Report

Natural Hazard and Risk Assessment

LOCATION: DUGALD RIVER WIND FARM PROJECT

DUGALD RIVER MINE ACCESS ROAD,

CLONCURRY, QLD 4824

CLONCURRY SHIRE COUNCIL

CLIENT: ERM AUSTRALIA PTY LTD

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Version History

Version	Date	Details	Author	Reviewer
Issue A	March 2025	Draft issue of NHRA for review	MD/AG	MC
Issue B	May 2025	Final issue of NHRA for DA	MD/JM	MC
Issue C	April 2026	Response to SARA IR	AB/JM	LW

Executive Summary

Covey Associates have prepared this Natural Hazard and Risk Assessment (NHRA) focused on bushfire and flood to support the Development Application of the proposed Dugald River Wind Farm Project (the Project) located in the Cloncurry Shire Council Local Government Area.

A desktop-based fire weather, topography and bushfire fuel analysis has been conducted to inform the radiant heat flux (RHF) assessment. Additionally, a preliminary desktop flooding assessment was undertaken to investigate the existing site topography and identify critical overland flow paths to better understand the magnitude of peak stormwater flows from the critical catchments.

The output from the RHF modelling specifies the necessary distances for separation between the Project infrastructure and unmanaged Bushfire Prone vegetation, required to achieve target RHFs as follows:

- Proposed WTG and substation to achieve 29 kW/m^2 or lower (at 1090 K flame temperature)
- Proposed BESS units and Critical Infrastructure to achieve 10 kW/m^2 or lower (at 1200 K flame temperature)

The NHRA notes that based upon the extent of vegetation clearing associated with the development, there is sufficient setback distance achieved between retained vegetation and placement of proposed infrastructure. and on this basis, appropriately sized Asset Protection Zones (APZs) will need to be established around the perimeter of all WTGs, the substation and BESS containers. Covey are not aware of any specific reason why implementation of the APZs should not be achievable for the proposed development – these APZs will be identified within subsequent reporting for the planning approval.

A bushfire and flooding compliance assessment against relevant State and Local Government policies has been provided in this NHRA, which doesn't highlight any specific deviations from policy requirements.

A Bushfire Management Plan (BMP) will also accompany the development application to address the following:

- All proposed bushfire risk management measures, including proposed APZ locations and extent
- Implementation and ongoing management responsibilities for the proposed bushfire risk management measures
- Final bushfire compliance assessment against relevant State and Local Government policies

Abbreviations Used in Report

Abbreviation	Full Meaning	Abbreviation	Full Meaning
AEP	Annual Exceedance Probability	DRM	Dugald River Mine
AFAC	Australasian Fire Authorities Council	DTMR	Department of Transport and Main Roads
AFDRS	Australian Fire Danger Rating System	ERM	Environmental Resources Management (client)
APZ	Asset Protection Zones	FBI	Fire Behaviour Index
AS	Australian Standard	FFDI	Forest Fire Danger Index
AWS	Automatic Weather Station	GEV	Generalized Extreme Value
BAL	Bushfire Attack Level	IPCC	Intergovernmental Panel on Climate Change
BCA	Building Code of Australia	MCU	Material Change of Use
BESS	Battery Energy Storage System	NHRA	Natural Hazard Risk Assessment
BHOC	Bushfire Hazard Overlay Code	QFD	Queensland Fire Department (Previously known as QFES, see below)
BMP	Bushfire Management Plan	QFES	Queensland Fire and Emergency Services
BOM	Bureau of Meteorology	RFSQ	Rural Fire Service Queensland
BPA	Bushfire Prone Area	RHF	Radiant Heat Flux
BRC	Bushfire Resilient Communities (2019)	SEMP	Safety and Emergency Management Plan
CFA	Victorian Country Fire Authority	SPP	State Planning Policy
CSC	Cloncurry Shire Council	VHC	Vegetation Hazard Class
CSIRO	Commonwealth Scientific and Industrial Research Organisation	WF	Wind Farm
DF	Disturbance Footprint		

Supporting Documentation		
Document	**Prepared by**	**Provided by**
Dugald River Mine – Response Guide Bushfires	*MMG Limited 2025*	ERM, 13/02/2025
Ground-truthed Regional Ecosystem Mapping	*Wulguru Technical Services 2024*	ERM, 12/02/2025

Contents

Figures

Tables

1 Introduction

1.1 Scope

Environmental Resources Management Pty Ltd (ERM), on behalf of MMG Dugald River Pty Ltd (MMG), has commissioned Covey Associates Pty Ltd (Covey) to complete a desktop Natural Hazard Risk Assessment (NHRA) to support a Development Application for a Material Change of Use (MCU) for the proposed Dugald River Wind Farm Project (the Project).

This NHRA focuses on **Bushfire** and **Flooding** risk relative to the Project's Disturbance Footprint (DF), though bushfire risk assessment includes assessment up to 150 metres around the subject lots.

A preliminary desktop flooding review identified three locations where the DF intersects significant flow paths. Accordingly, this NHRA provides a preliminary desktop flooding assessment to inform subsequent flood impact studies.

The bushfire risk assessment will assess and identify the potential bushfire impact to the proposed development as per the State Codes relevant to the development type (Wind Farm and BESS), and by using the guidance as outlined within the Bushfire Resilient Communities Technical Guide (QFES, 2019), including the following:

- Review historical fire weather, topography and fuels (vegetation) within, and adjacent to, the Project.
- Apply RHF modelling to assess the bushfire hazard and risk relevant to the proposed development, with the assessment informed by the methodology outlined within BRC.

A Bushfire Management Plan (BMP) will also be produced to accompany the development application and will detail the required bushfire risk mitigation measures and the compliance assessment against relevant State and Local Government policies.

1.2 Development Proposal

The Project is located adjacent to the Dugald River Mine (DRM) within the Cloncurry Shire Council (CSC) Local Government Area (LGA), approximately 60 km north-west of the Cloncurry township. The DF spans across several lots within the existing DRM operational footprint (refer to Table 1-1):

Table 1-1. Subject lots included within development area

Subject lot for which development resides	
Lot Number	**Plan Number**
92	SP353339
93	SP353339
36	AP23793

The Project is proposing the installation of the following infrastructure within the DF (refer to Figure 1-1) upon completion of development:

- 24 Wind Turbine Generators (WTGs)
- BESS yard containing
    - 66 BESS containers (total) producing up to 123 Megawatts (MW)
        - Stage 1: 18 BESS containers producing 36 MW
        - Stage 2: 48 BESS containers producing 87 MW
    - 33 Medium Voltage Power Stations (MVPS)
        - Stage 1: 9 MVPs
        - Stage 2: 24 MVPs
    - 4 switch-rooms
    - Office/control room and workshop/storage containers connected by a Dome shelter
    - Backup genset and auxiliary transformers
    - Harmonic filter enclosures
    - Internal access ways and fencing
- A new substation/switchyard collocated with the BESS yard containing:
    - 2 Transformers (220/33 kV)
    - Switchgear
    - Fencing
    - Overhead and buried powerlines
- Ancillary infrastructure including:
    - Meteorological masts
    - Internal roads
    - Firewater tank

The Project is expected to be delivered in two stages with the following infrastructure proposed in Stage 1, and the balance to be delivered in Stage 2:

- 8 Wind Turbine Generators (WTGs)
- Within the BESS yard
    - 18 BESS containers
    - 9 MVPS
    - 2 switch-rooms
    - Office/control room and workshop/storage containers connected by a Dome shelter
    - Backup genset and auxiliary transformers
    - Harmonic filter enclosures
    - Internal access ways and fencing
- 1 Transformer (220/33 kV) and associated switchgear in the substation
- Associated overhead powerlines, meteorological masts and internal roads
- Firewater tank

It is understood that the proposed WF and BESS development will operate in conjunction with the existing DRM mine operations, and once operational the following is expected:

- There will no permanent onsite staff, with attendance to the facility expected to be for periodic maintenance undertaken on a scheduled, or as needed basis.
- The facility will have 24/7 monitoring conducted onsite staff at the mine, and offsite by remote staff, with personnel able remotely manage BESS and wind turbine functionality.

In addition to the above, the following may expect to be required during construction phase), which will be temporary uses that are expected to be revegetated upon completion of construction:

- Laydown areas,
- Compound areas,
- Temporary site office,
- Concrete batching plant/s.

1.3 Site Overview

The majority of the Project (refer to Figure 1-1) is located on the Knapdale Range located to the west of the existing Dugald River Mine (DRM). Stage 2 of the Project extends north and south from the central area of the Knapdale Range with access to the northern section via the DRM Accommodation Camp, which itself is 2.25 km north-west of the mine.

The DF is oriented in a north-south direction along the Knapdale Range and is approximately 12 km in length. The majority of the DF has not been previously cleared of vegetation, which is predominately Low open eucalyptus woodlands however there are existing areas of disturbance associated with mining and exploration activities and the existing Tailings Storage Facility (TSF) for the DRM.

Existing vehicular access to the Project is via the DRM, from the Dugald River Mine Access Road which connects to Burke Developmental Road located to the east of the DF. An existing road also provides access to the Project via the DRM Accommodation Camp.

The existing DRM is serviced by a reticulated potable water line from Sunwater, which supplies water from the Ernest Henry and Lake Julius pipeline to an onsite raw water dam with a capacity of 24 ML. Additionally, the DRM and Accommodation Camp sites which have a combined capacity of 1,000,000 L of firewater, with the Accommodation Camp understood to have a 240 kL firewater tank, with a fire pump.

In addition to the existing firewater supplies above, the DRM also has the following equipment:

- two onsite fire appliances (with 2 kL capacity), and
- one mine water cart with 10 kL capacity.

The TSF is located to the north of the Knapdale Range; however, it is noted that this is unsuitable for use in firefighting due to the presence of heavy metals and a low pH.

1.4 Bushfire Planning Context

1.4.1 Technical Documents

This NHRA draws on the following bushfire compliance technical references:

- The State of Queensland. (2017). State Planning Policy.
- Queensland Government. (2019). Natural hazards, risk and resilience – Bushfire. State Planning Policy – state interest guidance material.
- Queensland Government. (2021). Natural hazards, risk and resilience state interest – Bushfire. Example, planning scheme assessment benchmarks.
- Queensland Fire and Emergency Services (QFES). (2019). Bushfire Resilient Communities. Technical Reference Guide for the State Planning Policy State Interest 'Natural Hazards, Risk and Resilience-Bushfire'.

The project BMP is also expected to reference the following bushfire compliance documents:

- Department of State Development, Infrastructure and Planning (2025). State Code 23 – Wind Farm Development, State Development Assessment Provisions v3.5
- Department of State Development, Infrastructure and Planning (2025). Planning Guideline: State Code 23 – Wind Farm Development,
- Department of State Development, Infrastructure and Planning (2025). State Code 27: Battery storage facility development. State Development Assessment Provisions v3.5
- Department of State Development, Infrastructure and Planning (2025). Planning Guideline: State Code 27: Battery storage facility development.
- Cloncurry Shire Council Planning Scheme Version 2 (2017) including Bushfire Hazard Overlay Code
- Country Fire Authority (2023) – *Design Guidelines and Model Requirements: Renewable Energy Fire Safety*,
- Standards Australia (2018) – AS 3959:2018 *Construction of buildings in bushfire-prone areas*,

Detail on select documents is provided in the sections below.

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

The State Planning Policy (SPP) is a key component of Queensland's planning system and expresses the state's interests in land use planning and development to secure a liveable, sustainable and prosperous Queensland.

The 'SPP - Natural hazards, risk and resilience state interest – Bushfire', is guidance material prepared primarily to support the implementation of the SPP and the interpretation of the *Natural hazards, risk and resilience* state interest, specifically for bushfire hazard. The guidance material addresses each of the state interest policy subparts and assessment benchmarks individually, in addition to mapping requirements. Accompanying the 'SPP - Natural hazards, risk and resilience state interest – Bushfire', is the Bushfire Resilient Communities: Technical Reference Guide (BRC), which provides technical guidance and the policy positions of Queensland Fire and Emergency Services (QFES) regarding the consideration of bushfire hazard as part of land use planning and development activities including the following:

- Outlines factors affecting bushfire hazard and potential bushfire risks and impacts
- Outlines the methodology used to prepare the statewide mapping of bushfire prone areas included in the State Planning Policy Interactive Mapping System (SPP IMS)

- Provides technical guidance on procedures for:
  - Reviewing SPP IMS bushfire prone area mapping
  - Undertaking a Bushfire Hazard Assessment (BHA) and Vegetation Hazard Class Assessment
  - Calculating asset protection zone provisions
  - Preparing a Bushfire Management Plan and Landscape Maintenance Plan
- Provides additional information to inform development conditions
- Guides the identification of suitably qualified people for assessments identified in the BRC.

1.4.3 Bushfire Prone Designation

Under the SPP – Natural Hazards, Risk and Resilience (Bushfire), a site is designated as bushfire prone if:

- 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; and/or
- If the area is shown on the State Planning Policy (SPP) Bushfire Prone Area (BPA) mapping (on the Interactive Mapping System) as a bushfire prone area.

As depicted on Figure 1-2, much the project development lots (see Table 1-1) have been identified as areas of ***Medium Potential, High Potential and Very High Potential Bushfire Intensity*** on the SPP BPA mapping, due to large tracts unmanaged woodland vegetation, typically observed in more rugged terrain (see Section 3 for more detail).

Given the development lots are designated as bushfire prone, this provides the legislative trigger to:

- Undertake a Bushfire Hazard and Risk Assessment, and
- Enforce all Building Classes to be constructed per Australian Standard (AS) 3959:2018 Construction of buildings in bushfire-prone areas (AS 3959).

1.4.4 State Development Assessment Provisions – State Codes 23 and 27

Proposals are required to respond to the following State Development Assessment Provisions, where submitting MCU development applications for facilities proposing renewable energy infrastructure:

- State Code 23 for wind farm developments
- State Code 27 for BESS developments

The aim of both State Code 23 and State Code 27 is to ensure unacceptable adverse impacts on individuals, communities and the environment do not arise because of the proposed wind farm and BESS development and assesses this through the stated purpose and a number of Performance Outcomes addressing a variety of matters, including bushfire risk management.

Further information on these will be provided in the project BMP.

1.4.5 Cloncurry Shire Council Bushfire Hazard Overlay Code

The Cloncurry Shire Council (CSC) Bushfire Hazard Overlay adopts the SPP BPA mapping, which as detailed in Section 1.4.3, designates the development lots as being bushfire prone. This designation triggers application of the CSC Bushfire Hazard Overlay Code (BHOC), which applies to all assessable development within the mapped overlay. Its purpose is to ensure development within bushfire-prone areas minimises risk to life, property, community and the environment, does not exacerbate risk beyond acceptable levels, and contributes to effective disaster management and recovery.

Further information on this will be provided in the project BMP.

1.4.6 CFA Design Guidelines for Renewable Energy Facilities

The Victorian Country Fire Authority (CFA) has developed design guidance for renewable energy facilities in their publication *Design Guidelines and Model Requirements: Renewable Energy Facilities v4* (CFA 2023). Given the lack of detailed design guidance in Queensland for managing bushfire risk to renewable energy facilities (namely Wind Farms), Covey proposes use of the CFA Design Guidelines to provide an appropriate technical benchmark.

Further information on this will be provided in the BMP prepared for the Project.

1.5 Flood Planning Context

1.5.1 SPP - Natural hazards, risk and resilience state interest –Flood

While the project site itself is not mapped as a flood hazard area under the SPP overlays, Dugald River (east of the DF) and Cabbage Tree Creek (west of the DF) are mapped as Flood Hazard Area – Level 1 (Queensland floodplain assessment overlay), informing the need for targeted flow-path assessment at crossings.

1.5.2 Cloncurry Shire Council

The site is zoned Rural under the Cloncurry Shire Planning Scheme (2017). The Flood Overlay Map (OM–3) identifies areas in the region with AEP 1%, AEP 0.2% and Interim Flood Plain Assessment. The DF is not itself mapped with a flood hazard overlay; however, within 2 km of the site, Cabbage Tree Creek (west) and Dugald River and tributaries (east) carry Interim Flood Plain Assessment mapping.

1.6 Other Relevant Documents

There are no known bushfire or flood reports or assessments that have been prepared previously for the Project.

MMG has previously prepared a Response Guide for Bushfires (2025) for the adjoining DRM which will be reviewed where relevant in the project BMP.

In addition to the existing bushfire response material detailed above, the following is also expected to be produced by others as part of the Project:

- Fire Safety Study for the BESS facility (authored by RiskCon), and
- Preliminary Emergency Management Plan for the Project (authored by RiskCon).

1.7 Document Review

This NHRA provides a point in time assessment subject to the approvals process. If the Project changes it is accepted that a revision to this Report is required.

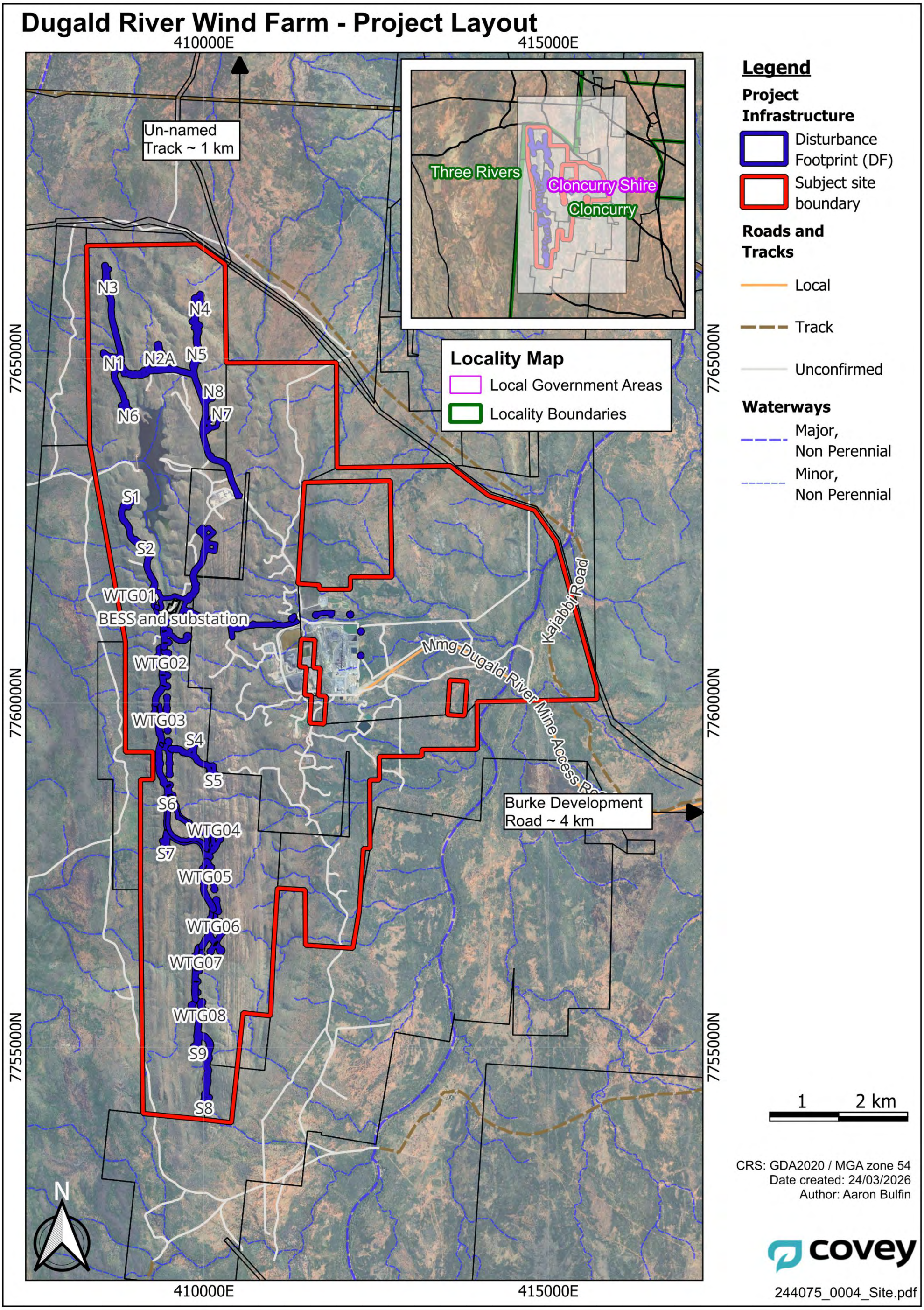


Figure 1-1. Site layout

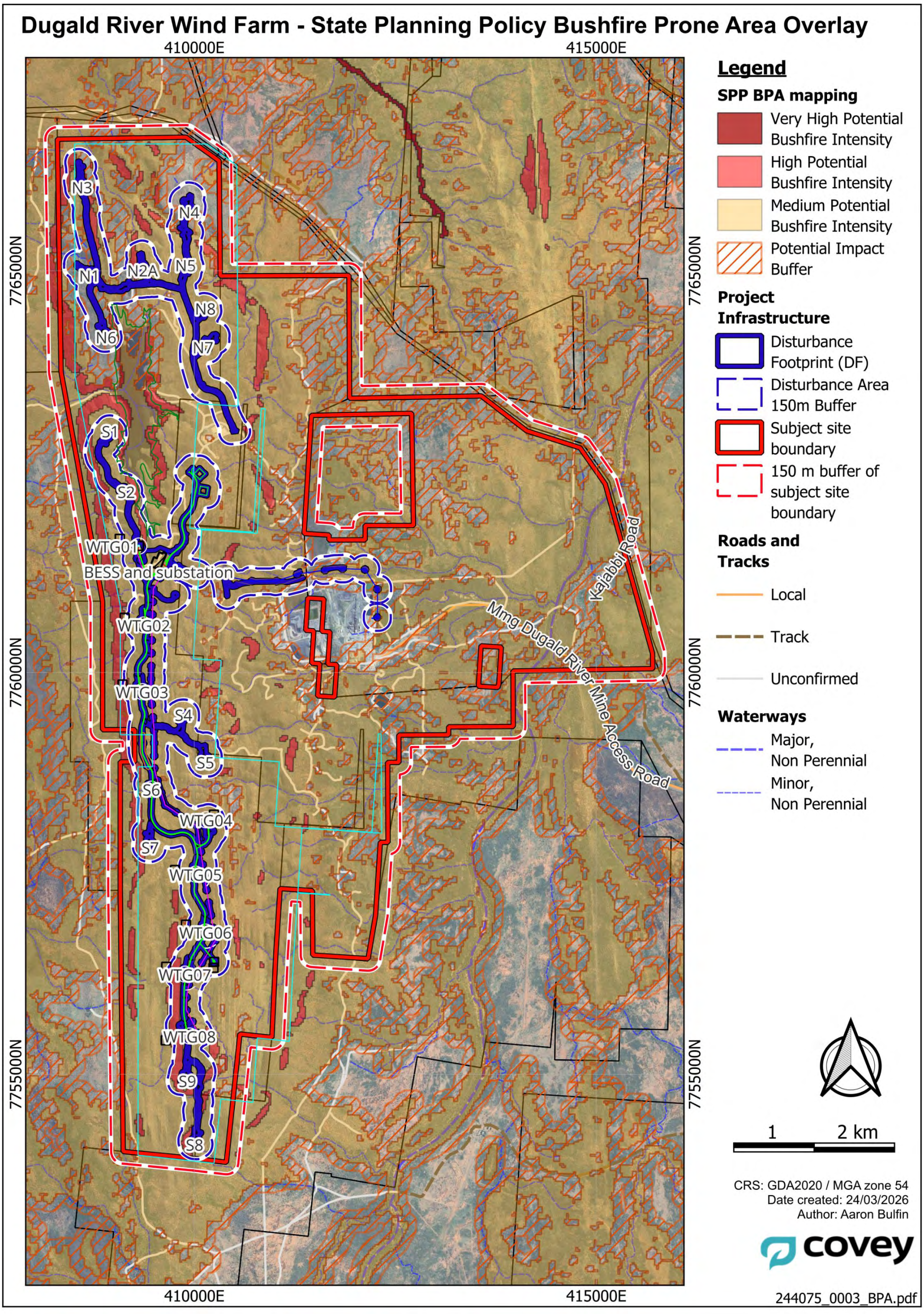


Figure 1-2. State Planning Policy Bushfire Prone Area mapping

2 Preliminary Flooding Hazard Assessment

The site does not contain any mapped flood hazard areas per State Planning Policy Mapping Overlays, however Dugald River to the east and Cabbage Tree Creek west of the DF are mapped as Flood Hazard Area – Level 1 – Queensland Floodplain Assessment Overlay as shown in Figure 2-1. Under the Cloncurry Shire Council Planning Scheme (2017) mapping, the DF itself is not mapped with any flood hazard overlays; however, the Planning Scheme Mapping of Interim Flood Plain Assessment aligns with the Flood Hazard Area – Level 1 along Cabbage Tree Creek and Dugald River.

The scope of the desktop assessment is to investigate the existing site topography to identify critical overland flow paths to better understand the magnitude of peak stormwater flows from the critical catchments.

The Project covers a disturbance footprint of approximately 135 ha which will be located within the defined DF of approximately 630 ha. It is expected that the fraction impervious within the DF will be less than 5% and the stormwater catchment discharge locations will be effectively identical to the pre-development condition. Therefore, any increase in post-development peak flows will generally be negligible, however, it is important to ensure any proposed structures and infrastructure are constructed above the defined flood event.

The topography of the DF was reviewed to determine the existing overland flow paths throughout the DF. The elevation data was based on the client provided DEM (1m resolution). The topography of the site is varying, and the majority of the site exists on a ridge running from north to south. The topography of the site is shown in Figure 2-2 .

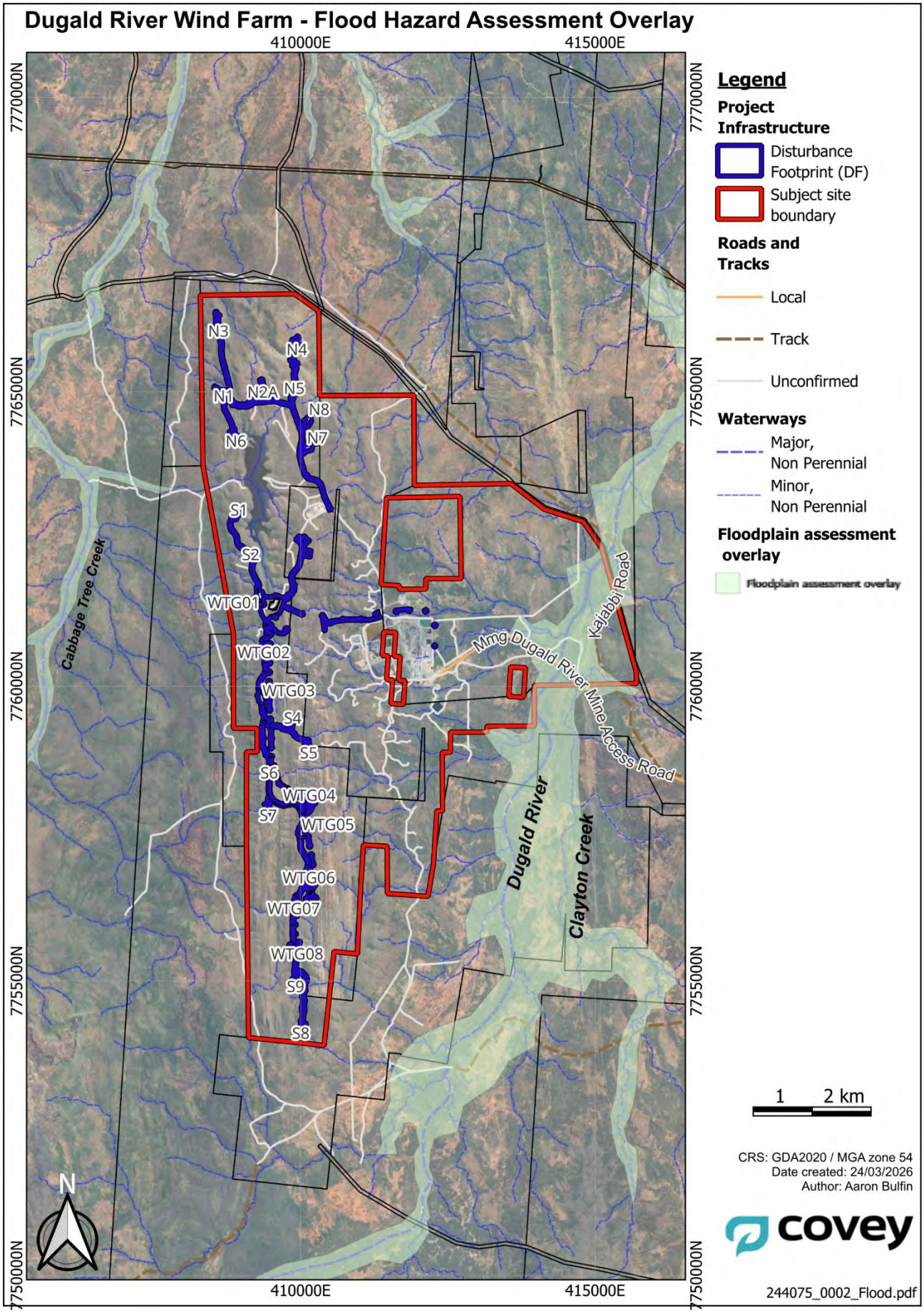


Figure 2-1. QLD Flood Hazard Assessment Overlay

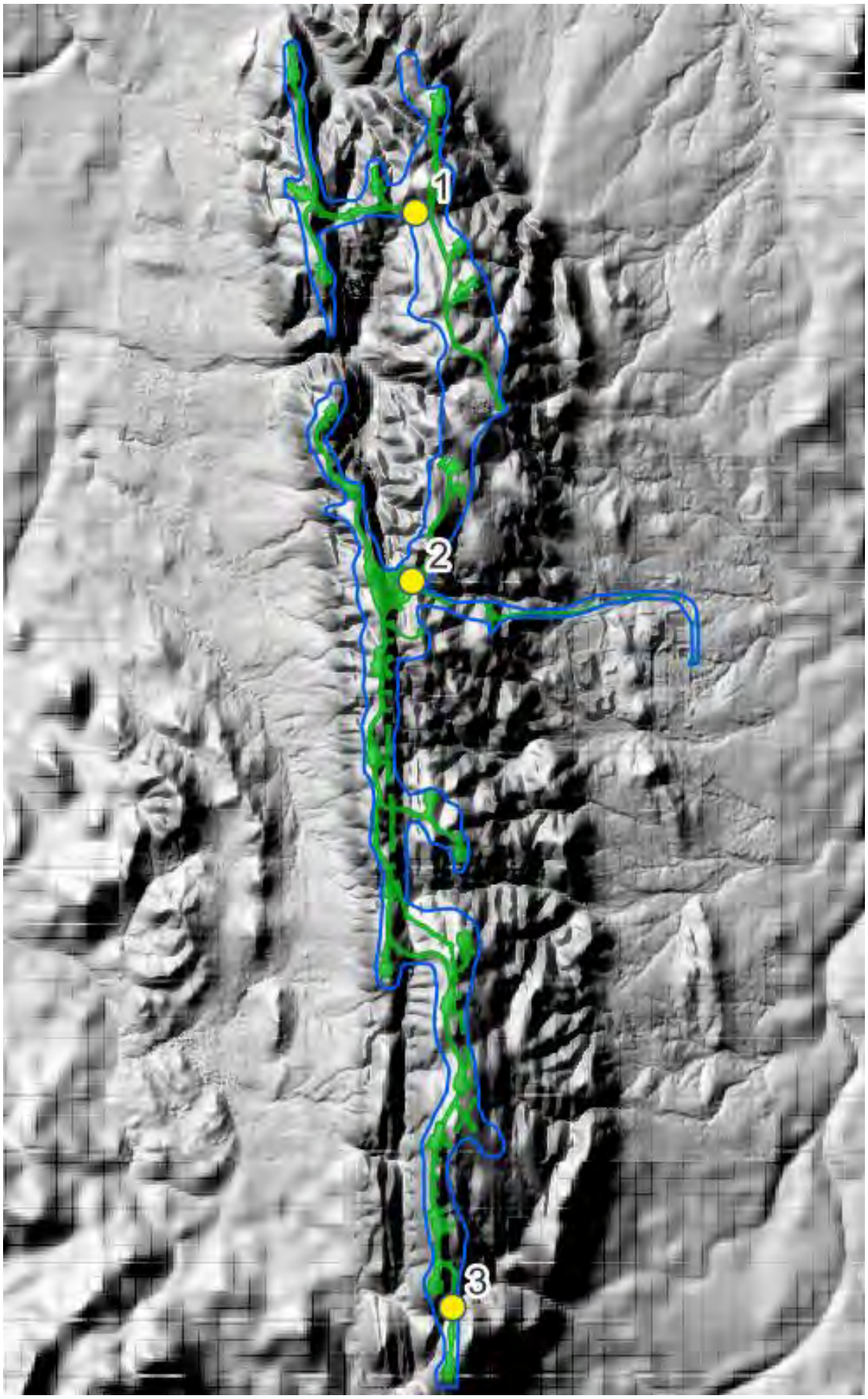


Figure 2-2. Site Topography

Three areas of interest, or critical catchments, have been highlighted. These have been identified as part of a preliminary analysis as potentially vulnerable locations that may experience a level of inundation during a rainfall event. For further details refer to Figure 2-3 to Figure 2-5. To better understand the approximate magnitude of flow from these flow paths, a rational method calculation was performed for each of these critical catchments and the results are summarised in Table 2-1.

Table 2-1. Catchment Rational Method Calculations

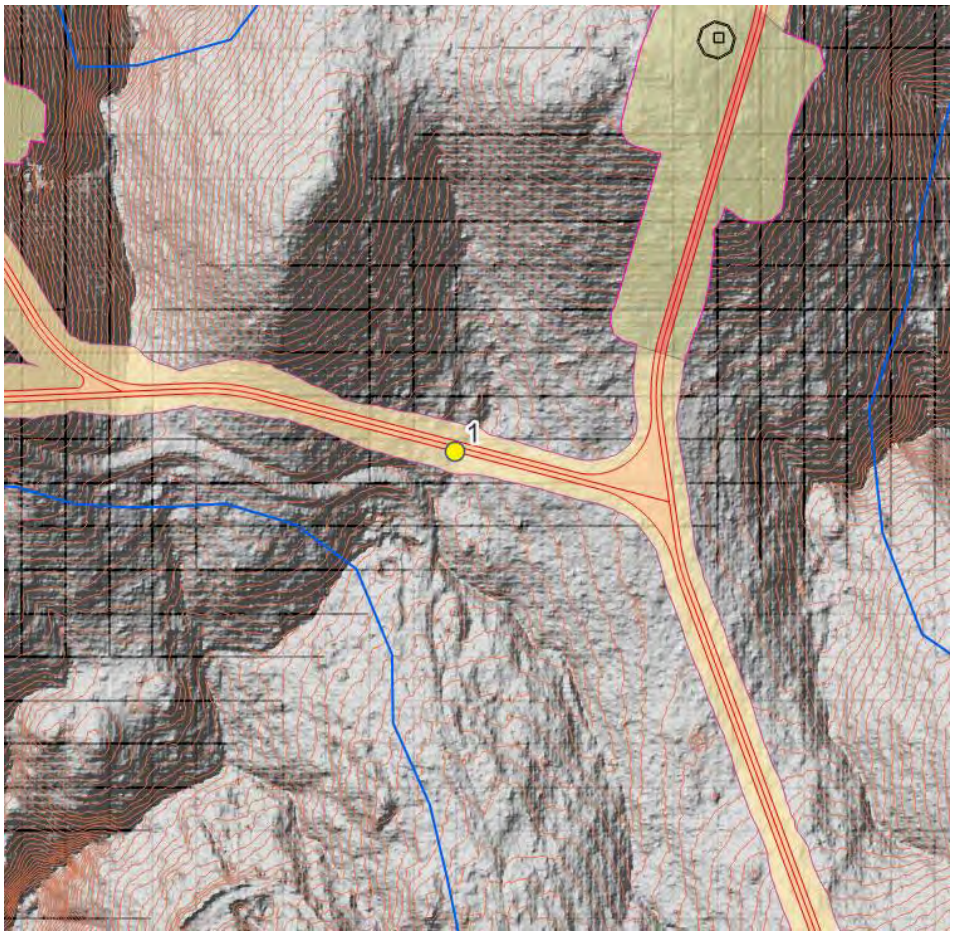
Catchment ID	Time of Concentration (min)	1% AEP Peak Flow Rate (m^3/s)
1	12	2.9
2	21	6.1
3	12	5.4

Based on the preliminary results the lowest time of concentration for the site is approximately 12 minutes for Catchments 2 and 3. For Catchment 2 the time of concentration is longer at approximately 21 minutes. The peak flow rate for each catchment ranges from 2.9m^3/s to 6.1m^3/s.

Figure 2-3 to Figure 2-5 show the locations and cross-sections of the critical overland flow paths. For the Catchment 1 flow path (Figure 2-3), the flow depth within the existing channel is approximately 0.7 m in a 1% AEP storm event.

For the flow path in Catchment 2 (Figure 2-4), a preliminary desktop calculation shows that the water depth would reach a depth of approximately 1.1 m while conveying the 1% AEP flow rate.

For the flow path in Catchment 3 (Figure 2-5), a preliminary desktop calculation shows that the water depth would reach a depth of approximately 0.8 m while conveying the 1% AEP flow rate.



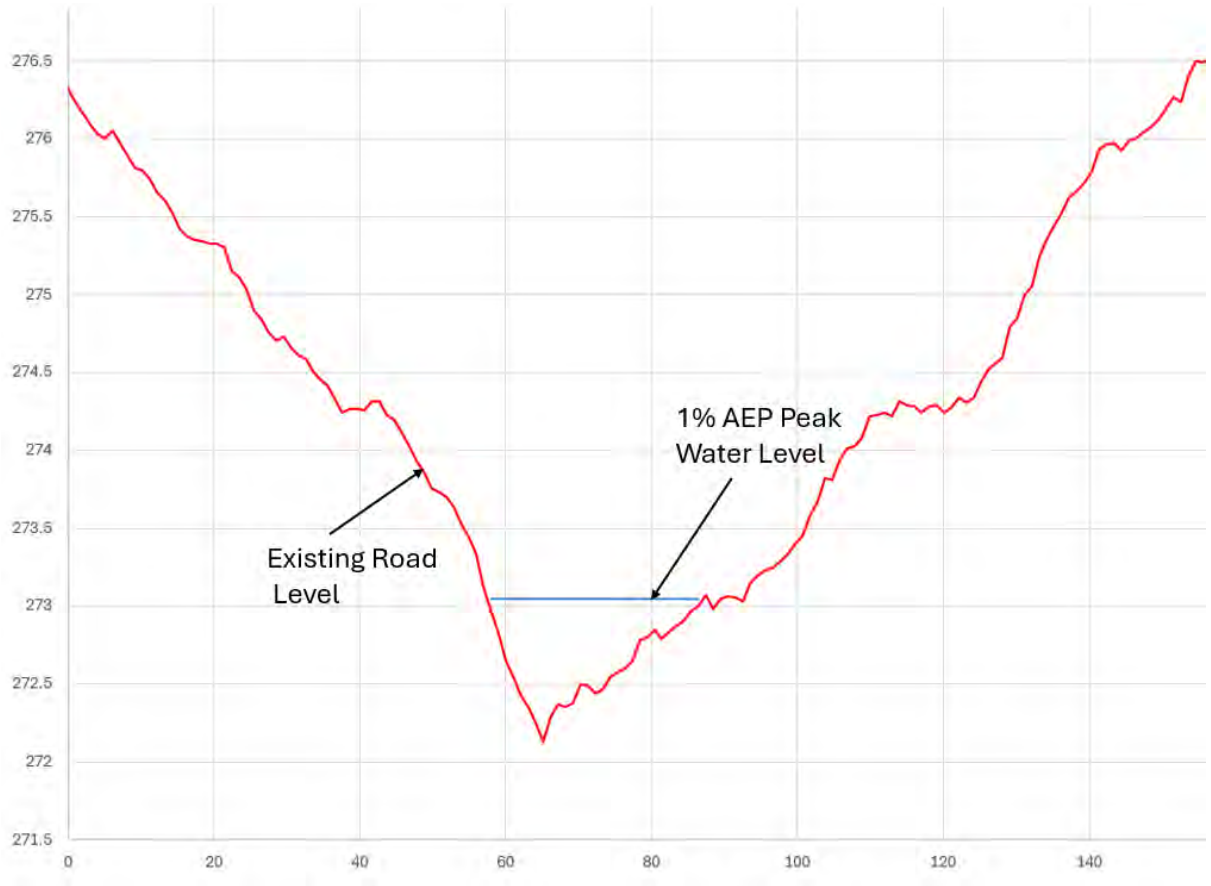


Figure 2-3. Catchment 1

Figure 2-4. Catchment 2

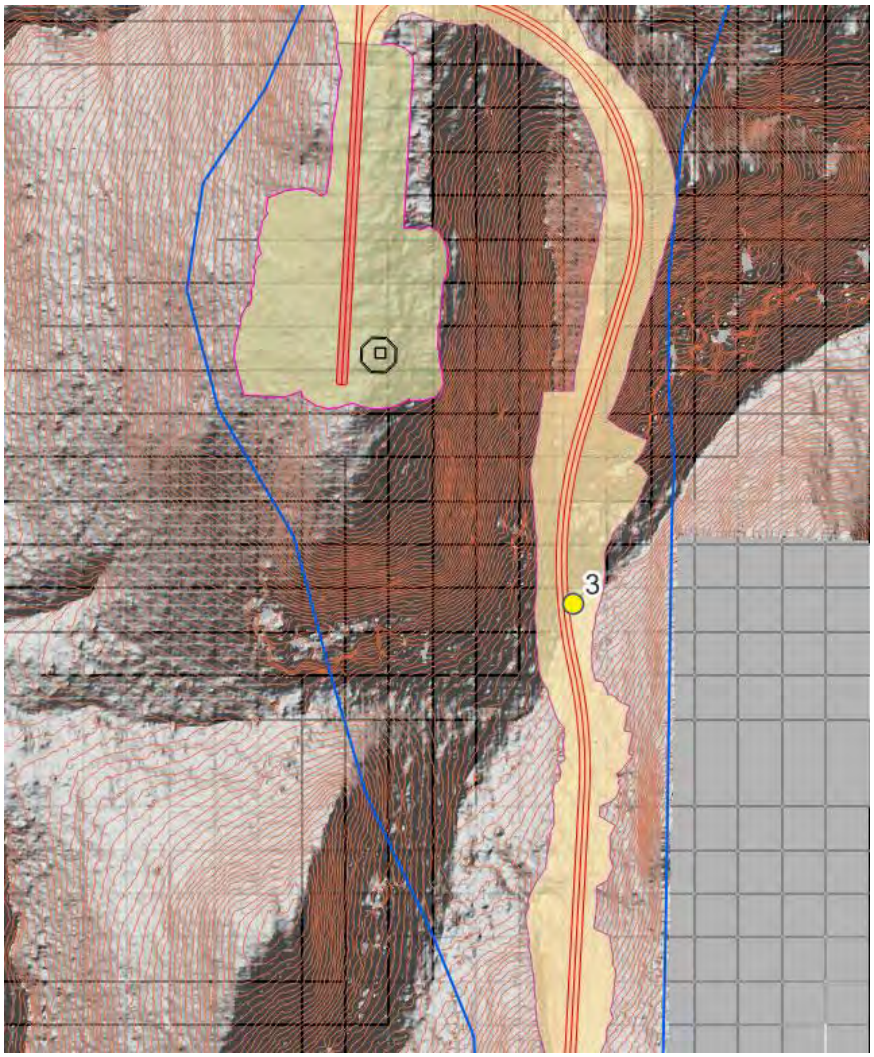


Figure 2-5. Catchment 3

The flooding analysis calculations shown in this report are preliminary only and provide an estimation of the potential flooding at the development site. However, these results are preliminary and are not to be relied upon for detailed layout design. It is recommended that the flood extent and flood impact of the site be determined as part of a detailed flood impact assessment (i.e. TUFLOW 2D flooding hydraulic analysis).

3 Bushfire Hazard Assessment

Bushfire severity is predominantly influenced by fuel, weather, and topography; each of which can have a varying effect on bushfires and their potential behaviour, with these main influences explored in the sub-sections below.

Bushfire severity as it relates to vegetation and topography is represented on the Bushfire Prone Area mapping developed by the Local and State government, where increased severity is a result of areas of steeper terrain and vegetation with higher potential fuel loads.

The State Planning Policy (SPP) Bushfire Prone Area (BPA) mapping is based upon the Potential Fireline Intensity, as determined by the fuel, weather, and topography (Newnham, Opie and Leonard, 2017), which classifies the potential risk of a fire front impacting the area with intensity as per Table 3-1.

Table 3-1. Bushfire Prone Area categories and associated intensities (QFES, 2019a).

Bushfire Prone Area Category	Potential Fire Line Intensity	Colour Code
Low	< 4,000 kW/m	clear
Medium	4,000 – 20,000kW/m	
High	20,000 – 40,000kW/m	
Very High	> 40,000kW/m+	

The State Planning Policy BPA mapping, which has been reproduced on Figure 1-2, identifies the majority of the DF associated with the Project, is wholly within areas mapped BPA.

Given bushfires respect no boundaries, bushfire hazards and risk are better captured at a landscape scale. For this reason, Covey has:

- Analysed the potential radiant heat flux as per BRC guidelines, thus fulfilling the statutory requirements.
- Reviewed the vegetation present within a 150 m radius of the subject lots of the Project, and the historical fires and fire weather observed for the local area, to provide a more thorough understanding of the landscape hazards.
- Reviewed the vegetation present within a 150 m surrounding the DF, to inform the RHF modelling for bushfire impact on the proposed infrastructure.

3.1 Fire Weather

Fire weather is often associated with meteorological conditions that can generate increased fire behaviour, making wildfire suppression efforts difficult for emergency personnel. Fire weather can be influenced by many local factors including temperature, wind, relative humidity, and drought factor, all of which are used to calculate Forest Fire Danger Index (FFDI[1]).

[1] FFDI was used in this report, instead of the new Australian Fire Danger Rating System (AFDRS) and the associated Fire Behaviour Index (FBI), as the data analysed was historical. Also, FFDI values are used as input for in RHF modelling.

3.1.1 Regional weather discussion

The Project is located within the Northwest Highlands Bioregion in Queensland. In this area, fire risk is typically linked to the occurrence of fire weather days or sequences of days of FFDI above 25, which are often characterised by temperatures above 37°C, low humidity and sustained winds (Queensland Parks and Wildlife Service, 2013b).

The Northwest Highlands Bioregion is characterized by a semi-arid climate with varying annual rainfall which is influenced by the passage of tropical monsoonal systems across the Gulf of Carpentaria. Although summer wet seasons do not occur every year and the arrival and duration of monsoon seasons vary considerably, this variation greatly impacts fire weather (Queensland Parks and Wildlife Service, 2013b). Annual rainfall in the region also influences fuel availability, specifically the growth and curing rates of grass. Spinifex, a dominant understorey grass within low open woodlands which are abundant across the region, has increased growth after years of above average rainfall. As such, fire regime and the occurrence of wildfires is determined largely by the interaction between seasonal rainfall and grass growth (Queensland Parks and Wildlife Service, 2013b).

3.1.2 Selection of FFDI for bushfire assessment

The FFDI is based on a combination of different weather conditions known to influence the risk of dangerous bushfire conditions in Australia, including temperature, rainfall, humidity and wind speed, and serves a proxy for fire severity such as rate of spread, intensity and difficult to suppress.

In addition to being used as an input to the SPP BPA mapping for Queensland using models prepared by CSIRO, FFDI values have been calculated using extreme value analysis of weather data including projected climate change to 2050 for a 1-in-20 year return period and included this in the BRC MapViewer as FFDI contours across the state (Queensland Fire Department and Queensland Government, 2025).

The mapped 1:20 year Recurrence Interval FFDI spatial data for Cloncurry (and the site) is **FFDI 95** (BRC Mapviewer), and Covey have adopted this as the input value for the RHF calculations

3.1.3 Historical weather analysis

Recent past weather patterns and trends was analysed for the site using data extracted from the Bureau of Meteorology (BoM) recorded from Australia's Automatic Weather Stations (AWS). Cloncurry Airport AWS (AWS 29141) is located approximately 55 km SE from the site of the development site. The AWS data was analysed for the years 2002-2025. Table 3-2 below provides the twenty-highest ranked FFDIs over the recorded period.

From the FFDI analysis, several days of elevated fire danger have occurred in Cloncurry Airport during the Autumn, Spring, and Summer months. Typically, this analysis shows that the highest ranked fire danger days are typically associated with:

- Air temperatures in the high range of (above 35°C);
- Low RH (≤15%), and relatively dry conditions (Drought Factor = 10); and
- Moderate breeze[2] (>28 km/hr) under varying wind directions.

[2] Based on the Beaufort wind scale – refer to The Beaufort Wind Scale | Royal Meteorological Society for more information.

Table 3-2: Top 20 highest ranked FFDI for Cloncurry Airport AWS 2002-2025

Rank	FFDI	Date	Season	T [°C]	Dew Point [°C]	RH [%]	Wind Speed [km/hr]	Wind Cardinal Direction	KBDI	Drought Factor
1	**83.6**	18/01/2020	SUMMER	**42.5**	1.3	**9**	**33.5**	SSW	197	**10.00**
2	**83.5**	17/01/2020	SUMMER	**41.8**	6.6	**12**	**38.9**	SSW	197	**10.00**
3	**80.9**	20/10/2019	SPRING	**37**	-4.4	**7**	**37.1**	SSE	189	**10.00**
4	**79.7**	20/10/2012	SPRING	**37.8**	-3.9	**7**	**35.3**	ENE	166	**10.00**
5	**79.0**	5/11/2020	SPRING	**42.6**	1.4	**8**	**29.5**	SSE	181	**10.00**
6	**78.3**	8/01/2022	SUMMER	**41.3**	-1.4	**7**	**29.5**	SSW	174	**10.00**
7	**75.4**	8/11/2019	SPRING	**39.4**	-7.2	**5**	**27.7**	S	194	**10.00**
8	**75.0**	2/12/2006	SUMMER	**43.9**	8.2	**12**	**31.3**	S	192.24	**10.00**
9	**73.9**	5/03/2025	AUTUMN	**43.7**	3.9	**9**	**27.7**	NW	188.04	**9.72**
10	**73.4**	9/03/2008	AUTUMN	**36.3**	3.5	**14**	**44.3**	E	185.97	**10.00**
11	**73.3**	28/10/2007	SPRING	**41.4**	2.2	**9**	**29.5**	NW	197.68	**10.00**
12	**72.4**	19/01/2020	SUMMER	**42.5**	1.3	**8**	**25.9**	SSW	197	**10.00**
13	**72.1**	15/11/2006	SPRING	**37.6**	-4	**7**	**31.3**	SSW	185.58	**10.00**
14	**71.7**	5/12/2004	SUMMER	**42**	2.6	**9**	**27.7**	SSW	194.87	**10.00**
15	**71.5**	18/11/2019	SPRING	**40.1**	-4.3	**6**	**25.9**	SSE	196	**10.00**
16	**71.5**	13/01/2019	SUMMER	**40.7**	5.7	**13**	**35.3**	E	201	**10.00**
17	**70.8**	21/09/2023	SPRING	**38.1**	-0.3	**8**	**31.3**	SSE	150	**10.00**
18	**70.8**	4/12/2012	SUMMER	**41.6**	2.3	**9**	**27.7**	SE	192	**10.00**
19	**70.7**	1/11/2020	SPRING	**36.9**	-6.5	**6**	**31.3**	SW	179	**9.70**
20	**70.3**	26/01/2013	SUMMER	**42.5**	8.3	**14**	**33.5**	S	176	**10.00**

3.1.4 Fire Danger Season

In Queensland there is no declared fire season; though depending on seasonality, the fire danger season typically extends from August through to December (Department of National Parks, 2013). For this region the approach towards the fire danger season is associated with increased temperatures, decreased rainfall, and low relative humidity (RH). Weather analysis of monthly FFDI distribution indicates that the period of the year for which dangerous fire weather occurs typically extends between August and December peaking in October (as shown in Figure 3-1.); thus, agreeing with the inferred fire danger season from the Planned Burn Guidelines

However, it should be noted that fire occurrences can have a random nature, and a few short sharp fire weather periods can result in conditions where fires may cause, or have the potential to cause, major damage. Damaging fires can occur in any given year, despite some years being drier and hotter than others.

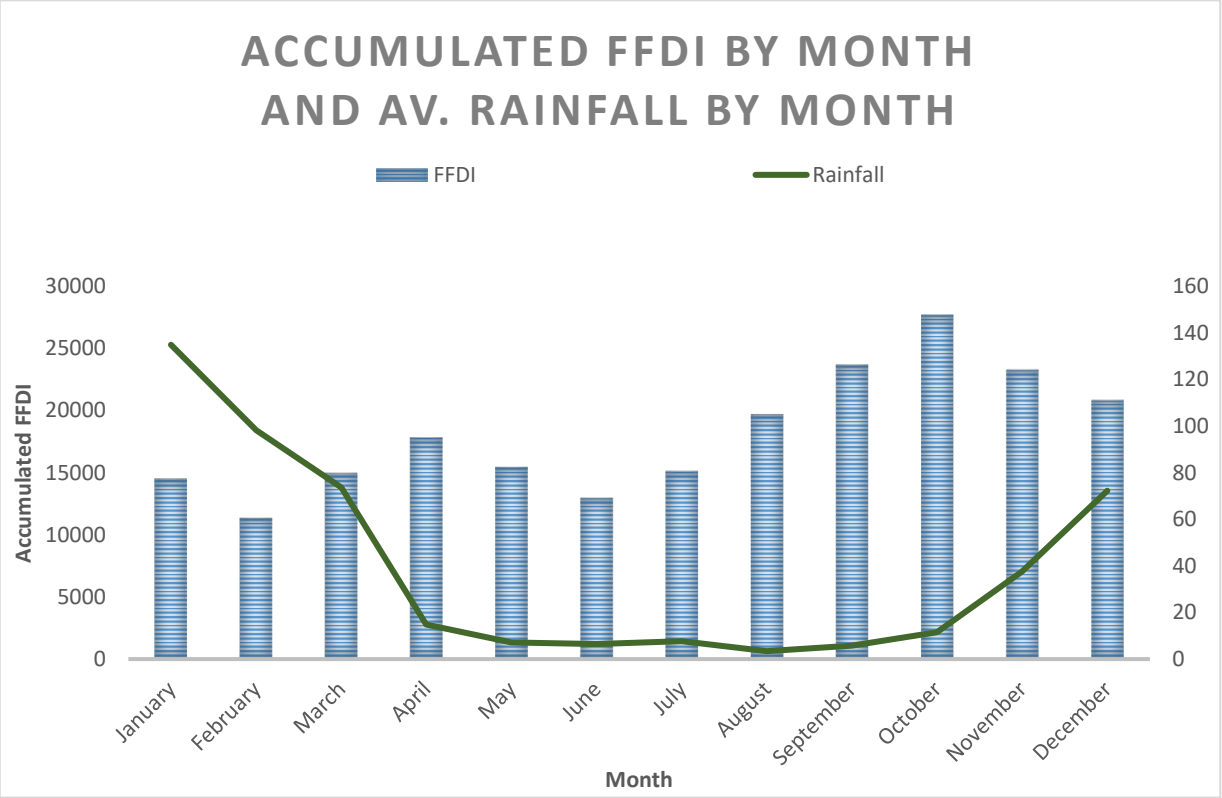


Figure 3-1: Accumulated FFDI and average rainfall by month for Cloncurry Airport AWS

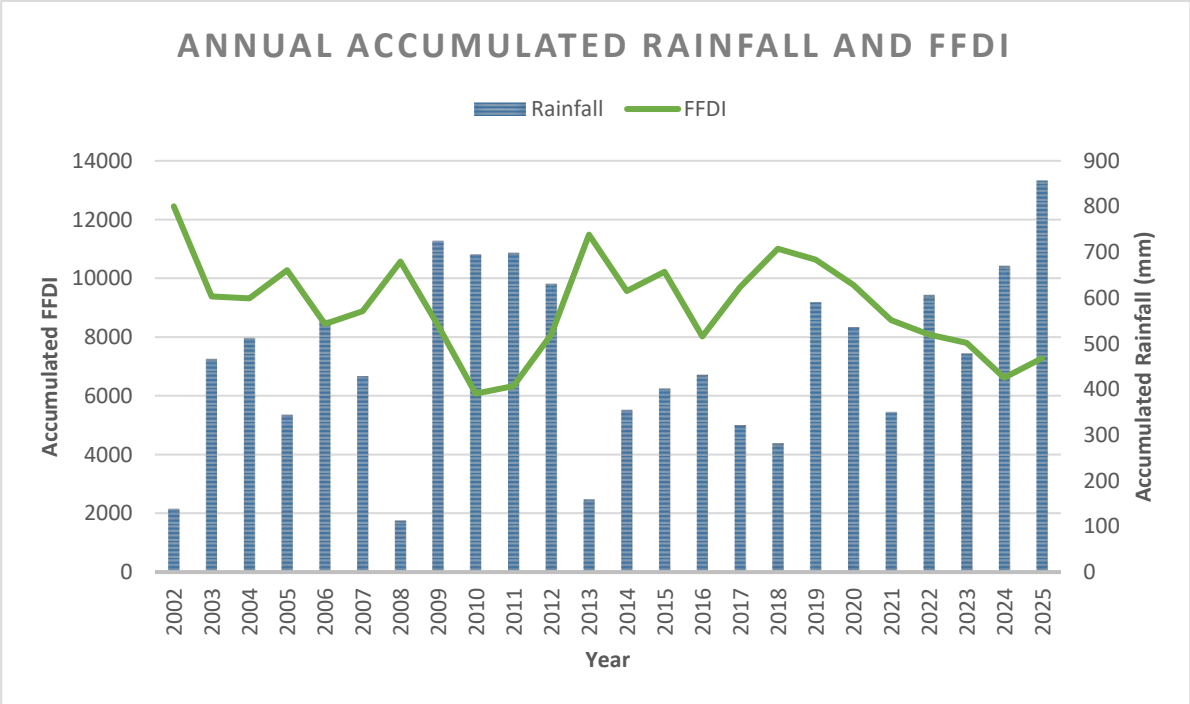


Figure 3-2. Annual Accumulated Rainfall and FFDI for Cloncurry AWS (2002-2025)

3.1.5 Climate Change Impact on FFDI

Climate change relative to the DF can be referenced in the 'Climate Change in Australia Report for Monsoonal North Cluster' developed by Commonwealth Scientific and Industrial Research Organisation (CSIRO) and BOM (Moise *et al.*, 2015). As discussed previously, monsoonal rainfall drives fuel availability in this region, where fuel dries and eventually burns after the wet season ends (Queensland Parks and Wildlife Service, 2013b). The

study suggests that further south in the Monsoonal North Cluster (e.g. Mt Isa) may not observe an active monsoon each year as a result of climate change, leading to less reliable rainfall and less frequent fire activity every few years (Moise *et al.*, 2015). The key findings for projected climate change within the Monsoonal North Cluster are summarised below:

- Very high confidence in:
  - Higher temperatures, and
  - Hot and more frequent hot days.
- High confidence in:
  - Increased intensity of heavy rainfall events, though changes to drought less clear,
  - Some increase in summer and spring wind speed,
  - Increase evaporation rates and reduced soil moisture,
  - Little change in solar radiation and relative humidity throughout the year, and
  - Little changes in fire frequency, though, where a fire does occur, more extreme fire behaviour.

As detailed in Section 3.1.2, the FFDI mapping in the BRC Mapviewer analyses weather data that includes projections for climate change to 2050, and as such, allowance for climate change is already incorporated into the modelling.

3.2 Topography

The slope and topography of land beneath areas of vegetation influence the rate of spread and subsequent severity of bushfire behaviour. To ensure the slope has been considered when undertaking this risk assessment, the landforms within the subject area have been modelled using available Digital Elevation Model (DEM) data sourced from Geoscience Australia at one second resolution (Elvis - Elevation and Depth - Foundation Spatial Data) and client supplied DEM data at 1m resolution. The Project infrastructure is positioned generally at elevations between 250 – 300m above sea level, at the top of the Knapdale Range, that spans in a north-south direction within the study area as shown in Figure 3-3.

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 uses. Fuel loads, especially for grass, may vary greatly depending on rainfall and, the agricultural land use.

To provide a broad context of the fuel type, fuel load, and fuel continuity across the landscape, vegetation within the 150 metres of the subject lots has been reviewed using the State mapped Vegetation Hazard Class (VHC) (QFES, 2019a) refer to Figure 3-4. The SPP requires assessment of the 150 m of vegetation around the DF, as such, vegetation was refined within 150 m of the DF (Figure 3-5); the refinement of the VHC is based on information gathered from a combination of:

- Ground-truthed Regional Ecosystems data prepared by Wulguru Technical Services (2024) spanning 16 + years provided by ERM on 12/02/2025,
- 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 from Google Satellite verified with ERM supplied imagery 12 July 2024.

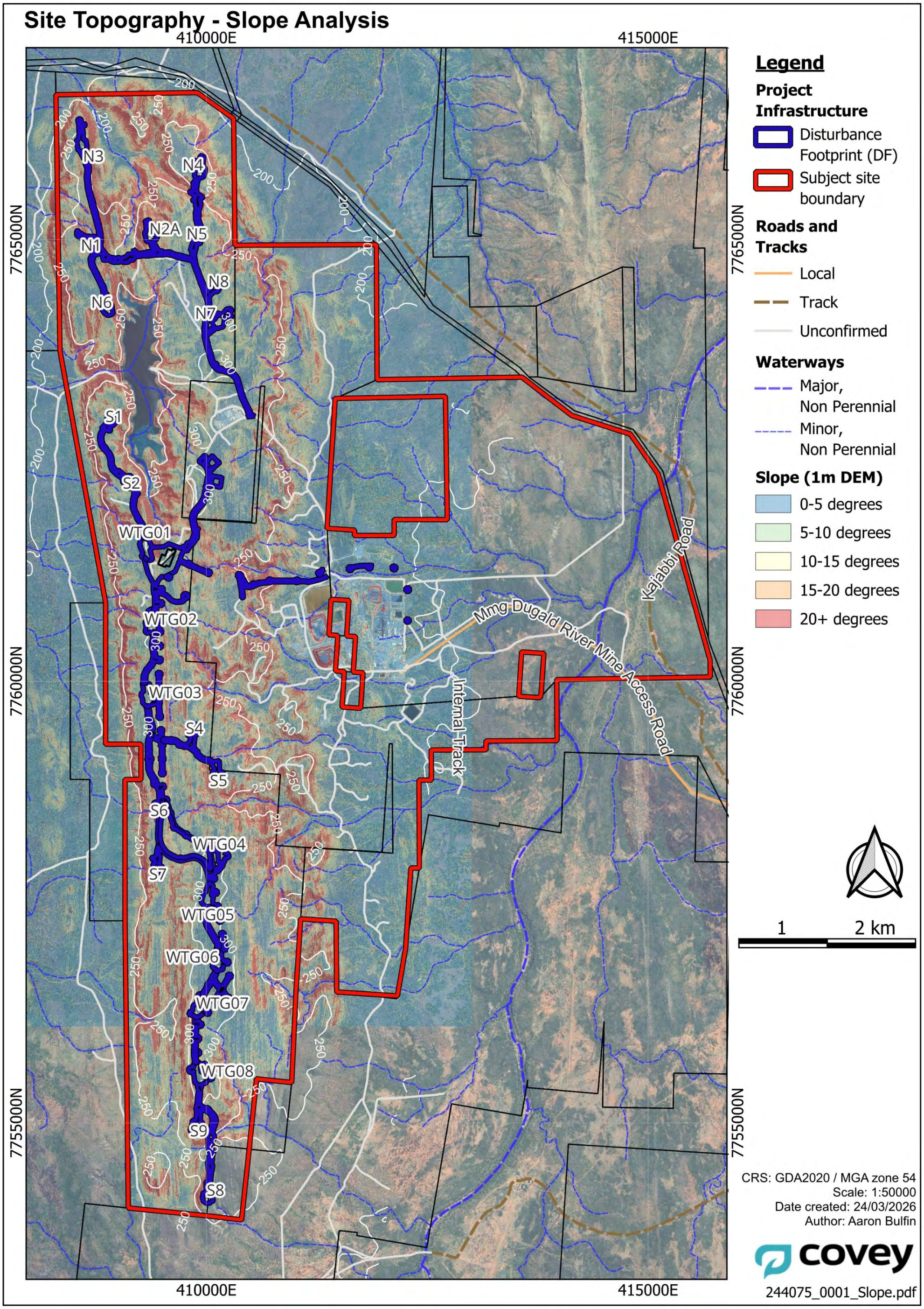


Figure 3-3. Site topography

BRC separates all surface landscape areas into three categories – Bushfire Prone, Grassfire Prone, and Low-Hazard vegetation. Bushfire Prone vegetation (VHC 16.2 19.2) dominates the project area, which aligns confidently with the BPA mapping (Figure 1-2). Whilst Low-Hazard vegetation (VHC 41.4, 42.6, 43.6) cover the a smaller portion of the project area (Figure 3-5). Table 3-3 below provides a breakdown of the fuel properties of the identified VHCs within 150 metres of the DF.

Table 3-3. Landscape vegetation within 150 meter buffer of the DF.

VHC	Description	Vegetation Type	Surface Fuel Load (t/ha)	Total Fuel Load (t/ha)	Prone Type	Modelled (RHF)
VHC 16.2	Eucalyptus dominated woodland on drainage lines and alluvial plains	Woodlands	11.1	11.6	Bushfire	Y
VHC 19.2	Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton Box.	Woodlands	7.3	9.1	Bushfire	Y
VHC 41.4	Discontinuous low grass or tree cover	Low-Threat	2	2	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

The VHCs mapped (QFES) within the DF and the surrounding 150 m were:

- 19.2 – Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box, or Normanton box, and
- 42.6 – Nil to very low vegetation cover.

The VHC verified (Ecological Assessment) within the DF and the surrounding 150 m were:

- VHC 16.2 – Eucalyptus dominated woodlands on drainage lines and alluvial plains,
- VHC 19.2 – Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box, or Normanton box,
- VHC 41.4 – Discontinuous low grass or tree cover,
- VHC 42.6 – Nil to very low vegetation cover, and
- VHC 43.6 – Water bodies.

Refer to Appendix A for enlarged maps of VHC within the DF.

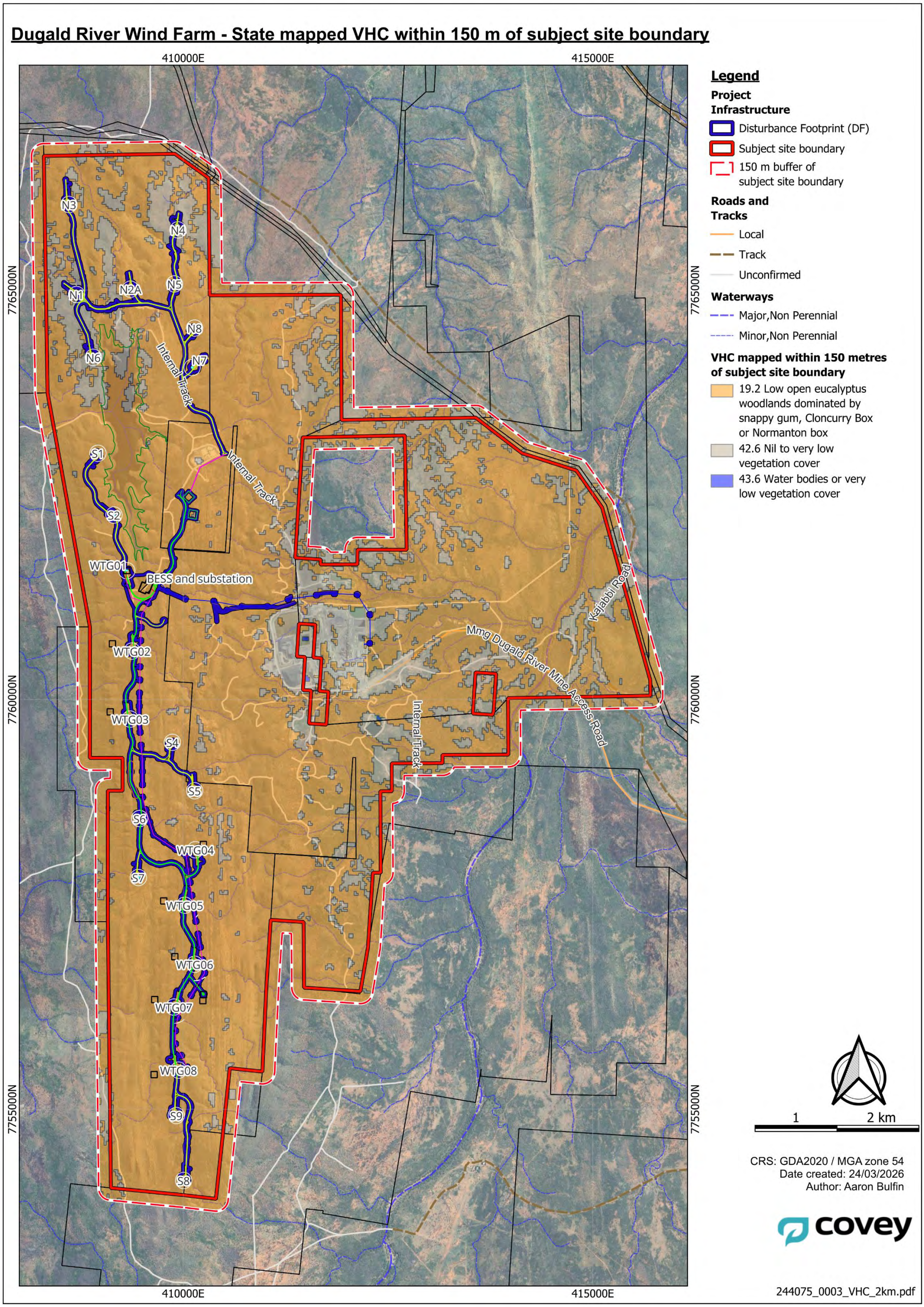


Figure 3-4. Mapped vegetation (VHC) within 150m of the subject lots – not refined

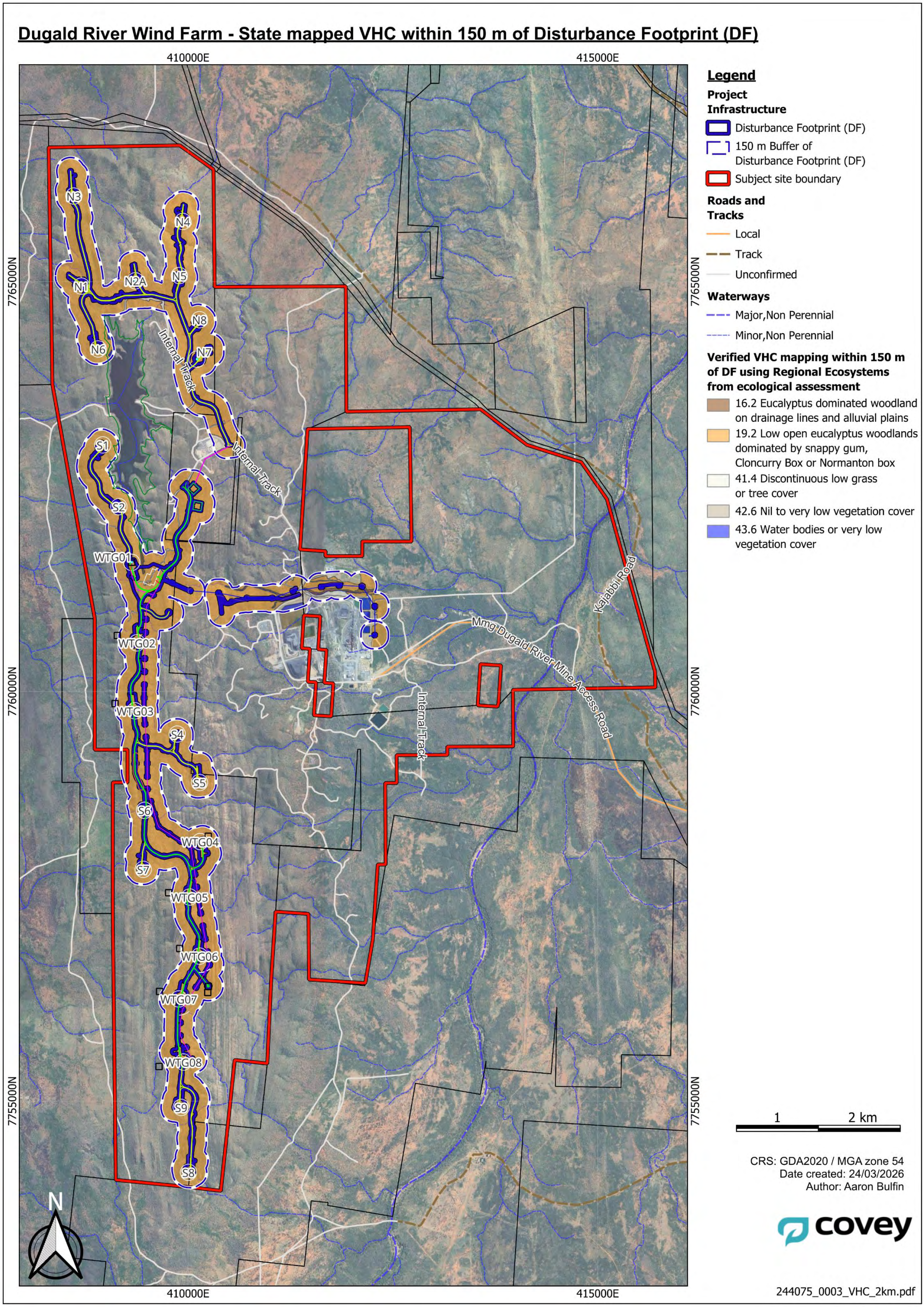


Figure 3-5. Mapped vegetation (VHC) within 150m of the DF based on site verified vegetation per data provided by ERM.

3.4 Fire Likelihood and Behaviour Discussion

Historical fire weather analysis provides some indication of the potential for large fires to develop in the future. Weather analysis indicates that these are more likely to approach the Project from a southerly wind arc. High fire intensity and flame lengths could be expected in patches of higher fuels and steep slopes. Fires in the region would typically be expected to be wind-driven within grasslands and fuel-driven in forested and wooded areas. However, as discussed, rainfall is also a key driver of fire activity within this bioregion due to its influence on grass growth within the low open woodlands that contain a hummock grass understorey. Following wet periods brought by monsoonal systems, grass can rapidly grow, leading to the accumulation of fuel, and subsequent increase in wildfire risk (Queensland Parks and Wildlife Service, 2013b).

Large expanses of woodland vegetation across the site and adjoining areas represent medium and high potential bushfire intensity based on SPP Bushfire Prone Area mapping. Very high potential bushfire intensity occurs at patches of dense bushland along ridgelines adjoining the DA to the west.

Historic wildfire occurrences in the local area over the past 10 years (since 2016) have been illustrated on Figure 3-6 and Figure 3-7 based on Queensland Fire Scar mapping data, which depicts several large bushfires having occurred around the study area over this timeframe and mostly within surrounding Eucalypt woodland vegetation. The Queensland Fire Scar mapping is based upon time-series differential satellite imagery (Sentinel-2) using vegetation cover change and spectral difference. It is seen as a relatively accurate methodology for determining the impact of bushfires across a landscape, by analysing the difference in the landscape pre- and post-fire.. Additionally, these have typically occurred within the fire season between September to December, with some occurring outside of the fire season in January to April however these may have been prescribed burns undertaken to reduce the extent and severity of uncontrolled bushfires. Notably, more recently on 13 January 2025, a large bushfire occurred within the DF and surrounding land which threatened the infrastructure associated with the DRM (isolated and illustrated alone on Figure 3-7). Media reports outline the fire was primarily grassfire driven and burned for approximately 3 days, with the fire front reaching around 5 – 6km and originated to the north-east of the DRM. It has been noted by MMG that this event resulted in negligible damage to the DRM was sustained as a result of this event.

A significant factor in bushfire development is the control of ignition events, with a number of potential internal and external ignition sources identified including:

- ***Potential internal bushfire ignition sources***
  - Electrical faults/failure from electrical components (including inverter or transformer failures);
  - Vegetation management (i.e., mowing) in dry conditions;
  - Ignition of vegetation from overhead transmission lines;
  - Unauthorised site access and arson;
  - Landholder activities;
  - Activities associated with the DRM (e.g. exploration drilling); and
  - Maintenance activities that may cause a spark (such as welding).
- ***Potential external bushfire ignition sources***
  - Lighting strike; and
  - External bushfire spreading via vegetation.

Given the potential to ignite a bushfire (both within and outside the development area), the existing bushfire fuels in the area, and the potential for elevated fire weather conditions, the growth and spread of large

bushfires to impact the proposed development is considered a risk that requires appropriate management measures to reduce to an acceptable level.

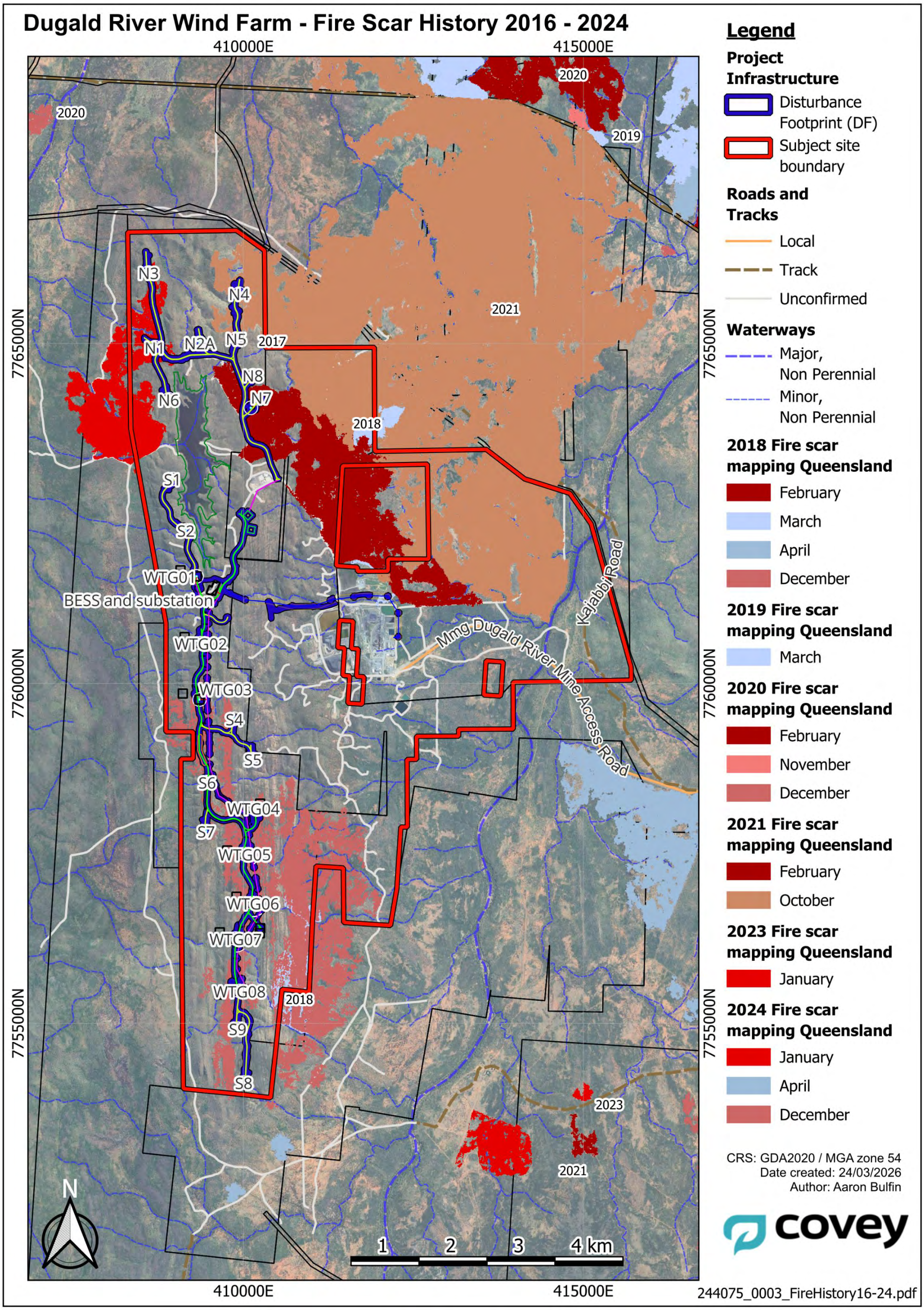


Figure 3-6. QLD fire scar history between 2015-2024 ('Queensland Fire Scars', 2024) from spatial data.

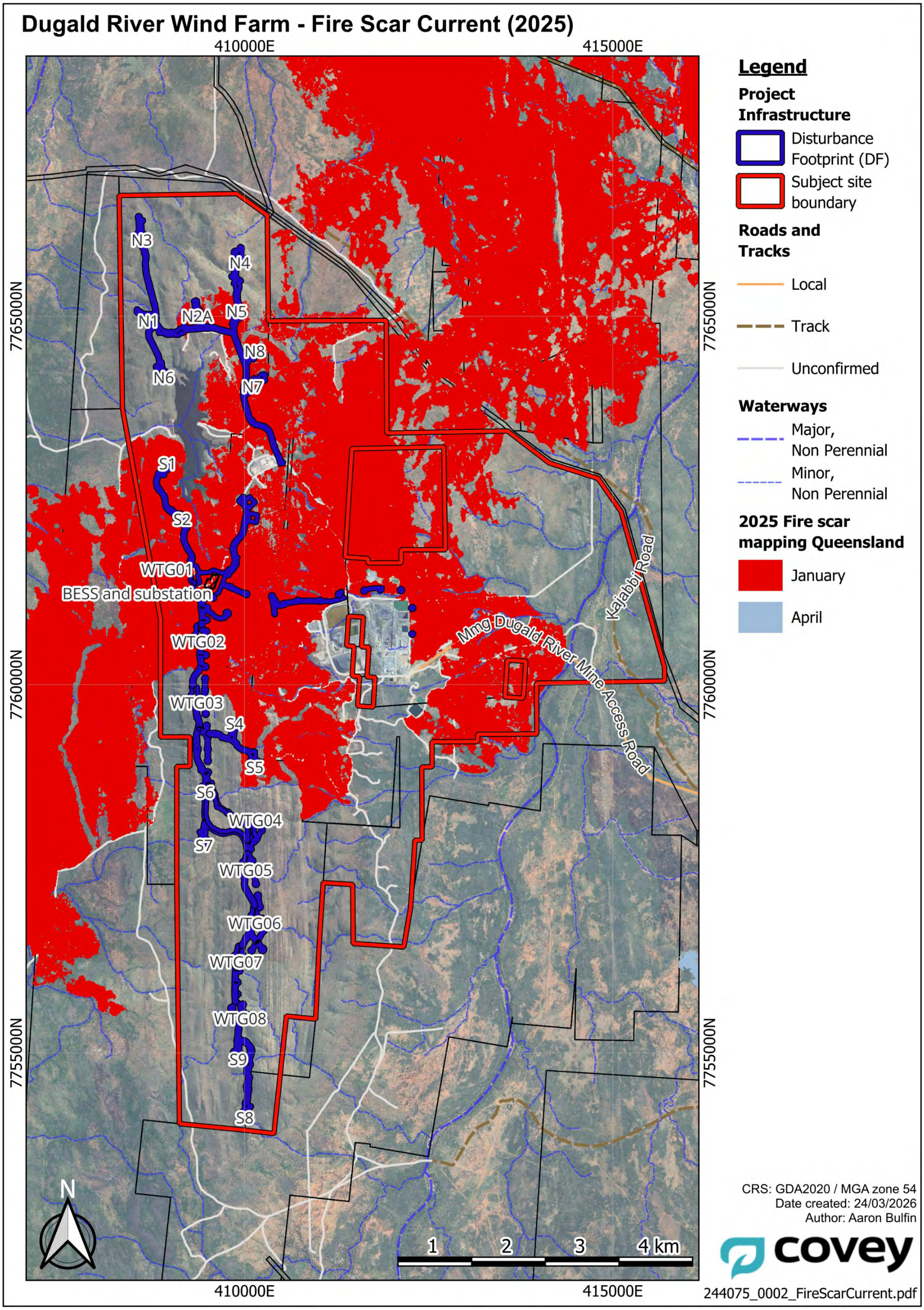


Figure 3-7. Current Fire Scar Mapping for 2025 ('Queensland Fire Scars', 2024) from spatial data.

4 Bushfire Risk Assessment

The broad process for effective risk management utilised in this NHRA is identified in Figure 4-1 and used under Creative Commons CC BY 4.0 from SPP 'Natural hazards, risk and resilience state interest – Bushfire' (QFES 2019a). While this NHRA seeks to establish the context, identify the bushfire hazard and detail anticipated bushfire risk, it doesn't propose risk treatments nor detail how compliance will be achieved with relevant bushfire risk management requirements, which will be detailed in the future BMP.

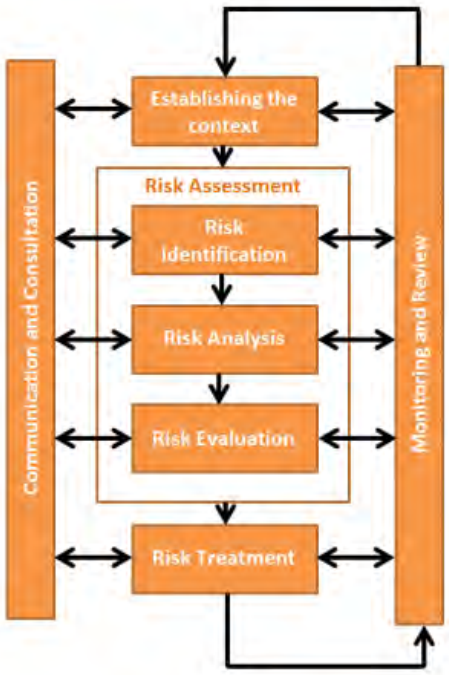


Figure 4-1. Risk management process (Queensland Government 2019; Figure 3).

4.1 Radiant Heat Flux Analysis

Bushfires present risks through flame contact, ember attack, and Radiant Heat Flux (RHF) exposure. To ensure developments are suitably placed within identified bushfire prone areas, RHF are undertaken to observe and inform sufficient setback distances. RHF calculations identify the rate at which heat transfers to a receiver from a potential fire and how the energy dissipates with increasing distance from the fire.

Subsequently the sizing of Asset Protection Zones (APZs); low fuel zones around buildings/critical infrastructure) should be informed by undertaking Radiant Heat Flux (RHF) calculations to determine the required setback distances, ensuring that the proposed infrastructure is sited as to not be impacted by unacceptable levels of RHF from potential bushfires.

4.1.1 Radiant Heat Flux Calculation Methodology and Inputs

To determine the potential bushfire RHF impact on the proposed BESS infrastructure and wind turbines, 1-D RHF calculations were undertaken in accordance with BRC, which specifies the application of Method 2 of Australian Standard (AS) 3959:2018 'Construction of buildings in bushfire-prone areas' ('AS3959'; Standards Australia 2018).

The 1-D RHF calculations are considered sufficient for the NHRA process to determine whether further bushfire risk management is required for the proposed infrastructure or not. Where required, 2-D RHF

mapping will be provided with the BMP to detail the appropriateness of proposed APZs to achieve target RHFs detailed in Section 4.1.2.

For this NHRA, the 1-D RHF calculations were undertaken using Inferno-BAL modelling software, which was developed in-house by Covey, and which replicates the AS 3959 Method 2 RHF calculations as per inputs detailed in Table 4-1, noting the following:

- Most inputs are default as per Method 2 AS 3959, including flame width
- For flame temperature:
  - AS 3959 specifies a flame temperature input value of 1,090°K to be applied to ancillary infrastructure
  - A higher flame temperature of 1,200°K is applied to developments that include *hazardous materials* as defined by the SPP (BESS).

Table 4-1. Radiant Heat Flux model assumptions – modified Method 2 of AS 3959

	Calculation Parameters	Flame Properties		Target
Situation	Default Inputs	Flame Temperature	Head Fire width	Radiant Heat Flux
WF infrastructure other than BESS (e.g. WTGs, substation)	Emissivity: 0.95 ε Heat of Combustion: 18600 kJ/kg Relative Humidity: 25% Ambient Temperature: 308°K Transmissivity: 0.775	**1090°K**	100 m	≤29 kW/m^2
BESS Units and Critical infrastructure components	Emissivity: 0.95 ε Heat of Combustion: 18600 kJ/kg Relative Humidity: 25% Ambient Temperature: 308°K Transmissivity: 0.775	**1200°K**	100 m	≤10 kW/m^2

In addition to the above, other RHF modelling inputs include the following as summarised on Table 4-2:

- As per Section 3.1.2, the 5% annual exceedance probability fire weather of **FFDI 95** has been adopted
- 1-metre DEM of the existing terrain surface to derive effective slope beneath vegetation but noting that given the DEM data does not include the proposed design surface, and as such, the RHF results are indicative given the site slope may be subject to change post-development.
  - *Effective Slope* is defined as the slope under the classified vegetation which most influences the bushfire attack (per AS3959-2018).
  - *Site Slope* is the slope under the subject area, site or asset (per AS3959-2018).
  - Varied slope values have been used to account for variation in elevation across the wind farm site.
  - Further description of 'effective slope' and 'site slope' is provided in Appendix B.
- Site specific vegetation hazard classes and their associated potential fuel loads for Bushfire Prone vegetation only, determined in accordance with procedure 5.4.2 Step 2 of BRC (2019) as per Table 3-3; and
  - According to section 7.6 of the BRC, RHF and Bushfire Attack Level (BAL) are not required to be calculated for grassfire prone VHCs or low hazard VHCs (QFES, 2019b). As such, VHC 41.4, VHC 42.6 and VHC 43.6 (all low hazard) were excluded from the model and Table 4-2.

- Rate of spread models are taken from those adopted in AS 3959, relevant to the bushfire fuel types as follows:
  - Woodland vegetation
    - R = 0.0012 * FFDI * SFL as per Catchpole et al, 1998

Table 4-2. Fuel input values and rate of spread equations (per BRC and AS3959).

FFDI	Vegetation Criteria				Rate of Spread Equation
	Vegetation Class	Vegetation Type	SFL (t/ha)	TFL (t/ha)	
95	VHC 16.2	Woodlands	11.1	11.6	R = 0.0012 * FFDI * SFL (Catchpole et al (1998)
95	VHC 19.2	Woodland	7.3	9.1	

Covey notes that there are limitations predicting fire weather, bushfire behaviour and conducting RHF analysis, which have been detailed in Appendix C.

4.1.2 Target Radiant Heat Flux

Four RHF values (40 kW/m^2, 29 kW/m^2, 19 kW/m^2 and 12.5 kW/m^2 @ 1090 K flame temperature) trigger specific Bushfire Attack Level (BAL) construction requirements under the Building Code of Australia, for certain building classifications, namely BAL-40, BAL-29, BAL-19 and BAL-12.5. A fifth classification also exists for buildings in areas with RHF >40 kW/m^2 where impact by direct flame impingement is almost certain, which is called BAL-FZ (flame-zone).

While the proposed infrastructure at this development are exempt from that BCA specified construction (i.e. they are not assessed as BCA building classifications), SPP guidance material (Natural Hazards, Risk and Resilience State Interest – Bushfire) recommends development footprints excluding roads (i.e. WTG, ancillary facilities such as site offices/compounds, on-site accommodation, switchboards, substations and static water supply points) to be separated from the closest assessable vegetation by a distance that achieves a RHF of 29 kW/m^2 or less. There is currently limited specific guidance regarding the target RHF for infrastructure containing hazardous materials such as the BESS units.

Notwithstanding the above, Covey notes the following:

- ***Wind Turbine Generators***
  - are constructed of non-flammable exterior materials that are highly unlikely to be ignited.
  - the likelihood of loss of life is considered very rare given that limited personnel will be present once the Project is operational. It is anticipated that personnel only onsite for periodic maintenance undertaken at a scheduled and as needed basis.
  - Based on the above, the target RHF for proposed WTG of 29 kW/m^2 or lower (at 1090 K flame temperature) is considered appropriate to comply with SPP guidance material and manage the risk of bushfire impact on the WTG.
- ***Transformers (Substation and in BESS yard)***
  - The risk to, and from, transformers is primarily related to potential for over-pressurisation of insulating oil tank resulting in rupture and subsequent pool fire.
  - Given the limited likelihood of failure, and the difficulty in igniting the insulating oil, the target RHF for proposed transformers of 29 kW/m^2 or lower (at 1090 K flame temperature) is considered appropriate.

- ***Buildings and Switch-rooms***
  - There are several buildings and switch-rooms proposed in the BESS yard.
  - The target RHF for these is 29 kW/m^2 or lower (at 1090 K flame temperature), which is consistent with SPP and Cloncurry BHOC requirements.
- ***BESS Units***
  - Contain Lithium-ion (Li-ion) battery cells housed in a metal container
  - The significant hazard posed by BESS units is primarily associated with thermal runaway occurring in the Li-ion batteries, and the fire and explosion risk that can accompany the release of flammable gases. Thermal runaway describes a process that is accelerated by increasing internal temperature, in turn releasing more energy that further increases temperature.
  - While the BESS container itself normally a non-combustible container, given the risk of thermal runaway being triggered by direct flame impingement and RHF impression on the container (albeit noted that internal battery and thermal management systems will operate to prevent this), it is appropriate to provide increased separation from unmanaged classified vegetation to address the thermal runaway risk.
  - Based on the above, a target RHF to such infrastructure of 10 kW/m^2 or lower (at 1200 K flame temperature) is considered appropriate to limit potential thermal runaway, noting that the peak RHF from a forest or woodland fire is typically 60 to 90 seconds.
  - This target RHF is consistent with SPP requirements for hazardous materials and infrastructure, as well as those defined in Cloncurry BHOC.

4.1.3 Radiant Heat Flux Results

The 1-D RHF extent have been calculated per AS 3959 Method 2 (see Table 4-3), using the input values as detailed in Section 4.1.1 above, including for both 1090 K and 1200 K flame temperatures. These values provide an indication of the range of potential setback distances that must be observed between the proposed infrastrucutre and the assessed bushfire prone vegetation.

Table 4-3. 1D calculations of required setbacks based on varying slopes and vegetation type (FFDI 95 per SPP).

FFDI	Vegetation	Slope		Distance required to achieve [using flame temp of 1090°K]				Distance required to achieve [using flame temp of 1200°K]
		Site	Effective	40 kW/m^2	29 kW/m^2	19 kW/m^2	12.5 kW/m^2	10 kW/m^2 for critical infrastructure
95	VHC 16.2 [Woodland]	1°	1°	8.5 m	11.5 m	17 m	24.5 m	40 m
		5°	5°	10.4 m	14.1 m	20.8 m	29.7 m	47.3 m
		10°	10°	13.5 m	18.3 m	26.7 m	37.5 m	57.9 m
		15°	15°	17.6 m	23.8 m	34.2 m	46.9 m	69.9 m
		20°	20°	23 m	30.6 m	43.1 m	57.6 m	83.1 m
		20°	25°	31 m	40.1 m	54.4 m	71 m	98.9 m
95	VHC 19.2 [Woodland]	1°	1°	5.8 m	7.9 m	11.8 m	17.3 m	29.5 m
		5°	5°	7 m	9.7 m	14.5 m	21.2 m	35.4 m
		10°	10°	9.2 m	12.6 m	18.8 m	27.3 m	44.1 m
		15°	15°	12 m	16.5 m	24.5 m	34.9 m	54 m
		20°	20°	15.7 m	21.6 m	31.7 m	43.6 m	64.7 m
		20°	25°	21.3 m	28.7 m	40.6 m	54.6 m	79.2 m

To provide more definitive results on the potential impact of RHF on the proposed WF/BESS infrastructure, 2-D RHF calculations were undertaken in accordance with BRC, which specifies the application of Method 2 of Australian Standard (AS) 3959:2018 'Construction of buildings in bushfire-prone areas' ('AS3959'; Standards Australia 2018). The RHF calculations were undertaken using Inferno-BAL modelling software, which was developed in-house by Covey, which applies Method 2 of AS3959 – refer to Appendix D for further details.

These 2-D RHF results have been analysed to assess the potential impact of bushfires on the proposed infrastructure of the development – with the target RHF observed at each asset location of each WTGs, substation, the proposed BESS containers, and other auxiliary infrastructure.

Based upon the extent of vegetation clearing associated with the DF, there is sufficient setback distance achieved between retained vegetation and placement of proposed infrastructure. On this basis, appropriately sized Asset Protection Zones (APZs) will need to be established around the perimeter of all WTGs, BESS units and the substation, to achieve the target RHF detailed in Section 4.1.2.

In addition to the proposed APZs, additional bushfire risk management measures may also be proposed to increase resilience to bushfire impact, but also to limit the opportunity for an onsite fire to escape and ignite a bushfire, and could include:

- Vegetation Modification and Management
- Vehicular Access Requirements (onsite)
- Bushfire Fighting Water Supply
- Infrastructure Design Requirements (to improve bushfire resilience)

All proposed bushfire risk management measures, including proposed APZs, are to be detailed and documented in the project BMP, which is to include guidance on the responsibilities for implementation of that measure in addition to ongoing management.

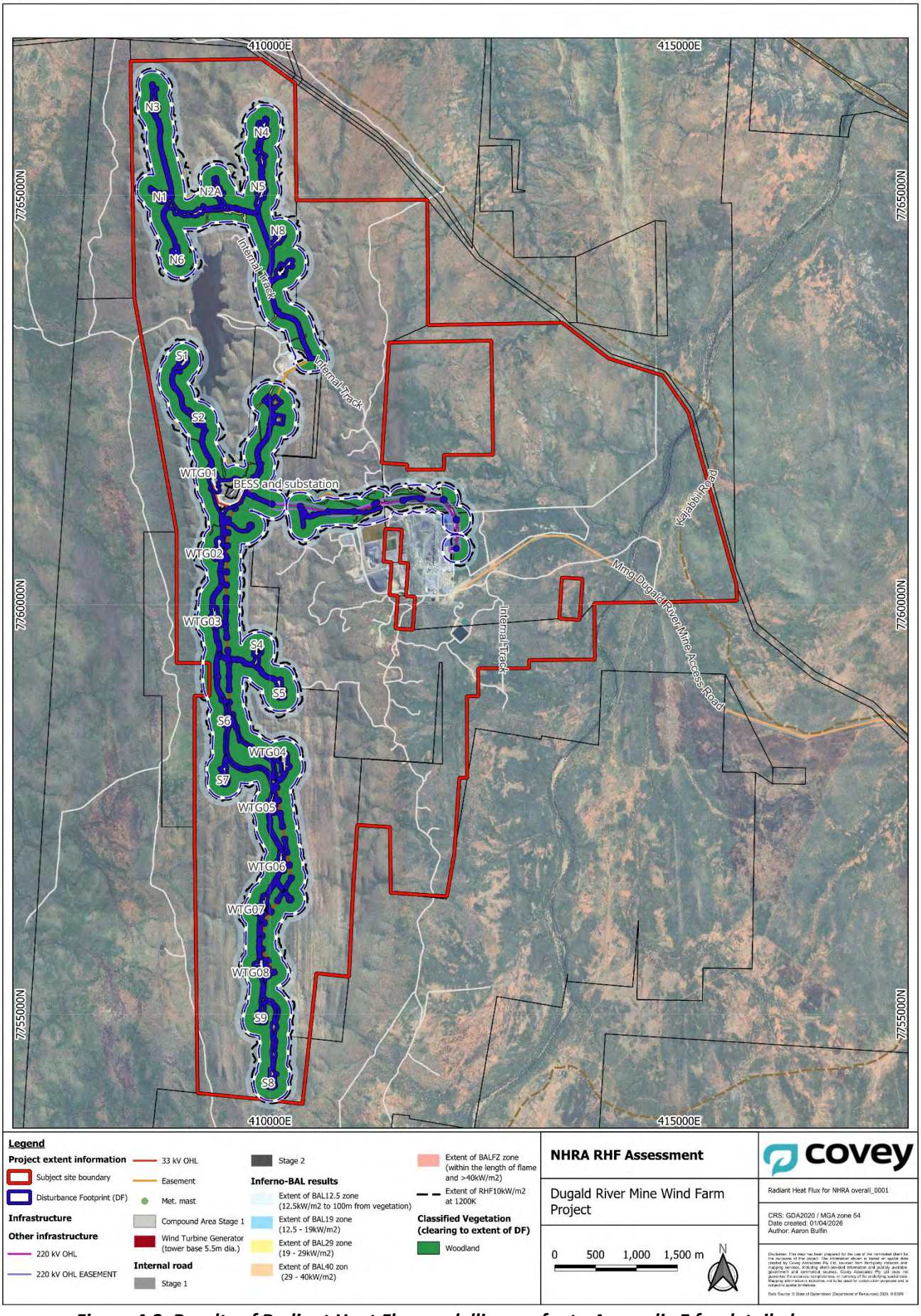


Figure 4-2. Results of Radiant Heat Flux modelling - refer to Appendix E for detailed maps

5 NHRA Outcomes and Compliance Assessment

This NHRA provided a preliminary flood hazard assessment and analysed the potential bushfire constraints and impacts to the proposed Dugald River Wind Farm Project. Additionally, a compliance assessment has been provided against the relevant requirements, based on the level of information and outcomes of the NHRA.

5.1 Flood Hazard Assessment Outcomes

The Project DF does not contain any mapped flood hazard areas per State Planning Policy or Cloncurry Shire Council mapping overlays, however Dugald River to the east, and Cabbage Tree Creek west, of the Development Area are mapped as Flood Hazard Area – Level 1 – Queensland floodplain assessment overlay and Interim Flood Plain Assessment for the SPP and CSC mapping respectively.

Three areas of interest, or critical catchments, were identified as part of a preliminary flood analysis as potentially vulnerable locations that may experience a level of inundation during a rainfall event. A rational method calculation was performed for each of these critical catchments to better understand the approximate magnitude of flow from these flow paths.

Based on the preliminary results the lowest time of concentration for the DF is approximately 12 minutes for Catchments 1 and 3, the peak flow rate for each catchment ranges from 2.9m^3/s to 6.1m^3/s and the flow depth for the three catchments ranges from approximately 0.7 m to 1.1 m in a 1% AEP storm event.

The flood analysis calculations provided in this Report are preliminary and offer only an estimation of potential flooding at the development site. These results are not suitable for use in detailed layout design. It is advised that a detailed flood impact assessment, such as a TUFLOW 2D hydraulic analysis, be undertaken to accurately assess the flood extent and impact on the site.

5.2 Bushfire Hazard Assessment Outcomes

The SPP Bushfire Prone Area mapping indicates that the Development Area is subject to Medium and High Potential Bushfire Intensity around areas of woody vegetation with Very High Potential Bushfire Intensity typically observed in gullies to the north and west of the DF.

Elevated fire danger typically occurs within the dryer and warmer months of the year – typically from August to December – though can also occur in other periods of extended dry weather (little to no rainfall). Days of elevated fire danger typically occurred with winds from a southerly arc. Though these observations are made based on weather analysis from nearby stations (within 100 km) it should be noted that elevated fire danger could occur at any time during the year, under the right weather conditions. The fire season for the area is also influenced by rainfall brought by monsoonal systems, with wet years usually leading to an increase in fuel loading (especially in the grass layer), and dry years resulting in reduced grass growth and lower fuel loads which may affect subsequent fire seasons.

Desktop analysis using ground truthed RE mapping indicates the DF is dominated by eucalypt dominated open woodlands (VHC 16.2, 19.2, 26.2), with smaller amounts of grassland (VHC 31.4) and low hazard vegetation (VHC 41.4, 42.6, 43.6). Indicative fuel loads for the bushfire hazardous vegetation within 150 m of the DF vary between 7.3 t/ha and 11.6 t/ha for the Eucalypt woodlands (QFES, 2019a).

The Project is located within undulating terrain, generally at elevations between 250 – 300 m above sea level, at the top of a hilly range that spans in a north-south direction.

Review of past bushfires in the local area surrounding the DRM, show that while not frequent, there is potential for significant bushfires in the area. This in conjunction with the elevated FFDI, significant bushfire

fuels and undulating topography, means that there is possibility for growth and spread of large bushfires to impact the proposed development, and as such, is a risk that requires appropriate management measures to reduce to an acceptable level.

5.2.1 Bushfire risk assessment

To determine whether sufficient separation from existing unmanaged Bushfire Prone vegetation exists to proposed infrastructure, 2-D radiant heat flux calculations were undertaken in accordance with AS 3959 Method 2, based on site specific fuel loads and topography, to achieve the target RHFs as follows:

- Proposed WTG and substation to achieve 29 kW/m^2 or lower (at 1090 K flame temperature)
- Proposed BESS units and Critical Infrastructure to achieve 10 kW/m^2 or lower (at 1200 K flame temperature)

Based upon the assessed extent of the vegetation clearing associated with the installation of the proposed infrastructure – that being the DF – there is sufficient space between the infrastructure and the bushfire risk (RHF assessed from vegetation). On this basis, appropriately sized Asset Protection Zones (APZs) will need to be established around the perimeter of all WTGs and BESS units, to achieve the target RHFs detailed in Section 4.1.2, in order to limit bushfire impact to an acceptable level, and ensure compliance with current planning legislation and guidance material. Covey is not aware of any specific reason why implementation of the APZs should not be achievable for the proposed development.

5.2.2 Future reporting requirements

While this NHRA has focused on bushfire hazard analysis and radiant heat flux impact, a Bushfire Management Plan (BMP) will need to accompany the development application to address the following:

- All proposed bushfire risk management measures, including
  - Vegetation Modification and Management, especially proposed APZ locations and extent
  - Vehicular Access Requirements (onsite)
  - Bushfire Fighting Water Supply
  - Infrastructure Design Requirements (to improve bushfire resilience)
- Implementation and ongoing management responsibilities for the proposed bushfire risk management measures
- Final bushfire compliance assessment against relevant State and Local Government policies, including relevant aspects of the following:
  - SPP - Natural hazards, risk and resilience – Bushfire.
  - State Code 23 – Wind Farm Development
  - State Code 27: Battery storage facility development
  - Cloncurry Shire Council Planning Scheme including Bushfire Hazard Overlay Code
  - CFA Design Guidelines and Model Requirements: Renewable Energy Fire Safety, which will be used for guidance on wind turbine compliance measures in bushfire prone areas.

5.3 Compliance Assessment

Covey has conducted an assessment against the bushfire and flooding related requirements of the following in the tables below (as noted):

- SPP - Natural hazards, risk and resilience – Bushfire (see Table 5-1)

- State Code 23 – Wind Farm Development (see Table 5-2)
- State Code 27: Battery storage facility development (see Table 5-3)
- Cloncurry Shire Council Planning Scheme including Bushfire Hazard Overlay Code (see Table 5-4)

As detailed in Section 5.2.2, the project BMP will provide more detail on the bushfire risk management strategy and associated mitigation measures, and as such, will include the final bushfire compliance assessment.

5.4 SPP - Natural hazards, risk and resilience – Compliance Assessment

Table 5-1. Development compliance SPP - Natural hazards, risk and resilience.

State Interest Policy		Compliance / Recommendations
1	Natural Hazard areas are identified including: (a) Bushfire prone areas (b) Flood hazard areas, (c) Landslide hazard areas, (d) Storm tide inundation areas, (e) Erosion prone areas.	As detailed in this NHRA, the majority of the development footprint, including proposed renewable energy infrastructure, has been identified within areas of ***Medium Potential***, ***High Potential*** and ***Very High Potential Bushfire Intensity*** on the SPP BPA mapping, due to large tracts unmanaged woodland vegetation, typically observed in more rugged terrain. The NHRA also notes that the development footprint does not contain any mapped flood hazard areas per State Planning Policy mapping overlays, however Dugald River to the east and Cabbage Tree Creek west of the DF are mapped as Flood Hazard Area – Level 1 – Queensland floodplain assessment overlay and Interim Flood Plain Assessment for the SPP and CSC mapping respectively. Consideration of hazards (c) to (e) are outside the scope of this NHRA.
2	A fit-for-purpose risk assessment is undertaken to identify and achieve an acceptable or tolerable level of risk for personal safety and property in natural hazard areas.	The project BMP accompanying the DA will detail a comprehensive bushfire risk management strategy and associated mitigation measures, to manage bushfire risk to the facility including people and property, while also managing the escape of onsite infrastructure to ignite a bushfire. This will be based on the guidance of the bushfire and renewable energy infrastructure hazard, bushfire risk analysis, the requirements of SC23, SC27 and Cloncurry Shire Council BHOC, and underpinned by relevant Model Requirements of the CFA Design Guidelines relating to renewable energy infrastructure. Though the DF is not impacted by the State Flood Hazard Overlay mapping, Covey has undertaken an assessment of potential flows from catchment areas around the DF. By analysing natural flow paths, several large catchments associated the development have been identified whereby the development crosses a natural flow path, and stormwater flows should be carefully considered to ensure the DF is not impacted, and vehicular access not impeded by these stormwater flows.

State Interest Policy		Compliance / Recommendations
		The flooding analysis calculations shown in the project NHRA are preliminary only and provide an estimation of the potential flooding within the development footprint. However, these results are preliminary and are not to be relied upon for detailed layout design. It is recommended that the flood extent and flood impact of the Project DF be determined as part of a detailed flood impact assessment (i.e. TUFLOW 2D flooding hydraulic analysis). This analysis if determined as needed would be undertaken prior to the construction phase of the project – no further flooding analysis would be required to support the planning approval.
3	Land in an erosion prone natural hazard area is not to be used for urban purposes, unless the land is located in: (a) an urban area in a planning scheme; or (b) an urban footprint identified in a regional plan.	**Not Applicable – Outside the scope of this project NHRA**
4	Development in bushfire, flood, landslide, storm tide inundation or erosion prone natural hazard areas: (a) avoids the natural hazard area; or (b) where it is not possible to avoid the natural hazard area, development mitigates the risks to people and property to an acceptable or tolerable level.	The siting of the proposed development in this location is required to be at the existing DRM site, and therefore alternative locations outside bushfire prone areas are not possible. The NHRA notes that the development footprint does not contain any mapped flood hazard areas per State Planning Policy mapping overlays. Given the bushfire hazard can't be avoided, the project BMP accompanying the DA will detail the mitigation strategy and measures required to be implemented into the proposed facility to appropriately manage the bushfire risk. The DF associated with this development is not impacted by the State Flood Hazard Overlay mapping; therefore, the development is considered as avoiding natural hazard (flooding) areas.
5	Development in natural hazard areas: (a) supports, and does not hinder disaster management capacity and capabilities, (a) directly, indirectly and cumulatively avoids an increase in the exposure or severity of the natural hazard and the potential for damage on the site or to other properties,	The proposed bushfire mitigation measures in the BMP will include: • Provision of appropriate separation from unmanaged vegetation to limit bushfire impact on proposed development. • Establish appropriate vehicular access across the site to all proposed infrastructure

State Interest Policy		Compliance / Recommendations
	(b) avoids risks to public safety and the environment from the location of the storage of hazardous materials and the release of these materials as a result of a natural hazard maintains or enhances the protective function of landforms and vegetation that can mitigate risks associated with the natural hazard.	• Utilises significant existing onsite firewater supplies and fire appliances for bushfire fighting purposes, and propose any required new firewater tank/s • The proposal is also supported by a Fire Safety Study addressing the onsite fire risk associated with the BESS and substation part of the facility, and a Emergency Management Plan for the facility proposing a number of emergency management procedures for the wind turbines. Given the above: • The proposed bushfire risk management strategy supports disaster management capacity and capabilities, by reducing burden on emergency services personnel through minimisation of bushfire impact (or spread) and improvement of onsite vehicular access and firewater supplies. • Avoids an increase in the exposure and severity of bushfire hazard through provision of appropriate separation from unmanaged vegetation to limit bushfire impact on proposed infrastructure, while preventing escape of onsite fire events to ignite a bushfire. Additionally, a number of fire protection measures are proposed to infrastructure to improve bushfire resilience, and to enable early onsite fire detection and suppression. • Similarly to the point above, the proposed separation from unmanaged vegetation, as well as fire protection measures, vehicular access and firewater, ensures that the BESS containers are well protected from bushfire impact, and not considered likely to exacerbate a bushfire, not ignite a bushfire in the unlikely event of an onsite BESS fire.

State Interest Policy		Compliance / Recommendations
		The DF associated with this development is not impacted by the State Flood Hazard Overlay mapping; therefore, the development is considered as avoiding natural hazard (flooding) areas
6	Community infrastructure is located and designed to maintain the required level of functionality during and immediately after a natural hazard event.	**Not Applicable – No community infrastructure is proposed as part of this development**
7	Coastal protection work in an erosion prone area is undertaken only as a last resort where coastal erosion or inundation presents an imminent threat to public safety or existing buildings and structures, and all of the following apply: (a) The building or structure cannot reasonably be relocated or abandoned. (b) Any erosion control structure is located as far landward as practicable and on the lot containing the property to the maximum extent reasonable. Any increase in coastal hazard risk for adjacent areas from the coastal protection work is mitigated.	**Not Applicable – Outside the scope of this NHRA**
8	Erosion prone areas within a coastal management district: Development does not occur unless the development cannot feasibly be located elsewhere and is: (a) coastal-dependent development; or (b) temporary, readily relocatable or able to be abandoned development; or (c) essential community infrastructure; or (d) minor development of an existing permanent building or structure that cannot be relocated or abandoned.	**Not Applicable – Outside the scope of this NHRA**
9	*Erosion prone areas within a coastal management district:* Development permitted in policy 8 above, mitigates the risks to people and property to an acceptable or tolerable level.	**Not Applicable – Outside the scope of this NHRA**

5.5 State Code 23 (Wind Farms) – Compliance Assessment

Covey have conducted an assessment against the bushfire and flooding related Performance Outcomes of SC23 in Table 5-2, omitting the following on the basis that they don't specifically relate to management of either risk and therefore outside the scope of this NHRA, and assumed to be addressed in other relevant reporting (as required):

- PO1 to PO4 (Protected wildlife and associated habitats and areas of high ecological value)
- PO5 (Agricultural Land)
- PO6 (Natural Drainage Patterns)
- PO7 to PO9 (Protecting water quality and erosion control)
- PO12 and PO13 (Acoustic Amenity)
- PO14 (Electromagnetic Interference)
- PO15 (Shadow Flicker)
- PO16 (Social Impacts)
- PO17 (Areas identified by state or local government planning instruments as having high scenic amenity)
- PO18 to PO21 (Transport Networks)
- PO22 and PO23 (Aviation safety, integrity and efficiency)
- PO24 to PO27 (Decommissioning)

Table 5-2. State Code 23 (Wind Farm) Assessment Criteria – Bushfire and Flooding Only

Performance Outcomes	Response
Natural hazards and extreme weather events	
PO10 Development is located, designed, constructed and operated to be responsive to natural hazards and extreme weather events	As detailed in this NHRA, the majority of the development footprint, including proposed renewable energy infrastructure, has been identified within areas of ***Medium Potential***, ***High Potential*** and ***Very High Potential Bushfire Intensity*** on the SPP BPA mapping. The siting of the proposed development in this location is required to be at the existing DRM site, and therefore alternative locations outside bushfire prone areas are not possible. Given the bushfire hazard can't be avoided, the project BMP accompanying the DA will detail a comprehensive bushfire risk management strategy and associated mitigation measures, to
PO11 Development is constructed and operated to protect the safety of people in the event of natural hazards or extreme weather events occurring.	

Performance Outcomes	Response
	manage bushfire risk to the facility including people and property, while also managing the escape of onsite infrastructure to ignite a bushfire. This will be based on the guidance of the bushfire and renewable energy infrastructure hazard, bushfire risk analysis, the requirements of SC23, SC27 and Cloncurry Shire Council BHOC, and underpinned by relevant Model Requirements of the CFA Design Guidelines relating to renewable energy infrastructure. The DF associated with this development is not impacted by the State Flood Hazard Overlay mapping; therefore, the development is considered as avoiding natural hazard (flooding) areas

5.6 State Code 27 (BESS) – Compliance Assessment

Covey have conducted an assessment against the bushfire and flooding related Performance Outcomes of SC23 in Table 5-3, omitting the following on the basis that they don't specifically relate to management of either risk and therefore outside the scope of this NHRA, and assumed to be addressed in other relevant reporting (as required):

- PO1 (Areas of high ecological value and associated wildlife habitats)
- PO8 (Social Impacts)
- PO9 and PO12 (Agricultural Land)
- PO16 to PO19 (Protecting Water Quality and Erosion Control)
- PO20 to PO21 (Acoustic Amenity and Vibration)
- PO22 (Visual Impact)
- PO23 (Lighting)
- PO24 to PO28 (Transport Networks)
- PO29 and PO30 (Infrastructure)
- PO31 to PO35 (Decommissioning)

Table 5-3. State Code 27 (BESS Facilities) Assessment Criteria – Bushfire and Flooding Only

Performance Outcomes	Response
Risk mitigation	
PO2 Development is designed, sited and constructed to ensure that risks from physical hazards, chemical hazards and battery failure hazards are avoided and/or mitigated with respect to: • **human health** and **safety;** and • the built and natural **environment**.	The project Fire Safety Study is the key document for reviewing the onsite fire risk associated with the BESS and substation part of the facility, and which addresses most of PO2, PO3 and PO4. Regarding potential bushfire impact, the BMP will detail proposed bushfire mitigation measures such as: • Provision of appropriate separation from unmanaged vegetation to limit bushfire impact on proposed BESS infrastructure, in addition to a number of bushfire resilience design measures (e.g. ember protection). • Establish appropriate vehicular access to the BESS infrastructure Given the above measures, the proposed BESS facility will be protected from bushfire primarily: • Through provision of appropriate separation from unmanaged vegetation to limit bushfire impact on proposed BESS infrastructure, which also serves to prevent escape of onsite fire events to ignite a bushfire. • A number of fire protection measures are proposed to the BESS infrastructure to improve bushfire resilience, and to enable early onsite fire detection and suppression. • The proposed separation from unmanaged vegetation, as well as fire protection measures, vehicular access and firewater, ensures that the BESS containers are well protected from bushfire impact, and not considered likely to exacerbate a bushfire, not ignite a bushfire in the unlikely event of an onsite BESS fire.
PO3 Development mitigates the risks of fire, explosion and thermal runaway from battery storage infrastructure.	
PO4 Development is designed to ensure fire and thermal events can be contained and isolated to prevent escalation and propagation to other developments and uses on and offsite.	
Incident response	
PO5 Development is designed to facilitate effective and efficient emergency service access and response in the event of a fire, bushfire (including cleared fire fighting areas at the interface of hazardous vegetation), explosion, contamination leak or any other incident requiring an emergency service response.	The project Fire Safety Study and Emergency Management Plan is the key documents for reviewing the required fire protection measures (including fire water) and onsite incident response for the proposed BESS infrastructure. Regarding potential bushfire impact, the BMP will propose bushfire mitigation measures such as:
PO6 The development:	

Performance Outcomes	Response
• provides appropriate fire detection, monitoring and notification to the site operator; and • ensures the electrical safety of the facility, in the event of an incident requiring emergency response.	• Provision of appropriate separation from unmanaged vegetation to limit bushfire impact on proposed BESS infrastructure, which includes a non-vegetated zone at the external perimeter interface • Vehicular access around the perimeter of the BESS containers to support a bushfire fighting response.
PO7 Development demonstrates that there is capacity to provide a reliable, sustainable and fit-for-purpose water supply.	
Natural hazards	
PO13 Development is located and sited to avoid **natural hazard** areas including **high erosion risk** areas and **bushfire prone areas.**	As detailed in this NHRA, the majority of the development footprint, including proposed renewable energy infrastructure, has been identified within areas of ***Medium Potential***, ***High Potential*** and ***Very High Potential Bushfire Intensity*** on the SPP BPA mapping. The siting of the proposed development in this location is required to be at the existing DRM site, and therefore alternative locations outside bushfire prone areas are not possible. The NHRA also notes that the development footprint does not contain any mapped flood hazard areas per State Planning Policy mapping overlays, however Dugald River to the east and Cabbage Tree Creek west of the DF are mapped as Flood Hazard Area – Level 1 – Queensland floodplain assessment overlay and Interim Flood Plain Assessment for the SPP and CSC mapping respectively. The DF associated with this development is not impacted by the State Flood Hazard Overlay mapping; therefore, the development is considered as avoiding natural hazard (flooding) areas
PO14 Where development cannot be located and sited to avoid **natural hazard** areas (e.g. **Bushfire prone areas**, and **high erosion risk** areas), demonstrate that: • there is no suitable alternative location; • infrastructure can function effectively during and after a **natural hazard** event; and • mitigation measures are implemented to reduce the risk to people, property and the **environment** to a tolerable level.	The siting of the proposed development in this location is required to be at the existing DRM site, and therefore alternative locations outside bushfire prone areas are not possible. The NHRA notes that the development footprint does not contain any mapped flood hazard areas per State Planning Policy mapping overlays. Given the bushfire hazard can't be avoided, the project BMP accompanying the DA will detail a comprehensive bushfire risk management strategy and associated mitigation measures, to manage bushfire risk to the facility including people and property, while also managing the escape of onsite infrastructure to ignite a bushfire. This will be based on the guidance of the bushfire and renewable energy infrastructure hazard, bushfire risk analysis, the requirements of SC23, SC27 and Cloncurry Shire Council BHOC, and underpinned by relevant Model

Performance Outcomes	Response
	Requirements of the CFA Design Guidelines relating to renewable energy infrastructure.
PO15 Bushfire hazard is identified and risk is mitigated through strategies for vegetation management, landscape management, water supply, provision of appropriate access, identification of safe assembly or evacuation routes and establishing cleared and maintained asset protection zones around infrastructure that is wholly contained on site.	The project BMP will detail the mitigation strategy and measures required to be implemented into the proposed facility to appropriately manage the bushfire risk, and includes strategies for vegetation modification and management, vehicular access, bushfire fighting water supply, a number of design and construction measures to improve bushfire resilience and ongoing management measures. The project Fire Safety Study and Emergency Management Plan is the key documents for reviewing the required fire protection measures and onsite incident response for the proposed BESS infrastructure.

5.7 Cloncurry Shire Council: Bushfire Hazard Overlay Code – Compliance Assessment

Covey have conducted an assessment against the bushfire-related Performance Outcomes and Acceptable Outcomes of the Cloncurry Shire Council Planning Scheme Bushfire Hazard Overlay Code (from Assessment Benchmarks for Assessable Development in Table 7.2.2.3-1) in Table 5-4 below.

Table 5-4. Bushfire Hazard Overlay Code s7.2.2.3 Assessment Benchmarks for Assessable Development (Table 7.2.2.3-1) Cloncurry Shire Council

Performance Outcomes	Acceptable Outcomes	Solutions
Siting and design of development		
PO1 Development maintains the safety of people and property by avoiding land within a bushfire hazard area (bushfire prone area).	**AO1.1** Development is located on land that is not subject to land within a bushfire hazard area (bushfire prone area). **OR** **AO1.2** Where development is located on land within a bushfire hazard area (bushfire prone area) (except for single dwellings on existing lots), it must comply with a Bushfire Management Plan prepared for the premises.	**Complies with AO1.2** As detailed in this NHRA, the majority of the development footprint, including proposed renewable energy infrastructure, has been identified within areas of ***Medium Potential***, ***High Potential*** and ***Very High Potential Bushfire Intensity*** on the SPP BPA mapping. The siting of the proposed development in this location is required to be at the existing DRM site, and therefore alternative locations outside bushfire prone areas are not possible. A BMP has been prepared to accompany the DA, and details the mitigation strategy and measures required to be implemented into the proposed facility to appropriately manage the bushfire risk.
PO2 A vulnerable use is not established or materially intensified within a bushfire hazard area (bushfire prone area) unless there is an overriding need or other exceptional circumstances. Note: Vulnerable uses are those involving:	**AO2.1** Vulnerable uses are not established or expanded.	**Not applicable to this planning application as no vulnerable use is proposed**

Performance Outcomes	Acceptable Outcomes	Solutions
(1) The accomodation or congregation of vulnerable sectors of the community such as child care centres, community care centre, educational establishments, detention facilities, hospitals, rooming accomodation, retirement facilities or residential care facilities; or (2) The provision of essential services including community uses, emergency services, utility installation, telecommunications facility, substations and major electricity infrastructure.		
PO3 Where reconfiguration of a lot is undertaken a formed, all weather access fire trail is provided between the hazardous vegetation and either the lot boundary or building envelope, and is readily accessible at all times for the type of fire fighting vehicles servicing the area. Editors's Note: A fire trail will not be required where it would not serve a practical fire management purpose.	**AO3.1** Lot boundaries are separated from hazardous vegetation by a public road or fire trail which has: (1) a reserve or easement width of at least 20m; (2) a minimum trafficable (cleared and formed) width of 4m capable of accomodating a 15 tonne vehicle and which is at least 6m clear of vegetation; (3) no cut or fill embankments or retaining walls adjacent to the 4m wide trafficable path; (4) a minimum of 4.8m vertical clearance; (5) turning areas for fire-fighting applicances in accordance with Qld Fire and Emergency Services' fire Hydrant and Vehicle Access Guidelines; (6) a maximum gradient of 12.5%; (7) a crossfall of no greater than 10 degrees;	**Not applicable to this planning application as no reconfiguration of a lot is proposed**

Performance Outcomes	Acceptable Outcomes	Solutions
	(8) drainage and erosion control devices in accordance with the standards prescribed in a planning scheme policy; (9) vehicular access at each end which is connected to the public road network; (10) designated fire trail signage; (11) if used, has gates locked with a system authorised by Qld Fire and Emergency Services; and (12) if a fire trail, has an access easement that is granted in facour of council and Qld Fire and Emergency Services.	
PO4 Where material change of use occurs the development is located and designed to ensure proposed buildings or building envelopes achieve a radiant heat flux level at any point of the building envelope respectivfely, of: (1) 10 kW/m^2 where involving a vulnerable use; or (2) 29 kW/m^2 otherwise. The radiant heat flux level is achieved by separtion unless this is not practically achievable. Editor's note: The radiant heat levels and separation distances are to be established in accordance with method 2 set out in AS3959-2009.	**AO4.1** Buildings or building envelopes are separated from hazardous vegetation by a distance that; (1) acheives a radient heat flux level of at any point on the building orenvelope respectively, of 10kW/m^2 for a vulnerable use or 29 kW/m^2 otherwise; and (2) is contained wholly within the development site. Editor's note: Where a separation distance is proposed to be achieved by utilising existing cleared developed areas external to the site certainly must be established (through tenure or other means) that the land will remain cleared of hazardous vegetation. For staged developments, temporary separation distances, perimeter roads or fire trails may be absorbed as part of subsequent stages. Editor's note: The achievement of a cleared separation distance may not be acheivable where other provisions within the planning scheme require protection of certain ecological, slope, visual or character features or functions.	**Complies with AO4.1** The only buildings proposed as part of the facility are the office/control room and workshop/storage containers, and the switchrooms, at the BESS yard. As detailed in the BMP, all are to have a APZ established around their perimeter (based on current locations) such that they are sited in areas of 29 kW/m^2 or lower. Each APZ is to be wholly located within the development site.
Emergency Evacuation Access		

Performance Outcomes	Acceptable Outcomes	Solutions
PO5 For development that will result in multiple buildings or lots, roads and access are designed to mitigate against bushfire hazard by ensuring adequate routes for: (a) fire-fighting and other emergency vehicles; and (b) the evacuation of people in the event of an emergency.	**AO5.1** Residential lots are designed so that their size and shape allow for efficient emergency access to buildings for fire-fighting appliances (e.g. by avoiding long narrow lots with long access drives to buildings). **AO5.2** Firebreaks are provided by a perimeter road that: (a) separates lots from areas of bushfire hazard; (b) has a minimum cleared width of 20 metres; (c) has a formed road width of 4m; and (d) complies with road standards as outlined in PSP3 Operational Works and Services. **AO5.3** Fire maintenance trails are located as close as possible to the boundaries of the lots and the adjoining bushland hazard, and: (a) have a minimum width of 6m; (b) have a formed width and gradient, and erosion control devices in accordance with Section 9.4.6 – Operational works and services code; (c) have a maximum gradient of 1 in 8 (12.5%); (d) are constructed and maintained to prevent erosion, provide adequate drainage and provide continuous access for fire fighting vehicles; (e) provide passing bays and turning areas for fire-fighting appliances; and (f) are either located on public land or within an access easement that is granted in favour of Cloncurry Shire Council and the QFRS (Queensland Fire and Rescue Service).	**Complies with AO5.6** A BMP has been prepared to detail the mitigation strategy and measures required to be implemented into the proposed facility to appropriately manage the bushfire risk.

Performance Outcomes	Acceptable Outcomes	Solutions
	AO5.4 Vehicular access is provided along and at each end of the fire break to existing fire maintenance trails or roads. **AO5.5** The development includes sufficient cleared breaks of 6m minimum width in retained bushland within the development (e.g. creek corridors and retained vegetation), to allow burning of sections and access for bushfire response. **AO5.6** Where development is located on land within a bushfire hazard area (bushfire prone area) (except for single dwellings on existing lots), development complies with a Bushfire Management Plan for the premises.	
Hazardous Materials		
PO6 Public safety and the environment are not adversely affected by the detrimental impacts of bushfire on the manufacture or storage of hazardous materials in bulk.	**AO6.1** Development complies with a Bushfire Management Plan for the premises.	**Complies with AO6.1** A BMP has been prepared to detail the mitigation strategy and measures required to be implemented into the proposed facility to appropriately manage the bushfire risk. As a minimum, the BMP will require a suitably sized NVZ/APZ is established around the perimeter of the BESS containers to achieve 10 kW/m^2 or less at the containers. Given the significant level of separation from the bushfire hazard, the bushfire impact on the stored hazardous goods should not be detrimental to public safety or the environment.

Performance Outcomes	Acceptable Outcomes	Solutions
Community Infrastructure and Essential services		
PO7 Essential services infrastructure within a site (including electricity, gas, water supply, wastewater and telecommunications), maintains its function during and immediately after bushfire events.	**AO7.1** Essential services infrastructure is located on land that is not subject to land within a bushfire hazard area (bushfire prone area).	**Not Applicable**
Water Supply		
PO8 Development provides an adequate and accessible water supply for fire-fighting purposes.	**AO8.1** Development involving new or existing buildings with a gross floor area greater than 50 m2 on each lot has: (a) a reliable reticulated water supply that has sufficient flow and pressure characteristics for firefighting purposes at all times (minimum pressure and flow is 10 litres a second at 200 kPa); **OR** (b) an on-site water storage of not less than 5,000 litres (e.g. accessible dam or tank with fire brigade tank fittings, swimming pool) for fire-fighting purposes which is: (i) fireproof; (ii) fitted with fire brigade tank fittings; (iii) accessible for fire fighting vehicles; and (iv) connected to a pump that is independent of mains electricity supply.	**Complies with AO8.1** The majority of the firewater requirements for the facility will be derived from the project FSS. A BMP has been prepared to detail the mitigation strategy and measures required to be implemented into the proposed facility to appropriately manage the bushfire risk, and will address any additional firewater requirements for bushfire fighting. Given the substantial existing firewater onsite at the mine and Accommodation Camp, the minimum static firewater requirements stated in AO8.1 (b) will be met.

6 References

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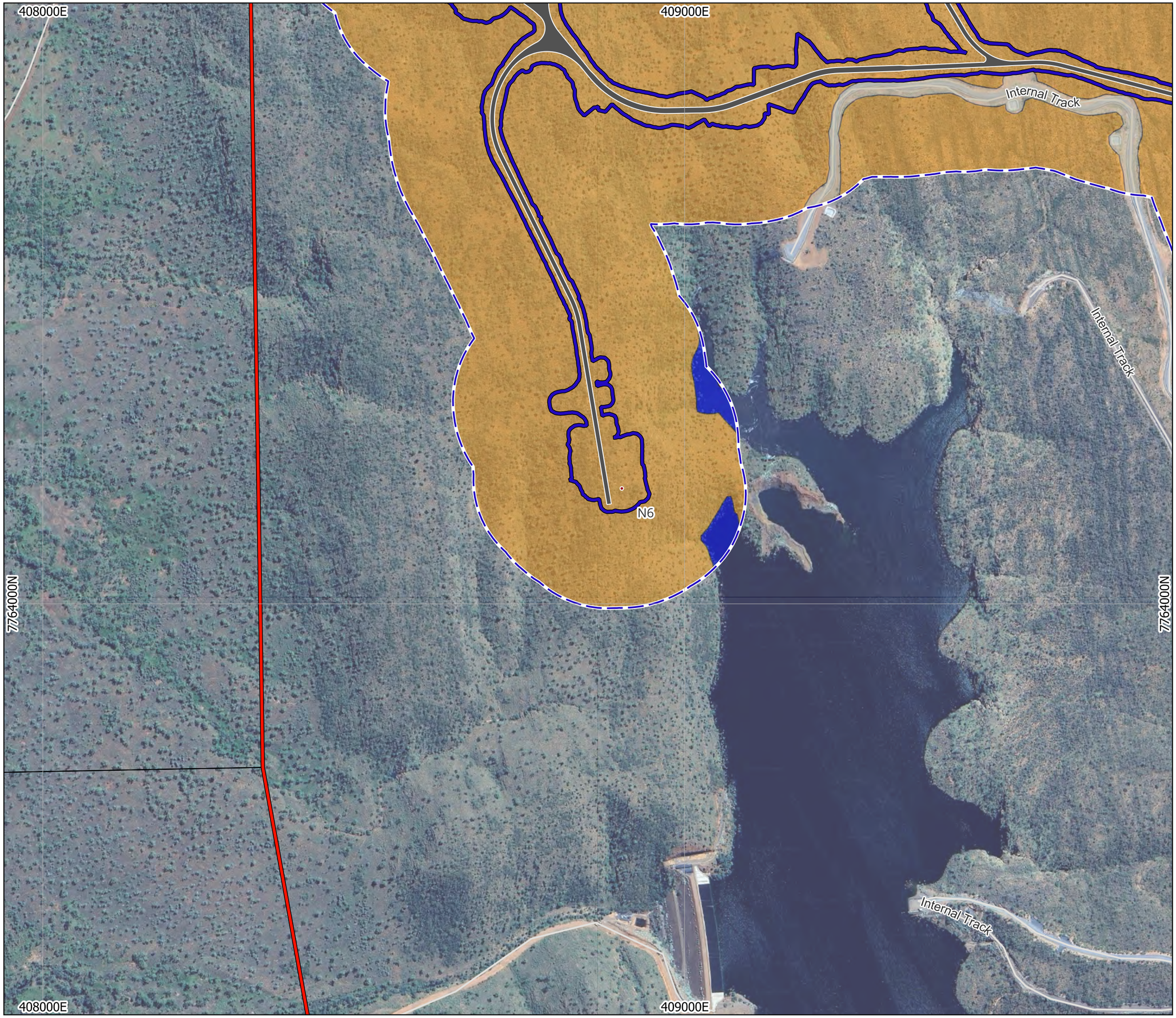
APPENDIX A

DETAILED MAPS OF VEGETATION HAZARD CLASS WITHIN 150 M OF DUGALD RIVER WIND FARM



Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 2

Roads and Tracks

- Unconfirmed

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box
- 42.6 Nil to very low vegetation cover
- 43.6 Water bodies or very low vegetation cover

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E
410000E
7766000N
7765000N
N3
N4
N1
N2A
N5

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 2

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E
410000E
7763000N
7762000N
S1
S2
Internal Track
Internal Track
Internal Track
Internal Track
Internal Track

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- Easement
- Compound Area Stage 1
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 16.2 Eucalyptus dominated woodland on drainage lines and alluvial plains
- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box
- 42.6 Nil to very low vegetation cover
- 43.6 Water bodies or very low vegetation cover

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E

410000E

7760000N

WTG02

WTG03

S4

Internal Track

Internal Track

Internal Track

409000E

410000E

7760000N

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 33 kV OHL
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box
- 42.6 Nil to very low vegetation cover

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E
410000E
7760000N
7759000N
WTG03
S4
S5
Internal Track

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 33 kV OHL
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E

410000E

7758000N

7758000N

S6

S7

WTG04

WTG05

409000E

410000E

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 33 kV OHL
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 2

Roads and Tracks

- Unconfirmed

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box
- 42.6 Nil to very low vegetation cover
- 43.6 Water bodies or very low vegetation cover

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

410000E

411000E

7763000N

Internal Track

Internal Track

Internal Track

Internal Track

Internal Track

410000E

411000E

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- Easement
- Compound Area Stage 1

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box
- 41.4 Discontinuous low grass or tree cover
- 42.6 Nil to very low vegetation cover

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E

410000E

7761000N

Internal Track

WTG01

Internal Track

BESS and substation

Internal Track

Internal Track

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 220 kV OHL
- 220 kV OHL EASEMENT
- 33 kV OHL
- Met. mast
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 16.2 Eucalyptus dominated woodland on drainage lines and alluvial plains
- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box
- 42.6 Nil to very low vegetation cover

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

412000E

413000E

7761000N

Internal Track

Mmg Dugald River Mine Access Road

412000E

413000E

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 220 kV OHL
- 220 kV OHL EASEMENT

Roads and Tracks

- Local
- Unconfirmed

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 16.2 Eucalyptus dominated woodland on drainage lines and alluvial plains
- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box
- 41.4 Discontinuous low grass or tree cover
- 42.6 Nil to very low vegetation cover
- 43.6 Water bodies or very low vegetation cover

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E
410000E
7757000N
7756000N
WTG06
WTG07

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 220 kV OHL
- 33 kV OHL
- Met. mast
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1

Roads and Tracks

- Unconfirmed

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E
410000E
WTG08
S9
S8
7755000N
7755000N
409000E
410000E

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 33 kV OHL
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

411000E

412000E

7761000N

Internal Track

Internal Track

Internal Track

Internal Track

Internal Track

Internal Track

411000E

412000E

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 220 kV OHL
- 220 kV OHL EASEMENT

Roads and Tracks

- Unconfirmed

Verified VHC mapping within 150 m of DF using Regional Ecosystems from ecological assessment

- 16.2 Eucalyptus dominated woodland on drainage lines and alluvial plains
- 19.2 Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box
- 41.4 Discontinuous low grass or tree cover
- 42.6 Nil to very low vegetation cover
- 43.6 Water bodies or very low vegetation cover

NHRA VHC detailed mapping

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised VHC mapping for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

APPENDIX B

EFFECTIVE AND SITE SLOPE DEFINITIONS

Topography can influence the rate of spread and flame parameters of bushfires, therefore effecting the potential Radiant Heat Flux (RHF). Method 2 of AS3959 requires the input of two specific slope values to determine the RHF; these are:

- Effective slope – the slope under the classified vegetation that most influences the bushfire attack; and
- Site slope – the slope of the land between the classified vegetation and the proposed infrastructure.

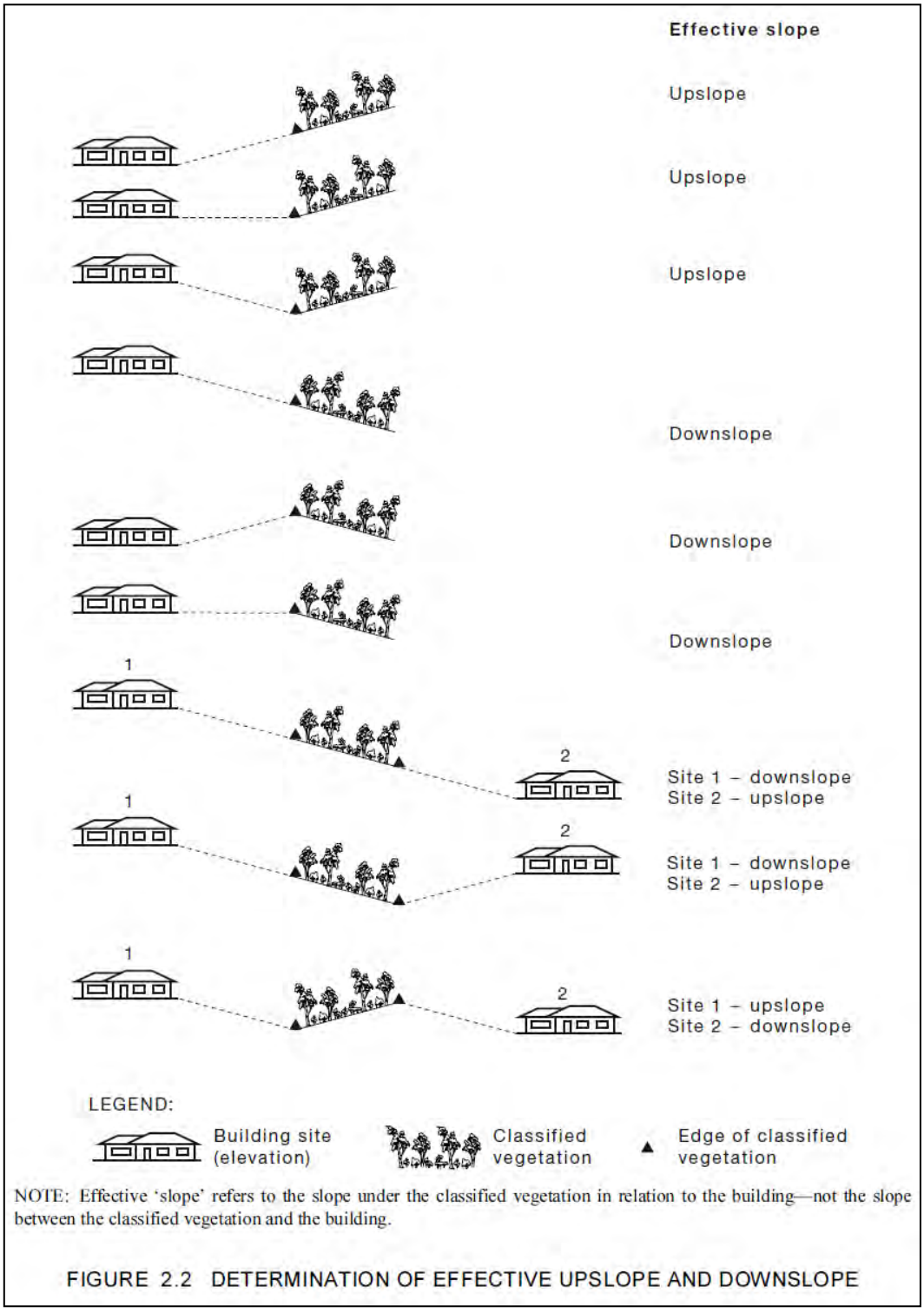
The site slope can affect the view factor, and therefore the results of the RHF impact on the infrastructure. The effective slope input influences the RHF calculations the most, therefore the determination of this slope becomes more critical. The slopes are categorised as 'upslope' or 'downslope' which is dependent upon the position of the building or infrastructure in relation to the classified vegetation (Australian Standards 2018):

- Downslope – If the land beneath the classified vegetation slopes downward from the edge closest to the infrastructure, it is regarded as 'downslope'—even if the terrain between the infrastructure and the vegetation edge varies in gradient; and
- Upslope – If the terrain beneath the classified vegetation rises from the edge closest to the infrastructure, it is classified as 'upslope,' regardless of how the ground slopes between the infrastructure and that vegetation edge.

The slope value inputs are reported in units of degrees, the input value of the effective slope is capped at 30 degrees downslope, and site slope is capped at 20 degrees regardless of slope category. The reason for these slope caps is that convective heat release in bushfires is no longer negligible in understanding the heat flux exposure on the infrastructure (Australian Standards 2018).

Plate 1 overleaf aims to provide clarity for determining the category of the effective slopes and whether the slope value used represents is an input value of up to 30 degrees (downslope) or 0-degrees (for all upslope scenarios).

The slope input values should be determined by site assessment, and the appropriate slope value can be adopted to determine the required setback distance to be applied between the classified vegetation and the infrastructure.



NOTE: Effective 'slope' refers to the slope under the classified vegetation in relation to the building—not the slope between the classified vegetation and the building.

FIGURE 2.2 DETERMINATION OF EFFECTIVE UPSLOPE AND DOWNSLOPE

Plate 1 - Visual aid for determining Slope Category *(Source: Australian Standards 2018)***.**

APPENDIX C

LIMITATIONS OF STUDY

Fire weather and bushfire behaviour are, by nature, difficult to predict with certainty, and as such limitations exist when predicting bushfires and designing for bushfire mitigation. The following limitations are noted:

- Fuel loads are based on State dataset and not site-specific fuel measurements,
- The assessment is primarily desktop-based and relies on various data inputs, some of which may be outdated.
- Fire behaviour at high fire danger ratings and under the influence of fire-induced winds driven by strong convection rates may become erratic beyond the bounds of prediction models (Cruz *et al.*, 2012), and
- Human-induced Climate Change may exacerbate fire behaviour and affect vegetation structure and floristics in different ways than those assumed in this study (Dowdy, 2018).

Also, the radiant heat modelling methodology:

- Assumes an omni-directional head-fire approaching the asset, however days of elevated fire weather tend to be from specific directions.
    - In this case, southerly wind signatures are typically associated with hazardous fire weather days, therefore large wildfires are likely to be approaching the development from those directions,
- Adopts older iterations of fire rate of spread models (per statutory standards such as AS 3959).
    - Most of these were formulated based on experiments undertaken in Victoria, in areas with fuel loads and structures vastly different from the ones for the study area. It is therefore hard to determine how accurately these models predict local fire behaviour, and
- Disregards interaction between weather parameters with topography and fuels, such as:
    - Rainfall and its interaction with fuels. For example, high rainfalls lead to increased vegetation growth and hence fuel loading. Different vegetation communities also dry out at varying rates, with grasslands curing faster than forests. This leads to fuel availability differentials after wet periods, and
    - Wind and its interaction with topography. Winds tend to channel and create eddies in high rugosity areas, such as hills, valleys, and slopes, leading to local conditions that can be significantly different from predicted prevailing wind directions and speeds. This in turn may lead to ‘unpredictable’ fire behaviour within those areas.
- Assumes that fuels are contiguous, with standard VHC fuel loading, and without land management treatments (e.g., grazing) being accounted for.
    - As such, the calculations are likely to be a snapshot in time rather than providing an overview of the potential outcomes of a wildfire impact.
- Does not accurately quantify potential fire intensities, nor can it identify likely fire paths that are likely to be experienced within the study area.
    - If the above parameters are to be investigated Covey recommends undertaking a dynamic and/or probabilistic bushfire behaviour analysis.

APPENDIX D

INFERNO-BAL RADIANT HEAT FLUX MODEL METHODOLOGY

INFERNO-BAL METHODOLOGY

Inferno-BAL is a module of the Inferno geospatial system designed by Covey Associates, to calculate radiant heat flux (RHF) and Bushfire Attack Level (BAL) from Method 2 in the AS3959 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 (tens of kilometres) at high spatial resolution (metre scale). All intensive computations utilise graphics processing units (GPUs) where possible allowing the rapid calculation of RHF 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 RHF at a given point is dependent on the flame length which, in turn, is strongly dependent on the effective slope of the vegetation. The AS3959 standard defines the effective slope as that *which most influences the bushfire attack*. To determine this 'most influential' slope Inferno-BAL calculates the effective slope in all directions around the given point and uses the maximum view factor from all directions to calculate the final RHF for the BAL value.

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 which most influences 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

The software first undertakes the following pre-processing actions:

1. Verify the input layers; and
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 (for example, water bodies).

View Factor and Effective Slope Calculation

Next the view factor from all possible directions is calculated as illustrated in Figure 1. The red circle is the point at which the BAL is required, the radial black lines are example search paths (only a fraction of which are shown in Figure 1) and the green polygons are patches of fuel. Two example fuels are shown here marked A and B.

The maximum search path length is defined by the user in the *maximum distance* input. The effective slope is calculated from the average gradient of the elevation along a transect from the intersection of the search path and the vegetation. The length of this transect is defined by the user, by default this is 20 m into the vegetation. These transects are shown as the dashed lines in Figure 1. A search path is ignored if it does not intersect any vegetation. The angular increment between the paths ensures every cell at the end of the search path is covered. For a maximum path length of 200 m this results in several thousand search paths per point.

To prevent very short vegetation transects from having an undue influence over the resultant radiant heat flux an optional minimal transect length is applied. By default, this is 1 m. Any paths less than this length are ignored in the calculation.

Many different methods were tested for the effective slope, including the gradient of the slope at the vegetation edge, and the maximum and median slopes along the line. The average gradient method was found to give the smoothest and least sensitive slope measurements within the vegetation out of all the methods tested.

In some cases, vegetation producing higher flame lengths may be behind intervening vegetation. For example, vegetation A in Figure 1 may produce shorter flame lengths and subsequently lower RHF than vegetation B. The calculation assesses up to 4 different vegetation types along each search path and takes the maximum of these as the resulting flame length. Search paths with multiple vegetation types are shown with double lines in Figure 1.

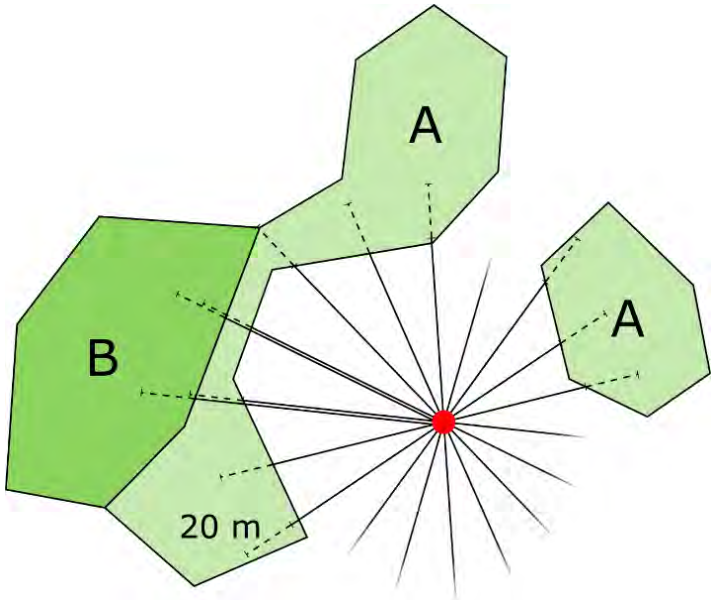


Figure 1 - Radiant heat flux calculation from point (red circle) along various search paths (black lines) to nearby vegetation (green polygons).

Rate of Spread and Distance Calculation

The encoded vegetation characteristics from the vegetation layer are then used to determine which of the eight AS3959 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 and distance to the vegetation is then used in the AS3959 view factor calculation. This uses the assumption of a rectangular flame with a fixed width (Eq. B8). The full AS3959 calculation uses an intensive iterative process for the RHF which is too computationally intensive to calculate for each search path. Instead, the view factor is found for a site slope of zero and flame angle of 90 degrees, representing the worst case. The search path resulting in the maximum view factor is found from all possible search paths.

Site Slope Calculation

Once the search path giving the maximum view factor is found, the site slope is calculated using the arctangent of the difference in elevation over this search path divided by the length of the vector. The site slope is clamped from -20 to 20 degrees, as in the AS3959 Method 2 standard.

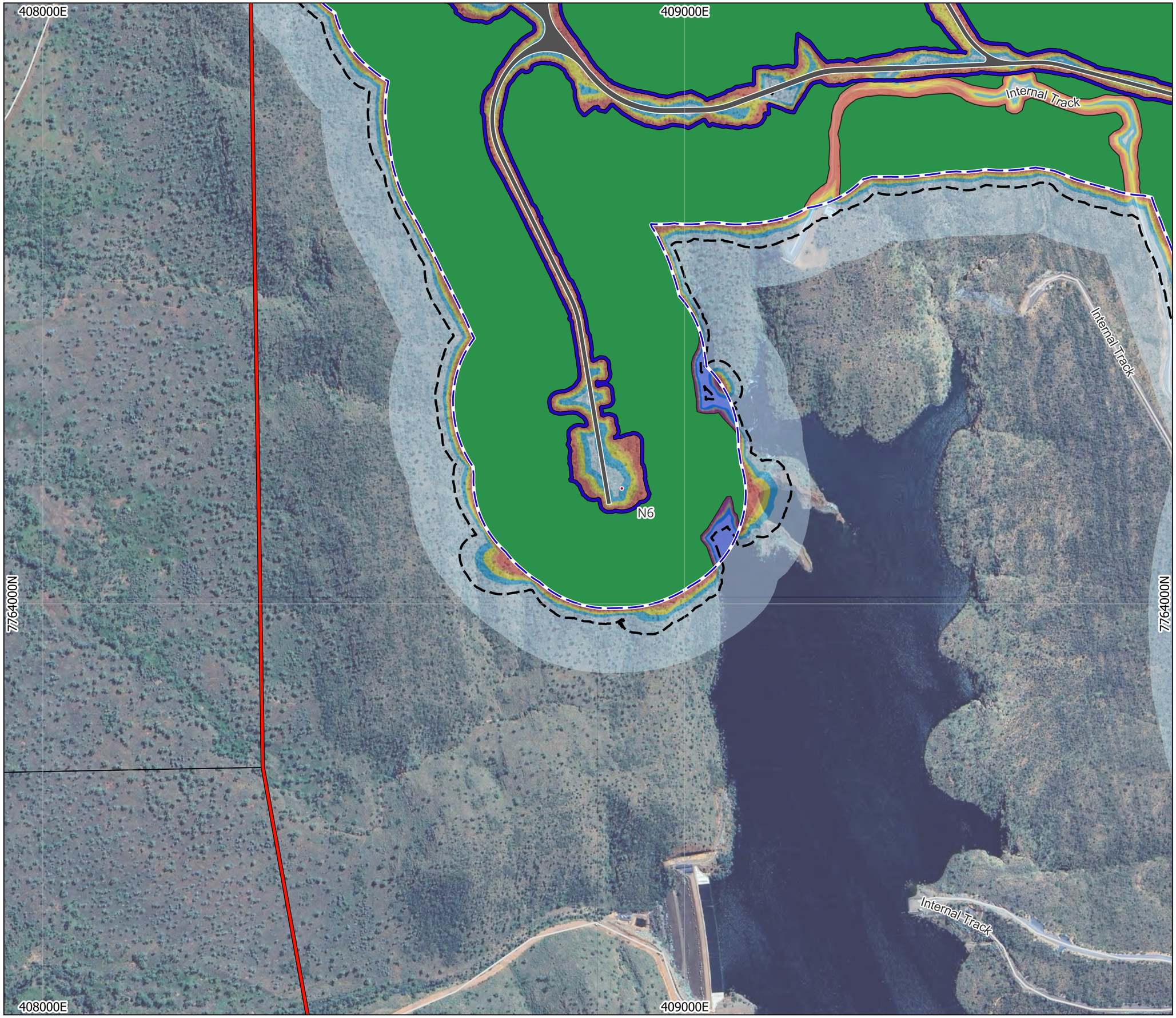
Radiant Heat Flux calculation

The RHF is then calculated using the full AS3959 iterative process at the calculation point for the search path giving the maximum view factor. 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).

This process is repeated for every point within the given area, resulting in a continuous map of RHF. The final steps in the process are to find the maximum radiant heat flux in each polygon plot, if supplied, to categorise these into the BAL levels and to generate the vector isolines of the radiant heat flux.

APPENDIX E

RADIANT HEAT FLUX RESULTS DETAILED MAPS



Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 2

Roads and Tracks

- Unconfirmed

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E
410000E
7766000N
7765000N
N3
N4
N1
N2A
N5

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 2

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E
410000E
7763000N
7762000N
S1
S2
Internal Track
Internal Track
Internal Track
Internal Track
Internal Track

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- Easement
- Compound Area Stage 1
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E

410000E

7760000N

WTG02

WTG03

S4

Internal Track

Internal Track

Internal Track

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 33 kV OHL
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E
410000E
7760000N
7759000N
WTG03
S4
S5
Internal Track

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 33 kV OHL
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E

410000E

7758000N

7758000N

S6

S7

WTG04

WTG05

409000E

410000E

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 33 kV OHL
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

410000E

Internal Track

N8

N7

Internal Track

Internal Track

7764000N

7764000N

410000E

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 2

Roads and Tracks

- Unconfirmed

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

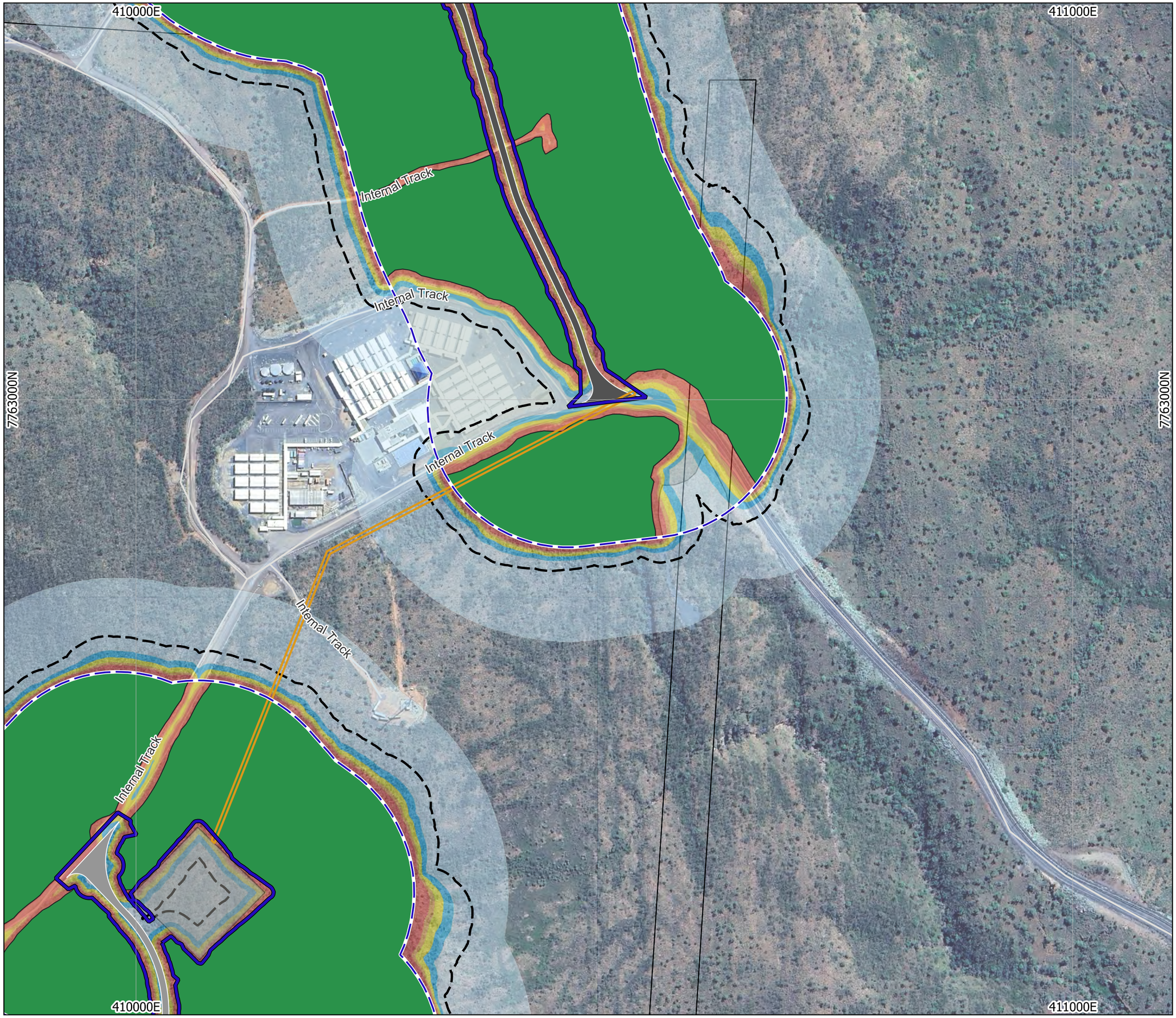
0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin



Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- Easement
- Compound Area Stage 1

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E

410000E

7761000N

Internal Track

WTG01

Internal Track

BESS and substation

Internal Track

Internal Track

409000E

410000E

7761000N

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 220 kV OHL
- 220 kV OHL EASEMENT
- 33 kV OHL
- Met. mast
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

412000E

413000E

7761000N

Internal Track

Mmg Dugald River Mine Access Road

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 220 kV OHL
- 220 kV OHL EASEMENT

Roads and Tracks

- Local
- Unconfirmed

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E
410000E
7757000N
7756000N
WTG06
WTG07

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 220 kV OHL
- 33 kV OHL
- Met. mast
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1

Roads and Tracks

- Unconfirmed

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

409000E
410000E
WTG08
S9
S8
7755000N
7755000N
409000E
410000E

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 33 kV OHL
- Wind Turbine Generator (tower base 5.5m dia.)

Internal road

- Stage 1
- Stage 2

Roads and Tracks

- Unconfirmed

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
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- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin

411000E

412000E

7761000N

Internal Track

Internal Track

Internal Track

Internal Track

Internal Track

Internal Track

411000E

412000E

Legend

Project extent information

- Subject site boundary
- Disturbance Footprint (DF)
- 150 m Buffer of Disturbance Footprint (DF)

Infrastructure

Other infrastructure

- 220 kV OHL
- 220 kV OHL EASEMENT

Roads and Tracks

- Unconfirmed

Classified Vegetation (clearing to extent of DF)

- Woodland

Inferno-BAL results

- Extent of BAL12.5 zone (12.5kW/m2 to 100m from vegetation)
- Extent of BAL19 zone (12.5 - 19kW/m2)
- Extent of BAL29 zone (19 - 29kW/m2)
- Extent of BAL40 zon (29 - 40kW/m2)
- Extent of BALFZ zone (within the length of flame and >40kW/m2)
- Extent of RHF10kW/m2 at 1200K

NHRA RHF Assessment

Dugald River Mine Wind Farm Project

0 100 200 m

N

covey

Revised Radiant Heat Flux Results for NHRA_0001

CRS: GDA2020 / MGA zone 54
Date created: 01/04/2026
Author: Aaron Bulfin