establish a firefighting water supply for non-habitable buildings, including high-risk uses. In the absence of specific requirements at the national or state level for Hydrogen production facilities, a conservative approach is applied in the firefighting water supply for the determination of the appropriate water supply. The facility will achieve simultaneous compliance with multiple sets of guidelines or standards, by applying the most stringent of the components of each. • The *Design Guidelines and Model Requirements – Renewable Energy Facilities* (Victorian Country Fire Authority March 2022) discusses multiple renewable energy types but not Hydrogen. The most stringent water requirements are for Battery Energy Storage Systems, and this will be applied. • The *Guidelines for Planning in Bushfire Prone Areas v1.4* (WAPC 2021) is prescriptive on access to the water supply and couplings to be installed. • *AS2419-2005: Fire Hydrant Installations* provides the appropriate water volume for the facility, water pressure, and number of hydrants.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	Element 4 A4.2	Required and will be established in the responsibilities (Section 6).
		Exposure Reduction	N/A			
		Vulnerability Reduction - Persons	A Bushfire Emergency Firefighting Capability Exists (Response)			
		Vulnerability Reduction – Buildings/Structures	Firefighting Capability			

	• *DFES Operational Requirement Guideline 5: Hydrants and Hose Length* (DFES April 2020) recommends a 60m hose lay rather than the 60m+10m stream in AS2419. A separate brief is provided as an Addendum outlining the combined water specifications for the facility.					
13	Fire hose reels will be installed throughout the site (final locations to be determined in detailed engineering phase). At a minimum, **two** fire hose reels must be installed within 60m of all areas for storage or processing of high-risk storage or processing areas (not the solar arrays).	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	Element 4 A4.2	Required and will be established in the responsibilities (Section 6).
		Exposure Reduction	N/A			
		Vulnerability Reduction - Persons	A Bushfire Emergency Firefighting Capability Exists (Response)			
		Vulnerability Reduction – Buildings/Structures	Firefighting Capability			
14	A visual buffer is intended to be planted between the Hydrogen Project and Northam-York Road. The species of tree will be determined by the Shire of Northam. Where a list is provided by the Shire of Northam, Bushfire Prone Planning will recommend a shortlist of tree species.	Threat Reduction	Prevent fire ignition and/or severity by controlling the fuel.	Bushfire Risk – Assessment and Management Report	Element 2 A2.1	Recommended only. Future inclusion in responsibilities (Section 6) will be dependent on the planning decision maker establishing a condition.
		Exposure Reduction	Separation from All Bushfire Threats			
		Vulnerability Reduction - Persons	N/A			
		Vulnerability Reduction – Buildings/Structures	N/A			
15	The trunk of any planted tree must be located >1.5 the mature height of that tree from buildings or other constructed vital assets. For example, Eucalyptus melliodora has a typical maximum height of 30m, and must thus be planted >45m from buildings and	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	N/A	Recommended only. Future inclusion in responsibilities (Section 6) will
		Exposure Reduction	Separation from All Bushfire Threats			

	constructed vital assets. It is therefore practical that shorter species are selected.	Vulnerability Reduction - Persons	N/A			be dependent on the planning decision maker establishing a condition.
		Vulnerability Reduction – Buildings/Structures	N/A			
16	Bushfire awareness training is recommended for full-time staff.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	N/A	Recommended only. Future inclusion in responsibilities (Section 6) will be dependent on the planning decision maker establishing a condition.
		Exposure Reduction	N/A			
		Vulnerability Reduction - Persons	Provision of Bushfire Emergency Information and Education			
		Vulnerability Reduction – Buildings/Structures	N/A			
17	It is recommended that the siting of high-risk components (hydrogen storage, electrolysers, and trucks) within the facility layout, is separated from any consequential hazard where practical. The separation distance should be either 6m, or 3 times the total height of the consequential fire hazard, whichever is greater. Consequential hazards include rubbish bins, fuel jerry cans, cardboard boxes, and any object composed of plastic or wood.	Threat Reduction	Prevent fire ignition by controlling heat energy source and fuel interactions	Bushfire Risk – Assessment and Management Report	Element 2 A2.1	Recommended only. Future inclusion in responsibilities (Section 6) will be dependent on the planning decision maker establishing a condition.
		Exposure Reduction	Separation from All Bushfire Threats			
		Vulnerability Reduction - Persons	N/A			
		Vulnerability Reduction – Buildings/Structures	Management And Maintaining Effectiveness Of Applied Protection Measures			
18	Measures including preparation, responses, and training (including designation of roles such as Fire Wardens) for bushfire events are required to be included in the future site Emergency Management Plan (document title pending).	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	N/A	Required and will be established in the
		Exposure Reduction	N/A			

		Vulnerability Reduction - Persons	Provision of Bushfire Emergency Information and Education			responsibilities (Section 6).
		Vulnerability Reduction – Buildings/Structures	N/A			
19	Staff and contractors working within the solar arrays are required to be contactable by the Hydrogen Project administration (via mobile/satellite phone, two-way radio etc).	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	N/A	Required and will be established in the responsibilities (Section 6).
		Exposure Reduction	N/A			
		Vulnerability Reduction - Persons	Provision of Bushfire Emergency Information and Education			
		Vulnerability Reduction – Buildings/Structures	N/A			
20	Future site Operating Procedures or Emergency Management Plan (document titles pending) identify which (if any) operations are to cease where a bushfire is identified within 10km. The	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	N/A	Required and will be established in the
		Exposure Reduction	N/A			

	operations identified should be those susceptible to ember attack.	Vulnerability Reduction - Persons	Provision of Bushfire Emergency Information and Education			responsibilities (Section 6).
		Vulnerability Reduction – Buildings/Structures	N/A			
21	Operating and maintenance procedures are to be developed to ensure regular maintenance of firefighting equipment and clearing of accumulated debris and other consequential fire hazards.	Threat Reduction	Prevent fire ignition and/or severity by controlling the fuel.	Bushfire Risk – Assessment and Management Report	Element 4 A4.2	Required and will be established in the responsibilities (Section 6).
		Exposure Reduction	N/A			
		Vulnerability Reduction - Persons	A Bushfire Emergency Firefighting Capability Exists (Response)			
		Vulnerability Reduction – Buildings/Structures	Management And Maintaining Effectiveness Of Applied Protection Measures			
22	It is required that the Toodyay State Emergency Service and Northam Volunteer Fire and Rescue Service is invited to inspect and familiarise with the site. Provide information in site fire response procedures. This invitation is to be extended after completion of construction and before commissioning. Additional invitations are recommended, which may be annual or ad-hoc as appropriate.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	N/A	Required and will be established in the responsibilities (Section 6).
		Exposure Reduction	N/A			
		Vulnerability Reduction - Persons	A Bushfire Emergency Firefighting Capability Exists (Response)			
		Vulnerability Reduction – Buildings/Structures	Firefighting Capability			
23	A manifest is to be provided and made available at site entry, detailing site fire response procedures and hazards.	Threat Reduction	N/A	Bushfire Risk – Assessment and Management Report	N/A	Required and will be established in the
		Exposure Reduction	N/A			

		Vulnerability Reduction - Persons	A Bushfire Emergency Firefighting Capability Exists (Response)			responsibilities (Section 6).
		Vulnerability Reduction – Buildings/Structures	Firefighting Capability			

6 RESPONSIBILITIES FOR IMPLEMENTATION AND MANAGEMENT OF THE BUSHFIRE PROTECTION MEASURES

6.1 Developer / Landowner Responsibilities – Prior to Operation

DEVELOPER/LANDOWNER RESPONSIBILITIES – PRIOR TO SALE OR OCCUPANCY/OPERATION	
No.	Implementation Actions
1	The local government may condition a development application approval with a requirement for the landowner/proponent to register a notification onto the certificate of title and deposited plan. This will be done pursuant to Section 70A *Transfer of Land Act 1893* as amended ('Factors affecting use and enjoyment of land, notification on title'). This is to give notice of the bushfire hazard and any restrictions and/or protective measures required to be maintained at the owner's cost. This condition ensures that: 1. Landowners/proponents are aware their lot is in a designated bushfire prone area and of their obligations to apply the stated bushfire risk management measures; and 2. Potential purchasers are alerted to the Bushfire Management Plan so that future landowners/proponents can continue to apply the bushfire risk management measures that have been established in the Plan.
2	Establish the 'Landowner' Asset Protection Zone (APZ) around habitable buildings (and other structures as required) to satisfy: • The minimum required dimensions. These are to be the greatest measurements derived from either the separation distances corresponding to the determined BAL rating for the subject building/structure, or the local government's annual firebreak / hazard reduction notice (issued under s33 of the Bushfires Act 1954), or a combination of these requirements [refer to Appendix B]; and • The standards established by the Guidelines DPLH, 2021 v1.4, Schedule 1, or as varied by the local government through their annually issued firebreak / hazard reduction notice when the variations have been endorsed by the WAPC and DFES as per s4.5.3 of the Guidelines. If native vegetation is required to be modified or removed, ensure that approval has been received from the relevant authority (refer to the applicable local government for advice). This is the responsibility of the developer prior to operation.
3	Prior to sale of the subject lots, each individual lot is to be compliant with current version of the Shire of Northam Firebreak Notice issued under s33 of the Bushfires Act 1954. This may include standards for asset protection zones that differ from Schedule 1 in the Guidelines DPLH, 2021 v1.4, with the intent to better satisfy local conditions. [Refer to the 'Siting and Design' assessments against the Bushfire Protection Criteria and the information presented in Appendix B].
4	Prior to occupancy, ensure the designated onsite shelter building has been designed and constructed in accordance with BAL-29 under AS3959.
5	Prior to occupancy, construct the private driveways to comply with the technical requirements referenced in the BMP.

6	Prior to occupancy, install the required firefighting static water supply to comply with the technical requirements stated in the BMP.
7	Implement the bushfire protection measures that have been established within Section 5.7 of this BMP as measures additional to those established by the acceptable solutions.
8	For the 'high risk land use' there is an outstanding obligation, created by Guidelines and consequently this Bushfire Management Plan, for a 'Bushfire Risk Assessment and Management Report' to be produced. Additional protection measures that have been identified in the Report, are to be incorporated into the operation's site emergency plan (produced by the operator to address all potential emergencies).
9	Prior to operation, ensure the Site Emergency Plan (document title pending) includes preparation and responses to bushfire emergencies, including recommendations within Section 5.7.
10	Prior to relevant building work, inform the builder of the existence of this approved Bushfire Management Plan (BMP). The plan identifies that the development site is within a designated bushfire prone area and states the indicative (or determined) BAL rating(s) that may (or will) be applied to buildings/structures. A BAL assessment report may be required to confirm determined ratings and will be required when ratings are indicative. BAL certificates will need to be issued to accompany building applications. The BMP may also establish, as an additional bushfire protection measure, that construction requirements to be applied will be those corresponding to a specified higher BAL rating. Compliance with the Building Code of Australia (Volumes 1 and 2 of the National Construction Code), will require certain bushfire resistant construction requirements be applied to residential buildings in bushfire prone areas (i.e., Class 1, 2 and 3 and associated Class 10a buildings and decks). Other classes of buildings may also be required to comply with these construction when established by the relevant authority or if identified as an additional bushfire protection measure within the BMP. The deemed to satisfy solutions that will meet the relevant bushfire performance requirements are found in AS 3959 – Construction of Building in Bushfire Prone Areas (as amended) and the NASH Standard - Steel Framed Construction in Bushfire Areas (as amended).

6.2 Landowner / Occupier Responsibilities – Ongoing Management

LANDOWNER/OCCUPIER – ONGOING MANAGEMENT	
No.	Management Actions
1	Maintain the 'Landowner' Asset Protection Zone (APZ) around habitable buildings (and other structures as required) to satisfy: • The minimum required dimensions. These are to be the greatest measurements derived from either the separation distances corresponding to the determined BAL rating for the subject building/structure, or the local government's annual firebreak / hazard reduction notice (issued under s33 of the Bushfires Act 1954), or a combination of these requirements [refer to Appendix B]; and • The standards established by the Guidelines DPLH, 2021 v1.4, Schedule 1, or as varied by the local government through their annually issued firebreak / hazard reduction notice when the variations have been endorsed by the WAPC and DFES as per s4.5.3 of the Guidelines.
2	Comply with the Shire of Northam Firebreak Notice issued under s33 of the Bush Fires Act 1954. Check the notice annually for any changes.
3	Maintain vehicular access routes within the lot to comply with the technical requirements referenced in the BMP and the relevant local government's annual firebreak / hazard reduction notice.
4	Maintain the static firefighting water supply tank and associated pipes/fittings/pump and vehicle hardstand in good working condition.
5	Ensure that builders engaged to construct dwellings/additions and/or other relevant structures on the lot, are aware of the existence of this approved Bushfire Management Plan (BMP). The plan identifies that the development site is within a designated bushfire prone area and states the indicative (or determined) BAL rating(s) that may (or will) be applied to buildings/structures. A BAL assessment report may be required to confirm determined ratings and will be required when ratings are indicative. BAL certificates will need to be issued to accompany building applications. The BMP may also establish, as an additional bushfire protection measure, that construction requirements to be applied will be those corresponding to a specified higher BAL rating. Compliance with the Building Code of Australia (Volumes 1 and 2 of the National Construction Code), will require certain bushfire resistant construction requirements be applied to residential buildings in bushfire prone areas (i.e., Class 1, 2 and 3 and associated Class 10a buildings and decks). Other classes of buildings may also be required to comply with these construction when established by the relevant authority or if identified as an additional bushfire protection measure within the BMP. The deemed to satisfy solutions that will meet the relevant bushfire performance requirements are found in AS 3959 – Construction of Building in Bushfire Prone Areas (as amended) and the NASH Standard - Steel Framed Construction in Bushfire Areas (as amended).
6	Ensure all future buildings the landowner has responsibility for, are designed and constructed in full compliance with: • The bushfire resistant construction requirements of the Building Code of Australia (Volumes 1 and 2 of the National Construction Code), as established by the Building Regulations 2012 (WA Building Act 2011); and

	• Any additional bushfire protection measures this Bushfire Management Plan has established are to be implemented.
7	Maintain the bushfire protection measures that have been established within Section 5.7 of this BMP as measures additional to those established by the acceptable solutions.
8	The bushfire specific content of the operation's site emergency plan (document title pending) must be reviewed annually, relevant information updated and ensure all bushfire related preparation procedures are carried out.

6.3 Local Government Responsibilities – Ongoing Management

LOCAL GOVERNMENT – ONGOING MANAGEMENT	
No.	Management Actions
1	Monitor landowner compliance with the annual Shire of Northam Firebreak Notice and with any bushfire protection measures that are: • Established by this BMP; • Are required to be maintained by the landowner/occupier; and • Are relevant to local government operations.

APPENDIX A: DETAILED BAL ASSESSMENT DATA AND SUPPORTING INFORMATION

A1: BAL Assessment Inputs Common to the Method 1 and Method 2 Procedures

A1.1: FIRE DANGER INDICES (FDI/FDI/GFDI)

When using Method 1 the relevant FDI value required to be applied for each state and region is established by AS 3959:2018, Table 2.1. Each FDI value applied in Tables 2.4 – 2.7 represents both the Forest Fire Danger Index (FFDI) and a deemed equivalent for the Grassland Fire Danger Index (GFDI), as per Table B2 in Appendix B. When using Method 2, the relevant FFDI and GFDI are applied.

The values may be able to be refined within a jurisdiction, where sufficient climatological data is available and in consultation with the relevant authority.

Relevant Jurisdiction:	WA	Region:	Whole State	Method 1	Applied FDI:	80
				Method 2	Applied FFDI:	80
					Applied GFDI:	110

A1.2: VEGETATION ASSESSMENT AND CLASSIFICATION

Vegetation Types and Classification

In accordance with AS 3959:2018 clauses 2.2.3 and C2.2.3.1, all vegetation types within 100 metres of the 'site' (defined as "the part of the allotment of land on which a building stands or is to be erected"), are identified and classified. Any vegetation more than 100 metres from the site that has influenced the classification of vegetation within 100 metres of the site, is identified and noted. The maximum excess distance is established by AS 3959: 2018 cl 2.2.3.2 and is an additional 100 metres.

Classification is also guided by the Visual Guide for Bushfire Risk Assessment in WA (WA Department of Planning February 2016) and any relevant FPA Australia practice notes.

Modified Vegetation

The vegetation types have been assessed as they will be in their natural mature states, rather than what might be observed on the day. Vegetation destroyed or damaged by a bushfire or other natural disaster has been assessed on its expected re-generated mature state. Modified areas of vegetation can be excluded from classification if they consist of low threat vegetation managed in a minimal fuel condition, satisfying AS 3959:2018 s2.2.3.2(f), and there is sufficient justification to reasonable expect that this modified state will exist in perpetuity.

The Influence of Ground Slope

Where significant variation in effective slope exists under a consistent vegetation type, these will be delineated as separate vegetation areas to account for the difference in potential bushfire behaviour, in accordance with AS 3959:2018 clauses 2.2.5 and C2.2.5.

THE INFLUENCE OF VEGETATION GREATER THAN 100 METRES FROM THE SUBJECT SITE	
Vegetation area(s) within 100m of the site whose classification has been influenced by the existence of bushfire prone vegetation from 100m – 200m from the site:	None
Assessment Statement:	No vegetation types exist close enough, or to a sufficient extent, within the relevant area to influence classification of vegetation within 100 metres of the subject site.

VEGETATION AREA 1						
Classification	**A. FOREST**					
Types Identified	Open forest A-03 Low open forest A-04					
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees		
Foliage Cover (all layers)	30-70%	Shrub/Heath Height	<2m	Tree Height	Up to 30m	
Dominant & Sub-Dominant Layers (species as relevant)	Vegetation with a comparable structure and assemblage to Class B Woodland, with a canopy coverage exceeding 30%.					
Post Development Assumptions:	N/A					

PHOTO ID: 1

PHOTO ID: 2

VEGETATION AREA 2						
Classification	**B. WOODLAND**					
Types Identified	Woodland B-05 Low woodland B-07					
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees		
Foliage Cover (all layers)	<30%	Shrub/Heath Height	<2m	Tree Height	Up to 30m	
Dominant & Sub-Dominant Layers (species as relevant)	Areas with an overstory of established trees and understory of grasses with limited shrubs and little to no regeneration visible.					
Post Development Assumptions:	N/A					

PHOTO ID: 3

PHOTO ID: 4

PHOTO ID: 5

PHOTO ID: 6

VEGETATION AREA 3						
Classification	**B. WOODLAND**					
Types Identified	Woodland B-05 Low woodland B-07					
Effective Slope	Measured	d/slope 2 degrees	Applied Range (Method 1)	Downslope >0-5 degrees		
Foliage Cover (all layers)	<30%	Shrub/Heath Height	<2m	Tree Height	Up to 30m	
Dominant & Sub-Dominant Layers (species as relevant)	Areas with an overstory of established trees and understory of grasses with limited shrubs and little to no regeneration visible. Area 3 includes a riparian buffer.					
Post Development Assumptions:	N/A					

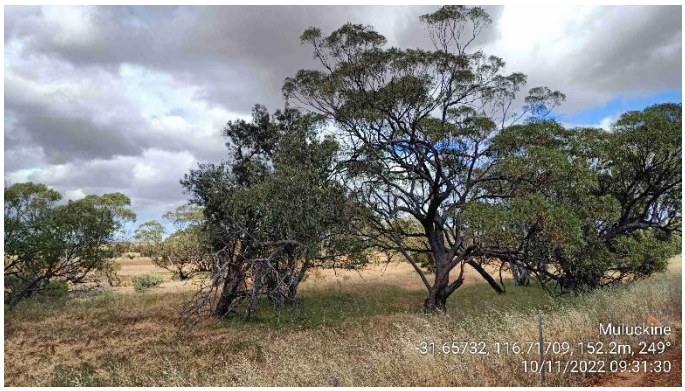


PHOTO ID: 7

PHOTO ID: 8

PHOTO ID: 9

PHOTO ID: 10

VEGETATION AREA 4						
Classification	**G. GRASSLAND**					
Types Identified	Dense sown pasture G-25 Open herbfield G-27					
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees		
Foliage Cover (all layers)	<10%	Shrub/Heath Height	N/A	Tree Height	Up to 30m	
Dominant & Sub-Dominant Layers (species as relevant)	Unmanaged areas or retained treed areas without either cropping or grazing with a low canopy coverage (<10%).					
Post Development Assumptions:	N/A					

PHOTO ID: 11

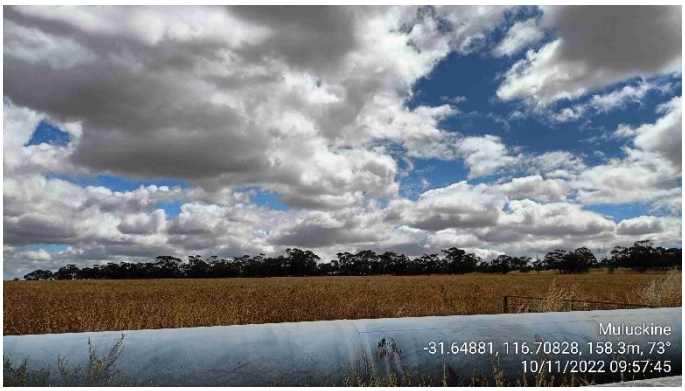


PHOTO ID: 12

VEGETATION AREA 5						
Classification	**A. FOREST**					
Types Identified	Open forest A-03 Low open forest A-04					
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees		
Foliage Cover (all layers)	30-70%	Shrub/Heath Height	<2m	Tree Height	Up to 30m	
Dominant & Sub-Dominant Layers (species as relevant)	Onsite vegetation with a comparable structure and assemblage to Class B Woodland, with a canopy coverage exceeding 30%.					
Post Development Assumptions:	N/A					

PHOTO ID: 13

PHOTO ID: 14

PHOTO ID: 15

PHOTO ID: 16

VEGETATION AREA 6						
Classification	**A. FOREST**					
Types Identified	Open forest A-03 Low open forest A-04					
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees		
Foliage Cover (all layers)	30-70%	Shrub/Heath Height	<2m	Tree Height	Up to 30m	
Dominant & Sub-Dominant Layers (species as relevant)	Vegetation with a comparable structure and assemblage to Class B Woodland, with a canopy coverage exceeding 30%.					
Post Development Assumptions:	N/A					

PHOTO ID: 17

PHOTO ID: 18

PHOTO ID: 19

PHOTO ID: 20

VEGETATION AREA 7						
Classification	**B. WOODLAND**					
Types Identified	Woodland B-05 Low woodland B-07					
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees		
Foliage Cover (all layers)	<30%	Shrub/Heath Height	<2m	Tree Height	Up to 30m	
Dominant & Sub-Dominant Layers (species as relevant)	Areas with an overstory of established trees and understory of grasses with limited shrubs and little to no regeneration visible.					
Post Development Assumptions:	N/A					

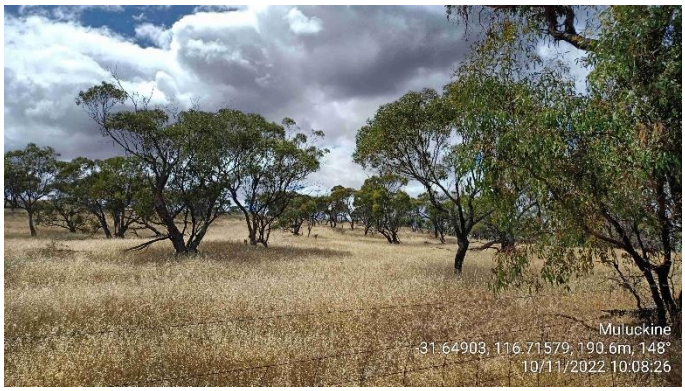


PHOTO ID: 21

PHOTO ID: 22

PHOTO ID: 23

PHOTO ID: 24

PHOTO ID: 25

PHOTO ID: 26

VEGETATION AREA 8						
Classification	**G. GRASSLAND**					
Types Identified	Open herbfield G-27					
Effective Slope	Measured	d/slope 2 degrees	Applied Range (Method 1)	Downslope >0-5 degrees		
Foliage Cover (all layers)	N/A	Shrub/Heath Height	N/A	Tree Height	N/A	
Dominant & Sub-Dominant Layers (species as relevant)	Sown crops (wheat).					
Post Development Assumptions:	N/A					

PHOTO ID: 27

PHOTO ID: 28

PHOTO ID: 29

PHOTO ID: 30

VEGETATION AREA 9						
Classification	G. GRASSLAND					
Types Identified	Sown pasture G-26					
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees		
Foliage Cover (all layers)	N/A	Shrub/Heath Height	N/A	Tree Height	N/A	
Dominant & Sub-Dominant Layers (species as relevant)	Pasture grazed to <10cm. This vegetation is low threat but must be classified as Class G Grassland.					
Post Development Assumptions:	N/A					

PHOTO ID: 31

PHOTO ID: 32

VEGETATION AREA 10						
Classification	G. GRASSLAND					
Types Identified	Tussock grassland G-22					
Effective Slope	Measured	flat 0 degrees	Applied Range (Method 1)	Upslope or flat 0 degrees		
Foliage Cover (all layers)	N/A	Shrub/Heath Height	N/A	Tree Height	N/A	
Dominant & Sub-Dominant Layers (species as relevant)	Unmanaged areas or retained treed areas without either cropping or grazing with a low canopy coverage (<10%).					
Post Development Assumptions:	N/A					

PHOTO ID: 33

PHOTO ID: 34

VEGETATION AREA 11	
Classification	**N/A**
Exclusion Clause	2.2.3.2 (a) >100m from site 2.2.3.2 (e) Non-vegetated area 2.2.3.2 (f) Low threat vegetation - minimal fuel condition.
Additional Justification:	Cleared, compacted hardstand, roads, developed areas, and vegetation managed in a low-threat, minimal fuel condition.
Post Development Assumptions:	N/A

PHOTO ID: 35

PHOTO ID: 36

A1.3: EFFECTIVE SLOPE

Measuring

Effective slope refers to the slope "under the classified vegetation which most significantly influences bushfire behaviour (AS 3959:2018, clause B4, CB4). It is not the average slope.

It is described as upslope, flat or downslope when viewed from the exposed element (e.g., building) looking towards the vegetation – and measured in degrees. Ground slope has a direct and significant influence on a bushfire's rate of spread and intensity, which increases when travelling up a slope.

The slope under the vegetation in closest proximity to the exposed element(s), over the distance that will most likely carry the entire depth of the flaming front, will be a significant consideration in the determination of the effective slope. This distance is determined as a function of the potential quasi-steady rate of spread and expected residence time (i.e., the flaming combustion period at a single point on the ground), of a bushfire in the specific vegetation type/landscape scenario.

Slope Variation Within Areas of Vegetation

Where a significant variation in effective slope exists under a consistent vegetation type, these will be delineated as separate vegetation areas to account for the difference in potential bushfire behaviour, in accordance with AS 3959:2018 clauses 2.2.5 and C2.2.5.

Slope Variation Due to Multiple Development Sites

When the effective slope, under a given area of bushfire prone vegetation, will vary significantly relative to multiple proposed development sites (exposed elements), then the effective slopes corresponding to each of the different locations, are separately identified.

The relevant (worst case) effective slope is determined in the direction corresponding to the potential directions of fire spread towards the subject building(s).

Differences in Application of Effective Slope - AS 3959:2018 Method 1 versus Method 2 Procedures

The Method 1 procedure provides five different slope ranges from flat (including all upslopes) to 20 degrees downslope to define the effective slope and bushfire behaviour model calculations apply the highest value in each range (i.e., 0^0, 5^0, 10^0, 15^0 or 20^0).

The Method 2 procedure requires an actual slope (up or down in degrees) to be determined. AS 3959:2018, clause B1 limits the effective slope that can be applied to 30 degrees downslope and 15 degrees upslope. Where any upslope is greater than 15 degrees, then 15 degrees is to be used.

SITE ASSESSMENT DETAILS - EXPLANATION & JUSTIFICATION

The effective slopes determined from the site assessment are recorded in Table 3.1 of this Bushfire Management Plan. When their derivation requires additional explanation and justification, this is provided below.

A1.4: SEPARATION DISTANCE

Measuring

The separation distance is the distance in the horizontal plane between the receiver (building/structure or area of land being considered) and the edge of the classified vegetation (AS 3959:2018, clause 2.2.4)

The relevant parts of a building/structure from which the measurement is taken is the nearest part of an external wall or where a wall does not exist, the supporting posts or columns. Certain parts of buildings are excluded including eaves and roof overhangs.

The edge of the vegetation, for forests and woodlands, will be determined by the unmanaged understorey rather than either the canopy (drip line) or the trunk (AS 3959:2018, clause C2.2.5).

Measured Separation Distance as a Calculation Input

If a separation distance can be measured because the location of the building/structure relative to the edge of the relevant classified vegetation is known, this figure can be entered into the BAL calculation. The result is a determined BAL rating.

Assumed Separation Distance as a Calculation Input

When the building/structure location within the lot is not known, an assumed building location may be applied that would establish the closest positioning of the building/structure relative to the relevant area of vegetation.

The assumed location would be based on a factor that puts a restriction on a building location such as:

- An established setback from the boundary of a lot, such as a residential design code setback or a restrictive covenant; or
- Within an established building envelope.

The resultant BAL rating would be indicative and require later confirmation (via a Compliance Report) of the building/structure actual location relative to the vegetation to establish the determined BAL rating.

Separation Distance as a Calculation Output

With the necessary site specific assessment inputs and using the AS 3959:2018 bushfire modelling equations, the range of separation distances that will correspond to each BAL rating (each of which represents a range of radiant heat flux), can be calculated. This has application for bushfire planning scenarios such as:

- When the separation distance cannot be measured because the exact location of the exposed element (i.e., the building, structure or area), relative to classified vegetation, is yet to be determined.

  In this scenario, the required information is the identification of building locations onsite that will correspond to each BAL rating. That is, indicative BAL ratings can be derived for a variety of potential building/structure locations; or

- The separation distance is known for a given building, structure or area (and a determined BAL rating can be derived), but additional information is required regarding the exposure levels (to the transfer of radiant heat from a bushfire), of buildings or persons, that will exist at different points within the subject site.

The calculated range of separation distances corresponding to each BAL rating can be presented in a table and/or illustrated as a BAL Contour Map – whichever is determined to best fit the purpose of the assessment.

For additional information refer to the information boxes in Section 3 'Bushfire Attack Levels (BAL) - Understanding the Results and Section 3.2. 'Interpretation of the BAL Contour Map'.

SITE ASSESSMENT DETAILS - EXPLANATION & JUSTIFICATION

Measured and assumed separation distances determined from the site assessment are recorded in Section 3, Table 3.1. When their derivation requires additional explanation and justification, including when the relevant R-Code or other regulated building setbacks are being applied, this is provided below.

A2: BAL Assessment Inputs Applied Using the Method 2 Procedure

STATING AND JUSTIFYING THE METHOD 2 CALCULATION INPUT VARIABLES APPLIED

As 3959:2018 Bal Determination Procedures: AS 3959:2018 establishes the official methodology to determine the radiant heat flux (RHF) a receiver (e.g., a building, structure, person or specified location), will potentially be exposed to from a fully developed bushfire within any adjacent classified vegetation. The methodology accounts for the configuration of a specific site and its surrounds.

The model calculations are complex. Consequently, AS 3959:2018 establishes two pathways to apply the methodology - a simplified procedure (Method 1) and a detailed procedure (Method 2).

Method 1: This procedure has limitations to both its scope and the degree to which site specific conditions can be applied. However, it requires minimal site assessment inputs and provides a standardised output that is satisfactory for many situations.

A moderate level of justification for some of the assessed inputs applied is required. This will demonstrate how the procedure detailed within AS 3959:2018 for Method 1(Section 2) has been followed.

Method 2: This procedure is used when the site conditions are out of the scope of Method 1 or when it is necessary to produce a more specific result. Higher levels of justification will be required for many of the input variables that are able to be modified using Method 2 (AS 3959:2018 Appendix B).

Section A2.1 below identifies the input variables that have been assessed for the proposed development and indicates the level of justification required for their application. The information contained within this Appendix will provide this justification information to the degree necessary.

A2.1: SUMMARY OF CALCULATION INPUTS APPLIED AND THE LEVEL OF JUSTIFICATION REQUIRED

AS 3959:2018 BUSHFIRE ATTACK LEVEL (BAL) DETERMINATION PROCEDURES INPUT VARIABLES FOR THE FIRE BEHAVIOUR AND RADIATION MODELS						
✓ Indicates which site specific variables have been assessed and applied to the assessment of the proposed development/use. Indicates an AS 3959 methodology or jurisdiction default variable (or a methodology calculated variable in the case of EOR or flame angle). No justification required. Indicates a variable that either must or can have an assessor value applied. Requires justification. Indicates a variable that can have an assessor value applied. Requires detailed justification.		**IDENTIFICATION OF THE CALCULATION INPUT VARIABLES ASSESSED AND/OR MODIFIED FOR THE PROPOSED DEVELOPMENT/USE**				
		Using Method 1		Using Method 2		
ASSESSOR QUALIFICATION REQUIRED [1]		BPAD Level 1		BPAD Level 3		
LEVEL OF JUSTIFICATION REQUIRED TO APPLY [2]		None	Moderate	None	Moderate	High
Fire weather	Fire danger index (FDI/FFDI/GFDI)			✓		
	Wind speed					
	Ambient temperature					
	Relative humidity					
Bushfire Prone Vegetation and slope of the land it grows on	Vegetation classification [3]				✓	
	Effective slope				✓	
	Understorey and total fuel loads [4]					
	Vegetation height					
	Fuel age					
	Fuel moisture					
Receiver (building) positioning parameters	Site slope					
	Separation distance				✓	
	Elevation of the receiver (EOR).					
Bushfire flame parameters	Flame temperature [5]			✓		
	Flame width					
	Flame angle					
	Flame emissivity					
	Heat of combustion					
INTERMEDIATE OUTPUT FROM THE FIRE BEHAVIOUR AND RADIATION MODELS						
Rate of Spread - derived from fuel loads, fuel type, fuel height, FDI, effective slope and wind speed.						
Fire Intensity – derived from fuel loads, rate of spread and heat of combustion [6]						
Path Length – derived from flame angle and separation distance.						
Transmittance – derived from ambient temperature and relative humidity.						
View Factor – derived from flame length, flame width, flame angle, separation distance, elevation of receiver and site slope.						
FINAL OUTPUT OF THE FIRE BEHAVIOUR AND RADIATION MODELS						
Flame Length – derived from fuel loads, ROS (for Forest, Woodland) and fire intensity (for Scrub, Shrubland, Grassland) [6]						
Radiant Heat Flux and the Corresponding Bushfire Attack Level (BAL) – derived from view factor, flame emissivity, flame temperature, transmittance and corresponding to the worst possible flame angle.						
TABLE NOTES (see next page)						

[1] **Authority to Use Method 2:** Within WA, use of this procedure is restricted to bushfire practitioners who hold the BPAD Level 3 accreditation as issued by the Fire Protection Association Australia (FPAA) through their Bushfire Planning and Design Accreditation Scheme (BPAD Scheme) that complies with the Western Australian Bushfire Accreditation Framework.

[2] **Level of Justification Required in Applying Method 2:** AS 3959:2018 Appendix B establishes the detailed procedure for the Method 2 determination of BAL(s) as consisting of 10 steps. When justification is required for an assessed variable value to be applied, the required level of justification can vary. The level definitions used in this table are:

Moderate: Requires the provision of readily available and understood argument and evidence such as when:

1. The methodology step requires or allows for an input variable to be a site assessed value; or
2. A methodology step requires a jurisdictionally determined value which the relevant authority may change for different land use scenarios; or

High: Requires a detailed argument, appropriate evidence and justification when:

1. The variable is derived from the methodology step that applies an AS 3959:2018 default value or determines an intermediate output value (i.e. the result of applying a step's equations).

[3] **Applying a Different Vegetation Classification:** This approach may be justified when certain characteristics of the site's local vegetation complex align with the broad based descriptions of AS 3959:2018, but expert knowledge identifies characteristics that would result in the applied AS 3959 bushfire behaviour model not being properly representative of a fire in the local vegetation. This potential outcome is in part due to the ecological classification of vegetation that is used in AS 3959 rather than a classification more aligned with fuel structure/fire behaviour.

The justification of using a different classification is predicated on the fact that the intent of classifying vegetation in the BAL determination methodology of AS 3959:2018, is to identify the most appropriate fire behaviour model equations to apply.

For example, with respect to contribution to potential fire behaviour, it is often more important to consider vegetation structure rather than canopy cover, yet canopy cover is a key classification factor applied in AS 3959:2018.

Also findings from more recent bushfire behaviour research is not yet incorporated into the current version of the Standard. Certain currently applied bushfire behaviour models within As 3959:2018 are outdated and may under or over predict radiant heat flux and flame length.

[4] **Modifying Fuel Loads:** Potential steady state maximum fuel loads at a specific site for a given vegetation classification may vary significantly (above and below) from those that are to be applied as the default values in AS 3959:2018.

The Standard only provides the single set of ecological descriptors and corresponding fuel loads that are to be applied to vegetation complexes across Australia, hence its accuracy for all situations will be questionable. The relevant authority for a jurisdiction can establish different fuel loads to be applied.

However, fuel loads for the purposes of determining expected fire behaviour have not currently been determined to the degree necessary in WA, which results in the default values both over and underestimating fuel loads for WA vegetation types. WA DFES in providing advice to decision makers, will currently not accept any assessment and subsequent variation of the default fuel loads. If any variation was to be applied in an assessment, it would need to be argued for based on appropriate evidence and the development of a merit based case to the satisfaction of the decision maker.

The one circumstance where Bushfire Prone Planning will reduce fuel loads is in the calculations associated with a short fire run in forest type vegetation – in which the developing fire will not crown. Therefore, most bark and all canopy fuels can justifiably be excluded from total fuel load.

Note [5] - Flame Temperature: The Guidelines (DPLH 2021, v1.4) Section 5.5.3.1.3 and the relevant acceptable solutions within the bushfire protection criteria, establish that the higher flame temperature of 1200 K is to be applied when determining the availability of suitable onsite sheltering options for tourism vulnerable land uses.

Note [6] – Fireline Intensity and Flame Length: These values are determined as intermediate and final outputs of the AS 3959:2018 modelling. Changing these values would not be a valid use of the methodology for a fully developed fire. However, for the circumstance of a developing fire in small patches or corridors of vegetation, there may be justification when an authoritative source is identified to provide an override value.

A2.2: FLAME TEMPERATURE

FLAME TEMPERATURE APPLIED

ESTABLISHED BY AS 3959:2018

The AS 3959:2018 radiation modelling assumes an effective flame temperature of 1090 K and that it is sustained for a 2 minute period over a fire front width of 100 m. It states that instantaneous flame temperature may peak above 1090 K (AS 3959:2018 Table B1, clause B2 and clause 1.5.17).

Existing scientific literature suggests that flame temperatures for determining flame emissive power vary greatly and the majority fall between 1000 K and 1200 K. An appropriate flame temperature is chosen from this range in accordance with the minimum level of stringency or safety required by the relevant authority having jurisdiction (AS 3959:2018, CB10.2).

ESTABLISHED BY THE GUIDELINES

The Guidelines (DPLH 2021, v1.4) Section 5.5.3.1.3 and the relevant acceptable solutions within the bushfire protection criteria, establish that the higher flame temperature of 1200 K is to be applied when determining the availability of suitable onsite sheltering options for tourism vulnerable land uses.

Relevant Site	Relevant Vegetation		Flame Temperature Applied (Kelvin)	Explanation and Justification
	Area	Class		
MEG Hydrogen Project	1	(A) Forest	**1200 K**	The requirement to apply the higher flame temperature is established by the Guidelines (refer to information above). This has been applied both for the onsite shelter building, and to allow for active defence of the site by staff or emergency services with suitable PPE.
	2	(B) Woodland		
	3	(B) Woodland		
	4	(G) Grassland		
	5	(A) Forest		
	6	(A) Forest		
	7	(B) Woodland		
	8	(G) Grassland		
	9	(G) Grassland		
	10	(G) Grassland		

A3: BAL Calculator – Copy of Input/Output Values

DETERMINING 10 kW/m² SEPARATION DISTANCES

e

FPA AUSTRALIA | FLAMESOL

Calculated December 1, 2022, 6:52 pm (MDc v.4.9)

Forest 0

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	80	Rate of spread	2.4 km/h
Vegetation classification	Forest	Flame length	19.8 m
Understorey fuel load	25 t/ha	Flame angle	63 °, 68 °, 73 °, 75 °, 77 ° & 82 °
Total fuel load	35 t/ha	Elevation of receiver	8.82 m, 9.17 m, 9.460000000000001 m, 9.56 m, 9.640000000000001 m & 9.800000000000001 m
Vegetation height	n/a	Fire intensity	43,400 kW/m
Effective slope	0 °	Transmissivity	0.843, 0.822, 0.796, 0.775, 0.764 & 0.712
Site slope	0 °	Viewfactor	0.4235, 0.3149, 0.2132, 0.144, 0.1168 & 0.0313
Flame width	100 m	Minimum distance to < 40 kW/m²	22.9 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	29.9 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	41.2 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	54.9 m
		Minimum distance to < 10 kW/m²	63.2 m

Rate of Spread - Mcarthur, 1973 & Noble et al., 1980
Flame length - NSW Rural Fire Service, 2001 & Noble et al., 1980
Elevation of receiver - Douglas & Tan, 2005
Flame angle - Douglas & Tan, 2005
Radiant heat flux - Drysdale, 1999, Sullivan et al., 2003, Douglas & Tan, 2005

Flat Forest

FPA AUSTRALIA | FLAMESOL

Calculated December 1, 2022, 6:53 pm (MDc v.4.9)

Woodland 0

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	80	Rate of spread	1.43 km/h
Vegetation classification	Woodland	Flame length	12.35 m
Understorey fuel load	15 t/ha	Flame angle	65 °, 71 °, 76 °, 79 °, 80 ° & 84 °
Total fuel load	25 t/ha	Elevation of receiver	5.6 m, 5.84 m, 5.99 m, 6.06 m, 6.08 m & 6.14 m
Vegetation height	n/a	Fire intensity	18,599 kW/m
Effective slope	0 °	Transmissivity	0.862, 0.845, 0.821, 0.797, 0.785 & 0.73
Site slope	0 °	Viewfactor	0.412, 0.3066, 0.2067, 0.14, 0.1137 & 0.0306
Flame width	100 m	Minimum distance to < 40 kW/m²	14.8 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	19.8 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	28.4 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	39.3 m
		Minimum distance to < 10 kW/m²	46.1 m

Rate of Spread - Mcarthur, 1973 & Noble et al., 1980
Flame length - NSW Rural Fire Service, 2001 & Noble et al., 1980
Elevation of receiver - Douglas & Tan, 2005
Flame angle - Douglas & Tan, 2005
Radiant heat flux - Drysdale, 1999, Sullivan et al., 2003, Douglas & Tan, 2005

Flat Woodland

FPA AUSTRALIA | FLAMESOL

Calculated December 1, 2022, 6:54 pm (MDc v.4.9)

Woodland 2

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	80	Rate of spread	1.65 km/h
Vegetation classification	Woodland	Flame length	13.74 m
Understorey fuel load	15 t/ha	Flame angle	66 °, 72 °, 77 °, 80 °, 81 ° & 86 °
Total fuel load	25 t/ha	Elevation of receiver	5.71 m, 5.78 m, 5.62 m, 5.29 m, 5.06 m & 2.93 m
Vegetation height	n/a	Fire intensity	21,352 kW/m
Effective slope	2 °	Transmissivity	0.859, 0.84, 0.8149999999999999, 0.792, 0.78 & 0.726
Site slope	2 °	Viewfactor	0.4152, 0.3079, 0.2079, 0.141, 0.1145 & 0.0307
Flame width	100 m	Minimum distance to < 40 kW/m²	16.1 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	21.6 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	30.8 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	42.3 m
		Minimum distance to < 10 kW/m²	49.4 m

Rate of Spread - Mcarthur, 1973 & Noble et al., 1980
Flame length - NSW Rural Fire Service, 2001 & Noble et al., 1980
Elevation of receiver - Douglas & Tan, 2005
Flame angle - Douglas & Tan, 2005
Radiant heat flux - Drysdale, 1999, Sullivan et al., 2003, Douglas & Tan, 2005

Downslope Woodland

FPA AUSTRALIA | FLAMESOL

Calculated December 1, 2022, 6:55 pm (MDc v.4.9)

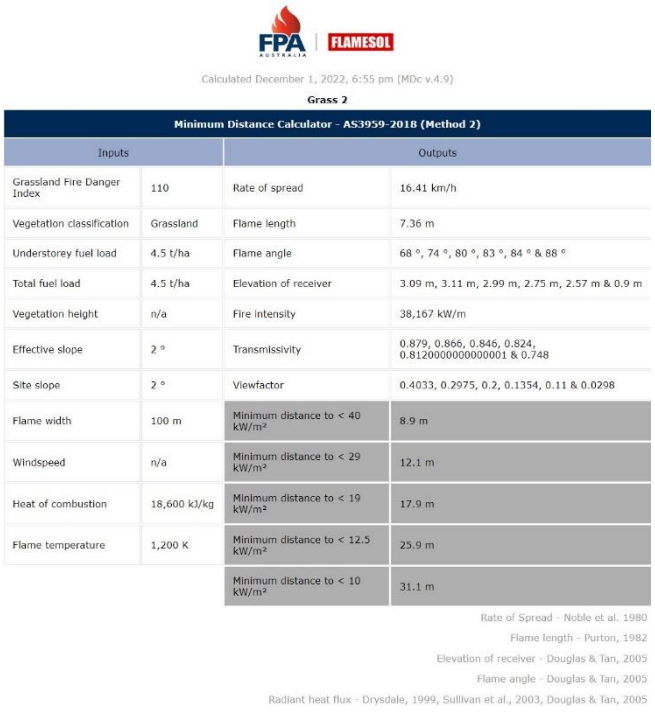
Grass 0

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Grassland Fire Danger Index	110	Rate of spread	14.3 km/h
Vegetation classification	Grassland	Flame length	6.87 m
Understorey fuel load	4.5 t/ha	Flame angle	66 °, 72 °, 78 °, 81 °, 82 ° & 86 °
Total fuel load	4.5 t/ha	Elevation of receiver	3.13 m, 3.26 m, 3.36 m, 3.39 m, 3.4 m & 3.42 m
Vegetation height	n/a	Fire intensity	33,247 kW/m
Effective slope	0 °	Transmissivity	0.881, 0.869, 0.85, 0.828, 0.8159999999999999 & 0.75
Site slope	0 °	Viewfactor	0.4037, 0.2976, 0.1994, 0.1344, 0.1096 & 0.0297
Flame width	100 m	Minimum distance to < 40 kW/m²	8.4 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	11.4 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	16.9 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	24.6 m
		Minimum distance to < 10 kW/m²	29.5 m

Rate of Spread - Noble et al. 1980
Flame length - Purton, 1982
Elevation of receiver - Douglas & Tan, 2005
Flame angle - Douglas & Tan, 2005
Radiant heat flux - Drysdale, 1999, Sullivan et al., 2003, Douglas & Tan, 2005

Flat Grassland



Calculated December 1, 2022, 6:55 pm (MDc v.4.9)

Grass 2

Minimum Distance Calculator - AS3959-2018 (Method 2)			
Inputs		Outputs	
Grassland Fire Danger Index	110	Rate of spread	16.41 km/h
Vegetation classification	Grassland	Flame length	7.36 m
Understorey fuel load	4.5 t/ha	Flame angle	68 °, 74 °, 80 °, 83 °, 84 ° & 88 °
Total fuel load	4.5 t/ha	Elevation of receiver	3.09 m, 3.11 m, 2.99 m, 2.75 m, 2.57 m & 0.9 m
Vegetation height	n/a	Fire intensity	38,167 kW/m
Effective slope	2 °	Transmissivity	0.879, 0.866, 0.846, 0.824, 0.8120000000000001 & 0.748
Site slope	2 °	Viewfactor	0.4033, 0.2975, 0.2, 0.1354, 0.11 & 0.0298
Flame width	100 m	Minimum distance to < 40 kW/m²	8.9 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	12.1 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	17.9 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	25.9 m
		Minimum distance to < 10 kW/m²	31.1 m

Rate of Spread - Noble et al. 1980
Flame length - Purton, 1982
Elevation of receiver - Douglas & Tan, 2005
Flame angle - Douglas & Tan, 2005
Radiant heat flux - Drysdale, 1999, Sullivan et al., 2003, Douglas & Tan, 2005

Downslope Grassland

APPENDIX B: ONSITE VEGETATION MANAGEMENT - THE APZ

THE ASSET PROTECTION ZONE (APZ) - DESCRIPTION

This is an area surrounding a habitable building containing either no fire fuels and/or low threat fire fuels that are managed in a minimal fuel condition. The primary objectives include:

- To ensure the building is sufficiently separated from the bushfire hazard to limit the impact of its direct attack mechanisms. That is, the dimensions of the APZ will, for most site scenarios, remove the potential for direct flame contact on the building, reduce the level of radiant heat to which the building is exposed and ensure some reduction in the level of ember attack (with the level of reduction being dependent on the vegetation types of present);
- To ensure any vegetation retained within the APZ presents low threat levels and prevents surface fire spreading to the building;
- To ensure other combustible materials that can result in consequential fire (typically ignited by embers) within both the APZ and parts of the building, are eliminated, minimised and/or appropriately located or protected. (Note: The explanatory notes in the Guidelines provide some guidance for achieving this objective and other sources are available. Research shows that consequential fire, ignited by embers, is the primary cause of building loss in past bushfire events); and
- To provide a defendable space for firefighting activities.

B1: The Dimensions and Location of the APZ to be Established and Maintained

UNDERSTANDING THE APZ PLANNING ASSESSMENT VERSUS ITS IMPLEMENTATION REQUIREMENTS

THE 'PLANNING BAL-29' APZ

It is important to understand is that the 'Planning BAL-29' APZ is not necessarily the size of the APZ that must be physically established and maintained by a landowner. It is a screening tool for making planning approval decisions.

The assessment against the Bushfire Protection Criteria is conducted for planning approval purposes. To satisfy acceptable solution 'A2.1: Asset Protection Zone', it must be demonstrated that certain minimum separation distances between the relevant building/structure and different classes of bushfire prone vegetation either exist or can be created and will remain in perpetuity.

The required minimum separation distances are those that will ensure the potential radiant heat impact on relevant existing or future buildings does not exceed 29 kW/m^2. The area of land contained within these separation distances is described as an Asset Protection Zone (APZ) and is to be comprised of non-vegetated land or low threat vegetation managed in a minimal fuel condition.

The applicable minimum separation distances will vary dependent on the vegetation types, the slope of the land they are growing on and other relevant factors specific to the site and its use.

The resulting 'Planning BAL-29' APZ dimensions may extend outside subject lot boundaries.

It is the purpose of the bushfire consultant's 'Supporting Assessment Detail', that is presented in the assessment against the acceptable solution A2.1, that will identify and justify how any offsite land within the 'Planning BAL-29 APZ (which the subject landowner has no authority or responsibility to manage), will meet the requirements of being either non-vegetated land or low threat vegetation managed in a minimal fuel condition and likely to remain in this state in perpetuity. Or otherwise, explain how this condition cannot be met.

It is the 'Planning BAL-29' APZ dimensions that will be stated in relevant tables and shown on maps as necessary in this BMP. The exceptions are the tables that are included within this appendix - when relevant to the subject lot(s) - which will present 'BAL Rating' and 'Landowner' APZ dimensions.

THE 'BAL RATING' APZ

The 'BAL Rating' APZ will ensure that the potential radiant heat exposure of the building/structure will be limited to the level that the applied construction requirements, (i.e., those corresponding to the building/structure's determined BAL rating), are designed to resist.

The minimum dimensions of the 'BAL Rating' APZ to be established and maintained will be those that correspond to the determined BAL rating for the specific building/structure. They will account for the specific conditions on and surrounding the subject lot.

The required dimensions of the 'BAL Rating' APZ establish the size of the APZ that must physically exist either entirely within a subject lot or in combination with an area of adjoining land.

If in combination with adjoining (offsite) land, it must be justified how the offsite land can most reasonably be expected to either remain unvegetated or be able to meet and maintain the APZ Standards in perpetuity, without any actions by the owner of the subject lot.

The applicable determined BAL rating will have been stated in the relevant assessment section of this BMP when it can be assessed as a 'determined' rather than 'indicative' rating. Otherwise, it will be shown on the BAL Certificate that is submitted as part of a building application.

THE 'LANDOWNER' APZ

Dimensions: The 'Landowner' APZ is to be established and maintained by the owner of the subject lot. The minimum dimensions are the 'BAL Rating' APZ dimensions except that they will be limited to the distance that they can be established within the subject lot. (Note: Any removal of native vegetation my require the approval of the relevant authority.

The remaining required separation distance outside the lot has been assessed by the bushfire consultant to be most likely to remain in a low threat state in perpetuity without any actions to be taken by the owner of the subject lot.

These minimum 'within the lot' APZ dimensions will only be greater when the relevant local government's annual firebreak / hazard reduction notice (issued under s33 of the Bushfires Act 1954), specifies the APZ dimensions to be applied within the lot and they are greater. Consequently, the 'Landowner' APZ dimensions can be a combination of the 'BAL Rating' Dimensions and the Local Government requirements. Check their annual notice for revisions to these requirements.

The dimensions of the 'Landowner' APZ establish the size of the APZ that must be established and maintained by the landowner within the subject lot.

Location: The 'Landowner' APZ for which the landowner has the responsibility to establish and maintain, is that which will exist entirely within the boundaries of the relevant lot, unless an approved formal and enforceable agreement allows them to manage a specified area of land external to the subject lot.

In most cases the landowner will only have authority and responsibility to establish and manage the APZ within the subject lot.

Otherwise, when there is a remaining part of the 'BAL Rating' APZ existing outside the subject lot, then these areas of land will, in most situations, include non-vegetated areas (e.g., roads / parking / drainage / water body), formally managed areas of vegetation (e.g., public open space / recreation areas / services installed in a common section of land) or an APZ on a neighbouring lot that is required to be established and maintained by the owner of that adjoining lot.

> *For vulnerable land uses, the 'BAL Rating' APZ and 'Landowner' APZ will also refer to the dimensions corresponding to radiant heat impact levels of 10 kW/m^2 and 2 kW/m^2 (calculated using 1200K flame temperature).*
>
> *For development applications only, the 'Landowner' APZ dimensions are also shown on the Property Bushfire Management Statement in Section 6.3.1 of this BMP when it is a required component of the Bushfire Management Plan.*

Table B1.1: The applicable 'Landowner' APZ Dimensions when the determined BAL rating (or maximum level of radiant heat i.e., kW/m^2) has been established by the BMP.

THE 'LANDOWNER' APZ DIMENSIONS TO BE ESTABLISHED AND MAINTAINED						
Relevant Buildings(s)	Indicative BAL Rating	Classified Vegetation Refer to Fig 3.1	Minimum Required Separation Distances (m) [building to vegetation]			
			The 'BAL Rating' APZ	<10kW/m2 Radiant Heat Flux	Established by the CFA Guidelines	As Directed by the Applicable 2022 Shire of Northam Firebreak Notice
Northern Solar Farm Expansion (Lot 6) And Southern Solar Farm (Lot 7)	BAL-29	Area 1	21	N/A	10	N/A
		Area 2	14	N/A	10	N/A
		Area 3	17	N/A	10	N/A
		Area 4	8	N/A	10	N/A
		Area 5	21	N/A	10	N/A
		Area 6	21	N/A	10	N/A
		Area 7	14	N/A	10	N/A
		Area 8	8	N/A	10	N/A
		Area 9	8	N/A	10	N/A
		Area 10	8	N/A	10	N/A
MEG Hydrogen Project (Lot 7)	BAL-12.5	Area 1	42	>63.2	10	20
		Area 2	29	>46.1	10	20
		Area 3	35	>49.4	10	22

		Area 4	17	>29.5	10	20
		Area 5	42	>63.2	10	20
		Area 6	42	>63.2	10	20
		Area 7	29	>46.1	10	20
		Area 8	17	>29.5	10	20
		Area 9	17	>29.5	10	20
		Area 10	17	>29.5	10	20
Comments: Multiple guiding documents and recommendations exist and may dictate the required APZ dimensions. For each relevant structure, the highest separation distance for each vegetation type is to be applied.						

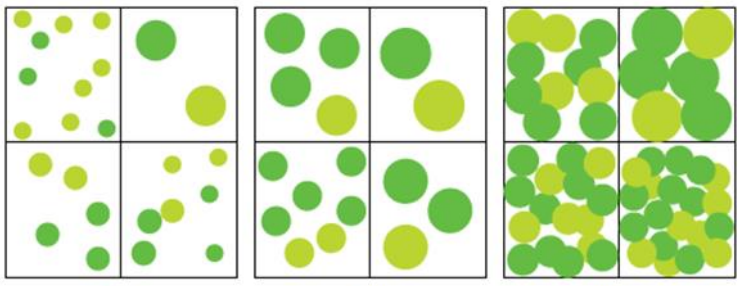
B2: The Standards for the APZ as Established by the Guidelines (DPLH, v1.4)

Within the Guidelines (source: https://www.wa.gov.au/government/document-collections/state-planning-policy-37-planning-bushfire-prone-areas), the management Standards are established by:

- Schedule 1: Standards for Asset Protection Zones (see extract below) established by the Guidelines; and
- The associated explanatory notes (Guidelines E2) that address (a) managing an asset protection zone (APZ) to a low threat state (b) landscaping and design of an asset protection zone and (c) plant flammability.

ELEMENT 2: SITING AND DESIGN OF DEVELOPMENT

SCHEDULE 1: STANDARDS FOR ASSET PROTECTION ZONES

OBJECT	REQUIREMENT
Fences within the APZ	• Should be constructed from non-combustible materials (for example, iron, brick, limestone, metal post and wire, or bushfire-resisting timber referenced in Appendix F of AS 3959).
Fine fuel load (Combustible, dead vegetation matter <6 millimetres in thickness)	• Should be managed and removed on a regular basis to maintain a low threat state. • Should be maintained at <2 tonnes per hectare (on average). • Mulches should be non-combustible such as stone, gravel or crushed mineral earth or wood mulch >6 millimetres in thickness.
Trees* (>6 metres in height)	• Trunks at maturity should be a minimum distance of six metres from all elevations of the building. • Branches at maturity should not touch or overhang a building or powerline. • Lower branches and loose bark should be removed to a height of two metres above the ground and/or surface vegetation. • Canopy cover within the APZ should be <15 per cent of the total APZ area. • Tree canopies at maturity should be at least five metres apart to avoid forming a continuous canopy. Stands of existing mature trees with interlocking canopies may be treated as an individual canopy provided that the total canopy cover within the APZ will not exceed 15 per cent and are not connected to the tree canopy outside the APZ. **Figure 19:** Tree canopy cover – ranging from 15 to 70 per cent at maturity  15% 30% 70%

Shrub* and scrub* (0.5 metres to six metres in height). Shrub and scrub >6 metres in height are to be treated as trees.	• Should not be located under trees or within three metres of buildings. • Should not be planted in clumps >5 square metres in area. • Clumps should be separated from each other and any exposed window or door by at least 10 metres.
Ground covers* (<0.5 metres in height. Ground covers >0.5 metres in height are to be treated as shrubs)	• Can be planted under trees but must be maintained to remove dead plant material, as prescribed in 'Fine fuel load' above. • Can be located within two metres of a structure, but three metres from windows or doors if >100 millimetres in height.
Grass	• Grass should be maintained at a height of 100 millimetres or less, at all times. • Wherever possible, perennial grasses should be used and well-hydrated with regular application of wetting agents and efficient irrigation.
Defendable space	• Within three metres of each wall or supporting post of a habitable building, the area is kept free from vegetation, but can include ground covers, grass and non-combustible mulches as prescribed above.
LP Gas Cylinders	• Should be located on the side of a building furthest from the likely direction of a bushfire or on the side of a building where surrounding classified vegetation is upslope, at least one metre from vulnerable parts of a building. • The pressure relief valve should point away from the house. • No flammable material within six metres from the front of the valve. • Must sit on a firm, level and non-combustible base and be secured to a solid structure.

** Plant flammability, landscaping design and maintenance should be considered – refer to explanatory notes*

B3: The Standards for the APZ as Established by the Local Government

Refer to the firebreak / hazard reduction notice issued annually (under s33 of the Bushfires Act 1954) by the relevant local government. It may state Standards that vary from those established by the Guidelines and that have been endorsed by the WAPC and DFES as per Section 4.5.3 of the Guidelines.

A copy of the applicable notice is not included here as they are subject to being reviewed and modified prior to issuing each year. Refer to ratepayers notices and/or the local government's website for the current version.

B4: Maintaining Low Threat and Non-Vegetated Areas Excluded from Classification

AS 3959 establishes the methodology for determining a bushfire attack level (BAL). The methodology includes the classification of the subject site's surrounding vegetation according to their 'type' and the application of the corresponding bushfire behaviour models to determine the BAL. Certain vegetation can be considered as low threat and excluded from classification. Where this has occurred in assessing the site, the extract from AS3959:2018 below state the requirements (including the size of the vegetation area if relevant to the assessment) for maintenance of those areas of land.

2.2.3.2 *Exclusions—Low threat vegetation and non-vegetated areas*

The following vegetation shall be excluded from a BAL assessment:

(a) Vegetation of any type that is more than 100 m from the site.

(b) Single areas of vegetation less than 1 ha in area and not within 100 m of other areas of vegetation being classified vegetation.

(c) Multiple areas of vegetation less than 0.25 ha in area and not within 20 m of the site, or each other or of other areas of vegetation being classified vegetation.

(d) Strips of vegetation less than 20 m in width (measured perpendicular to the elevation exposed to the strip of vegetation) regardless of length and not within 20 m of the site or each other, or other areas of vegetation being classified vegetation.

(e) Non-vegetated areas, that is, areas permanently cleared of vegetation, including waterways, exposed beaches, roads, footpaths, buildings and rocky outcrops.

(f) Vegetation regarded as low threat due to factors such as flammability, moisture content or fuel load. This includes grassland managed in a minimal fuel condition, mangroves and other saline wetlands, maintained lawns, golf courses (such as playing areas and fairways), maintained public reserves and parklands, sporting fields, vineyards, orchards, banana plantations, market gardens (and other non-curing crops), cultivated gardens, commercial nurseries, nature strips and windbreaks.

NOTES:

1 Minimal fuel condition means there is insufficient fuel available to significantly increase the severity of the bushfire attack (recognizable as short-cropped grass for example, to a nominal height of 100 mm).

2 A windbreak is considered a single row of trees used as a screen or to reduce the effect of wind on the leeward side of the trees.

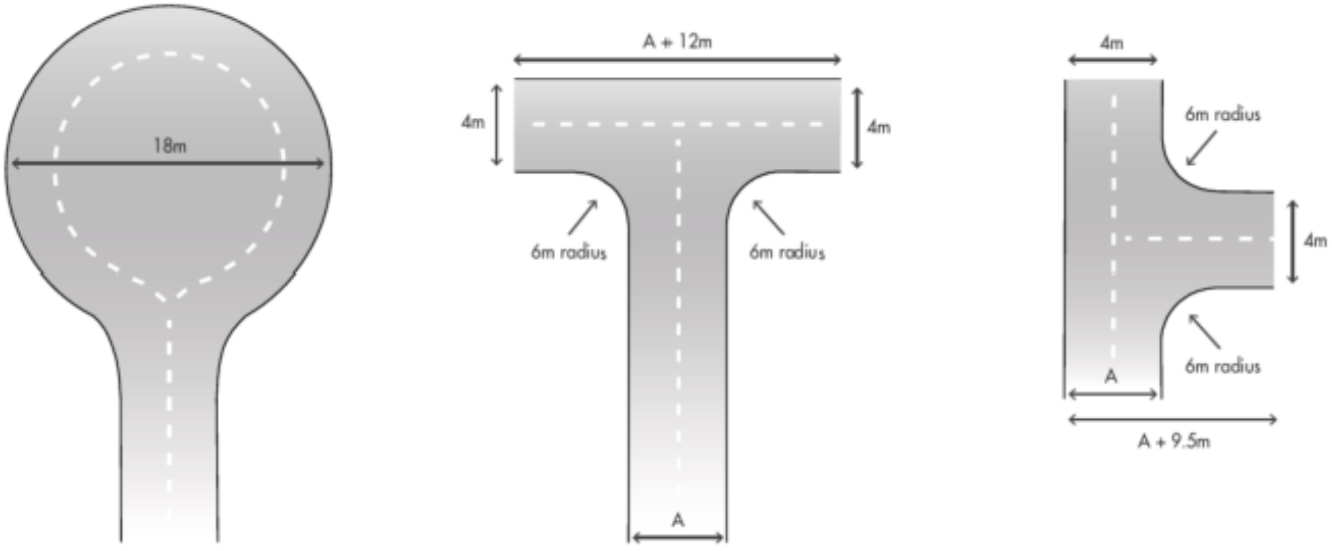
APPENDIX C: TECHNICAL REQUIREMENTS FOR VEHICULAR ACCESS

The design/layout requirements for access are established by the acceptable solutions of the Guidelines (DPLH, 2021 v1.4) Element 3 and vary dependent on the access component, the land use and the presence of 'vulnerable' persons. Consequently, the best reference source are the Guidelines. The technical requirements that are fixed for all components and uses are presented in this appendix.

GUIDELINES TABLE 6, EXPLANATORY NOTES E3.3 & E3.6 AND RELEVANT ACCEPTABLE SOLUTIONS

Technical Component	Vehicular Access Types / Components			
	Public Roads	Emergency Access Way [1]	Fire Service Access Route [1]	Battle-axe and Private Driveways [2]
Minimum trafficable surface (m)	In accordance with A3.1	6	6	4
Minimum Horizontal clearance (m)	N/A	6	6	6
Minimum Vertical clearance (m)	4.5			
Minimum weight capacity (t)	15			
Maximum Grade Unsealed Road [3]	As outlined in the IPWEA Subdivision Guidelines	1:10 (10%)		
Maximum Grade Sealed Road [3]		1:7 (14.3%)		
Maximum Average Grade Sealed Road		1:10 (10%)		
Minimum Inner Radius of Road Curves (m)		8.5		

Turnaround Area Dimensions for No-through Road, Battle-axe Legs and Private Driveways [4]



Passing Bay Requirements for Battle-axe leg and Private Driveway

When the access component length is greater than the stated maximum, passing bays are required every 200m with a minimum length of 20m and a minimum additional trafficable width of 2m (i.e. the combined trafficable width of the passing bay and constructed private driveway to be a minimum 6m).

Emergency Access Way – Additional Requirements

Provide a through connection to a public road, be no more than 500m in length, must be signposted and if gated, gates must be open the whole trafficable width and remain unlocked.

[1] To have crossfalls between 3 and 6%.

[2] Where driveways and battle-axe legs are not required to comply with the widths in A3.5 or A3.6, they are to comply with the Residential Design Codes and Development Control Policy 2.2 Residential Subdivision.

[3] Dips must have no more than a 1 in 8 (12.5% or 7.1 degree) entry and exit angle.

[4] The turnaround area should be within 30m of the main habitable building.

APPENDIX D: TECHNICAL REQUIREMENTS FOR FIREFIGHTING WATER SUPPLY

D1: Reticulated Areas – Hydrant Supply

The Guidelines state "where a reticulated water supply is existing or proposed, hydrant connection(s) should be provided in accordance with the specifications of the relevant water supply authority."

The main scheme water suppliers / authorities in WA are The Water Corporation, AqWest – Bunbury Water Corporation and Busselton Water Corporation. Various local authority exists in other non-scheme and regional areas. However, most existing fire hydrants are connected to Water Corporation water mains.

Consequently, the hydrant location specifications from The Water Corporation's 'No 63 Water Reticulation Standard' (Ver 3 Rev 15) are provided in the extract below with the key distances relevant to bushfire planning assessments being highlighted. This Standard is deemed to be the baseline criteria for developments and should be applied unless different local water supply authority conditions apply. Other applicable specification will be found in the Standard.

Note: The maximum distance from a hydrant to the rear of a lot/building is generally interpreted as not applicable to large lot sizes where the maximum distance becomes an impractical limitation i.e., typically rural residential areas.

2.2.1.5 Appurtenances

c. Hydrants

Hydrants shall be screw-down hydrant with built-in isolation valve and installed only on DN100 or larger pipes. Hydrants shall be located:

- so that the maximum distance between a hydrant and the rear of a building envelope, (or in the absence of a building envelope the rear of the lot) shall be 120m;
- so that spacing (as measured by hose-run) between hydrants in non-residential or mixed use areas shall be maximized and no greater than 100m;
- so that spacing (as measured by hose-run) between hydrants in residential areas with lots per dwelling <10,000m² shall be maximized and no greater than 200m;
- so that spacing between hydrants (as measured by hose-run) in rural residential areas where minimum lots per dwelling is >10,000 m² (1ha) shall be maximized and no greater than 400m;
- centrally along the frontage of a lot to avoid being under driveways, unless the lot features a frontage 6m or less, in which case it shall be placed to the side opposite the driveway;
- at lots that have the widest frontage in the local area;
- where appropriate at the truncation of road junctions or intersections so that they can serve more than one street and can be readily located;
- on both sides of the major roads at staggered intervals where there are mains on both sides of the road;
- at major intersections on dual multi-lane roads, where two hydrants are to be sited on diagonally opposite corners;
- hydrants should be located at least 20m from traffic calming devices i.e., median slow points or chokers, chicanes, mini traffic circles, and intersection 'pop-outs' to ensure traffic is not impeded;
- in a position not less than 10m from any high voltage main electrical distribution equipment such as transformers and distribution boards, liquefied petroleum gas or other combustible storage;
- directly on top of the main using a tee unless proved to be impractical.

D2: Non-Reticulated Areas – Static Supply

For specified requirements, refer to the Guidelines Element 4: Water – Acceptable Solution A4.2 , Explanatory Notes E4 (that provide water supply establishment detail under the headings of water supply; independent water and power supply; strategic water supplies, alternative water sources and location of water tanks) and the technical requirements established by Schedule 2 (reproduced below).

SCHEDULE 2: WATER SUPPLY DEDICATED FOR BUSHFIRE FIREFIGHTING PURPOSES

2.1 Water supply requirements

Water dedicated for firefighting should be provided in accordance with Table 7 below, and be in addition to water required for drinking purposes.

Table 7: Water supply dedicated for bushfire firefighting purposes

PLANNING APPLICATION	NON-RETICULATED AREAS
Development application	10,000L per habitable building
Structure Plan / Subdivision: Creation of 1 additional lot	10,000L per lot
Structure Plan / Subdivision: Creation of 3 to 24 lots	10,000L tank per lot **or** 50,000L strategic water tank
Structure Plan / Subdivision: Creation of 25 lots or more	50,000L per 25 lots or part thereof Provided as a strategic water tank(s) or 10,000L tank per lot

2.2 Technical requirements

2.2.1 Construction and design

An above-ground tank and associated stand should be constructed of non-combustible material. The tank may need to comply with AS/NZS 3500.1:2018.

Below ground tanks should have a 200mm diameter access hole to allow tankers or emergency service vehicles to refill direct from the tank, with the outlet location clearly marked at the surface. The tank may need to comply with AS/NZS 3500.1:2018. An inspection opening may double as the access hole provided that the inspection opening meets the requirements of AS/NZS 3500.1:2018. If the tank is required under the BCA as part of fire hydrant installation, then the tank will also need to comply with AS 2419.

Where an outlet for an emergency service vehicle is provided, then an unobstructed, hardened ground surface is to be supplied within four metres of any water supply.

2.2.2 Pipes and fittings

All above-ground, exposed water supply pipes and fittings should be metal. Fittings should be located away from the source of bushfire attack and be in accordance with the applicable section below, unless otherwise specified by the local government.

2.2.2.1 Fittings for above-ground water tanks:

- Commercial land uses: 125mm Storz fitting; or
- Strategic water tanks: 50mm or 100mm (where applicable and adapters are available) male camlock coupling with full flow valve; or
- Standalone water tanks: 50mm male camlock coupling with full flow valve; or
- Combined water tanks: 50mm male camlock coupling with full flow valve or a domestic fitting, being a standard household tap that enables an occupant to access the water supply with domestic hoses or buckets for extinguishing minor fires.

2.2.2.2 Remote outlets

In certain circumstances, it may be beneficial to have the outlet located away from the water supply. In such instances in which a remote outlet is to be used, the applicant should consult the local government and DFES on their proposal.

EXAMPLE CONSTRUCTION AND FITTINGS	
	
Strategic 47,000 Litre Concrete Tank & Protected Fittings	
	
10,000 Litre Concrete Tank	Storz and Camlock Couplings
	
Full Flow 50mm Ball Valve	Full Flow 50mm Gate Valve and Male Camlock

BUSHFIRE PRONE PLANNING

MEG Hydrogen Project
(Northam Solar Farm)

Bushfire Risk Assessment & Management Report

Produced to meet the relevant requirements of STATE PLANNING POLICY 3.7 Planning in Bushfire Prone Areas & Guidelines

Lots 6 and 7 Northam-York Road, Muluckine

Shire of Northam

1 December 2022

Job Reference No: 170545

BPP GROUP PTY LTD T/A BUSHFIRE PRONE PLANNING

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

LEVEL 1, 159-161 JAMES STREET
GUILDFORD WA 6055

PO BOX 388
GUILDFORD WA 6935

08 6477 1144 | admin@bushfireprone.com.au

DOCUMENT CONTROL

PREPARATION		
Author:	Mike Scott (BPAD Level 3 No. 27795)	
Co-Author:	Neil Stoney	

VERSION HISTORY		
Version	Details	Date
1.0	Original	1 December 2022
-	-	

Bushfire Risk Assessment Report Template v2.7

DISTRIBUTION					
Destination		Version	No. Copies	Hard Copy	Electronic Copy
Person	Email				
Mick Hutt	mhutt@igeh2.com	1.0	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

1 CONSULTANT STATEMENTS 5

2 INTRODUCTION 10

2.1 THE ASSET (DEVELOPMENT) AND/OR USE SUBJECT TO ASSESSMENT 10

2.2 THE RISK ASSESSMENT OBJECTIVES 12

2.3 THE APPLIED RISK ASSESSMENT PROCESS 14

2.3.1 THE DEFINITION OF RISK 14

2.3.2 THE ASSESSMENT PROCESS (FRAMEWORK) 14

2.3.3 RISK LEVEL ANALYSIS 15

2.3.4 USING THE ASSESSMENT PROCESS TO MEET THE STATED OBJECTIVES 16

2.3.5 BUSHFIRE PROTECTION MEASURE EFFECTIVENESS RATINGS 16

2.4 THE BUSHFIRE HAZARD - BEHAVIOUR AND ATTACK MECHANISMS 18

2.5 OUTLINE OF REPORT CONSTRUCTION 19

3 ASSESSMENT SUMMARY 20

3.1 THE ASSESSED THREAT, EXPOSURE AND VULNERABILITY LEVELS ESTABLISHING THE RISK LEVEL 20

3.2 THE ASSESSED RISK LEVEL ASSOCIATED WITH A BUSHFIRE EVENT AND ITS TOLERABILITY 22

3.2.1 ADJUSTMENT OF RESIDUAL RISK TOLERABILITY ..... **Error! Bookmark not defined.**

3.3 BUSHFIRE PROTECTION MEASURE APPLICATION & IMPLEMENTATION SUMMARY 24

3.3.1 THREAT (BUSHFIRE HAZARD) REDUCING PROTECTION MEASURES 25

3.3.2 EXPOSURE REDUCING PROTECTION MEASURES - PERSONS 26

3.3.3 VULNERABILITY REDUCING PROTECTION MEASURES - PERSONS 28

3.3.4 EXPOSURE REDUCING PROTECTION MEASURES – BUILDINGS / OTHER STRUCTURES/ INFRASTRUCTURE 30

3.3.5 VULNERABILITY REDUCING PROTECTION MEASURES – BUILDINGS / OTHER STRUCTURES / INFRASTRUCTURE 31

4 IDENTIFICATION OF THE ELEMENTS AT RISK 33

5 IDENTIFICATION OF THE BUSHFIRE HAZARD 35

5.1 ONSITE BUSHFIRE PRONE VEGETATION 36

5.2 OFFSITE BUSHFIRE PRONE VEGETATION 39

5.3 THE BROADER LANDSCAPE/ENVIRONMENT AND ITS POTENTIAL TO INTENSIFY FIRE BEHAVIOUR 40

5.4 ASSESSMENT OF VEGETATION CHARACTERISTICS DRIVING BUSHFIRE ATTACK MECHANISM THREAT LEVELS 43

5.5 THE MODELLED BUSHFIRE - POTENTIAL RADIANT HEAT TRANSFER AND FLAME LENGTH 46

6 BUSHFIRE HAZARD THREAT LEVELS ASSESSMENT 47

6.1 PROTECTION MEASURES AVAILABLE TO REDUCE BUSHFIRE THREAT LEVELS AND THEIR APPLICATION STATUS 47

6.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES 52

6.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (THREAT REDUCTION) 53

6.4 ASSESSED HAZARD THREAT LEVELS 53

7 EXPOSURE LEVEL ASSESSMENT OF THE ELEMENTS AT RISK 54

7.1 PERSONS ONSITE OR TEMPORARILY OFFSITE 54

7.1.1 PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS AND THEIR APPLICATION STATUS 54

7.1.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES 59
7.1.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (EXPOSURE REDUCTION) 60
7.1.4 ASSESSED EXPOSURE LEVELS 60
7.2 PERSONS ON ACCESS/EGRESS ROUTES IN VEHICLES 61
7.2.1 PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS AND THEIR APPLICATION STATUS 61
7.2.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES 64
7.2.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (EXPOSURE REDUCTION) 65
7.2.4 ASSESSED EXPOSURE LEVELS 65
7.3 BUILDINGS AND STRUCTURES NCC CLASSES 1-10 (ELEMENT AT RISK CATEGORIES 3-10) 66
7.3.1 PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS AND THEIR APPLICATION STATUS 66
7.3.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES 72
7.3.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (EXPOSURE REDUCTION) 73
7.3.4 ASSESSED EXPOSURE LEVELS 73
7.4 FIXED (HARD) INFRASTRUCTURE ASSETS: SOLAR ARRAYS 74
7.4.1 PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS AND THEIR APPLICATION STATUS 74
7.4.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES 80
7.4.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (EXPOSURE REDUCTION) 81
7.4.4 ASSESSED EXPOSURE LEVELS 81
7.5 FIXED (HARD) INFRASTRUCTURE ASSETS: HYDROGEN ELECROLYSERS, TRANSPORT, AND STORAGE 82
7.5.1 PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS AND THEIR APPLICATION STATUS 82
7.5.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES 90
7.5.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (EXPOSURE REDUCTION) 91
7.5.4 ASSESSED EXPOSURE LEVELS 91
8 VULNERABILITY LEVEL ASSESSMENT OF THE ELEMENTS AT RISK 92
8.1 PERSONS ONSITE OR TEMPORARILY OFFSITE 92
8.1.1 PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS AND THEIR APPLICATION STATUS 92
8.1.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES 98
8.1.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (VULNERABILITY REDUCTION) 99
8.1.4 ASSESSED VULNERABILITY LEVELS 99
8.2 PERSONS ON ACCESS/EGRESS ROUTES (IN VEHICLES) OR PATHWAYS 100
8.2.1 PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS AND THEIR APPLICATION STATUS 100
8.2.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES 103
8.2.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (VULNERABILITY REDUCTION) 104
8.2.4 ASSESSED VULNERABILITY LEVELS 104
8.3 BUILDINGS AND STRUCTURES NCC CLASSES 1-10 (ELEMENT AT RISK CATEGORIES 3-10) 105
8.3.1 PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS AND THEIR APPLICATION STATUS 105
8.3.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES 114
8.3.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (VULNERABILITY REDUCTION) 115

8.3.4 ASSESSED VULNERABILITY LEVELS 115
8.4 FIXED (HARD) INFRASTRUCTURE ASSETS: SOLAR ARRAYS 116
8.4.1 PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS AND THEIR APPLICATION STATUS 116
8.4.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES 124
8.4.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (VULNERABILITY REDUCTION) 125
8.4.4 ASSESSED VULNERABILITY LEVELS 125
8.5 FIXED (HARD) INFRASTRUCTURE ASSETS: HYDROGEN ELECROLYSERS, TRANSPORT, AND STORAGE 126
8.5.1 PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS AND THEIR APPLICATION STATUS 126
8.5.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES 134
8.5.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (VULNERABILITY REDUCTION) 135
8.5.4 ASSESSED VULNERABILITY LEVELS 135
APPENDIX 1: RATIONALE FOR THE SELECTION OF THE APPLIED RISK ASSESSMENT PROCESS 136
APPENDIX 2: RISK LEVEL ANALYSIS – ADDITIONAL EXPLANATION 138
APPENDIX 3: THE ALARP PRINCIPLE AND THE RISK TOLERANCE SCALE APPLIED 141
APPENDIX 4: THE BUSHFIRE HAZARD – BEHAVIOUR AND ATTACK MECHANISMS 145
APPENDIX 5: THE BROADER LANDSCAPE AND EXTREME BUSHFIRE EVENTS 149
APPENDIX 6: HAZARD REDUCTION BURNING – ADDITIONAL INFORMATION 153
1. SIGNIFICANT AREAS (LARGER) AREAS OF BUSHFIRE PRONE VEGETATION 153
2. THE BROADER LANDSCAPE 154
APPENDIX 7: BUSHFIRE ATTACK LEVELS AND BAL CONTOUR MAPS EXPLAINED 156
ADDENDUM 1 157
1. ADDENDUM SUB-HEADING 157
GLOSSARY 158
BIBLIOGRAPHY 167

List of Figures

Figure 2.1: Site diagram 11
Figure 2.2: Understanding disaster risk (Source: United Nations Office for Disaster Risk Reduction [46]) 14
Figure 2.3: Framework of the applied risk assessment process. 15
Figure 5.1: Onsite classified vegetation and topography map 38

1 CONSULTANT STATEMENTS

The intent of this section of the port is to assist those tasked with reading this report and making decisions by providing a subjective summary of the assessment outcomes and/or clarify the reported outcomes.

Importantly, the summary and its statements draw on the relevant practical experience of the bushfire practitioner compiling or approving this report, that has been derived from planning and managing bushfire events.

In the absence of the required set of risk factor criteria, risk level matrix and risk tolerability scale being established by the regulatory authorities to enable the derivation of a 'determined' risk level - this statement will necessarily be framed around the applied assessment process that derives an 'indicative risk' level (refer to section 2.3.4 and Appendix 2).

RECOMENDATIONS AND REQUIREMENTS

The following are the recommended or required treatments which have been established through the risk assessment process.

Design and Construction Recommendations

The Site Office building is to be designated as an Onsite Shelter. The building is required to be built to the bushfire construction requirements corresponding to BAL-29 (as per AS 3959 or the NASH Standard) as a minimum.

The <10kW/m2 radiant heat flux APZ applied to the Hydrogen Project exceeds the 12kW/m2 critical threshold of common electrical cabling. Cabling and plumbing beyond the facility footprint are recommended to be installed underground, or shielded with non-combustible material (or enclosed) where practical.

Cabling associated with solar arrays are recommended to be installed underground, or shielded with non-combustible material (or enclosed) where practical.

It is recommended non-combustible elements are included in structure design/construction where practical.

Where a Class 1-10 building is enclosed, it is recommended that the structure applies ember screening to openings to roof, wall, or internal cavities. Screening should have an aperture of <2mm and be corrosion-resistant steel, bronze, or aluminium.

Where installed, sprinkler systems are recommended to be automatically activated.

It is recommended that hydrant boosters and other firefighting systems as appropriate, are supported by generators to ensure continued operation.

Internal access to the MEG Hydrogen Project (not the solar farms) is required to have a minimum 6m trafficable surface to ensure access/egress is available for both staff and responders.

At the detailed design stage, it is recommended that designs are investigated for:

- Roof/building complexities which may trap debris or collect embers
- Cabling/piping contacting the ground or any arrangement of associated structures creating a 'pocket' for accumulation of debris.

These complexities are recommended to be removed, enclosed, or filled with non-combustible material (such as mineral earth) where practical. Consideration should be given to making the arrangement self-cleaning through wind action to the greatest extent possible. Functionally this means preventing details which may accumulate leaf litter which will not naturally be cleared by wind.

The *Guidelines for Planning in Bushfire Prone Areas* does not establish a firefighting water supply for non-habitable buildings, including high-risk uses. In the absence of specific requirements at the national or state level for Hydrogen production facilities, a conservative approach is applied in the firefighting water supply for the determination of the appropriate water supply. The facility will achieve simultaneous compliance with multiple sets of guidelines or standards, by applying the most stringent of the components of each.

- The *Design Guidelines and Model Requirements – Renewable Energy Facilities* (Victorian Country Fire Authority March 2022) discusses multiple renewable energy types but not Hydrogen. The most stringent water requirements are for Battery Energy Storage Systems, and this will be applied.
- The *Guidelines for Planning in Bushfire Prone Areas v1.4* (WAPC 2021) is prescriptive on access to the water supply and couplings to be installed.
- *AS2419-2005: Fire Hydrant Installations* provides the appropriate water volume for the facility, water pressure, and number of hydrants.
- *DFES Operational Requirement Guideline 5: Hydrants and Hose Length* (DFES April 2020) recommends a 60m hose lay rather than the 60m+10m stream in AS2419.

A separate brief is provided as an Addendum within the associated BMP, outlining the combined water specifications for the facility.

Fire hose reels will be installed throughout the site (final locations to be determined in detailed engineering phase). At a minimum, **two** fire hose reels must be installed within 60m of all areas for storage or processing of high-risk storage or processing areas (not the solar arrays).

Asset Protection Zones

Solar arrays are required to install a BAL-29 dimensioned APZ, and additionally a minimum APZ of 10 metres.

All constructed assets and Class 1-10 of the Hydrogen Project are required to install an APZ which will limit radiant heat flux exposure to<10kW/m2 (calculated at 1200K). In terms of AS3959 this is within BAL-12.5. The reasoning for this APZ, is it exceeds planning requirements, far exceeds the thresholds of all assets onsite, and allows for suitably protected Emergency Services personnel (or site personnel with suitable training and PPE) to actively defend the site during the passage of a fire front. These persons can combat consequential fires or provide external cooling to assets if necessary.

A visual buffer is intended to be planted between the Hydrogen Project and Northam-York Road. The species of tree will be determined by the Shire of Northam. A shortlist of tree species from the Shire of Northam tree list, has been provided.

The trunk of any planted tree must be located >1.5 the mature height of that tree from buildings or other constructed vital assets. For example, Eucalyptus melliodora has a typical maximum height of 30m, and must thus be planted >45m from buildings and constructed vital assets. It is therefore practical that shorter species are selected.

It is recommended that any security fences or other potential fuel loads will be constructed using non-combustible material. Landscaping (gardens) which may be included within the APZ should avoid use of constructed heavy fuels (e.g. timber sleepers as garden edges, plastic or timber lattice).

Details/Requirements for Future Operational Documents (Operating Procedures and Emergency Plans)

Bushfire awareness training is recommended for full-time staff.

It is recommended that the siting of high-risk components (hydrogen storage, electrolysers, and trucks) within the facility layout, is separated from any consequential hazard where practical. The separation distance should be either 6m, or 3 times the total height of the consequential fire hazard, whichever is greater. Consequential hazards include rubbish bins, fuel jerry cans, cardboard boxes, and any object composed of plastic or wood.

Measures including preparation, responses, and training (including designation of roles such as Fire Wardens) for bushfire events are required to be included in the future site Emergency Management Plan (document title pending).

Staff and contractors working within the solar arrays are required to be contactable by the Hydrogen Project administration (via mobile/satellite phone, two-way radio etc).

Future site Operating Procedures or Emergency Management Plan (document titles pending) identify which (if any) operations are to cease where a bushfire is identified within 10km. The operations identified should be those susceptible to ember attack.

Operating and maintenance procedures are to be developed to ensure regular maintenance of firefighting equipment and clearing of accumulated debris and other consequential fire hazards.

It is required that the Toodyay State Emergency Service and Northam Volunteer Fire and Rescue Service is invited to inspect and familiarise with the site. Provide information in site fire response procedures. This invitation is to be extended after completion of construction and before commissioning. Additional invitations are recommended, which may be annual or ad-hoc as appropriate.

A manifest is to be provided and made available at site entry, detailing site fire response procedures and hazards.

CONDUCTING THE ASSESSMENT

A site assessment was conducted to analyse the location and identify:

- The vegetation and potential impact on the proposed infrastructure; and
- Topography in relation to potential fire behaviour.

THE PRIMARY RISK AND ITS ASSESSMENT

The proposed High-Risk Land Use must consider the dual risk of:

- an independent bushfire event causing damage, failure, or loss of the facility, and;
- site operations, accident, or failure causing a bushfire event.

Rather than assess the likelihood of failure/damage causing ignition of a high-risk asset (not due to bushfire), this potential ignition is **assumed** for the purposes of this assessment. This assumption allows this potential for ignition to be dealt with by the appropriate persons (manufacturers or designers), whilst the potential for such a fire to ignite a bushfire can be considered by bushfire practitioners. The factors considered in assessing the hazard posed by such onsite fires are:

- The separation of ignition sources (storage and processing areas of combustible materials) from bushfire prone vegetation;
- Presence of combustible material around ignition sources to spread fire;
- Fuel types within the facility and the APZ which may generate embers;
- Shielding of potential fire locations to either contain the fire, or eliminate flame protrusion and reduce radiated heat flux;
- Capacity for fire to spread between combustible materials onsite, including specific heat capacity, separation between hazards, and fire attack vectors (flame, radiant heat, ember, explosion);
- Automatic detection, shutdown, and/or suppression to prevent fire spread;
- The capacity for staff to contain any onsite ignition, including training, communication, firefighting utilities and water supply;

- Ensuring appropriate responses of staff or emergency services are possible and that access and water supply is available;
- Availability of emergency services.

The primary risk being considered in this report is the potential for hydrogen electrolysers, storage, or transport, to be structurally compromised and/or ignite during a bushfire event.

The assessment of the level of risk that applies to the facility (both inherent and residual), is a function of the threat levels presented by the bushfire prone vegetation and the exposure and vulnerability of the facility to these threats.

The factors considered in assessing the bushfire hazard threat levels includes:

- The types of vegetation adjacent to the development area in terms of its structure, species assemblage (including flammability and firebrand generation), arrangement, quantity, and potential future condition;
- The potential for accumulation of debris around the structures and components as a potential source of consequential fire;
- The potential level of radiant heat that can be emitted by a fire in the vegetation;
- Potential flame lengths and flame residence time which influences time the structures and components will be subject to the maximum radiant heat levels; and
- The potential for application of protection measures to reduce threat levels.

The factors considered in assessing the exposure of the structures and components to bushfire threats includes:

- The separation distance between the vegetation and the structures/storage and associated components;
- The potential for application of additional separation and/or shielding protection measures to reduce exposure.

The factors considered in assessing the vulnerability of the structures and components to bushfire threats includes:

- The type of structural materials and manufacturing applied to the relevant components;
- The temperature or heat flux at which the structural and operational integrity of relevant components are likely to be compromised (e.g. critical point);
- The existence of constructed consequential fire fuels and their capacity to be compromised (specific heat capacity);
- The potential for application of protection measures to reduce vulnerability.

This risk assessment assumes that for a major fire event within the hydrogen electrolysers, storage, or transport, there is no appropriate setback from bushfire prone vegetation. The event where bushfire prone vegetation is ignited is an extreme (potentially catastrophic) onsite scenario. A fireball due to onsite explosion could reach up to 100m, with flaming debris potentially reaching much greater distances. There is no appropriate Asset Protection Zone or shielding (barrier) to mitigate the consequence of a catastrophic event.

The only appropriate mitigation measure in preventing ignition of bushfire prone vegetation due to onsite events, is to prevent the onsite event from occurring. This is stringently addressed through project design and procedures.

THE OUTCOME OF THE ASSESSMENT

The inherent risk level (i.e., the current risk after accounting for existing and any 'planned' protection measures), to the proposed MEG Hydrogen Project and Northam Solar Farm expansion from a bushfire event in adjacent vegetation is **HIGH** for high-risk production/storage, **MODERATE** for solar arrays and structures, and **LOW** for persons either onsite or accessing/egressing.

The tolerability rating of the inherent risk level is determined as **INTOLERABLE** for high-risk components and either **TOLERABLE** or **ACCEPTABLE** for all other elements at risk, however it is not 'as low as reasonably practical'. With due consideration of acceptability, practicality and cost, the risk can be lowered by the application of the recommended protection measures.

The residual risk level (i.e., risk which remains after the application of protection measures that are additional to those that already exist or are 'planned') is **VERY LOW** for persons onsite, and **LOW** for all other elements at risk**.**

The tolerability rating of all residual risk levels is determined as **ACCEPTABLE** because they are 'as low as reasonably practical'.

2 INTRODUCTION

2.1 THE ASSET (DEVELOPMENT) AND/OR USE SUBJECT TO ASSESSMENT

The proposed development includes two components across Lots 6 and 7 Northam-York Road, Muluckine, approximately 1km east of the Northam townsite. The subject lots and neighbouring lots are largely cleared of native vegetation excepting fragmented pockets of remnant or replanted woodland. The dominant vegetation type is grassland, being either grazing pasture or sown crops (wheat).

Lot 6 contains the existing Northam Solar Farm development. The solar farm is proposed to be expanded, which will may adjoin the perimeter of the existing arrays on Lot 6, and/or a new development on Lot 7 to the south >250m from the existing solar farm. Both locations are considered.

The MEG Hydrogen Project is proposed on Lot 7, which will produce green hydrogen through electrolysis. Stage 1 of the facility will include a total of 10MW of electrolysers. The layout of a potential Stage 2 expansion is not currently known. The Risk Assessment and Treatments within this report are applicable to both Stage 1 and the potential Stage 2 of the facility. The MEG Hydrogen Project includes hydrogen electrolysers, storage bullets, and trucks for transport, which are considered the high-risk components of the site.

Figure 2.1: Site diagram

2.2 THE RISK ASSESSMENT OBJECTIVES

Establishing the objectives directs the way the assessment process is conducted, and the type of information reported. Relevant objectives are typically determined by the applicability of one or more of the following three key factors:

1. The type of proposed or existing development. This can include:
    a) Construction or modification of buildings, structures and infrastructure assets; or
    b) Subdivision of land.
2. The type of proposed or ongoing land use. This can include:
    a) Those defined as industrial, commercial or residential; and
    b) Including those that have a planning classification of 'high risk' or 'vulnerable' - including tourism and event uses.
3. The relevant stage of planning. This can include but is not limited to:
    a) An existing development and/or use for which an assessment of the necessity for and the potential to improve bushfire resilience is conducted and the consequent lowering of the associated risks identified.
    b) At the strategic planning stage of new development/use when final details of the proposed development/use are not fully known and therefore relevant protection measures can potentially be identified and incorporated into design.
    c) At the final planning stage that requires approval or a 'decision to proceed'. All relevant details of the proposed development/use are known. The requirement at this stage is to inform decision makers by providing an assessment of the residual bushfire risk.

The primary objectives for the subject development and/or use are collated as a summary in Table 2.1.

Table 2.1: Identifying the risk assessment objectives for the subject development/use.

RISK ASSESSMENT OBJECTIVES - INFORMATION TO BE DERIVED
Identify: The types of bushfire prone vegetation (considering factors that include components, arrangement and fuel loads), that exist onsite and offsite. Initially this may be limited to a desktop assessment with ground truthing to follow at a later date.
Determine: The relative threat levels each bushfire hazard attack mechanism (direct and indirect) presents. Determine if the broader physical landscape surrounding the subject development/use has the potential to increase or decrease the levels of those threats.
Identify: All at risk physical elements that are exposed to the potential threats of the bushfire hazard.
Identify: Assets that owners/operators are prepared to lose from consequential fire resulting from a bushfire event, rather than apply sufficient protection measures i.e., the asset loss risk is to be retained. This may be due to cost or practicability. Consideration the consequent risk from asset abandonment and the availability of person risk mitigation measures.
Identify: All at risk human elements that are exposed to the potential threats of the bushfire hazard.
Identify: All at risk commercial / private large livestock elements that are exposed to the potential threats of the bushfire hazard and whose care represents a potential exposure and vulnerability setting for person elements.
Identify: Bushfire protection measures that have or can be applied to reduce bushfire hazard threat levels to the greatest extent allowable and practicable.

RISK ASSESSMENT OBJECTIVES - INFORMATION TO BE DERIVED
Identify: Bushfire protection measures that have or can be applied to reduce the exposure and vulnerability of buildings/structures, infrastructure and other physical assets, to the potential threats of the bushfire hazard. The intent being to increase asset resilience to the threats to the greatest extent practicable.
Identify: Bushfire protection measures that have or can be applied to reduce the exposure and vulnerability of persons to the potential threats of the bushfire hazard to the greatest extent practicable.
Applicable to New Development and/or Use: Inform relevant persons (planners / designers / operators / owners), at the appropriate planning stage, of available bushfire protection measures to be incorporated into siting, design, construction, education and management, to optimise bushfire performance. Identify site specific protection measures, from the defined sets of bushfire protection measure principles, that have the potential to be applied as a package of protection measures. The intent is to achieve at least a tolerable level of risk to persons and property by ensuring that: • Buildings, structures and other physical assets are resilient against bushfire hazard threats, to the greatest extent practicable. • Persons have their exposure and vulnerability to bushfire hazard threats reduced, to the greatest extent practicable. Provide implementation advice as necessary.
Assess: The indicative residual risk levels to inform planners / designers / operators / owners and/or relevant decision makers. This is to be achieved through the application of the following information that has been established by the bushfire consultant: • The process for determining relative threat, exposure and vulnerability levels; • the indicative risk matrix; and • the risk tolerance scale. (Refer to Section 2.3.4, Appendix 2 and the glossary for additional information).
Assess: The determined residual risk levels to inform planners / designers / operators / owners and/or relevant decision makers. This is to be achieved through the application of the following information that has been established by the relevant authorities: • threat, exposure and vulnerability level criteria; • a determined risk level matrix; and • a risk tolerance scale. (Refer to Section 2.3.4, Appendix 2 and the glossary for additional information).

2.3 THE APPLIED RISK ASSESSMENT PROCESS

2.3.1 THE DEFINITION OF RISK

For the applied risk assessment process, the relevant risks are the potential for loss of life, injury, or destroyed or damaged assets which results in personal loss and economic loss due to disruption of services and/or repair or replacement of buildings and infrastructure. The source of the risk is the bushfire as a natural hazard.

2.3.2 THE ASSESSMENT PROCESS (FRAMEWORK)

To conduct and report the risk assessment process, Bushfire Prone Planning has adapted the understanding of disaster risk as described by the United Nations Office for Disaster Risk Reduction (UNDRR) and shown in Figure 2.2.

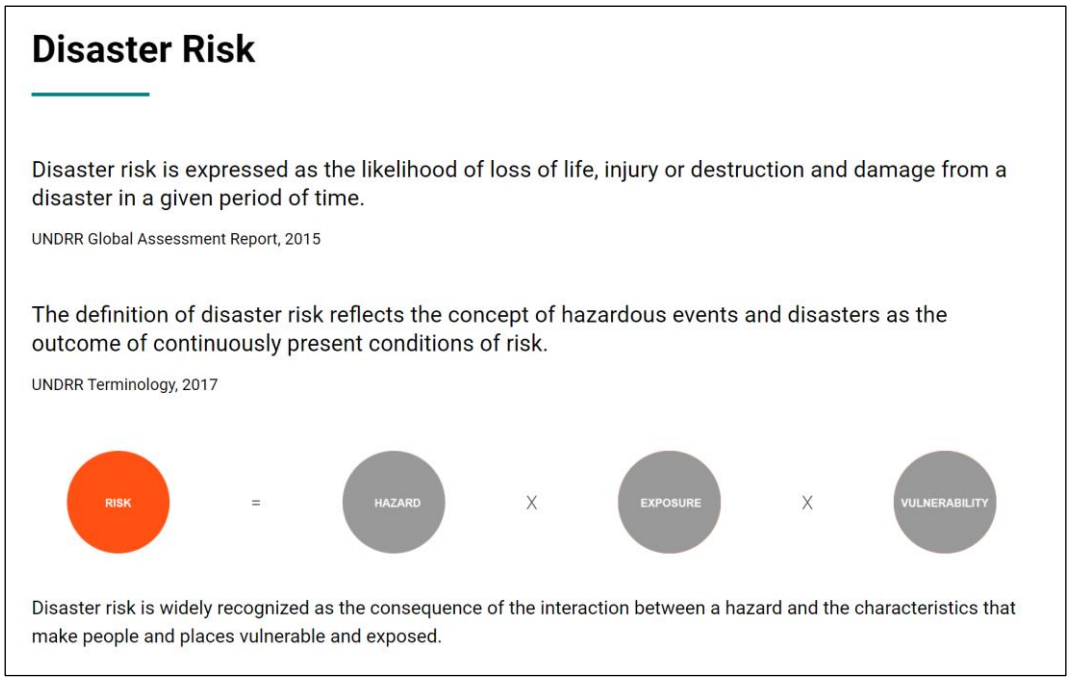


Figure 2.2: Understanding disaster risk (Source: United Nations Office for Disaster Risk Reduction [46]).

Although the UNDRR approach is designed to addresses disaster risk at large scale strategic levels, it can justifiably be applied to all scales of planning because it is focused on natural hazards and establishes a concept that can be readily adapted. The rationale for adopting this approach, rather than the methodology established by the National Emergency Risk Assessment Guidelines (AIDR 2020, NERAG), is provided in Appendix 1.

Also utilised within this assessment approach are relevant principles and measures to be applied in the development of bushfire risk mitigation strategies that are detailed in the Bushfire Verification Method Handbook [14].

PROCESS OVERVIEW

The risk presented by a natural hazard (such as a bushfire) is a consequence of the interaction between the potential threats associated with the hazard and the exposure and vulnerability of any elements at risk from those threats (the 'exposed elements').

The application of available protection measures will lower the risk by:

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

Figure 2.3 illustrates the framework of the adapted risk assessment process (refer to the glossary for terminology information and Appendix 2 provides greater detail of the risk analysis component of the assessment process).

THE FRAMEWORK OF BUSHFIRE PRONE PLANNING'S APPLIED RISK ASSESSMENT PROCESS

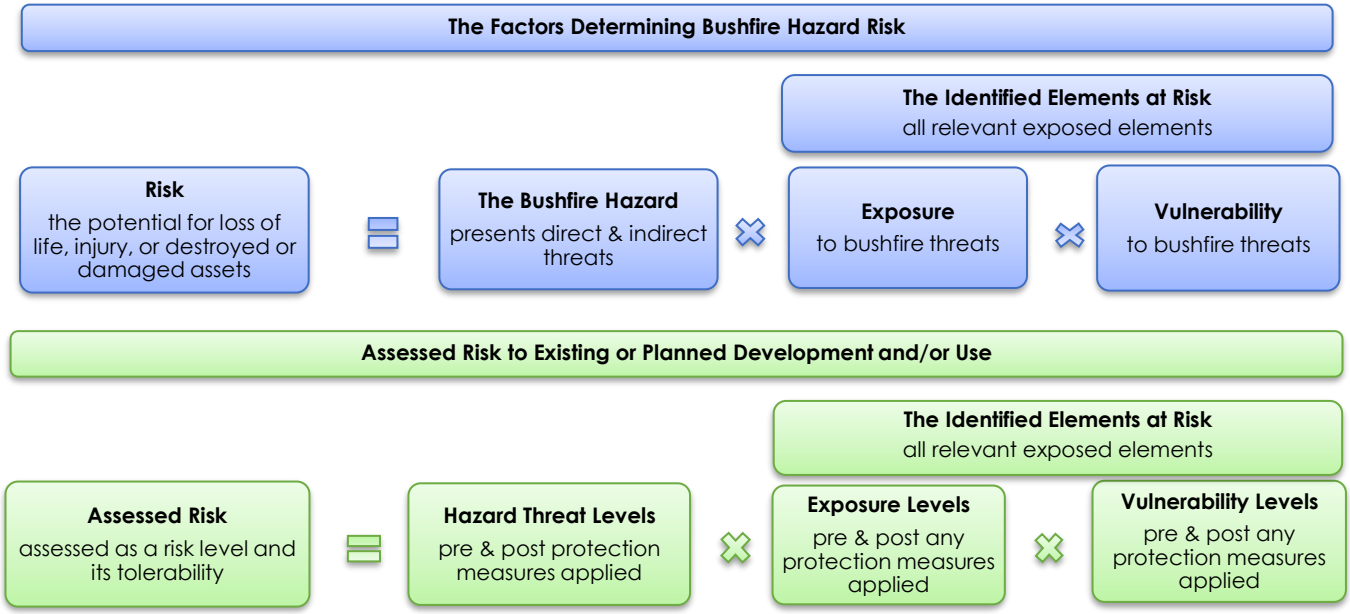


Figure 2.3: Framework of the applied risk assessment process.

2.3.3 RISK LEVEL ANALYSIS

(Refer to Appendix 2 and 3 and the Glossary for additional information.)

When the derivation of risk levels is a stated assessment objective, the risk analysis will derive a risk level as a summary outcome. The required risk level analysis can be conducted for either each exposed element separately and/or the proposed or existing development/use overall.

The risk level can be reported as either indicative or determined:

- **Indicative Risk Level**: This is derived based on a comparison of the numbers of protection measures able to be applied with the number of possible measures in the protection measure 'universe'. Appropriate weighting is given to the level of effectiveness of each of the measures. The intent is to provide a qualitative understanding of the level of risk that exists, to assist with making the required decisions.
- **Determined Risk Level**: This is derived using defined sets of risk factor criteria that correspond to each hazard threat level, exposure level and vulnerability level, for the elements at risk. Subsequently, how these defined levels are then applied to establish a determined risk level and its tolerability, is defined by an accepted risk level matrix and risk tolerance scale.

  The risk factor criteria must reflect societies preparedness to tolerate risk and should be determined by regulatory authorities exercising their responsibilities. The criteria will vary dependent on development/use type and scale.

  Consequently, the risk factor criteria (and potentially the risk level matrix and risk tolerance scale) need to be defined by the regulatory authorities before they can be applied in assessing a determined risk level.

Dependent on the stage of development/use, or to meet differing assessment objectives, the risk level can also be reported as:

- **Inherent Risk:** As the current risk when the assessment has only accounted for the bushfire protection measures that are either already in place (for existing development/use), or are planned to be incorporated into the proposed development/use; or
- **Residual Risk:** As the remaining risk when the assessment has also accounted for the application of any additional protection measures recommended by this report. If there are none, the residual risk is the same as the inherent risk.

2.3.4 USING THE ASSESSMENT PROCESS TO MEET THE STATED OBJECTIVES

The reporting objectives (established in Section 2.2) will vary for different types and stages of proposed (or existing) development/use. However, the same base framework is able to be utilised and the process can be adapted to achieve the required outcomes.

Figure 2.4 provides further detail of the adopted assessment process, based on the framework shown in Figure 2.3.

2.3.5 BUSHFIRE PROTECTION MEASURE EFFECTIVENESS RATINGS

The following effectiveness ratings (refer to Table 2.2)are applied to the applicable bushfire protection measures, as part of the risk assessment process, and as a factor applied in deriving 'relative' threat, exposure and vulnerability levels.

The more effective a bushfire protection measure is, the greater its value in increasing bushfire resilience (buildings/structures), and/or increasing the safety of persons and in decreasing the level of risk associated with bushfire.

The effectiveness ratings incorporate the qualities of:

1. **Independence:** As a qualitative assessment of the extent to which the protection measure has the capacity to reduce threat, exposure and vulnerability levels as a standalone measure as opposed to requiring the cumulative capacity of additional protection measures (an additional one or more as a package); and
2. **Passiveness:** The capacity of protection measures to function without the active involvement of persons.

The rating assumes that the greater the independence and passiveness of a protection measure, the greater is its effectiveness.

Table 2.2: Bushfire protection measure effectiveness ratings.

THE APPLIED BUSHFIRE PROTECTION MEASURE EFFECTIVENESS RATINGS	
Rating / Descriptor	Protective Characteristics and Capability
Very High (Independent and Passive)	Very significant risk reduction as an independent (standalone) measure. Impact on risk reduction is immediate and persistent in all scenarios. Operates passively with no or minimal requirement for ongoing implementation, management and maintenance. A priority measure to be implemented wherever possible.
High (Independent and Passive)	Material risk reduction as an independent (standalone)measure; Operates passively with none or minimal requirement for ongoing implementation, management and maintenance.
Effective (Independent and Active)	Material risk reduction as an independent (standalone) measure; Effectiveness relies on active implementation, management, maintenance and/or response.
Moderate (Dependant and Passive or Active)	Alone the measure will have limited impact on risk reduction. It has additive value when combined with other protection measures to create a 'package' of bushfire protection measures. Effectiveness is achieved both passively and/or with active implementation, management, maintenance and/or response.
Not Relevant	The measure is not relevant to the type of development/use. (Note: this is different to not being able to be applied – it is just not relevant to any configuration of the subject development/use).

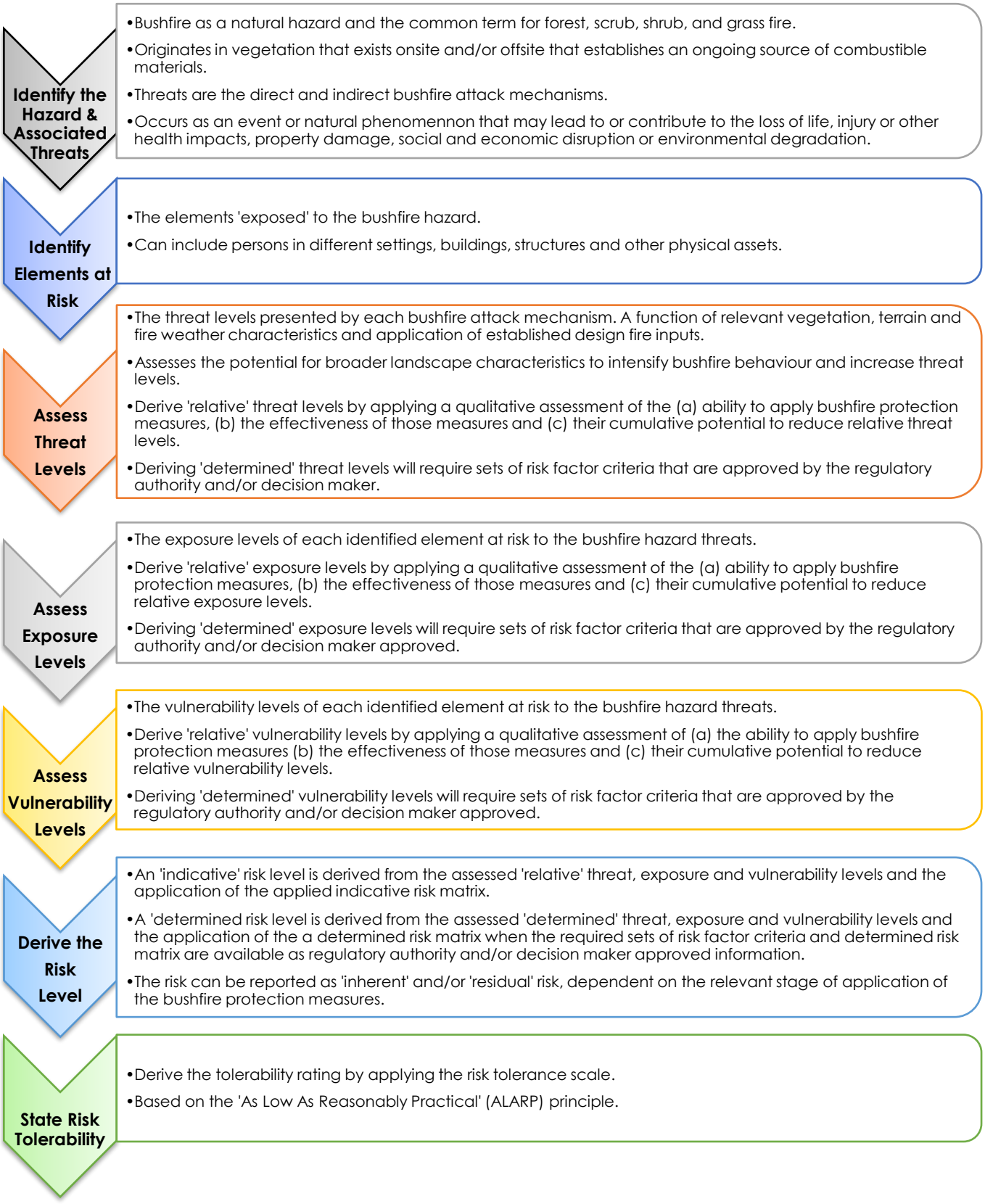


Figure 2.4: Outline of the adapted risk assessment process applied in this report.

2.4 THE BUSHFIRE HAZARD - BEHAVIOUR AND ATTACK MECHANISMS

Information regarding bushfire attack mechanisms and the potential influence of the broader landscape on the intensification of fire behaviour, is provided in Appendix 4 and 5. The content of these appendices is outlined below. Providing this information is intended to:

1. Assist those tasked with making design, construction, planning and management decisions (based on the information and assessments presented in this report), to have a better understanding of bushfire hazards where this may not be within their general field of expertise. This knowledge may also benefit development of innovative protection measures to increase the bushfire resilience of buildings/structures and/or improve persons safety and/or reduce bushfire threat levels; and
2. Assist readers understand why the assessment of the bushfire hazard threats and the presentation of the identified protection measures is organised the way it is in this report. It can also assist with guiding the search for additional information when necessary.

CONTENT OF APPENDIX 4

1. Factors Influencing Bushfire Behaviour
    - Vegetation and other fuels - key characteristics
    - Weather
    - Topography
2. Bushfire Direct Attack Mechanisms
    - Ember attack
    - Radiant heat attack
    - Bushfire flame attack
    - Surface fire attack
3. Bushfire Indirect Attack Mechanisms
    - Debris accumulation
    - Consequential fire
    - Fire driven wind
    - Tree strike and/or obstruction

CONTENT OF APPENDIX 5

1. Recent bushfire research
2. Dynamic Fire Behaviours
    - Spotting
    - Fire whirl/tornado
    - Junction fire
    - Crown fire
    - Eruptive fire
    - Fire channelling (vorticity-driven lateral spread)
    - Conflagrations
    - Downbursts
    - Pyroconvective events.
3. Drivers of deep flaming
4. Extreme bushfire events
5. Physical requirements of terrain, fuel load (and windspeed) for deep flaming.

2.5 OUTLINE OF REPORT CONSTRUCTION

The Development Application supported by this Risk Assessment and the associated Bushfire Management Plan, includes the construction of the MEG Hydrogen Project and the expansion of the existing solar array.

The two components are considerably separated (>300m) and are entirely different uses. Vegetation hazards, persons onsite, access routes, and Class 1-10 buildings have been considered in combination as they are either applicable to both components, or to the MEG Hydrogen Project only.

Fixed (hard) infrastructure assets have been assessed twice, with the solar array and hydrogen production components contained within their own section.

3 ASSESSMENT SUMMARY

The assessment summary is presented in three parts:

Section 3.1 states the derived bushfire threat levels, and the exposure and vulnerability levels of each element at risk – as the factors from which the risk levels are derived.

Section 3.2 two shows the type of risk level that is to be reported, states the derived risk levels and the tolerability of that risk - for each exposed element and each identified area of bushfire prone vegetation.

Section 3.3 presents a summary of the bushfire protection measures that can be applied and are currently implemented or are recommended to be implemented. The operational document in which the measures should be identified is noted.

3.1 THE ASSESSED THREAT, EXPOSURE AND VULNERABILITY LEVELS ESTABLISHING THE RISK LEVEL

Table 3.1: The assessed threat levels of the bushfire hazard.

ASSESSED HAZARD THREAT LEVELS [1]		
Bushfire Prone Vegetation	Relative Threat Level [2]	
	Inherent	Residual
Vegetation within the subject lots and watercourse reserve (150m survey buffer). Refer to Figure 5.1.	Moderate	Low
All bushfire prone vegetation within the broader locality (10km radius) including along access routes.	Moderate	

[1] Refer to Section 6 for detailed assessment information.

[2] Refer to Appendix 2 for explanatory information.

Table 3.2: The assessed exposure and vulnerability levels for each exposed element to the stated area of bushfire prone vegetation.

ASSESSED EXPOSURE AND VULNERABILITY LEVELS OF IDENTIFIED ELEMENTS AT RISK [1]				
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer). Refer to Figure 5.1.			
Elements At Risk[2]	Relative Exposure Level [3]		Relative Vulnerability Level [3]	
Description	Inherent	Residual	Inherent	Residual
Persons located onsite and temporarily offsite	Moderate	Very Low	Low	Very Low
Buildings/Structures - NCC Classes 1-10	High	Low	Moderate	Low
Fixed (hard) infrastructure assets: solar arrays	Moderate	Moderate	High	Moderate
Fixed (hard) infrastructure assets: hydrogen electrolysers, transport, and storage	High	Low	High	Moderate
[1] Refer to Sections 7 and 8 for detailed assessment information. [2] Refer to their identification in Section 5. [3] Refer to Appendix 2 for explanatory information.				
Vegetation Area / Location	All bushfire prone vegetation within the broader locality (10km radius) including along access routes.			
Elements At Risk[2]	Relative Exposure Level [3]		Relative Vulnerability Level [3]	
Description	Inherent	Residual	Inherent	Residual
Persons on access/egress routes (in vehicles) or pathways	Moderate		Low	
[1] Refer to Sections 7 and 8 for detailed assessment information. [2] Refer to their identification in Section 5. [3] Refer to Appendix 2 for explanatory information.				

3.2 THE ASSESSED RISK LEVEL ASSOCIATED WITH A BUSHFIRE EVENT AND ITS TOLERABILITY

Table 3.3: Identifying the 'type' of risk level being assessed and reported in this report.

THE TYPE OF RISK LEVEL DERIVED FROM THE ASSESSMENT [1]			
Indicative Risk		Determined Risk	
Inherent	Residual	Inherent	Residual
✓	✓	☐	☐
[1] Refer to Section 2, Appendix 2 and the glossary for explanatory information (inherent/residual corresponds to the level that available protection measures have been considered in the assessment with 'residual' including recommended measures).			

Table 3.4: The tolerability of the assessed risk levels for each exposed element and corresponding to the identified areas of bushfire prone vegetation.

THE ASSESSED BUSHFIRE RISK LEVEL AND TOLERABILITY [2]					
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer). Refer to Figure 5.1.				
Elements At Risk [1]	Indicative Risk Level [2]		Inherent Risk Tolerability (ALARP) [3]	Residual Risk Tolerability (ALARP) [3]	Adjusted Residual Risk Tolerability (ALARP) [4]
Description	Inherent	Residual			
Persons located onsite and temporarily offsite	**L6**	**VL2**	Acceptable but NOT ALARP	Acceptable	N/A
Buildings/Structures - NCC Classes 1-10	**M8**	**L4**	Tolerable but NOT ALARP	Acceptable	N/A
Fixed (hard) infrastructure assets: solar arrays	**M8**	**L6**	Tolerable but NOT ALARP	Acceptable	N/A
Fixed (hard) infrastructure assets: hydrogen electrolysers, transport, and storage	**H9**	**L5**	Unacceptable	Acceptable	N/A
Vegetation Area / Location	All bushfire prone vegetation within the broader locality (10km radius) including along access routes.				
Elements At Risk [1]	Indicative Risk Level [2]		Inherent Risk Tolerability (ALARP) [3]	Residual Risk Tolerability (ALARP) [3]	Adjusted Residual Risk Tolerability (ALARP) [4]
Description	Inherent	Residual			
Persons on access/egress routes in vehicles	**L6**		Acceptable as IS ALARP	Acceptable as IS ALARP	N/A
Supporting Comments: The Tolerability or Acceptability of a risk level is determined by whether it is 'reasonably practical' for the inherent risk level to be lowered further with the application of the assessed available and recommended bushfire protection measures.					
[1] Refer to their identification in Section 5. [2] Refer to Section 2, Appendix 2 and the glossary for explanatory information (inherent/residual corresponds to the level that available protection measures have been considered in the assessment with 'residual' including recommended measures).					

[3] Refer to Appendix 3 for information supporting the application of the tolerance scale.

[4] Refer to Section 3.2.1 for adjustment justification when applicable.

3.3 BUSHFIRE PROTECTION MEASURE APPLICATION & IMPLEMENTATION SUMMARY

ENSURING THE PROTECTION MEASURES ARE APPLIED THROUGH THE RELEVANT OPERATIONAL DOCUMENTS

The assessed 'base' hazard threat level and the ability to apply bushfire protection measures, are the key determinants of the risk to persons and property associated with the subject development/use.

Existing, planned and recommended protection measures have been accounted for in the derivation of the inherent and residual risk levels for each identified element at risk.

Consequently, it is crucial that these applied protection measures are incorporated into the relevant operational documents to ensure their actual implementation - if proceeding with the development/use is approved.

The relevant operational documents will likely be comprised of one or more of the following:

- **Bushfire Management Plan (BMP). This could be either:**
    - The BMP developed to satisfy planning approval requirements in which a limited number of bushfire protection measures are being addressed as the bushfire protection criteria to be met. The BMP also has scope to recommend additional protection measures as required and justifiable; or
    - A BMP that has been produced as part of an organisations operational requirements;
- **Bushfire Emergency Plan (BEP)** - which addresses a particular set of bushfire protection measures associated with the prevention, preparation, response and recovery procedures for a bushfire emergency event, particularly for those land uses that involve 'vulnerable' persons.;
- **Site Emergency Plan** – which typically is prepared for uses associated with higher risk operations that involve flammable/hazardous materials or may present a source of ignition for bushfire prone vegetation. For these uses, there is a regulatory requirement for an appropriate site emergency plan to establish how a range of relevant emergency events is to be prepared for and responded to. A bushfire event is an additional emergency that must be incorporated into that plan; or
- **Project Design Documents** – which are in the development phase and require specific information about the protection measures that can be incorporated to mitigate risk associated with a bushfire event.
- **Bushfire Resilience Works Program** – for an existing or planned development/use (operation) the works program document will detail additional works and procedures (i.e. protection measures) that need to be conducted to improve the bushfire resilience of persons and property – as a once off or annually. It also identifies the priority level for individual works so that potentially limited funds can be allocated in the most effective way.

  The relevant information is derived from the results of this Bushfire Risk – Assessment and Management Report which essentially is utilised as a bushfire threat and resilience audit for the existing operation.

The check to ensure the incorporation of bushfire protection measures into the relevant operational document is established within the tables below. It is aligned with each individual bushfire protection measure that is presented as a summary description grouped by element at risk and the protection principle being employed.

The detailed protection measure information is contained within Sections 6, 7 and 8 of this report.

Table 3.6 summarises the bushfire protection measures that currently exist and/or are recommended to be implemented and that are to be maintained into the future.

The detail of these measures is set out in the Hazard Threat Level, Exposure and Vulnerability assessment tables.

The checklist identifies the Infinite Green Energy operational documents that are recommended to be updated and/or created to incorporate the requirements and responsibilities into the documents.

3.3.1 THREAT (BUSHFIRE HAZARD) REDUCING PROTECTION MEASURES

Table 3.6: Summarised application of threat reducing protection measures (refer to section 6.1 for details).

Threat Reducing Protection Measure			Application Status Subject Development/Use		Checklist – Incorporate into Stated Operational Documents				
Protection principle	Ref. No.	Brief Description	Exists or Planned (fully/partly)	Additionally Recommended	Bushfire Management Plan	Bushfire Emergency Plan	Site Emergency Plan	Project Design	Works Program
Prevent fire ignition and/or severity by controlling the fuel	1.1	Remove offsite bushfire fuel	✓		✓			✓	
	1.2	Reduce offsite bushfire fuel - hazard reduction burning							
	1.3	Reduce offsite bushfire fuel- mechanical							
	1.4	Remove onsite bushfire fuel	✓	✓	✓				
	1.5	Reduce onsite bushfire fuel - hazard reduction burning							
	1.6	Reduce onsite bushfire fuel - mechanical							
	1.7	Reduce onsite consequential fire fine fuels	✓		✓				
	1.8	Reduce road verge fuel	✓					✓	
	1.9	Greater enforcement applied to compliance with the local government's fire break and fuel load notice							
Prevent fire ignition by controlling heat energy sources	1.10	Operational procedures – fire safe site procedures		✓			✓		
	1.11	Operational procedures – hazard reduction burning							
	1.12	Equipment design – limit potential for spark production	✓					✓	
	1.13	Legal enforcement – of total fire bans	✓		✓		✓		
	1.14	Legal enforcement – methods to reduce arson							
	1.15	Education of persons							
Prevent fire ignition by controlling heat energy source and fuel interactions	1.16	Shielding of ignition sources from bushfire fuels							
	1.17	Separation of ignition sources from bushfire fuels							
	1.18	Equipment design – control energy transfer to fuels							

3.3.2 EXPOSURE REDUCING PROTECTION MEASURES - PERSONS

Table 3.7: Summarised application of exposure reducing protection measures for the subject persons (refer to sections 7.1.1 & 7.2.1 for details).

Exposure Reducing Protection Measure - Persons			Application Status Subject Development/Use		Checklist – Incorporate into Stated Operational Documents				
Protection Principle	Ref. No.	Brief Description	Exists or Planned (fully/partly)	Additionally Recommended	Bushfire Management Plan	Bushfire Emergency Plan	Site Emergency Plan	Project Design	Works Program
Separation from All Bushfire Threats	Persons Located Onsite and Temporarily Offsite								
	2.1	Stay away from the subject site							
	2.2	Stay within the subject site – remote offsite hazard							
	2.3	Relocate away from remote offsite hazard - safer offsite location available							
	2.4	Evacuate from the subject site - safer offsite location(s) available	✓					✓	
	2.5	Relocate within the subject site - safer onsite area							
	2.6	Relocate within the subject site – pathway to safer onsite area/building							
	2.7	Pre-emptively relocate away from the subject site							
	Persons on Access / Egress Routes in Vehicles								
	3.1	Locating route away from adjacent hazards							
	3.2	Egress routes located to ensure driving away from hazard	✓					✓	
	3.3	Greater road width							
	3.4	Reduce and maintain road verge fuel to low threat state							
Shielding from All Bushfire Threats	Persons Located Onsite and Temporarily Offsite								
	2.8	On-site shelter building – community bushfire refuge standard							
	2.9	On-site shelter building – accommodation not part of site use							
	2.10	On-site shelter building – appropriate threat resilience		✓	✓			✓	
	2.11	On-site shelter structure – Class 10c							
	2.12	Constructed barrier – shield persons in the open							

	2.13	Natural barrier - shield persons in the open							
	2.14	Constructed/natural barrier – shielding for persons on pathways to safer onsite area/building:							
	Persons on Access / Egress Routes in Vehicles								
	3.5	Vehicle type – protection level							

3.3.3 VULNERABILITY REDUCING PROTECTION MEASURES - PERSONS

Table 3.8: Summarised application of vulnerability reducing protection measures for the subject persons (refer to sections 8.1.1 & 8.2.1 for details).

Vulnerability Reducing Protection Measure - Persons			Application Status Subject Development/Use		Checklist – Incorporate into Stated Operational Documents				
Protection Principle	Ref. No.	Brief Description	Exists or Planned (fully/partly)	Additionally Recommended	Bushfire Management Plan	Bushfire Emergency Plan	Site Emergency Plan	Project Design	Works Program
Transport and Multiple Evacuation Destinations and Routes Available	Persons Located Onsite and Temporarily Offsite								
	7.1	Sufficient evacuation transport available	✓						
	7.2	Multiple safer offsite locations available	✓						
Provision of Bushfire Emergency Information and Education	7.3	Bushfire emergency plan							
	7.4	Bushfire emergency poster							
	7.5	Bushfire protection measures to be implemented are published in the relevant operational documents		✓	✓		✓		
	7.6	Prominent display of information stating safe early evacuation is the primary procedure							
	7.7	Egress pathway signage							
	7.8	Trained personnel onsite	✓	✓			✓		
	7.9	Build community resilience through education							
	7.10	Encourage 'property bushfire resilience assessments'							
A Bushfire Emergency Firefighting Capability Exists (Response)	7.11	Personnel onsite can manage bushfire emergency procedures		✓			✓		
	7.12	Personnel onsite can operate firefighting equipment	✓				✓	✓	
	7.13	Locations of vulnerable persons are registered							
	7.14	External emergency services available	✓	✓	✓		✓		
Apply Best (Safer) Road Design and Construction (Materials)	Persons on Access / Egress Routes in Vehicles								
	8.1	Road width	✓						
	8.2	Road gradient	✓						

	8.3	Road Clearance	✓						
	8.4	Road Surface Materials	✓						
	8.5	Driver road ahead visibility and signage	✓						
	8.6	Road length	✓						
	8.7	Interconnected roads	✓						
Evacuees Self-Sufficient (Local Awareness and Transport)	8.8	Persons onsite have local awareness	✓						
	8.9	Persons onsite have own transport	✓						

3.3.4 EXPOSURE REDUCING PROTECTION MEASURES – BUILDINGS / OTHER STRUCTURES/ INFRASTRUCTURE

Table 3.9: Summarised application of exposure reducing protection measures for the subject buildings / other structures / infrastructure (refer to sections 7.3.1, 7.4.1 & 7.5.1 for details).

Exposure Reducing Protection Measure - Buildings / Other Structures/ Infrastructure			Application Status Subject Development/Use		Checklist – Incorporate into Stated Operational Documents				
Protection Principle	Ref. No.	Brief Description	Exists or Planned (fully/partly)	Additionally Recommended	Bushfire Management Plan	Bushfire Emergency Plan	Site Emergency Plan	Project Design	Works Program
Separation from All Bushfire Threats	4.1, 5.1, 6.1	Asset protection zone (APZ)	✓	✓	✓				
	4.2, 5.2, 6.2	Siting of buildings/structures - wind							
	4.3, 5.3, 6.3	Use of non-vegetated areas and/or public open space	✓					✓	
	4.4, 5.4, 6.4	Landscaping - tree location	✓	✓	✓				✓
	4.5, 5.5, 6.5	Separation of stored flammable products - gas in cylinders	✓					✓	
	4.6, 5.6, 6.6	Separation from stored flammable products – fuels / other hazardous materials	✓	✓			✓	✓	
	4.7, 5.7, 6.7	Separation from stored and constructed combustible items	✓					✓	
Shielding from All Bushfire Threats	4.8, 5.8, 6.8	Constructed Barrier – shielding from bushfire							
	4.9, 5.9, 6.9	Constructed Barrier – shielding from consequential fire							
	4.10, 5.10, 6.10	Natural Barrier - landforms							
	4.11, 5.11, 6.11	Planted Barrier - vegetation	✓	✓					
	4.12, 5.12, 6.12	Shield non-structural essential elements		✓				✓	

3.3.5 VULNERABILITY REDUCING PROTECTION MEASURES – BUILDINGS / OTHER STRUCTURES / INFRASTRUCTURE

Table 3.10: Summarised application of vulnerability reducing protection measures for the subject buildings / other structures / infrastructure (refer to sections 8.3.1, 8.4.1 & 8.5.1 for detail).

Vulnerability Reducing Protection Measure - Buildings / Other Structures/ Infrastructure			Application Status Subject Development/Use		Checklist – Incorporate into Stated Operational Documents				
Protection Principle	Ref. No.	Brief Description	Exists or Planned (fully/partly)	Additionally Recommended	Bushfire Management Plan	Bushfire Emergency Plan	Site Emergency Plan	Project Design	Works Program
Design and Construction (Materials)	9.1, 10.1, 11.1	Construction to a standard - AS 3959:2018	✓	✓	✓			✓	
	9.2, 10.2, 11.2	Construction to a standard – NASH Standard							
	9.3, 10.3, 11.3	Construction materials – external and internal cavity building elements		✓	✓			✓	
	9.4, 10.4, 11.4	Construction materials – consequential fire fuels	✓	✓	✓			✓	
	9.5, 10.5, 11.5	Construction – resistant to high wind	✓					✓	
	9.6, 10.6, 11.6	Construction – gas supply	✓					✓	
	9.7, 10.7, 11.7	Construction - electricity supply and/or non-structural essential elements	✓	✓	✓			✓	
	9.8, 10.8, 11.8	Minimise debris and ember accumulation – re-entrant detail	✓	✓	✓			✓	
	9.9, 10.9, 11.9	Minimise debris and ember accumulation – trapping surfaces	✓	✓	✓			✓	
	9.10, 10.10, 11.10	Minimise debris and ember accumulation – roof plumbing		✓	✓			✓	
	9.11, 10.11, 11.11	Minimise debris and ember accumulation – construction cavities		✓				✓	
	9.12, 10.12, 11.12	Minimise flame/radiant heat/ember/debris entry - external openings	✓					✓	

	9.13, 10.13, 11.13	Screening and sealing - gaps and penetrations		✓	✓			✓	
	9.14, 10.14, 11.14	Screening - external doors and windows	✓		✓			✓	
	9.15, 10.15, 11.15	Shutters - external doors and windows							
	9.16, 10.16, 11.16	Landscaping construction - fences and walls	✓	✓	✓			✓	
Firefighting Capability	9.17, 10.17, 11.17	Firefighting water supply	✓	✓	✓		✓	✓	
	9.18, 10.18, 11.18	Firefighting equipment – active operation	✓				✓	✓	
	9.19, 10.19, 11.19	Firefighting equipment – passive operation	✓				✓	✓	
	9.20, 10.20, 11.20	Firefighting equipment – maintain operability	✓	✓	✓		✓	✓	
	9.21, 10.21, 11.21	Firebreaks – primarily for access	✓		✓		✓		✓
Management And Maintaining Effectiveness Of Applied Protection Measures	9.22, 10.22, 11.22	Formal management / maintenance plan – actions and responsibilities		✓	✓		✓		

4 IDENTIFICATION OF THE ELEMENTS AT RISK

Elements at risk are those exposed to the bushfire hazard threats identified in Section 5. This section establishes the generic list of possible elements at risk and identifies the exposed elements of the subject development/use.

Table 4.1: Identification of the elements at risk for which this risk assessment and management report is produced.

THE ELEMENTS AT RISK (THE EXPOSED ELEMENTS)	
Type Description	Identification of Relevant Elements
Persons located onsite: as part of site operations or visitors) and **Persons temporarily offsite as part of site operations**: (e.g. tourism day trips)	✓
Persons on Access/Egress Routes (in Vehicles): i.e., roads, driveways, access ways	✓
Buildings - NCC Class 1 & 2: residential - of a domestic nature	
Buildings - NCC Class 3: residential – of long term or transient nature, for unrelated people	
Buildings – NCC Class 5: offices for professional or commercial purposes	
Buildings – NCC Class 6: shops selling retail goods or services to the public	
Buildings – NCC Class 7: warehouses & carparks - storage – wholesale goods / vehicles	
Buildings – NCC Class 8: factory / workshop / laboratory - in which a process is carried out	✓
Buildings – NCC Class 9: health care / residential care / assembly	
Buildings or Structures – NCC Class 10: non-habitable – shed / carport / garage / fence / retaining wall etc.	✓
Non-Building Accommodation: caravans / camper trailers / tents etc	
Fixed (Hard) Infrastructure Assets: telecommunications / power generation / transport / water supply / waste management	✓
Livestock/Animals: as part of commercial or private operations (saleyards / events / wildlife sanctuaries).	

Table 4.2: Description of the elements at risk that are subject to assessment for the proposed/existing development and/or use.

ELEMENT AT RISK DETAIL FOR THE SUBJECT DEVELOPMENT/USE	
Elements At Risk	Element Description
Persons located onsite and temporarily offsite	The site will be staffed with 2 personnel (estimated) during standard working hours Monday to Friday. Potential transient staff include maintenance/construction contractors and truck drivers transporting hydrogen. Major maintenance that might be required would include replacement of equipment or infrastructure as needed. This would involve larger numbers of personnel for limited periods as required.
Persons on access/egress routes in vehicles	Staff, contractors and/or emergency services accessing to / egressing from the facility.
Buildings/Structures - NCC Classes 1-10	The MEG Hydrogen Project as a whole will likely be considered a Class 8, type C building under the NCC. The site includes multiple potential

	designations including the Site Office (Class 5) and storage bullets (Class 10a).
Fixed (hard) infrastructure assets	Electrolysers Storage bullets Truck loading apparatus Loaded trucks Associated electrical infrastructure
Fixed (hard) infrastructure assets	Solar arrays (existing and proposed)

5 IDENTIFICATION OF THE BUSHFIRE HAZARD

ONSITE AND OFFSITE VEGETATION – RATIONALE FOR SEPARATE IDENTIFICATION

The approach adopted in this report is to separately identify onsite and offsite bushfire prone vegetation when the distinction exists, and it is necessary.

Onsite Vegetation

This is considered to be vegetation that exists on a given lot or lots or a large area of land that can be considered a tenement (e.g. a mining tenement) and for which the owner or occupier has certain rights to conduct activities upon. The 'onsite' land is the subject site on which the existing or proposed development and/or use is to be conducted.

The existence of these rights makes it more likely that an authority will exist to make and maintain any required changes to the extent and the composition of any bushfire prone vegetation that exists 'onsite'. The only constraint will be any environmental conditions established by relevant authorities.

Offsite Vegetation

This is considered to be vegetation that exists external to what can be considered 'onsite'. For these lands the owner/operator does not normally have any authority to modify or manage this bushfire prone vegetation to reduce threats and maintain that reduction in perpetuity. Rather, the authority for modifying and managing 'offsite' vegetation resides with a third party such as another landowner or a government authority.

Implications for Risk Assessment and Implementation of Relevant Protection Measures

- It is likely to be near certain that a greater number of relevant bushfire protection measures can be established on land identified as 'onsite' compared to land that is identified as 'offsite'.
- A responsibility can be established for owners and/or operators of onsite land to ensure the ongoing maintenance of those protection measures.
- In comparison, management of offsite vegetation requires the establishment of enforceable vegetation management agreements if any reduction in threat level is to be achieved and accounted for in the threat level assessment. These can be problematic to establish.

  The required assessment of the broader landscape's influence on bushfire hazard threat levels will most likely be considering vegetation and terrain that is external to the subject development/use site and therefore needs to be separately identified.

5.1 ONSITE BUSHFIRE PRONE VEGETATION

<table>
<tr><td>Map I.D. / Area No. / Location</td><td colspan="4">Vegetation within the subject lots and watercourse reserve (150m survey buffer). Refer to Figure 5.1.</td></tr>
<tr><td rowspan="3">Classification or Exclusion Clause</td><td colspan="2">Class A Forest</td><td rowspan="3">Effective Slope (deg)</td><td rowspan="3">Upslope or flat 0
Downslope >0-5</td></tr>
<tr><td colspan="2">Class B Woodland</td></tr>
<tr><td colspan="2">Class G Grassland</td></tr>
<tr><td>Types Identified</td><td>Open forest A-03</td><td>Low woodland B-07</td><td>Sown pasture G-26</td><td>Closed tussock grassland G-21</td></tr>
<tr><td>Description & Classification Justification</td><td colspan="4">Class G Grassland: Three distinct assemblages of grassland are present. Grazing pasture, sown crops (cereal) which will generally be harvested prior to the bushfire season, and retained treed areas without either cropping or grazing with a low canopy coverage (<10%).
Class B Woodland: Areas with an overstory of established trees and understory of grasses with limited shrubs. The woodland areas include a riparian zone.
Class A Forest: Vegetation with a comparable structure and assemblage to Class B Woodland, with a canopy coverage exceeding 30%. Realistically the bushfire behaviour of the vegetation is unlikely to exceed that modelled for Class B Woodland.</td></tr>
<tr><td>Post Development Assumptions:</td><td colspan="4">APZs will be established as described in the BMP. This will only require management of grasses. There is the intention to landscape a visual buffer around the southern portion of the Hydrogen Project. This vegetation can be managed in a low threat state, however additional requirements have been established in this Risk Assessment to minimise any residual hazard.</td></tr>
<tr><td colspan="5"> 


</td></tr>
<tr><td colspan="2">Grazing pasture</td><td colspan="3">Sown crops</td></tr>
<tr><td colspan="5"> 


</td></tr>
<tr><td colspan="2">Woodland along watercourse</td><td colspan="3">Retained woodland within crop fields</td></tr>
</table>

	
Higher density riparian woodland (forest)	High canopy density forest

Figure 5.1

Topography & Classified Vegetation

Lots 6 and 7 on Plan 1164, Area : 317.1 ha
Northam-York Road
MULUCKINE
SHIRE OF NORTHAM

AREA : 1
Class (A) Forest
Effective slope: 0°

AREA : 2
Class (B) Woodland
Effective slope: 0°

AREA : 3
Class (B) Woodland
Effective slope: >0° to 5°

AREA : 4
Class (G) Grassland
Effective slope: 0°

AREA : 7
Class (B) Woodland
Effective slope: 0°

AREA : 8
Class (G) Grassland
Effective slope: 0°

AREA : 9
Class (G) Grassland
Effective slope: 0°

AREA : 10
Class (G) Grassland
Effective slope: 0°

AREA : 11
Excluded

Lot 6

YORK RD

NORTHAM-YORK RD

Mortlock R.

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

- Subject Site
- Other Lots

Proposed Building

- MEG Hydrogen (All Structures)
- Solar Arrays

Vegetation Assessment

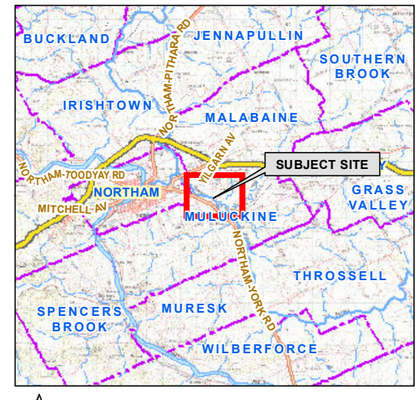
- 150m from Subject Site

Classified

- Class (A) Forest
- Class (B) Woodland
- Class (G) Grassland
- Exclusion 2.2.3.2

0 250 500 750
Metres

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



Aerial Imagery : Landgate/SLIP
Image Date : Feb 2021

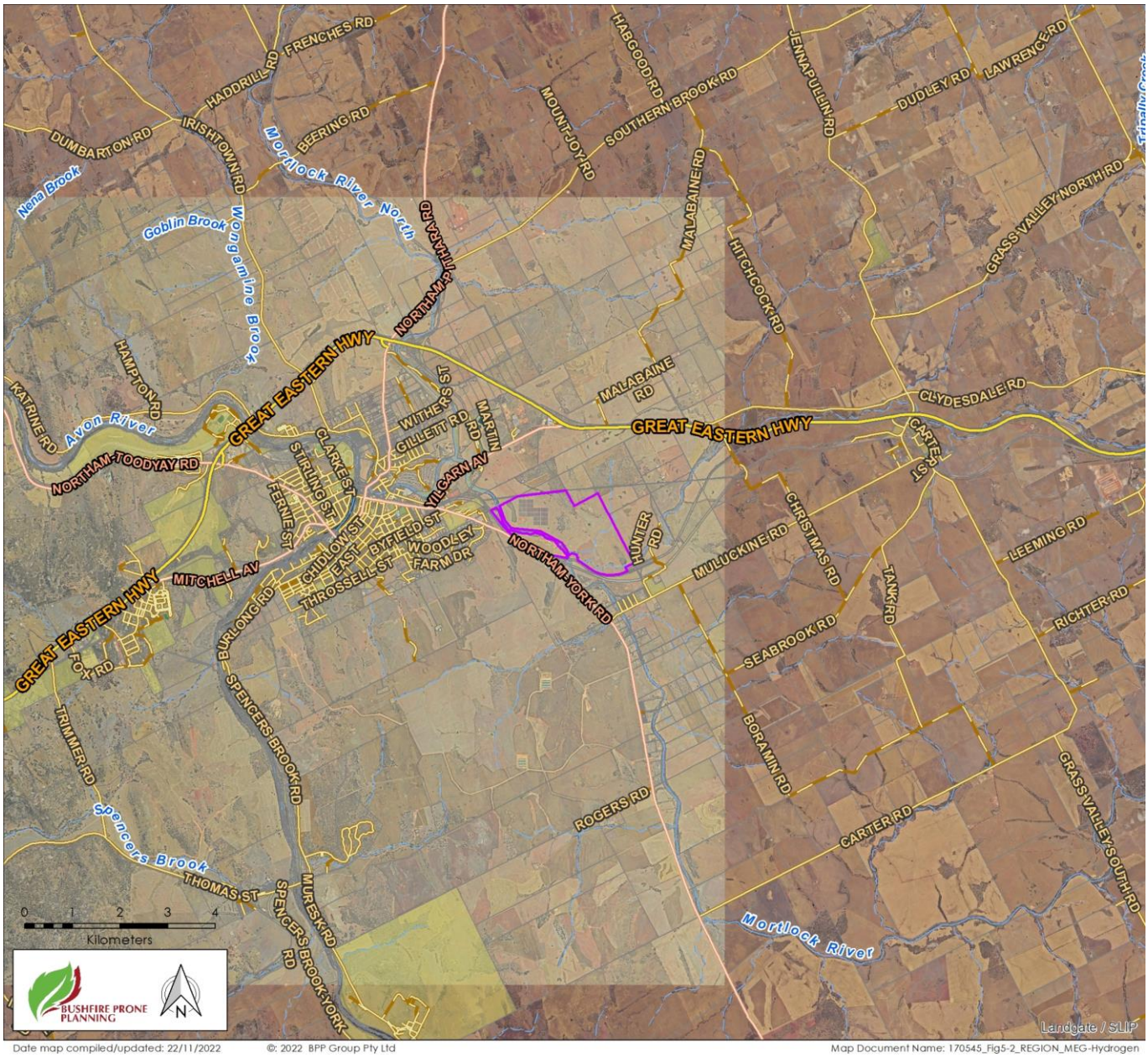
Coordinate System: GDA 1994 MGA Zone 50
Projection: Universal Transverse Mercator Units: Metre
Map compiled by: Neil Stoney 8/12/2022
Map updated by: Neil Stoney 8/12/2022
A3 Scale 1:10,500

BUSHFIRE PRONE PLANNING

Map Document Path / Name: K:\Projects\Jobs 2017\170545 - Lot 6 (131) Northam-York Road, Muluckine (BMP)\170545 - Hydrogen Production Facility (BMP BRMP) - Aug 2022\Mapping\MXD\170545_Fig5-1_RISK-VEG_MEG-Hydrogen.mxd

5.2 OFFSITE BUSHFIRE PRONE VEGETATION

Map I.D. / Area No. / Location	All bushfire prone vegetation within the broader locality (10km radius) including along access routes.			
Classification or Exclusion Clause	Class A Forest		Effective Slope (deg)	Upslope or flat 0
	Class B Woodland			Downslope >0-5
	Class G Grassland			
Types Identified	Open forest A-03	Woodland B-05	Sown pasture G-26	
Description & Classification Justification	The vegetation offsite within the broader locality is comparable to that within the assessment area. The area is dominated by sown pasture or crops, with fragmented areas of woodland and forest. Larger sections of remnant woodland do exist within the locality, though are fragmented by areas of grassland. The most relevant such section adjoins the northern boundary of Lot 6.			



5.3 THE BROADER LANDSCAPE/ENVIRONMENT AND ITS POTENTIAL TO INTENSIFY FIRE BEHAVIOUR

More recent research into bushfire propagation has highlighted the role of environmental factors that are responsible for dynamic bushfire propagation and subsequent extreme fire development. Dynamic fire propagation arises from complex interactions between the terrain, the atmosphere and the fire. The intensified fire behaviour of an extreme bushfire event will significantly increase the threat levels generated by the bushfire attack mechanisms. Refer to Appendix 5 for an explanation of dynamic fire behaviours (DFBs) and their involvement in extreme bushfire events.

Consequently, in assessing the bushfire hazard threat levels to which the at risk elements could be exposed, the potential for dynamic bushfire propagation and subsequent development of extreme bushfire events within the broader landscape surrounding a subject site, must be assessed. The results of this assessment are incorporated into the assessed bushfire hazard threat levels for each attack mechanism is Section 5.5.

Table 5.2: Broader landscape assessment – the potential for extreme fire events to increase threat levels.

ASSESSING THE POTENTIAL FOR AN EXTREME BUSHFIRE EVENT TO DEVELOP AND INCREASE THE LEVEL OF THREATS IMPACTING THE SUBJECT SITE			
Relevant Physical Factors [1]	Factor Existence in Surrounding Landscape	Potential to Increase Bushfire Threat Levels	Assessment Comments
Physical factors more typically associated with conflagrations that are more likely to exist as large surface based bushfire events			
Large continuous areas of bushfire prone vegetation	Partially Exists	Low	The region is dominated by sown pasture (grassland). Pockets of forest and woodland exist but are considerably separated and/or irregularly shaped, such that a continuous fire run displaying forest or woodland fire behaviour is limited.
Heavier fuel loads	Does Not Exist		Remnant forest and woodland structure is generally grasses (<30cm) with canopy elevated to 1m. A dense understory is rare. Grassland is generally slashed/grazed <10cm, or else being crops (e.g. wheat onsite), which will be harvested. The grassland on subject Lot 7 is in fact excludable, but is necessary to classify as a worst-case scenario. Fuels loads associated with each vegetation type are moderate to low (excepting wheat crops).
Fuel types (bark) that produce significant quantities of embers / firebrands (spotting) and can be long lasting;	Partially Exists		Grassland fuels do not generate long distance embers. The remnant forest/woodland assemblages are dominated by flooded gum and red morrel (coarse bark) and white gums (smooth bark) which will generate low to moderate embers.
Sufficient area of land and vegetation to support multiple fires of scale	Substantially Exists		Multiple fires may exist and the intensity will vary due to the fragmentation of grassland and forest pockets.

ASSESSING THE POTENTIAL FOR AN EXTREME BUSHFIRE EVENT TO DEVELOP AND INCREASE THE LEVEL OF THREATS IMPACTING THE SUBJECT SITE			
Relevant Physical Factors [1]	Factor Existence in Surrounding Landscape	Potential to Increase Bushfire Threat Levels	Assessment Comments
Terrain that can facilitate development of topographically modified winds (e.g. scarp or foehn-like)	Does Not Exist		The landscape is gently undulating, with total elevation changes up to 20m but with slopes not exceeding 5 degrees.
Strong synoptic winds (i.e., not fire driven)	Possible to Occur		The closest BOM station is in Northam (<5km away). The average summer wind speed is generally below 20km/h. Strong winds (30-50km/h) occur with approximately 8% frequency. Strong winds are possible and cannot be accurately predicted in advance.
Physical factors with identified links to deep flaming and the development of pyroconvective, coupled atmosphere, bushfire events			
Terrain slopes of approximately 24^0 or greater - or some degrees lower with greater wind speeds (increases potential for eruptive fire).	Does Not Exist	Moderate	The landscape is gently undulating, with total elevation changes up to 20m but with slopes not exceeding 5 degrees.
Rugged terrain with local relief in the order of at least 300m (increases potential for eruptive fire).	Does Not Exist		
Terrain with leeward slopes >20-25 degrees (increases potential for vorticity-driven lateral spread)	Does Not Exist		
Wind direction within $30\text{-}40^0$ of topographic aspect (increases potential for vorticity-driven lateral spread)	Partially Exists		The closest BOM station is in Northam (<5km away). The recorded summer weather wind rose does not show a dominant wind direction.
Wind speed in excess of approximately 20 km/hr (increases potential for vorticity-driven lateral spread)	Substantially Exists		A 20km/h wind speed is approximately average for summer, therefore frequency of wind speeds exceeding 20km/h approximately 50%.
Heavy forest fuel types with loads in excess of 15-20 t/ha (increases potential for vorticity-driven lateral spread)	Does Not Exist		Remnant forest and woodland structure is generally grasses (<30cm) with canopy elevated to 1m. A dense understory is rare. Fuel loads will generally be <15t/ha. Areas classified as forest are due to canopy coverage only, tiered understory is not present.
Fuel moisture content around 5% or less (associated with vorticity-driven lateral spread)	Substantially Exists		Low fuel moisture is likely, as the understory is generally grassy (fine fuels cure more readily).
Sufficiently sized areas (scale) of bushfire prone vegetation to potentially support deep flaming and supply the required quasi-instantaneous energy release.	Does Not Exist		Bushfire prone vegetation is of sufficient extent to support deep flaming. The vegetation types, fuel loads, and topography do not support the atmospheric/localised effects of deep flaming.

ASSESSING THE POTENTIAL FOR AN EXTREME BUSHFIRE EVENT TO DEVELOP AND INCREASE THE LEVEL OF THREATS IMPACTING THE SUBJECT SITE			
Relevant Physical Factors [1]	Factor Existence in Surrounding Landscape	Potential to Increase Bushfire Threat Levels	Assessment Comments
Atmospheric instability to create opportunity for atmospheric coupling and violent pyroconvection.	Possible to Occur		It will be assumed, as a minimum, that at most locations, the potential for vertical movement of air without any resistance to that movement (e.g. temperature inversions) can always exist. That is, it is not sufficiently risk averse to assume that atmospheric instability will never exist – different temperature air masses can always interact as a consequence of the passage of different weather systems at any location.
[1] These are physical terrain / environment factors that are either required for certain dynamic fire behaviours or will enhance the potential for and the development of an extreme bushfire event.			

5.4 ASSESSMENT OF VEGETATION CHARACTERISTICS DRIVING BUSHFIRE ATTACK MECHANISM THREAT LEVELS

This qualitative assessment derives the **base threat levels** of identified areas of bushfire prone vegetation by accounting for:

1. Fuel types, arrangement and quantities; and
2. The existence of relevant characteristics within the broader landscape that have the potential to intensify bushfire behaviour and increase threat levels.

Note: This assessment does not account for the existence or potential application of threat reducing protection measures or the level of exposure and vulnerability of elements at risk. These are accounted for in subsequent steps of the risk assessment process that results in the derivation of inherent and/or residual risk levels.

Table 5.3: The assessed potential for bushfire attack mechanisms originating from vegetation to adversely impact exposed elements.

CHARACTERISTICS ASSESSMENT OF THE BUSHFIRE PRONE VEGETATION AND ITS POTENTIAL TO IMPACT [1] ELEMENTS AT RISK – THE BASE THREAT LEVEL		
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).	
Identified Characteristics that will Contribute to the Severity of the Attack Mechanism and Consequent Base Threat Level to All Elements at Risk		Base Threat Level (the relative potential for adverse impact on exposed elements)
Direct Bushfire Attack Mechanisms		
Ember Attack: This threat level is strongly correlated with the existence of bark fuels. The varied typical rates of spread and residence time for flame fronts in different vegetation types is also incorporated into the threat level assessment (these impact on time available to make decisions and time exposed to threats).	Ember Attack can result from both immediate and regional vegetation. Other attack mechanisms below have not considered vegetation within the broader locality. Within 150m of the development: The grass type fuels are finer fuels and will produce very little, short distance small embers with short lives. The majority of these embers will be consumed as part of the flame front which will have a residence time (the flaming phase at a point on the ground) typically less than 10 seconds. Consequently, embers from grassland presents a limited threat. The remnant forest and woodland vegetation is dominated by red morrel and flooded gum (coarse bark), medium distance ember attack and is likely to impact the site, and white gum (smooth bark) which will rarely carry for sufficient distance to impact the site. The vegetation buffer along the watercourse running between subject lots 6 and 7 includes a mix of species and cannot be managed in its entirely. This may potentially	Moderate

CHARACTERISTICS ASSESSMENT OF THE BUSHFIRE PRONE VEGETATION AND ITS POTENTIAL TO IMPACT [1] ELEMENTS AT RISK – THE BASE THREAT LEVEL			
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).		
		impact the Hydrogen Project with short-distance spotting. This poses the primary ember hazard. Within the locality: Landscape-scale pasture and the pockets of remnant forest/woodland are unlikely to generate embers sufficient to impact the site from >150m.	
Radiant Heat Attack: This threat level is a function of fuel characteristics (size, shape, quantity, type, arrangement and moisture content) and the landscape and weather factors that can intensify fire behaviour. Larger flame sizes and higher temperatures produce higher levels of heat. The varied typical rates of spread and residence time for flame fronts in different vegetation types is also incorporated into the threat level assessment (these impact on time available to make decisions and time exposed to threats).		Fine fuel loads for the grassland (pasture) vegetation ranges from 2 t/ha for grazed pasture, 4 t/ha for unmanaged understory (generally wild oats), to >6 t/ha for sown crops (prior to harvest). Harvested crop will likely average 4 t/ha. The modelled solid portion flame lengths for the identified grassland vegetation type, on land ranging from flat to 0-5 degrees downslope, are up to 7m to 9m. These are shorter to medium flame lengths. The potential impact of the radiant heat transfer is going to be moderated by the short residence time (the flaming phase at a point on the ground) for the flame front. For much of the identified grassland vegetation types, the residence time will typically be less than 10 seconds. The residual radiant heat after the passage of the fire front will be low. The remnant woodland along the watercourse has an irregular canopy coverage, little ladder fuels, and a greatly restricted fire run. It will not emit the modelled heat flux for a woodland fire. To the south of the proposed development is a band of mixed scrub or woodland which will be cleared in establishing the truck entry lane.	Low
Bushfire Flame Attack: This threat level is a function of potential flame lengths which are significantly influenced by fine fuel loads and the slope of the land on which the fire is burning. The varied typical rates of spread and residence time for flame fronts in different vegetation types is also incorporated into the threat level assessment (these impact on time available to make decisions and time exposed to threats).		The modelled solid portion flame lengths for the identified grassland vegetation type, on land ranging from flat to 0-5 degrees downslope, are up to 7m to 9m. The modelled flame lengths for forest in the same range are 19.8m to 26.2m. The setbacks to establish the BAL-29 APZ required for planning approval, are 8m flat/ 9m downslope for grassland and 21/27m for forest, exceeding the maximum flame lengths in both cases.	Low

CHARACTERISTICS ASSESSMENT OF THE BUSHFIRE PRONE VEGETATION AND ITS POTENTIAL TO IMPACT [1] ELEMENTS AT RISK – THE BASE THREAT LEVEL		
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).	
Surface Fire Attack: This threat level is a function of the existence of intermittent surface fuels surrounding and leading up to exposed elements.	Grassland does not accumulate significant surface fuels/debris. Woodland vegetation produces sufficient leaf litter (surface fuel) that the hazard must be considered.	Moderate
Indirect Bushfire Attack Mechanisms		
Debris Accumulation: This threat level is a function of having a source of vegetative debris, its extent and proximity to exposed elements.	There will be limited debris accumulation due to predominantly grassland vegetation. Some debris will exist within the woodland areas.	Low
Consequential Fire: This threat level is a function of the existence of accumulated debris (fine fuels) and stored or constructed combustible / flammable items that exist either as part of the site use or operations or are adjoining/adjacent buildings/structures (heavy fuels).	The potential for debris accumulation has been assessed. Hydrogen production and storage is a considerable consequential fire hazard. This does not apply to solar arrays.	High
Fire Driven Wind: This threat level is correlated with the potential for development of extreme bushfire events (refer to Appendix 5).	The assessment in Section 5.3 identifies the potential for an extreme bushfire event to develop to be low and the potential to further increase bushfire threat levels through the development of a pyroconvective event to be moderate. Consequently, the base threat level of this attack mechanism is low.	Low
Tree Strike and Obstruction: This threat level is a function of the existence of trees, their proximity to exposed elements and an exposed element that can subsequently be vulnerable to other bushfire attack mechanisms due to damage or obstruction.	The proposed locations for the solar array and hydrogen project are relatively clear. Planting of a visual buffer is proposed between the hydrogen project and Northam-York Road. The species of trees will be determined by the Shire of Northam, and advice is provided within this Risk Assessment. An element may be considered at risk where the setback from the tree is <1.5x the mature height of that tree.	Moderate
[1] Refer to glossary.		

5.5 THE MODELLED BUSHFIRE - POTENTIAL RADIANT HEAT TRANSFER AND FLAME LENGTH

For the identified vegetation the modelled (design) fire will apply the most applicable fire behaviour and radiant heat models in determining the level of threat presented by the flame contact and radiant heat direct attack mechanisms of fire.

These models will be either those applied to Bushfire Attack Level (BAL) determination within AS 3959:2018 or other models as identified and justified in this report. The information in this section states the levels of radiant heat transfer at the stated distances from the element at risk in either BAL ratings or kW/m^2 (and flame lengths as relevant).

This information is considered in assessing threat levels in Section 5. Refer to Appendix 7 for additional information.

Table 5.4: Vegetation separation distances corresponding to radiant heat transfer levels.

THE CALCULATED VEGETATION SEPARATION DISTANCES CORRESPONDING TO THE STATED LEVEL OF RADIANT HEAT [1]									
Vegetation Classification [2]		Effective Slope [degree range]	Separation Distances (m) Corresponding to Stated Level of Radiant Heat						
			Bushfire Attack Level						10 kW/m^2 Radiant Heat
Area /Location	Class		BAL-FZ	BAL-40	BAL-29	BAL-19	BAL12.5	BAL-LOW	
1	(A) Forest	Upslope or flat 0	<16	16-<21	21-<31	31-<42	42-<100	>100	>63.2
2	(B) Woodland	Upslope or flat 0	<10	10-<14	14-<20	20-<29	29-<100	>100	>46.1
3	(B) Woodland	d/slope >0-5	<13	13-<17	17-<25	25-<35	35-<100	>100	>49.4
4	(G) Grassland	Upslope or flat 0	<6	6-<8	8-<12	12-<17	17-<50	>50	>29.5
5	(A) Forest	Upslope or flat 0	<16	16-<21	21-<31	31-<42	42-<100	>100	>63.2
6	(A) Forest	d/slope >0-5	<20	20-<27	27-<37	37-<50	50-<100	>100	>67.4
7	(B) Woodland	Upslope or flat 0	<10	10-<14	14-<20	20-<29	29-<100	>100	>46.1
8	(G) Grassland	Upslope or flat 0	<6	6-<8	8-<12	12-<17	17-<50	>50	>29.5
9	(G) Grassland	d/slope >0-5	<7	7-<9	9-<14	14-<20	20-<50	>50	>31.1
10	(G) Grassland	Upslope or flat 0	<6	6-<8	8-<12	12-<17	17-<50	>50	>29.5
11	(G) Grassland	Upslope or flat 0	<6	6-<8	8-<12	12-<17	17-<50	>50	>29.5
12	(G) Grassland	d/slope >0-5	<7	7-<9	9-<14	14-<20	20-<50	>50	>31.1

[1] Derived from method 1 BAL determination methodology (AS 3959:2018 Section 2, Table 2.5). All modelling input and output values in Appendix A of the associated BMP.
[2] Refer to Figure 5.1.

6 BUSHFIRE HAZARD THREAT LEVELS ASSESSMENT

SUMMARY OF THE QUALITATIVE ASSESSMENT PROCESS

1. Identify all protection measures (grouped by protection principle) that are available to reduce threat levels and rate their effectiveness;
2. Produce a numerical summary of all potential threat reducing protection measures that are available and determine their application status;
3. Assess the potential threat reducing impact of the package of protection measures that is able to be applied. The effectiveness rating weights the potential impact of an individual measure; and

1. Derive the threat level, for each identified area of bushfire prone vegetation, by accounting for:
    - The relevant characteristics of the vegetation as they influence the bushfire attack mechanisms and establish the base threat level;
    - The potential threat increasing influence of the broader landscape; and
    - The impact of the applied package of protection measures in reducing threat levels (refer to Section 2.3.3 and Appendix 2 for additional risk assessment process information).

6.1 PROTECTION MEASURES AVAILABLE TO REDUCE BUSHFIRE THREAT LEVELS AND THEIR APPLICATION STATUS

Table 6.1: For the stated area of vegetation, all available bushfire protection measures for preventing or reducing the potential for fire ignition and eliminating or reducing its threat levels.

PROTECTION MEASURES TO REDUCE BUSHFIRE THREAT LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).					
PROTECTION PRINCIPLE - PREVENT FIRE IGNITION AND/OR SEVERITY BY CONTROLLING THE FUEL: Eliminate or reduce vegetation fuel loads, modify their properties (vegetation types and the arrangement of the fuels). Maintain the measures over time to eliminate bushfire or lower the severity of fire behaviours and the consequent threat levels. The measures may conflict with desired / regulated environmental conservation outcomes and this remains a potential limitation.						
1.1	**Remove Offsite Bushfire Fuel:** Remove fuel permanently by clearing bushfire prone vegetation when an authority exists.	Very High	Partly	No	Yes	No
Informative and/or Site Specific Comment/Assessment: A portion of the northern verge vegetation following Northam-York Road will be permanently removed to install the slip lane for site entry. Further offsite vegetation removal is not under the control of the developer.						

PROTECTION MEASURES TO REDUCE BUSHFIRE THREAT LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
1.2	**Reduce Offsite Bushfire Fuel:** Programmed hazard reduction burning when an authority exists to conduct and maintain (refer to Appendix 6 for additional information).	Not Relevant	N/A	N/A	N/A	N/A
1.3	**Reduce Offsite Bushfire Fuel:** Mechanical fuel reduction to 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, minimise 'ladder' fuels' - when an authority exists to conduct and maintain.	Not Relevant	N/A	N/A	N/A	N/A
1.4	**Remove Onsite Bushfire Fuel:** Remove fuel permanently by clearing bushfire prone vegetation when approved.	Very High	Yes	Yes	Yes	Yes
Informative and/or Site Specific Comment/Assessment: Native vegetation onsite has been largely cleared. The remaining bushfire prone vegetation is sown pasture (grassland) or remnant woodland, either following the watercourse or else pockets retained within the wheat fields. *Clearing a portion of the vegetation is required to establish the required APZs, which are beyond the BAL-29 setback required for planning approval.*						
1.5	**Reduce Onsite Bushfire Fuel:** Programmed hazard reduction burning (refer to Appendix 6 for additional information).	Not Relevant	N/A	N/A	N/A	N/A
1.6	**Reduce Onsite Bushfire Fuel:** Mechanical fuel reduction to 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, minimise 'ladder' fuels' - when approved.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: Hazard reduction burning or mechanical reduction of onsite grassland (sown pasture) would need to be completed annually. Reduction/modification over time is not applicable to grassland. Management measures will not be applied to remnant for environmental reasons.						
1.7	**Reduce Onsite Consequential Fire Fine Fuels:** Apply the specifications for an Asset Protection Zone (APZ) surrounding the exposed element(s) to ensure this area contains minimal consequential fire fuels and is maintained in a low threat state. The specifications are established in the Guidelines [22] within the *Explanatory Notes for Element 2 of the Bushfire Protection Criteria and Schedule 1: Standards for Asset Protection Zones.*	Effective	Yes	No	Yes	No
Informative and/or Site Specific Comment/Assessment: The APZ requirements are applied through the associated BMP.						
1.8	**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.	Effective	Partly	No	Yes	No
Informative and/or Site Specific Comment/Assessment: A portion of the northern verge vegetation following Northam-York Road will be permanently removed to install the slip lane for site entry. Further offsite vegetation removal is not under the control of the developer.						

PROTECTION MEASURES TO REDUCE BUSHFIRE THREAT LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
1.9	**Greater Enforcement Applied to Compliance with the Local Government's Fire Break and Fuel Load Notice:** Inform the relevant landowners of the high level of enforcement that will be applied under the authority conferred through Section 33 of the Bush Fires Act 1954.	Effective	Yes	No	No	No
Informative and/or Site Specific Comment/Assessment: The level of enforcement is determined by the Local Government.						
PROTECTION PRINCIPLE – PREVENT FIRE IGNITION BY CONTROLLING HEAT ENERGY SOURCES: Fire prevention focussed on potential ignition sources from human actions and/or faulty or poorly designed equipment. Natural causes of ignition (lightning) cannot be controlled and are a limitation.						
1.10	**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.	Moderate	Yes	No	No	Yes
Informative and/or Site Specific Comment/Assessment: The operating procedures of the Hydrogen Production have not yet been developed, and must necessarily be extremely stringent in controlling ignition sources. Additional measures to reduce the risk of bushfire ignition are not applicable, as these measures are assumed to be implemented in reducing the risk of igniting onsite hazards. *It is recommended the future site operating procedures or emergency management plan (document titles pending) identify which (if any) operations are to cease where a bushfire is identified within 10km. The operations identified should be those susceptible to ember attack.* *The operational procedures for the proposed and existing solar arrays are appropriate.*						
1.11	**Operational Procedures:** Ensure proper management of hazard reduction burning as an unintended ignition source.	Not Relevant	N/A	N/A	N/A	N/A
1.12	**Equipment Design:** 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.	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: To be included in equipment design at purchase stage. All equipment must meet minimum national and state standards and guidelines, and this is considered adequate.						
1.13	**Legal Enforcement:** Impose restrictions on source of ignition operations by enforcing total fire bans.	Effective	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Total fire bans will be complied with. Total fire ban exemptions will be applied for if necessary for site functionality.						
1.14	**Legal Enforcement:** Reduce arson events by monitoring / enforcement / penalties.	Moderate	Yes	No	No	No

PROTECTION MEASURES TO REDUCE BUSHFIRE THREAT LEVELS		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Informative and/or Site Specific Comment/Assessment: Unlikely to have any impact given the scale of relevant vegetation and the population density of the region. Arson of the hydrogen project is extremely dangerous (potentially deadly) and additional penalties are unlikely to have an impact.						
1.15	**Education:** Educate persons to reduce the occurrence of accidental ignitions in vegetation by persons and/or vehicles, particularly with regard to road reserves.	Not Relevant	N/A	N/A	N/A	N/A
PROTECTION PRINCIPLE - PREVENT FIRE IGNITION BY CONTROLLING HEAT ENERGY SOURCE AND FUEL INTERACTIONS: Fire prevention focussed on limiting potential ignition sources by preventing a source and a fuel being able to interact.						
1.16	**Shielding of Ignition Sources:** 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.	Not Relevant	N/A	N/A	N/A	N/A
1.17	**Separation of Ignition Sources:** Establish sufficient separation distance between bushfire fuels and heat energy sources such as electricity generation / transmission, fuel supplies, stored flammable products etc.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: The potential for ignition of bushfire prone vegetation due to onsite events is highly unlikely given the necessarily stringent controls around onsite fire ignition, including cleaning debris from vehicles, restriction on smoking areas, increased fire control systems etc. The event where bushfire prone vegetation is ignited is an extreme (potentially catastrophic) onsite scenario. A fireball due to onsite explosion could reach up to 100m, with flaming debris potentially reaching much greater distances. There is no appropriate Asset Protection Zone or shielding (barrier) to mitigate the consequence of a catastrophic event.						
1.18	**Equipment Design:** Through design and materials, control heat energy transfer via conduction, convection and radiation of heat energy.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: All equipment must meet minimum national and state standards and guidelines, and this is considered adequate. Controls applied are independent of bushfire requirements. Strict controls will be applied to the hydrogen project, independent of bushfire requirements.						

[1] **Protection Measure Effectiveness Rating:** Refer to section 2.3.5 for explanation and defining.

[2] **Protection Measure Application Status:**

- **Possible:** Protection measures that can potentially be applied to the proposed development/use;
- **Exists**: Protection measures already implemented by existing components of the proposed development/use. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary);
- **Planned:** Protection measures that:
    - Are incorporated into the site plans;

PROTECTION MEASURES TO REDUCE BUSHFIRE 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 yet to be submitted 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 yet to be submitted 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).

6.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES

Table 6.2: For the stated area of bushfire prone vegetation, the summarised number of bushfire protection measures that can be applied (and their corresponding effectiveness rating), is compared to the number available.

BUSHFIRE THREAT REDUCING PROTECTION MEASURES – SUMMARY NUMBERS						
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).					
The Protection Principle	Effectiveness Rating [1]	Numbers of Protection Measures				
		Total Available	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Prevent Fire Ignition and/or Severity by Controlling the Fuel	Very High	2	2	1	2	1
	High	-	-	-	-	-
	Effective	3	3	-	2	-
	Moderate	-	-	-	-	-
	Not Relevant	4	-	-	-	-
Prevent Fire Ignition by Controlling Heat Energy (Ignition) Sources	Very High	-	-	-	-	-
	High		-	-	-	-
	Effective	1	1	1	-	-
	Moderate	3	3	1	-	1
	Not Relevant	2	-	-	-	-
Prevent Fire Ignition by Controlling Heat Energy Source and Fuel Interactions	Very High	-	-	-	-	-
	High	-	-	-	-	-
	Effective	-	-	-	-	-
	Moderate	-	-	-	-	-
	Not Relevant	3	-	-	-	-
Total Numbers	**Very High**	**2**	**2**	**1**	**2**	**1**
	High	**-**	**-**	**-**	**-**	**-**
	Effective	**4**	**4**	**1**	**2**	**-**
	Moderate	**3**	**3**	**1**	**-**	**1**
	Not Relevant	**9**	**-**	**-**	**-**	**-**
	Totals	**18**	**9**	**3**	**4**	**2**

[1] Protection Measure Effectiveness Rating: Refer to section 2.3.5 for explanation and defining.

[2] Protection Measure Application Status: Refer to table footnotes on previous page.

6.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (THREAT REDUCTION)

Table 6.3: The potential impact of the applied protection measures in reducing threat levels in the stated area of bushfire prone vegetation.

ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (THREAT REDUCTION)								
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).							
Threat Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accumulation	Consequential Fire	Fire Driven Wind	Tree Strike / Obstruction
Existing and Planned (applied to inherent risk)	Medium	Medium	Significant	Medium	Medium	Minimal	Significant	Minimal
	Medium				Medium			
Existing, Planned and Recommended (applied to residual risk)	Significant	Very Significant	Very Significant	Significant	Medium	Significant	Significant	Minimal
	Very Significant				Significant			
[1] Corresponds to the stage at which the risk level is to be reported i.e. inherent or residual (refer to Section 2.3.3) [2] Refer to Appendix 4 for explanatory information.								

Assessment Comments: Existing and Planned measures include the application of the BAL-29 APZ required for planning approval. Recommended measures include the application of the <10kW/m2 APZ from high-risk plant, infrastructure, and use areas (within the Hydrogen Project), and shutdown of processes susceptible to ember attack when a local bushfire is identified.

6.4 ASSESSED HAZARD THREAT LEVELS

Assessed as a function of the base threat levels of the bushfire hazard (refer to Section 5.5) and the number and effectiveness of protection measures that will be applied and their ability to reduce the base levels of threat from the identified areas of bushfire prone vegetation (Note: This assessment is independent of the exposure level and vulnerability level assessments).

Table 6.4: The assessed threat levels corresponding to the stated area of bushfire prone vegetation.

ASSESSED HAZARD THREAT LEVELS								
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).							
Threat Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accumulation	Consequential Fire	Fire Driven Wind	Tree Strike / Obstruction
Existing and Planned (applied to inherent risk)	Low	High	Moderate	Moderate	Low	Extreme	Very Low	Very Low
	Moderate							
Existing, Planned and Recommended (applied to residual risk)	Very Low	Low	Very Low	Low	Low	Extreme	Very Low	Very Low
	Low							
[1] Corresponds to the stage at which the risk level is to be reported i.e. inherent or residual (refer to Section 2.3.3). [2] Refer to Appendix 2 for explanatory information.								

Assessment Comments: Consequential fire hazards are not necessarily susceptible to bushfire impacts. The threat level of 'Extreme' is based on the potential hazard- regardless of the vulnerability or exposure of that hazard, which is managed through Existing and Proposed protection measures through the Risk Assessment.

7 EXPOSURE LEVEL ASSESSMENT OF THE ELEMENTS AT RISK

SUMMARY OF THE QUALITATIVE ASSESSMENT PROCESS

4. Identify all protection measures (grouped by protection principle) that are available to reduce exposure levels and rate their effectiveness;
5. Produce a numerical summary of all potential exposure reducing protection measures that are available and determine their application status;
6. Assess the potential exposure reducing impact of the package of protection measures that is able to be applied. The effectiveness rating weights the potential impact of an individual measure; and
7. Derive the exposure level of the identified element at risk, to the threats presented by each identified area of bushfire prone vegetation (refer to Section 2.3.3 and Appendix 2 for additional risk assessment process information).

7.1 PERSONS ONSITE OR TEMPORARILY OFFSITE

7.1.1 PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS AND THEIR APPLICATION STATUS

Table 7.1: All available protection measures to reduce exposure of the stated element at risk to bushfire hazard threats and their application to the subject development/use.

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
ELEMENT AT RISK:	**PERSONS LOCATED ONSITE AND TEMPORARILY OFFSITE**					
PROTECTION PRINCIPLE – SEPARATION FROM THE HAZARD: 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:** In response to a pre-determined fire danger rating and/or total fire ban or set months of the year (bushfire season), prevent access to, occupancy or operation of the subject site (i.e. closure of use). The relevant conditions and the requirement to stay away will be established through a Bushfire Emergency Plan.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: The measure is unnecessarily restrictive to commercial operations.						
2.2	**Stay Within the Subject Site – Remote Hazard:** For offsite tourism operations, all associated persons (staff, guests, visitors), in response to a pre-determined fire danger rating and/or total fire ban, will remain on-site as better	Not Relevant	N/A	N/A	N/A	N/A

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	communication and sheltering options exist on-site. The relevant conditions and the requirement to stay will be established through a Bushfire Emergency Plan.					
Informative and/or Site Specific Comment/Assessment:						
2.3	**Relocate Away from Remote Hazard - Safer Offsite Location Available:** For offsite tourism operations (where persons are to be moved 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. That is, two safer locations will exist.	Not Relevant	N/A	N/A	N/A	N/A
2.4	**Evacuate from the Subject Site: Safer Offsite Location(s) Available:** A building/area is 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 very unlikely to be simultaneously impacted by a bushfire event.	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Staff will commute to the site daily (likely living in the local area) and self-evacuate.						
2.5	**Relocate Within the Subject Site - Safer Onsite 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.	Moderate	Yes	No	No	No
Informative and/or Site Specific Comment/Assessment: The measure has not been applied as an appropriate building is available for use, providing greater protection.						
2.6	**Relocate Within the Subject Site – Pathway to Safer Onsite Area/Building:** To facilitate the lower risk movement, on foot, 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 4). • At least 6m from stored and constructed large heavy fuels (refer to Appendix 4). • At least 12m from constructed large heavy fuels that are buildings/structures other than the one being evacuated. Additionally: • The pathway/route is constructed of non-combustible materials; • No gas bottles are venting towards the pathway/route; and	Not Relevant	N/A	N/A	N/A	N/A

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	• 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.					
Informative and/or Site Specific Comment/Assessment: The measure is not practical for the hydrogen project as fuels are located in various locations onsite. The solar arrays do not have an onsite building designated as they are generally unstaffed, and any staff present must proceed to the hydrogen project as an emergency response.						
2.7	**Pre-Emptively Relocate Away from the Subject Site:** In response to a pre-determined fire danger rating and/or total fire ban or other established conditions, 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 a Bushfire Emergency Plan.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: The measure is unnecessarily restrictive to commercial operations.						
PROTECTION PRINCIPLE – SHIELDING FROM THE HAZARD: 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 Refuge:** For a 'vulnerable land use' (defined by SPP 3.7 [43]), 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: preferred floor area per person is an increase from 0.75 m^2 to 1.0 m^2 (Guidelines v1.4) [22].	Not Relevant	N/A	N/A	N/A	N/A
2.9	**On-site Shelter Building – No Accommodation in the Site Use:** For a 'vulnerable land use' (defined by SPP 3.7 [43]), and for which 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).	Not Relevant	N/A	N/A	N/A	N/A
2.10	**On-site Shelter Building – Appropriate Threat Resilience:** For other than a 'vulnerable land use' (defined by SPP 3.7 [43]), provide a building that incorporates sufficient design and construction protection measures to reduce the building vulnerability to bushfire and consequential fire threats to an appropriate level (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).	Effective	Yes	No	No	Yes
Informative and/or Site Specific Comment/Assessment: The measure will be applied to the appropriate available building (the Site Office). The building will be subject to <10kW/m2 radiant heat flux (calculated at 1200K) and constructed to the specifications of BAL-29 under AS3959, at a minimum.						

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
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.	Not Relevant	N/A	N/A	N/A	N/A
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].	Not Relevant	N/A	N/A	N/A	N/A
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.	Not Relevant	N/A	N/A	N/A	N/A
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].	Moderate	Yes	No	No	No
Informative and/or Site Specific Comment/Assessment: Persons onsite can quickly move from anywhere within the hydrogen project and the On-site Shelter Building. Any persons beyond the hydrogen project (within the solar arrays) will drive to the Shelter Building, not walk.						

[1] **Protection Measure Effectiveness Rating:** Refer to section 2.3.5 for explanation and defining.

[2] **Protection Measure Application Status:**

- **Possible:** Protection measures that can potentially be applied to the proposed development/use;
- **Exists**: Protection measures already implemented by existing components of the proposed development/use. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary);
- **Planned:** Protection measures that:

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend
• 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 yet to be submitted 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 yet to be submitted 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).					

7.1.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES

Table 7.2: For the stated element at risk and area of bushfire prone vegetation, the summarised number of bushfire protection measures that can be applied (and their corresponding effectiveness rating), is compared to the number available.

EXPOSURE REDUCING PROTECTION MEASURES – SUMMARY NUMBERS							
Element at Risk	Persons located onsite and temporarily offsite						
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).						
The Protection Principle	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Exists	Planned	Additionally Recommend	
Separation from the Hazard	Very High	-	-	-	-	-	
	High	-	-	-	-	-	
	Effective	-	-	-	-	-	
	Moderate	2	2	1	-	-	
	Not Relevant	5	-	-	-	-	
Shielding from the Hazard	Very High	-	-	-	-	-	
	High	-	-	-	-	-	
	Effective	1	1	-	-	1	
	Moderate	1	1	-	-	-	
	Not Relevant	5	-	-	-	-	
Total Numbers	**Very High**	**-**	**-**	**-**	**-**	**-**	
	High	**-**	**-**	**-**	**-**	**-**	
	Effective	**1**	**1**	**-**	**-**	**1**	
	Moderate	**3**	**3**	**1**	**-**	**-**	
	Not Relevant	**10**	**-**	**-**	**-**	**-**	
	Totals	**14**	**4**	**1**	**-**	**1**	

[1] Protection Measure Effectiveness Rating: Refer to section 2.3.5 for explanation and defining.

[2] Protection Measure Application Status: Refer to table footnotes on previous page.

7.1.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (EXPOSURE REDUCTION)

Table 7.3: For the stated element at risk, The potential impact of the applied protection measures in reducing exposure levels to the stated area of bushfire prone vegetation.

ASSESSED IMPACT OF APPLIED MEASURES (EXPOSURE REDUCTION)								
Element at Risk	Persons located onsite and temporarily offsite							
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).							
Exposure Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accum.	Conseq. Fire	Fire Driven Wind	Tree Strike / Obstruct
Existing and Planned (applied to inherent risk)	Minimal	Medium	Significant	Medium	Minimal	Medium	Minimal	Significant
	Medium				Medium			
Existing, Planned and Recommended (applied to residual risk)	Significant	Very Significant	Very Significant	Medium	Significant	Very Significant	Significant	Significant
	Very Significant				Significant			
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 4 for explanatory information.								

Assessment Comments: The only recommended measure is to nominate the Site Office as the shelter location, and to construct the building to AS 3959 specifications for BAL-29. The entirety of the Hydrogen Project (including the shelter building) is to establish a <10kW/m2 radiant heat flux APZ.

7.1.4 ASSESSED EXPOSURE LEVELS

Assessed as a function of the capacity to apply sufficient exposure reducing protection measures, their individual effectiveness and their combined impact in reducing the exposure of the identified element at risk (Note: This assessment is independent of the threat level and vulnerability level assessments).

Table 7.4: For the stated element at risk, the assessed exposure level corresponding to the stated area of bushfire prone vegetation.

ASSESSED EXPOSURE LEVELS	
Element at Risk	Persons located onsite and temporarily offsite
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).
Exposure Reducing Protection Measures Applied to Assessment [1]	Relative Exposure Level [2]
Existing and Planned	Moderate
Existing, Planned and Recommended	Very Low
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 2 for explanatory information.	

Assessment Comments: With a shelter location available, persons onsite are extremely unlikely to be exposed to significant bushfire impacts.

7.2 PERSONS ON ACCESS/EGRESS ROUTES IN VEHICLES

7.2.1 PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS AND THEIR APPLICATION STATUS

Table 7.5: All available protection measures to reduce exposure of the stated element at risk to bushfire hazard threats and their application to the subject development/use.

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		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:	All bushfire prone vegetation within the broader locality (10km radius) including along access routes.					
PROTECTION PRINCIPLE - SEPARATION FROM ALL BUSHFIRE THREATS: To utilise distance away from all relevant bushfire hazard threats (direct and indirect attack mechanisms) while traversing an access/egress route in a vehicle to lower the exposure of persons to the threats for the expected time on the route.						
3.1	**Locating 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	Partly	No	No
Informative and/or Site Specific Comment/Assessment: Internal access alternatives are restricted by the existing development(s) and bridge crossing. The proposed developments are located based on available cleared space (grassland), aspect required for solar arrays, and appropriate distance from the site access point to Northam-York Road. *Northam-York Road travels along grassland vegetation for most of its length. This is not under the control of the developer.*						
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
Informative and/or Site Specific Comment/Assessment: The routes do not exist or travel away from vegetation hazards, however the hazard is primarily grassland. Larger forested sections are not adjacent to the route.						
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.	Not Relevant	N/A	N/A	N/A	N/A
3.4	**Reduce and Maintain Road Verge Fuel to Low Threat State:** Road verges, or part off, have vegetation removed or reduced to a minimal fuel, low threat state annually to increase the separation distance from the bushfire hazard. This is	Not Relevant	N/A	N/A	N/A	N/A

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	practical when an authority exists to conduct the management and will have greater impact as a protection measure if there is certainty it will be carried out.					
Informative and/or Site Specific Comment/Assessment: The measure is not under the control of the developer.						
PROTECTION PRINCIPLE - SHIELDING FROM ALL BUSHFIRE THREATS: To utilise constructed or natural shielding to reduce the exposure of persons traversing the access/egress routes to the direct attack mechanisms of bushfire. 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	**Vehicle Type – Protection Level:** 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.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: Most evacuees vehicles will have an enclosed cabin, but it is unreasonable for this to be assumed, expected, or required.						

[1] **Protection Measure Effectiveness Rating:** Refer to section 2.3.5 for explanation and defining.

[2] **Protection Measure Application Status:**

- **Possible:** Protection measures that can potentially be applied to the proposed development/use;
- **Exists**: Protection measures already implemented by existing components of the proposed development/use. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary);
- **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 yet to be submitted 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).

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend

• **Additionally Recommend:** Protection measures that:
  • Exist in a yet to be submitted 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).					

7.2.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES

Table 7.6: For the stated element at risk and area of bushfire prone vegetation, the summarised number of bushfire protection measures that can be applied (and their corresponding effectiveness rating), is compared to the number available.

EXPOSURE REDUCING PROTECTION MEASURES – SUMMARY NUMBERS						
Element at Risk	Persons on access/egress routes in vehicles					
Access/Egress Route ID	All bushfire prone vegetation within the broader locality (10km radius) including along access routes.					
The Protection Principle	Effectiveness Rating [1]	Numbers of Protection Measures				
		Total Available	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Separation from the Bushfire Hazard	Very High	1	-	-	-	-
	High	1	-	1	-	-
	Effective	-	-	-	-	-
	Moderate	-	-	-	-	-
	Not Relevant	2	-	-	-	-
Shielding from the Bushfire Hazard	Very High	-	-	-	-	-
	High	-	-	-	-	-
	Effective	-	-	-	-	-
	Moderate	-	-	-	-	-
	Not Relevant	1	-	-	-	-
Total Numbers	**Very High**	**1**	**-**	**-**	**-**	**-**
	High	**1**	**-**	**1**	**-**	**-**
	Effective	**-**	**-**	**-**	**-**	**-**
	Moderate	**-**	**-**	**-**	**-**	**-**
	Not Relevant	**3**	**-**	**-**	**-**	**-**
	Totals	**5**	**-**	**1**	**-**	**-**

[1] Protection Measure Effectiveness Rating: Refer to section 2.3.5 for explanation and defining.

[2] Protection Measure Application Status: Refer to table footnotes on previous page.

7.2.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (EXPOSURE REDUCTION)

Table 7.7: For the stated element at risk, The potential impact of the applied protection measures in reducing exposure levels to the stated area of bushfire prone vegetation.

ASSESSED IMPACT OF APPLIED MEASURES (EXPOSURE REDUCTION)								
Element at Risk	Persons on access/egress routes in vehicles							
Access/Egress Route ID	All bushfire prone vegetation within the broader locality (10km radius) including along access routes.							
Exposure Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accumulation	Consequential Fire	Fire Driven Wind	Tree Strike / Obstruction
Existing and Planned (applied to inherent risk)	Minimal	Minimal	Medium	Medium	Significant	Medium	Medium	Significant
	Minimal				Medium			
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 4 for explanatory information.								

7.2.4 ASSESSED EXPOSURE LEVELS

Assessed as a function of the capacity to apply sufficient exposure reducing protection measures, their individual effectiveness and their combined impact in reducing the exposure of the identified element at risk (Note: This assessment is independent of the threat level and vulnerability level assessments).

Table 7.8: For the stated element at risk, the assessed exposure level corresponding to the stated area of bushfire prone vegetation.

ASSESSED EXPOSURE LEVELS	
Element at Risk	Persons on access/egress routes in vehicles
Access/Egress Route ID	All bushfire prone vegetation within the broader locality (10km radius) including along access routes.
Exposure Reducing Protection Measures Applied to Assessment [1]	Relative Exposure Level [2]
Existing and Planned (applied to inherent risk)	Moderate
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 2 for explanatory information.	

Assessment Comments: The local and regional road network and its proximity to bushfire prone vegetation is not under the control of the landowner. No recommendations are applied.

The evacuation routes available are effective at allowing for rapid egress from the local area without exposing evacuees to bushfire impacts. Evacuation routes travel through bushfire prone vegetation for most of their length, however the vegetation bounding the route is generally grassland with limited pockets of woodland. The relative exposure level is a function of the hazard posed based on the existing vegetation structure and location rather than protection measures applicable.

7.3 BUILDINGS AND STRUCTURES NCC CLASSES 1-10 (ELEMENT AT RISK CATEGORIES 3-10)

7.3.1 PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS AND THEIR APPLICATION STATUS

Table 7.9: All available protection measures to reduce exposure of the stated element at risk to bushfire hazard threats and their application to the subject development/use.

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
ELEMENT AT RISK: BUILDINGS/STRUCTURES - NCC CLASSES 1-10 (CATEGORIES 5, 8, 10a, 10b)						
PROTECTION PRINCIPLE – SEPARATION FROM ALL BUSHFIRE THREATS (SITING): To locate (site) the buildings and attached/adjacent structures at distances away from the direct and indirect attack mechanisms of bushfire (the hazard threats) to reduce their exposure. The required distances will be dependent on the relative threat levels and the degree of bushfire resilience that is or is planned to be incorporated into the exposed elements through design and construction.						
4.1	**Asset Protection Zone (APZ):** Ensure an APZ can be established surrounding the exposed element(s) to create the required separation distance from the bushfire hazard and its threats (the direct and indirect attack mechanisms). This is to be an area containing minimal fire fuels and maintained in a low threat state. The *Explanatory Notes for Element 2 of the Bushfire Protection Criteria and Schedule 1: Standards for Asset Protection Zones* established in the Guidelines [22] provides the key requirements for establishing and maintaining an APZ. Additional requirements may exist within a relevant local governments firebreak notice, or the responsibilities established by an applicable Bushfire Management Plan (BMP). 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 different authority (e.g. firebreak notice of BMP). As a minimum avoid dimensions (separation distances) that correspond to BAL-FZ and BAL-40 ratings for any given site/vegetation combination of relevant the parameters (Note: 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 APZ should be contained solely within the boundaries of each lot, except in instances where the neighbouring lot(s) or adjacent public land will be managed in a low-fuel state on an ongoing basis, in perpetuity. ***Note that the APZ does not provide separation from the consequential fire attack mechanism. Separation from consequential fire fuels requires additional assessment and management.***	Effective	Yes	No	Yes	Yes
Informative and/or Site Specific Comment/Assessment: A BAL-12.5 APZ can be established around all structures and relevant assets onsite, as outlined in the associated BMP. This exceeds the BAL-29 APZ for planning approval. *The high-risk components of the site are required to apply an APZ as appropriate to the asset. This is outlined in Sections 7.4, 7.5, 8.4, and 8.5.*						

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
4.2	**Siting of Buildings/Structures - Wind:** Site the buildings and attached/adjacent structures in locations that have lower wind exposure. Avoid the top and sides of ridges which are especially vulnerable to fire driven winds as well as topographically influenced winds. Winds can directly or indirectly (carrying materials/debris) cause damage to the external building envelope potentially allowing flame, radiant heat and ember entry.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: The local area is gently undulating. There is little difference in wind exposure between possible locations.						
4.3	**Use of Non-Vegetated Areas and/or Public Open Space:** Reduce exposure by increasing separation from APZ landscaping vegetation and/or the bushfire hazard by incorporating these lowest threat areas adjacent to buildings/structures and/or adjacent to the bushfire hazard. These lowest threat components of the APZ include non-vegetated areas (e.g. footpaths, paved areas, roads, parking, drainage, swimming pools), formally managed areas of vegetation (public open space and other recreation areas) and services installed in a common section of non-vegetated land. These elements create robust and easier managed asset protection zones.	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The buildings will be surrounded by a sealed, trafficable hardstand (truck loop road). This will create a minimum 6m non-vegetated buffer as the closest portion of the APZ.						
4.4	**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 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.	Moderate	Yes	No	Yes	Yes
Informative and/or Site Specific Comment/Assessment: A visual buffer is intended to be planted between the Hydrogen Project and Northam-York Road. *The species of tree will be determined by the Shire of Northam. This Risk Assessment includes a recommendation of tree species from the list provided by the Shire of Northam.* *It is required that the trunk of any planted tree, be located >1.5 the mature height of that tree from buildings or other constructed vital assets. For example, Eucalyptus melliodora has a typical maximum height of 30m, and must thus be planted >45m from buildings and constructed vital assets. It is therefore practical that shorter species are selected.*						

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
4.5	**Separation of 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 and LP Gas cylinder safety in bushfire prone areas (Energy Safety – Govt. of WA). 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).	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Any LPG will be stored in compliance with AS 1596.						
4.6	**Separation from Stored Flammable Products – Fuels / Other Hazardous Materials:** Establish sufficient separation distance between the consequential fire fuels and buildings/structures. The required separation distance will be dependent on the fuel and storage type.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: Fuels and hazardous materials will be stored throughout the site and within structures as part of site operations.						
4.7	**Separation from Stored and Constructed Combustible Items:** These consequential fire fuels include: • Stored Combustible Items - Heavy Fuels e.g. building materials, packaging materials, firewood, 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. • 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".*	Moderate	Yes	Yes	No	No

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	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.					
Informative and/or Site Specific Comment/Assessment: 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.						
PROTECTION PRINCIPLE – SHIELDING FROM ALL BUSHFIRE 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.						
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 of these threats to vulnerable exposed elements. 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
Informative and/or Site Specific Comment/Assessment: The measure is not cost-effective for the scale which would be required to be effective (functional height and perimeter), and the radiant heat flux exposure of the assets (maximum BAL-12.5).						

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
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.	Moderate	Yes	No	No	No
Informative and/or Site Specific Comment/Assessment: Consequential fire hazards onsite are sealed within containers which are constructed to withstand 37.5kW/m2 radiant heat flux for a period of no less than 18 minutes. *The measure would have a negligible impact given the low radiant heat and no flame contact the stored hydrogen tanks would be exposed to.*						
4.10	**Natural Barrier - Landforms:** Use existing natural landforms to reduce buildings/structures exposure to radiant heat, and lower wind speeds (prevailing synoptic and/or fire driven).	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: No landforms are present.						
4.11	**Planted Barrier - 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).	Moderate	Yes	No	Yes	Yes
Informative and/or Site Specific Comment/Assessment: A visual buffer is intended to be planted between the Hydrogen Project and Northam-York Road. *The species of tree will be determined by the Shire of Northam. This Risk Assessment includes a recommendation of tree species from the list provided by the Shire of Northam.*						
4.12	**Shield Non-Structural Essential Elements:** These are elements essential to the continued operation of the building/structure which are potentially exposed to fire attack mechanisms of both bushfire and consequential fire. They include cabling and plumbing associated with power / data transmission and water / fuel 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 bushfire threats. Shielding includes underground installation.	Moderate	Yes	No	Yes	Yes
Informative and/or Site Specific Comment/Assessment: All essential elements associated with Class 1-10 buildings will be positioned such that they are subject to a maximum 10kW/m2 radiant heat flux (BAL-12.5). *Cabling and plumbing beyond the footprint of buildings or constructed assets are recommended to be installed underground, or shielding with non-combustible material (or enclosed) where practical.*						
[1] **Protection Measure Effectiveness Rating:** Refer to section 2.3.5 for explanation and defining.						

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend

[2] Protection Measure Application Status:

- **Possible:** Protection measures that can potentially be applied to the proposed development/use;
- **Exists**: Protection measures already implemented by existing components of the proposed development/use. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary);
- **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 yet to be submitted 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 yet to be submitted 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).

7.3.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES

Table 7.10: For the stated element at risk and area of bushfire prone vegetation, the summarised number of bushfire protection measures that can be applied (and their corresponding effectiveness rating), is compared to the number available.

EXPOSURE REDUCING PROTECTION MEASURES – SUMMARY NUMBERS						
Element at Risk	Buildings/Structures - NCC Classes 1-10					
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).					
The Protection Principle	Effectiveness Rating [1]	Numbers of Protection Measures				
		Total Available	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Separation from the Hazard	Very High	-	-	-	-	-
	High	-	-	-	-	-
	Effective	1	1	-	1	1
	Moderate	4	4	3	1	1
	Not Relevant	2	-	-	-	-
Shielding from the Hazard	Very High	-	-	-	-	-
	High	1	1	-	-	-
	Effective	-	-	-	-	-
	Moderate	3	3	-	2	2
	Not Relevant	1	-	-	-	-
Total Numbers	**Very High**	**-**	**-**	**-**	**-**	**-**
	High	**1**	**1**	**-**	**-**	**-**
	Effective	**1**	**1**	**-**	**1**	**1**
	Moderate	**7**	**7**	**3**	**3**	**3**
	Not Relevant	**3**	**-**	**-**	**-**	**-**
	Totals	**12**	**9**	**3**	**4**	**4**

[1] Protection Measure Effectiveness Rating: Refer to section 2.3.5 for explanation and defining.

[2] Protection Measure Application Status: Refer to table footnotes on previous page.

7.3.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (EXPOSURE REDUCTION)

Table 7.11: For the stated element at risk, The potential impact of the applied protection measures in reducing exposure levels to the stated area of bushfire prone vegetation.

ASSESSED IMPACT OF APPLIED MEASURES (EXPOSURE REDUCTION)								
Element at Risk	Buildings/Structures - NCC Classes 1-10							
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).							
Exposure Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accum.	Conseq. Fire	Fire Driven Wind	Tree Strike / Obstruct
Existing and Planned (applied to inherent risk)	Minimal	Medium	Significant	Minimal	Minimal	Medium	Minimal	Minimal
	Medium				Minimal			
Existing, Planned and Recommended (applied to residual risk)	Significant	Very Significant	Very Significant	Medium	Significant	Significant	Minimal	Significant
	Significant				Significant			
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 4 for explanatory information.								

7.3.4 ASSESSED EXPOSURE LEVELS

Assessed as a function of the capacity to apply sufficient exposure reducing protection measures, their individual effectiveness and their combined impact in reducing the exposure of the identified element at risk (Note: This assessment is independent of the threat level and vulnerability level assessments).

Table 7.12: For the stated element at risk, the assessed exposure level corresponding to the stated area of bushfire prone vegetation.

ASSESSED EXPOSURE LEVELS	
Element at Risk	Buildings/Structures - NCC Classes 1-10
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).
Exposure Reducing Protection Measures Applied to Assessment [1]	Relative Exposure Level [2]
Existing and Planned (applied to inherent risk)	High
Existing, Planned and Recommended (applied to residual risk)	Low
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 2 for explanatory information.	

Assessment Comments: The relative exposure levels consider two primary inputs:

The BAL-29 APZ required for planning approval (including potential retained vegetation maintained to low threat), against the required <10kW/m2 radiant heat flux APZ from all structures associated with the Hydrogen Project, and;

The visual buffer (trees to be planted) between the Hydrogen Project and Northam-York Road having no controls applied, against the shortlisted tree selection provided and the requirement for 1.5x mature height setback of tree plantings.

7.4 FIXED (HARD) INFRASTRUCTURE ASSETS: SOLAR ARRAYS

7.4.1 PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS AND THEIR APPLICATION STATUS

Table 7.13: All available protection measures to reduce exposure of the stated element at risk to bushfire hazard threats and their application to the subject development/use.

	EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
ELEMENT AT RISK: FIXED (HARD) INFRASTRUCTURE ASSETS						
PROTECTION PRINCIPLE – SEPARATION FROM ALL BUSHFIRE THREATS (SITING): To locate (site) the buildings and attached/adjacent structures at distances away from the direct and indirect attack mechanisms of bushfire (the hazard threats) to reduce their exposure. The required distances will be dependent on the relative threat levels and the degree of bushfire resilience that is or is planned to be incorporated into the exposed elements through design and construction.						
5.1	**Asset Protection Zone (APZ):** Ensure an APZ can be established surrounding the exposed element(s) to create the required separation distance from the bushfire hazard and its threats (the direct and relevant indirect attack mechanisms). This is to be an area containing minimal fire fuels and maintained in a low threat state. The *Explanatory Notes for Element 2 of the Bushfire Protection Criteria and Schedule 1: Standards for Asset Protection Zones* established in the Guidelines [22] provides the key requirements for establishing and maintaining an APZ. Additional requirements may exist within a relevant local governments firebreak notice, or the responsibilities established by an applicable Bushfire Management Plan (BMP). 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 different authority (e.g. firebreak notice or BMP). As a minimum avoid dimensions (separation distances) that correspond to BAL-FZ and BAL-40 ratings for any given site/vegetation combination of the relevant parameters. Note that 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 APZ should be contained solely within the boundaries of each lot, except in instances where the neighbouring lot(s) or adjacent public land will be managed in a low-fuel state on an ongoing basis, in perpetuity. ***Note that the APZ does not provide separation from the consequential fire attack mechanism. Separation from consequential fire fuels requires additional assessment and management.***	Effective	Yes	Yes	Yes	Yes
Informative and/or Site Specific Comment/Assessment: A BAL-29 APZ can be established around all structures and relevant assets onsite, as outlined in the associated BMP. The solar arrays are not susceptible to this heat flux exposure for the relatively short residence period of a grassland fire (<30 seconds). The setbacks to establish the BAL-29 APZ required for planning approval, are 8m flat/ 9m downslope for grassland. This matches or exceeds the maximum flame lengths of 7m and 9m respectively. Flame contact is unlikely with the required setback.						

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
The Design Guidelines and Model Requirements – Renewable Energy Facilities (CFA March 2022) *requires that solar arrays have a minimum 10m APZ. This is the most stringent of the available requirements, and has thus been applied to the proposed solar arrays.* ***Note** that terminology differences exist between state authorities. In Victoria, 'Firebreak' may refer to either a perimeter access or a low threat area around an asset. In Western Australia, a 'Firebreak' and an 'Asset Protection Zone' are separate terms.*						
5.2	**Siting of Buildings/Structures - Wind:** Site the buildings/structures/infrastructure in locations that have lower wind exposure. Avoid the top and sides of ridges which are especially vulnerable to fire driven winds as well as topographically influenced winds. Winds can directly or indirectly (carrying materials/debris) cause damage to the external building envelope potentially allowing flame, radiant heat and ember entry.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: The local area is consistent and re-siting will have little effect on wind experienced.						
5.3	**Use of Non-Vegetated Areas and/or Public Open Space:** Reduce exposure by increasing separation from APZ landscaping vegetation and/or the bushfire hazard by incorporating these lowest threat areas adjacent to buildings/structures and/or adjacent to the bushfire hazard. These lowest threat components of the APZ include non-vegetated areas (e.g. footpaths, paved areas, roads, parking, drainage, swimming pools), formally managed areas of vegetation (public open space and other recreation areas) and services installed in a common section of non-vegetated land. These elements create robust and easier managed asset protection zones.	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Solar panels are located within areas of cleared or slashed grasses, and will be surrounded by a non-vegetated firebreak.						
5.4	**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.	Moderate	Yes	Yes	No	No

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Informative and/or Site Specific Comment/Assessment: Trees (both existing and revegetating) are not present within 30m of any proposed fixed infrastructure (assumed 1.5 x 20m height).						
5.5	**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 and LP Gas cylinder safety in bushfire prone areas (Energy Safety – Govt. of WA). 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).	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Any LPG will be stored in compliance with AS 1596.						
5.6	**Separation from Stored Flammable Products – Fuels / Other Hazardous Materials:** Establish sufficient separation distance between the consequential fire fuels and buildings/structures. The required separation distance will be dependent on the fuel and storage type.	Not Relevant	N/A	N/A	N/A	N/A
5.7	**Separation from Stored and Constructed Combustible Items:** 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. • 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".*	Not Relevant	N/A	N/A	N/A	N/A

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	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.					
Informative and/or Site Specific Comment/Assessment: The solar array areas will not include other components (e.g. structures, fuel storage, timber debris etc). Separation between panels is the only asset-to-asset fire consideration.						
PROTECTION PRINCIPLE – SHIELDING FROM ALL BUSHFIRE 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.						
5.8	**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 threats to vulnerable exposed elements. 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]	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: The measure is not cost-effective for the scale which would be required to be effective (functional height and perimeter).						

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
5.9	**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.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: There are no relevant consequential hazards to shield.						
5.10	**Natural Barrier - Landforms:** Use existing natural landforms to reduce buildings/structures exposure to radiant heat, and lower wind speeds (prevailing synoptic and/or fire driven).	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: No such landforms exist.						
5.11	**Natural Barrier – Vegetation:** 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).	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: Tall vegetation will not be included near solar arrays as they will block sunlight.						
5.12	**Shield Non-Structural Essential Elements:** These are elements essential to the continued operation of the built asset which are potentially exposed to fire attack mechanisms of both bushfire and consequential fire. They include cabling and plumbing associated with power / data transmission and water / fuel 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.	Moderate	Yes	No	No	Yes
Informative and/or Site Specific Comment/Assessment: Cabling associated with solar arrays are recommended to be installed underground, enclosed within a structure, or shielded with non-combustible material where practical.						

[1] **Protection Measure Effectiveness Rating:** Refer to section 2.3.5 for explanation and defining.

[2] **Protection Measure Application Status:**

- **Possible:** Protection measures that can potentially be applied to the proposed development/use;
- **Exists**: Protection measures already implemented by existing components of the proposed development/use. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary);
- **Planned:** Protection measures that:

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend
• 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 yet to be submitted 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 yet to be submitted 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).					

7.4.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES

Table 7.14: For the stated element at risk and area of bushfire prone vegetation, the summarised number of bushfire protection measures that can be applied (and their corresponding effectiveness rating), is compared to the number available.

EXPOSURE REDUCING PROTECTION MEASURES – SUMMARY NUMBERS						
Element at Risk	Fixed (hard) infrastructure assets					
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).					
The Protection Principle	Effectiveness Rating [1]	Numbers of Protection Measures				
		Total Available	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Separation from the Hazard	Very High	-	-	-	-	-
	High	-	-	-	-	-
	Effective	1	1	1	1	1
	Moderate	3	3	3	-	-
	Not Relevant	3	-	-	-	-
Shielding from the Hazard	Very High	-	-	-	-	-
	High	-	-	-	-	-
	Effective	-	-	-	-	-
	Moderate	1	1	-	-	1
	Not Relevant	4	-	-	-	-
Total Numbers	**Very High**	**-**	**-**	**-**	**-**	**-**
	High	**-**	**-**	**-**	**-**	**-**
	Effective	**1**	**1**	**1**	**1**	**1**
	Moderate	**4**	**4**	**3**	**-**	**1**
	Not Relevant	**7**	**-**	**-**	**-**	**-**
	Totals	**12**	**5**	**4**	**1**	**2**

[1] Protection Measure Effectiveness Rating: Refer to section 2.3.5 for explanation and defining.

[2] Protection Measure Application Status: Refer to table footnotes on previous page.

7.4.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (EXPOSURE REDUCTION)

Table 7.15: For the stated element at risk, The potential impact of the applied protection measures in reducing exposure levels to the stated area of bushfire prone vegetation.

ASSESSED IMPACT OF APPLIED MEASURES (EXPOSURE REDUCTION)								
Element at Risk	Fixed (hard) infrastructure assets							
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).							
Exposure Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accumulation	Consequential Fire	Fire Driven Wind	Tree Strike / Obstruction
Existing and Planned (applied to inherent risk)	Minimal	Medium	Medium	Significant	Significant	Minimal	Minimal	Very Significant
	Medium				Medium			
Existing, Planned and Recommended (applied to residual risk)	Medium	Significant	Significant	Significant	Significant	Medium	Minimal	Very Significant
	Significant				Medium			
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 4 for explanatory information.								

7.4.4 ASSESSED EXPOSURE LEVELS

Assessed as a function of the capacity to apply sufficient exposure reducing protection measures, their individual effectiveness and their combined impact in reducing the exposure of the identified element at risk (Note: This assessment is independent of the threat level and vulnerability level assessments).

Table 7.16: For the stated element at risk, the assessed exposure level corresponding to the stated area of bushfire prone vegetation.

ASSESSED EXPOSURE LEVELS	
Element at Risk	Fixed (hard) infrastructure assets
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).
Exposure Reducing Protection Measures Applied to Assessment [1]	Relative Exposure Level [2]
Existing and Planned (applied to inherent risk)	Moderate
Existing, Planned and Recommended (applied to residual risk)	Moderate
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 2 for explanatory information.	

Assessment Comments: Given the brief residence period of grassland fires, the additional measures of shielding cabling and installing a minimum 10m APZ, will have a minor impact on relative exposure.

7.5 FIXED (HARD) INFRASTRUCTURE ASSETS: HYDROGEN ELECROLYSERS, TRANSPORT, AND STORAGE

7.5.1 PROTECTION MEASURES AVAILABLE TO REDUCE EXPOSURE LEVELS AND THEIR APPLICATION STATUS

Table 7.17: All available protection measures to reduce exposure of the stated element at risk to bushfire hazard threats and their application to the subject development/use.

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
ELEMENT AT RISK: FIXED (HARD) INFRASTRUCTURE ASSETS						
PROTECTION PRINCIPLE – SEPARATION FROM ALL BUSHFIRE THREATS (SITING): To locate (site) the buildings and attached/adjacent structures at distances away from the direct and indirect attack mechanisms of bushfire (the hazard threats) to reduce their exposure. The required distances will be dependent on the relative threat levels and the degree of bushfire resilience that is or is planned to be incorporated into the exposed elements through design and construction.						
6.1	**Asset Protection Zone (APZ):** Ensure an APZ can be established surrounding the exposed element(s) to create the required separation distance from the bushfire hazard and its threats (the direct and relevant indirect attack mechanisms). This is to be an area containing minimal fire fuels and maintained in a low threat state. The *Explanatory Notes for Element 2 of the Bushfire Protection Criteria and Schedule 1: Standards for Asset Protection Zones* established in the Guidelines [22] provides the key requirements for establishing and maintaining an APZ. Additional requirements may exist within a relevant local governments firebreak notice, or the responsibilities established by an applicable Bushfire Management Plan (BMP). 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 different authority (e.g. firebreak notice or BMP). As a minimum avoid dimensions (separation distances) that correspond to BAL-FZ and BAL-40 ratings for any given site/vegetation combination of the relevant parameters. Note that 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 APZ should be contained solely within the boundaries of each lot, except in instances where the neighbouring lot(s) or adjacent public land will be managed in a low-fuel state on an ongoing basis, in perpetuity. ***Note that the APZ does not provide separation from the consequential fire attack mechanism. Separation from consequential fire fuels requires additional assessment and management.***	Effective	Yes	No	Yes	Yes
Informative and/or Site Specific Comment/Assessment: The BAL-29 APZ required for planning approval is not necessarily applicable to high-risk infrastructure.						

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend

The steel pipework has been identified as the most vulnerable component of the electrolysers and bullets. Based on generic failure data, the pipework is able to withstand a heat flux of 37.5kW/m2 for a period of no less than 18 minutes. AS3959 construction standards assume integrity of a period of 20 minutes while exposed to the maximum heat flux expressed by the associated BAL rating. This data means the piping (as the vulnerable component) is suitable for a BAL-29 setback, and almost to BAL-40.

The minimum acceptable setbacks therefore are 6.5m to Class G Grassland and 11m to Class B Woodland.

Table V.3.2 Uncertainties in Failure Times for Steel Pipes

COMPONENT	TIMES TO FAILURE (minutes)		
	JET FLAME	POOL FIRE	37.5 kW/m^2
Best estimate	5	10	No failure
Range	2 - 10	4 - 60	18 - No failure

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend

FPA AUSTRALIA | FLAMESOL

Calculated September 6, 2022, 1:32 pm (BALc v.4.9)

Grassland 0

Bushfire Attack Level calculator - AS3959-2018 (Method 2)			
Inputs		Outputs	
Grassland Fire Danger Index	110	Rate of spread	14.3 km/h
Vegetation classification	Grassland	Flame length	6.87 m
Understorey fuel load	4.5 t/ha	Flame angle	58 °
Total fuel load	4.5 t/ha	Panel height	5.82 m
Vegetation height	n/a	Elevation of receiver	2.91 m
Effective slope	0 °	Fire intensity	33,247 kW/m
Site slope	0 °	Transmissivity	0.884
Distance to vegetation	6.5 m	Viewfactor	0.5284
Flame width	100 m	Radiant heat flux	35.54 kW/m²
Windspeed	n/a	Bushfire Attack Level	BAL-40
Heat of combustion	18,600 kJ/kg		
Flame temperature	1,090 K		

Rate of Spread - Noble et al. 1980
Flame length - Purton, 1982
Elevation of receiver - Douglas & Tan, 2005
Flame angle - Douglas & Tan, 2005
Radiant heat flux - Drysdale, 1999, Sullivan et al., 2003, Douglas & Tan, 2005

FPA AUSTRALIA | FLAMESOL

Calculated September 6, 2022, 1:29 pm (BALc v.4.9)

Woodland 0

Bushfire Attack Level calculator - AS3959-2018 (Method 2)			
Inputs		Outputs	
Fire Danger Index	80	Rate of spread	1.43 km/h
Vegetation classification	Woodland	Flame length	12.35 m
Understorey fuel load	15 t/ha	Flame angle	56 °
Total fuel load	25 t/ha	Panel height	10.24 m
Vegetation height	n/a	Elevation of receiver	5.12 m
Effective slope	0 °	Fire intensity	18,599 kW/m
Site slope	0 °	Transmissivity	0.873
Distance to vegetation	11 m	Viewfactor	0.5608
Flame width	100 m	Radiant heat flux	37.23 kW/m²
Windspeed	n/a	Bushfire Attack Level	BAL-40
Heat of combustion	18,600 kJ/kg		
Flame temperature	1,090 K		

Rate of Spread - Mcarthur, 1973 & Noble et al., 1980
Flame length - NSW Rural Fire Service, 2001 & Noble et al., 1980
Elevation of receiver - Douglas & Tan, 2005
Flame angle - Douglas & Tan, 2005
Radiant heat flux - Drysdale, 1999, Sullivan et al., 2003, Douglas & Tan, 2005

The potential for ignition of bushfire prone vegetation due to onsite events is highly unlikely given the necessarily stringent controls around onsite fire ignition, including cleaning debris from vehicles, restriction on smoking areas, increased fire control systems etc. The event where bushfire prone vegetation is ignited is an extreme (potentially catastrophic) onsite scenario. A fireball due to onsite explosion could reach up to 100m, with flaming debris potentially reaching much greater distances. There is no appropriate Asset Protection Zone to mitigate the consequence of a catastrophic event.

The APZ required to be installed from all constructed assets and Class 1-10 of the Hydrogen Project, is to limit heat flux exposure to<10kW/m2 (calculated at 1200K). In terms of AS3959 this is within BAL-12.5.

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
The reasoning for this APZ, is it exceeds planning requirements, far exceeds the thresholds of all assets onsite, and allows for suitably protected Emergency Services personnel (or site personnel with suitable training and PPE) to actively defend the site during the passage of a fire front. These persons can combat consequential fires or provide external cooling to assets if necessary. *The <10kW/m2 APZ is established as the required APZ within the associated BMP.*						
6.2	**Siting of Buildings/Structures - Wind:** Site the buildings/structures/infrastructure in locations that have lower wind exposure. Avoid the top and sides of ridges which are especially vulnerable to fire driven winds as well as topographically influenced winds. Winds can directly or indirectly (carrying materials/debris) cause damage to the external building envelope potentially allowing flame, radiant heat and ember entry.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: The local area is gently undulating. There is little difference in wind exposure between possible locations.						
6.3	**Use of Non-Vegetated Areas and/or Public Open Space:** Reduce exposure by increasing separation from APZ landscaping vegetation and/or the bushfire hazard by incorporating these lowest threat areas adjacent to buildings/structures and/or adjacent to the bushfire hazard. These lowest threat components of the APZ include non-vegetated areas (e.g. footpaths, paved areas, roads, parking, drainage, swimming pools), formally managed areas of vegetation (public open space and other recreation areas) and services installed in a common section of non-vegetated land. These elements create robust and easier managed asset protection zones.	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The Hydrogen Project will be surrounded by a sealed, trafficable hardstand (truck loop road). This will create a minimum 6m non-vegetated buffer as the closest portion of the APZ.						
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.	Moderate	Yes	No	Yes	Yes

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Informative and/or Site Specific Comment/Assessment: A visual buffer is intended to be planted between the Hydrogen Project and Northam-York Road. *The species of tree will be determined by the Shire of Northam. This Risk Assessment includes a recommendation of tree species from the list provided by the Shire of Northam.* *It is required that the trunk of any planted tree, be located >1.5 the mature height of that tree from buildings or other constructed vital assets. For example, Eucalyptus melliodora has a typical maximum height of 30m, and must thus be planted >45m from buildings and constructed vital assets. It is therefore practical that shorter species are selected.*						
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 and LP Gas cylinder safety in bushfire prone areas (Energy Safety – Govt. of WA). 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).	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Any LPG will be stored in compliance with AS 1596.						
6.6	**Separation from Stored Flammable Products – Fuels / Other Hazardous Materials:** Establish sufficient separation distance between the consequential fire fuels and buildings/structures. The required separation distance will be dependent on the fuel and storage type.	Moderate	Yes	Yes	No	Yes
6.7	**Separation from Stored and Constructed Combustible Items:** 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. • 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".*	Moderate	Yes	Yes	No	Yes

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	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.					
Informative and/or Site Specific Comment/Assessment: Fuels and hazardous materials will be stored throughout the site and within structures as part of site operations. 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. *It is recommended that the siting of high-risk components (hydrogen storage, electrolysers, and trucks) within the facility layout, is separated from any consequential hazard where practical. The separation distance should be either 6m, or 3 times the total height of the consequential fire hazard, whichever is greater. Consequential hazards include rubbish bins, fuel jerry cans, cardboard boxes, and any object composed of plastic or wood.*						
PROTECTION PRINCIPLE – SHIELDING FROM ALL BUSHFIRE 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 threats to vulnerable exposed elements. 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

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Informative and/or Site Specific Comment/Assessment: The measure is not cost-effective for the scale which would be required to be effective (functional height and perimeter), and the radiant heat flux exposure of the assets (maximum 10kW/m2 radiant heat flux/BAL-12.5).						
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.	Moderate	Yes	No	No	No
Informative and/or Site Specific Comment/Assessment: Informative and/or Site Specific Comment/Assessment: Consequential fire hazards onsite are sealed within containers which are constructed to withstand 37.5kW/m2 radiant heat flux for a period of no less than 18 minutes. *The measure would have a negligible impact given the low radiant heat and no flame contact the stored hydrogen tanks would be exposed to.*						
6.10	**Natural Barrier - Landforms:** Use existing natural landforms to reduce buildings/structures exposure to radiant heat, and lower wind speeds (prevailing synoptic and/or fire driven).	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: No landforms are present.						
6.11	**Natural Barrier – Vegetation:** 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).	Moderate	Yes	No	Yes	Yes
Informative and/or Site Specific Comment/Assessment: A visual buffer is intended to be planted between the Hydrogen Project and Northam-York Road. *The species of tree will be determined by the Shire of Northam. This Risk Assessment includes a recommendation of tree species from the list provided by the Shire of Northam.*						
6.12	**Shield Non-Structural Essential Elements:** These are elements essential to the continued operation of the built asset which are potentially exposed to fire attack mechanisms of both bushfire and consequential fire. They include cabling and plumbing associated with power / data transmission and water / fuel 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.	Moderate	Yes	No	No	Yes
Informative and/or Site Specific Comment/Assessment: All high-risk components will be positioned such that they are subject to a maximum 10kW/m2 radiant heat flux (BAL-12.5). *Cabling and plumbing beyond the footprint of buildings or constructed assets are recommended to be installed underground, or shielding with non-combustible material (or enclosed) where practical.*						

EXPOSURE REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend

[1] **Protection Measure Effectiveness Rating:** Refer to section 2.3.5 for explanation and defining.

[2] **Protection Measure Application Status:**

- **Possible:** Protection measures that can potentially be applied to the proposed development/use;
- **Exists**: Protection measures already implemented by existing components of the proposed development/use. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary);
- **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 yet to be submitted 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 yet to be submitted 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).

7.5.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES

Table 7.18: For the stated element at risk and area of bushfire prone vegetation, the summarised number of bushfire protection measures that can be applied (and their corresponding effectiveness rating), is compared to the number available.

EXPOSURE REDUCING PROTECTION MEASURES – SUMMARY NUMBERS						
Element at Risk	Fixed (hard) infrastructure assets					
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).					
The Protection Principle	Effectiveness Rating [1]	Numbers of Protection Measures				
		Total Available	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Separation from the Hazard	Very High	-	-	-	-	-
	High	-	-	-	-	-
	Effective	1	1	-	1	1
	Moderate	5	5	4	1	3
	Not Relevant	1	-	-	-	-
Shielding from the Hazard	Very High	-	-	-	-	-
	High	1	1	-	-	-
	Effective	-	-	-	-	-
	Moderate	3	3	-	1	2
	Not Relevant	1	-	-	-	-
Total Numbers	**Very High**	**-**	**-**	**-**	**-**	**-**
	High	**1**	**1**	**-**	**-**	**-**
	Effective	**1**	**1**	**-**	**1**	**1**
	Moderate	**8**	**8**	**4**	**2**	**5**
	Not Relevant	**2**	**-**	**-**	**-**	**-**
	Totals	**12**	**10**	**4**	**3**	**6**

[1] Protection Measure Effectiveness Rating: Refer to section 2.3.5 for explanation and defining.

[2] Protection Measure Application Status: Refer to table footnotes on previous page.

7.5.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (EXPOSURE REDUCTION)

Table 7.19: For the stated element at risk, The potential impact of the applied protection measures in reducing exposure levels to the stated area of bushfire prone vegetation.

ASSESSED IMPACT OF APPLIED MEASURES (EXPOSURE REDUCTION)								
Element at Risk	Fixed (hard) infrastructure assets							
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).							
Exposure Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accumulation	Consequential Fire	Fire Driven Wind	Tree Strike / Obstruction
Existing and Planned (applied to inherent risk)	Minimal	Medium	Significant	Minimal	Minimal	Medium	Minimal	Minimal
	Medium				Minimal			
Existing, Planned and Recommended (applied to residual risk)	Significant	Very Significant	Very Significant	Medium	Significant	Significant	Minimal	Significant
	Significant				Significant			
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 4 for explanatory information.								

7.5.4 ASSESSED EXPOSURE LEVELS

Assessed as a function of the capacity to apply sufficient exposure reducing protection measures, their individual effectiveness and their combined impact in reducing the exposure of the identified element at risk (Note: This assessment is independent of the threat level and vulnerability level assessments).

Table 7.20: For the stated element at risk, the assessed exposure level corresponding to the stated area of bushfire prone vegetation.

ASSESSED EXPOSURE LEVELS	
Element at Risk	Fixed (hard) infrastructure assets
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).
Exposure Reducing Protection Measures Applied to Assessment [1]	Relative Exposure Level [2]
Existing and Planned (applied to inherent risk)	High
Existing, Planned and Recommended (applied to residual risk)	Low
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 2 for explanatory information.	

Assessment Comments: The relative exposure levels consider two primary inputs:

The BAL-29 APZ required for planning approval (including potential retained vegetation maintained to low threat), against the required <10kW/m2 radiant heat flux APZ from all structures associated with the Hydrogen Project, and;

The visual buffer (trees to be planted) between the Hydrogen Project and Northam-York Road having no controls applied, against the shortlisted tree selection provided and the requirement for 1.5x mature height setback of tree plantings.

8 VULNERABILITY LEVEL ASSESSMENT OF THE ELEMENTS AT RISK

SUMMARY OF THE QUALITATIVE ASSESSMENT PROCESS

1. Identify all protection measures (grouped by protection principle) that are available to reduce vulnerability levels and rate their effectiveness;
2. Produce a numerical summary of all potential vulnerability reducing protection measures that are available and determine their application status;
3. Assess the potential vulnerability reducing impact of the package of protection measures that is able to be applied. The effectiveness rating weights the potential impact of an individual measure; and
4. Derive the vulnerability level of the identified element at risk, to the threats presented by each identified area of bushfire prone vegetation (refer to Section 2.3.3 and Appendix 2 for additional risk assessment process information).

8.1 PERSONS ONSITE OR TEMPORARILY OFFSITE

8.1.1 PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS AND THEIR APPLICATION STATUS

Table 8.1: All available protection measures to reduce exposure of the stated element at risk to bushfire hazard threats and their application to the subject development/use.

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
ELEMENT AT RISK: PERSONS LOCATED ONSITE AND TEMPORARILY OFFSITE						
PROTECTION PRINCIPLE – TRANSPORT AND MULTIPLE EVACUATION DESTINATIONS AND ROUTES AVAILABLE						
7.1	**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.	Effective	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The location is within 2.6km of travel from the built-out area of the Northam townsite, but is otherwise relatively remote with no public transport, nor a reasonably walking commute. All staff must necessarily have their own transport. Any staff using bicycles can egress in the vehicles of other staff.						
7.2	**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.	Very High	Yes	Yes	No	No

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	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.					
Informative and/or Site Specific Comment/Assessment: Two-way access is available immediately on leaving the site. Multiple routes are available to multiple destinations within the local region including the townsites of Northam (north), Grass Valley (east), and York (south).						
PROTECTION PRINCIPLE – PROVISION OF BUSHFIRE EMERGENCY INFORMATION AND EDUCATION						
7.3	**Bushfire Emergency Plan:** Is produced and appropriately located within the site of the subject development/use. It is an operational document that details site specific preparation, response, recovery and review procedures. It is produced for use by the site owners, managers, operators and occupants (as relevant).	Effective	Yes	No	No	No
7.4	**Bushfire Emergency Poster:** A poster is prominently displayed, for the attention of all persons onsite. It presents the key emergency contacts, information sources and response procedures in the event of a bushfire event. It has increased value attached to its display when there are no bushfire emergency trained persons onsite or no persons that are familiar with the site and local area.	Moderate	Yes	No	No	No
7.5	**Bushfire Protection Measures to be Implemented are Published in the Relevant Operational Documents:** The relevant documents can include the Bushfire Management Plan (BMP), the Bushfire Emergency Plan (BEP), the Site Emergency Plan (as required to be developed by the operators of 'high risk' land uses), and any relevant documents associated with a projects design phase. The purpose of this measure is to ensure the application of relevant protection measures, that have been identified in this Bushfire Risk Assessment and Management Report, will be acted upon through responsibilities created by the operational documents.	Effective	Yes	No	No	Yes
Informative and/or Site Specific Comment/Assessment: The proposed facility has limited staffing (maximum 2 site staff and 2 truck drivers during operational periods). Permanent site staff will likely live within the local area, or else be familiar with evacuation routes. Contractors can be directed by staff. *Site staff are to be familiar with emergency procedures and preparation/display of separate bushfire emergency procedures is not necessary.* *The relevant information is to be included in the site Emergency Management Plan (document title pending), to include preparation and responses to bushfire emergencies.*						

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
7.6	**Prominent Display of Information Stating Safe Early Evacuation is the Primary Procedure:** For the subject development/use evacuation in the event of a bushfire within the locality has or is likely to be determined as the primary response procedure and that it must be conducted early. This option is available. The emphasis on early rather than a late evacuation is important. Analysis of past events identify that most people who die in bushfires are caught in the open, either in vehicles or on foot, because they have left their property too late. For evacuation to provide the safest response for occupants, it must be conducted early. Being on roads when a bushfire is close is a high risk action. Otherwise, sheltering-in-place is likely to provide greater protection to persons – particularly when a suitable onsite shelter place is identified.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: Site staff will be aware of the emergency response procedure, and can direct contractors (if present).						
7.7	**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.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: Staff will be familiar with the site. The Hydrogen Project will have regular staffing and is entirely trafficable by foot, and occupants can quickly move to the onsite shelter location. The solar arrays will usually be unstaffed, and any staff present will have their vehicle nearby and know the location of the Hydrogen Project (as it is next to the site entry). *Staff and contractors working within the solar arrays are required to be contactable by the Hydrogen Project administration (via mobile/satellite phone, two-way radio etc).*						
7.8	**Trained Personnel Onsite:** Operational persons (staff) are provided with bushfire emergency management training, aligned with the subject site's prepared Bushfire Emergency Plan (BEP). The intent also includes identifying the specific roles and persons to fill any required responsibilities that have determined through the BEP construction process.	Moderate	Yes	No	Yes	Yes
Informative and/or Site Specific Comment/Assessment: The site Emergency Management Plan (document title pending) will designate Fire Wardens who will be trained in implementing the site responses to bushfire.						
7.9	**Build Community Resilience Through Education:** When relevant to the type and scale of proposed development/use, the delivery of effective education programs can result in lowering the vulnerability of the community to a bushfire event, once the information has been acted upon and packages of protection measures put in place. Local government develops an ongoing program of innovative and leading edge community and landowner education that builds on the information presented within this Bushfire Risk Assessment and Management Report. Subsequent implementation of recommended/required protection measures can be encouraged through legislation, education, audits, enforcement and penalties as appropriate.	Not Relevant	N/A	N/A	N/A	N/A

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	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.					
7.10	**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 buildings and persons. It identifies appropriate protection measures to increase bushfire resilience.	Not Relevant	N/A	N/A	N/A	N/A
PROTECTION PRINCIPLE – A BUSHFIRE EMERGENCY FIREFIGHTING CAPABILITY EXISTS (RESPONSE)						
7.11	**Personnel Onsite Can 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 site preparation, response and recovery procedures from the required 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 required Bushfire Emergency Plan for the subject development/use and will ensure the preparation, response and recovery procedures established by the required Bushfire Emergency Plan are conducted appropriately and provide emergency event guidance to any other persons onsite.	Effective	Yes	No	No	Yes
Informative and/or Site Specific Comment/Assessment: The site Emergency Management Plan (document title pending) will designate Fire Wardens who will be trained in implementing the site responses to bushfire.						
7.12	**Personnel Onsite 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.	Moderate	Yes	No	Yes	No
Informative and/or Site Specific Comment/Assessment: Staff will receive basic instruction on operation of firefighting equipment and procedures for suppression or prevention of fire spread.						
7.13	**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 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.	Not Relevant	N/A	N/A	N/A	N/A

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Informative and/or Site Specific Comment/Assessment: No vulnerable persons will be onsite.						
7.14	**External Emergency Services Available:** An emergency service with a bushfire response capability is located within a realistic operational distance of the subject development/use. Bushfire services include volunteer bushfire brigades, volunteer fire and emergency services, DFES career fire and Rescue Service or Parks and Wildlife. Even if an emergency service response capability exists, effectiveness will be limited by number of resources and their availability likelihood 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. 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."*	Effective	Yes	Yes	No	Yes
Informative and/or Site Specific Comment/Assessment: It is required that the Toodyay State Emergency Service and Northam Volunteer Fire and Rescue Service is invited to inspect and familiarise with the site. Provide information in site fire response procedures. This invitation is to be extended after completion of construction and before commissioning. Additional invitations are recommended, which may be annual or ad-hoc as appropriate. A manifest is to be provided and made available at site entry, detailing site fire response procedures and hazards.						

[1] **Protection Measure Effectiveness Rating:** Refer to section 2.3.5 for explanation and defining.

[2] **Protection Measure Application Status:**

- **Possible:** Protection measures that can potentially be applied to the proposed development/use;
- **Exists**: Protection measures already implemented by existing components of the proposed development/use. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary);
- **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

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend
• Exist in a yet to be submitted 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 yet to be submitted 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).					

8.1.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES

Table 8.2: For the stated element at risk and area of bushfire prone vegetation, the summarised number of bushfire protection measures that can be applied (and their corresponding effectiveness rating), is compared to the number available.

VULNERABILITY REDUCING PROTECTION MEASURES – SUMMARY NUMBERS							
Element at Risk	Persons located onsite and temporarily offsite						
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).						
The Protection Principle	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Exists	Planned	Additionally Recommend	
Transport and Multiple evacuation destinations and routes available	Very High	1	1	1	-	-	
	High	-	-	-	-	-	
	Effective	1	1	1	-	-	
	Moderate	-	-	-	-	-	
	Not Relevant	-	-	-	-	-	
Provision of bushfire emergency information and education	Very High	-	-	-	-	-	
	High	-	-	-	-	-	
	Effective	2	2	-	-	1	
	Moderate	2	2	-	1	1	
	Not Relevant	4	-	-	-	-	
A bushfire emergency firefighting capability exists (response)	Very High	-	-	-	-	-	
	High	-	-	-	-	-	
	Effective	2	2	1	-	2	
	Moderate	1	1	-	1	-	
	Not Relevant	1	-	-	-	-	
Total Numbers	**Very High**	**1**	**1**	**1**	**-**	**-**	
	High	**-**	**-**	**-**	**-**	**-**	
	Effective	**5**	**5**	**2**	**-**	**3**	
	Moderate	**3**	**3**	**-**	**2**	**1**	
	Not Relevant	**5**	**-**	**-**	**-**	**-**	
	Totals	**14**	**9**	**3**	**2**	**4**	

[1] Protection Measure Effectiveness Rating: Refer to section 2.3.5 for explanation and defining.

[2] Protection Measure Application Status: Refer to table footnotes on previous page.

8.1.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (VULNERABILITY REDUCTION)

Table 8.3: For the stated element at risk, The potential impact of the applied protection measures in reducing vulnerability levels to the stated area of bushfire prone vegetation.

ASSESSED IMPACT OF APPLIED MEASURES (VULNERABILITY REDUCTION)								
Element at Risk	Persons located onsite and temporarily offsite							
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).							
Vulnerability Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accumulation	Consequential Fire	Fire Driven Wind	Tree Strike / Obstruction
Existing and Planned (applied to inherent risk)	N/A	Medium	Significant	N/A	Medium	Medium	N/A	N/A
	Significant				Medium			
Existing, Planned and Recommended (applied to residual risk)	N/A	Very Significant	Significant	N/A	Medium	Very Significant	N/A	N/A
	Very Significant				Significant			
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 4 for explanatory information.								

8.1.4 ASSESSED VULNERABILITY LEVELS

Assessed as a function of the capacity to apply sufficient vulnerability reducing protection measures, their individual effectiveness and their combined impact in reducing the vulnerability of the identified element at risk (Note: This assessment is independent of the threat level and exposure level assessments).

Table 8.4: For the stated element at risk, the assessed exposure level corresponding to the stated area of bushfire prone vegetation.

ASSESSED VULNERABILITY LEVELS	
Element at Risk	Persons located onsite and temporarily offsite
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).
Vulnerability Reducing Protection Measures Applied to Assessment [1]	Relative Vulnerability Level [2]
Existing and Planned (applied to inherent risk)	Low
Existing, Planned and Recommended (applied to residual risk)	Very Low
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 2 for explanatory information.	

Assessment Comments: Persons are not vulnerable to direct ember attack or surface fire impacts. The solar farm developments will not be staffed (except intermittent maintenance), so the assessment is in relation to the Hydrogen Project.

Recommendations are for the inclusion of preparation, responses and training for bushfire events to be included in the future site Emergency Management Plan (document title pending), and for the Toodyay State Emergency Service and Northam Volunteer Fire and Rescue Service to be invited to familiarise with the site. A suitable onsite shelter building will be provided, and all occupants will be aware of evacuation routes and have transport available.

8.2 PERSONS ON ACCESS/EGRESS ROUTES (IN VEHICLES) OR PATHWAYS

8.2.1 PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS AND THEIR APPLICATION STATUS

Table 8.5: All available protection measures to reduce exposure of the stated element at risk to bushfire hazard threats and their application to the subject development/use.

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		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:	All bushfire prone vegetation within the broader locality (10km radius) including along access routes.					
PROTECTION PRINCIPLE – APPLY BEST (SAFER) ROAD DESIGN AND CONSTRUCTION (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.						
8.1	**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	No	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The measure is not under the control of the landowner/developer. Northam-York Road is a local main road and approximately 8m wide, usually with trafficable shoulders for a minimum 10m trafficable horizontal clearance.						
8.2	**Road Gradient:** Ensure appropriate road gradients are available. Lower gradients ensure traction and speed can be maintained and 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.	High	No	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The measure is not under the control of the landowner/developer. The road gradients are almost entirely flat.						
8.3	**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;	High	No	Yes	No	No

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Informative and/or Site Specific Comment/Assessment: Trees and powerlines do not overhang the road, so vertical clearance is unrestricted.						
8.4	**Road Surface Materials:** 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.	High	No	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The measure is not under the control of the landowner/developer. Northam-York Road has a sealed, all-weather surface designed to carry heavy and industrial vehicles. There is no limitation for the residential vehicles (<2 ton) used by site staff.						
8.5	**Driver Visibility and Road Ahead Signage:** Ensure that road design provides high levels of visibility ahead (at least 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 'blind' corners and crests to the greatest extent possible.	High	No	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The measure is not under the control of the landowner/developer. Northam-York Road has long straight sections (minimum length 500m) with gentle curves (<20 degrees).						
8.6	**Road / Pathway Length:** Shorter distances to safer locations reduce the length of time persons remain vulnerable to bushfire threats.	Very High	No	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The measure is not under the control of the landowner/developer. The nearest low threat area is Northam townsite, reached after approximately 2.6km (2 mins) travel.						
8.7	**Interconnected Roads:** Ensuring that the design of the road network provides through roads and avoids dead-end roads, provides the choice of alternative routes for drivers to minimise close contact with a bushfire event. Otherwise vehicles and persons can be trapped.	High	No	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The measure is not under the control of the landowner/developer. Some minor side roads in the area are no through-roads. All major roads are through-roads, and only major roads are required for access/egress (Northam-York Road and Muluckine Road).						
PROTECTION PRINCIPLE – EVACUEES SELF-SUFFICIENT (LOCAL AWARENESS AND 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 meet the SPP 3.7 definition of 'vulnerable' where the most vulnerable are likely to be less 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.						

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
8.8	**Self Sufficient Persons with Local Awareness:** These are the type of persons that will be present on the site of the proposed development/use.	Effective	Yes	Yes	No	No
8.9	**Persons Onsite Have Own Transport:** There is no need to have arrangements in place for external provision of evacuation vehicles.	Effective	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Staff will likely live within the local area, or else be familiar with the road network and evacuation routes. Staff and contractors/visitors must necessarily have their own transport to access the site. Any persons using bicycles can egress in the vehicles of other staff.						

[1] **Protection Measure Effectiveness Rating:** Refer to section 2.3.5 for explanation and defining.

[2] **Protection Measure Application Status:**

- **Possible:** Protection measures that can potentially be applied to the proposed development/use;
- **Exists**: Protection measures already implemented by existing components of the proposed development/use. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary);
- **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 yet to be submitted 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 yet to be submitted 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).

8.2.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES

Table 8.6: For the stated element at risk and area of bushfire prone vegetation, the summarised number of bushfire protection measures that can be applied (and their corresponding effectiveness rating), is compared to the number available.

VULNERABILITY REDUCING PROTECTION MEASURES – SUMMARY NUMBERS							
Element at Risk	Persons on access/egress routes in vehicles						
Access/Egress Route ID	All bushfire prone vegetation within the broader locality (10km radius) including along access routes.						
The Protection Principle	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Exists	Planned	Additionally Recommend	
Road Design and Construction (Materials)	Very High	1	-	1	-	-	
	High	6	-	6	-	-	
	Effective	-	-	-	-	-	
	Moderate	-	-	-	-	-	
	Not Relevant	-	-	-	-	-	
Evacuees Self-Sufficient in Transport and Local Knowledge	Very High	-	-	-	-	-	
	High	-	-	-	-	-	
	Effective	2	2	2	-	-	
	Moderate	-	-	-	-	-	
	Not Relevant	-	-	-	-	-	
Total Numbers	**Very High**	**1**	**-**	**1**	**-**	**-**	
	High	**6**	**-**	**6**	**-**	**-**	
	Effective	**2**	**2**	**2**	**-**	**-**	
	Moderate	**-**	**-**	**-**	**-**	**-**	
	Not Relevant	**-**	**-**	**-**	**-**	**-**	
	Totals	**9**	**2**	**9**	**-**	**-**	

[1] Protection Measure Effectiveness Rating: Refer to section 2.3.5 for explanation and defining.

[2] Protection Measure Application Status: Refer to table footnotes on previous page.

8.2.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (VULNERABILITY REDUCTION)

Table 8.7: For the stated element at risk, the assessed impact of the applied protection measures corresponding to the stated area of bushfire prone vegetation.

ASSESSED IMPACT OF APPLIED MEASURES (VULNERABILITY REDUCTION)								
Element at Risk	Persons on access/egress routes in vehicles							
Access/Egress Route ID	All bushfire prone vegetation within the broader locality (10km radius) including along access routes.							
Vulnerability Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accumulation	Consequential Fire	Fire Driven Wind	Tree Strike / Obstruction
Existing and Planned (applied to inherent risk)	Medium	Significant	Significant	Significant	N/A	N/A	Minimal	Medium
	Significant				Medium			
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 4 for explanatory information.								

8.2.4 ASSESSED VULNERABILITY LEVELS

Assessed as a function of the capacity to apply sufficient vulnerability reducing protection measures, their individual effectiveness and their combined impact in reducing the vulnerability of the identified element at risk (Note: This assessment is independent of the threat level and exposure level assessments).

Table 8.8: For the stated element at risk, the assessed exposure level corresponding to the stated area of bushfire prone vegetation.

ASSESSED VULNERABILITY LEVELS	
Element at Risk	Persons on access/egress routes in vehicles
Access/Egress Route ID	All bushfire prone vegetation within the broader locality (10km radius) including along access routes.
Vulnerability Reducing Protection Measures Applied to Assessment [1]	Relative Vulnerability Level [2]
Existing and Planned (applied to inherent risk)	Low
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 2 for explanatory information.	

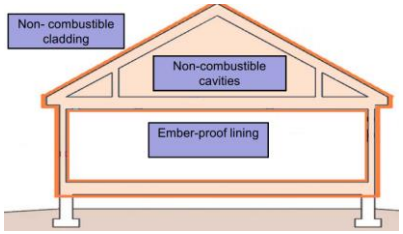
Assessment Comments: No recommendations are applicable. The inherent and residual risk are the same. Suitable transportation, awareness, and suitable egress route(s) are all available and are not under the control of the developer to improve.

8.3 BUILDINGS AND STRUCTURES NCC CLASSES 1-10 (ELEMENT AT RISK CATEGORIES 3-10)

8.3.1 PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS AND THEIR APPLICATION STATUS

Table 8.9: All available protection measures to reduce exposure of the stated element at risk to bushfire hazard threats and their application to the subject development/use.

	VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
ELEMENT AT RISK: BUILDINGS/STRUCTURES - NCC CLASSES 1-10 (CATEGORIES 5, 8, 10a, 10b)						
PROTECTION PRINCIPLE – DESIGN AND CONSTRUCTION (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.					
9.1	**Construction to a Standard - 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	Yes	No	Yes
9.2	**Construction to a Standard – NASH Standard [33]:** Apply the specified requirements to construction. The Standard:	Not Relevant	N/A	N/A	N/A	N/A

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend
"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;  • 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.					
Informative and/or Site Specific Comment/Assessment: Structures which are not enclosed do not have a construction which can comply with AS 3959 or NASH. Any relevant buildings (such as a site office or enclosed warehouse) are to be constructed to BAL-12.5 at a minimum, however this will not influence the High Risk components of the proposed use. These are addressed in Section 8.4 as a Fixed (Hard) Infrastructure Asset.					

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
9.3	**Construction Materials – External And Internal Cavity Building Elements:** Excluding 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	Unknown	No	Yes
Informative and/or Site Specific Comment/Assessment: The construction of proposed structures is currently unknown. They will likely be primarily masonry, steel, aluminium and cement sheeting. It is recommended non-combustible elements are included where practical.						
9.4	**Construction Materials – Consequential Fire Fuels:** For constructed large consequential fire fuels, construct using non-combustible materials to the fullest extent possible. These include: • Surrounding landscaping items - fences/screens, retaining walls, gazebos, plastic water tanks etc; • Attached structures - decks, verandahs, stairs, carports, garages, pergolas, patios, etc; • 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].	Very High	Yes	Yes	No	Yes
Informative and/or Site Specific Comment/Assessment: Non-structural features such as lattice, garden edging, fencing etc are recommended to be composed from non-combustible materials where practical.						
9.5	**Construction – Resistant To High Wind:** 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 houses 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 broader landscape.	High	Yes	Yes	No	No

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Informative and/or Site Specific Comment/Assessment: Due to the location of the site being almost entirely pasture or cropland on flat ground, it is extremely unlikely that fire-driven wind would be sufficient to compromise structural integrity. Ember screening and enclosed subfloors will reduce the impact of wind-blown embers. No measures are available in management of wind-blown embers for open-faced structures.						
9.6	**Construction – Gas Supply:** All gas cylinders are installed and maintained in accordance with AS 1596. This standard includes requirements for small portable cylinders and larger cylinders used for domestic house supply. These include: • 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 local 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 local 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.	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Gas cylinders will be positioned >6m from stored combustible material and comply with AS1596.						
9.7	**Construction - 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.	Moderate	Yes	No	Yes	Yes
Informative and/or Site Specific Comment/Assessment: Common electrical cabling reaches its critical point at >12kWm2. The APZ for the proposed Hydrogen Project has been determined at <10kW/m2 radiant heat flux, and calculated at 1200K flame temperature rather than the 1090K assumed in AS3959 Method 1. It is recommended that exposed electrical cabling beyond the footprint of buildings and constructed assets, be shielded from radiant heat and consequential fire by burying underground, enclosing within a structure, or shielding with non-combustible material.						

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
9.8	**Minimise Debris and Ember Accumulation – Re-Entrant Detail:** Avoid or minimise the accumulation of unburnt debris and embers by avoiding 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).	High	Yes	Unknown	No	Yes
9.9	**Minimise Debris and Ember Accumulation – Trapping Surfaces:** Avoid or minimise the use of exposed combustible surfaces that can trap and accumulate embers. These can 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).	Moderate	Yes	Unknown	No	Yes
9.10	**Minimise Debris and Ember Accumulation – Roof Plumbing:** 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.	Moderate	Yes	Unknown	No	Yes
Informative and/or Site Specific Comment/Assessment: The design of Class 1-10 buildings is unknown at this stage but are likely relatively simple. It is recommended that future designs are investigated for complexities which may trap debris or collect embers, and remove or enclose these complexities where practical. Functionally this means preventing details which may accumulate debris and leaf litter which will not naturally be cleared by wind.						
9.11	**Minimise Debris and Ember Accumulation – Construction Cavities:** 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.	Moderate	Yes	Unknown	No	Yes
Informative and/or Site Specific Comment/Assessment: Any subfloor cavities must be enclosed, sealed with non-combustible material, or have ember screening installed. Some proposed structures may have open faces as part of the core design.						
9.12	**Minimise Flame/Radiant Heat/Ember/Debris Entry - External Openings:** Limit potential sites for entry through the external envelope to internal spaces and combustible materials within (as consequential fire fuels).	High	Yes	No	Yes	No
9.13	**Screening and Sealing - Gaps and Penetrations:** Apply fire rated sealants and/or install metal screening (corrosion resistant steel, bronze, aluminium <2mm aperture).	Moderate	Yes	No	No	Yes

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	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.					
Informative and/or Site Specific Comment/Assessment: It is recommended that any enclosed Class 1-10 buildings have ember screening/sealants installed on any gaps and penetrations.						
9.14	**Screening - 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.	Moderate	Yes	No	Yes	No
9.15	**Shutters - External Doors and Windows**: Fire rated shutters Installed to significantly increase bushfire resistance of the vulnerable building elements. Any requirement for onsite manual activation is a potential limitation to effectiveness.	Moderate	Yes	No	No	No
Informative and/or Site Specific Comment/Assessment: The primary hazard is the interaction of onsite fuels (hydrogen processing and storage) and bushfire prone vegetation. The measures are excessive for the minor improvement of resilience in relevant buildings. Ember screening over openable parts of windows will be required due to the requirement for buildings to be constructed to their assessed BAL.						
9.16	**Landscaping Construction - Fences and Walls:** Non-combustible materials are used for fences, walls (including retaining walls), screens, garden edging, play equipment and other built structures - as potential consequential fire fuels. Where relevant, the capacity to resist high winds, to minimise potential for impact damage to subject building/structure, should also be incorporated.	Moderate	Yes	No	No	Yes
Informative and/or Site Specific Comment/Assessment: Any security fences or other potential fuel loads should be constructed using non-combustible material. Landscaping (gardens) which may be included within the APZ should avoid use of constructed heavy fuels (e.g. timber sleepers as garden edges, plastic or timber lattice).						
PROTECTION PRINCIPLE – FIREFIGHTING CAPABILITY: Provide sufficient, reliable and bushfire resilient water supply and delivery capability as is necessary for active and/or passive systems.						
9.17	**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;	Effective	Yes	Yes	No	Yes

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	• 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.					
Informative and/or Site Specific Comment/Assessment: The site is serviced with a reticulated water supply but this is unlikely to be sufficient for firefighting operations. A static firefighting water supply will be supplied. *The Guidelines for Planning in Bushfire Prone Areas does not establish a firefighting water supply for non-habitable buildings, including high-risk uses. In the absence of specific requirements at the national or state level for Hydrogen production facilities, a conservative approach is applied in the firefighting water supply for the determination of the appropriate water supply. The facility will achieve simultaneous compliance with multiple sets of guidelines or standards, by applying the most stringent of the components of each.* • *The* Design Guidelines and Model Requirements – Renewable Energy Facilities (Victorian Country Fire Authority March 2022) *discusses multiple renewable energy types but not Hydrogen. The most stringent water requirements are for Battery Energy Storage Systems, and this will be applied.* • *The* Guidelines for Planning in Bushfire Prone Areas v1.4 (WAPC 2021) *is prescriptive on access to the water supply and couplings to be installed.* • AS2419-2005: Fire Hydrant Installations *provides the appropriate water volume for the facility, water pressure, and number of hydrants.* • DFES Operational Requirement Guideline 5: Hydrants and Hose Length (DFES April 2020) *recommends a 60m hose lay rather than the 60m+10m stream in* AS2419. *A separate brief is provided as an Addendum within the associated BMP, outlining the combined water specifications for the facility.*					
9.18	**Firefighting Equipment – Active Operation:** In addition to a dedicated water supply, appropriate firefighting equipment is installed (pumps, hoses, sprinklers etc). 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). 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.	Effective	Yes	Yes	No	No
9.19	**Firefighting Equipment – Passive Operation:** 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	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Additional firefighting equipment and systems will be installed, including fire extinguishers, hose reels, deluge systems in the truck bay, and sprinklers. Additional measures have not been provided.						
9.20	**Firefighting Equipment – Maintain Operability:** 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	Moderate	Yes	Yes	Yes	Yes

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	(e.g. falling trees/branches, fire, or other impact sources). For example, bury transmission systems to the greatest extent possible.					
Informative and/or Site Specific Comment/Assessment: The firefighting water supply will be compliant with both Design Guidelines and Model Requirements – Renewable Energy Facilities *and the* Guidelines for Planning in Bushfire Prone Areas *including access and construction of the tanks and boosters. It is recommended that hydrant boosters and other firefighting systems as appropriate, are supported by generators to ensure continued operation.*						
9.21	**Firebreaks – Primarily for Access:** Installation and maintenance of firebreaks to remove vegetation, limit surface fire progression and facilitate firefighting access / backburning.	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The site is currently compliant with the Shire of Northam Firebreak Notice.						
PROTECTION PRINCIPLE – MANAGEMENT AND MAINTAINING 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.						
9.22	**Formal Management/Maintenance Plan – Actions and Responsibilities:** Through a bushfire management plan, site operations emergency plan, bushfire emergency plan, operational annual works plan and/or a 'firebreak' notice, 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; and • The relevant protection measures are known and understood; and • Responsibilities are created The different documents will be able to satisfactorily perform this function to differing extents.	Effective	Yes	No	No	Yes
Informative and/or Site Specific Comment/Assessment: The documents have been or will be produced. Ongoing requirements established in this Risk Assessment and Section 5.7 of the associated Bushfire Management Plan, must be included in operational documents.						

[1] **Protection Measure Effectiveness Rating:** Refer to section 2.3.5 for explanation and defining.

[2] **Protection Measure Application Status:**

- **Possible:** Protection measures that can potentially be applied to the proposed development/use;
- **Exists**: Protection measures already implemented by existing components of the proposed development/use. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary);
- **Planned:** Protection measures that:

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend
• 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 yet to be submitted 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 yet to be submitted 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).					

8.3.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES

Table 8.10: For the stated element at risk and area of bushfire prone vegetation, the summarised number of bushfire protection measures that can be applied (and their corresponding effectiveness rating), is compared to the number available.

VULNERABILITY REDUCING PROTECTION MEASURES – SUMMARY NUMBERS							
Element at Risk	Buildings/Structures - NCC Classes 1-10						
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).						
The Protection Principle	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Exists	Planned	Additionally Recommend	
Design and Construction (Materials)	Very High	2	2	1	-	2	
	High	4	4	2	1	2	
	Effective	-	-	-	-	-	
	Moderate	9	9	1	3	6	
	Not Relevant	1	-	-	-	-	
Firefighting Capability	Very High	-	-	-	-	-	
	High	1	1	1	-	-	
	Effective	2	2	2	-	1	
	Moderate	2	2	2	1	1	
	Not Relevant	-	-	-	-	-	
Management and Maintaining Effectiveness of Applied Protection Measures	Very High	-	-	-	-	-	
	High	-	-	-	-	-	
	Effective	1	1	-	-	1	
	Moderate	-	-	-	-	-	
	Not Relevant	-	-	-	-	-	
Total Numbers	**Very High**	**2**	**2**	**1**	**-**	**2**	
	High	**5**	**5**	**3**	**1**	**1**	
	Effective	**3**	**3**	**2**	**-**	**2**	
	Moderate	**11**	**11**	**3**	**4**	**7**	
	Not Relevant	**1**	**-**	**-**	**-**	**-**	
	Totals	**22**	**21**	**9**	**5**	**12**	

[1] Protection Measure Effectiveness Rating: Refer to section 2.3.5 for explanation and defining.

[2] Protection Measure Application Status: Refer to table footnotes on previous page.

8.3.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (VULNERABILITY REDUCTION)

Table 8.11: For the stated element at risk, The potential impact of the applied protection measures in reducing vulnerability levels to the stated area of bushfire prone vegetation.

ASSESSED IMPACT OF APPLIED MEASURES (VULNERABILITY REDUCTION)								
Element at Risk	Buildings/Structures - NCC Classes 1-10							
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).							
Vulnerability Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accumulation	Consequential Fire	Fire Driven Wind	Tree Strike / Obstruction
Existing and Planned (applied to inherent risk)	Minimal	Significant	Medium	Medium	Minimal	Significant	Medium	Minimal
	Medium				Medium			
Existing, Planned and Recommended (applied to residual risk)	Significant	Very Significant	Significant	Significant	Significant	Very Significant	Medium	Minimal
	Significant				Significant			
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 4 for explanatory information.								

Assessment Comments: The protection measures concentrate on reducing the vulnerability of building(s) to ember attack, including ember screening, construction to AS 3959, and preventing leaf litter/debris accumulation. The structural components of the proposed Class 1-10 buildings are likely already resistant to bushfire impacts but are recommended to be non-combustible to the highest practical level.

8.3.4 ASSESSED VULNERABILITY LEVELS

Assessed as a function of the capacity to apply sufficient vulnerability reducing protection measures, their individual effectiveness and their combined impact in reducing the vulnerability of the identified element at risk (Note: This assessment is independent of the threat level and exposure level assessments).

Table 8.12: For the stated element at risk, the assessed exposure level corresponding to the stated area of bushfire prone vegetation.

ASSESSED VULNERABILITY LEVELS	
Element at Risk	Buildings/Structures - NCC Classes 1-10
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).
Vulnerability Reducing Protection Measures Applied to Assessment [1]	Relative Vulnerability Level [2]
Existing and Planned (applied to inherent risk)	Moderate
Existing, Planned and Recommended (applied to residual risk)	Low
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 2 for explanatory information.	

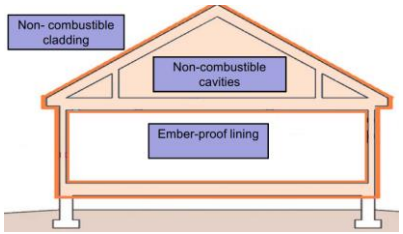
Assessment Comments: Class 1-10 buildings will be robust against bushfire impacts.

8.4 FIXED (HARD) INFRASTRUCTURE ASSETS: SOLAR ARRAYS

8.4.1 PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS AND THEIR APPLICATION STATUS

Table 8.13: All available protection measures to reduce exposure of the stated element at risk to bushfire hazard threats and their application to the subject development/use.

	VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
ELEMENT AT RISK: FIXED (HARD) INFRASTRUCTURE ASSETS						
PROTECTION PRINCIPLE – DESIGN AND CONSTRUCTION (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.						
10.1	**Construction to a Standard - 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.	Not Relevant	N/A	N/A	N/A	N/A
10.2	**Construction to a Standard – 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.	Not Relevant	N/A	N/A	N/A	N/A

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	Key attributes of the Standard that may have relevance to other built assets include: • 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.					
10.3	**Construction Materials – External and Internal Cavity Building Elements:** Excluding 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.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: Solar arrays do not have a construction which can comply with AS 3959 or NASH, and do not have internal or external cavities.						
10.4	**Construction Materials – Consequential Fire Fuels:** For constructed large consequential fire fuels, construct using non-combustible materials to the fullest extent possible. These can include attached structures, adjacent structures and surrounding landscaping items.	Very High	Yes	Yes	No	No

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Informative and/or Site Specific Comment/Assessment: Supports and framework are non-combustible, being largely concrete or steel. The solar arrays cannot have their materials modified.						
10.5	**Construction – Resistant To High Wind:** 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 broader landscape.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: Solar arrays cannot have their design modified.						
10.6	**Construction – 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 local 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 local 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	Not Relevant	N/A	N/A	N/A	N/A

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	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.					
Informative and/or Site Specific Comment/Assessment: Gas will not be stored within the arrays.						
10.7	**Construction Materials – Non-Structural Essential Elements:** Utilise fire/radiant heat rated products (rated to the level determined as necessary), for the construction of non-structural elements that are essential to the continued operation of the built asset and are exposed to a bushfire hazard. These include cabling and plumbing associated with power / data transmission and water / fuel transport.	High	Yes	Unknown	No	Yes
Informative and/or Site Specific Comment/Assessment: A BAL-29 APZ is applied to the solar arrays, as they are resistant to the radiant heat experienced for the short duration of a grassland fire (maximum residence 30 seconds). The APZ will prevent flame contact and extreme levels of radiant heat. Common electrical cabling reaches its critical point at >12kWm2. It is recommended that exposed electrical cabling within the solar array developments, be shielded from radiant heat and consequential fire by burying underground, enclosing within a structure, or shielding with non-combustible material.						
10.8	**Minimise Debris and Ember Accumulation – Re-Entrant Detail:** Avoid or minimise the accumulation of unburnt debris and embers by avoiding 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).	High	Yes	Yes	No	No
10.9	**Minimise Debris and Ember Accumulation – Trapping Surfaces:** Avoid or minimise the use of exposed combustible surfaces that can trap and accumulate embers. These can 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).	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The design of solar arrays cannot be modified. Supports and framework are simple posts at ground-level and arrays are elevated from the ground.						

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
10.10	**Minimise Debris and Ember Accumulation – Roof Plumbing:** 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.	Not Relevant	N/A	N/A	N/A	N/A
10.11	**Minimise Debris and Ember Accumulation – Construction Cavities:** 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.	Not Relevant	N/A	N/A	N/A	N/A
10.12	**Minimise Flame/Radiant Heat/Ember/Debris Entry - External Openings:** Limit potential sites for entry to internal spaces through the external envelope and combustible materials within (as consequential fire fuels).	Not Relevant	N/A	N/A	N/A	N/A
10.13	**Screening and Sealing - 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.	Not Relevant	N/A	N/A	N/A	N/A
10.14	**Screening - 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.	Not Relevant	N/A	N/A	N/A	N/A
10.15	**Shutters - External Doors and Windows**: Fire rated shutters Installed to significantly increase bushfire resistance of the vulnerable building elements. Any requirement for onsite manual activation is a potential limitation to effectiveness.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: Solar arrays do not have the above components.						
10.16	**Landscaping Construction - Fences and Walls:** Non-combustible materials are used for fences, walls (including retaining walls), screens and other built structures - as potential consequential fire fuels. Where relevant, the capacity to resist high winds, to minimise potential for impact damage to subject building/structure, should also be incorporated.	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Existing and future fencing is metal chain wire with no combustible components.						

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
PROTECTION PRINCIPLE – FIREFIGHTING CAPABILITY: Provide sufficient, reliable and bushfire resilient water supply and delivery capability as is necessary for active and/or passive systems.						
10.17	**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; • 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.	Effective	Yes	Yes	Yes	Yes
Informative and/or Site Specific Comment/Assessment: Following the approach for the Hydrogen Project, the highest standards available will be applied. The Design Guidelines and Model Requirements – Renewable Energy Facilities (Victorian Country Fire Authority March 2022) *requires a 45,000L water supply for the solar farm component of the development. The* Guidelines for Planning in Bushfire Prone Areas *does not establish a firefighting water supply for non-habitable buildings, including high-risk uses, however the generally accepted supply is 50,000L minimum larger scale, non-habitable constructions.* *The water supply to service the Hydrogen Project will be located near the site entry and will be compliant with the requirements for couplings and access of both sets of* Guidelines. *The 1,152,000L minimum water supply for the hydrogen project will be ample for the purposes of the solar farm components of the development.*						
10.18	**Firefighting Equipment – Active Operation:** 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.	Not Relevant	N/A	N/A	N/A	N/A
10.19	**Fire Fighting Equipment – Passive Operation:** 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).	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: Additional firefighting equipment is not proposed.						

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
10.20	**Fire Fighting Equipment – Maintain Operability:** 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.	Moderate	Yes	Yes	Yes	Yes
Informative and/or Site Specific Comment/Assessment: The firefighting water supply will be compliant with both Design Guidelines and Model Requirements – Renewable Energy Facilities *and the* Guidelines for Planning in Bushfire Prone Areas *including access and construction of the tanks and boosters. It is recommended that hydrant boosters and other firefighting systems as appropriate, are supported by generators to ensure continued operation.*						
10.21	**Firebreaks – Primarily for Access:** Installation and maintenance of firebreaks to remove vegetation, limit surface fire progression and facilitate firefighting access / backburning.	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The site will comply with the Shire of Northam Firebreak Notice. A firebreak will be installed and maintained both around the lot boundary, and around the solar farm perimeter.						
PROTECTION PRINCIPLE – MANAGEMENT AND MAINTAINING 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.						
10.22	**Formal Management/Maintenance Plan – Actions and Responsibilities:** Through a bushfire management plan, site operations emergency plan, bushfire emergency plan, operational annual works plan and/or a 'firebreak' notice, 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; and • The relevant protection measures are known and understood; and • Responsibilities are created The different documents will be able to satisfactorily perform this function to differing extents.	Effective	Yes	No	No	Yes
Informative and/or Site Specific Comment/Assessment: The documents have been or will be produced. Ongoing requirements established in this Risk Assessment and Section 5.7 of the associated Bushfire Management Plan, must be included in operational documents.						

[1] **Protection Measure Effectiveness Rating:** Refer to section 2.3.5 for explanation and defining.

[2] **Protection Measure Application Status:**

- **Possible:** Protection measures that can potentially be applied to the proposed development/use;

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
		Possible	Exists	Planned	Additionally Recommend

- **Exists**: Protection measures already implemented by existing components of the proposed development/use. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary);
- **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 yet to be submitted 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 yet to be submitted 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).

8.4.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES

Table 8.14: For the stated element at risk and area of bushfire prone vegetation, the summarised number of bushfire protection measures that can be applied (and their corresponding effectiveness rating), is compared to the number available.

VULNERABILITY REDUCING PROTECTION MEASURES – SUMMARY NUMBERS							
Element at Risk	Fixed (hard) infrastructure assets						
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).						
The Protection Principle	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Exists	Planned	Additionally Recommend	
Design and Construction (Materials)	Very High	1	1	1	-	-	
	High	2	2	2	-	1	
	Effective	-	-	-	-	-	
	Moderate	2	2	2	-	-	
	Not Relevant	11	-	-	-	-	
Firefighting Capability	Very High	-	-	-	-	-	
	High	-	-	-	-	-	
	Effective	1	1	1	1	1	
	Moderate	2	2	2	1	1	
	Not Relevant	2	-	-	-	-	
Management and Maintaining Effectiveness of Applied Protection Measures	Very High	-	-	-	-	-	
	High	-	-	-	-	-	
	Effective	1	1	-	-	1	
	Moderate	-	-	-	-	-	
	Not Relevant	-	-	-	-	-	
Total Numbers	**Very High**	**1**	**1**	**1**	**-**	**-**	
	High	**2**	**2**	**2**	**-**	**1**	
	Effective	**2**	**2**	**1**	**1**	**2**	
	Moderate	**4**	**4**	**4**	**1**	**1**	
	Not Relevant	**13**	**-**	**-**	**-**	**-**	
	Totals	**22**	**9**	**8**	**2**	**4**	

[1] Protection Measure Effectiveness Rating: Refer to section 2.3.5 for explanation and defining.

[2] Protection Measure Application Status: Refer to table footnotes on previous page.

8.4.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (VULNERABILITY REDUCTION)

Table 8.15: For the stated element at risk, The potential impact of the applied protection measures in reducing vulnerability levels to the stated area of bushfire prone vegetation.

ASSESSED IMPACT OF APPLIED MEASURES (VULNERABILITY REDUCTION)								
Element at Risk	Fixed (hard) infrastructure assets							
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).							
Vulnerability Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accumulation	Consequential Fire	Fire Driven Wind	Tree Strike / Obstruction
Existing and Planned (applied to inherent risk)	Significant	Medium	Medium	Minimal	Significant	Medium	Medium	Minimal
	Medium				Medium			
Existing, Planned and Recommended (applied to residual risk)	Significant	Significant	Medium	Medium	Significant	Significant	Medium	Minimal
	Significant				Medium			
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 4 for explanatory information.								

8.4.4 ASSESSED VULNERABILITY LEVELS

Assessed as a function of the capacity to apply sufficient vulnerability reducing protection measures, their individual effectiveness and their combined impact in reducing the vulnerability of the identified element at risk (Note: This assessment is independent of the threat level and exposure level assessments).

Table 8.16: For the stated element at risk, the assessed exposure level corresponding to the stated area of bushfire prone vegetation.

ASSESSED VULNERABILITY LEVELS	
Element at Risk	Fixed (hard) infrastructure assets
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).
Vulnerability Reducing Protection Measures Applied to Assessment [1]	Relative Vulnerability Level [2]
Existing and Planned (applied to inherent risk)	High
Existing, Planned and Recommended (applied to residual risk)	Moderate
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 2 for explanatory information.	

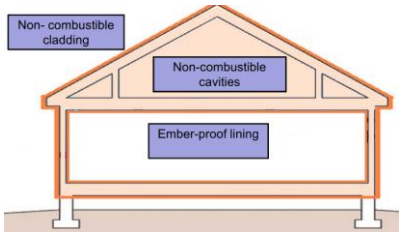
Assessment Comments: Construction and design of solar arrays cannot be modified. Arrays are largely non-combustible or robust, however some combustible components are required for operation. Solar arrays are not a high-risk use, in that they do not pose a greater hazard to bushfire prone vegetation than other commercial operations or residential uses.

8.5 FIXED (HARD) INFRASTRUCTURE ASSETS: HYDROGEN ELECROLYSERS, TRANSPORT, AND STORAGE

8.5.1 PROTECTION MEASURES AVAILABLE TO REDUCE VULNERABILITY LEVELS AND THEIR APPLICATION STATUS

Table 8.17: All available protection measures to reduce exposure of the stated element at risk to bushfire hazard threats and their application to the subject development/use.

	VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES	Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
ELEMENT AT RISK: FIXED (HARD) INFRASTRUCTURE ASSETS						
PROTECTION PRINCIPLE – DESIGN AND CONSTRUCTION (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.						
11.1	**Construction to a Standard - 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	No	Yes	No	No
11.2	**Construction to a Standard – 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.	Not Relevant	N/A	N/A	N/A	N/A

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	Key attributes of the Standard that may have relevance to other built assets include: • 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.					
Informative and/or Site Specific Comment/Assessment: The assets do not have a construction which can comply with AS 3959 or NASH. *The steel pipework has been identified as the most vulnerable component of the electrolysers and bullets. Based on generic failure data, the pipework is able to withstand a heat flux of 37.5kW/m2 for a period of no less than 18 minutes. AS3959 construction standards assume integrity of a period of 20 minutes while exposed to the maximum heat flux expressed by the associated BAL rating. This data means the piping (as the vulnerable component) is suitable for a BAL-29 setback, and almost to BAL-40.* *All structures within the Hydrogen Project are required to establish a <10kW/m2 radiant heat flux Asset Protection Zone, which equates to BAL-12.5.* *Therefore, the assets will exceed the requirements of their assessed BAL rating under AS 3959.*						
11.3	**Construction Materials – External and Internal Cavity Building Elements:** Excluding 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	No	Yes

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
11.4	**Construction Materials – Consequential Fire Fuels:** For constructed large consequential fire fuels, construct using non-combustible materials to the fullest extent possible. These can include attached structures, adjacent structures and surrounding landscaping items.	Very High	Yes	Unknown	No	Yes
Informative and/or Site Specific Comment/Assessment: No combustible structural elements have been identified. Constructed potential fuels are advised to be constructed of non-combustible materials, wherever possible.						
11.5	**Construction – Resistant To High Wind:** 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 broader landscape.	High	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Assets will either be storage bullets (not susceptible to wind impact) or be enclosed within structures.						
11.6	**Construction – 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.	Moderate	Yes	Yes	No	No

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	The objective is to reduce the risk of local 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 local 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.					
Informative and/or Site Specific Comment/Assessment: Gas cylinders will be positioned >6m from stored combustible material and comply with AS1596.						
11.7	**Construction Materials – Non-Structural Essential Elements:** Utilise fire/radiant heat rated products (rated to the level determined as necessary), for the construction of non-structural elements that are essential to the continued operation of the built asset and are exposed to a bushfire hazard. These include cabling and plumbing associated with power / data transmission and water / fuel transport.	High	Yes	Yes	Yes	Yes
Informative and/or Site Specific Comment/Assessment: A <10kW/m2 radiant heat flux APZ has been applied to the assets. Common electrical cabling reaches its critical point at >12kWm2, steel piping at >37.5kW/m2, and PVC piping at 120 degrees Celsius. The components do not require shielding given the APZ setback. It is recommended that exposed electrical cabling beyond the footprint of buildings and constructed assets, be shielded from radiant heat and consequential fire by burying underground, enclosing within a structure, or shielding with non-combustible material.						
11.8	**Minimise Debris and Ember Accumulation – Re-Entrant Detail:** Avoid or minimise the accumulation of unburnt debris and embers by avoiding 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).	High	Yes	Unknown	Yes	Yes
11.9	**Minimise Debris and Ember Accumulation – Trapping Surfaces:** Avoid or minimise the use of exposed combustible surfaces that can trap and accumulate embers. These can 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).	Moderate	Yes	Unknown	Yes	Yes
Informative and/or Site Specific Comment/Assessment: The structure design and construction allow for little debris accumulation.						

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Where the electrical cabling 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.						
11.10	**Minimise Debris and Ember Accumulation – Roof Plumbing:** 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.	Not Relevant	N/A	N/A	N/A	N/A
11.11	**Minimise Debris and Ember Accumulation – Construction Cavities:** 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.	Not Relevant	N/A	N/A	N/A	N/A
11.12	**Minimise Flame/Radiant Heat/Ember/Debris Entry - External Openings:** Limit potential sites for entry to internal spaces through the external envelope and combustible materials within (as consequential fire fuels).	Not Relevant	N/A	N/A	N/A	N/A
11.13	**Screening and Sealing - 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.	Not Relevant	N/A	N/A	N/A	N/A
11.14	**Screening - 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.	Not Relevant	N/A	N/A	N/A	N/A
11.15	**Shutters - External Doors and Windows**: Fire rated shutters Installed to significantly increase bushfire resistance of the vulnerable building elements. Any requirement for onsite manual activation is a potential limitation to effectiveness.	Not Relevant	N/A	N/A	N/A	N/A
Informative and/or Site Specific Comment/Assessment: Electrolysers and onsite and truck storage do not have the above components.						
11.16	**Landscaping Construction - Fences and Walls:** Non-combustible materials are used for fences, walls (including retaining walls), screens and other built structures - as potential consequential fire fuels. Where relevant, the capacity to resist high winds, to minimise potential for impact damage to subject building/structure, should also be incorporated.	Moderate	Yes	No	No	Yes

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
Informative and/or Site Specific Comment/Assessment: Any security fences or other potential fuel loads should be constructed using non-combustible material. Landscaping (gardens) which may be included within the APZ should avoid use of constructed heavy fuels (e.g. timber sleepers as garden edges, plastic or timber lattice).						
PROTECTION PRINCIPLE – FIREFIGHTING CAPABILITY: Provide sufficient, reliable and bushfire resilient water supply and delivery capability as is necessary for active and/or passive systems.						
11.17	**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; • 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.	Effective	Yes	Yes	No	Yes
Informative and/or Site Specific Comment/Assessment: The site is serviced with a reticulated water supply but this is unlikely to be sufficient for firefighting operations. A static firefighting water supply will be supplied. *The Guidelines for Planning in Bushfire Prone Areas does not establish a firefighting water supply for non-habitable buildings, including high-risk uses. In the absence of specific requirements at the national or state level for Hydrogen production facilities, a conservative approach is applied in the firefighting water supply for the determination of the appropriate water supply. The facility will achieve simultaneous compliance with multiple sets of guidelines or standards, by applying the most stringent of the components of each.* • *The* Design Guidelines and Model Requirements – Renewable Energy Facilities (Victorian Country Fire Authority March 2022) *discusses multiple renewable energy types but not Hydrogen. The most stringent water requirements are for Battery Energy Storage Systems, and this will be applied.* • *The* Guidelines for Planning in Bushfire Prone Areas v1.4 (WAPC 2021) *is prescriptive on access to the water supply and couplings to be installed.* • AS2419-2005: Fire Hydrant Installations *provides the appropriate water volume for the facility, water pressure, and number of hydrants.* • DFES Operational Requirement Guideline 5: Hydrants and Hose Length (DFES April 2020) *recommends a 60m hose lay rather than the 60m+10m stream in* AS2419. *A separate brief is provided as an Addendum within the associated BMP, outlining the combined water specifications for the facility.*					
11.18	**Firefighting Equipment – Active Operation:** 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).	Effective	Yes	Yes	No	No

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	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.					
11.19	**Fire Fighting Equipment – Passive Operation:** 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	Yes	No	No
Informative and/or Site Specific Comment/Assessment: Additional firefighting equipment and systems will be installed, including fire extinguishers, hose reels, deluge systems in the truck bay, and sprinklers. Additional measures have not been provided.						
11.20	**Fire Fighting Equipment – Maintain Operability:** 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.	Moderate	Yes	Yes	Yes	Yes
Informative and/or Site Specific Comment/Assessment: The firefighting water supply will be compliant with both Design Guidelines and Model Requirements – Renewable Energy Facilities *and the* Guidelines for Planning in Bushfire Prone Areas *including access and construction of the tanks and boosters. It is recommended that hydrant boosters and other firefighting systems as appropriate, are supported by generators to ensure continued operation.*						
11.21	**Firebreaks – Primarily for Access:** Installation and maintenance of firebreaks to remove vegetation, limit surface fire progression and facilitate firefighting access / backburning.	Moderate	Yes	Yes	No	No
Informative and/or Site Specific Comment/Assessment: The site is currently compliant with the Shire of Northam Firebreak Notice.						
PROTECTION PRINCIPLE – MANAGEMENT AND MAINTAINING 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.						
11.22	**Formal Management/Maintenance Plan – Actions and Responsibilities:** Through a bushfire management plan, site operations emergency plan, bushfire emergency plan, operational annual works plan and/or a 'firebreak' notice, 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; and • The relevant protection measures are known and understood; and • Responsibilities are created	Effective	Yes	No	No	Yes

VULNERABILITY REDUCING PROTECTION MEASURES – ALL AVAILABLE MEASURES		Effectiveness Rating [1]	Application Status [2]			
			Possible	Exists	Planned	Additionally Recommend
	The different documents will be able to satisfactorily perform this function to differing extents.					
Informative and/or Site Specific Comment/Assessment: The documents have been or will be produced. Ongoing requirements established in this Risk Assessment and Section 5.7 of the associated Bushfire Management Plan, must be included in operational documents.						

[1] **Protection Measure Effectiveness Rating:** Refer to section 2.3.5 for explanation and defining.

[2] **Protection Measure Application Status:**

- **Possible:** Protection measures that can potentially be applied to the proposed development/use;
- **Exists**: Protection measures already implemented by existing components of the proposed development/use. These measures are accounted for in assessing 'inherent' risk levels (refer to Glossary);
- **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 yet to be submitted 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 yet to be submitted 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).

8.5.2 NUMBER ANALYSIS OF AVAILABILITY VERSUS APPLICATION OF PROTECTION MEASURES

Table 8.18: For the stated element at risk and area of bushfire prone vegetation, the summarised number of bushfire protection measures that can be applied (and their corresponding effectiveness rating), is compared to the number available.

VULNERABILITY REDUCING PROTECTION MEASURES – SUMMARY NUMBERS							
Element at Risk	Fixed (hard) infrastructure assets						
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).						
The Protection Principle	Effectiveness Rating [1]	Numbers of Protection Measures					
		Total Available	Application Status [2]				
			Possible	Exists	Planned	Additionally Recommend	
Design and Construction (Materials)	Very High	2	2	1	-	2	
	High	4	3	4	2	2	
	Effective	-	-	-	-	-	
	Moderate	3	3	2	1	2	
	Not Relevant	7	-	-	-	-	
Firefighting Capability	Very High	-	-	-	-	-	
	High	1	1	1	-	-	
	Effective	2	2	2	-	1	
	Moderate	2	-	-	-	-	
	Not Relevant	-	-	-	-	-	
Management and Maintaining Effectiveness of Applied Protection Measures	Very High	-	-	-	-	-	
	High	-	-	-	-	-	
	Effective	1	1	-	-	1	
	Moderate	-	-	-	-	-	
	Not Relevant	-	-	-	-	-	
Total Numbers	**Very High**	**2**	**2**	**1**	**-**	**2**	
	High	**5**	**4**	**5**	**2**	**2**	
	Effective	**3**	**3**	**2**	**-**	**2**	
	Moderate	**5**	**3**	**2**	**1**	**2**	
	Not Relevant	**7**	**-**	**-**	**-**	**-**	
	Totals	**22**	**12**	**10**	**3**	**8**	

[1] Protection Measure Effectiveness Rating: Refer to section 2.3.5 for explanation and defining.

[2] Protection Measure Application Status: Refer to table footnotes on previous page.

8.5.3 ASSESSED IMPACT OF APPLIED PROTECTION MEASURES (VULNERABILITY REDUCTION)

Table 8.19: For the stated element at risk, The potential impact of the applied protection measures in reducing vulnerability levels to the stated area of bushfire prone vegetation.

ASSESSED IMPACT OF APPLIED MEASURES (VULNERABILITY REDUCTION)								
Element at Risk	Fixed (hard) infrastructure assets							
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).							
Vulnerability Reducing Protection Measures Applied to Assessment [1]	The Bushfire Hazard Threats [2]							
	Direct Attack Mechanisms				Indirect Attack Mechanisms			
	Embers	Radiant Heat	Flame	Surface Fire	Debris Accumulation	Consequential Fire	Fire Driven Wind	Tree Strike / Obstruction
Existing and Planned (applied to inherent risk)	Significant	Significant	Medium	Medium	Minimal	Medium	Medium	Minimal
	Medium				Minimal			
Existing, Planned and Recommended (applied to residual risk)	Significant	Very Significant	Medium	Significant	Medium	Very Significant	Medium	Minimal
	Significant				Significant			
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 4 for explanatory information.								

Assessment Comments: High-risk assets associated with the Hydrogen Project are robust against bushfire impacts (>37.5kW/m2 heat flux threshold). There necessarily cannot be ember entry points, else hydrogen gas would escape.

The firefighting water supply specifications will be compliant with multiple standards and guidelines, established within the associated BMP.

8.5.4 ASSESSED VULNERABILITY LEVELS

Assessed as a function of the capacity to apply sufficient vulnerability reducing protection measures, their individual effectiveness and their combined impact in reducing the vulnerability of the identified element at risk (Note: This assessment is independent of the threat level and exposure level assessments).

Table 8.20: For the stated element at risk, the assessed exposure level corresponding to the stated area of bushfire prone vegetation.

ASSESSED VULNERABILITY LEVELS	
Element at Risk	Fixed (hard) infrastructure assets
Vegetation Area / Location	Vegetation within the subject lots and watercourse reserve (150m survey buffer).
Vulnerability Reducing Protection Measures Applied to Assessment [1]	Relative Vulnerability Level [2]
Existing and Planned (applied to inherent risk)	High
Existing, Planned and Recommended (applied to residual risk)	Moderate
[1] Corresponds to the stage of risk level being reported i.e. inherent or residual. Refer to Section 2.3.3 [2] Refer to Appendix 2 for explanatory information.	

Assessment Comments: It is not reasonably practical to reduce the relative vulnerability below 'Moderate,' where the asset itself is potentially highly flammable/combustible.

APPENDIX 1: RATIONALE FOR THE SELECTION OF THE APPLIED RISK ASSESSMENT PROCESS

The following information regarding the selection and adaptation of the risk assessment process applied in this report is presented to help inform persons tasked with understanding this report.

KEY DRIVERS

Bushfire Prone Planning has considered the following key drivers in determining the most appropriate risk assessment process to apply:

1. **The relevant hazard types.**

   Bushfire hazards are a natural hazard rather than a human-induced hazard (refer to glossary and see limitations of ISO 31000 in the next section). Natural processes and phenomena present unique types of threats.

   Consequently, the assessment process needs to be able to specifically deal with the unique characteristics of bushfire hazards in a way that derives meaningful risk-based information that can be readily interpreted and applied.

   A logical framework is needed around which the development of bushfire protection measures (risk treatments) can be constructed, assessed and understood by those tasked with making decisions based on the provided information.

2. **The relevant risks to be addressed.**

   The specific risks are limited to the potential loss of life, injury, or destroyed or damaged assets that are associated with a bushfire hazard. These originate from the hazard's direct and indirect bushfire attack mechanisms and the response of persons and property to these threats.

3. **The complexity and/or scale of proposed development/use.**

   For different development/use proposals, there are significant differences in the types of information required for the hazard risk assessments and the derivation of operationally useful information that is to be applied to mitigating the associated risks.

   These differences include scale e.g. from development or activities on a single lot to development or activities within a region.

   Also, different uses may be able to tolerate different levels of risk. For example the Guidelines v1.4 cl 5.5.2 establish that "different tourism land uses … may require different levels of risk management".

   Consequently, the applied risk management process needs to be able to accommodate these differences and remain both logical, useable and efficient to compile. It needs to be capable of being relatively easy to scale up or down to provide a relevant and actionable report.

LIMITATIONS OF ISO 31000:2018 AND NERAG

The approach adopted by Bushfire Prone Planning (BPP) contrasts with the typical approach historically used in various Australian jurisdictions. This historical approach conducts the risk management process by applying the *National Emergency Risk Assessment Guidelines (AIDR 2020, NERAG)*.

However, the considered view of BPP is that the *NERAG* approach is unable to effectively provide (a) the required assessment methodology for assessing risk associated with a bushfire hazard or (b) evaluate the impact of specific bushfire protection measures - to the level of detail and relevance required for the planning of development and uses. That is, the key drivers determining the suitable methodology cannot be satisfied.

It is not practical to fully justify the above statement here, but the following is noted:

The determination of pre and post treatment risk levels is a key objective of NERAG. These are determined as the product of consequence and likelihood ratings. These ratings have the following inherent weaknesses in meeting the risk assessment requirements for a natural bushfire hazard:

1. Consequence ratings are derived from a set of established qualitative and quantitative criteria - which are very broad based and have less relevance at smaller scales of development/use. No direct link between the application of a risk treatment(s) and how they can justifiably be assessed as being able to alter a consequence level is established; and

2. Likelihood ratings of both the emergency event and the consequences are difficult to separate. They are derived from a set of established quantitative (probability) criteria. They also typically look backward and not forward and their determination is problematic with respect to sourcing relevant and sufficient data.

   Varying the levels of likelihood has limited applicability when the pragmatic requirement is to assume an emergency event will occur. The level of risk to which the at risk elements are exposed and vulnerable when a bushfire does occur, should have the most relevance to planning its location, design and construction, or allowing it.

   The determination of level of relevant risks by relying on the accuracy and relevance of the probability of the bushfire occurring should be given much less weighting. A more robust reduction in risk will result from being protected by something more physical/tangible than probability.

Also relevant is that the *NERAG* state they are "primarily focussed on assessing emergency risks" and that they are "structured to align broadly with relevant sections of *ISO 31000:2018 – Risk Management Guidelines*".

ISO 31000:2018 states that its intended use is "… to provide guidelines on managing risk faced by organisations".

The key point is that organisational risk is derived from a 'human-induced hazard' rather than a natural hazard (refer to the glossary). However, it is the bushfire natural hazard that is the source of risk being addressed by requirements established by SPP 3.7 and the associated Guidelines.

Consequently, it is BPP's considered opinion that applying *ISO 31000:2018* and *NERAG* (in its current form) to assessing risk associated with a bushfire hazard has significant application and relevance limitations.

THE APPLIED ADAPTED RISK ASSESSMENT APPROACH

In acknowledging the key drivers, and the limitations of the risk management process developed by ISO 31000 and adapted by NERAG, Bushfire Prone Planning has adapted the understanding of disaster risk that is used by the United Nations Office for Disaster Risk Reduction (UNDRR).

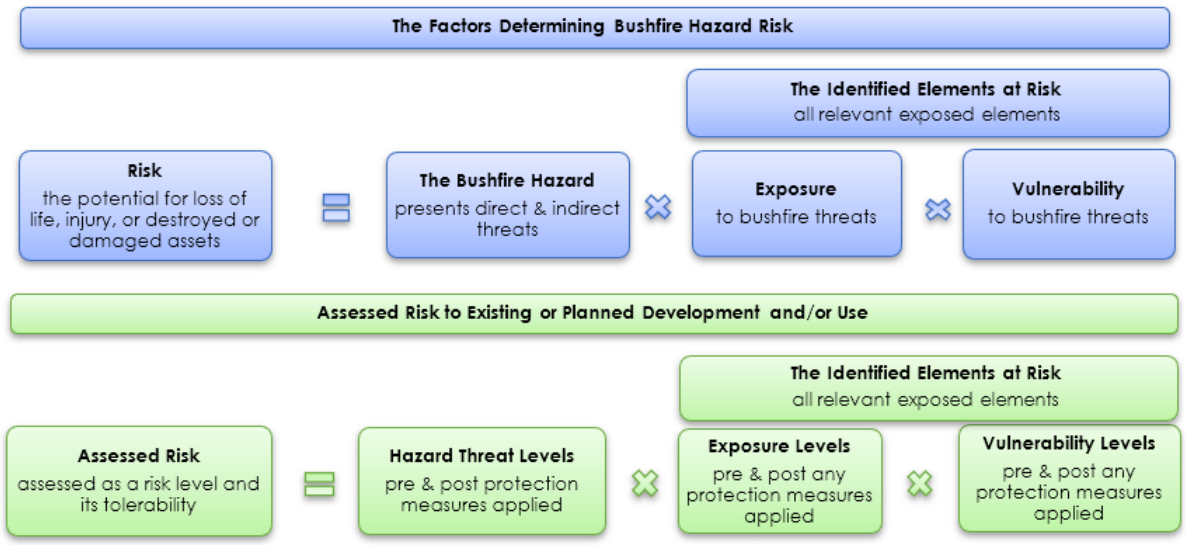
Although the UNDRR approach is designed to addresses disaster risk at large scale strategic levels, it can justifiably be applied to all scales of planning because it is focused on natural hazards and establishes a concept that can be readily adapted.

The risk assessment report that is developed applying this process presents relevant, logical, comprehensive and practical facts, to appropriately inform those persons tasked with either:

- Planning the siting, design, construction and management of development/use to ensure an appropriate level of bushfire resilience is achieved and limiting associated risks to tolerable levels; or
- With making pragmatic planning approval decisions.

The Figure below (copy of Figure 2.3) illustrates the framework of the adapted risk assessment process (refer to the glossary for terminology information and Appendix 2 provides greater detail of the risk analysis component of the assessment process).

THE FRAMEWORK OF BUSHFIRE PRONE PLANNING'S APPLIED RISK ASSESSMENT PROCESS



APPENDIX 2: RISK LEVEL ANALYSIS – ADDITIONAL EXPLANATION

INDICATIVE RISK LEVELS

Justification for reporting indicative risk levels is based on the following factors:

1. There is a finite 'universe' of bushfire protection measure principles that can be applied to reducing hazard threats and the exposure and vulnerability of at risk elements;
2. There will be a range of development/use specific protection measures associated with each protection measure principle. The number of available protection measures will vary dependent on the type and scale of development/use, but effectively there will also be a practical limit; and
3. Bushfire protection measures will vary in their standalone effectiveness at mitigating risk (refer to section 2.3.5);

Consequently, an indication of the level of risk – for a given development/use - can be gained by:

1. Assessing 'relative' threat levels.
2. Deriving 'relative' exposure and vulnerability levels by:
    a) Assessing how many protection measure principles and associated measures are applicable and can be applied;
    b) Assessing the relative effectiveness of each protection measure; and
    c) Comparing the numbers of applied protection measures with the number of possible measures in the protection measure 'universe'.
3. Making a qualitative assessment of the potential impact of the applied protection measures (including appropriate weighting given to their individual effectiveness) that can reduce the relative threat, exposure and vulnerability levels.
4. Derive the indicative risk level by applying the risk matrix shown as Table A2.1 and establish the tolerability of the risk by applying the risk tolerance scale of Table A3.2, Appendix 3.

Providing an indicative risk level establishes a qualitative understanding of the level of risk that potentially exists and is intended to inform and assist with making various planning decisions.

Deriving indicative risk levels is essentially a compilation and assessment of physical facts rather than determinations of what is to constitute different levels of threat, exposure and vulnerability and subsequently intolerable, tolerable and acceptable levels of risk for every development/use scenario.

An indicative risk level can be derived from an assessment of the site, the planned development/use and the knowledge and experience of the bushfire practitioner – such that an opinion can be provided regarding risk levels.

DETERMINED RISK LEVELS

Reporting determined risk levels will require reference information being available to the assessor so that 'determined' levels of threat, exposure and vulnerability can be established (this contrasts with the 'relative' levels required in deriving an indicative risk level).

The required reference information are the risk factor criteria, the risk level matrix and the risk tolerability scale.

Risk Factor Criteria

The required risk factor criteria will 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 will 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 will be required. The rationale for this statement includes:

- 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;
- Recognition that different levels of risk can be tolerated by different development, use and scale is indicated in the Guidelines v1.4 where cl 5.5.2 establishes that "different tourism land uses … may require different levels of risk management"; and
- To account for the variation, one risk level matrix could establish a moderate determined risk level for a given development type/use/scale and combination of threat, exposure and vulnerability levels.

  For the same combination of threat, exposure and vulnerability levels but for a different development type/use/scale, a different risk level matrix could establish an extreme determined risk level; and

Risk Tolerance Scale

After the 'determined' risk level has been derived from the risk assessment process, a methodology is required to classify the risk level as either unacceptable, tolerable or acceptable. Currently Bushfire Prone Planning is applying the ALARP principle and associated risk tolerance scale (refer to Appendix 3).

The Current Limitations to Deriving a Determined Risk Level

The required reference information (i.e. the risk factor criteria, sets of risk matrices and the risk tolerance scale) is necessarily required to be provided by the relevant regulatory authorities /decision makers. The rationale for this statement is:

1. The information must reflect the expectations and understanding and accepting of risk as held by society and communities, and directed through its governing bodies;
2. The information must be standardised to the greatest extent possible so that it provides an acceptable and trusted basis on which the determined risk level can be derived and be relied upon in making decisions.
3. Properly establishing the reference information cannot be justifiably relegated to individual assessors with varied expertise, qualification and without any approved responsibility to provide such information. Their expertise might more appropriately be utilised in assisting the responsible authorities to establish the information.

Where the required reference information has not been established and provided by the responsible authorities, determined risk levels cannot be the final outcome when using this risk assessment process. Currently, this reference information does not exist.

HOW THE LIKELIHOOD OF A BUSHFIRE EVENT OCCURRING HAS BEEN DEALT WITH

The approach taken with the applied risk assessment process is to apply the pragmatic assumption that a bushfire will occur. It is assumed it 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 accepts 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.

This contrasts with applying a quantitative approach based on the historical record of past bushfire event 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. It cannot 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 much easier, more practical (and likely economical), to incorporate at initial planning stages rather than the retro-establishment of protection measures when circumstances change 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.

Table A2.1: Risk matrix for deriving indicative risk levels from the assessed relative levels of threat, exposure and vulnerability.

INDICATIVE RISK LEVEL MATRIX						
Relative Threat Level (a)	**Relative Exposure Level (b)**	**Relative 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**

Indicative risk level key: VL = very low, L = low, M = moderate, H = high, E = extreme.
The qualitative relative levels are assigned a numerical value.
The indicative risk value is calculated as = (a + b + c) – 2 and range from 1 (lowest) to 13 (greatest).
The indicative risk 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.

APPENDIX 3: THE ALARP PRINCIPLE AND THE RISK TOLERANCE SCALE APPLIED

The following information is intended to provide an understanding of the ALARP principle and provide justification for its application in this risk assessment report.

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 – including its adaption for use in the following Australian guidelines:

- 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 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.

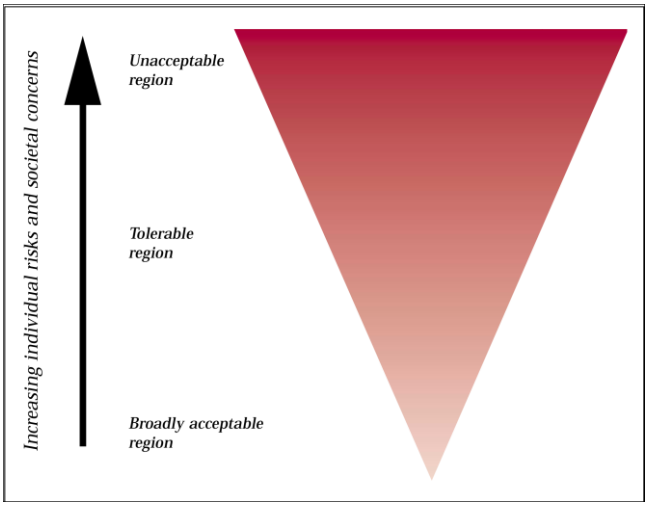


Figure A3.1: HSE framework for the tolerability of risk (source: HSE-UK, 2001)

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 A3.1: 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 particular 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.	

RISK TOLERANCE SCALE

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. Where planning approval is being sought, identify if the determined residual risk levels can be considered as tolerable or acceptable and therefore capable of being approved for this factor, or not.

The risk tolerance scale to be applied within the risk assessment report, when the required risk factor criteria and risk level matrix are available, is established in Table A3.2.

Table A3.2: The applied risk tolerance scale

<table>
<tr><th colspan="4">APPLIED RISK TOLERANCE SCALE - INCORPORATING THE ALARP PRINCIPLE</th></tr>
<tr><th>Indicative / Determined 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 rowspan="2">Moderate</td><td rowspan="2">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>Acceptable
- if ALARP -</td></tr>
<tr><td>Low</td><td colspan="2" 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</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>

APPLICATION JUSTIFICATION

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.

*****

APPENDIX 4: THE BUSHFIRE HAZARD – BEHAVIOUR AND ATTACK MECHANISMS

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 (broader landscape scale) can have additional implications for the development of extreme bushfire events and the consequent increase in bushfire threat levels (refer to Appendix 5 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 broader landscape scale can have implications for the development of extreme bushfire events and consequent increase in bushfire threat levels (refer to Appendix 5 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 broader 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 5 for additional information).

BUSHFIRE DIRECT ATTACK MECHANISMS

EMBER ATTACK: Ember attack is the most common way for 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 (roofs, gutters, doors, windows, re-entrant corners)
- They enter gaps in structures envelopes to vulnerable internal cavities and spaces.
- 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.

An ember is a small particle of burning material that is transported in the winds that 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 has collected or been placed on the ground.

Of the plant materials, bark is the predominant source of embers but built timber elements will also produce embers.

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 tree tops 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 that are lower than fine fibrous or ribbon barks.

(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).

The importance of establishing protection measures to mitigate the potential impact of consequential fire ignited by the ember attack mechanism, cannot be overstated.

RADIANT HEAT ATTACK: This heat radiates in all directions from a bushfire and can potentially be felt hundreds of meters away. The amount of heat that a flame can transfer to other objects is influenced by the flame size and its 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 the weather and topography factors that can intensify fire behaviour (described at end of this section).

Radiant heat:

- Can damage or destroy elements that are vulnerable to higher levels of heat;
- 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 people when they are not physically shielded. Protective clothing can provide only limited protection.

BUSHFIRE FLAME ATTACK: When flames make contact with structures they can flow over, under and around – impacting surfaces not directly facing the bushfire.

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.

SURFACE FIRE ATTACK: These are low intensity fires (less than 0.5m high) burning along the ground consuming mostly intermittent fine fuels such as vegetation debris, litter, and mulches. They are typically patchy and erratic in their direction and short lived (<40 seconds) when burning in the absence of heavier fuels.

Typically these fires will be on the land immediately surrounding buildings and associated structures and other heavy fuels. Their importance as a threat is the bringing of direct flame contact, higher radiant heat and embers closer to these exposed elements.

BUSHFIRE INDIRECT ATTACK MECHANISMS

DEBRIS ACCUMULATION: The relevant debris are combustible fine fuels that can accumulate (by falling or being windblown) in close proximity to subject structures and their surrounding structures and other heavy fuels. This makes the burning of these structures/fuels much easier and more likely through the ignition of the accumulated debris by ember attack.

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 potential threat level will be determined by:

- The presence of vegetation types that produce quantities of debris with those that produce in the driest and hottest part of the year presenting a greater threat;
- The extent of this vegetation; and
- The proximity of this vegetation to the exposed and vulnerable structures.

CONSEQUENTIAL FIRE:

Consequential fire Is the burning of vulnerable (combustible/flammable) materials, items and structures that exist within the area surrounding the subject building or structure – the surrounding vulnerable elements.

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 are threats that are separate from and additional to the threats generated by the bushfire front itself - which can be and often is, a considerable distance away.

The importance of establishing protection measures to mitigate the potential impact of consequential fire cannot be overstated.

Consequential fire fuels consist of both fine and heavy fuels.

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.

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;
  - 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].

FIRE DRIVEN WIND: Severe bushfires are commonly accompanied by high winds due to the prevailing weather conditions. Localised high winds can be induced by the bushfire. When the required factors exist, the bushfire can couple with the atmosphere (pyro-convective) resulting in extreme bushfire events and gusty, severe windspeeds.

These winds can directly damage the external envelope of a building or structure by pressure (low and high) or the carriage of varying types of solid debris. This provides openings for other bushfire attack mechanisms to enter and ignite internal cavities.

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:
- Fall and obstruct access to or egress from, a structure or site being impacted by bushfire.

***

APPENDIX 5: THE BROADER LANDSCAPE AND EXTREME BUSHFIRE EVENTS

The content of this appendix is an overview of information that supports the assessment approach of section 5.4 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 broader 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, a number of 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 particular relevance to this risk assessment are the topographic aspects of the broader 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:

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 – as a result 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 broader 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 and 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 5.5.

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 6: HAZARD REDUCTION BURNING – ADDITIONAL INFORMATION

The following information provides supporting guidance to the relevant bushfire protection measures that reduce bushfire hazard threat levels by reducing fuel levels.

1. SIGNIFICANT AREAS (LARGER) AREAS OF BUSHFIRE PRONE VEGETATION

Annually

Prior to the bushfire season ensure the following management of the identified areas of vegetation is conducted:

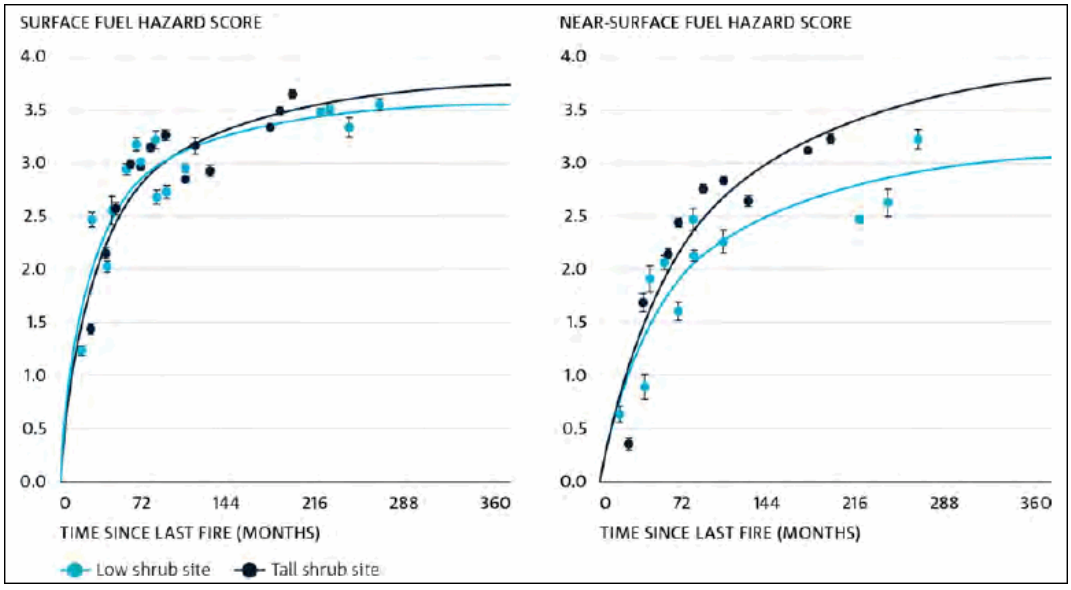
- Maintain the pruning of all trees and tall shrubs to a height of at least 2m from the ground and remove the material; and
- Remove any dead trees (that are not habitat trees), fallen branches and dead shrubs.

Burn Interval

Conduct hazard reduction burns at intervals that will ensure surface and near surface fuel loads (i.e. fine fuels – accumulated leaf litter, combustible plant materials and twigs up to 6mm diameter) remain less than 8 t/ha at all times.

It is likely the burning interval will need to be shorter than that which is typically currently conducted. The following statement and data from the Climate and Disaster Technical Report, CSIRO, 2020 [17] indicates the requirement for increased frequency of hazard reduction due to the rapid increase in surface and near surface fuel loads after hazard reduction burning.

"The only study published on the dynamics and structure of fine fuel in dry eucalypt forest following prescribed fire is that of Gould et al. (2011) utilising data to drive an exponential fuel accumulation relation for the key fuel attributes of surface fuel hazard and near-surface fuel hazard. In this study of time since fire in jarrah forest (Eucalyptus marginata), it was found that, over the 20-year period of the study (1979-1999) while surface fuel loads continued to increase indefinitely (up to and beyond 20 years), attributes such as percent cover and hazard score essentially plateaued after 6-9 years. Similarly, near-surface fuel loads were found to stop increasing significantly after 15-18 years whereas near-surface height and hazard score stopped increasing significantly after 9-12 years and 12-15 years, respectively (Figure 14). Bark hazard was found to be affected by hazard reduction burning for up to 12 years after hazard reduction burning"



"Figure 14 Recovery of surface (left) and near-surface fuel hazard (right) in Jarrah Forest following hazard reduction burning. Under these conditions these fuel attributes returned to equivalent long unburnt state after approximately 12-15 years but the response in the first few years following burning is extremely rapid, ***achieving 75% of fuel hazard within 4 years (surface) and 5-7 years (near-surface) depending on presence of shrub layer*** *(Redrawn from Gould et al. 2011)"*

2. THE BROADER LANDSCAPE

The following information has merit for consideration and is taken from the peer reviewed paper '*A framework for prioritising prescribed burning on public land in Western Australia'; Howard T. et al, DBCA and DFES; International Journal of Wildland Fire 2020, 29, 314-325.*

To develop and apply this protection measure it is likely interested entities, such as local government will need to engage and work with the relevant state government agency responsible for the identified areas of vegetation.

The collaboration will be necessary to establish the required indicators of acceptable risk - as they are determined through the application of the following published framework - and to establish a responsibility to conduct the ongoing management of these areas of vegetation to maintain compliance with the established indicators.

KEY RELEVANT POINTS FROM THE FRAMEWORK (QUOTED)

Introduction to the framework:

- *The framework provides principles and a rationale for programming fuel management with indicators to demonstrate that bushfire risk has been reduced to an acceptable level.*
- *Each bushfire risk management zone is divided into fire management areas, based on the management intent. These are areas where fuels will be managed primarily to minimise the likelihood of fire causing adverse impacts on human settlements or critical infrastructure, to reduce the risk of bushfire at the landscape scale or to achieve other land management outcomes. Indicators of acceptable bushfire risk are defined for each fire management area and are modified according to the distribution of assets and potential fire behaviour in the landscape.*
- *The framework establishes principles and a rationale for programming fuel management and, critically, provides indicators that demonstrate that bushfire risk has been reduced to an acceptable level. The acceptable level of bushfire risk is determined through a risk assessment and prioritisation process.*

Principles for managing bushfire risk applied in the framework:

- ***Consistent with international standard:*** *The regional risk framework commits to applying risk management in a manner that is consistent with AS ISO 31000: 2018 Risk management guidelines (Standards Australia 2018). This involves adherence to the principles of risk management, and applying the risk management process to the identification, assessment and treatment of risk.*
- ***Fuels are managed to reduce the harm:*** *Managing the fuel available to burn is critical to managing the threat posed by bushfire. The available fuel, and its structure, affect the speed and intensity of a bushfire, which, in turn, determine both its potential to cause damage and suppression difficulty. Done at appropriate temporal and spatial scales, managing the quantity, structure and distribution of fuel available has been demonstrated to be an effective and efficient way to reduce the severity and extent of damage by bushfires.*
- ***Fuel management does not eliminate risk:*** *Fuel management aims to reduce the negative consequences of bushfires rather than prevent their occurrence. Given the importance of fire to maintaining ecosystem health and resilience, it is neither desirable nor feasible to eliminate bushfire from natural landscapes and it is recognised that both planned and unplanned fire can have benefits. Fuel management aims to reduce risk to an acceptable level by greatly enhancing and supporting the effectiveness of other measures, including bushfire law, fire suppression, urban planning, building codes for fire-prone areas and community preparedness.*
- Fuel management is planned and integrated. Bushfire management puts people first, risk is managed at an appropriate scale and ecological requirements are considered when managing fuel.

Framework for managing bushfire risk by prescribed burning:

- The framework identifies bushfire risk management zones (BRMZ), recognises different fuel types (and associated fuel accumulation and fire behaviour models), classifies public lands within each zone into fire management areas (FMA) - with the Settlement-Hazard Separation classification being the relevant fire management area for the Mundaring town centre - and develops indicators of acceptable risk.
- ***Bushfire Risk Management Zones:*** *The framework identifies eight bushfire risk management zones (BRMZ) characterised by broad consistency of land use, asset distribution, fire environment (vegetation, fuels and climate) and fire management practices that combine to create a characteristic risk profile (Fig. 2). The Southwest zone includes the majority of the state's population, urban development and infrastructure.*
- ***Fuel Types****: The framework recognises 13 broad types across Western Australia. Fuel types are based primarily on structural attributes of the vegetation that influence fire behaviour. For each fuel type, best available information*

has been assembled regarding post-fire patterns of fuel accumulation, fire ecology, including the requirements of fire sensitive species and communities, harmful fire regimes and fire regimes compatible with ecosystem health. Where possible, the framework assigns each fuel type appropriate fuel accumulation and fire behaviour models and identifies the key weather attributes required to model fire behaviour. These models are used when setting indicators of acceptable bushfire risk, which are defined for different fuels according to the rates of fuel accumulation and the fire behaviour they may support.

- ***Fire Management Areas:*** *Public lands within each BRMZ are further classified into four fire management areas (FMAs) characterised as Settlement-Hazard Separation, Critical Infrastructure Buffer, Landscape Risk Reduction and Remote Area Management. These FMAs are defined by the primary intent of fuel management, which is a function of potential fire behaviour and the type and distribution of assets characteristic of the area. The framework recognises six classes of assets that may be affected by bushfire: settlements, dispersed populations, critical infrastructure, protected species and communities, economic assets and other assets (non-critical infrastructure, ecological, cultural).*
- *The Settlement-Hazard Separation FMA provides an area proximal to settlements where fuels are managed relatively intensively to minimise the likelihood of a bushfire being sustained, damaging properties or endangering people. Here, fuel management to protect settlements takes precedence over other land management objectives, though other land management outcomes can be pursued to the extent that they do not conflict with the primary management intent.*
- *The extent of the area described by each FMA varies according to the fuel type and the BRMZ in which it occurs … The breadth of the Settlement-Hazard Separation FMA is calculated to be sufficient to significantly reduce the likelihood of damage to assets from direct flame contact, radiant heat and ember attack and to provide adequate opportunity for fire suppression. This calculation is based on a combination of data derived from fire behaviour models and expert practitioner judgement. The Settlement-Hazard Separation FMAs are the largest in forest fuels that are prone to long-range spotting, severe ember storms and crown fire behaviour.*
- ***Indicators of Acceptable Bushfire Risk:*** *Are set for bushfire-prone fuel types in each FMA … Indicators are expressed in terms of the proportion of the landscape that is managed such that the treated fuels will not support a head fire of an intensity that precludes effective suppression action under weather conditions corresponding to the 95th percentile fire danger index … Weather conditions (air temperature, relative humidity, wind speed) corresponding to the 95th percentile FFDI are identified and used as inputs to fire behaviour models for calculating forward rate of spread and fire intensity (Table 1).*
- *The intent of fuel management is to reduce the quantity and alter the arrangement of fuels such that a bushfire is likely to spread more slowly, burn with lower intensity, be easier to suppress and cause less damage.*
- ***The indicators of acceptable risk for the Settlement-Hazard Separation FMA for open eucalypt forest and tall/open eucalypt forest is a target of 60% of fuel less than threshold intensity for a distance of 5km surrounding settlements.***

As an open eucalypt forest example at the Perth rural urban interface, the fuel age and load to achieve threshold fire intensity under weather conditions representing 95th percentile values of the FFDI for the Bickley location are stated as 5 years and 8 t/ha.

APPENDIX 7: BUSHFIRE ATTACK LEVELS AND BAL CONTOUR MAPS EXPLAINED

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 results in different separation distances, away from bushfire prone vegetation, corresponding to a given BAL rating.

In assessing risk, knowing the separation distances away from each identified area of classified vegetation that correspond to a BAL rating, assists with evaluating threat levels from that bushfire hazard and the exposure levels of elements at risk.

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 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.

THE BAL CONTOUR MAP - ILLUSTRATING THE CALCULATED SEPARATION DISTANCES CORRESPONDING TO BAL RATINGS

The BAL contour map illustrates different coloured contour intervals extending out from each different area of classified bushfire prone vegetation. The minimum and maximum distances of each contour, from each area of vegetation, is a diagrammatic representation of the calculated separation distances that correspond to each BAL rating. These take into account the specific site conditions.

Each coloured contour represents a different bushfire attack level and anything within that contour will be subject to that BAL rating and its corresponding level of radiant heat.

ADDENDUM 1

1. ADDENDUM SUB-HEADING

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 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 3 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) 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, if deemed necessary. *(Source: DPLH, 2019)* Certain levels of risk may be tolerated, provided that the risks are known and managed. *(Source: AIDR LUPDRC, 2020)*

	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)*

BIBLIOGRAPHY

[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.