covey

Report

Bushfire Management Plan

LOCATION: AURA LAKES PRECINCT 17-18 (PART OF) AND PRECINCT 19

CLIENT: STOCKLAND DEVELOPMENT PTY LTD

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Executive Summary

This Bushfire Management Plan (BMP) has been prepared by Covey Associates to support the proposed material change of use, reconfiguring a lot and operational works for part of precinct 17, 18 and precinct 19 (proposed development) of the proposed Aura Lakes context plan.

This BMP assesses the risk of the proposed development within a mapped Bushfire Prone Area, assessing specifically against the example Bushfire Overlay Code in the *Natural Hazards, Risk and Resilience – Bushfire, State Planning Policy State Interest guidance material* (Queensland Government, 2019). The requirements and a description of how these code requirements are addressed in the proposed development design are detailed in Section 5 and 6 of this report. This BMP focuses solely on bushfire-related risk and mitigation strategies and further investigations might be required to support a development application, e.g., Engineering Services Report, ecological assessments, etc.

The bushfire hazard level, bushfire-related risk level and RHF level applicable to the proposed development are not considered unreasonable and should not prohibit the development of the site subject to the measures detailed in this BMP being complied with.

Abbreviations Used in Report

Abbreviation	Full Meaning
AS3959	AS 3959:2018 – Construction of Buildings in bushfire-prone areas
AWS	Automatic Weather Station
BAL	Bushfire Attack Level
BCA	Building Code of Australia
BMP	Bushfire Management Plan
BRC	Bushfire Resilient Communities
FFDI	Forest Fire Danger Index
RHF	Radiant Heat Flux
SPP	State Planning Policy
VHC	Vegetation Hazard Class
w	Understorey fuel load
W	Total fuel load

Supporting Documentation	
Document	**Prepared by**
Bushfire Management Plan: Aura Lakes Context Plan	*Land and Environment Consultants Pty Ltd (27 June 2024)*
Bushfire Management Plan: Aura Lakes Aura Lakes Precinct 18 (part of)	*Land and Environment Consultants Pty Ltd (4 July 2024)*
Aura Lakes Proposal Plan Precinct 17 (Part), Precinct 18 (Part of) and Precinct 19. AU12885-53.	*RPS Group (29 October 2024)*
Aura Lakes Gagalba Lakes Statement of Landscape Intent	*Urbis Pty Ltd (10 April 2024)*
Environmental Rehabilitation Plan – Aura Precincts 17, 18 and 19 and Part Precinct 6. Calaundra South Priority Development Area. Document number 30031518.	*SMEC (9 February 2023)*
Appendix C Residential Development Controls	*RPS (2024)*

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1 Introduction

1.1 Scope

The proponent, Stockland Development Pty Ltd (Stokland), engaged Covey Associates Pty Ltd (Covey) to prepare a site-specific Bushfire Management Plan (BMP) to support the proposed material change of use, reconfiguring a lot and operational works for part of precincts 17, 18 and 19 (proposed development; Appendix A) of the Aura Lakes context plan. The proposed development is located within lot 1/SP332399, part of lot 2/SP334580 and part of lot 3/SP333886 (the site). A development application is being made for the proposed development under the Caloundra South Urban Development Area Development Scheme. Economic Development Queensland is the assessment authority (refer to Figure 2-1 in section 2 and Appendix A).

Per the Caloundra South Urban Development Area Development Scheme, the proposed development is required to achieve the objectives of the State Planning Policy – Part E Natural hazards, risk and resilience (The State of Queensland Department of Infrastructure Local Government and Planning, 2017). The site is identified as a bushfire hazard area by the Aura Lakes Bushfire prone area map (prepared by Land and Environment Consultants, 2024) (refer to Figure 3-1 in section 3). This BMP assesses the risk of the proposed development being located within a mapped Bushfire Prone Area, and details how the recommended bushfire mitigation measures achieve the purpose and outcomes, in accordance with the example Bushfire Overlay Code in the *Natural Hazards, Risk and Resilience – Bushfire, State Planning Policy State Interest guidance material* (Queensland Government, 2019) (SPP guidance material).

1.2 Objectives

The objectives of the BMP are to:

1. Achieve consistency with purposes and policy measures of the SPP guidance material, *Bushfire Resilient Communities* (BRC) (Queensland Fire and Emergency Services, 2019a) and the Bushfire Management Plan: Aura Lakes Context Plan (*Context BMP*; Land and Environment Consultants, 2024);
2. Understand and document the extent of bushfire risk for the BMP area by undertaking a Radiant Heat Flux (RHF) assessment; and
3. Devise bushfire risk mitigation measures for all land subject to the plan, with due regard for people, property, infrastructure, and the environment.

1.3 Document Review

Covey recommends reviewing this BMP after 5 years from the date of issue, or until such time as there is a revision to the development, whichever is lesser. The *Context BMP* identified mitigation measures to be incorporated in future Aura Lakes development.

1.4 Planning Context

1.4.1 Existing Bushfire Management Plan

The *Bushfire Management Plan: Aura Lakes Context Plan* was previously developed by Land and Environment Consultants Pty Ltd (2024) to illustrate the intent of development and possible uses and conservation areas within the site. The mitigation measures detailed in the *Context BMP* were:

- Future allotments or development footprints within allotments must be separated from hazardous vegetation by the preliminary bushfire hazard setbacks of the *Context BMP* (reproduced in Figure 1-1);
- Where practical, esplanade roads, linear parks and lifestyle buffers (refer to Appendix A) must be used to separate allotments from hazardous vegetation. Where engineering constraints prevent this mitigation measure, allotments adjoining the hazardous vegetation must be of a size which can accommodate a bushfire hazard setback and development footprint;
- Bushfire hazard setback must not be located within the stormwater management area or the Bells Creek corridor and environmental buffers;
- Future development applications must not rely on Sunshine Coast Council to maintain vegetation for the purpose of providing a bushfire hazard setback unless the maintenance is within a park;
- Landscaping within the sports, recreation and linear parks must be designed to establish low fuel hazard areas with discontinuous bushfire fuels. These areas must consist of hardened areas or turf, which is maintained as lawn at a nominal height of 10 centimetres;
- Formal gardens can be established within the sports, recreation and linear parks, provided they are separated from any adjoining areas of hazardous vegetation and regularly maintained clear of weeds, woody regrowth, rubbish and vegetation debris;
- Scattered tree plantings are permissible within the sports, recreation and linear parks as long as they do not overhang the boundaries of adjoining allotments when they reach maturity;
- Landscaping within allotments associated with residential, mixed-use (residential, entertainment, food and beverage), school, community centre, neighbourhood meeting room and centre and a district centre land uses must be designed in accordance with Part 5 of Bushfire Resilient Building Guidance for Queensland Homes (CSIRO, 2020). Also, plant selection must favour the list of plant species in Appendix E of the same document;
- Future allotments must be connected to mains water and a reticulated hydrant system must be installed in the new road reserves, and water supply must be in accordance with the local water retailer's specifications for supply and pressure;
- Roads and driveways must be designed and constructed to meet requirements for an urban fire truck in the Fire hydrant and vehicle access guidelines which defers to the *Road Planning and Design Manual – 2nd Edition* (DTMR 2013);
- Existing access tracks (refer to Figure 1-1) must continue to be maintained as alternate emergency access and egress until the proposed sub-arterial and trunk roads have been developed;
- Buildings within 100 m of hazardous vegetation must be designed and constructed in accordance with the relevant BAL construction specifications in AS 3959-2018 as required under the *Building Code of Australia* (ABCB 2023); and,
- Services, i.e., water, electricity, gas, and communications, must be installed underground.

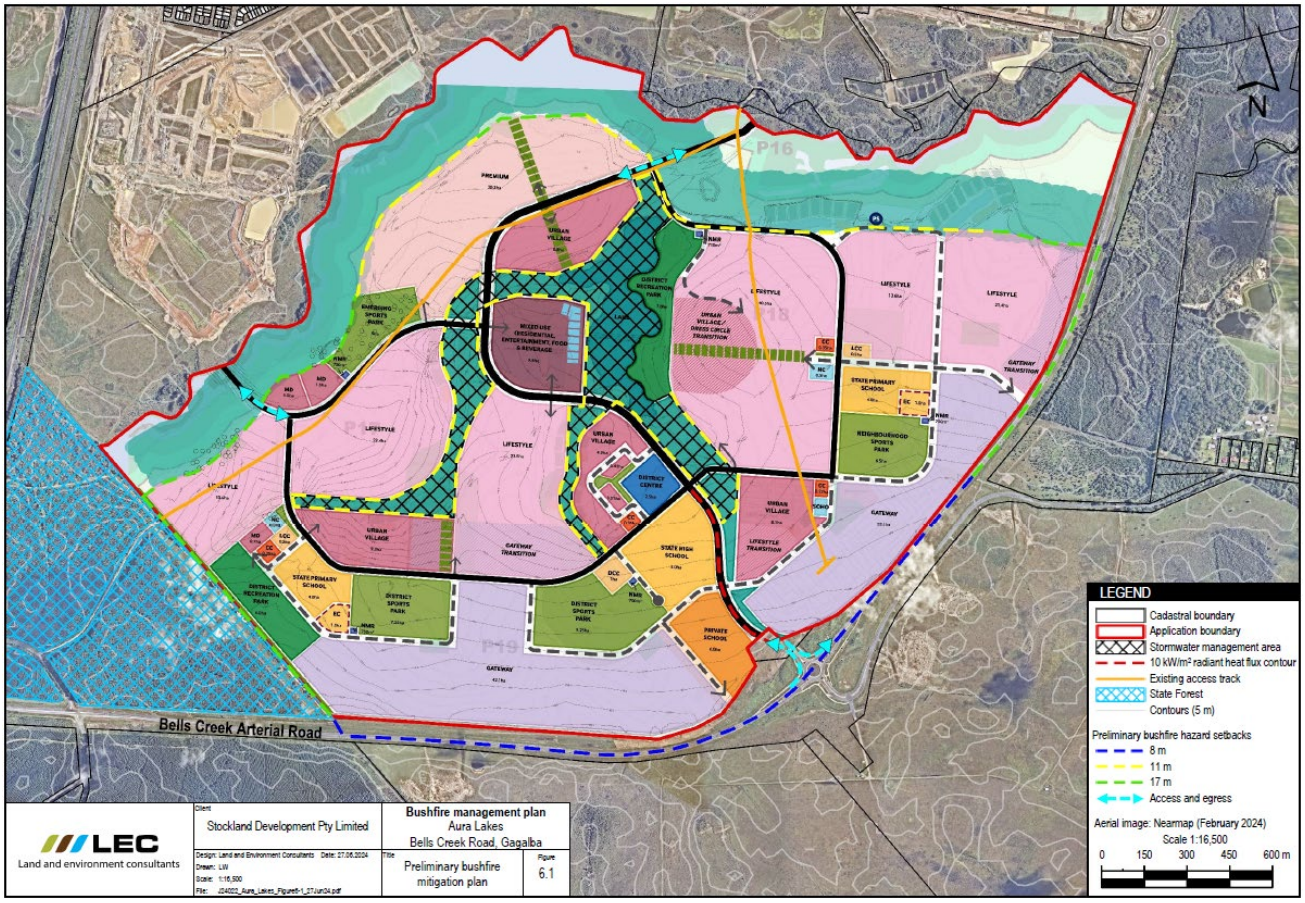


Figure 1-1. Bushfire Management Context Plan (Land and Environment Consultants Pty Ltd)

1.4.2 Bushfire Prone Designation

Formal designation of an area as "Bushfire Prone" provides the legislative trigger to enforce all Building Classes to be constructed in accordance with AS 3959 – 2018 Construction of buildings in bushfire prone areas (AS3959).

1.4.3 SPP - Natural hazards, risk and resilience state interest – Bushfire

The SPP - *Natural hazards, risk and resilience state interest – Bushfire*, identifies two ways a site may be designated as bushfire prone. These are as follows:

1. If the land is identified by a local government in a local planning instrument as a bushfire prone area, based on a localised bushfire study, prepared by a suitably qualified person; or,
2. If the local government has not identified bushfire prone areas in a local planning instrument in accordance with (1) above, the area is shown on the State Planning Policy Interactive Mapping System as a bushfire prone area.

1.5 Bushfire Context

The following documents are identified as being referenced to provide the performance criteria and technical specifications for this Bushfire Management Plan:

1. The State of Queensland (2017). State Planning Policy.
2. Queensland Government (2019). Natural hazards, risk and resilience – Bushfire. State Planning Policy – state interest guidance material.

3. Queensland Government (2021). Natural hazards, risk and resilience state interest – Bushfire. Example planning scheme assessment benchmarks,
4. Queensland Fire and Emergency Services (2019a). Bushfire Resilient Communities. Technical Reference Guide for the State Planning Policy State Interest "Natural Hazards, Risk and Resilience-Bushfire".
5. Queensland Fire and Emergency Services (2019b). Fire Hydrant and Vehicle Access Guidelines for Residential, Commercial and Industrial Lots.
6. Standards Australia (2018). AS 3959 - 2018 Construction of buildings in bushfire prone areas: SAI Global.
7. SAI Global((2021). AS 2419.1:2021 Fire Hydrant Installations for Buildings; Australian Standards.

2 Site Details

The site is located between Bells Creek and Bells Creek Road, Gagalba (Figure 2-1). The land adjacent to the site and within the context plan area is planned for future development, which will include a mix of residential, educational, recreational, and drainage uses. A new sub-arterial road connecting to Bells Creek Arterial Road will facilitate access to and from the proposed development until the sub-arterial and trunk road network within the context plan area is established.

2.1 Proposed Development

Appendix A and Figure 2-1 detail the subdivision plan for the proposed development, including the layout of roads, residential lots, large allotments (>2,000 m^2), and open spaces. A total of 2,924 lots will be created. Large allotments are designated for childcare, a state primary school, a state high school, a private school, emerging community uses, multiple residential uses (e.g., townhouses), local/community/neighbourhood/district centres. It is understood the local, community, neighbourhood and district centre are largely intended for commercial uses such as shops, amenities and food and drink outlet.

2.2 Access

At master planned community plan sealing, the proposed development will be accessed via Bells Creek Arterial Road and two main sub-arterial access points connecting to the approved development to the north (refer to Appendix A). Until the proposed development is completed, existing vehicle access tracks within the context plan area will be maintained to allow access and egress to private and emergency vehicles.

2.3 Water Supply

The proposed development will be connected to a reticulated mains water supply, with fire hydrants located within the future road reserve.

Figure 2-1. Site

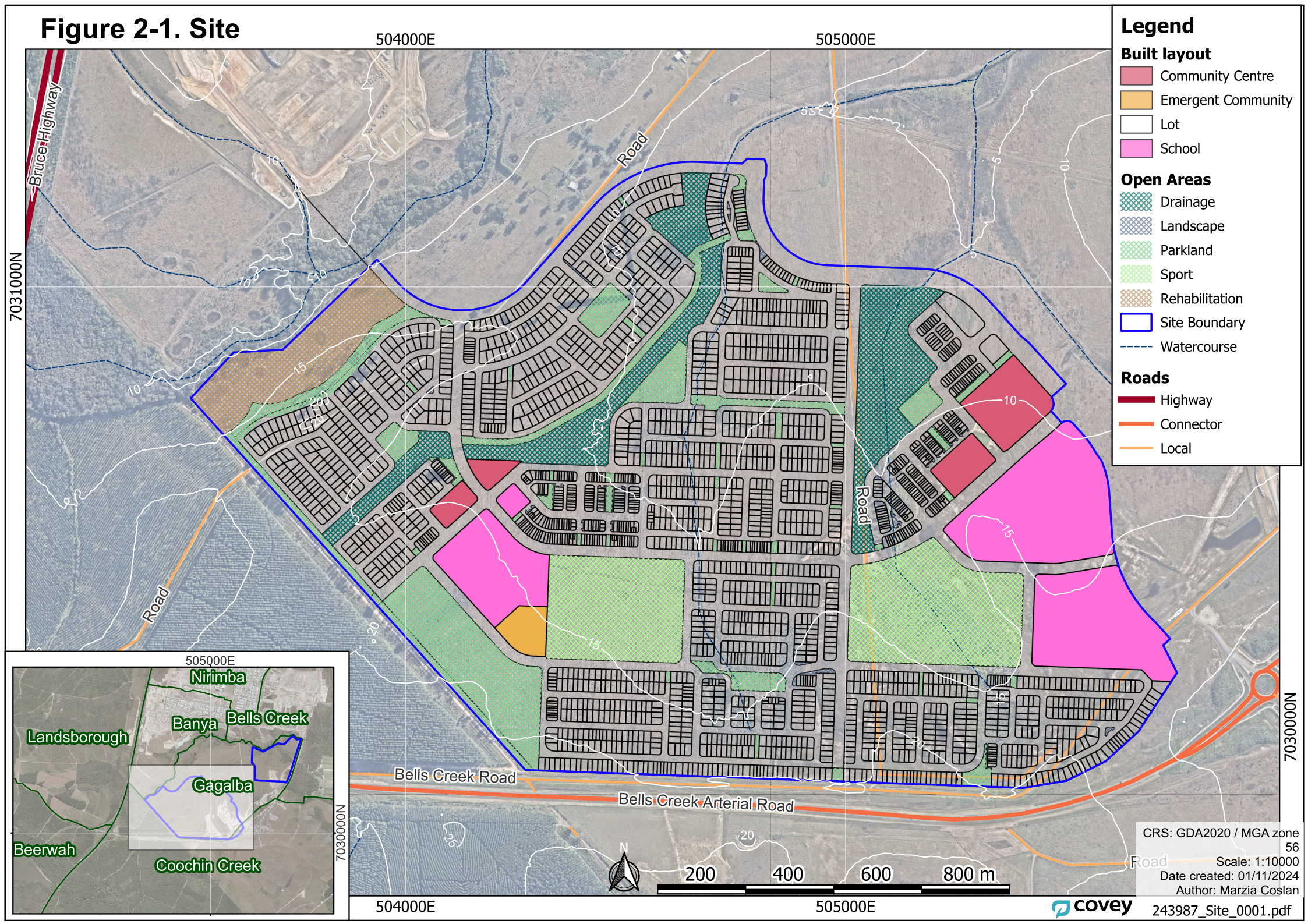
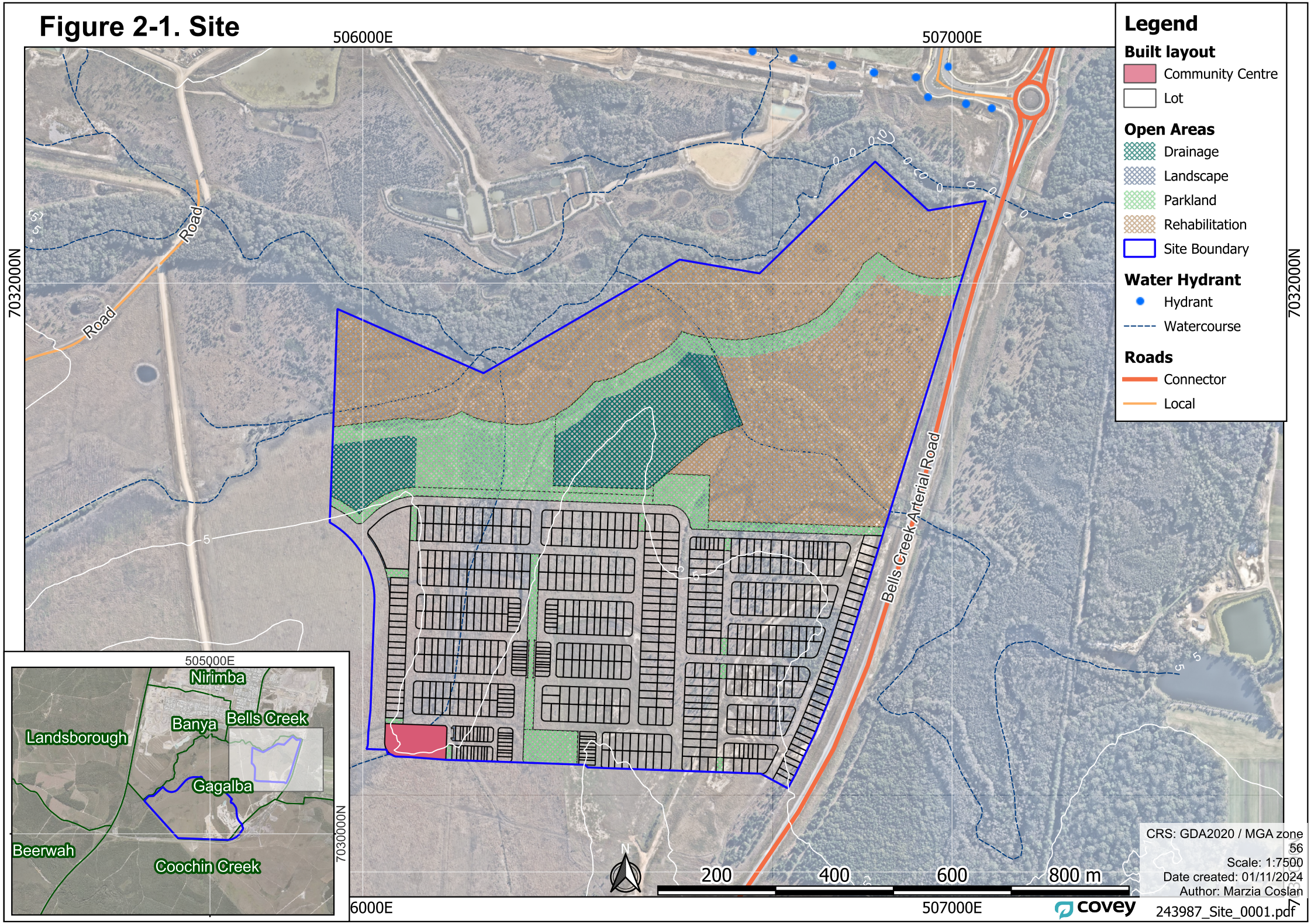


Figure 2-1. Site



3 Bushfire Hazard

The State Planning Policy mapping identifies the site as subject to High Potential Bushfire Intensity, Medium Potential Bushfire Intensity and associated impact buffer. A site-specific Bushfire Prone Area (BPA) extent was prepared for the proposed Aura Lakes context plan by Land and Environment Consultants (2024) (Figure 3-1).

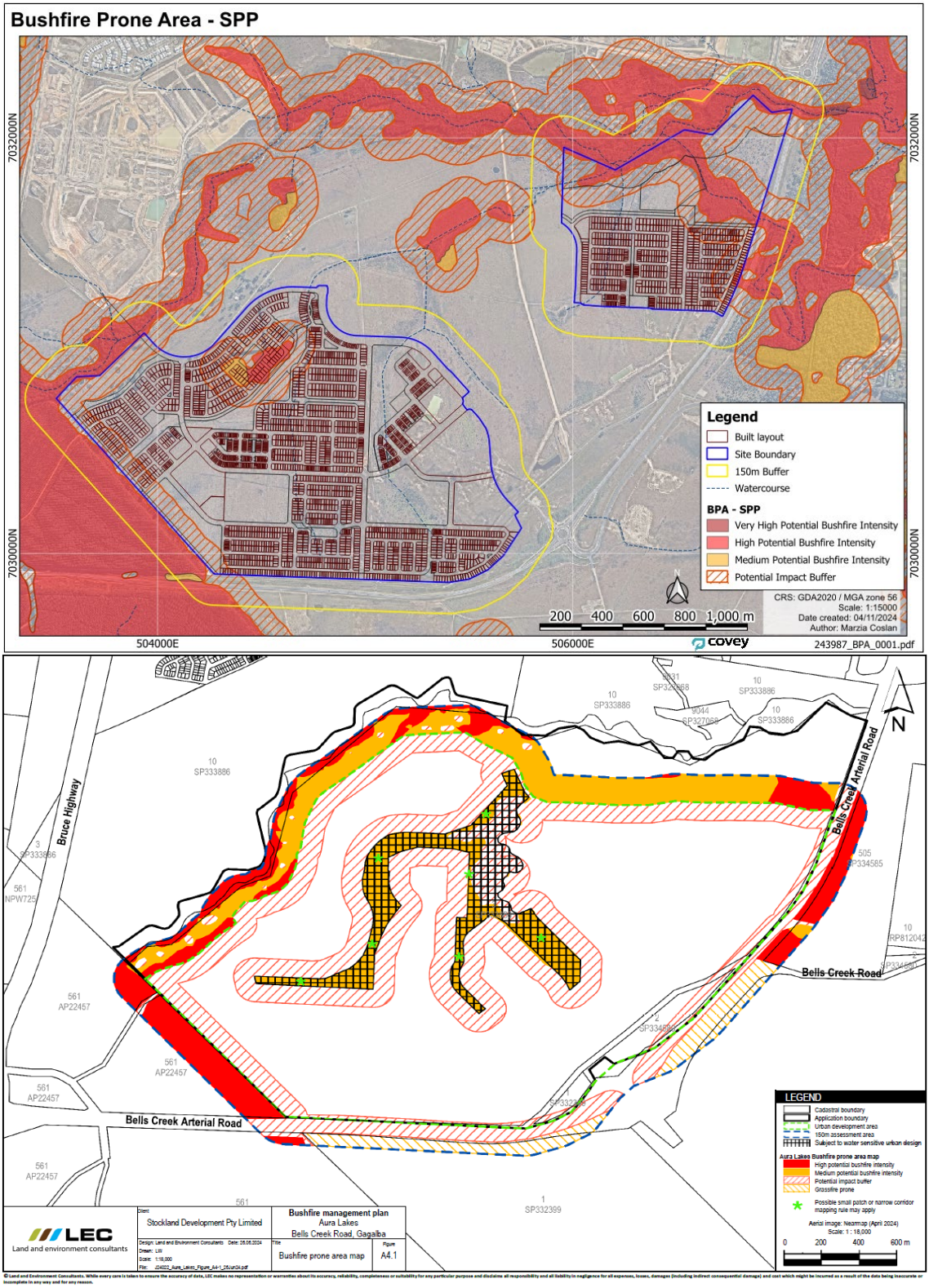


Figure 3-1. BPA per SPP (top) and specific to Aura Lakes context plan (bottom) (Land and Environment Consultants 2024).

3.1 Site Topography

Topography was verified during the site assessment and was considered consistent with the Digital Elevation Model obtained from (*Elvis - Elevation and Depth - Foundation Spatial Data*, n.d.). Covey site's Digital Elevation Model (5m resolution) with the site's planned earthworks and completed a slope analysis (Figure 3-2). The site is mostly flat, gently sloping to the south. The steeper areas are focused on creek banks through the northern extent of the site.

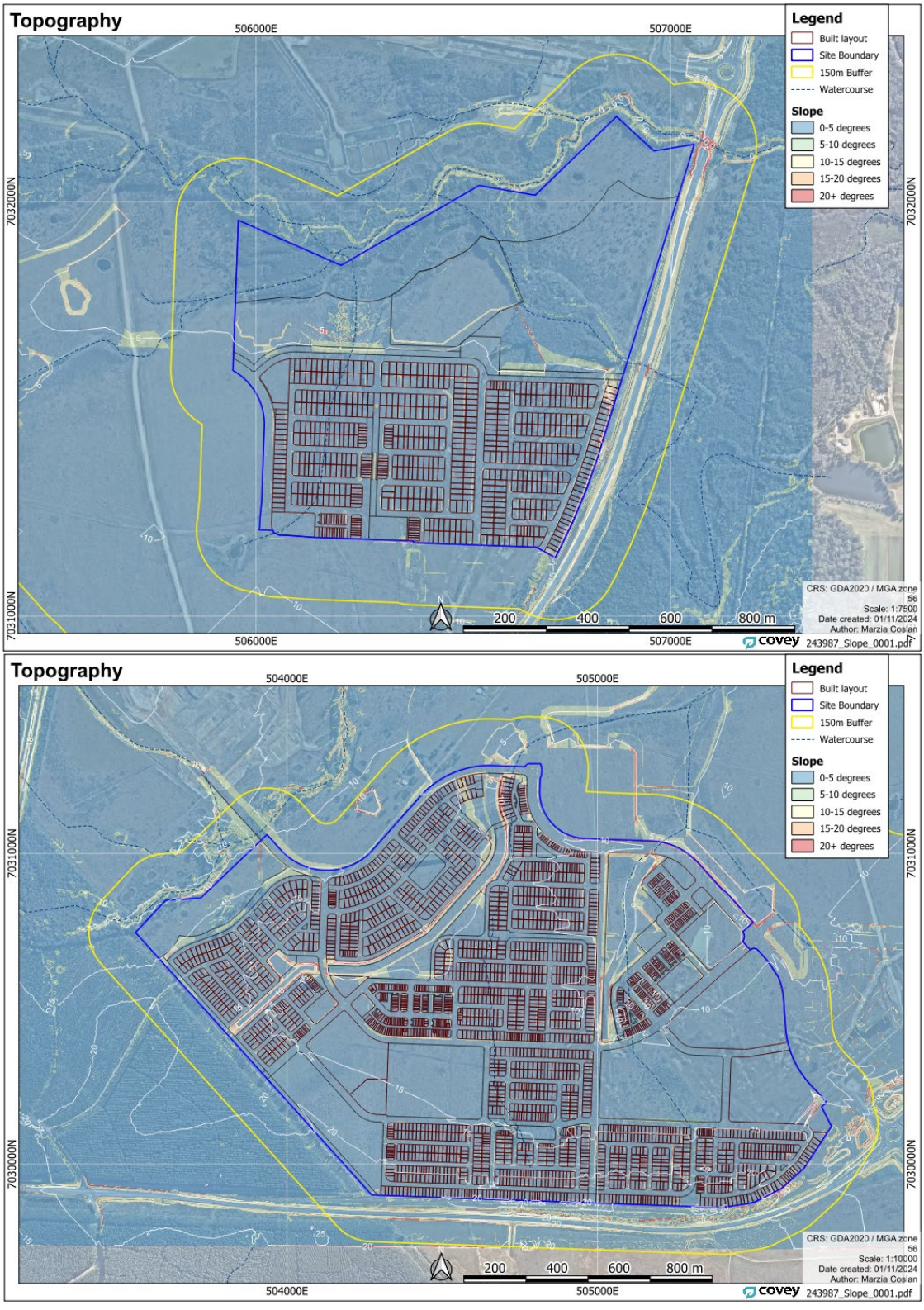


Figure 3-2. Slope analysis – including planned earthworks.

3.2 Weather

Fire weather is often associated with meteorological conditions that generate increased fire behaviour, resulting in difficulty suppressing wildfires. Fire weather can be influenced by many local factors including temperature, wind, relative humidity, and drought factor – all of which are used to calculate the Forest Fire Danger Index (FFDI[1]). Fire risk is typically linked to the occurrence of fire weather days or sequences of days of an FFDI above 25 (Queensland Parks and Wildlife Service, 2022).

An analysis of past weather patterns and trends was completed for the site using observational data extracted from the closest Bureau of Meteorology (BoM) Australia's Automatic Weather Station (AWS). For this site, we analysed data from Beerburrum AWS from 1999 – 2024 (AWS 40284; approximately 14 km SW from the site).

Analysis of monthly accumulated FFDI indicates that the fire season typically extends between July and November, peaking in August/September (seasonally dependent) (Figure 3-3). However, fires can also occur outside of the typical fire season period. Damaging fires can also occur in any given year, despite some years being drier and hotter than others.

Figure 3-3. Accumulated FFDI by Month for Beerburrum.

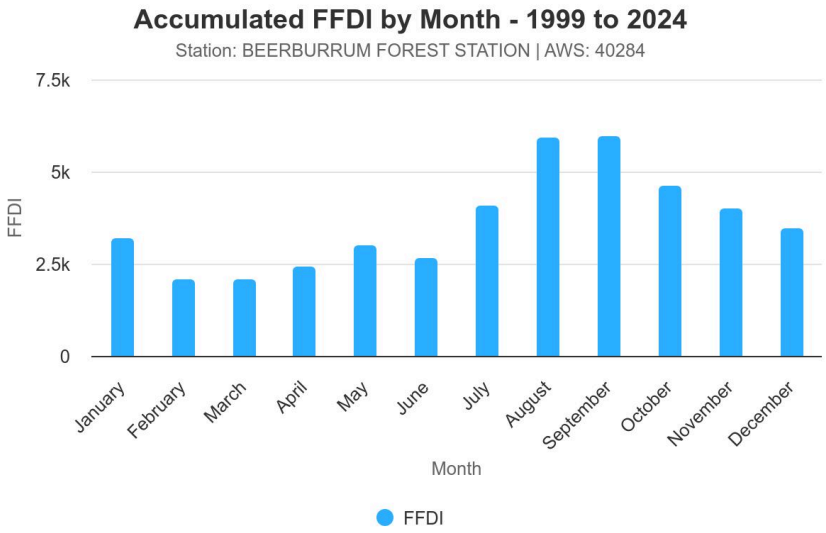


Table 3-1 provide the highest ranked FFDIs over the recorded period – where the total number in the ranking is the number of complete years of historical weather data from Beerburrum AWS (i.e., twenty-five years for Beerburrum from 1999-2024). These show that the highest-ranked fire danger days are typically associated with:

- Air temperatures in excess of 30^{O}C;
- Low RH (≤20%);
- Westerly / north westerly arc winds; and,
- Relatively dry conditions (Drought Factor ≥ 8.5).

[1] FFDI were used in this report, instead of the new Australian Fire Danger Rating System and Fire Behavior index, as the data we analyzed was historical. Also, FFDI values are used as input for in RHF modeling.

Table 3-1 - Highest Ranked FFDI for Beerburrum AWS 1999-2024

Rank	Date	T (°C)	Dew Point (°C)	RH (%)	Wind Speed (km/hr)	Wind direction (deg)	Wind Cardinal Direction	KBDI	Drought Factor	FFDI
1	16/11/2014	43	8.7	13	14.8	270	W	159	10	47.8
2	8/11/2019	38.2	-1.8	8	11.2	310	NW	122	9.9	44.0
3	6/09/2019	33.7	-3.5	7	13	310	NW	135	10	41.2
4	8/10/2004	37.7	5.7	13	13	250	W	180	10	38.3
5	6/10/2005	38.8	5.4	14	13	270	W	142	9.9	38.0
6	4/12/2012	40.1	7.5	15	13	250	W	158	9.6	37.2
7	28/09/2017	38.2	9.7	15	13	330	NW	169	10	36.4
8	27/09/2003	34.7	2.3	13	14.8	250	W	146	10	36.1
9	7/10/2001	33.8	2.6	11	13	270	W	172	10	36.0
10	2/12/2018	39.1	10.4	18	14.8	310	NW	141	10	35.3
11	7/10/2013	36.7	3.8	12	9.4	250	W	143	10	35.2
12	4/09/2019	33.3	-3.8	9	9.4	220	SW	129	10	34.8
13	4/01/2014	43.4	15.5	18	9.4	260	W	162	9.6	34.5
14	9/09/2000	29.2	0.8	13	20.5	260	W	126	9.9	33.8
15	7/10/2012	36.4	3.6	13	9.4	240	SW	142	10	33.7
16	1/10/2000	34.7	4.3	15	14.8	270	W	148	10	33.7
17	9/11/2019	30.8	-4.3	8	9.4	230	SW	127	10	33.1
18	26/11/2018	35	1.4	12	9.4	230	SW	121	9.9	32.9
19	28/11/2018	38.2	9.7	18	13	260	W	127	10	32.8
20	30/10/2001	37.1	4.1	13	13	260	W	160	8.6	32.4

3.2.1 Rainfall

The occurrence of days with high fire danger is also influenced by annual rainfall, as seen for the analysed AWS, where typically low annual rainfall results in higher accumulated annual FFDIs (Figure 3-4). Conversely, years of above-average rainfall can lead to increased vegetation growth. Therefore, although high rainfall levels are less conducive to extensive wildfire impact in the short term, this effect might be reversed in successive years. As such, having an above-average year of rainfall cannot be perceived as reducing the on-going fire risk.

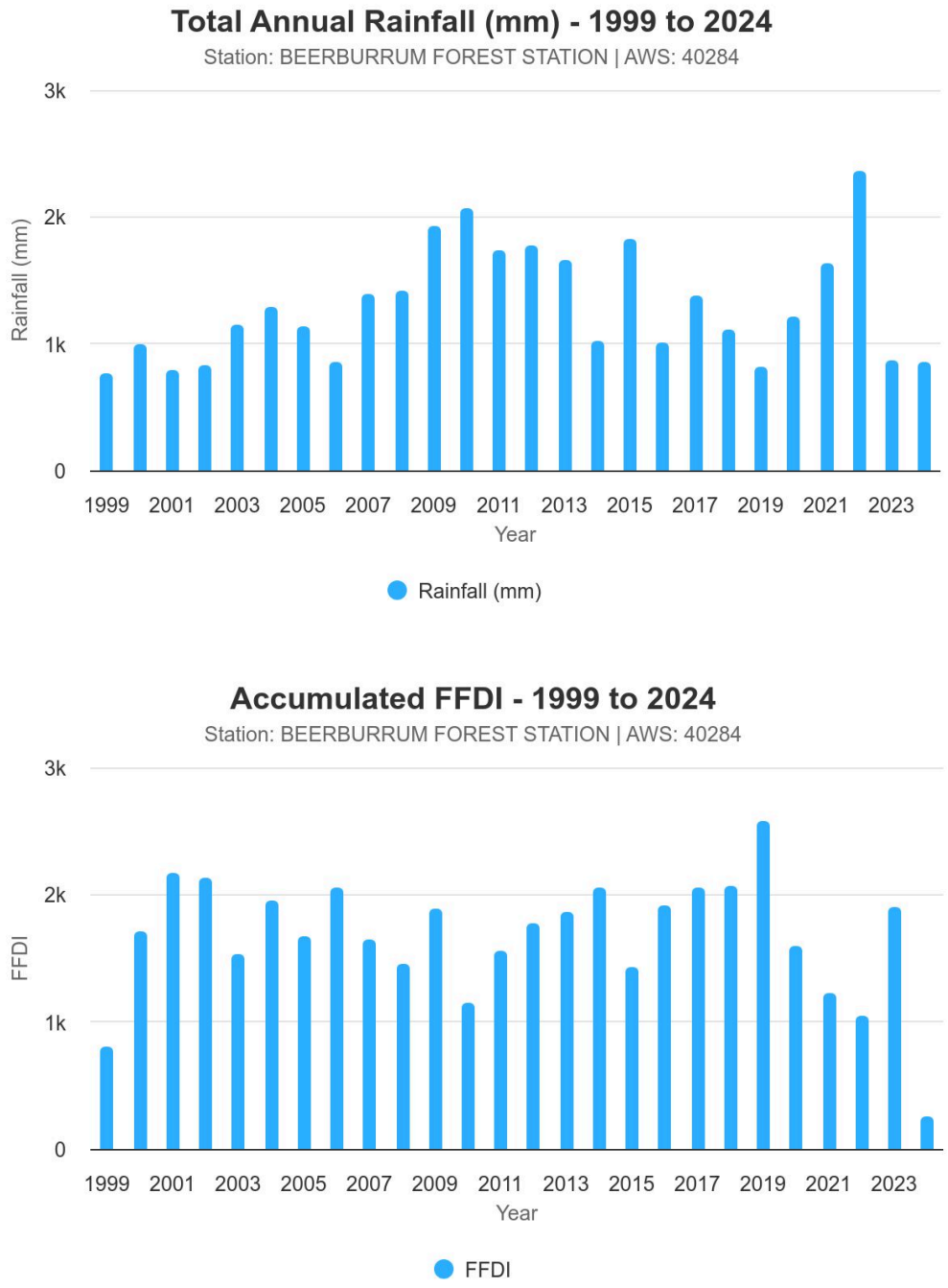


Figure 3-4 - Annual Rainfall vs Accumulated FFDI

3.2.2 Wind Speed & Direction

Continental air masses influence weather associated with various Fire Danger Ratings. Drier air masses (associated with elevated fire danger) move toward the Australian coastline from inland (i.e. from the west at the site), while maritime and moisture airmasses move to the coast from the sea. Figure 3-5 shows wind directions for FFDI classes 0-12 (Low to Moderate), 13-25 (High) and 26-50 (Very High), for Beerburrum AWS assessed period (1999 to 2024). FFDIs greater than 50 have not occurred over the assessment period. The analysis reveals that FFDI above 25 tend to come from a westerly arc, under inland continental winds influence.

Winds associated with lower FFDIs tend to be easterlies and have higher relative humidity associated with a maritime influence.

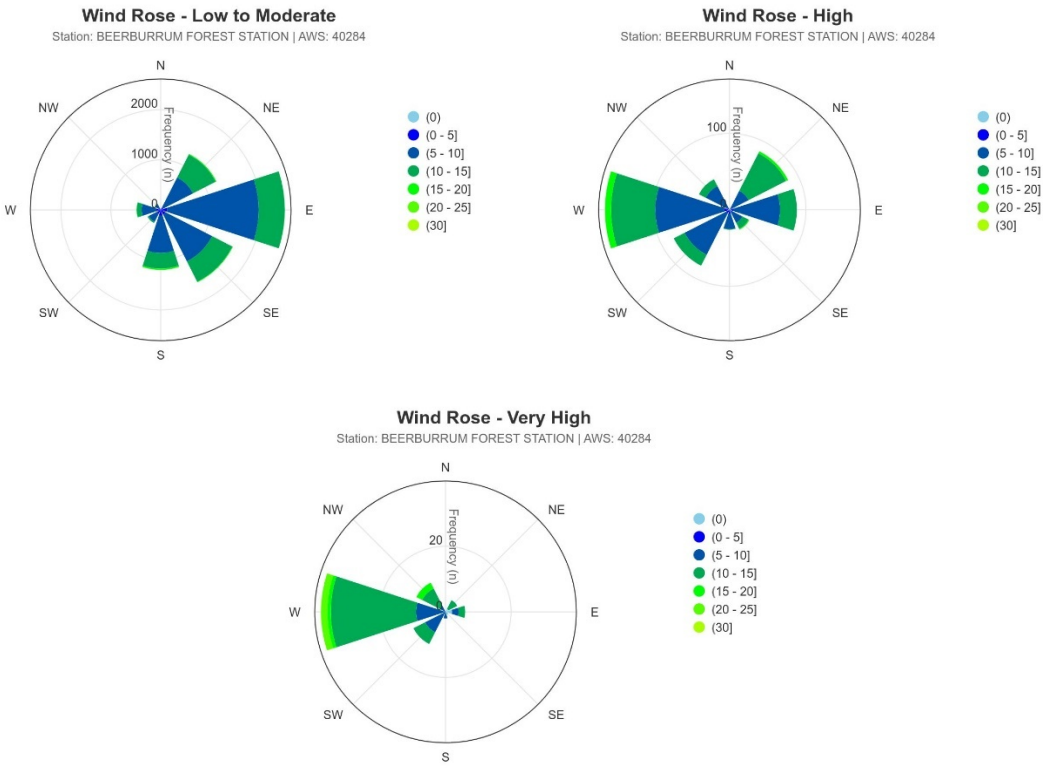


Figure 3-5. Wind Rose and accumulated days (count) for 'Low to Moderate' (0<FFDI<12) 'High'(12<FFDI<25) and 'Very High' (25<FFDI<50) Fire Danger Rating Days.

3.2.3 Generalised Extreme Value

A Generalised Extreme Value Analysis (GEV), a regression technique, that indicates the frequency of extreme values. The GEV technique is frequently used to predict extreme weather such as storms, cyclones and flooding events (Douglas et al., 2014). Covey completed a GEV analysis based on the recorded FFDI data at Beerburrum AWS for the study period (Figure 3-6).

$$y = 31.5302 + 4.4525 \times \ln(x) \qquad (r^2 = 0.9848) \qquad \text{(Beerburrum AWS)}$$

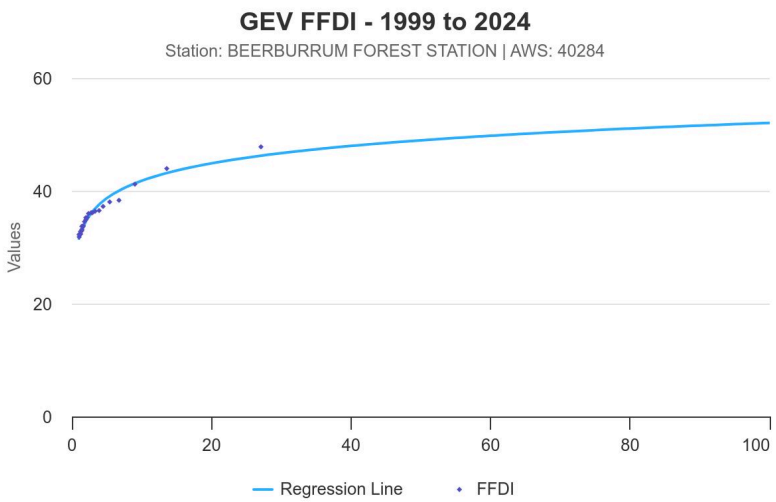


Figure 3-6. GEV Regression analysis Beerburrum (1999-2024) y axis = FFDI; x axis = recurrence years.

This analysis provides an indication of the Annual Return Interval (ARI) of fire weather. Table 3-2 contains the calculated FFDI values for key return intervals. It is important to note that the GEV recurrence value indicates the likely return period of fire weather and not a fire event. Extreme fire weather may come and go without a fire occurring. Therefore, the probability of a fire occurring within the right position within the landscape during these periods of extreme weather and impacting the development are orders of magnitude lower.

Table 3-2. GEV Recurrence Interval of FFDI Beerburrum (1999-2024)

Recurrence Interval (Years)	Beerburrum AWS FFDI
1	32
20	45
25	46
50	49
100	52
200	55
500	59

The mapped SPP 1:20 year Recurrence Interval FFDI spatial data (https://catalyst.qfes.qld.gov.au/.) was created in 2014, and thus doesn't consider the latest 10 years of weather data. The SPP prescribed spatial FFDI for the site is 53 and for Beerburrum is 54. Our GEV analysis indicate that these values approximately represent a 1 in 124-year recurrence Interval for the site, and a 1 in 155-year recurrence interval for Beerburrum using the GEV equation, rather than a 1:20 year recurrence.

Note, that the SPP prescribed FFDI is higher than the results of our analysis. This difference can be attributed to the exceptionally high FFDIs recorded during the 1994 Beerburrum Fire (Hunt et al., 1995) likely included in the SPP derived value analysis. An FFDI of 53 was used in the radiant heat flux (RHF) analysis outlined in Section 4 per SPP.

3.2.4 Climate Change impact on FFDI

Climate change relative to the project site can be referenced in the *Climate Change in Australia Report for East Coast Cluster* developed by CSIRO and BOM (A. Dowdy et al., 2015), key findings for projected climate change within the East Coast Cluster is summarized below:

- Very high confidence in;
  - Higher temperatures,
  - Hot and more frequent hot days, with less frost,
- High Confidence in;
  - Increased intensity of heavy rainfall events, though changes to drought less clear,
  - Increase evaporation rates and reduced soil moisture,
  - Little change in solar radiation and reduced humidity throughout the year,
  - Some decrease in Winter wind speed, with fewer East Coast Lows, and
  - An overall harsher Fire Weather climate in the future.

It should be noted that fire weather and fire behaviour are, by nature, difficult to predict with certainty. Therefore, the following limitations exist when predicting bushfires and designing for bushfire mitigation:

- Fire behaviour at elevated FFDIs and under the influence of fire-induced winds driven by strong convection rates can become erratic and thus can be beyond the bounds of predictive models (Cruz et al., 2012); and
- Human-induced climate change may exacerbate fire behaviour and affect vegetation structure and floristics differently than what was assumed in this project (A. J. Dowdy, 2018).

3.3 Bushfire Fuels

Fuel load and arrangement significantly impact bushfire behaviour's potential severity and scale. Fuel characteristics vary along with changes in type, density and extent of vegetation communities and land use. The SPP requires assessment of the 150 m of vegetation adjacent to assets. The vegetation within the study area was classified into Vegetation Hazard Classes (VHC) (Queensland Fire and Emergency Services, 2019a) based on existing and proposed vegetation using information gathered from:

- Aura Lakes Statement of Landscape Intent (Urbis, 2023);
- Environmental Rehabilitation Plan (SMEC, 2023);
- Site-verified Regional Ecosystem data from field observations;
- State Regional Ecosystem spatial data (https://qldspatial.information.qld.gov.au/catalogue);
- Vegetation Hazard Class (https://qldspatial.information.qld.gov.au/catalogue); and
- Aerial imagery.

3.3.1 Site Assessment

A site inspection was undertaken on the 16th October 2024 to verify the mapped regional ecosystems and corresponding vegetation hazard classes at the site (Figure 3-7, refer to Appendix B for photos). The site and surrounding land are currently utilized for grazing livestock and consist of grassy paddocks. A corridor of remnant vegetation is located along Bells Creek, and Beerwah State Forest is located southwest of site. The VHC classes identified align with the Environmental Rehabilitation Plan prepared by SMEC (2023).

3.3.2 Post-Development Vegetation

Table 3-3 and Figure 3-7 detail the post-development VHC types and extent, as per Development Layout Plan, Statement of Landscape Intent, Environmental Rehabilitation Plan, and site assessment. Note that the post-

development VHC assumes that the adjoining development stages are constructed generally in accordance with the approved context plan (Appendix A). Also, Covey assumed that the vegetation palette within rehabilitation area along Bells Creek will follow that described for each Habitat Management Unit per Table 2-2 of the Environmental Rehabilitation Plan prepared by SMEC (2023).

Table 3-3. Site post-development VHC.

VHC	VHC Description
VHC 9.1	Moist to dry eucalypt open forests on coastal lowlands and ranges
VHC 22.1	Melaleuca open forests on seasonally inundated lowland coastal swamps
VHC 28.1	Open forests in coastal locations with species such as she-oak or swamp box
VHC 29.3	Heathlands and associated scrubs and shrublands
VHC 36.1	Exotic & hardwood plantation
VHC 39.2	Discontinuous low to moderate tree cover in built-up areas
VHC 40.4	Continuous low grass or tree cover
VHC 41.4	Discontinuous low grass or tree cover
VHC 42.6	Nil to very low vegetation cover
VHC 43.6	Water bodies

3.4 Summary

The proposed development is situated in a largely flat area and is bounded by a pine plantation to the southwest and future melaleuca and heathland revegetated areas along Bells Creek. Based on analysis of Beerburrum AWS weather data, the 1-in-20 year recurrence FFDI is 45; and the highest recorded FFDI was 47.8, in 2014. Note that, in our Radiant Heat Flux analysis we adopted FFDI 53 per SPP.

Figure 3-7. Vegetation Hazard Class

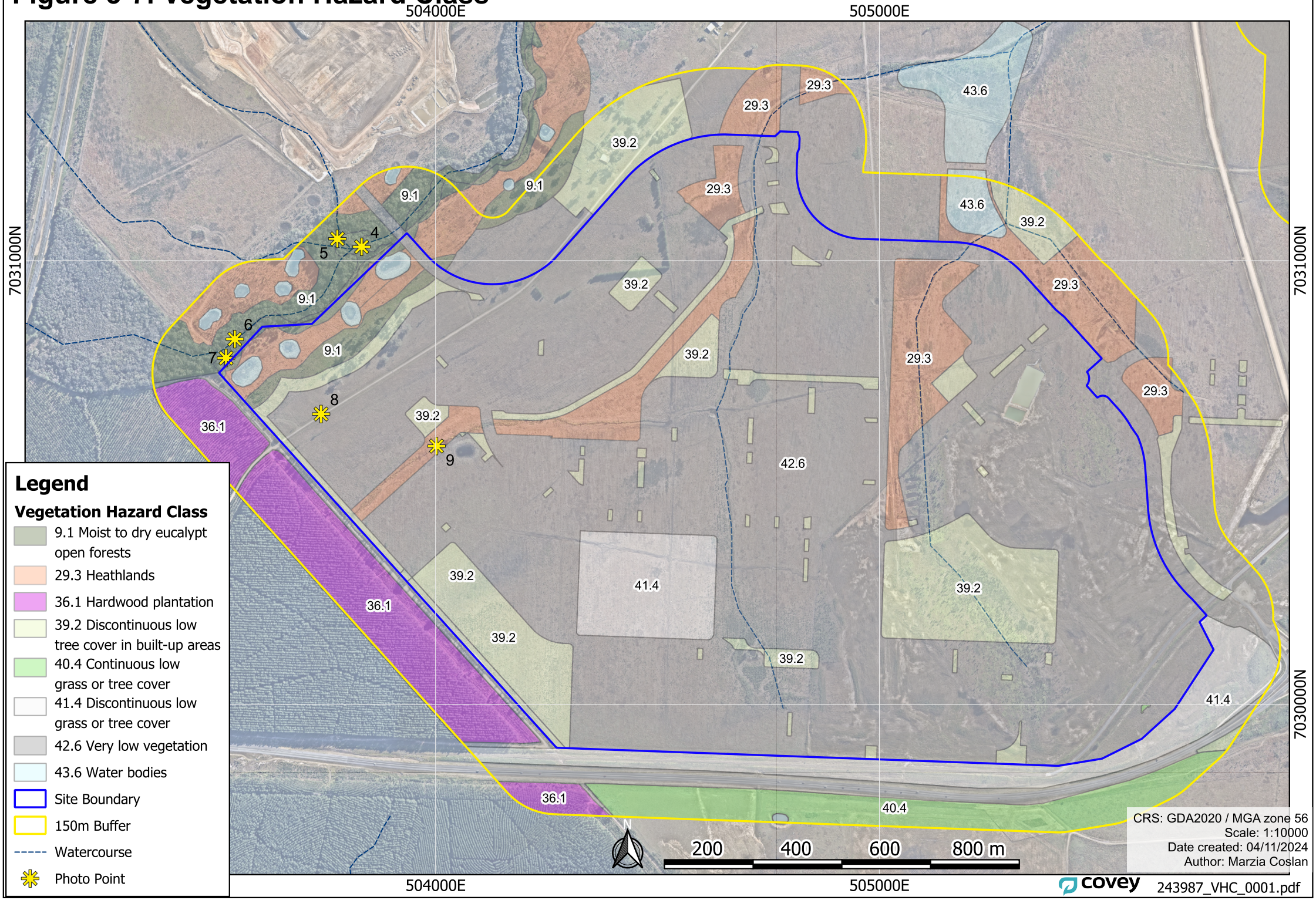
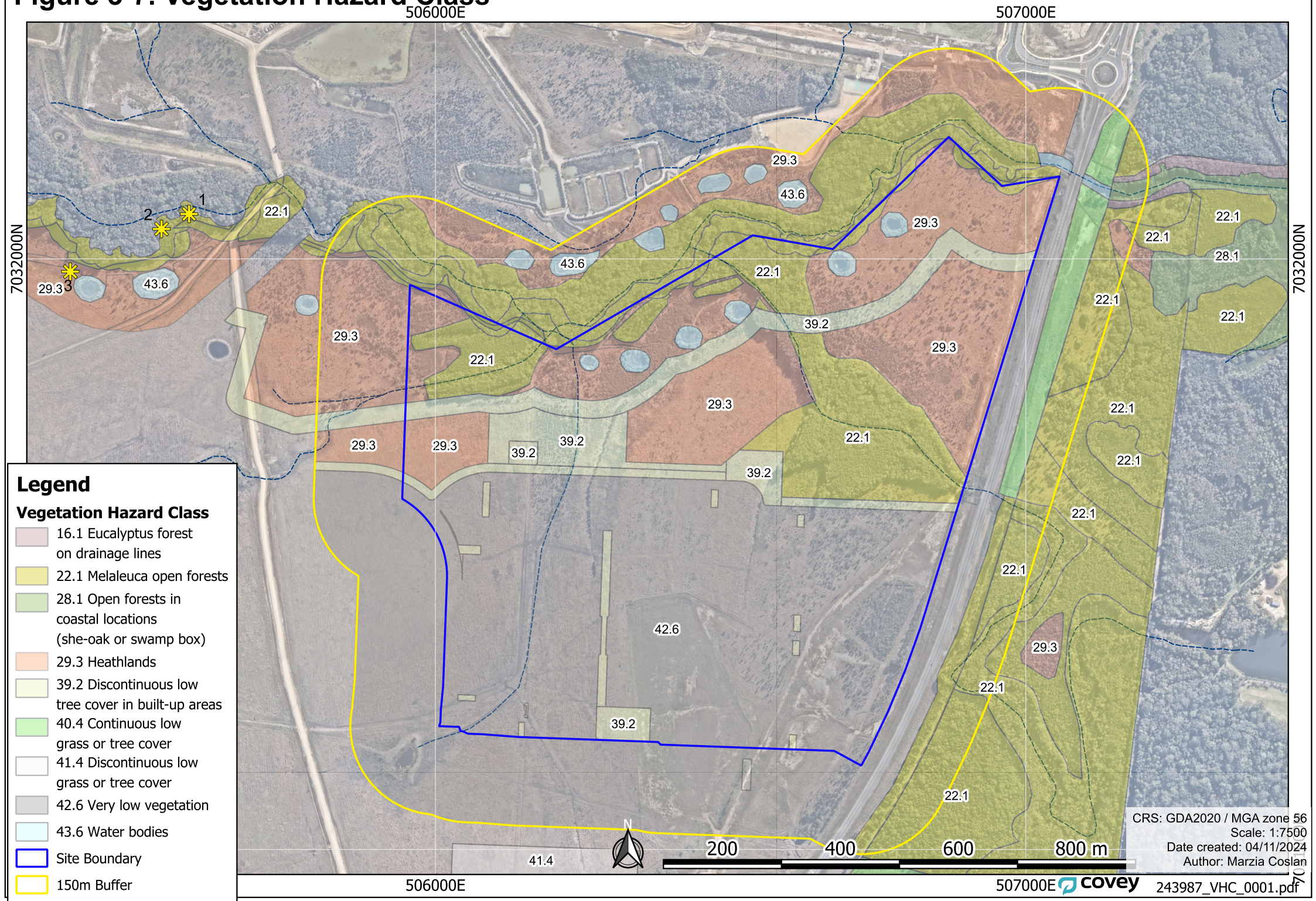


Figure 3-7. Vegetation Hazard Class



4 Bushfire Assessment

4.1 Bushfire Impact Analysis and RHF Ratings

Radiant Heat Flux (RHF) modelling identifies the rate at which heat transfers to a receiver from a potential fire and how the energy dissipates with increasing distance from the fire. Radiant Heat Flux modelling was undertaken in accordance with Method 2 of AS3959, with the adoption of BRC prescribed Forest Fire Danger Index (FFDI) and fuel loads from the SPP (Table 4-1). Also, given that vulnerable uses are included in the proposed development, Covey undertook two RHF model, adopting:

1. 1,090˚K flame temperature for residential, mixed-use and community centre uses; and
2. 1,200˚K flame temperature for schools and childcare.

Note that the proponent indicated that mixed-use developments and community centres will not include vulnerable uses or essential infrastructure.

The RHF model was undertaken with Inferno modelling software, which was developed in-house by Covey (refer to Appendix C for further details). The model incorporated the following input values, satisfying BRC:

- A FFDI of 53, representing the 5% Annual Exceedance Probability (AEP) fire weather event (Queensland Fire and Emergency Services, 2019a).
- State Planning Policy fuel load values per Table 4-1
  Vegetation bushfire-prone type, understorey and total fuel loading (referred to as w and W, respectively) were derived from BRC.

Table 4-1. VHC fuel loading, vegetation prone type and Rate of Spread model adopted

VHC	VHC Description	Vegetation Type	*w* (t/ha)	*W* (t/ha)	Prone Type	Modelled
VHC 9.1	Moist to dry eucalypt open forests on coastal lowlands and ranges	Forests	21	24.2	Bushfire	Y
VHC 22.1	Melaleuca open forests on seasonally inundated lowland coastal swamps	Forests	23.4	28.4	Bushfire	Y
VHC 28.1	Open forests in coastal locations with species such as she-oak or swamp box	Forests	24.9	26.9	Bushfire	Y
VHC 29.3	Heathlands and associated scrubs and shrublands	Scrub	14.5	20.1	Bushfire	Y
VHC 36.1	Exotic & hardwood plantation	Forests	23.8	26	Bushfire	Y
VHC 39.2	Discontinuous low to moderate tree cover in built-up areas	Low-threat	5	8	Low Hazard	N
VHC 40.4	Continuous low grass or tree cover	Grassland	4.5	5	Grassfire	N
VHC 41.4	Discontinuous low grass or tree cover	Low-threat	2.5	3	Low Hazard	N
VHC 42.6	Nil to very low vegetation cover	Low-threat	2	2	Low Hazard	N
VHC 43.6	Water bodies	Low-threat	0	0	Low Hazard	N

According to Section 7.6 of the BRC, radiant heat flux is not required to be calculated for grassfire-prone VHCs or low hazard VHC's (Queensland Fire and Emergency Services, 2019a). VHC 40.4 is considered *grassfire prone* and 39.2, 41.4 , 42.4 and 43.6 are *low hazard*; as such, these vegetation communities were not included in the RHF model (refer to BRC Figure 14 and s 7.6(5)).

Corridors of flammable vegetation less than 50 m in width are unlikely to support a fully developed flame front (Queensland Fire and Emergency Services, 2019a); as such they were downgraded to low hazard as per methodology used Queensland State-wide mapping of Bushfire Prone Areas (Leonard & Opie, 2017). Figure 4-1 shows bushfire and grass fire prone vegetation after applying the narrow corridor filtering rule and vegetation classified as low hazard under State Planning Policy.

4.1.1 Results

The SPP guidance material (Queensland Government, 2019) recommends development footprints be exposed to less than 29 kW/m^2 RHF, and vulnerable uses to be exposed to less than 10 kW/m^2 RHF (calculated with an input flame temperature of 1,200˚K).

Based on the RHF modelling results, the majority of the proposed lots are located to have an RHF of less than 29 kW/m^2 during credible worst-case bushfire events impacting the development (Figure 4-2). Note that, lots 3834, 6715 - 6717, 6197 – 6208, 6223 – 6209, 6244, 2646 – 6249, 8021 are exposed to RHF greater than 29 kW/m^2 under BRC bushfire scenario, and no mitigation measures being implemented (refer to section 5 of the BMP for further information).

Also, all the vulnerable uses (childcare, state primary school, state high school and private school) are exposed to less than 10 kW/m^2 (calculated with an input 1,200˚K flame temperature), with the exception of the State Highschool, where the 10 kW/m^2 RHF isoline infiltrates the lot boundary by approximately 2.3 m.

Note that, a Bushfire Attack Level assessment may be required to be undertaken in accordance with AS3959 before construction works of the buildings on the created lots. A Bushfire Attack Level (BAL) assessment does not form part of the assessment within this report.

4.2 Potential human impact and sheltering sites

Radiant heat flux and expected impacts on the human body are outlined in Table 4-2 for reference.

Table 4-2. Radiant heat flux impacts *(Penney et al., 2020).*

Radiant Heat Flux (kW/m^2)	Human effect
30	Significant chance of instantaneous fatality for unprotected exposed persons.
23.5	Likely fatality for extended exposure and chance of instantaneous fatality for unprotected exposed persons.
16.7	Significant chance of fatality for unprotected extended exposure.
10	Tenability threshold for bushfire fighters.
5	Limited human trials indicated no adverse effects
4.2	Will cause pain in 15-20 seconds unprotected exposure. Will cause injury after 30 seconds unprotected exposure.
3	Operational threshold for bushfire fighters attempting suppression.
2.5	Level of exposure permitted for evacuating occupants in the Building Code of Australia
2.1	Minimum heat radiation required to cause pain after 60 seconds unprotected exposure
1.3	Exposure from mid-day sun

Figure 4-1. Vegetation Hazard Class with Narrow Corridors filter applied

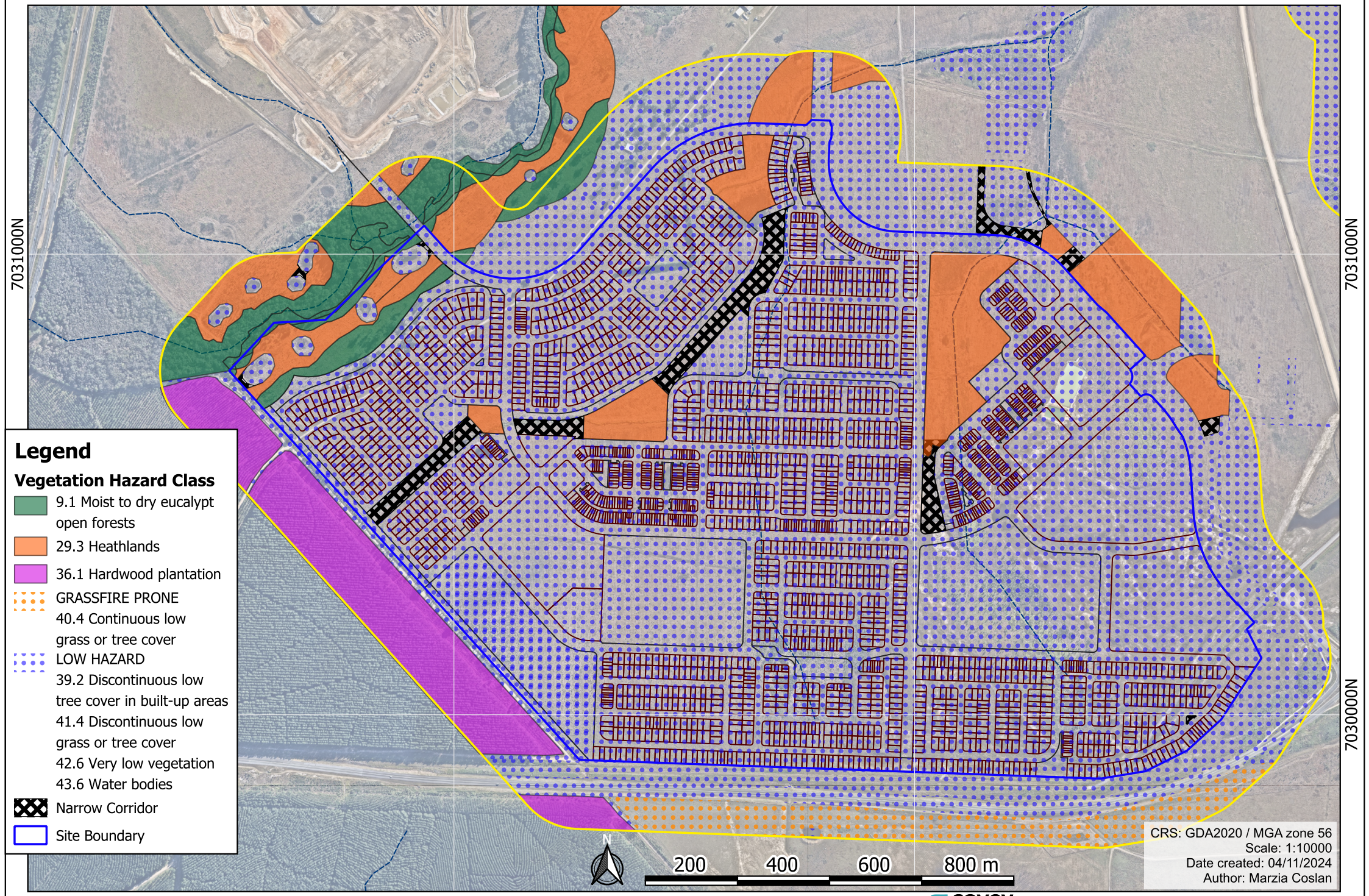


Figure 4-1. Vegetation Hazard Class with Narrow Corridors filter applied

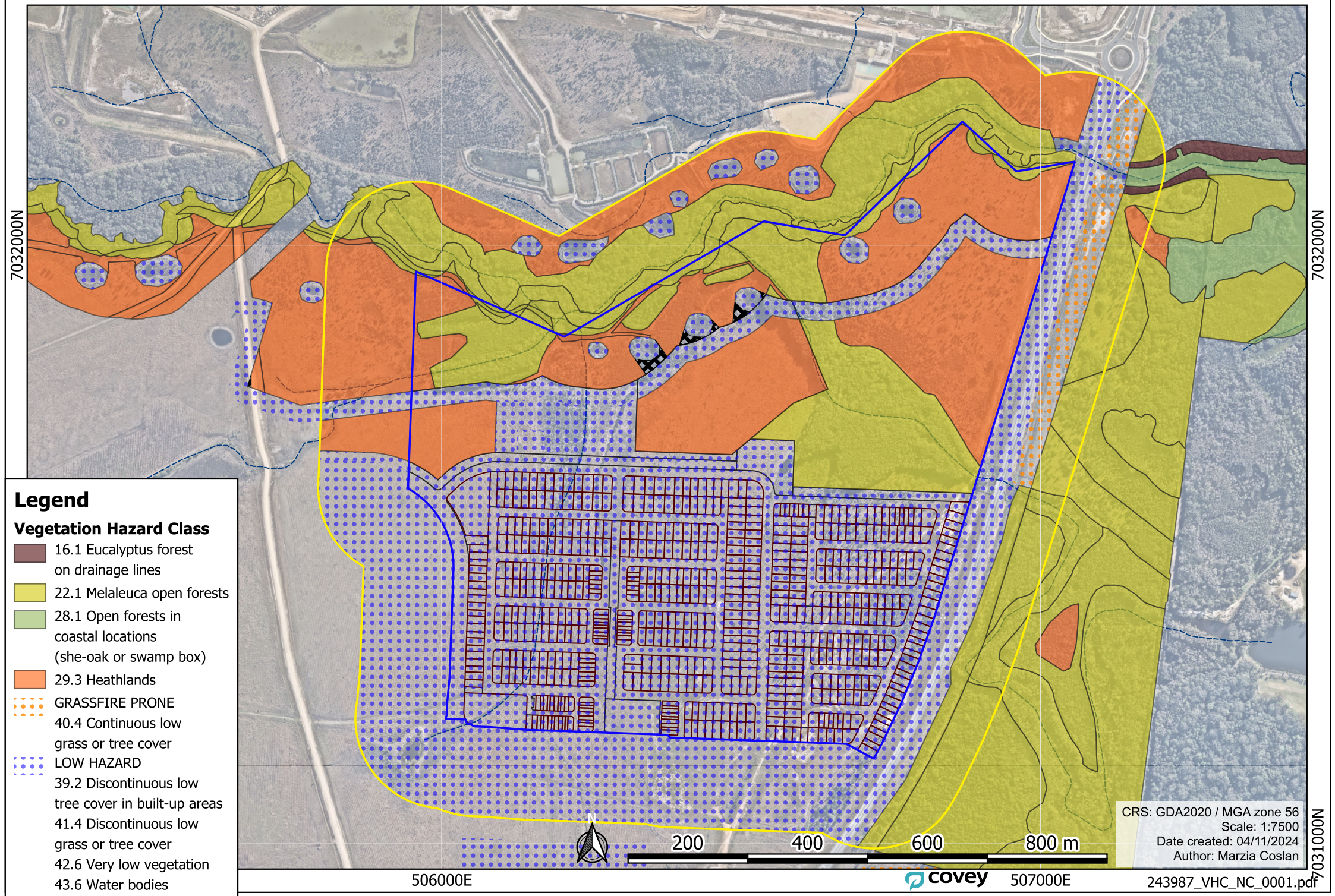
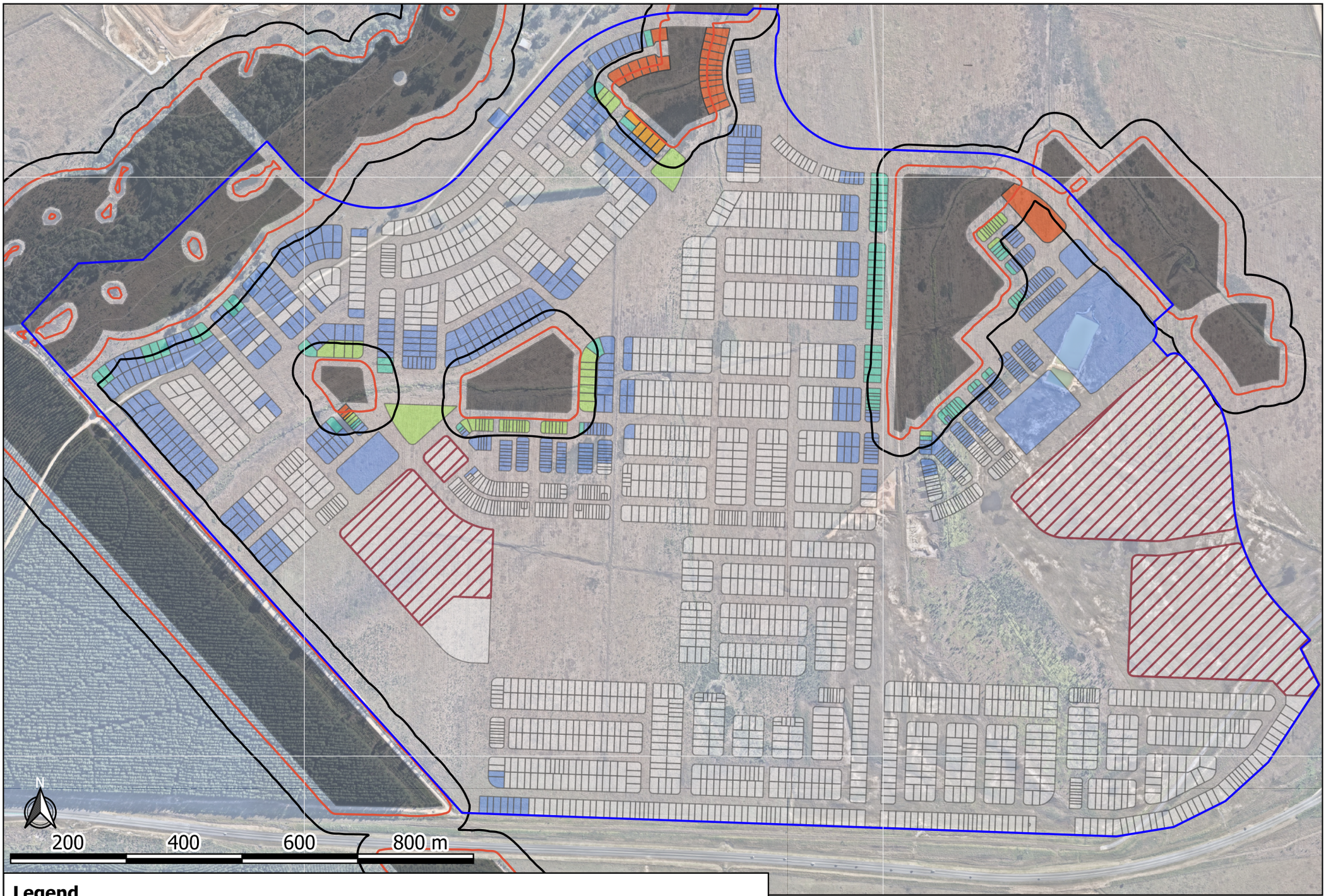


Figure 4-2. Radiant Heat Flux Modelling Output.



Legend

RHF isoline 1090K
29 kW/m2

RHF Isoline 1200K
10 kW/m2

Lots RHF Exposure
< 12.5 kW/m2
12.5 kW/m2 - 19 kW/m2
19 kW/m2 - 29 kW/m2
29 kW/m2 - 40 kW/m2
>40 kW/m2
>100m away from bushfire prone vegetation

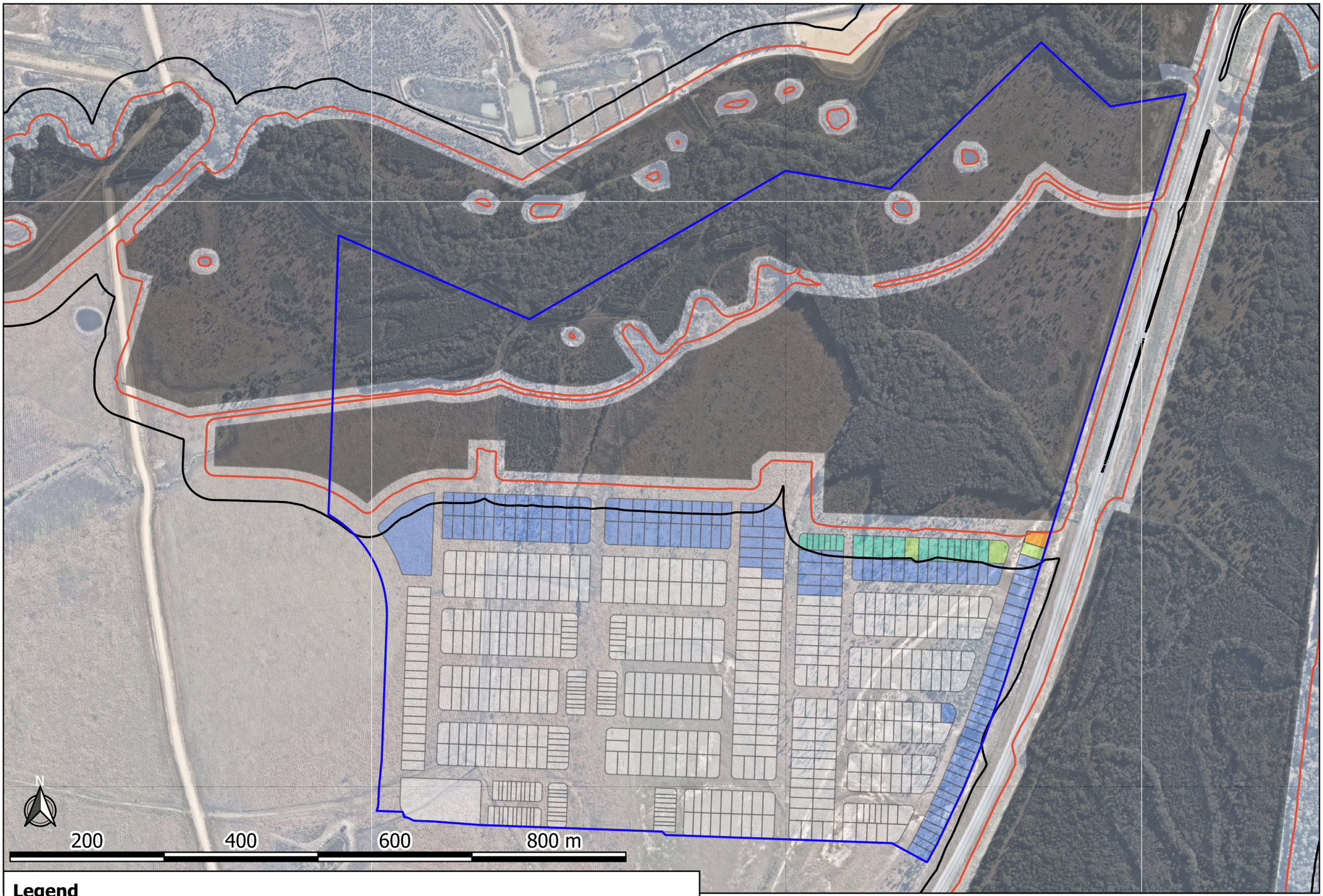
Vulnerable Use
Bushfiore Prone Vegetation
Site Boundary

CRS: GDA2020 / MGA zone 56
Scale: 1:8000
Date created: 04/11/2024
Author: Marzia Coslan

covey

243987_RHF_0001.pdf

Figure 4-2. Radiant Heat Flux Modelling Output.



CRS: GDA2020 / MGA zone 56
Scale: 1:6000
Date created: 04/11/2024
Author: Marzia Coslan

covey

243987_RHF_0001.pdf

5 Bushfire Mitigation Measures

The following section outlines bushfire mitigation measures to be incorporated into the proposed development design. These measures aim to comply with the BRC and SPP guidance material. Provided that the mitigation measures outlined in this section are implemented, the bushfire risk for the proposed development is deemed to be acceptable.

5.1 Setbacks / RHF exposure

The modelling indicates that the majority of the proposed lots will be exposed to less than 29 kW/m^2 RHF per BRC (Figure 4-2). Note that, proposed lots 3834, 6715 - 6717, 6197 – 6208, 6223 – 6209, 6244, 2646 – 6249, 8021 are exposed to RHF greater than 29 kW/m^2 prior to mitigation measures being implemented. The proposed lots dedicated to childcare, state primary school, and private school (vulnerable uses) are exposed to less than 10 kW/m^2 (calculated with an input 1,200°K flame temperature). Note that, the 10 kW/m^2 RHF isoline infiltrates the State Highschool lot boundary by approximately 2.3 m. Based on the Residential Development Controls (RSP 2024) outlined in Figure 5-1, it is expected that the frontage setback building envelopes will ensure vulnerable use structures will be exposed to RHF levels on proposed less than 10 kW/m^2.

		URBAN VILLA ALLOTMENTS		VILLA ALLOTMENTS		PREMIUM VILLA ALLOTMENTS		COURTYARD & TRADITIONAL ALLOTMENTS		PREMIUM TRADITIONAL ALLOTMENTS		MULTIPLE RESIDENTIAL ALLOTMENTS (DUPLEX)	
		8.5m–9.99m Wide		10m–12.49m Wide		12.5m–13.99m Wide		14m - 17.99m Wide		18.0m Wide +			
		Ground Floor	First Floor	Ground Floor	First Floor	Ground Floor	First Floor	Ground Floor	First Floor	Ground Floor	First Floor	Ground Floor	First Floor
Front & Rear (metres) [2]													
Front / Primary Frontage		2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Garage	Single	5.0	n/a	5.0	n/a	5.0	n/a	5.0	n/a	5.0	n/a	5.0	n/a
	Double	5.0		5.0		5.0		5.0		5.0		5.0	
Rear		1.5	3.0	1.5	3.0	1.5	3.0	1.5	3.0	1.5	3.0	1.0 [1]	1.0 [1]
Rear Setback for Lots Adjoining the BCA Acoustic Fence		4.0 - 6.0 [3 4]	4.0 - 6.0 [3 4]	4.0 - 6.0 [3 4]	4.0 - 6.0 [3 4]	4.0 - 6.0 [3 4]	4.0 - 6.0 [3 4]	4.0 - 6.0 [3 4]	4.0 - 6.0 [3 4]	4.0 - 6.0 [3 4]	4.0 - 6.0 [3 4]	4.0 - 6.0 [3 4]	4.0 - 6.0 [3 4]
Side (metres) [2]													
Built to Boundary		0.0	0.9	0.0	0.9	0.0	1.0	0.0	1.0	0.0	1.5	0.0	1.0
Non Built to Boundary		0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.5	1.5	1.0	1.0
Corner Lots — Secondary frontage		2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Garage and On-site Car Parking													
On site parking requirements (minimum)		1 space to be covered and enclosed. Single garages (up to 3.5m in width) or tandem garages are acceptable.		1 space to be covered and enclosed. Single garages (up to 3.5m in width) or tandem garages are acceptable. Double garages (greater than 3.5m in width) are permitted for: - 2 storey dwellings; and - single storey dwellings provided note 20 above is met. Double garages must be located on any dwelling with 4 bedrooms or greater.		1 space per dwelling to be covered and enclosed. Single, tandem or double garage acceptable. Double garages must be located on any dwelling with 4 bedrooms or greater.		1 space to be covered and enclosed. Single, tandem or double garage acceptable. Double garages must be located on any dwelling with 4 bedrooms or greater.		1 space to be covered and enclosed. Single, tandem or double garage acceptable. Double garages must be located on any dwelling with 4 bedrooms or greater.		1 space per dwelling to be covered and enclosed. Double garages must be located on any dwelling with 4 bedrooms or greater.	
Garage location		Garages are to be located along the built to boundary wall.		Garages are to be located along the built to boundary wall.		Garages are to be located along the built to boundary wall.		Garages are to be located along the built to boundary wall.		Garages are to be located along the western or southern boundary where appropriate.		Garages are to be located along the western or southern boundary where appropriate.	
Site Cover (maximum)		60%		60%		60%		60%		60%		75%	

Figure 5-1. Plan of Development table (reproduced from RSP, 2024).

5.1.1 Asset Protection Zone

Six Asset Protection Zones (APZ) must be implemented within proposed drainage/landscaped areas per Figure 5-2 to reduce the RHF exposure of the issue lots (3834, 6715 - 6717, 6197 – 6208, 6223 – 6209, 6244, 2646 – 6249, 8021) to SPP acceptable levels. Within APZ, vegetation should be modified and/or maintained to reduce fuel load and mechanisms of bushfire attack such as flame and radiant heat. Specifically, APZs are to ensure that building envelopes are exposed to less than 29 kW/m^2 in perpetuity. The APZs are to follow the Bushfire Landscaping Guidelines detailed in section 5.4.

Note that no APZ is recommended within the drainage area adjacent to the high school; rather it is recommended that the building footprints associate with the high school are located beyond the 10 kW/m^2 RHF isoline (calculated with an input 1,200°K flame temperature).

5.1.2 National Construction Code (NCC)

Note that, this assessment is focused on planning legislation. The Bushfire Prone Area overlay also triggers building to be constructed in accordance with Building Code of Australia (BCA) Ancillary provisions and additional construction requirements in bushfire prone areas. The BCA requires Class 1, Class 2, Class 3 buildings, and Class 10a building or deck associated with a Class 1, 2 or 3 to be constructed per AS 3959-2018 (National Construction Code, 2022a, 2022b). The NCC was updated in 2022 and certain Class 9 Buildings are now subject to additional bushfire requirements; refer to Part G5 and Specification 43 of NCC Volume 1 (National Construction Code, 2022). Part of the relevant sections have been included in Appendix D. A Bushfire Attack Level assessment may be required to be undertaken in accordance with AS3959 before construction works of the buildings on the created lots, and do not form part of the assessment within this report.

Figure 5-2. Asset Protection Zones to be implemented

Legend

- Asset Protection Zone
- APZ width

RHF isoline - 1090K

- 29 kW/m2
- Bushfire Prone Vegetation

Lots RHF exposure

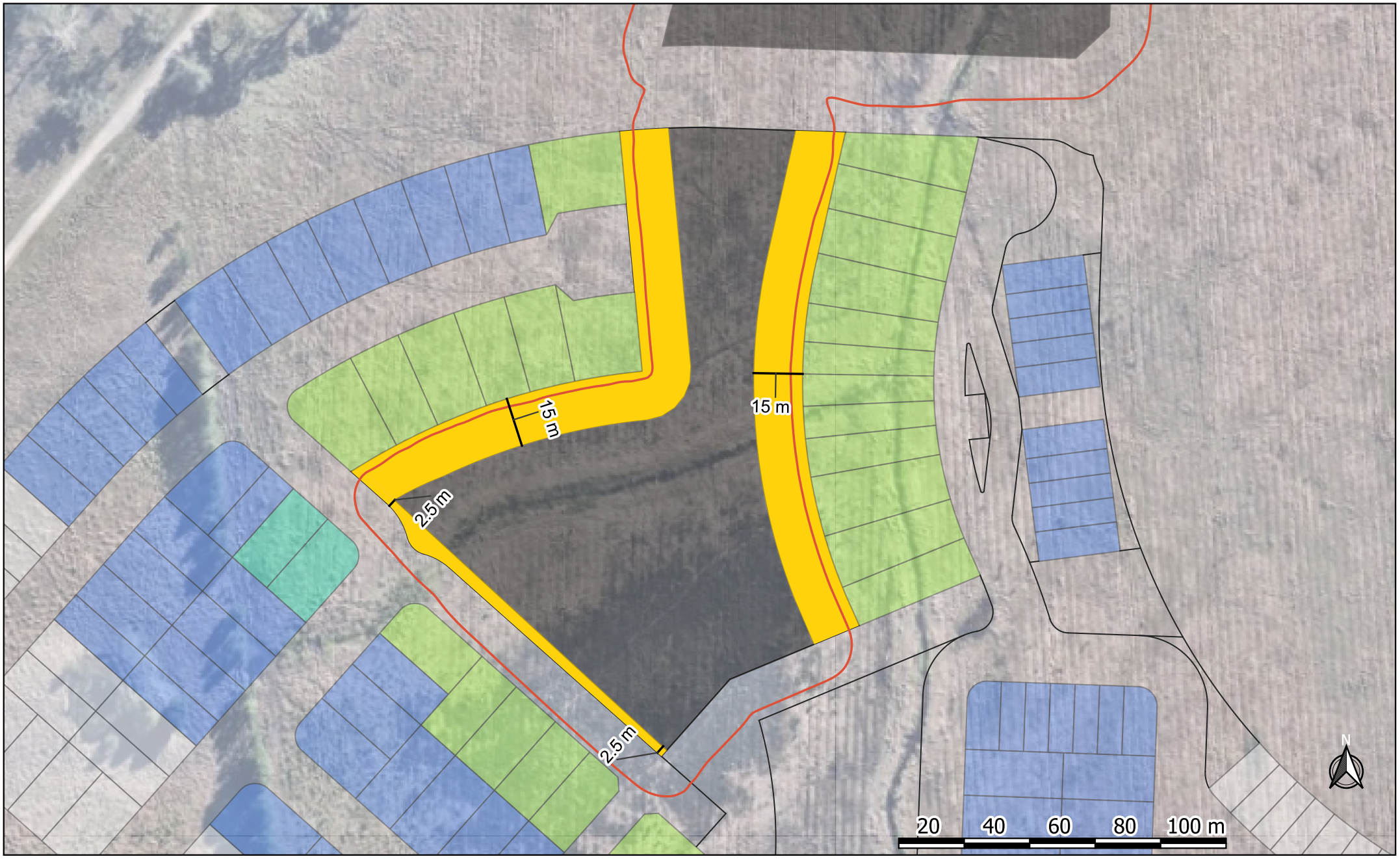
- < 12.5 kW/m2
- 12.5 kW/m2 - 19 kW/m2
- 19 kW/m2 - 29 kW/m2
- >100m away from bushfire prone vegetation

CRS: GDA2020 / MGA zone 56
Scale: 1:1000
Date created: 05/11/2024
Author: Marzia Coslan

covey

243987_APZ_0001.pdf

Figure 5-2. Asset Protection Zones to be implemented



Legend

- Asset Protection Zone
- APZ width

RHF isoline - 1090K

- 29 kW/m2
- Bushfire Prone Vegetation

Lots RHF exposure

- < 12.5 kW/m2
- 12.5 kW/m2 - 19 kW/m2
- 19 kW/m2 - 29 kW/m2
- >100m away from bushfire prone vegetation

CRS: GDA2020 / MGA zone 56
Scale: 1:1500
Date created: 05/11/2024
Author: Marzia Coslan

covey

243987_APZ_0001.pdf

Figure 5-2. Asset Protection Zones to be implemented

Legend

- Asset Protection Zone
- APZ width

RHF isoline - 1090K

- 29 kW/m2
- Bushfire Prone Vegetation

Lots RHF exposure

- < 12.5 kW/m2
- 12.5 kW/m2 - 19 kW/m2
- 19 kW/m2 - 29 kW/m2

CRS: GDA2020 / MGA zone 56
Scale: 1:1000
Date created: 05/11/2024
Author: Marzia Coslan

covey

243987_APZ_0001.pdf

Figure 5-2. Asset Protection Zones to be implemented

Legend

- Asset Protection Zone
- APZ width

RHF isoline - 1090K

- 29 kW/m2
- Bushfire Prone Vegetation

Lots RHF exposure

- < 12.5 kW/m2
- 12.5 kW/m2 - 19 kW/m2
- 19 kW/m2 - 29 kW/m2

CRS: GDA2020 / MGA zone 56
Scale: 1:1000
Date created: 05/11/2024
Author: Marzia Coslan

covey

243987_APZ_0001.pdf

5.2 Access

At master planned community plan sealing, the proposed development will be accessed via Bells Creek Arterial Road and two main sub-arterial access points connecting to the approved development to the north. Until the proposed development is completed, existing vehicle access tracks within the context plan area will be maintained to allow access and egress to 2-wheel drive private and emergency vehicles.

The design and construction of infrastructure is to ensure accessibility to all existing and proposed infrastructure to emergency services. Access roads, including internal driveways are to follow *Fire hydrant and vehicle access guidelines* (Queensland Fire and Emergency Services, 2019c). This guideline defers to the *Road Planning and Design Manual – 2nd Edition* (Department of Transport and Main Roads, 2021). Access design and construction should incorporate the following parameters:

- Minimum roadway clearance of 3.5 m wide by 4.8 m high to allow access for a fire truck;
- Be accessible in all weather conditions and able to accommodate a vehicle of 15 tonnes for the trafficable road width;
- Road grades must facilitate the safe passage of fire trucks;
- Roads must allow for fire trucks to turn at the end of dead-end roads; and
- Provision is made for fire trucks to turn at the end of dead-end roads (Figure 5-3)

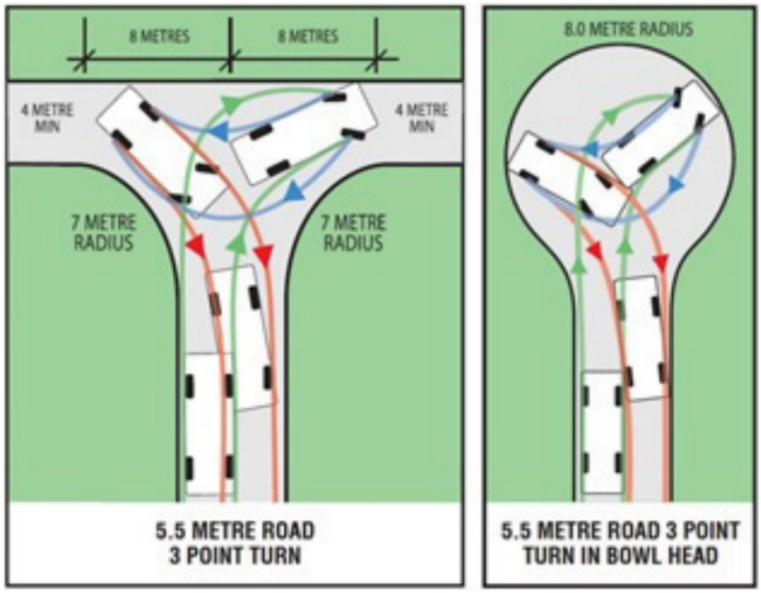


Figure 5-3. **Vehicle Turning Points** (Queensland Fire and Emergency Services, 2019b).

5.3 Fire-fighting Water Supply

The proposed development will be conditioned to provide a connection to the mains water supply, including for firefighting purposes. Provision will be made to connection to water mains supply, with suitable allocation of fire-fighting infrastructure (hydrants) in accordance with the local water retailer's specifications and the *Australian Standard – Fire hydrant installations system design, installation and commissioning* (AS 2419.1:2021).

5.4 Bushfire Landscaping Guidelines

Landscaping within the site, including areas mapped as low hazard vegetation (refer to section 3.3 and 5.1.1 of this BMP) should utilise plant species that do not exacerbate the level of bushfire threat. The landscaping design within the proposed development must not constitute a bushfire threat and should be in line with Statement of Landscape Intent (Urbis 2024).

This may be achieved through aligning landscaping with Low Threat exclusion clauses defined in AS3959, S2.2.3.2. Examples include:

(i) Landscaping design within the low fuel zone being consistent with AS3959 S2.2.3.2(f) to ensure vegetation does not create vertically and horizontally continuous fuel structures that may contribute to bushfire intensity (Figure 5-4);
(ii) Where areas of bushland are to be included as part of landscaping design in the low fuel zone, ensure they are consistent with AS3959 S2.2.3.2, being less than 0.25 ha in area and not within 20 m of each other or proposed dwellings (Figure 5-5);
(iii) Utilise non-vegetated areas within the development consistent with AS3959 S2.2.3.2 (e) to provide enhanced separation between buildings and vegetation identified as a bushfire threat external to the site boundaries; and,
(iv) Utilise 'Fire-Wise' plant species that are resistant to the effects of fire (guidance can be found at http://www.cfa.vic.gov.au/plan-prepare/landscaping-for-bushfire).

The Landscape Concept Design prepared by Project Urban (Revision E -09/08/2024) was reviewed by Covey and is in line with the bushfire landscaping guidelines detailed above.

Figure 5-4. Low Threat vegetation (left) and Low Threat public open space (right).

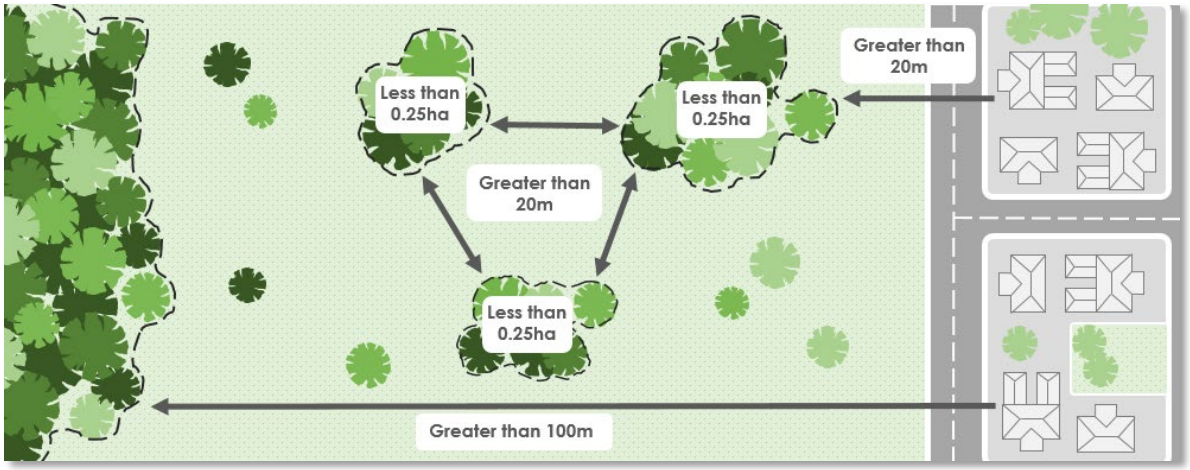


Figure 5-5. AS3959 Exclusions—Low threat vegetation and non-vegetated areas.

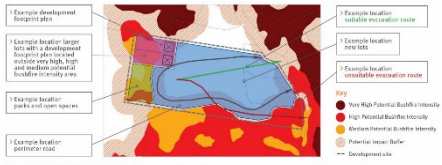
6 Performance Criteria and Compliance

This BMP applies acceptable outcomes to achieve the Performance Outcomes as detailed in the example Bushfire Overlay Code of the SPP guidance material (Queensland Government, 2019). The Performance Outcomes detailed in the SPP guidance material are addressed in the development design are summarised in Table 5-1.

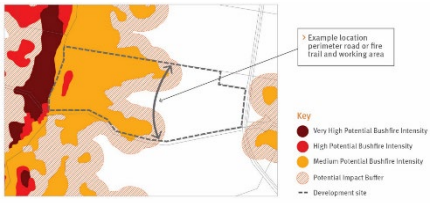
Table 6-1. Satisfaction of the SPP guidance material example Bushfire Overlay Code.

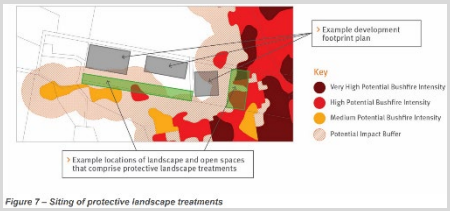
Performance Outcomes	Acceptable Outcomes	Development Compliance
Section A Reconfiguring a lot (RaL) – where creating lots of more than 2,000 square metres		
PO1 The subdivision layout: a. enables future buildings to be located away from slopes and landforms that expose people or property to an intolerable risk to life or property; and b. facilitates emergency access and operational space for firefighters in a reduced fuel area between future buildings and structures and hazardous vegetation, that reduce risk to an acceptable or tolerable level. Note – An applicant may seek to undertake a site-level verification of the location and nature of hazardous vegetation and resulting potential bushfire intensity levels, for example where changes in foliage have occurred (e.g. as a consequence of adjoining permanent urban development) or where an applicant seeks to verify the regional ecosystem map inputs. This verification should form part of a bushfire hazard assessment in accordance with the methodology in the QFES Bushfire resilient communities document. The outcomes of this assessment can demonstrate how an alternate solution to the acceptable outcome can deliver an acceptable or tolerable level of risk.	**AO1.1** A development footprint plan is identified for each lot that avoids ridgelines, saddles and crests where slopes exceed 15 per cent. **AO1.2** A development footprint plan is identified for each lot that is separated from the closest edge to the adjacent mapped medium, high or very high potential bushfire intensity area by: a. a distance that is no closer than the distances specified in Table 5 at all development footprint plan boundaries; or b. a distance that achieves a radiant heat flux level of 29 kW/m^2 or less at all development footprint plan boundaries. Note – This separation area is often termed an asset protection zone. Note – The radiant heat flux levels can be established by undertaking a bushfire hazard assessment in accordance with the methodology in the QFES Bushfire resilient communities document.	**Compliant** Fourteen proposed lots cover more than 2,000 m^2. These incorporate the community centres, multiple residential and schools. All multiple residential and community centres lots are exposed to less than 29 kW/m^2. The proposed lots dedicated to childcare, state primary school, and private school (vulnerable uses) are exposed to less than 10 kW/m^2 (calculated with an input 1,200°K flame temperature). Note that, the 10 kW/m^2 RHF isoline infiltrates the State High school lot boundary by approximately 2.3 m. Based on the Residential Development Controls (RSP 2024), it is expected that the frontage setback building envelope will ensure exposure RHF levels lower than 10 kW/m^2 (Figure 5-1).
PO2 The subdivision layout enables: a. future buildings to be located as close as possible to property entrances to facilitate safe evacuation during a bushfire event; and b. future site access to be located and designed to allow safe evacuation of the site by occupants and maintain access by emergency services under critical event conditions.	**AO2** A development footprint plan is identified for each lot that: a. is located within 60 metres of the street frontage; and b. sited to enable a route between the development footprint plan and the street frontage with a gradient that does not exceed of 12.5 per cent.	**Compliant** The site is largely flat and all proposed lots will have access via a street frontage. The proposed development is to ensure accessibility to all existing and proposed infrastructure to emergency services. Access roads, including internal driveways are to follow Fire hydrant and vehicle access guidelines (Queensland Fire and Emergency Services, 2019c). This guideline defers to the Road Planning and Design Manual – 2nd Edition (Department of Transport and Main Roads, 2021).

Section B Reconfiguring a lot (RaL) – where creating lots of 2,000 square metres or less		
PO3 The subdivision layout: a. avoids creating lots on slopes and landforms that expose people or property to an intolerable risk to life or property; and b. facilitates emergency access and operational space for firefighters in a reduced fuel area between future buildings and structures and hazardous vegetation, that reduce risk to an acceptable or tolerable level. Note – An applicant may seek to undertake a site-level verification of the location and nature of hazardous vegetation and resulting potential bushfire intensity levels, for example where changes in foliage have occurred (e.g. as a consequence of adjoining permanent urban development) or where an applicant seeks to verify the regional ecosystem map inputs. This verification should form part of a bushfire hazard assessment, in accordance with the methodology in the QFES Bushfire resilient communities document. The outcomes of this assessment can demonstrate how an alternate solution to the acceptable outcome can deliver an acceptable or tolerable level of risk.	**AO3.1** The subdivision layout results in lots that are sited so that they are separated from the closest edge to the adjacent mapped medium, high or very high potential bushfire intensity area by: a. a distance that is no closer than the distances specified in Table 5 at all lot boundaries; or b. a distance that achieves a radiant heat flux level of 29 kW/m^2 or less: i. at the building envelope, if identified at RaL stage; or ii. where a building envelope is not identified, at all lot boundaries. Note – This separation area is often termed an asset protection zone. Note – The radiant heat flux levels can be established by undertaking a bushfire hazard assessment in accordance with the methodology in the QFES Bushfire resilient communities document. Note – For staged developments, temporary separation areas may be absorbed as part of subsequent stages. Note – Existing cleared areas external to the site may only be used in calculating necessary separation where tenure ensures that the land will remain cleared of hazardous vegetation (for example the land is a road, watercourse or highly managed park in public ownership). **AO3.2** The subdivision layout does not create lots that are within bushfire prone areas and on ridgelines, saddles and crests where slopes exceed 15 per cent (roads and parks may be located in these areas).	**Compliant** The RHF modelling indicates that most of the proposed residential and community centre lots will be exposed to less than 29 kW/m2 RHF per BRC (Figure 4-2). Six Asset Protection Zones (APZ) must be implemented within proposed drainage/landscaped areas per Figure 5-2 to reduce the RHF exposure of the issue lots (3834, 6715 - 6717, 6197 – 6208, 6223 – 6209, 6244, 2646 – 6249, 8021) to SPP acceptable levels. Within APZs, vegetation should be modified and/or maintained to reduce fuel load and mechanisms of bushfire attack such as flame and radiant heat. Specifically, APZs are to ensure that building envelopes are exposed to less than 29 kW/m2 in perpetuity. The APZs are to follow the Bushfire Landscaping Guidelines detailed in section 5.4. The site lacks steep slopes or ridgelines, that would increase bushfire risk and affect the design of the proposed allotments
Section C Reconfiguring a lot (RaL) – where creating more than 20 lots		
PO4 The subdivision layout is designed to minimise the length of the development perimeter and number of lots exposed to hazardous vegetation. Note – For example, avoid finger-like subdivision patterns or substantive vegetated corridors between lots.	**AO4** No acceptable outcome is prescribed.	**Compliant** All proposed lots adjacent to an area of assessable bushfire hazardous vegetation within this assessment have been sited to ensure a suitable buffer is in place through the implementation of a road network. This will allow all proposed residential and community centre lots to be exposed to less than 29 kW/m^2; and vulnerable uses to be

		exposed to less than 10 kW/m^2 (Figure 4-2 and Figure 5-2) No finger-like subdivision patterns or significant vegetation corridors have been included in the proposed development.
PO5 The subdivision layout provides for adequate access and egress and safe evacuation routes, to achieve an acceptable or tolerable risk to people.	**AO5.1** The subdivision layout: a. avoids the creation of bottle-neck points in the movement network within the development (for example, avoids hourglass patterns); and b. ensures the road network has sufficient capacity for the evacuating population. **AO5.2** The subdivision layout ensures evacuation routes: a. direct occupants away from rather than towards or through areas with a greater potential bushfire intensity; and b. minimise the length of route through bushfire prone areas. Refer Figure 5.	**Compliant dependent on approval of adjoining stages** The proposed development assessed within this BMP provides a design layout that demonstrates suitable separation from bushfire hazards to proposed development lots, provides a suitable road network that will allow for access of emergency vehicles, and egress of residents away from approaching bushfire risks. The proposed road network has been designed to limit the amount of dead-ends (cul-de-sacs), and ensures sufficient roadway width to allow for two-way passing and access of larger emergency service vehicles. Until the proposed development is completed, existing vehicle access tracks within the context plan area will be maintained to allow access and egress to private and emergency vehicles. The design and construction of infrastructure is to ensure accessibility to all existing and proposed infrastructure to emergency services. Access roads, including internal driveways are to follow Fire hydrant and vehicle access guidelines (Queensland Fire and Emergency Services, 2019c). This guideline defers to the Road Planning and Design Manual – 2nd Edition (Department of Transport and Main Roads, 2021).
 *Figure 5 – Subdivision layout and evacuation routes*		
PO6 The subdivision layout provides adequate buffers between hazardous vegetation and development. Note – An applicant may seek to undertake a site-level verification of the location and nature of hazardous vegetation and resulting potential bushfire intensity levels, for example where changes in foliage have occurred (e.g. as a consequence of adjoining permanent urban development) or where an applicant seeks to verify the regional ecosystem map inputs. This verification should form part of a bushfire hazard assessment, in accordance with the	**AO6.1** The subdivision layout results in an asset protection zone being located to create a separation area from adjacent mapped medium, high or very high potential bushfire intensity areas. **AO6.2** The asset protection zone is comprised of: a. parks and open spaces; and/or	**Compliant** The modelling indicates that most of the proposed residential and community centre lots will be exposed to less than 29 kW/m^2 RHF per BRC (Figure 4-2). Six Asset Protection Zones (APZ) must be implemented within proposed drainage/landscaped areas per Figure 5-2 to reduce the RHF exposure of the issue lots (3834, 6715 - 6717, 6197 – 6208, 6223 –

methodology in the QFES Bushfire resilient communities document. The outcomes of this assessment can demonstrate how an alternate solution to the acceptable outcome can deliver an acceptable or tolerable level of risk.	b. lots greater than 2000 square metres; and/or c. public roads (termed perimeter roads). Note – Parks and open space may be located within the mapped medium, high and very high potential bushfire intensity areas to create a separation between the development and the balance of the bushfire prone area. Note – Portions of lots greater than 2000 square metres may be located within the mapped medium, high and very high potential bushfire intensity areas. Refer Figure 5. **AO6.3** Where the asset protection zone includes lots greater than 2000 square metres a development footprint plan is identified for each lot that is located in accordance with AO1.2.	6209, 6244, 2646 – 6249, 8021) to SPP acceptable levels. Within APZ, vegetation should be modified and/or maintained to reduce fuel load and mechanisms of bushfire attack such as flame and radiant heat. Specifically, APZs are to ensure that building envelopes are exposed to less than 29 kW/m2 in perpetuity. The APZs are to follow the Bushfire Landscaping Guidelines detailed in section 5.4. The proposed lots dedicated to childcare, state primary school, and private school (vulnerable uses) are exposed to less than 10 kW/m^2 (calculated with an input 1,200°K flame temperature). Note that, the 10 kW/m^2 RHF isoline infiltrates the State High school lot boundary by approximately 2.3 m. Based on the Residential Development Controls (RSP 2024), it is expected that the frontage setback building envelope will ensure exposure RHF levels lower than 10 kW/m^2 (Figure 5-1). All proposed lots adjacent to an area of assessable bushfire hazardous vegetation within this assessment have been sited as to ensure a suitable buffer is in place through the implementation of a road network or APZ if required.
PO7 Parks or open space provided as part of the asset protection zone do not create additional bushfire prone areas. Note –The undertaking of a bushfire hazard assessment, in accordance with the methodology in the QFES Bushfire resilient communities document may assist in demonstrating compliance with this performance outcome.	**AO7** Where the asset protection zone includes parks or open spaces, they: a. comprise only low threat vegetation, including grassland managed in a minimal fuel condition, maintained lawns, golf courses, maintained public reserves and parklands, cultivated gardens and nature strips; or b. are designed to ensure a potential available fuel load is maintained at less than eight tonnes/hectare in aggregate and with a fuel structure that remains discontinuous. Note – Minimal fuel condition means there is insufficient fuel available to significantly increase the severity of the bushfire attack, for example short-cropped grass to a nominal height of 10 centimetres.	**Compliant** Landscaping within the site, including areas mapped as low hazard vegetation, such as local linear park, local recreation park, neighbourhood recreation park, neighbourhood sports park, and pedestrian links, (refer to section 3.3 and 5.1.1 of this BMP) should utilise plant species that do not exacerbate the level of bushfire threat. The landscaping design within the proposed development must not constitute a bushfire threat and should be in line with Statement of Landscape Intent (Urbis 2024). The Landscape Concept Design prepared by Project Urban (Revision E -09/08/2024) was reviewed by Covey and is in line with the bushfire landscaping guidelines detailed in section 5.4 of the BMP.
PO8 Perimeter roads are accessible for fire-fighting vehicles, to facilitate emergency access and	**AO8.1** Where the asset protection zone includes a perimeter road it:	**Compliant** A perimeter road is to be established around the outer edge of the

operational space for fire-fighting, maintenance works and hazard reduction activities.	a. has a two-lane sealed carriageway clear of hazardous vegetation; and b. is connected to the wider public road network at both ends and at intervals of no more than 200 metres; and c. does not include design elements that may impede access for fire-fighting and maintenance for fire-fighting purposes (for example traffic calming involving chicanes). **AO8.2** Where the subdivision contains a reticulated water supply, the road network and fire hydrants are designed and installed in accordance with: a. *Fire Hydrant and Vehicle Access Guidelines for residential, commercial and industrial lots*, Queensland Fire and Emergency Services, 2015, unless otherwise specified by the relevant water entity; and b. the *Road Planning and Design Manual 2nd edition*, Department of Transport and Main Roads, 2013.	proposed lots adjacent to bushfire prone vegetation. This perimeter road will be connected to the wider public road network. The proposed road network has been designed to limit the number of dead-ends (cul-de-sacs), and ensures sufficient roadway width to allow for two-way passing and access of larger emergency service vehicles. The proposed development will be conditioned to provide connection to mains water supply, with provision of a piped water network capable of supplying sufficient flow and pressure for fire-fighting purposes. Provision will be made to connection to water mains supply, with suitable allocation of fire-fighting infrastructure (hydrants) in accordance with the local water retailer's specifications and the Australian Standard – Fire hydrant installations system design, installation and commissioning (AS 2419.1:2021).
Section D Reconfiguring a lot (RaL) – where creating additional lots for the purpose of residential development and a reticulated water supply is not provided		
PO9 The subdivision layout provides for perimeter roads or fire trail and working areas that are accessible by the type of fire-fighting vehicles servicing the area, to facilitate emergency access and operational space for fire-fighting, maintenance works and hazard reduction activities.	**AO9** The subdivision layout includes: a. a fire trail and working area designed and constructed in accordance with the design parameters in Table 6 that separates the residential lot or development footprint plan from adjacent mapped medium, high or very high potential bushfire intensity areas; or b. a perimeter road designed and constructed in accordance with AO8.1. Refer Figure 6.	**<u>Not Applicable</u>** The development is to provide connection to mains water supply.
 *Figure 6 – Siting of fire trail and working area*		
Section E Material change of use		
PO10 Site layout achieve an acceptable or tolerable risk to people. Landscape or open space provided as part of the development:	**AO10.1** Site layout places the landscape and open spaces within the site between premises and adjacent mapped medium, high or very high	**<u>Compliant</u>** All proposed lots adjacent to an area of assessable bushfire hazardous vegetation within this assessment

a. acts as a buffer between hazardous vegetation and development; and b. does not create additional bushfire prone areas. Note – An applicant may seek to undertake a site-level verification of the location and nature of hazardous vegetation and resulting potential bushfire intensity levels, for example where changes in foliage have occurred (e.g. as a consequence of adjoining permanent urban development) or where an applicant seeks to verify the regional ecosystem map inputs. This verification should form part of a bushfire hazard assessment in accordance with the methodology in the QFES Bushfire resilient communities document. The outcomes of this assessment can demonstrate how an alternate solution to the acceptable outcome can deliver an acceptable or tolerable level of risk.	potential bushfire intensity areas. Refer Figure 7. **AO10.2** This landscaping and open space comprises protective landscape treatments that: a. comprise only low threat vegetation, including grassland managed in a minimal fuel condition, maintained lawns, golf courses and cultivated gardens; or b. are designed to ensure a potential available fuel load is maintained at less than 8 tonnes/hectare in aggregate and that fuel structure remains discontinuous. Note – Minimal fuel condition means there is insufficient fuel available to significantly increase the severity of the bushfire attack, for example short-cropped grass to a nominal height of 10 centimetres.	have been sited to ensure a suitable buffer is in place through the implementation of a road network or APZ if required. This will allow all proposed residential and community centre lots to be exposed to less than 29 kW/m^2; and vulnerable uses to be exposed to less than 10 kW/m^2 (Figure 4-2 and Figure 5-2) Landscaping within the site, including areas mapped as low hazard vegetation, such as local linear park, local recreation park, neighbourhood recreation park, neighbourhood sports park, and pedestrian links, (refer to section 3.3 and 5.1.1 of this BMP) should utilise plant species that do not exacerbate the level of bushfire threat. The landscaping design within the proposed development must not constitute a bushfire threat and should be in line with Statement of Landscape Intent (Urbis 2024). The Landscape Concept Design prepared by Project Urban (Revision E -09/08/2024) was reviewed by Covey and is in line with the bushfire landscaping guidelines detailed in section 5.4 of the BMP.
 *Figure 7 – Siting of protective landscape treatments*		
PO11 The development establishes evacuation areas, to achieve an acceptable or tolerable risk to people.	**AO11** If in an isolated location, development establishes direct access to a safe assembly/evacuation area. Note – Guidance on identifying safe evacuation areas is contained in the QFES Bushfire resilient communities document.	**Not Applicable** The proposed development is not situated in an isolated area. However, both the proposed state primary, high school and private schools and sports park are outside the bushfire hazard zone and would serve as safe locations for assembly or evacuation if needed.
PO12 If on a lot of over 2000m^2, where involving a new premises or an existing premises with an increase in development footprint, development: a. locates occupied areas as close as possible to property entrances to facilitate safe evacuation during a bushfire event; and b. ensures vehicular access is located and designed to allow safe	**AO12** No acceptable outcome is prescribed.	**Not Applicable**

evacuation of the site by occupants and maintain access by emergency services under critical event conditions.		
PO13 Development is located within a reticulated water supply area or includes a dedicated static water supply that is available solely for fire-fighting purposes and can be accessed by fire-fighting vehicles. Note – Swimming pools, farm ponds and dams are not considered reliable sources of static water supply in Queensland due to regular drought events. [Note for Local Government – Information on how to provide an appropriate static water supply, may form a condition of a development approval. For further information on preferred solutions refer to the QFES Bushfire resilient communities document.]	**AO13** No acceptable outcome is prescribed.	**Compliant** The proposed development will be conditioned to provide connection to mains water supply, with provision of a piped water network capable of supplying sufficient flow and pressure for fire-fighting purposes. Provision will be made to connection to water mains supply, with suitable allocation of fire-fighting infrastructure (hydrants) in accordance with the local water retailer's specifications and the Australian Standard – Fire hydrant installations system design, installation and commissioning (AS 2419.1:2021).
PO14 Vulnerable uses listed in Table 7 are not established or intensified within a bushfire prone area unless: a. there is an overriding need in the public interest for the new or expanded service the development provides; and b. there are no other suitable alternative locations within the required catchment; and c. site planning can appropriately mitigate the risk (for example, siting ovals for an educational establishment between the hazardous vegetation and structures. Note – The preparation of a bushfire management plan in accordance with the methodology in the QFES Bushfire resilient communities document may assist in demonstrating compliance with this performance outcome.	**AO14** No acceptable outcome is prescribed	**Not Applicable** The proposed lots dedicated to childcare, state primary school, and private school (vulnerable uses) are exposed to less than 10 kW/m^2 (calculated with an input 1,200°K flame temperature). Note that, the 10 kW/m^2 RHF isoline infiltrates the State High school lot boundary by approximately 2.3 m. Based on the Residential Development Controls (RSP 2024), it is expected that the frontage setback building envelope will ensure exposure RHF levels lower than 10 kW/m^2 (Figure 5-1). All proposed lots adjacent to an area of assessable bushfire hazardous vegetation within this assessment have been sited as to ensure a suitable buffer is in place through the implementation of a road network or APZ if required.
PO15 Community infrastructure providing essential services listed in Table 7 are not established within a bushfire prone area unless: a. there is an overriding need in the public interest for the new or expanded service the development provides (for example, there are no other suitable alternative locations that can deliver the required level of service or meet emergency service response times during and immediately after a bushfire event); and	**AO15** No acceptable outcome is prescribed.	**Not Applicable** The proponent has indicated that proposed community centres (including Local, District, Neighbourhood Community Centres) are largely intended for commercial uses such as shops, amenities and food and drink outlet. Any community infrastructure providing essential services is to be exposed to less than 10 kW/m^2 (calculated with an input 1,200°K flame temperature).

b. the infrastructure can function effectively during and immediately after a bushfire event. Note – The preparation of a bushfire management plan in accordance with the methodology in the QFES Bushfire resilient communities document may assist in demonstrating compliance with this performance outcome.		
PO16 Development avoids or mitigates the risks to public safety and the environment from the manufacture or storage of materials listed in Table 7 that are hazardous in the context of bushfire to an acceptable or tolerable level. Note – The preparation of a bushfire management plan in accordance with the methodology in the *QFES Bushfire resilient communities* document may assist in demonstrating compliance with this acceptable outcome. Editor's note – In addition to the requirements of this code the *Work Health and Safety Act 2011* and associated Regulation and Guidelines, the *Environmental Protection Act 1994* and the relevant building assessment provisions under the *Building Act 1975* contain requirements for the manufacture and storage of hazardous substances. Information is provided by Business Queensland on the requirements for storing and transporting hazardous chemicals, available at: www.business.qld.gov.au/running-business/protecting-business/risk-management/hazardous-chemicals/storing-transporting.	**AO16** No acceptable outcome is prescribed.	**Not Applicable** The proposed development does not involve from the manufacture or storage of hazardous materials from a bushfire perspective.
Section F Where involving an asset protection zone		
PO17 Asset protection zones are designed and managed to ensure they do not increase the potential for bushfire hazard. Note – The preparation of a landscape management plan undertaken in accordance with the methodology in the QFES Bushfire resilient communities document may assist in demonstrating compliance with this performance outcome.	**AO17.1** Landscaping treatments within any asset protection zone comprise only low threat vegetation, including grassland managed in a minimal fuel condition, maintained lawns, golf courses, maintained public reserves and parklands, vineyards, orchards, cultivated gardens, commercial nurseries, nature strips and windbreaks. Note – Minimal fuel condition means there is insufficient fuel available to significantly increase the severity of the bushfire attack, for example short-cropped grass to a nominal height of 10 centimetres. OR	**Not Applicable** Landscaping within the site, including areas mapped as low hazard vegetation, such as local linear park, local recreation park, neighbourhood recreation park, neighbourhood sports park, and pedestrian links, (refer to section 3.3 and 5.1.1 of this BMP) should utilise plant species that do not exacerbate the level of bushfire threat. The landscaping design within the proposed development must not constitute a bushfire threat and should be in line with Statement of Landscape Intent (Urbis 2024). The Landscape Concept Design prepared by Project Urban (Revision E -09/08/2024) was reviewed by Covey and is in line with the bushfire landscaping guidelines detailed in section 5.4 of the BMP.

	AO17.2 Landscaping management within any asset protection zone maintains a: a. potential available fuel load which is less than eight tonnes/hectare in aggregate; and b. fuel structure which is discontinuous. Note – The preparation of a landscape management plan undertaken in accordance with the methodology in the QFES Bushfire resilient communities document may assist in demonstrating compliance with this acceptable outcome.	Six Asset Protection Zones (APZ) must be implemented within proposed drainage/landscaped areas per Figure 5-2 to reduce the RHF exposure of the issue lots (3834, 6715 - 6717, 6197 – 6208, 6223 – 6209, 6244, 2646 – 6249, 8021) to SPP acceptable levels. Within APZ, vegetation should be modified and/or maintained to reduce fuel load and mechanisms of bushfire attack such as flame and radiant heat. Specifically, APZs are to ensure that building envelopes are exposed to less than 29 kW/m2 in perpetuity. The APZs are to follow the Bushfire Landscaping Guidelines detailed in section 5.4.
Section G Where planning provisions or conditions of approval require revegetation or rehabilitation		
PO18 Revegetation or rehabilitation areas are designed and managed to ensure they do not result in an unacceptable level of risk or an increase in bushfire intensity level. Note – The undertaking of a bushfire hazard assessment in accordance with the methodology in the QFES Bushfire resilient communities document may assist in demonstrating compliance with this performance outcome.	AO18.1 Required revegetation or rehabilitation: a. is located outside of any asset protection zone; or b. maintains a potential available fuel load which is less than eight tonnes/hectare in aggregate and fuel structure which is discontinuous. Note – The preparation of a landscape management plan undertaken in accordance with the methodology in the QFES Bushfire resilient communities document may assist in demonstrating compliance with acceptable outcome (b). **AO18.2** Revegetation or rehabilitation of areas located within mapped medium, high or very high potential bushfire intensity areas, revegetate and rehabilitate in a manner that maintains or reduces the existing fuel load. OR Revegetation or rehabilitation of areas located within the mapped potential impact buffer area, revegetate and rehabilitate in a manner that maintains or reduces the existing fuel load. Note – The preparation of a vegetation management plan undertaken in accordance with the methodology in the QFES Bushfire resilient communities document may assist in demonstrating compliance with this acceptable outcome.	**Compliant** The rehabilitation plan detailed by SMEC (2023) was taken in consideration in the preparation of this BMP. The proposed development incorporates appropriate setbacks from the potential bushfire hazard arising from rehabilitated areas (Figure 4-2).

7 Conclusion

The site is subject to a high potential bushfire intensity and medium potential bushfire intensity per BPA specific to Aura Lakes context plan (Section 3 of BMP). This BMP detailed the bushfire hazards to which the development is exposed and the bushfire mitigation measures required to be implemented to reduce the risk to acceptable levels per *Natural Hazards, Risk and Resilience, State Planning Policy State Interest guidance material* (Queensland Government, 2019) and BRC. Specifically, this report outlines the required bushfire mitigation measures required for the development to satisfy Bushfire Overlay Code Assessment Benchmarks (Section 5 and 6 respectively). Provided the bushfire mitigation measures detailed in this BMP are implemented, the bushfire hazard level, bushfire-related risk level and RHF level applicable to the proposed development are not considered unreasonable and should not prohibit the development of the site.

This BMP focused solely on bushfire-related risk and mitigation strategies, and further investigations, such as an engineering services report or ecological assessments, might be required to support a development application.

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Appendix A

Layout and Context Plan (RSP 2024)

Legend

- Application Boundary
- Adjoining Approval - DEV2023/1458
- Lifestyle Buffer

Land Uses

- Town Square
- District Centre
- Neighbourhood Centre
- Neighbourhood Meeting Room
- District Community Centre
- Local Community Centre
- State High School
- State Primary School
- Emerging Community
- Private School
- Child Care
- Medium Density
- Conservation Open Space
- Drainage Open Space
- District Sports Park
- District Recreation Park
- District Linear Park
- Neighbourhood Recreation Park
- Local Recreation Park
- Local Linear Park
- Embellishment (Road Reserve)

Lot Type

Other

- Urban Warehouse - 12m x 14m
- Fonzie Front - 8m x 25m
- Fonzie Back (Micro Unit) - 4.7m x 11.5m
- Urban Mini Micro - 4.5m x 12m
- Urban Loft Type A - 8.5m x 12m
- Urban Loft Type B - 8.2m x 12m
- Urban Loft Type C - 8.3m x 12m
- Urban Loft Type D - 7.5m x 12m
- Urban Loft Type E - 8.5m x 12m
- Bower Type A - 6.5m x 15m
- Bower Type B - 8.5m x 15m
- Bower Type C - 6.5m x 15m

16.5m Deep

- Rear Loaded Laneway Terrace - 4.6m Wide
- Rear Loaded Laneway Terrace - 6.6m Wide
- Rear Loaded Laneway Terrace - 6.6m+ Wide (Ends)

21m Deep

- Rear Loaded Laneway Terrace - 4.6m Wide
- Rear Loaded Laneway Terrace - 6.6m Wide
- Rear Loaded Laneway Terrace - 6.6m+ Wide (Ends)
- Front Loaded Terrace - 7.5m Wide
- Front Loaded Terrace - 9m+ Wide (Ends)

25m Deep

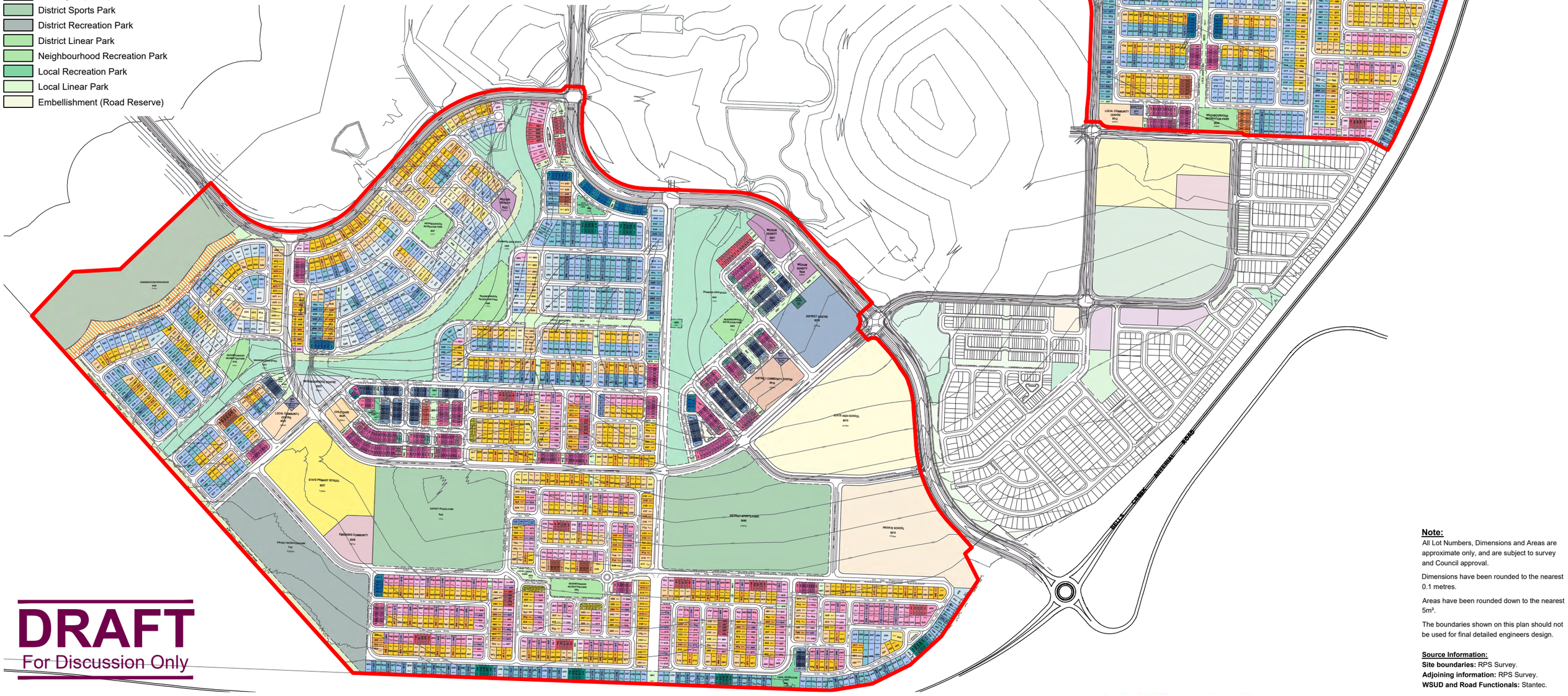
- Rear Loaded Laneway Terrace - 4.6m Wide
- Rear Loaded Laneway Terrace - 6.6m Wide
- Rear Loaded Laneway Terrace - 6.6m+ Wide (Ends)
- Front Loaded Terrace - 7.5m Wide
- Front Loaded Terrace - 9m+ Wide (Ends)
- Villa - 10m Wide
- Premium Villa - 12.5m Wide
- Courtyard - 14m Wide
- Traditional - 16m Wide
- Premium Traditional - 18m Wide

28m Deep

- Rear Loaded Laneway Terrace - 4.6m Wide
- Rear Loaded Laneway Terrace - 6.6m Wide
- Rear Loaded Laneway Terrace - 6.6m+ Wide (Ends)
- Front Loaded Terrace - 7.5m Wide
- Front Loaded Terrace - 9m+ Wide (Ends)
- Villa - 10m Wide
- Premium Villa - 12.5m Wide
- Courtyard - 14m Wide
- Traditional - 16m Wide
- Premium Traditional - 18m Wide

30m Deep

- Front Loaded Terrace - 7.5m Wide
- Front Loaded Terrace - 9m+ Wide (Ends)
- Villa - 10m Wide
- Premium Villa - 12.5m Wide
- Courtyard - 14m Wide
- Traditional - 16m Wide
- Premium Traditional - 18m Wide



DRAFT
For Discussion Only

Note:
All Lot Numbers, Dimensions and Areas are approximate only, and are subject to survey and Council approval.

Dimensions have been rounded to the nearest 0.1 metres.

Areas have been rounded down to the nearest 5m².

The boundaries shown on this plan should not be used for final detailed engineers design.

Source Information:
Site boundaries: RPS Survey.
Adjoining information: RPS Survey.
WSUD and Road Functionals: Stantec.

PLAN REF: AU12885 – 53
Rev No: –
DATE: 29 OCTOBER 2024
SHEET: 1 OF 15
DRAWN BY: JC
CHECKED BY: MD

0 90 180 270 360 450 **1 : 9,000 @ A3**

AURA LAKES
PROPOSAL PLAN
PRECINCT 17 (PART), PRECINCT 18 (PART) & PRECINCT 19

Stockland
AURA

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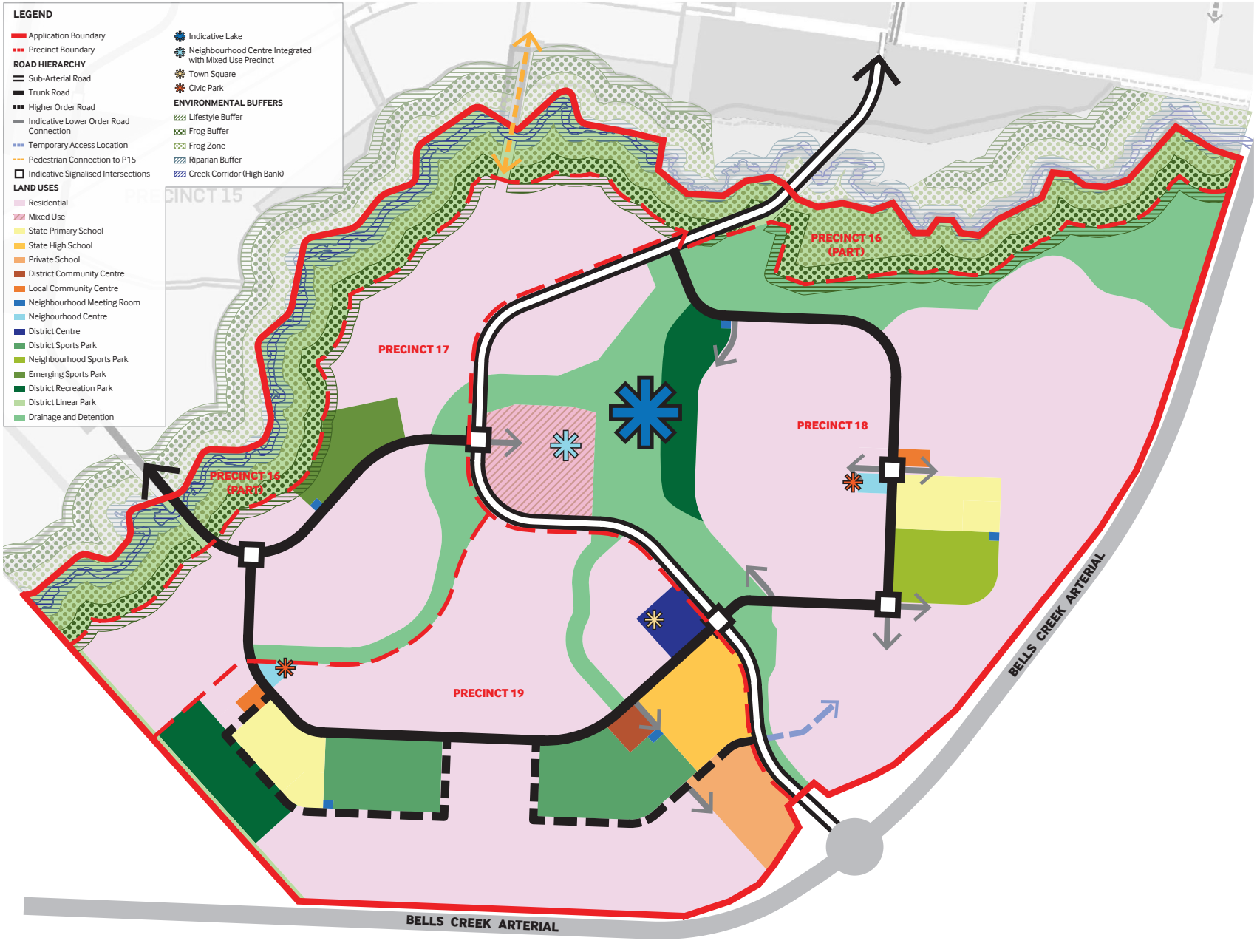

0 20 40 60 80 120 1 : 5,000 @ A1

AURA LAKES
SITE CONTEXT PLAN
P17, P18 & P19

PLAN REF: AU12885-14B
DATE: 22 MARCH 2024
CLIENT: STOCKLAND
DRAWN BY: MD / JC
CHECKED BY: MD / PHE

DISCLAIMER

The contents of this plan are conceptual and for discussion purposes only. All areas and dimensions are approximate and subject to relevant studies, survey, engineering and Council approval.

The information used in this plan is drawn from the following sources:

Site Boundaries: Urbis & RPS Survey.
Adjoining Context Area Information: Urbis.
Environmental Buffers: RPS Survey.

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Appendix B

Site Assessment Photos

Photo Point 1 – VHC 22.1	*Photo Point 2 – VHC 22.1 - creek line*

Photo Point 3 – VHC 29.3

Photo Point 3 – VHC 29.3

Photo Point 4 – VHC 9.1

Photo Point 5 – VHC 9.1 creek line	***Photo Point 6 – VHC 9.1***

Photo Point 7 – VHC 9.1

Photo Point 8 – VHC 36.1 (from afar)

Photo Point 9 – VHC 29.3

Appendix C

Inferno-BAL

Inferno-BAL is a module of the Inferno geospatial system designed by Covey Associates, to calculate radiant heat flux and Bushfire Attack Level (BAL) from Method 2 in the AS3925 standard. Rather than calculating radiant heat flux at a single point, Inferno-BAL assesses heat flux at each point within a given area. This allows contours of radiant heat flux to be determined, as well as the maximum potential radiant heat flux and subsequent BAL level over plots and structures. The system is designed to work over very large areas (10s of kilometres) at high spatial resolution (meter scale). All intensive computations utilise graphics processing units (GPUs) where possible allowing the rapid calculation of radiant heat flux over these large spatial scales. The system also utilises a server-driven approach where calculations can be queued until resources are available, then data delivered on request.

The heat flux calculations require the following to determine flame length:

- the vegetation characteristics, i.e., fuel type and fuel load;
- the distance to the vegetation patch;
- the site slope between the calculation point and the vegetation patch; and,
- the effective slope under the vegetation influencing the fire behaviour.

To obtain the above information, Inferno-BAL requires the following inputs:

- a digital elevation map, giving the vertical height above a given datum, and
- a geo-located vector data set consisting of flammable vegetation polygons.
  Each vegetation polygon, or patch, must encode total and surface fuel loads, and fuel type (Forest, Woodlands, Shrublands, Scrub, Mallee, Rainforest, Moorlands or, Grassland – per AS 3959). This can be encoded as a field within the polygon data, or the values can be populated using a code from an auxiliary table.

If required, an additional vector data set representing building envelopes can be included in the model to obtain the aggregate maximum radiant heat flux over spatially specified polygons.

Pre-Processing

Given that (1) radiant heat flux calculations are computationally intensive and (2) Inferno-BAL was designed to be able to calculate radiant heat flux over entire Local Government Areas, each combination of fuel load and fuel type is categorised and the RHF calculations are run only on nearest vegetation type/load combination. Specifically, the software undertakes the following pre-processing actions:

1. Verify the input layers;
2. Rate-of-spread model and fuel load values are populated for each vegetation patch.
   Any patches with an un-burnable fuel type are removed (e.g., VHC 43.6 waterbodies).
3. All combination of fuel type and fuel load are categorised, and each combination assigned an ID.
4. For each unique ID the polygon nearest to the calculation point, is used in radiant heat flux calculations.

An example of this categorisation is shown in Figure 1. The four vegetation patches depicted are classified as ID 1 (Grass fuel type of 1 t/ha fuel load), ID 2 (Grass fuel type of 0.5 t/ha fuel load, and ID 3 (Forest fuel type of 10 t/ha). The radiant heat flux calculation is performed three times, one for each of the nearest ID patches. In this case, the grass patch of ID 1 located at a greater distance from the calculation point (shown with a dashed line) is not included in the radiant heat flux model.

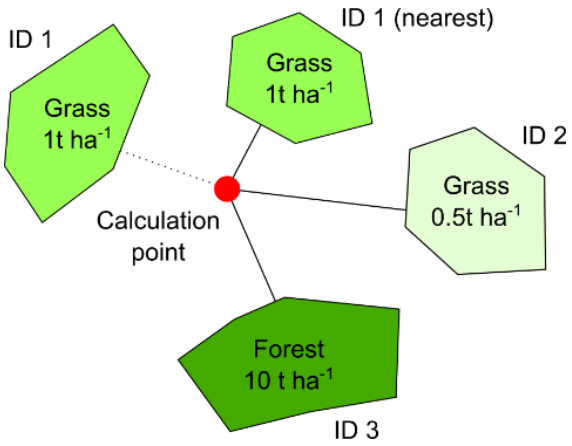

Figure 1 – Pre-processing of vegetation.

Note that this methodology may, in very marginal cases, result in a potential underestimation of radiant heat flux. This would only occur if ID patches at further distances were located on very steep terrain. This shortcoming will be addressed in future revisions of the system.

Distance Calculation

The distance is determined by searching for the point on the nearest edge over all polygons surrounding the calculation point. Once this nearest point is found the direction and distance to the patch can be found from the vector connecting the calculation point to the point on the edge (as shown by the arrow in Figure 2).

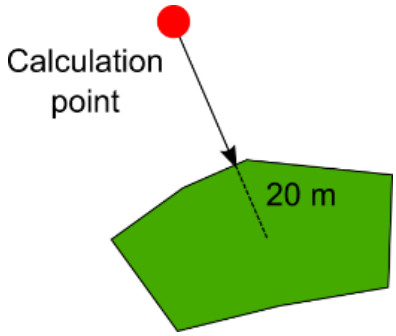

Figure 2 - Path to assess effective slope.

Site Slope Calculation

The site slope is calculated using the arctangent of the difference in elevation over the vector divided by the length of the vector. The site slope is clamped from -20 to 20 degrees, as in the AS3959 Method 2 standard.

Effective Slope Calculation

The effective slope is determined by extending a path 20 m into the vegetation patch (as shown by the dashed line in Figure 2) and calculating the slope over this path, per the method used in site slope calculations. The effective slope is clamped from -15 to 30 degrees, as in the AS3959 Method 2 standard.

Radiant Heat Flux calculation

The encoded vegetation characteristics from the vegetation vector layer are then used to determine which of the eight AS 3959 rate-of-spread models to adopt. From each of these a model for flame length is used (which may depend on an intermediate fire intensity empirical model for some fuel types, as in the AS3959 standard Eqns. B3, B4 and B5). The flame length is then used in the AS3959 iterative process to determine the flame angle giving the view factor, and hence maximum radiant heat flux, at the calculation point. This step involves some significant assumptions as outlined in the AS3959 standard, including the application of an empirical model for the atmospheric transmissivity (Eq. B9) and use of formula for view factor assuming a rectangular flame with a fixed width (Eq. B8 of AS 3959).

This process is repeated for each of the vegetation IDs and the maximum value over all these calculations is used as the final value of the radiant heat flux. The final steps in the process are to find the maximum radiant heat flux in each polygon plot, if supplied, and to categorise these into the BAL levels and to generate the vector isolines of the radiant heat flux.

Appendix D

NCC certain Class 9 Buildings

The proposed Woombye Care Facility would be considered a *residential care building* classified as a Class 9c building within the National Construction Code (NCC) Building Code of Australia (2022). Class 9c buildings describe residential care facilities that accommodate residents with a mix of low and high care needs (National Construction Code, 2019). Five BAL standards (BAL-FZ, BAL-40, BAL-29, BAL-29 and BAL-12.5) calculated per AS 3959 trigger specific construction requirements under the Building Code of Australia. Further, certain Class 9 buildings are subject to additional bushfire protection requirements. This Appendix replicates relevant sections of the NCC , particularly focusing on deem-to-satisfy solutions.

Part G5 Construction in bushfire prone areas

G5O1 Objective

The Objective of this Part is to—

(a) safeguard occupants from injury from the effects of a bushfire; and
(b) protect buildings from the effects of a bushfire; and
(c) facilitate temporary shelter for building occupants who may be unable to readily evacuate the building prior to a bushfire.

Applications

(1) G5O1(a) and (b) apply in a designated bushfire prone area to—
  (a) a Class 2 or 3 building; or
  (b) a Class 10a building or deck associated with a Class 2 or 3 building.
(2) G5O1(a), (b) and (c) apply in a designated bushfire prone area to—
  (a) a Class 9a health-care building; and
  (b) a Class 9b—
    (i) early childhood centre; and
    (ii) primary or secondary school; and
  (c) a Class 9c residential care building; and
  (d) a Class 10a building or deck immediately adjacent or connected to a building of a type listed in (a) to (c).

G5P2 Additional bushfire requirements for certain Class 9 buildings

A building that is constructed in a designated bushfire prone area and occupied by people who may be unable to readily evacuate the building prior to a bushfire must, to the degree necessary—

(a) (a)reduce the risk of an untenable indoor environment for occupants during a bushfire event, appropriate to the—
  (i) location of the building relative to fire hazards, including—
    (A) classified vegetation; and
    (B) adjacent buildings, structures and movable objects; and
    (C) carparking areas and allotment boundaries; and
    (D) other combustible materials; and
  (ii) number of occupants to be accommodated within the building; and
  (iii) intensity of bushfire attack on the building; and
  (iv) duration of occupancy; and
  (v) intensity of potential consequential fires; and

(vi) occupant tenability within the building before, during and after the bushfire event; and

(vii) (vii)combined effects of structural, fire exposure and other effects to which the building may reasonably be subjected; and

(viii) provision of fire fighting equipment and water supply to facilitate protection of the building; and

(b) be provided with vehicular access to the site to enable firefighting and emergency personnel to defend or evacuate the building; and

(c) have access to a sufficient supply of water for firefighting purposes on the site; and

(d) provide safe access within the site to the building (including carparking areas), as well as safe egress after the bushfire event.

Applications

G5P2 applies to the following buildings located in a designated bushfire prone area—

(a) a Class 9a health-care building; and

(b) a Class 9b—

(i) early childhood centre; and

(ii) primary or secondary school; and

(c) a Class 9c residential care building; and

Notes

For a building that is subject to G5P2, and therefore outside the scope of G5V1, the building would need to comply with either—

(a) Performance Requirement G5P2 by means of a Performance Solution; or

(b) the Deemed-to-Satisfy Provisions of G5D4 if the building is located in an area subject to a Bushfire Attack Level (BAL) not exceeding BAL – 12.5.

Deemed-to-Satisfy Provisions

G5D4 Protection – certain Class 9 buildings

(1) In a designated bushfire prone area, the following must comply with Specification 43:

(a) a Class 9a health-care building; and

(b) a Class 9b—

a. early childhood centre; and

b. primary or secondary school; and

(c) a Class 9c residential care building; and

(2) In a designated bushfire prone area, a Class 10a building or deck immediately adjacent or connected to a building of a type listed in (1) must comply with S43C2 and S43C13.

Deemed-to-Satisfy Provisions

Specification 43 – Bushfire Protection for Certain Class 9 Buildings

The following section outline the additional bushfire protection measures required within Specification 43 of the NCC Building Code of Australia (National Construction Code, 2019).

S43C2 Separation from classified vegetation

(1) The building must be separated from classified vegetation –
   a. By not less than the minimum distance specified in Table S43C2; or
   b. Such that radiant heat flux on exposed building elements will not exceed 10 kW/m^2.

(2) For the purposes of (1), the term 'classified vegetation' has the meaning that it has in AS 3959.

Table S43C2: Minimum distance of building to classified vegetation

Vegetation Classification	Slope	Minimum distance (m) of the building to classified vegetation
High risk	Upslope and flat land	60
High risk	Downslope max 20 degrees	110
Medium risk	Upslope and flat land	40
Medium risk	Downslope max 20 degrees	80
Low risk	Upslope and flat land	30
Low risk	Downslope max 20 degrees	50

Table Notes

(1) Table values are based on FDI of 100 in accordance with AS 3959.
(2) High risk equates to vegetation classification of forest and woodland in accordance with AS 3959.
(3) Medium risk equates to vegetation classification of scrub and rainforest in accordance with AS 3959.
(4) Low risk equates to vegetation classification of shrubland, mallee/mulga and grassland in accordance with AS 3959.

S43C3 Separation between buildings

(1) The building must be located not less than 12 m from any other building.
(2) The separation distance *required* by (1) need not be complied with if the building is constructed:
   a. With *external walls* that have an FRL of not less than 60/60/60 when tested from the outside, including any openings protected in accordance with AS 3959 for BAL – 19 or greater; or
   b. For *external walls* and roof, using a material or system that satisfies the test criteria of AS 1530.8.1 for a radiant heat flux of 10 kW/m^2 or greater.

S43C4 Separation from allotment boundaries and carparking areas

(1) The building must be located not less than 10 m from any allotment boundary or open carparking area/spots.
(2) The separation distance *required* by (1) need not be complied with if the building is constructed:
   a. With *external walls* that have an FRL of not less than 60/60/60 when tested from the outside, including any openings protected in accordance with AS 3959 for BAL – 19 or greater; or
   b. For *external walls* and roof, using a material or system that satisfies the test criteria of AS 1530.8.1 for a radiant heat flux of 10 kW/m^2 or greater.

S43C5 Separation from hazards

The *external walls* and roof of the building must be protected from potential hazards on the *site* such as liquefied petroleum gas bottles, fuel storage, storage of combustible materials, waste bins, vehicles, machinery and the like, by –

(a) A separation distance of not less than 10 m; or
(b) Where within the 10 m separation described in (a), constructed with *external walls* that have an FRL of not less than 60/60/60 when tested from the outside, including any openings protected in accordance with AS 3959 for BAL – 19 or greater; or
(c) For *external walls* and roof, using a material or system that satisfies the test criteria of AS 1530.8.1 for a radiant heat flux of 10 kW/m^2 or greater.

S43C6 Non-combustible path around building

A *non-combustible* pathway directly adjacent to the building and not less than 1.5 m wide must be provided around the perimeter of the building.

S43C7 Access pathways

(1) Access pathways that lead to a road or *open space* must:
    a. be readily identifiable; and
    b. have an even surface; and
    c. have a minimum clear width of not less than 1 m.
(2) If the access pathway is an *accessway* that is *required* to comply with Part D4, the requirements of Part D4 override (1) to the extent of any inconsistency.

S43C8 Exposed external areas

An external area designed to hold people unable to be safety accommodated within the building, that may be exposed to radiant heat flux from a fire front during a bushfire event, must not be exposed to an incident radiant heat flux from the fire from exceeding 1 kW/m^2 above background solar radiant heat flux.

S43C9 Internal tenability

To maintain internal tenability throughout the duration of occupancy during a bushfire event, the building must comply with the following:

(a) An air handling system must be provided that is capable of—
    (i) being adjusted for full recycling of internal air for a period of not less than 4 hours to avoid the introduction of smoke into the building; and
    (j) maintaining an internal air temperature of not more than 25°C.
(b) The building envelope must be designed such that if an air handling system required by (a) fails, then—
    (i) internal air temperatures can be maintained below 39°C; and
    (j) internal surface temperatures can be maintained below 60°C.
(c) If the building is divided into separate compartments then, for the purposes of (a), each compartment must have a separate air handling system.
(d) Each air handling system required by (a) must be designed to account for the activation of smoke detectors from low concentrations of smoke from external sources, so as to ensure that air-conditioning and other essential systems remain operational.

S43C10 Building envelope

The building envelope must be constructed in accordance with AS 3959 – BAL 19 or greater, except that where the use of combustible materials is permitted by AS 3959, they are not to be used unless permitted by C2D10(4), (5) or (6).

S43C11 Supply of water for fire-fighting purposes

Water for fire-fighting purposes must be available and consist of—

(a) a fire hydrant system complying with E1D2, or
(b) a static water supply consisting of tanks, swimming pools, dams or the like, or a combination of these, together with suitable pumps, hoses and fittings, capable of providing the required flow rate for a period of not less than 4 hours, determined in consultation with the relevant fire brigade.

S43C12 Emergency power supply

(1) Emergency power must be provided to support, for not less than 4 hours before and 2 hours after the passing of the fire front during a bushfire event, the ongoing operation of—
    a. air handling systems to maintain internal tenability; and
    b. any pumps for fire-fighting; and
    c. any emergency lighting and exit signs; and
    d. any other emergency equipment listed in C3D14(6) and required to be provided.
(2) Manual control for emergency back-up power supply must be provided to facilitate manual intervention where the power supply fails or runs out.

S43C13 Signage

Signage must be provided to warn building occupants against storing combustible materials under or adjacent to the building.

S43C14 Vehicular access

Vehicular access to the building must be provided in accordance C3D5(2), as if the building were a large, isolated building for the purposes of C3D4.