S5 ENVIRONMENTAL

BUSHFIRE HAZARD ASSESSMENT AND MANAGEMENT PLAN

12, 18 & 26 Cloverdale Road, Doolandella 4077

Client: Nexus Urban Consulting Pty Ltd
Reference: S521210_BHAMP_v1.1
Date: 5 June 2023

Table of Contents

Figures

Tables

Quality Control

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Version Control

Version	Description	Date	Author	Reviewer	Approver
1.0	For Submission	5 June 2023	SV (Env. Scientist)	RS (Director)	RS (Director)
1.1	Minor Amendments	6 June 2023	SV (Env. Scientist)	RS (Director)	RS (Director)

Disclaimer

S5 Consulting Pty Ltd trading as S5 Environmental has developed this Bushfire Hazard and Bushfire Attack Level Assessment, taking into consideration the Australian Standard (AS3959-2018) - Construction of Buildings in Bushfire-prone Areas, the State Planning Policy and relevant local authority policies and guidelines. However, there can be no guarantee that following the recommendations made in this assessment can guarantee safety of property and human life.

Fire is an element of nature, and as such fire events (small or large) can have disastrous outcomes even with the best planning in place. The authors of this report and S5 Consulting Pty Ltd accept no responsibility for any harm to property or human life caused by fire or any other cause to persons utilising property or structures.

Abbreviations

AHD	Australian Height Datum
AS 3959-2018	*Australian Standard 3959-2018 Construction of Buildings in Bushfire-prone Areas*
BAL	Bushfire Attack Level
BCA	Building Code of Australia
BCC	Brisbane City Council
BMP	Bushfire Management Plan
BMZ	Bushfire Management Zone
BRC	Bushfire Resilient Communities (The State of Queensland 2017)
CFA	Country Fire Authority
DES	Department of Environment and Science
DNRME	Department of Natural Resources, Mines and Energy
DoR	Department of Resources
EPZ	Environmental Protection Zone
FFDI	Forest Fire Danger Index
ha	Hectares
NCC	National Construction Code
RE	Regional Ecosystem
SEQ	South East Queensland
SPP	*State Planning Policy, 2017*
VHC	Vegetation Hazard Class

1.0 INTRODUCTION

S5 Environmental was commissioned by Nexus Urban Consulting , on behalf of their client Qld International Investments, to undertake a new Bushfire Hazard Assessment and Management Plan (BHAMP) as a response to the Brisbane City Council (BCC) issued Information Request (A006067610) regarding the proposed Development Application for Reconfiguring a Lot at 26 Cloverdale Road, Doolandella , refer to **Table 1**.

In addition to responding to Council's RFI, the aim of this BHAMP is to undertake a site-specific bushfire hazard assessment, determine any set back required between the proposed development and hazardous vegetation and prepare a Bushfire Management Plan to ensure the proposed development is not exposed to an unacceptable bushfire risk and can comply with the relevant legislative bushfire requirements.

Table 1. Site Description

Street Address	12, 18 & 26 Cloverdale Rd, Doolandella 4077	**Lot on Plan**	Lot 101 on RP90234 Lot 102 on RP90234 Lot 103 on RP90234
LGA	Brisbane City Council (BCC)	**Area**	23,143 m^2 22,764 m^2 17,452 m^2
Zone	Emerging Community	**Neighbourhood Plan**	Doolandella Neighbourhood Plan
Current State	Lot 101, 102 and 103 on RP90234, herein referred to as the 'subject site' is currently zoned as an Emerging Community Zone under the BCC. The subject site currently contains several dwellings and sheds located at the front of each property facing onto Cloverdale Road. Lot 101 furthermore contains a shipping container and derelict pool south of the dwelling, and pond on the shared boundary with Lot 102. South of the dwellings, the subject site opens into paddocks which extend south into the site. The paddocks extend to a creek running north-west to south-east through the centre of the site. Lot 102 contains a driveway which continues south through to the end of the paddocks, whilst Lot 103 contains what presumably was once cattle mustering facilities within its paddock. Dense vegetation continues south through the remainder of the site following on from the creek. A pocket of rehabilitation work has recently been undertaken immediately south of the driveways end, continuing approximately 50 meters into the dense vegetation. Refer to **Figure 1**.		
Proposed Development	A 3 into 35 lot subdivision is proposed for the subject site. The additional lots will be situated within the northern half of the site and will be accessed via a new road connecting directly to Cloverdale Road to the north. A drainage reserve is proposed along a stormwater channel (and culvert crossing) between lots 30 to 33 and 35 along the western boundary. A bioretention basin is located immediately south of the proposed subdivision on the site's eastern boundary. The balance of the site is to be dedicated as an Environmental Protection Zone (EPZ). A		

	dwelling is proposed within the northern extent of the EPZ, between lots 24 and 25. See **Figure 2** for the proposed development footprint.
Potentially Hazardous Vegetation	Post development, potentially hazardous vegetation is situated to the north, east and south of the proposed development. This potentially hazardous vegetation was determined to reflect the regional ecosystem (RE) 12.5.3 and 12.5.3a. These regional ecosystems are described as: **RE 12.5.3:** *Eucalyptus racemosa* subsp. *racemosa* woodland with *Corymbia intermedia, E. siderophloia +/- E. tindaliae, E. resinifera, E. pilularis, E. microcorys, Angophora leiocarpa*. *Melaleuca quinquenervia* is often a prominent feature of lower slopes. Minor patches (<1ha) dominated by *Corymbia citriodora* subsp. *variegata* sometimes occur. Occurs on complex of remnant Tertiary surfaces +/- Cainozoic and Mesozoic sediments. Not a wetland; and **RE 12.5.3a:** Mixed woodland to open forest usually containing *Corymbia intermedia, Eucalyptus racemosa* subsp. *racemosa* and at least a presence of *Eucalyptus seeana*. Other commonly associated species include *Angophora leiocarpa, E. siderophloia, E. microcorys, C. citriodora* subsp. *variegata* and *Lophostemon suaveolens.* Occurs on complex of remnant Tertiary surfaces +/- Cainozoic and Mesozoic sediments. Not a wetland.

Figure 1. Site Aerial (source: Nearmaps, date: 01/04/23)

Figure 2. Site Plan – Proposed (source: Intrax, drawing no: S152485, issue: D-1, date: 22 May 2023)

2.0 STATUTORY REQUIREMENTS

2.1 Development Applications in Bushfire Prone Areas

Bushfire Prone Areas are identified at both the State and Local Government Level. The State Planning Policy (SPP) Bushfire Prone Area map was developed by CSIRO to map areas with Very High, High and Medium Potential Bushfire Intensity. The SPP also maps a 100 m Potential Impact Buffer.

The Brisbane City Council (BCC) *City Plan 2014* implements the Bushfire hazard overlay code which acts as a development constraint within the BCC locality. It is understood that the *City Plan 2014* has not integrated all aspects of the SPP: Safety and Resilience to Hazards (Natural Hazards, Risk and Resilience – Bushfire Prone Areas). As such the SPP bushfire hazard mapping, as well as BCC's Bushfire hazard overlay, were consulted to determine the preliminary bushfire hazard ratings of the site and locality (within 150 m), refer to **Figure 3** and **Figure 4**.

The BCC Bushfire Hazard Overlay has mapped the balance of the assessment area under a combination of all four Bushfire Hazard categories (i.e., high hazard area, medium hazard area, high hazard buffer area and medium hazard buffer area). The footprint of the proposed residential subdivision within the northern extent of the subject site is mapped primarily under medium hazard area and medium hazard buffer area.

The SPP Bushfire Prone Areas Overlay similarly maps the almost all of the 150 m assessment area under a combination of medium potential bushfire intensity and potential impact buffer. The SPP maps the entirety of the development footprint for the residential subdivision as potential impact buffer.

Due to potentially hazardous vegetation being mapped within and around the proposed development site, further investigation of the site-specific bushfire hazard characteristics has been undertaken to determine the actual hazard of the site.

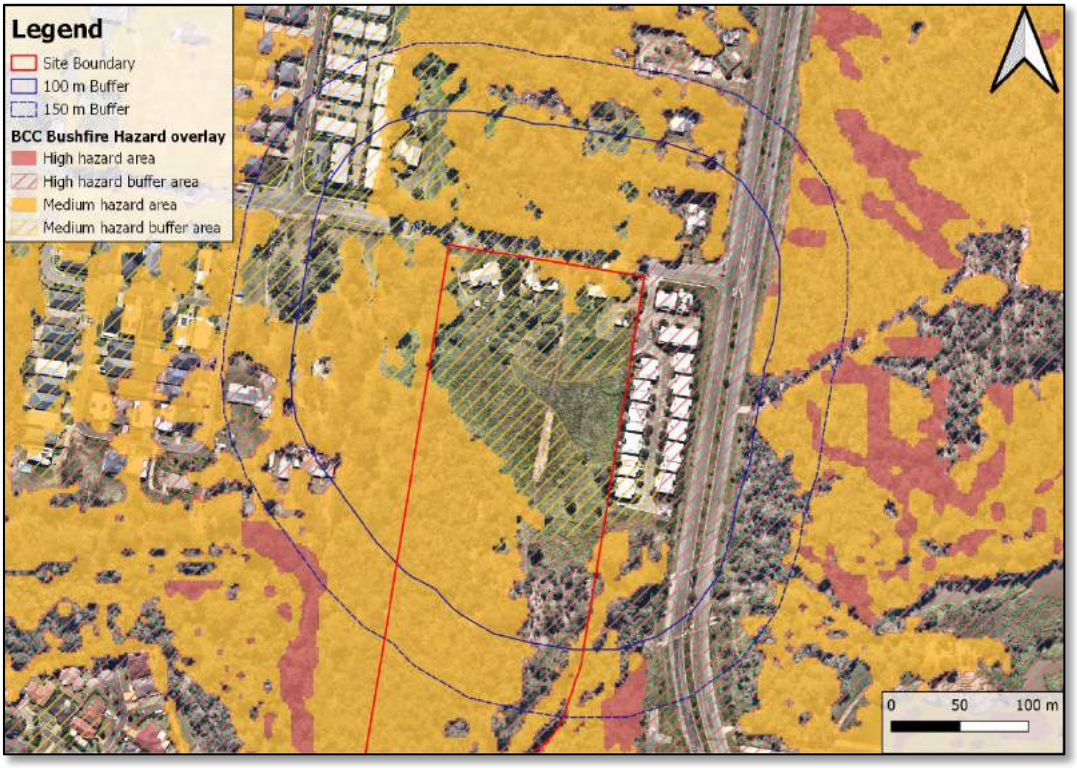

Figure 3. BCC Bushfire Hazard Mapping within and in Proximity to the Site

Figure 4. SPP Bushfire Prone Area Mapping within and in Proximity to the Site

3.0 METHODOLOGY

3.1 Bushfire Hazard Assessment

The SPP Potential Bushfire Intensity classifications are based on the *New Methodology for State-wide Mapping of Bushfire Prone Areas in Queensland* (Leonard *et al.* 2014). This State-wide mapping methodology was developed to identify Bushfire Prone Areas in support of bushfire hazard provisions of Queensland's State Planning Policy. The new methodology scales bushfire hazard based on the Potential Fire-line Intensity (PFLI) of a severe bushfire and can be used to predict the radiation profile of areas located adjacent to potentially hazardous vegetation and an associated Potential Impact Buffer.

Accordingly, the classification of an area's PFLI is calculated as a combination of the following three metrics, using the below equation (Leonard *et al.* 2014):

- Total fuel load (W);
- The McArthur Forest Fire Danger Index (FFDI), and
- Maximum Landscape Slope (θ in ^{o}).

$$FI = 0.62\, W^2\, FFDI \exp(0.069\, \theta)$$

For the purposes of the bushfire hazard assessment, S5 Environmental have utilised data from the Queensland Fire and Emergency Services (QFES) published to the Queensland Government's Queensland Spatial Catalogue (QSpatial) for fuel load and FFDI. PFLI is delineated into a number of hazard categories shown in **Table 2**, and each patch of hazardous vegetation can be classed as Very High, High, Medium, Grassland or low hazard according to the PFLI determined for that specific patch. Any patch of hazardous vegetation classed as Very High, High or Medium is buffered by 100m called the Potential Impact Buffer.

The Potential Impact Buffer is also considered a Bushfire Prone Area, along with hazardous vegetation with a PFLI of Very High, High or Medium. Any development within a bushfire prone area requires further assessment of radiant heat exposure, assessment against the relevant local planning scheme bushfire code and/or an assessment against the SPP assessment benchmarks for Natural hazards, risk and resilience relevant to bushfire and the development of a site-specific bushfire management plan to ensure that the proposed development is exposed to an acceptable or tolerable bushfire risk.

Table 2 Potential Bushfire Intensity Classification

Potential Bushfire Intensity Class	Potential Fire-line Intensity (PFLI)
Very high	>40,000kW/m
High	20,000 – 40,000kW/m
Medium	4,000 – 20,000kW/m
Low	<4,000kW/m

3.2 Modification of Potential Intensity of Small Patches and Corridors

Using the Bushfire Resilient Communities (BRC) methodology in Section 4.2.6 (The State of Queensland 2019b), small patches of hazardous vegetation and narrow corridors were removed from the map of hazardous vegetation within 150 m of the proposed development. This is as small, isolated and/or narrow patches of hazardous vegetation are not large enough to support a fully developed fire. As stated in the BRC methodology (The State of Queensland 2019b), small, isolated or narrow patches are unlikely to reach a potential fire-line intensity greater than 4,000 kW/m and as such, are considered to be low hazard and not classed as a Bushfire Prone Area. The *SPP Technical Reference Guide - Bushfire Resilient Communities* (2019) summarises research by Leonard and Opie (2017) outlines four steps to filter out small patches and narrow corridors of continuous fuel (see **Table 3** below).

Table 3 Steps to Downgrade Bushfire Intensity

Step	Description
1	Remove small, isolated patches of **continuous** fuel (< 1ha) surrounded completely by either discontinuous fuel or no fuel. These patches must be further than 100 m from other continuous fuel patches greater than 2 ha in area.
2	Downgrade intensity of small patches (0.5 to 3 ha) of **continuous** vegetation surrounded completely by either discontinuous or no fuel, which is more than 100 m from other **continuous** fuel patches greater than 2 ha in area.
3	Remove narrow corridors of **continuous** fuel (50 m, or less in width). The process erodes, then dilates by 25 m in width all **continuous** fuel patches in relation to **discontinuous** areas.
4	Remove small fragments (< 0.5 ha) of shrub-dominated or hazardous tree vegetation.

3.3 Radiant Heat Exposure Assessment

Radiant heat exposure for the proposed development was calculated using a Method 2 from the AS3959-2018. This Method 2 calculates the Bushfire Attack Level (BAL) for a proposed development by determining the minimum distance between hazardous vegetation and the development to achieve each BAL level. As BAL directly correlates to radiant heat exposure, this calculation reflects the level of bushfire risk for a proposed development (see **Table 4**).

To determine the radiant heat exposure for the proposed development, the online Flamesol Minimum Distance Calculator (FPA 2017) was used to determine the required setbacks to hazardous vegetation to achieve an acceptable radiant heat exposure for the proposed development.

Currently, S5 Environmental understand there is one set of inputs for a Method 2 calculation in accordance with AS3959-2018 or Bushfire Resilient Communities (BRC), which are accepted by BCC. Inputs to the BAL/radiant heat exposure assessment used for the purposes of this assessment include the sets of parameters as summarised in **Table 5**. S5 Environmental have opted for the use of AS Method 2(b) within

the below radiant heat flux assessment. This approach and set of inputs are generally more conservative and accurate as they incorporate higher fuel loads and flame temperature, as well as a site specific FFDI.

Table 4 BAL and Radiant Heat Exposure

BAL Score	Radiant Heat Exposure
Low	-
12.5	12.5 kW/m^2
19	19 kW/m^2
29	29 kW/m^2
40	40 kW/m^2
Flame zone (FZ)	> 40 kW/m^2

Table 5 Parameter inputs for Method 2 from AS3959-2018

Parameter	AS Method 2
Surface fuel load (t/ha)	Surface fuel load for identified VHC (surface + near surface)
Overall fuel load (t/ha)	Total fuel load for identified VHC
Flame temperature	1,200 K
FDI/FFDI	From Catalyst/QSpatial
Standard inputs	Bushfire Resilient Communities (QG 2019)
Effective slope	Measured as the slope under the hazardous vegetation. A minimum effective slope of 1 ° is utilised if vegetation slopes uphill or is at the same elevation (flat).
Site slope	Measured as the slope between the hazardous vegetation and the site. A minimum site slope of 1 ° is utilised if vegetation slopes uphill or is at the same elevation (flat).
Flame Width	Flame width is assumed to be 100 m (AS 3959-2018) unless a short-fire run.

3.4 Short Fire Run

Small or narrow patches of hazardous vegetation are unlikely to support a fully developed bushfire due to their limited size (see **Figure 5** for a schematic representation of how fire moves across a landscape, demonstrating this). As such, the flame width and height in these small patches will not reach the standard inputs for the Method 2 from AS3959-2018 as these standard inputs are based on a fully developed bushfire. In these cases, a short fire run calculation can be used. The short fire run methodology can only be applied

when there is a maximum fire run of 150m as measured on the effective slope. In these cases where a short fire run can be justified, and thus a reduced flame width and height for a Method 2 calculation, the method from the *Short Fire Run: Methodology for Assessing Bush Fire Risk for Low Risk Vegetation* (NSW Rural Fire Service, 2019) is adopted.

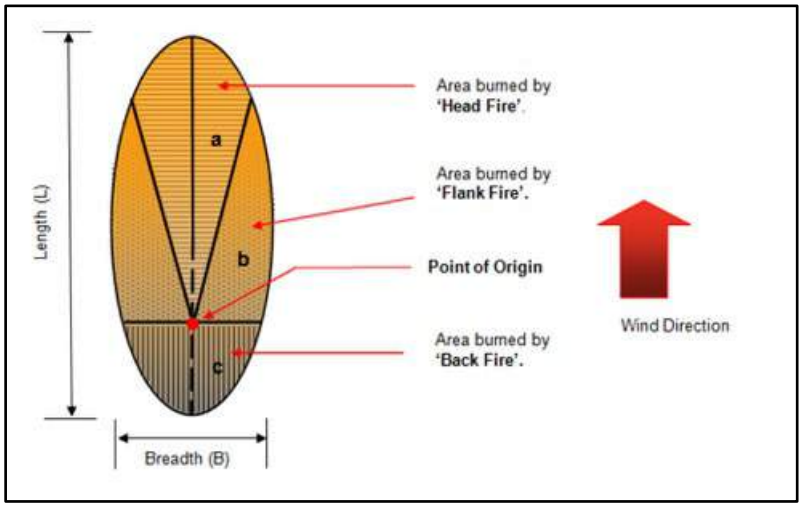

Figure 5. Schematic Diagram of Simple Elliptical Fire Growth Model (Van Wagner 1969) from NSW Rural Fire Surface (2019)

4.0 BUSHFIRE HAZARD ASSESSMENT

4.1 Potential Fire-line Intensity Assessment

In accordance with *A New Methodology for State-wide mapping of bushfire prone areas in Queensland* (Leonard *et al.* 2014), fuel loads derived from ground-truthed Vegetation Hazard Classes (VHCs), effective slope and FFDI were used to calculate the PFLI of hazardous vegetation within 150m of the proposed development and hazardous into the relevant PFLI category. The following sections discuss how these parameters were determined to calculate PFLI for hazardous vegetation in proximity to the proposed development.

4.1.1 Vegetation Hazard Class Mapping

In accordance with the *New Methodology for State-wide Mapping of Bushfire Prone Areas in Queensland* (Leonard *et al.* 2014), potential fuel loads are assigned to vegetation categories (Vegetation Hazard Classes – VHCs) formed by amalgamating land use and vegetation types with a moderately consistent fuel load and structure.

The potential fuel load assigned to each VHC is generally representative of the higher fuel load expected for the typical vegetation types, landscape and site conditions within each VHC and approximates the ***80th percentile (%) fuel load of the "long unburnt condition"*** for the class (generally greater than 10 years without burning).

Using QFES Catalyst Mapping, numerous VHCs were mapped within and adjacent to the subject site. An extract of the Catalyst Mapping is shown below in **Figure 6**.

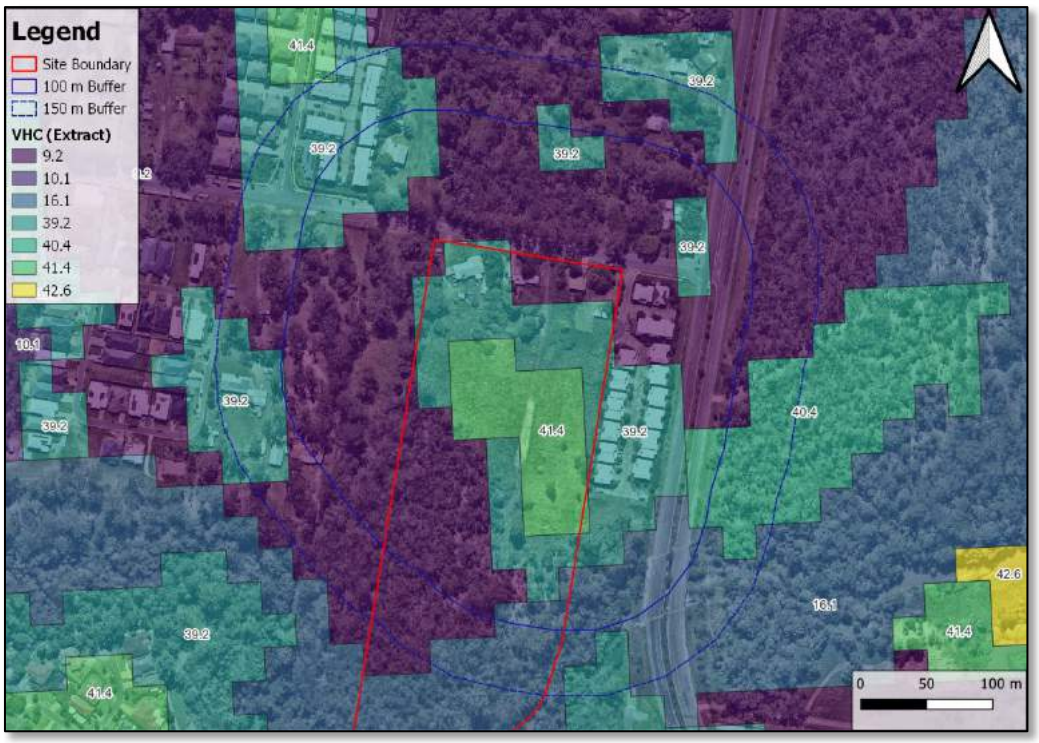

Figure 6. Extract of Vegetation Hazard Classes from Catalyst

4.1.2 Vegetation Hazard Class Verification

To ground-truth the State Government VHCs mapped within and adjacent to the subject site, S5 Environmental's Ecologists conducted a site visit on the 3rd of November 2021 and subsequently undertook a Reliability Assessment in accordance with BRC comparing available bushfire and vegetation mapping with on-ground conditions. The reliability assessment incorporated a comprehensive review of available aerial mapping of the site, including a 150 m buffered area, external to the proposed development.

Post development, the northern extent of the subject site has been mapped to reflect VHC 42.6 *'Nil to very low vegetation cover*', reflecting scarcity of vegetation throughout the proposed residential subdivision. VHC 42.6 mapping has been extended throughout much of the overall assessment area (i.e., within 150 m of the proposed development) to the north and east, reflecting the existing or approved highly dense residential developments. The Detailed Ecological Assessment (file reference: S521210_DEA001V1.0) identified native vegetation to the south of the residential development, vegetation proposed for retention within the EPZ, reflects numerous regional ecosystems (REs), specifically 12.5.3a, 12.3.7 and 12.3.11. S5 have conservatively mapped this vegetation as RE 12.5.3a, equivalent to VHC 9.2 '*Moist to dry eucalypt woodland on coastal lowlands and ranges*', as this vegetation possesses the highest fuel load. The proposed bioretention basin along the sites eastern boundary has been modified to reflect VHC 40.4 '*Continuous low grass or tree cover'* as it will not be managed in as 'low' bushfire state post-development.

Vegetation within the eastern extent of the assessment area, associated with the Blunder Creek environmental corridor, was mapped by the State Government VHC as a heterogeneous patch of vegetation containing VHC 9.2, 40.4 and 16.1 *'Eucalyptus dominated forest on drainage lines and alluvia plains*'. Again, this vegetation was modified to VHC 9.2 as a conservative measure as this VHC possesses the highest fuel load of all three VHCs. Areas containing sparse canopy trees over maintained grass understories were identified to the north and west of the proposed residential development. These areas were modified to reflect VHC 39.2 *'Low to moderate tree cover in built-up areas*', reflecting the tree cover within these areas. Finally, a small corridor of rehabilitation works reflecting RE 12.5.3, equivalent to VHC 9.1 '*Moist to dry eucalypt open forests on coastal lowlands and ranges*', have been approved within the development directly north of Cloverdale Road.

The VHC mapping has, therefore, been modified to reflect the on-ground conditions more accurately, and to reflect the post-development state of the subject site and locality (see **Figure 7**). As spatially indicated in **Figure 7**, the modified VHCs have been restricted to a 150 m buffer from the development area, as the more distant areas are not relevant for the purposes of this Bushfire Hazard Assessment.

Plates 1 to **7** below show the various areas and communities existing across the site and throughout the assessment area.

Plate 1 View south through the subject site. The residential subdivision will extend to the tree-line and has accordingly been mapped as VHC 42.6. Vegetation in the background, which is to be retained within the EPZ, has been mapped as VHC 9.2.

Plate 2 View north through the development area which has been modified to VHC 42.6.

Plate 3 View of council enforced rehabilitation along the northern extent of the EPZ. Planting palette to reflect VHC 9.2.

Plate 4 View of the waterway at the interface between the southern extent of the residential subdivision (left) and native vegetation retained within the EPZ (right).

Plate 5 View of the proposed location for the detention basin (VHC 40.4) to the south of the residential subdivision.

Plate 6 View of VHC 9.2 within the EPZ.

Plate 7 Alternative view of VHC 9.2 to the south of the residential subdivision.

Figure 7. Ground-truthed and Post-development Vegetation Hazard Classes

4.1.3 Fuel Loads

Table 6 below, summarises the associated fuel loads of the final VHCs in relation to the proposed development.

Table 6 Summary of VHCs and their Associated Fuel Continuity and Loads

VHC	VHC Description	Fuel Continuity	Potential Fuel Load * (t/ha)
			Total
9.1	Moist to dry eucalypt open forests on coastal lowlands and ranges	Continuous	24.2
9.2	Moist to dry eucalypt woodland on coastal lowlands and ranges	Continuous	17.2
39.2	Low to moderate tree cover in built-up areas	Discontinuous	8
40.4	Continuous low grass or tree cover	Continuous	5
42.6	Nil to very low vegetation cover	Discontinuous	2

*CSIRO A Methodology for State-wide Mapping of Annual Fuel Load and Bushfire Hazard in Queensland. Glenn Newnham, Kimberley Opie, Justin Leonard CSIRO Land and Water, 2017.

After ground-truthing the VHCs within the assessment area, continuous VHCs were rasterized to undergo the processing stages. Continuous and discontinuous fuel VHCs are defined as:

- **Continuous**: Vegetation and land uses which possess generally consistent fuel loads which can develop a full flame front; and
- **Discontinuous**: Vegetation and land uses which possess fuel loads which are incapable of supporting a full flame front.

The rasterization process extracts the attribute value of the polygon which occupies the centre of the raster pixel (a 25 m by 25 m cell) and uses it to populate the same cell within a raster layer. This will result in continuous VHCs within the assessment area being rasterized whilst discontinuous VHCs remain un-rasterized. Refer to **Figure 8**.

4.1.4 Modification of Potential Intensity of Small Patches and Corridors

Following the rasterization of continuous fuel VHCs within the assessment area (i.e., VHC 9.1, 9.2 and 40.4), S5 Environmental have investigated the application of the processing stages. Step 3, the removal of narrow corridors less than 50 m in width, appears to be applicable on the rasterized narrow corridor of VHC 9.1 to the north of the subject site. However, the rasterization process is only to be used as a guide to downgrade and in this scenario, the underlying corridor of VHC 9.1 exceeds 50 m in width and cannot be downgraded. The corridor investigated for the application of Step 3 is illustrated in **Figure 8**.

As such, the processing stages do not apply to the proposed development.

Figure 8. Narrow Corridor Investigated under Step 3 of the Processing Stages

4.1.5 Slope Assessment

The slope of vegetated land over which a bushfire passes has a strong influence on both the intensity and rate of spread of the bushfire. From a bushfire hazard assessment perspective, the relevant slopes to consider are the slopes beneath areas of potentially hazardous vegetation, defined as "effective slope" in AS 3959-2018, that would be retained within or adjacent to the proposed development site. Also relevant, is whether the vegetated land is situated upslope or downslope of the proposed development. As fire travels faster upslope, there is a significant reduction in risk and fire-line intensity for sites that sit below the vegetation. Potentially hazardous vegetation to the north was determined to be upslope of the proposed development. Potentially hazardous vegetation to the east was determined to be level with the proposed development, whilst potentially hazardous vegetation to the south was determined to be downslope and approximately level to the proposed development, respectively (refer **Figure 9**).

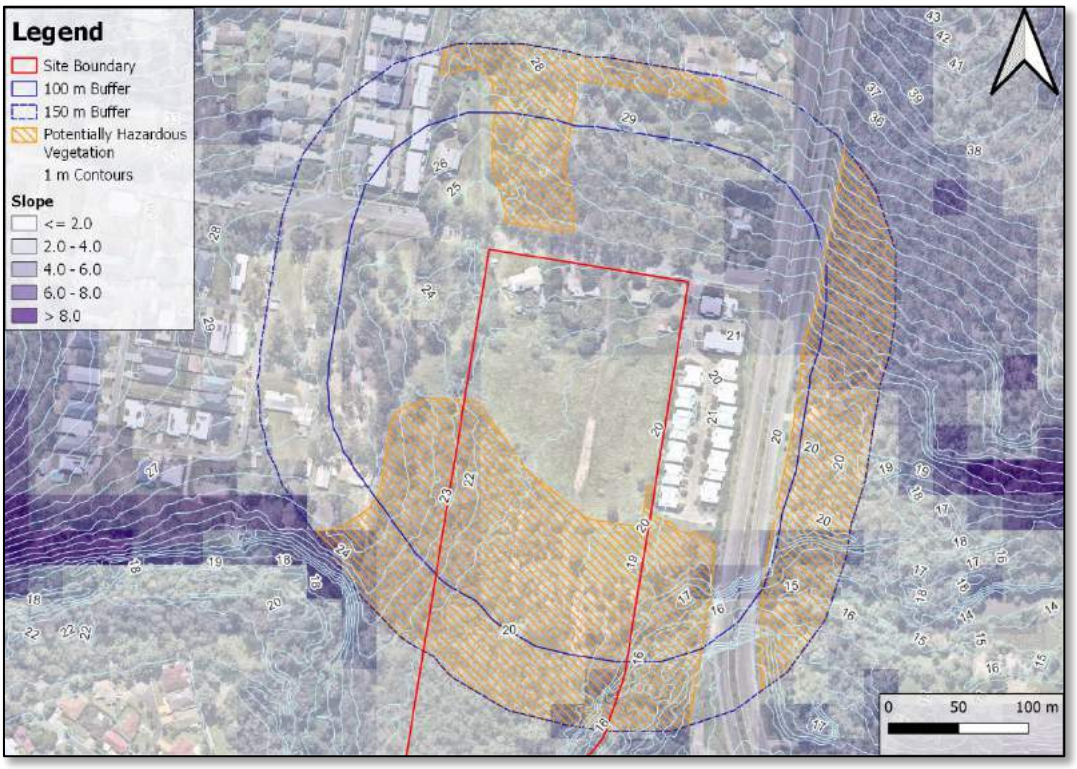

Figure 9. Slope within and in Proximity to the Proposed Development

4.1.6 Forest Fire Danger Index

In accordance with the Australian Standard (AS) 3959-2018, *Construction of Buildings in Bushfire Prone Areas*, the Fire Danger Index (FDI) indicates the chance of a fire starting, its intensity, rate of spread and the difficultly of its suppressions, according to several combinations of relative humidity, air temperature, wind speed as well as long- and short-term drought effects. The QFES Catalyst Mapping indicates that the site-specific Forest Fire Danger Index (FFDI) for the subject site is **56**.

4.1.7 Final PFLI

A final PFLI for patches of hazardous vegetation (determined in **Section 4.1**) has been calculated using the PFLI equation in **Section 3.1**. Based on this PFLI calculation, the potentially hazardous vegetation to the

north of the proposed development was mapped to contain areas of high potential bushfire intensity (i.e., 20,000 to 40,000 kW/m), associated with VHC 9.1. Vegetation associated with VHC 9.2 to the south and east of the proposed development was mapped to contain medium potential bushfire intensity (i.e., 4,000 to 20,000 kW/m), whilst potentially hazardous vegetation associated with VHC 40.4 was mapped to contain low potential bushfire intensity (< 4,000 kW/m). Refer to **Figure 10**.

4.2 Hazardous Vegetation

Vegetation mapped as VHC 9.1 to the north and vegetation mapped as VHC 9.2 to the south and east of the proposed development area was determined to be the only hazardous vegetation within the assessment area. As this vegetation is within 100 m of the proposed development area, the proposed residential subdivision is therefore within a Bushfire Prone Area. As such, a Bushfire Attack Level (BAL) assessment has been conducted to determine the radiant heat flux future Lots may be exposed to.

Figure 10. Potential Fire Line Intensity

5.0 BUSHFIRE ATTACK LEVEL ASSESSMENT

This BAL assessment has focused on the potential impact of a fire event in hazardous vegetation located within 100 m of the subject site. Hazardous vegetation in relation to the proposed development was determined to be the vegetation to the north and south of the development area (refer to **Figure 10**). A Method 2 assessment in accordance with AS3959-2018 utilising the online Flamesol Minimum Distance Calculator was undertaken to determine the required setbacks from hazardous vegetation to the north, south and east of the proposed development (see **Table 7** and **Figure 11**). Refer to **Appendix B** for inputs and outputs from the Flamesol Minimum Distance Calculator.

Table 7. Summary of Setbacks and Radiant Heat Exposure for the Proposed Development

Radiant Heat Exposure (kW/m^2)	BAL	Distance from Hazardous Vegetation		
		North	East	South
-	Low	100 m	100 m	100 m
12.5	12.5	40.1 m	30.7 m	32.1 m
19	19	29 m	21.7 m	22.7 m
29	29	20.3 m	14.7 m	15.5 m
40	40	15.1 m	10.9 m	11.5 m
> 40	FZ	< 15.1 m	< 10.9 m	< 11.5 m

Figure 11. Radiant Heat Flux Setbacks

Based on the results of the radiant heat exposure assessment, the BLEs within lots 3 to 21, 32 and 33 will achieve a maximum BAL score of 12.5, whilst lots 1, 2, 22, 31, 34 and 35 will achieve a maximum BAL score of BAL 19. The BLEs within lots 23 to 30 and the EPZ will achieve a maximum score of 29 following the recommendations of the bushfire management plan. Refer to **Table 8**.

Table 8. BAL Requirements for Proposed Lots

Lot/s	Applicable BAL Score
3 to 21, 32 and 33	12.5
1, 2, 22, 31, 34 and 35	19
23* to 30 and EPZ	29

*The dwelling within lot 23 must be located outside the very south-western extent of the BLE to ensure BAL 29 is achieved. This is further detailed in **Section 6.3.1 Siting of Development**, below.

Accordingly, a Bushfire Management Plan has been prepared and presented in **Section 6.0**.

6.0 BUSHFIRE MANAGEMENT PLAN

This Bushfire Management Plan (BMP) identifies management measures that must be implemented to ensure that the risk of bushfire attack is reduced to an acceptable level. It is first important to understand the processes that influence bushfire behaviour (**Section 6.1**), and the sources of damage that threaten people, infrastructure and property (**Section 6.2**).

6.1 Bushfire Behaviour

Understanding bushfire behaviour is imperative when planning new development. There are three main factors which influence fire behaviour as follows:

1) Topography

Slope influences the speed and intensity of a fire. Fire is known to burn faster uphill as flames and radiant heat preheat the vegetation ahead of the fire, drying it out and making it increasingly flammable. As a rule of thumb, for every 10 degrees slope, fire doubles in speed. Refer to **Figure 12**, below.

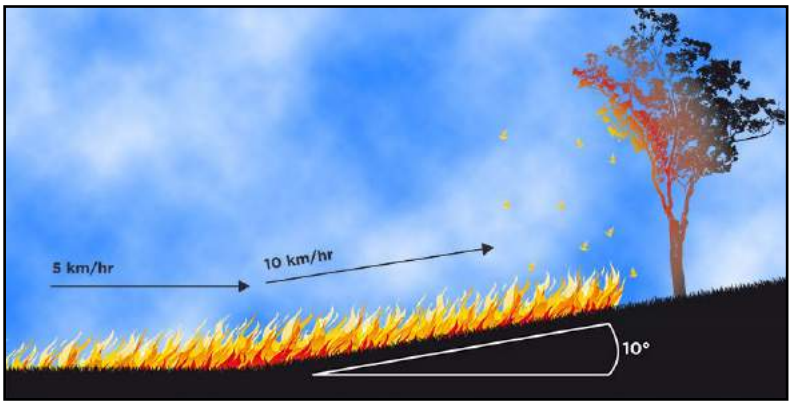

Figure 12. Effects of Topography on Bushfire (source: Country Fire Authority)

2) Weather Conditions

Bushfire weather conditions are fundamentally defined by temperature, humidity, wind, atmospheric conditions and past rainfall. For example, summer weather conditions increase the flammability of vegetation. Wind influences the speed and direction in which fire travels, fire intensity and possibility of spot fires from burning debris. A measure of weather conditions is the Forest Fire Danger Index (FFDI) and Grassland Fire Danger Index (GFDI). These measures are useful in determining the fire danger rating (refer to **Fire Danger Rating** in **Figure 13**).

3) Vegetation

Vegetation is the source of fuel for a bushfire. The amount of fuel surrounding a building can directly impact a buildings survival. Vegetation management, landscaping for bushfire and breaking the continuity of vegetation can limit the spread of fire.

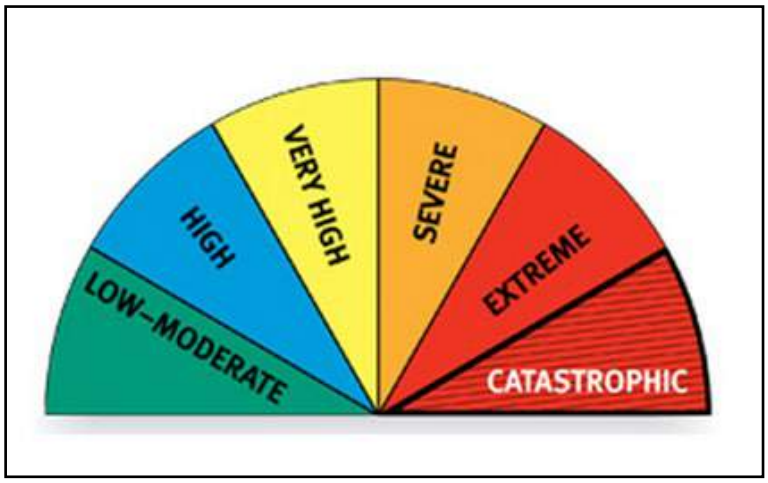

Figure 13. Fire Danger Rating (source: Queensland Government, Emergency Services and Safety)

6.2 Bushfire Damage Sources

The Country Fire Authority (2009) states, "*Bushfires can vary in intensity and scale across the landscape*". As the past bushfire events throughout Australia have illustrated, bushfires can be devastating and lead to long-running fires which are difficult to suppress. Building survival is influenced by many interacting factors. The four main ways buildings are destroyed during a bushfire include:

- Ember attack;
- Radiant heat;
- Direct flame contact; and
- Fire-driven wind.

Ember Attack

Research indicates that the most common way buildings catch on fire is through ember attack (80% of house loss). Ember attack occurs when small burning twigs, bark, leaf are carried by wind and land in and around a building. Embers can ignite flammable plants, leaf litter, fences, outdoor furniture and sheds (refer to **Figure 14**, below). Ember attack is addressed within the AS 3959-2018 through Construction Standard requirements.

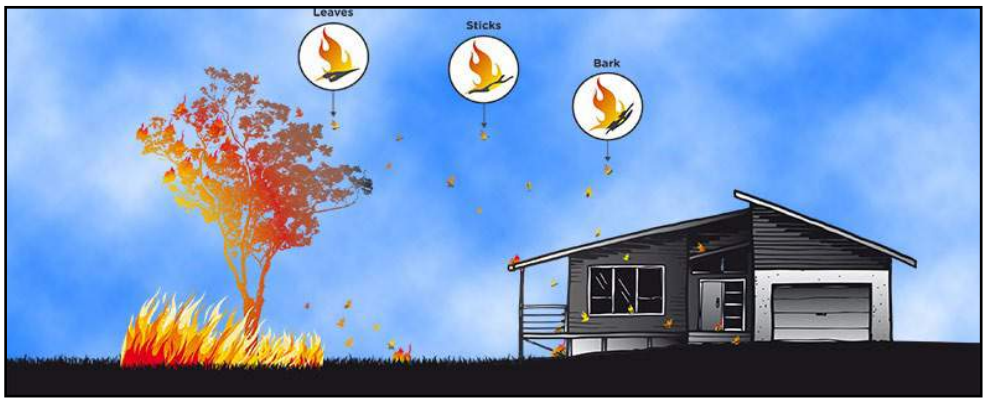

Figure 14. Ember Attack (source: Country Fire Authority)

Radiant Heat

Radiant heat is the heat created from burning fuel during a bushfire. Radiant heat can ignite surfaces without direct flame contact or ember attack, dry out vegetation ahead of the bushfire, crack glass (allowing embers to enter a building) and distort and melt materials (refer to **Figure 15**, below). The most common cause of loss of human life is via radiant heat (CFA, 2018).

Figure 15. Radiant Heat (source: Country Fire Authority)

Direct Flame Contact

Direct flame contact occurs when a fire front reaches a building, this is referred to as the 'Flame Zone'. Approximately 20% of house loss occurs when houses/buildings are directly adjacent to bushland.

Fire-driven Wind

Fire-driven wind can carry embers, cause trees to fall onto buildings, can break windows and destroy structures. The closer a building is to a fire front, the more severe the impact of fire-driven wind.

6.3 Management and Mitigation Measures – Permanent Buildings

Management and mitigation measures are generally outlined in relevant planning instruments at both the State and Local Government level.

Mitigation measures emphasize resilience to bushfire and are categorised into the following groups for the permanent structures within the site.

- Layout design;
- Building and construction requirements;
- Firefighting infrastructure;
- Bushfire emergency plan; and
- Vegetation management and landscaping

6.3.1 Layout Design

Access and Egress

Access to the proposed residential subdivision will be achieved directly off Cloverdale Road to the north. Additionally, access and egress will be achieved via foot through the residential development on the adjacent property to the east, 6 Cloverdale Road, which will prevent entrapment during a bushfire event. S5 Environmental recommend the internal road be constructed to the road design requirements for emergency vehicle access as outlined within *Table 8.2.5.3 C* of Section 8.2.5 Bushfire Overlay Code, to be confirmed by the Project Town Planner or Engineer. Cloverdale Road and Blunder Road are considered suitable to carry emergency fire-fighting appliances, provide emergency evacuation and to prevent entrapment during a bushfire.

Siting of Development

The proposed residential development is sited within an area of Low Potential Fire Line Intensity (> 4,000 kW/m^2). S5 Environmental stipulate that the dwelling within lot 23 is located within the BLE to ensure a maximum BAL score of 29 is achieved (i.e., outside the south-western corner of the designated BLE). Following this, BAL 29 will be the maximum BAL score achieved by the proposed development. These setbacks were modelled utilising the Flamesol BAL Minimum Distance Calculator (refer to **Appendix B**). The siting of the development is considered to ensure the proposed development is exposed to an acceptable level of bushfire risk.

6.3.2 Building and Construction Requirements

In accordance with the BCA, the AS 3959-2018 requirements for construction of buildings applies to any new Class 1, 2, 3 or 10a Building (when ancillary to a Class 1, 2, or 3 Building). Therefore, any future habitable Class 1, 2 and/or 3 buildings and their ancillary Class 10a building/s within the development must adhere to the relevant BAL construction Standards based on their location.

Early Warning Systems

Smoke alarms should be installed in accordance with the Building Code of Australia and the AS 3786-1993 - *Smoke Alarms*. The Queensland Fire and Emergency Services recommends photoelectric smoke alarms (not ionization alarms). Photoelectric smoke alarms are generally more effective than ionization types as they detect visible particles of combustion.

6.3.3 Firefighting Infrastructure

The site is expected to be connected to a reticulated water supply network. It is expected that the reticulated water supply network within the area complies with the provisions outlined in the SEQ Water Supply, Sewage Design and Construction Code.

6.3.4 Bushfire Emergency

In the event of a Bushfire Emergency, the local QFES should be contacted immediately. The Durack Fire and Rescue Station is located approximately 4.4 km (by road) to the north of the subject site. The contact details for the Durack Fire and Rescue Station are:

- Address: 506 Blunder Road, Durack QLD 4077

- Phone: (07) 3565 4181, **Please note that in fire emergencies the triple zero (000) emergency telephone number should be used.**

6.3.5 Vegetation Management and Landscaping

Bushfire Management Zone (BMZ) and Low Fuel Load Areas

The QFES acknowledges the type, location and ongoing maintenance of landscaping as a necessary Bushfire Protection Measure. A Bushfire Management Zone (BMZ) has been proposed within lots 23 to 30 and the northern extent of the EPZ (see **Figure 16**). This BMZ will extend approximately 15.5 m off the southern lot boundaries and must be maintained in perpetuity to guarantee ongoing protection from bushfires in the locality.

Whilst it is acknowledged that council have requested that the bushfire management zone be located north of the proposed drainage channel, S5 Environmental have confirmed via the hydraulic engineers that the drainage channel is to consist of a maintained understory with scattered shrubs. We further understand that the maintained understory is to consist of mown turf to accommodate flows. Accordingly, with the use of low-flammability shrub species and the implementation of a bushfire covenant requiring ongoing maintenance of the understory, the required bushfire setbacks can incorporate the drainage channel.

Figure 16. Proposed Bushfire Management Zone

Bioretention Basin

The proposed bioretention basin was assessed as hazardous vegetation within the Bushfire Hazard Assessment. To further minimise the bushfire risk towards lots 22 to 24, S5 Environmental stipulate that the

bioretention basin be kept in a low fuel state in perpetuity. This can be achieved by utilising low flammability species and ensuring sufficient separation between vegetation layers (i.e., canopy, groundcover, etc).

Landscaping

S5 Environmental recommend that future lot owners adhere to the following advice (outlined in the SPP Technical Reference Guide – Bushfire Resilient Communities) on low flammability landscaping.

Landscaping plays an important role in increasing a buildings' ability to endure bushfire attack. Landscaping for bushfire reduces the risk of ember attack which is the most common cause of building loss during bushfire. This includes utilisation of low flammability treatments such as rock mulches, concrete retaining blocks, and appropriate plantings.

Appropriate plant attributes to consider implementing in landscape design to reduce bushfire risk include:

- High leaf moisture content;
- Lower volatile oil content;
- Higher leaf mineral content;
- Broad-leaved species;
- Resilience to pruning;
- Low ignition likelihood;
- A low volume of persistent dead leaves/branches;
- Smooth or tightly held bark; and,
- Leaves and twigs that do not regularly fall,

Management of landscaped areas should ensure that there is no accumulation of litter and woody debris on garden beds and should ensure that there is horizontal and vertical separation of plants. Any grass within the proposed lots should never exceed 10 cm in height. Irrigation of garden and greenery areas could be considered to ensure a well-watered, low flammability landscape.

The Victorian Country Fire Authority (CFA) have produced an online Plant Selection Key which facilitates landscape designers and property owners to select fire wise garden plants. The CFA have also produced the publication 'Landscaping for Bushfire: Garden Design and Plant Selection' (CFA, 2011). The publication outlines planning, designing, choosing suitable plants, maintaining gardens and provides a Plant Selection Key, and can be obtained from their website.

In addition, trees should not overhang the roofline of the building, touch walls or other elements of a building and plants greater than 10 centimetres in height at maturity must not be placed directly in front of a window or other glass feature.

7.0 CONCLUSION

This Bushfire Hazard Assessment concluded that the proposed development is within 100m of potentially hazardous vegetation to the north and south. The AS 3959-2018 Method 2 radiant heat flux exposure assessment determined that the residential development will be exposed to a maximum radiant heat exposure of 29 kW/m^2, equivalent to BAL 29. Accordingly, all buildings exposed to BAL 12.5 or greater will have to adhere to the relevant BAL construction requirements.

S5 Environmental have prepared a site-specific Bushfire Management Plan to support the proposed residential development, which recommends key mitigation measures to be implemented to ensure the risk to people, infrastructure and property is acceptable and minimised. Of note, a BMZ is recommended within lots 23 to 30 and the EPZ to ensure a maximum BAL score of 29 is achieved by BLEs within these lots. Additionally, the proposed bioretention basin and drainage channel must be kept in a low fuel state in perpetuity.

Overall, the proposed development complies with the relevant BCC bushfire related assessment benchmarks, refer to **Appendix A**.

8.0 REFERENCES

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APPENDIX A

Bushfire Hazard Overlay Code Response

PERFORMANCE OUTCOMES	ACCEPTABLE OUTCOMES	COMMENTS	COUNCIL USE ONLY
Section A – If for accepted development subject to compliance with identified requirements (acceptable outcomes only) or assessable development)			
PO1 Development: a. minimises the bushfire hazard; b. maximises the protection of life and property from bushfire; c. addresses the bushfire hazard determined by a bushfire hazard assessment; d. where not in compliance with an approved bushfire management plan or development footprint: i. achieves a bushfire attack level that is less than or equal to BAL-29; or ii. achieves a bushfire attack level that is less than or equal to BAL-12.5 if for vulnerable uses, difficult to evacuate uses, assembly uses, essential community infrastructure or involving the handling or storage of hazardous chemicals exceeding amount specified in Table 8.2.5.3.D; or	**AO1.1** Development is designed and sited in compliance with: a. an approved bushfire management plan relevant to the full nature of the uses, which identifies the level of bushfire hazard and the location of hazardous vegetation affecting the development; or b. an approved development footprint identifying the development footprint plan and bushfire management footprint plan; or c. a bushfire hazard assessment and bushfire management plan prepared in accordance with the Bushfire planning scheme policy which: i. is undertaken by a suitably qualified person with technical expertise in the field of bushfire hazard identification and mitigation; ii. determines the relevant bushfire attack level for that part of the site in which development is proposed; iii. identifies the location of hazardous vegetation that poses a bushfire risk to the development.	Complies – S5 Environmental understand that, following the approval of this report, the proposed development will be designed and sited in compliance with an approved bushfire management plan. Additionally, the above bushfire hazard assessment determined the proposed residential subdivision will be sited in an area of Low PFLI and will achieve a maximum BAL score of 29.	

PERFORMANCE OUTCOMES	ACCEPTABLE OUTCOMES	COMMENTS	COUNCIL USE ONLY
iii. if on a site of an existing premises and not a vulnerable use, difficult to evacuate use, assembly use, essential community infrastructure or involving the handling or storage of hazardous chemicals exceeding amounts specified in Table 8.2.5.3.D: A. does not extend beyond the bounds of the existing development footprint; B. does not increase the GFA by 10% or 100m2, whichever is the greater; C. does not involve a new use on the site; D. is supported by a bushfire risk assessment prepared by a suitably qualified person with technical expertise in the field of bushfire hazard identification and mitigation, which demonstrates that the bushfire risk is acceptable. Note—Bushfire hazard is generally assessed based on the vegetation existing on site, adjacent and nearby to the site at the time of application. However, the level of bushfire hazard posed by any areas subject to revegetation or regrowth	Note—Where a bushfire hazard assessment determines that the bushfire hazard for the part of the site in which development is proposed is 'low', no further assessment against this code is required. Note—A 'low' bushfire attack level must not be assumed for development in the Potential impact sub-category and in any areas subject to revegetation or regrowth vegetation even where the area is non-vegetated or vegetation is considered low threat in accordance with AS 3959 Construction of buildings in bushfire-prone areas. The Bushfire planning scheme policy provides advice about the sources of information to be consulted to determine areas subject to revegetation or regrowth vegetation and the hazard classification of that vegetation in its mature state. Note—A bushfire management plan is to be prepared having regard to any bushfire hazard assessment undertaken to prepare a neighbourhood plan. Note—Any bushfire management zone, asset protection zone or similarly defined area approved as part of a bushfire management plan used for bushfire management purposes is considered to be a bushfire management footprint plan. A building protection zone can compromise both the development footprint plan and the bushfire management footprint plan.		
	AO1.2 Development where not in compliance with an approved bushfire management plan or development footprint identifying the development footprint plan and bushfire management footprint plan: a. achieves a bushfire attack level that is less than or equal to:	N/A – Following approval of this report, the proposed development will be in compliance with an approved bushfire management plan.	

PERFORMANCE OUTCOMES	ACCEPTABLE OUTCOMES	COMMENTS	COUNCIL USE ONLY
vegetation is assessed as if that area had reached its mature state. The Bushfire planning scheme policy provides advice about the sources of information to be consulted to determine areas subject to revegetation or regrowth vegetation and the hazard classification of that vegetation in its mature state. Note—Where a bushfire risk assessment is required it must be carried out in accordance with the State Planning Policy and the National Emergency Risk Assessment Guidelines prepared by the Australian Institute of Disaster Resilience.	i. BAL-29; or ii. BAL-12.5 if for vulnerable uses, difficult to evacuate uses, assembly uses, essential community infrastructure or involving the handling or storage of hazardous chemicals exceeding the amount specified in Table 8.2.5.3.D. Note—Bushfire attack level (BAL) is the radiant heat flux that will be experienced during a bushfire and is a measure of heat energy impact expressed as kW/m2. BAL is measured within the area of the nominated development footprint plan and excludes the area of any bushfire management footprint plan.		
Additional performance outcomes and acceptable outcomes for all development in Biodiversity areas overlay if on a site larger than 2,500 m^2			
PO8 Development through the siting, design, and construction of buildings, access routes and fire maintenance trails, and ongoing site management: a. provides effective separation from sources of bushfire risk; b. responds to the bushfire risk in that location; c. maintains the safety and protection of people and property over time;	**AO8** Development locates building protection zones as shown on Figure b and Figure c, driveways and access routes and any fire maintenance trails: a. outside of the Biodiversity areas overlay; or b. within the existing disturbed, degraded or cleared areas, using natural fire breaks to avoid vegetation clearing and to avoid or otherwise minimise	Complies – S5 Environmental understand the proposed development is located within the northern extent of the subject site which has been historically cleared. Native vegetation throughout the southern extent of the site will be protected under an environmental protection zone.	

PERFORMANCE OUTCOMES	ACCEPTABLE OUTCOMES	COMMENTS	COUNCIL USE ONLY
d. maximises the protection of vegetation in areas of high biodiversity value. Note—A bushfire management plan prepared in accordance with the Bushfire planning scheme policy can assist in demonstrating compliance with this performance outcome that ensures: • ongoing site management, such as the bushfire risk to buildings, does not increase beyond the standard to which they have been designed and constructed; • appropriate design and maintenance of the site, and access routes and driveways.	fragmentation or incursions into a habitat area, fauna movement corridor or remnant vegetation.		
Section B—If for assessable development other than ROL			
PO9 Development: c. provides for safe and efficient evacuation and emergency services access to the site during a bushfire; d. does not concentrate large numbers of people or locate significant worker or resident	**AO9.1** Development: a. does not increase the number of people living, working on or visiting the site by more than 10%; or b. increasing the number of people living, working on or visiting the site, or vulnerable uses, difficult to evacuate uses or assembly uses by more than 10%, implements the recommendations of an approved bushfire management plan, which identifies measures that address the identified bushfire risk relevant to the development.	Complies – Following the approval of the above bushfire management (BMP), the proposed development will be in compliance with an approved BMP which identifies risks and appropriate measures to reduce the risk associated with the proposed development.	

PERFORMANCE OUTCOMES	ACCEPTABLE OUTCOMES	COMMENTS	COUNCIL USE ONLY
populations in an area of bushfire hazard; e. avoids locating the following uses in an area of bushfire hazard: i. vulnerable uses; ii. difficult to evacuate uses; iii. assembly uses. Note—This includes consideration of appropriate alternative shelter for vulnerable uses, management of health and wellbeing requirements during evacuation, safe site operation, and access and egress arrangements in bushfire events. Note—A bushfire management plan prepared in accordance with the Bushfire planning scheme policy can assist in demonstrating compliance with this performance outcome.		Additionally, the bushfire hazard assessment determined the proposed development is located within an area of Low PFLI and will be exposed to a maximum radiant heat flux of 29 kW/m^2. S5 Environmental are as such of the opinion that the proposed development does not pose an unacceptable risk to people, public health and safety, and the environment.	
	AO9.2 Development provides alternative access routes that meet the road design requirements of items 1–7 in Table 8.2.5.3.C, for the following: a. an extension to existing premises which increases the number of people living, working on or visiting the site by more than 10%; b. the introduction of vulnerable, difficult to evacuate or assembly uses.	Performance Solution – S5 Environmental understand that access/egress to the proposed development will be afforded directly off Cloverdale Road to the north. It is understood that this road will meet the design requirements as outlined in Table 8.2.5.3.C, to be confirmed by the project Town Planner or Engineer. A secondary egress option is provided via the residential	

PERFORMANCE OUTCOMES	ACCEPTABLE OUTCOMES	COMMENTS	COUNCIL USE ONLY
		development to the east of the subject. Although only accessible on foot, S5 Environmental understand this secondary egress route is directed away from hazardous vegetation to the south and will prevent entrapment in a bushfire scenario.	
Additional performance outcomes and acceptable outcomes if involving storage or handling on site of hazardous chemicals in quantities that would be equivalent to or exceed the threshold quantities set out in Table 8.2.5.3.D			
PO10 Development does not cause: a. unacceptable risk to people, property and the environment due to the impact of bushfire on the storage or handling on site of hazardous chemicals; b. excessive danger or difficulty to emergency services for emergency response or evacuation.	**AO10** Development for storage or handling of hazardous chemicals: a. is not located within the bushfire overlay; or b. complies with an approved bushfire management plan prepared in accordance with the Bushfire planning scheme policy which identifies measures that ensure the development: i. mitigates the bushfire risk relevant to the development;	N/A – S5 Environmental understand the proposed development is for a residential development and will not include the storage or handling of hazardous chemicals.	

PERFORMANCE OUTCOMES	ACCEPTABLE OUTCOMES	COMMENTS	COUNCIL USE ONLY
	ii. does not pose an unacceptable risk to people, public health and safety or risk environmental harm; iii. does not present significant difficulties to emergency services for emergency response or evacuation. Note—Bushfire management plans and site-based risk assessments are prepared in accordance with the Bushfire planning scheme policy. Guidance on the preparation of a hazard and risk analysis is provided in the Industrial hazard and risk assessment planning scheme policy. Note—Any risk mitigation measures, including construction of underground tanks or fire-protected above-ground tanks or package stores, are in compliance with AS 1940-2004 The storage and handling of flammable and combustible liquids.		
Additional performance outcomes and acceptable outcomes for essential community infrastructure			
PO11 Development for essential community infrastructure is located, designed and sited to: a. protect the safety of people during a bushfire;	**AO11** Development for essential community infrastructure: a. is ancillary to and not relied on for the provision of the essential service during a bushfire; or b. implements an approved bushfire management plan prepared in accordance with the Bushfire	N/A – Proposed development will not include essential community infrastructure.	

PERFORMANCE OUTCOMES	ACCEPTABLE OUTCOMES	COMMENTS	COUNCIL USE ONLY
b. not create or increase the exposure of people to an unacceptable risk from a bushfire; c. minimise the risk to vulnerable populations from a bushfire; mitigate the impacts on the community and environment from the effects of a bushfire on the development.	planning scheme policy which identifies measures that: i. ensure the development allows for safe and efficient emergency access and site evacuation during a bushfire; ii. do not pose an unacceptable risk to people on a premises during a bushfire; iii. ensure the development is not at risk of failure during a bushfire which results in health or safety risks or adverse environmental impacts; iv. enable people and property to be defended safely and effectively from a bushfire.		
PO12 Development for essential community infrastructure is able to function effectively during and immediately after bushfire events.	**AO12** Development for essential community infrastructure: a. is ancillary to and not relied upon for the provision of the essential service during a bushfire; or b. containing elements vital to the function of the essential service during a bushfire is not located in the Bushfire overlay area; or c. implements an approved bushfire management plan prepared in accordance with the Bushfire planning scheme policy which identifies measures that ensure that:	N/A – Proposed development will not include essential community infrastructure.	

PERFORMANCE OUTCOMES	ACCEPTABLE OUTCOMES	COMMENTS	COUNCIL USE ONLY
	i. essential community infrastructure is able to function during bushfire events; ii. access necessary to maintain safety or function of the development is not compromised by a bushfire; **iii.** mitigation measures are not unduly reliant on human activation to respond to a bushfire; **iv.** the safe storage of valuable records or items of cultural or historical significance, including storage of public records under the Public Records Act 2002, is able to be maintained during a bushfire event.		
Additional performance outcomes and acceptable outcomes if for landscaping or a park landscape plan is a requirement for development			
PO13 Development provides landscaping that does not create an unacceptable risk to people or property and provides for ongoing management of risk to the development and people from a bushfire.	AO13 Development is in compliance with a landscaping plan which: a. is prepared in compliance with an approved bushfire management plan; b. preserves the requirements of any building protection zone; c. does not increase the exposure of a habitable building not located in a building protection zone to a bushfire hazard.	Complies – S5 Environmental have made landscaping recommendations within the BMP which will ensure onsite vegetation is maintained within a low fuel state and predominantly utilises low-fuel vegetation species.	

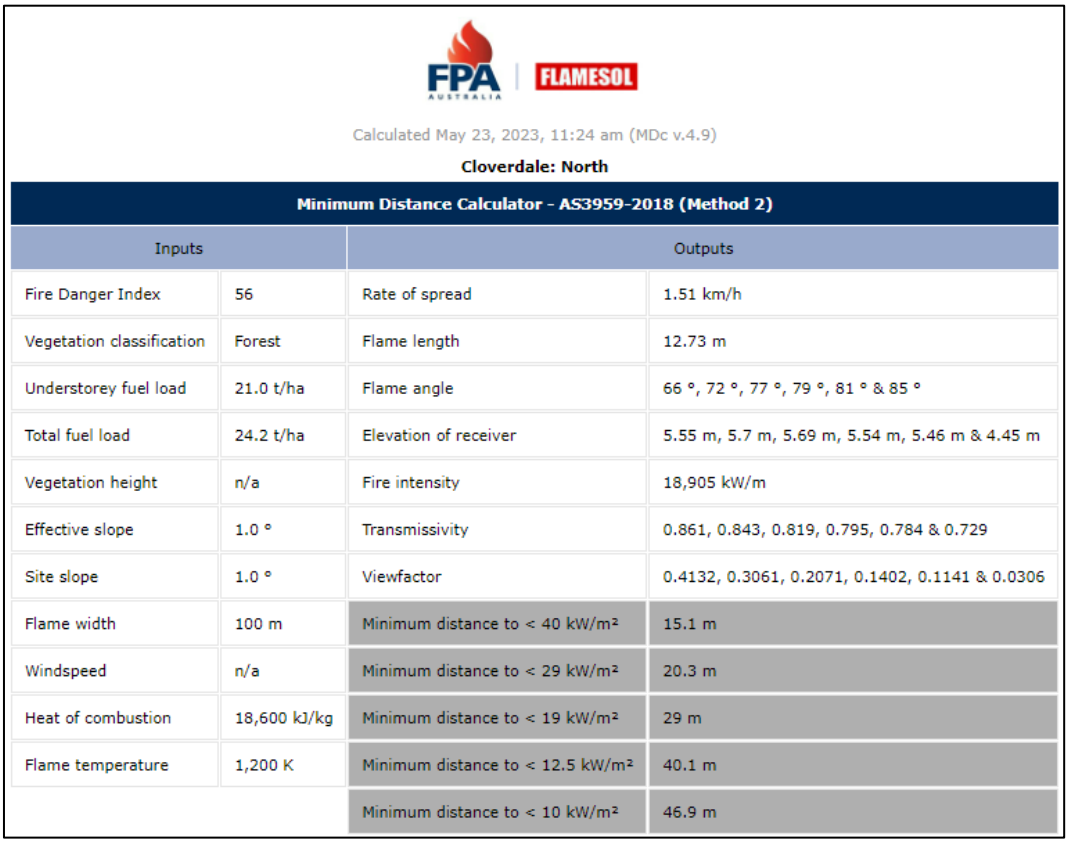
PERFORMANCE OUTCOMES	ACCEPTABLE OUTCOMES	COMMENTS	COUNCIL USE ONLY
	Note—The requirements of a building protection zone are shown in Figure b and Figure c.		
PO14 Development for a park is designed so that the park: a. is practical to maintain and requires minimal resources to be restored to its designed function and condition after a bushfire; b. provides for safe and efficient site evacuation and efficient emergency services access avoiding potential for entrapment during a bushfire; c. does not place unacceptable bushfire risk on an adjoining or nearby site, people and assets; d. provides efficient access for fire fighting; e. provides ongoing protection from bushfire for major park assets and buildings. Note—A bushfire management plan prepared in accordance with the Bushfire planning scheme policy can assist in demonstrating compliance with this performance outcome.	**AO14** Development provides a park landscape plan that complies with a bushfire management plan prepared in accordance with the Bushfire planning scheme policy.	N/A – Proposed development does not include a park.	

APPENDIX B

Flamesol Inputs and Outputs

Summary of Input Parameters for Hazardous Vegetation to the North

Parameter	Input	Note
FFDI	56	Source: QFES Catalyst Mapping.
Surface Fuel Load	21.0 t/ha	Surface and Near Surface Fuel Load – QFES VHC 9.1 Surface Fuel Loads. This is in line with BCC's Technical Bushfire Guide for the calculation of understorey or surface fuel loads.
Overall Fuel Load	24.2 t/ha	Total Fuel Load – QFES VHC 16.1 Total Fuel Loads.
Effective Slope	1 ^{o}	Hazardous vegetation is sited upslope of the proposed development. A minimum Effective Slope of 1 ^{o} was utilised.
Site Slope	1 ^{o}	Hazardous vegetation is sited upslope of the proposed development. A minimum Site Slope of 1 ^{o} was utilised.
Flame Temperature	1,200 K	Standard input in accordance with the BRC.
Flame Width	100 m	Standard input, in accordance with AS 3959-2018.



Calculated May 23, 2023, 11:24 am (MDc v.4.9)

Cloverdale: North

Minimum Distance Calculator - AS3959-2018 (Method 2)			
Inputs		Outputs	
Fire Danger Index	56	Rate of spread	1.51 km/h
Vegetation classification	Forest	Flame length	12.73 m
Understorey fuel load	21.0 t/ha	Flame angle	66 °, 72 °, 77 °, 79 °, 81 ° & 85 °
Total fuel load	24.2 t/ha	Elevation of receiver	5.55 m, 5.7 m, 5.69 m, 5.54 m, 5.46 m & 4.45 m
Vegetation height	n/a	Fire intensity	18,905 kW/m
Effective slope	1.0 °	Transmissivity	0.861, 0.843, 0.819, 0.795, 0.784 & 0.729
Site slope	1.0 °	Viewfactor	0.4132, 0.3061, 0.2071, 0.1402, 0.1141 & 0.0306
Flame width	100 m	Minimum distance to < 40 kW/m²	15.1 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	20.3 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	29 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	40.1 m
		Minimum distance to < 10 kW/m²	46.9 m

Flamesol Calculator Outputs for Required Setbacks from Hazardous Vegetation to the North-West

Summary of Input Parameters for Hazardous Vegetation to the East

Parameter	Input	Note
FFDI	56	Source: QFES Catalyst Mapping.
Surface Fuel Load	14.9 t/ha	Surface and Near Surface Fuel Load – QFES VHC 9.2 Surface Fuel Loads. This is in line with BCC's Technical Bushfire Guide for the calculation of understorey or surface fuel loads.
Overall Fuel Load	17.2 t/ha	Total Fuel Load – QFES VHC 9.2 Total Fuel Loads.
Effective Slope	1 º	Hazardous vegetation to the east is approximately level to the proposed development. A minimum Effective Slope of 1 º was utilised.
Site Slope	1 º	Hazardous vegetation to the east is approximately level to the proposed development. A minimum Site Slope of 1 º was utilised.
Flame Temperature	1,200 K	Standard input in accordance with the BRC.
Flame Width	100 m	Standard input, in accordance with AS 3959-2018.

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Calculated May 23, 2023, 11:25 am (MDc v.4.9)

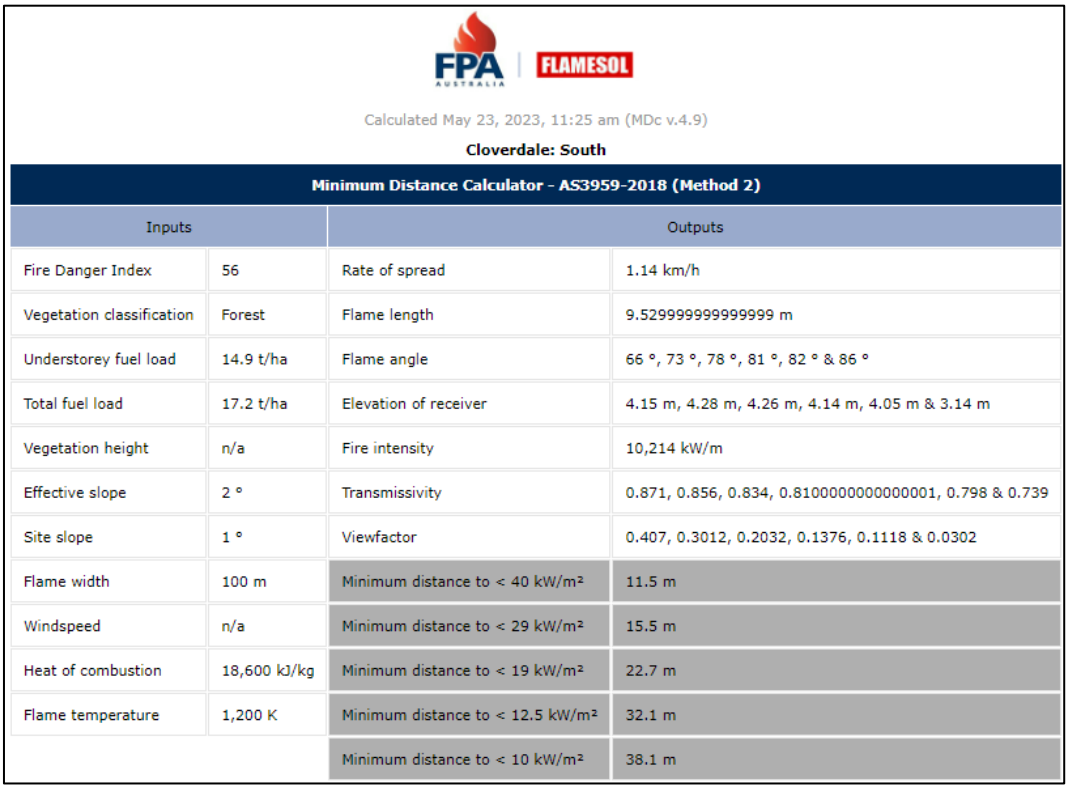
Cloverdale: East

Minimum Distance Calculator - AS3959-2018 (Method 2)			
Inputs		Outputs	
Fire Danger Index	56	Rate of spread	1.07 km/h
Vegetation classification	Forest	Flame length	9.029999999999999 m
Understorey fuel load	14.9 t/ha	Flame angle	67 °, 73 °, 78 °, 81 °, 82 ° & 86 °
Total fuel load	17.2 t/ha	Elevation of receiver	3.96 m, 4.06 m, 4.04 m, 3.92 m, 3.83 m & 2.94 m
Vegetation height	n/a	Fire intensity	9,533 kW/m
Effective slope	1 °	Transmissivity	0.873, 0.858, 0.836, 0.8129999999999999, 0.801 & 0.741
Site slope	1 °	Viewfactor	0.407, 0.3013, 0.2021, 0.1374, 0.1113 & 0.0301
Flame width	100 m	Minimum distance to < 40 kW/m²	10.9 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	14.7 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	21.7 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	30.7 m
		Minimum distance to < 10 kW/m²	36.6 m

Flamesol Calculator Outputs for Required Setbacks from Hazardous Vegetation to the East

Summary of Input Parameters for Hazardous Vegetation to the South

Parameter	Input	Note
FFDI	56	Source: QFES Catalyst Mapping.
Surface Fuel Load	14.9 t/ha	Surface and Near Surface Fuel Load – QFES VHC 9.2 Surface Fuel Loads. This is in line with BCC's Technical Bushfire Guide for the calculation of understorey or surface fuel loads.
Overall Fuel Load	17.2 t/ha	Total Fuel Load – QFES VHC 9.2 Total Fuel Loads.
Effective Slope	2 º	The previous bushfire hazard assessment completed by Queensland Bushfire Planning (October 2021) for the proposed development used a Nikon Forestry Pro Range Finder and Inclinometer and determined the hazardous vegetation was downslope of the proposed development area.
Site Slope	1 º	Hazardous vegetation is sited directly up to the proposed residential development. A minimum Site Slope of 1 º was utilised.
Flame Temperature	1,200 K	Standard input in accordance with the BRC.
Flame Width	100 m	Standard input, in accordance with AS 3959-2018.



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Calculated May 23, 2023, 11:25 am (MDc v.4.9)

Cloverdale: South

Minimum Distance Calculator - AS3959-2018 (Method 2)			
Inputs		Outputs	
Fire Danger Index	56	Rate of spread	1.14 km/h
Vegetation classification	Forest	Flame length	9.529999999999999 m
Understorey fuel load	14.9 t/ha	Flame angle	66 °, 73 °, 78 °, 81 °, 82 ° & 86 °
Total fuel load	17.2 t/ha	Elevation of receiver	4.15 m, 4.28 m, 4.26 m, 4.14 m, 4.05 m & 3.14 m
Vegetation height	n/a	Fire intensity	10,214 kW/m
Effective slope	2 °	Transmissivity	0.871, 0.856, 0.834, 0.8100000000000001, 0.798 & 0.739
Site slope	1 °	Viewfactor	0.407, 0.3012, 0.2032, 0.1376, 0.1118 & 0.0302
Flame width	100 m	Minimum distance to < 40 kW/m²	11.5 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	15.5 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	22.7 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	32.1 m
		Minimum distance to < 10 kW/m²	38.1 m

Flamesol Calculator Outputs for Required Setbacks from Hazardous Vegetation to the South