Draft Bushfire Risk Assessment: Western Sydney Aerotropolis

Western Sydney Planning Partnership

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Executive Summary

This Bushfire Risk Assessment (the Assessment) has been prepared to inform and assist with the planning of the Western Sydney Aerotropolis. The plan takes the form of a Bush Fire Strategic Study, as required by *Planning for Bushfire Protection 2019* (RFS 2019) for proposals of this nature. The contents of the Assessment provide detail to address all the components, measures and matters requested and demonstrate that the proposed development within the Aerotropolis complies with the requirements of *Planning for Bushfire Protection 2019*. *Planning for Bushfire Protection 2019* requires certain protective measures be met in order to make a building less likely to suffer damage or destruction from bush fires. It is not the intention of the measures to prevent the development of land in bush fire prone areas.

The Assessment aims to:

- assess the existing bushfire risk across the Aerotropolis;
- manage bushfire risk in accordance with *Planning for Bushfire Protection 2019*; and
- identify potential bushfire threats, suitable asset protection zones from features such as riparian corridors, protected vegetation and revegetated areas, and road network requirements.

The landscape bushfire risk includes assessment of bushfire hazard, potential fire behaviour and bushfire history within the Assessment area. Additionally, the impacts of climate change with regard to bushfire risk have been assessed, with the effects of climate change likely to result in a harsher fire-weather climate. The Fire Danger Index 100 setting adopted by *Planning for Bushfire Protection 2019* has been considered in light of climate change scenarios, as well as with regard to a bushfire weather analysis relevant to the locality.

The landscape bushfire risk analysis indicates that the potential for attack by bushfires exists in most years, if not all, due to weather conditions and fuel continuity. It is also reasonably foreseeable that Bushfire Attack Levels under Catastrophic Fire Danger Rated days could occur and therefore assessment of individual allotment risks under the *Planning for Bushfire Protection 2019* benchmarks are appropriate to identify bushfire protection measures specific to individual allotments that cannot be achieved at this scale of assessment.

The indicative road layout provides for multiple access routes, both east-west and north-south across the site in the event of fires either approaching or starting within the Assessment area. The extent of revegetated riparian corridors may result in increased risk to access options being cut off. However, given the size of the site and number of access options indicated that the risk of isolation of the site or a precinct is minimal.

The Aerotropolis assessment area has been evaluated in relation to the feasibility of bushfire protection measures. The required bushfire protection measures in accordance with *Planning for Bushfire Protection 2019* are achievable within the Aerotropolis and will reduce the bushfire risk associated with future development that will occur within the Aerotropolis precincts. All asset protection zones will be within urban capable land.

1. Introduction

1.1 Background

This Bushfire Risk Assessment (the Assessment) has been prepared to inform and assist with the planning of the Western Sydney Aerotropolis (**Figure 1**) to help implement the vision of Western Parkland City. The plan takes the form of a Bush Fire Strategic Study, as required by *Planning for Bushfire Protection 2019* for proposals of this nature.

The Western Sydney Aerotropolis is identified as Bush Fire Prone Land. For this Assessment, the minimum components of a Bush Fire Strategic Study listed in Table 4.2.1 and bushfire protection measures identified in the *Planning for Bushfire Protection 2019* have been provided herein with additional information where necessary to detail the combination of measures proposed.

The contents of the Assessment provide detail to address all the components, measures and matters requested and demonstrate that the proposed development within the Aerotropolis complies with the requirements of *Planning for Bushfire Protection 2019*.

1.2 Aims and Objectives

The Assessment provides an evaluation of the landscape bushfire risk and the residual risk for development following the provision of bushfire protection measures. It includes consideration of the following strategic assessment matters raised in *Planning for Bushfire Protection 2019*:

- ensuring land is suitable for development in the context of bush fire risk;
- ensuring new development on Bush Fire Prone Land will comply with *Planning for Bushfire Protection 2019*;
- minimising reliance on performance-based solutions;
- providing infrastructure associated with emergency evacuation and firefighting operations; and
- facilitating appropriate ongoing land management practices.

The Assessment aims to:

- assess the existing bushfire risk across the Aerotropolis;
- manage bushfire risk in accordance with *Planning for Bushfire Protection 2019*; and
- identify potential bushfire threats, suitable asset protection zones from features such as riparian corridors, protected vegetation and revegetated areas, and road network requirements.

1.3 Assessment Area

The Western Sydney Aerotropolis (Aerotropolis) comprises 11,200 hectares of land surrounding the Western Sydney International (Nancy Bird Walton) Airport (the Airport), bound by Bringelly Road to the south and Warragamba Dam and the Prospect Reservoir pipeline to the north. The location of the Aerotropolis and its boundaries can be seen in **Figure 1**. The Aerotropolis includes the Local Government Areas of Penrith and Liverpool. The Aerotropolis has been divided into ten precincts. Precincts to be rezoned and planned for in the initial stage include the Aerotropolis Core, Northern Gateway, Badgerys Creek, Agribusiness, Wianamatta-South Creek and Mamre Road. The Mamre Road Precinct was rezoned

in June 2020 and will preserve land for environmental conservation and open space, as well as securing a site for a potential Western Sydney freight intermodal terminal and has not been considered in this Assessment. The remaining precincts; Dwyer Road, Kemps Creek, North Luddenham and Rossmore, will be subject to future processes and assessment.

For the purposes of this study, the Assessment area includes all land within a 5km radius of the Aerotropolis (see **Figure 2-Figure 11 inclusive**).

1.4 Rezoning Process

The Western Sydney Aerotropolis proposes to rezone the land to include land use zones for Agribusiness, Enterprise, Environment and Recreation, Infrastructure, Major Infrastructure Corridors and Mixed Use for the purposes of supporting the draft Aerotropolis Development Control Plan and to allow bushfire risks to be strategically planned to achieve a better outcome (see **Figure 2**).

1.5 Proposed Land Use Zones

The Aerotropolis is divided into ten precincts, six of which are the focus of initial precinct planning: Aerotropolis Core, Northern Gateway, Wianamatta-South Creek, Badgerys Creek, Agribusiness, Mamre Road. As stated above, the Mamre Road Precinct was rezoned in June 2020. The remaining precincts (Kemps Creek, Rossmore, Dwyer Road and North Luddenham) are not considered as part of this Assessment and will be rezoned at a later stage under the Aerotropolis State Environmental Planning Policy.

Land uses assigned to each of the initial precincts are laid out in **Table 1** below.

Table 1: Proposed land uses for the initial precincts for Aerotropolis covered in the Assessment

Precinct	Zoning	Land Uses	Potential Jobs	Potential Residents
Aerotropolis Core	• Mixed Use • Enterprise • Environment & Recreation	Advanced manufacturing, defence and aerospace, research and development activity, high technology industry and infrastructure, education (including vocational and tertiary education); professional services, business incubator hubs, creative industries including 'pop- up installations' and festivals/ events, commercial offices, food and beverage, indoor and outdoor recreation and sports facilities, medium to high density residential near the Metro station; retail, community; civic, entertainment, cultural facilities; green open and public space on public and private lands; public and private medical services, visitor accommodation, integrated health hub	50,000 – 60,000	20,000 - 24,000
Northern Gateway	• Enterprise • Environment & Recreation • Mixed Use	High technology commercial enterprise/ industry, warehousing and logistics, education, offices, retail, residential, health services, entertainment, tourism facilities, cultural and creative industries, green public and private open spaces, recreation and visitor accommodation	19,000 – 21,000	8,000 – 10,000

Precinct	Zoning	Land Uses	Potential Jobs	Potential Residents
Wianamatta-South Creek	• Environment & Recreation	Water management, open space, recreation facilities, pedestrian and cycle connectivity, community and cultural facilities, environment protection and restaurants or cafes.	Minimal	No additional dwellings
Badgerys Creek	• Enterprise • Environment & Recreation	Defence and aerospace, advanced manufacturing activity, high technology industry, airport supporting development, local retail, Aerotropolis enabling industries, modernised resource recovery industries, light industrial, social infrastructure.	9,000 – 11,000	No additional dwellings
Agribusiness	• Agribusiness • Enterprise • Environment & Recreation	Agribusiness, intensive fresh and value- added food production, food innovation technology and research, food production and processing, fresh food produce markets, warehousing and logistics, high technology industry, ancillary rural residential, complementary offices and retail, education, circular economy enabling infrastructure, biosecurity enabling infrastructure, integrated logistics hub.	8,000 – 10,000	Minimal

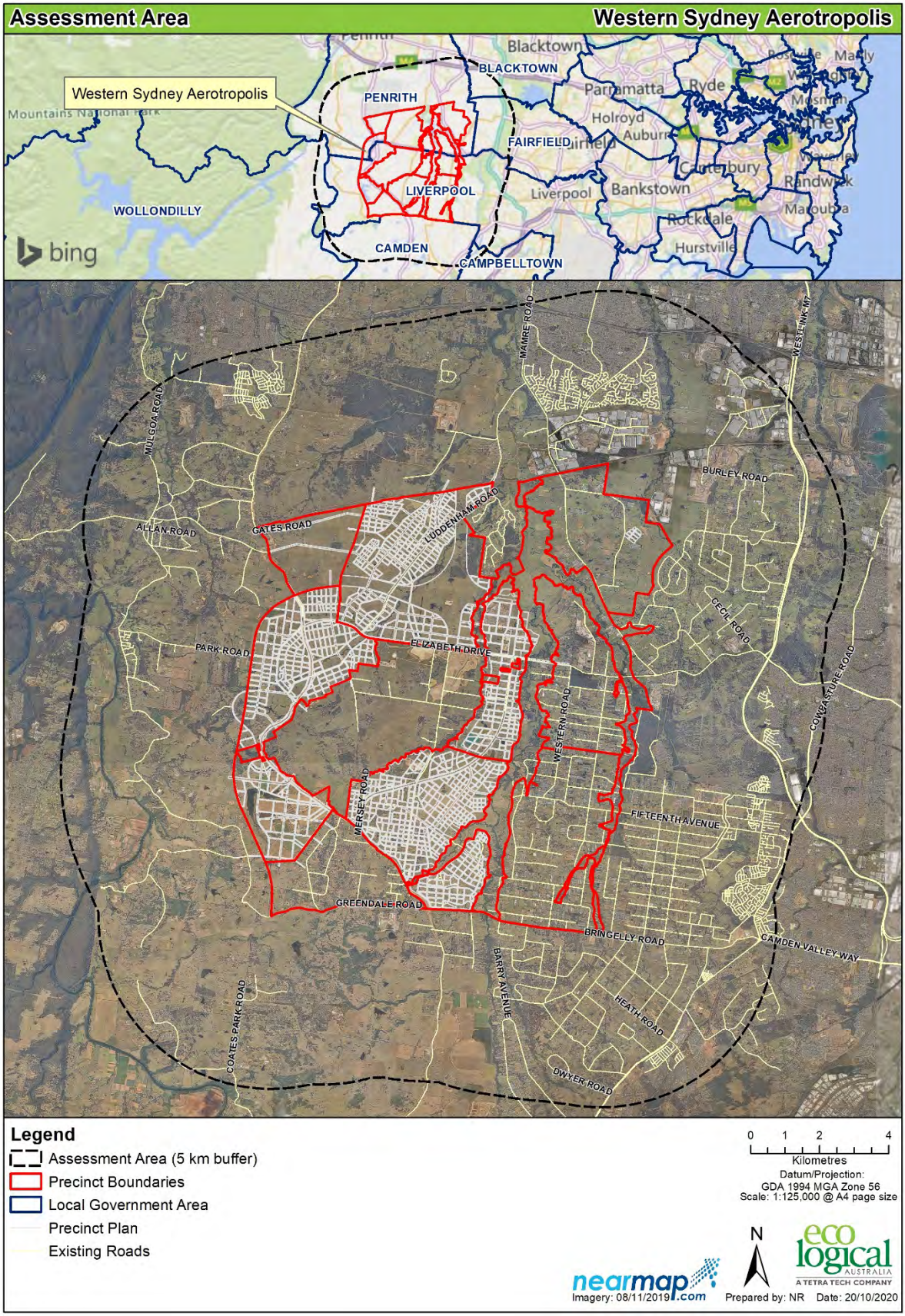

Figure 1: Aerotropolis Location

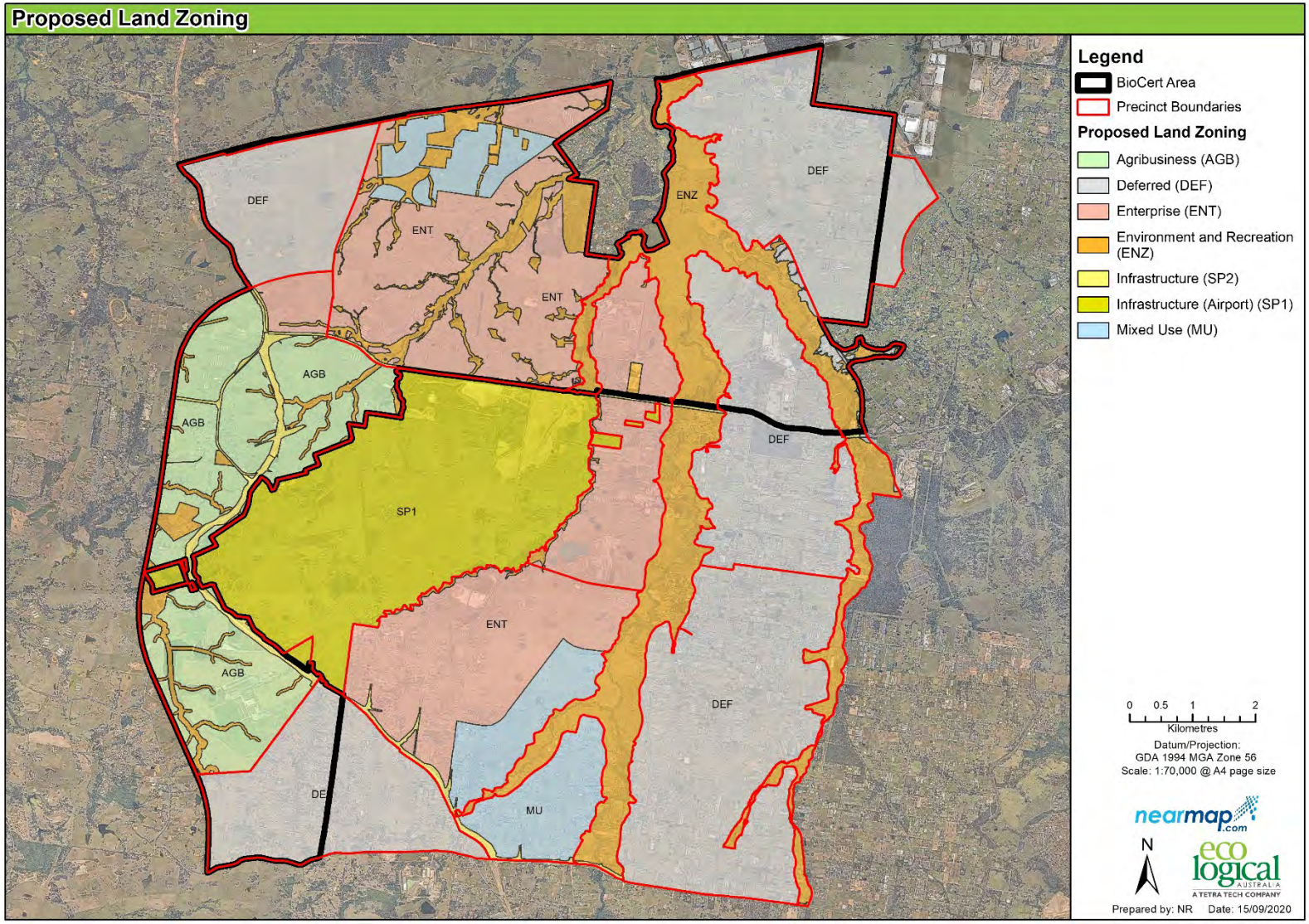

Figure 2: Proposed Zoning

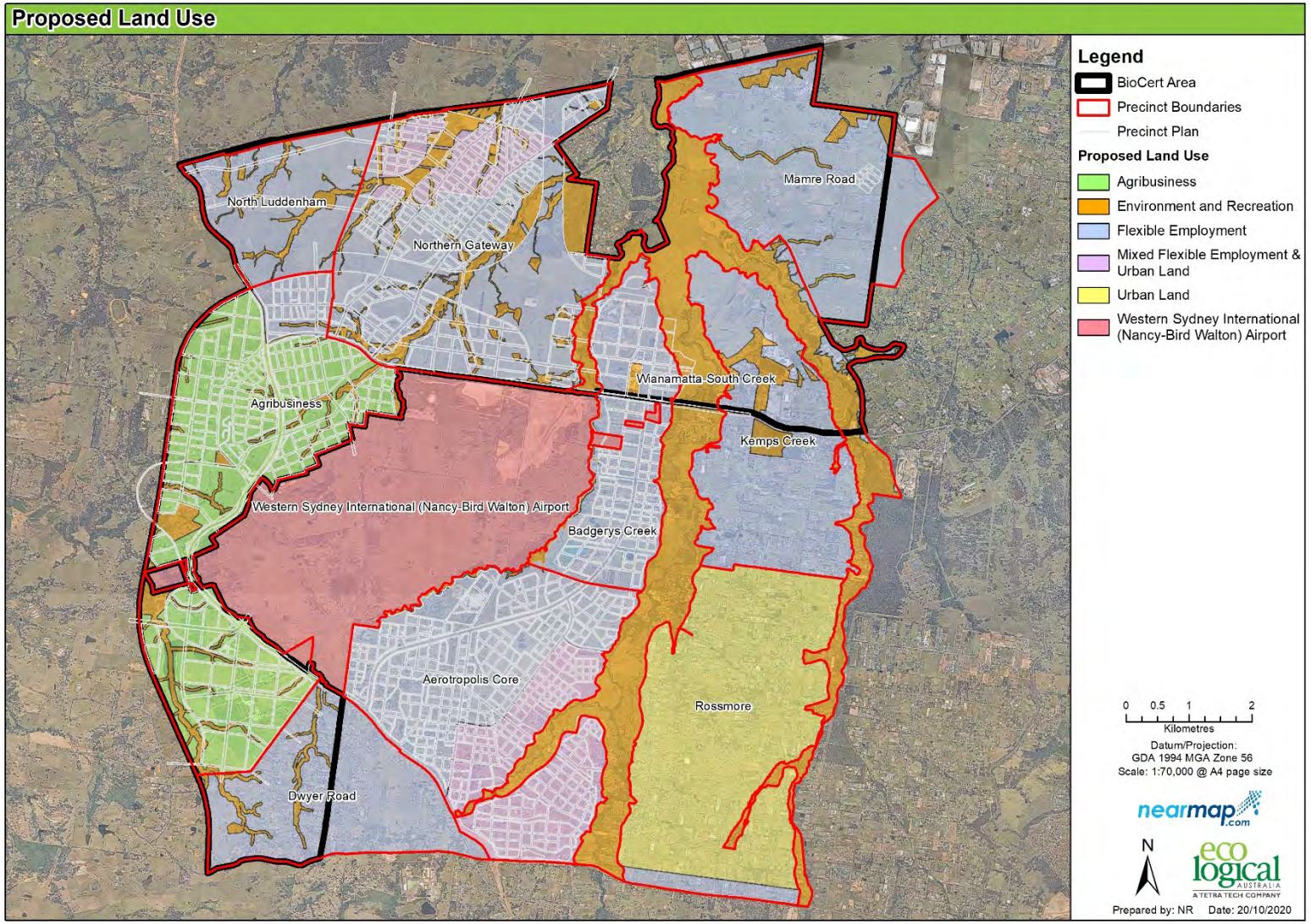

Figure 3: Proposed Land Use

2. Bushfire Landscape Risk Assessment

The landscape bushfire risk includes assessment of bushfire hazard, potential fire behaviour and bushfire history within the Assessment area.

2.1 Bushfire Hazard

Land within the Aerotropolis is classified as bush fire prone and is located within a wider landscape of Bush Fire Prone Land (**Figure 4**) showing the existing mapping. This is expected to change as the precincts are developed, with an indicative future bushfire prone land map based on expected retained vegetation provided as **Figure 5.**

Bush Fire Prone Land mapping is a trigger for the consideration of bushfire protection measures for new developments. Bush Fire Prone Land is separated into three categories based on vegetation type and potential bush fire risk:

1. Vegetation Category 1 (red): Land considered to be the highest risk for bushfire and surrounded by a 100m buffer (buffer is yellow)
2. Vegetation Category 2 (light orange): Land is considered to be a lower bush fire risk than categories 1 and 3. Surrounded by a 30m buffer (buffer is yellow).
3. Vegetation Category 3 (dark orange): Land is considered to be a medium bush fire risk. Surrounded by a 30m buffer (buffer is yellow).

Planning for Bushfire Protection 2019 requires certain protective measures be met in order to make a building less likely to suffer damage or destruction from bush fires. It is not the intention of the measures to prevent the development of land in bush fire prone areas. However, in order to provide adequate protection from bush fires, it may be necessary to modify the style, construction material or sighting of a building.

The existing bushfire hazard is extensive and continuous to the north of the subject land, within a broader landscape of managed low density residential and agricultural areas. A proposed network of connected riparian corridors potentially exposes the Assessment area to bushfires.

In the north west of the site the land is predominately large undeveloped lots, interconnected with heavily vegetated riparian corridors. Rural residential and agricultural lots are interspersed in the south east of the subject land. The discontinuity of the Bush Fire Prone Land from north to south reflects the change in Local Government Areas and associated current planning controls across the site.

Bushfire hazard has been classified using the *Planning for Bushfire Protection 2019* methodology through assessment of vegetation and slope.

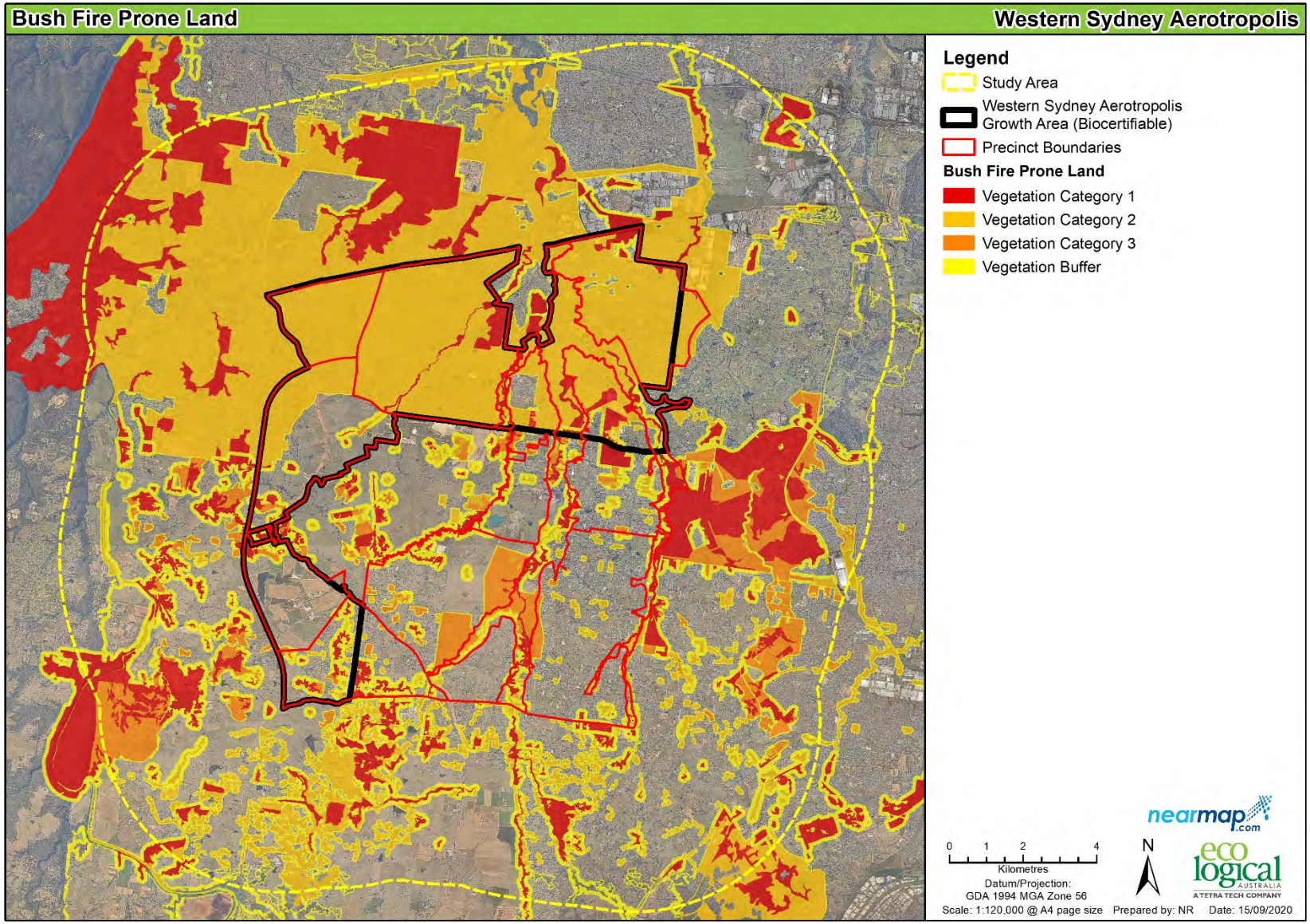

Figure 4: Current Bush Fire Prone Land Map within Aerotropolis and the surrounding landscape

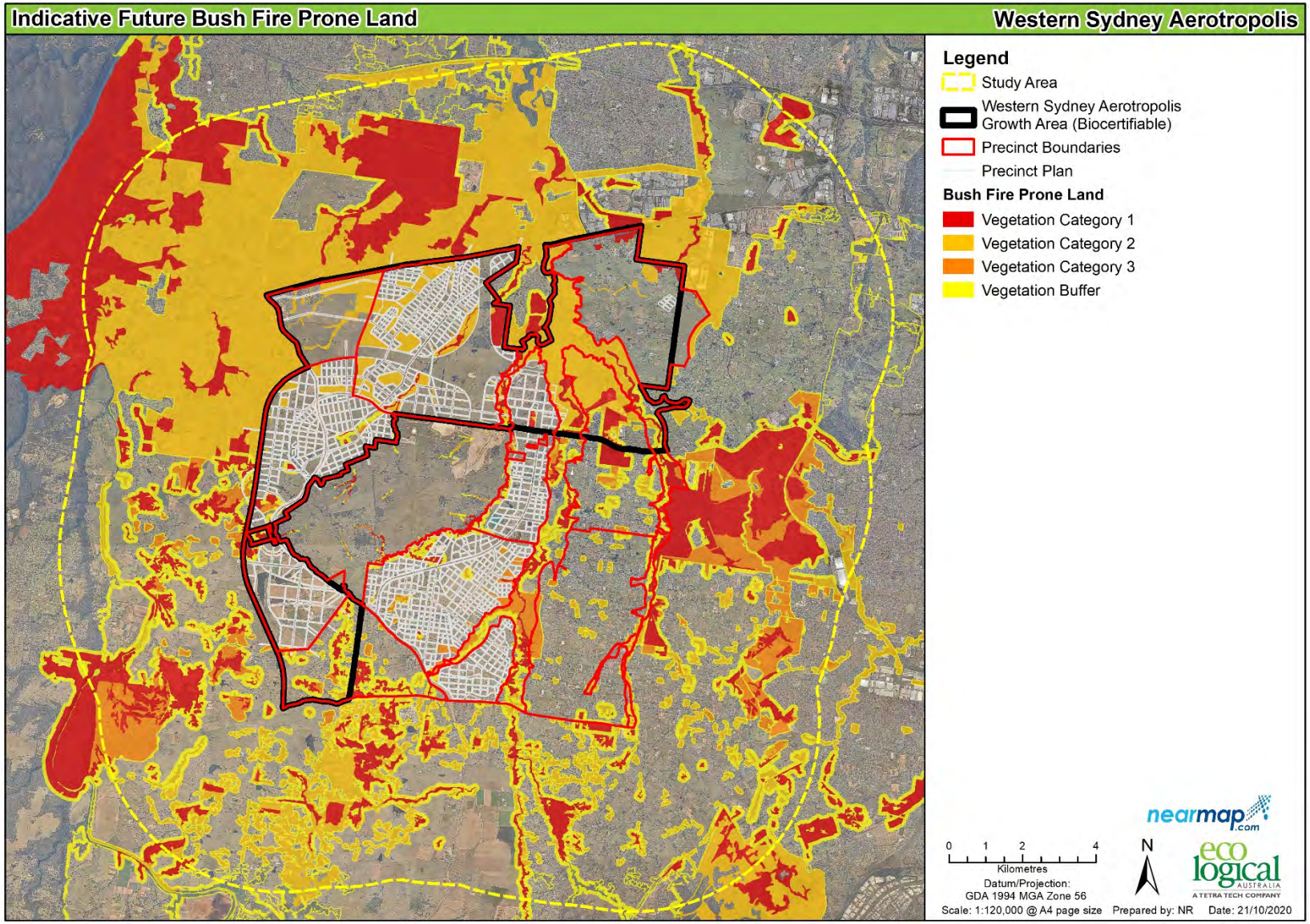

Figure 5. Indicative future Bush Fire Prone Land Map for the Aerotropolis

2.1.1 Vegetation

The subject land is within a landscape comprised predominantly of Grassland with narrow patches of Forested Wetland vegetation along extensive riparian corridors. Grassland vegetation dominates the Assessment area in the north west and south west where large rural residential and agriculture development is less widespread. To the south west and north west, expansive areas of Woodland vegetation interconnect along numerous riparian corridors as shown in **Figure 8**.

To the north east and south east, Grassland is less dominant due to the extent of development in the area, with only small areas of Woodland and Forested Wetland remaining in segments along riparian corridors. Although Forest vegetation is present in the east and west, it is generally minimal throughout the precincts.

Throughout the precincts, vegetation is most extensive within the land to be zoned Environmental and Recreation. This includes broad riparian corridors to the east and narrower areas to the west. To assess the hazard associated with the riparian corridors, a number of assumptions were made. The mapped hydroline was buffered for the Assessment area based on Office of Water/Natural Resources Access Regulator distances for riparian corridors, with an additional 5 m included either side of regulated corridor widths to allow consideration for changes in stream flow, validation of top of bank and future configuration of riparian corridors that may arise from specialist advice not available at the time of this Assessment. Where no existing vegetation mapping was available for the riparian corridors – Forested Wetland was assigned as the predominant *Planning for Bushfire Protection 2019* formation.

It is expected that this data input will evolve, and change based on various factors including:

- Validation of Top of Bank;
- Future configuration of riparian corridors that may incorporate riparian 'averaging' or extended corridor widths; and
- Consideration of management and revegetation of riparian corridors that may result in changes to vegetation formation in these areas.

It is expected that revegetation and modification of the current hazard is likely to occur to reflect the varying proposed land uses, indicated as local, district and regional open spaces. The indicative management and revegetation of these areas is as follows:

- Local open space: <2ha and will be highly embellished 'park' with playgrounds, paths and require extensive management, with minimal retained existing vegetation apart from individual trees;
- District open space: 2-5ha and will be highly embellished. Likely to include sports fields and therefore minimal retained existing vegetation; and
- Regional open space: typically 30% of the park will be highly embellished (water features, playgrounds, paths, signage) and 70% retained in its current condition i.e. bushland areas.

The spatial extent and continuity of these vegetation types are yet to be finalised; however the regional open spaces have the potential to support both higher intensity and difficult to control fires subject to their location and arrangement. However due to the size of the development site providing an area of 11,200 ha within which bushfire resilience can be incorporated, it is expected that such risk can be

managed through design, management and maintenance without impacting on the environmental values of the regional open spaces.

Vegetation has been classified into Keith Formations and Keith Class (Keith 2004) and assigned a potential total fuel load (tonnes / hectare) using Table A1.12.8 from *Planning for Bushfire Protection 2019*. **Figure 8** and **Table 2** show the vegetation. **Table 3** shows the area of each vegetation formation by precinct proposed to be retained in environment and recreation lands.

Table 2: Vegetation formation, class and fuel allocation for the Assessment area

Vegetation formation	Keith Class	Overall fuel including bark and canopy (t/ha)*
Forest (wet and dry sclerophyll)	Cumberland Dry Sclerophyll forests	36.1
Grassy and Semi-Arid Woodland	Coastal Valley Grassy Woodland	20.2
Forested Wetland	Coastal Floodplain wetlands	15.1
Grassland	Exotic and agricultural grassland	6
Freshwater Wetlands	Coastal Freshwater Lagoon	4.4

*Overall fuel load including Bark and Canopy from Table A1.12.8 from Planning for Bushfire Protection (RFS 2019)

Table 3. Proposed retained vegetation formation by precinct

Vegetation formation by precinct/location	Area (hectares)
Aerotropolis Core	***328***
Forested Wetland	90
Grassland	180
Woodland	58
Agribusiness	***380***
Forested Wetland	119
Grassland	211
Woodland	50
Badgerys Creek	***125***
Forest	8
Forested Wetland	27
Grassland	85
Woodland	5
Dwyer Road	***88***
Forested Wetland	40
Grassland	1
Woodland	47
Kemps Creek	***113***
Forest	43
Forested Wetland	10

Grassland	56
Woodland	4
Mamre Road	***65***
Forest	3
Forested Wetland	19
Grassland	9
Woodland	34
North Luddenham	***144***
Forested Wetland	30
Grassland	107
Woodland	7
Northern Gateway	***361***
Forest	<1
Forested Wetland	93
Grassland	188
Woodland	79
Rossmore	***91***
Forested Wetland	26
Grassland	46
Woodland	19
Western Sydney International (Nancy-Bird Walton) Airport	***164***
Forested Wetland	79
Grassland	8
Woodland	77
Wianamatta-South Creek	***1236***
Forest	9
Forested Wetland	459
Freshwater Wetland	1
Grassland	704
Woodland	63
Grand Total	***3096***

2.1.2 Topography and Slope

Figure 9 shows that the precincts are located on areas of flat to undulating land, currently utilised for agricultural enterprises. There are changes in elevation along existing riparian corridors. This is the case for most of the existing agricultural area throughout the Campbelltown, Camden and Liverpool Local Government Areas. Lower elevations are evident where riparian corridors dominate the landscape to the east, west and in the centre of the Aerotropolis.

The Assessment area ranges in elevation from 20 - 25 m to 120 - 125 m above sea level (see **Figure 9**). This variation in topography, such as changes in elevation evident along the western boundary of the

Aerotropolis, mean that any long running fires from the north-west may periodically be subject to downhill spread. This potential for downhill spread will reduce fire intensity and the rate of spread, and therefore may assist in efforts to control potential fires. However, upslope spread has the potential to cause longer distance spotting and impacts on the Aerotropolis.

Within precincts, a 2 m Digital Elevation Model was generated from 25 cm contours, whilst 1 m contours where used to generate a 10 m Digital Elevation Model for the broader 5 km assessment area. A Slope interpolation was then undertaken in ArcGIS and the output slope raster classified into the following slope classes (see **Figure 9**):

- >0° – 5°
- >5° – 10°
- >10° – 15°
- >15° – 20°
- >20°– 25°
- >25°

2.1.3 Bushfire Weather

The Aerotropolis is located within the Cumberland and Macarthur Bush Fire Risk Management Zones. The typical / average climate in the Cumberland Zone Bush Fire Management Committee area and the Macarthur Bush Fire Management Committee is generally warm temperate, experiencing warm to hot summers and cool to mild winters (**Figure 6**). Rainfall is more pronounced in Summer/Autumn from January to March with a dry winter and spring (**Figure 7**), with eastern areas having traditionally higher rainfall patterns when compared to western areas. The bush fire danger period generally runs between October and March each year.

Adverse fire weather conditions associated with the bush fire danger period in these zones are associated with dry winters, followed by August and September winds which provide potential fire conditions for the cured Grassland areas, along with north-westerly winds accompanied by high temperatures and low relative humidity, providing weather conditions conducive for large spreading bush fires. Extreme fire danger can occur in these zones in summer where occasional strong winds produce cold fronts. The end of the fire season in most years is characterised by summer rainfall and slightly higher relative humidity.

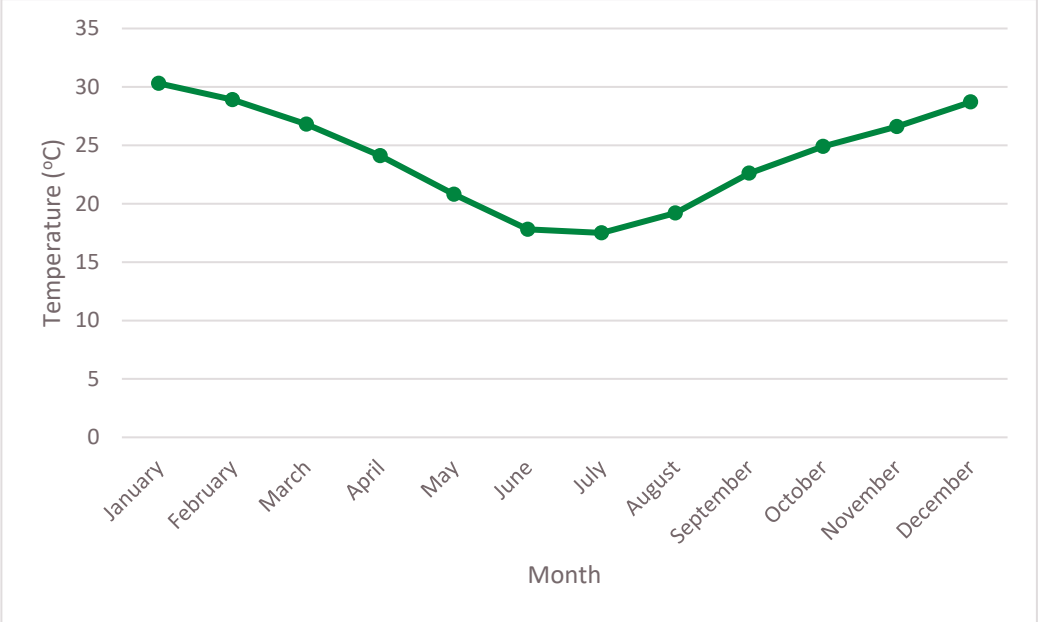

Figure 6. Mean maximum temperature (°C) 1995 - 2020 for Badgerys Creek AWS

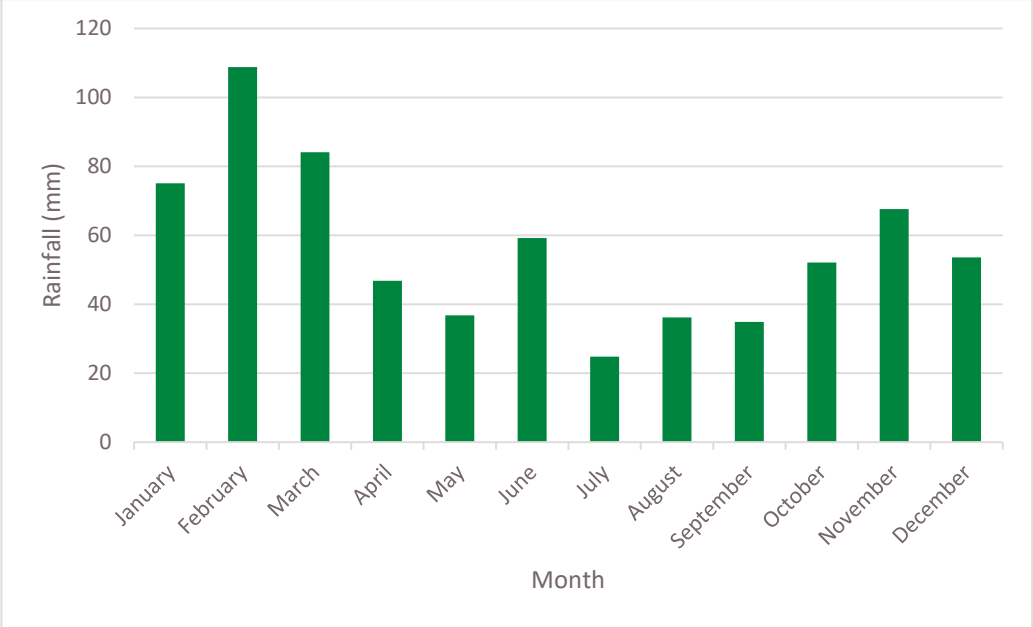

Figure 7: Mean rainfall (mm) 1995 - 2020 for Badgerys Creek AWS

2.1.3.1 Climate change

Late century (2090) climate change projections (RCP 8.5) by the CSIRO and Bureau of Meteorology (2020) for Richmond predict less rainfall (-11%) and a 4.2°C increase in average annual temperature will occur. For the nearer future (2030), natural variability is predicted to dominate any projected changes.

In relation to temperature projections for the near future (2030), the annual averaged warming across all emission scenarios is projected to be around 0.9 to 1.2°C above the climate of 1986–2005. By late in the century (2090), the projected range of warming is 1.5 to 3°C for an intermediate emissions scenario (RCP 4.5) and 3.0 to 4.2°C under a high emissions scenario (RCP 8.5) (CSIRO and BoM, 2020).

The projected changes are likely to result in a harsher fire-weather climate linked to decreased rainfall and seasonal variation, along with increased temperatures and frequency of storms. However, enhanced summer rainfall in some scenarios could moderate the number of severe fire weather days (CSIRO and BoM, 2020). In this study, the Fire Danger Index 100 setting adopted by *Planning for Bushfire Protection 2019* and considered in light of climate change scenarios, and with regard to a bushfire weather analysis relevant to the locality.

2.1.3.2 Bushfire Weather Analysis

A bushfire weather analysis was undertaken in order to identify the likely bushfire weather conditions that the site could experience from the main bushfire attack sectors. Weather data developed by Lucas (2010) under the National Historical Fire Weather Dataset (1972-2015) incorporates the daily Forest Fire Danger Index, where suitable inputs are available, from over 70 weather stations across Australia. Data from the Sydney Airport and Richmond weather stations (station numbers 66037 and 67033/67105 respectively) were analysed to determine the maximum Forest Fire Danger Index for a 1 in 50-year event, being the accepted recurrence period for land use planning in *Planning for Bushfire Protection 2019*.

The dataset for each weather station was split into subsets based on identified directions of potential bushfire attack, including:

- North to south-east (clockwise);
- South-east to South-west (clockwise);
- South-west to North (clockwise);
- And a combination of all directions;

To determine the 1:50 recurrence value, a Generalised Extreme Value analysis method was undertaken to calculate the Forest Fire Danger Index value within each data subset (**Table 4**). Although the Generalised Extreme Value model has been used in other disciplines for analysing extreme events (i.e. flooding recurrence values), it is only in recent times to have been considered appropriate for bushfire weather analysis (Douglas 2017). The Generalised Extreme Value methodology and its use to analyse bushfire weather data is discussed in a number of papers by Douglas et al (2014; 2016).

Table 4: Fire Danger Index for a 1 in 50-year event

Weather Station	Max Recorded FFDI	All directions	N to SE	SE to SW	SW to N
Sydney Airport	116	116	63	47	116
Richmond Airport	96	105	52	45	105

The Forest Fire Danger Index values for Sydney Airport are worse (higher) than those for Richmond Airport, and therefore deemed more appropriate for consideration as 'worst case', and thus adopted in this study.

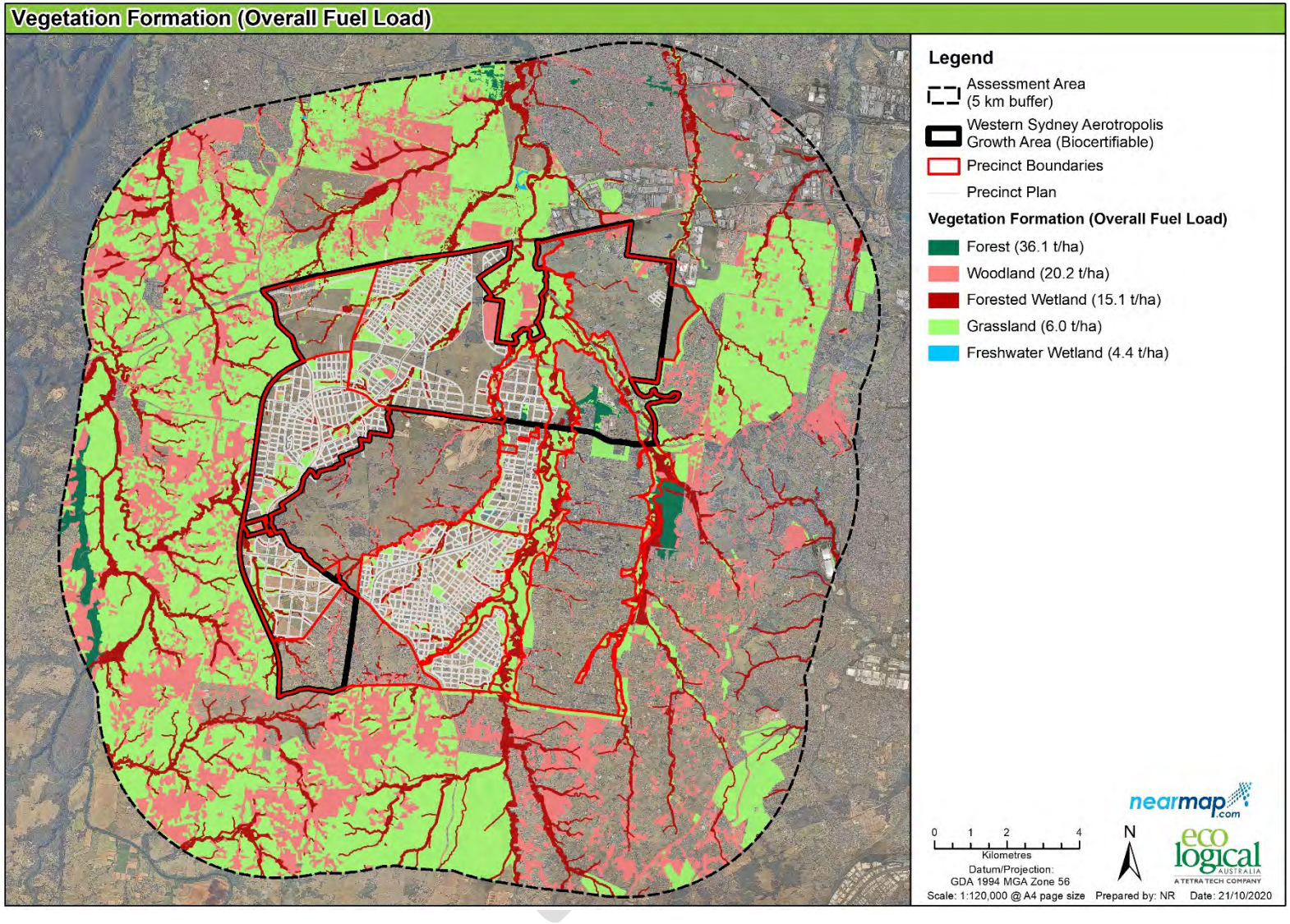

Figure 8: Vegetation formation / fuel classification of Aerotropolis and the surrounding landscape

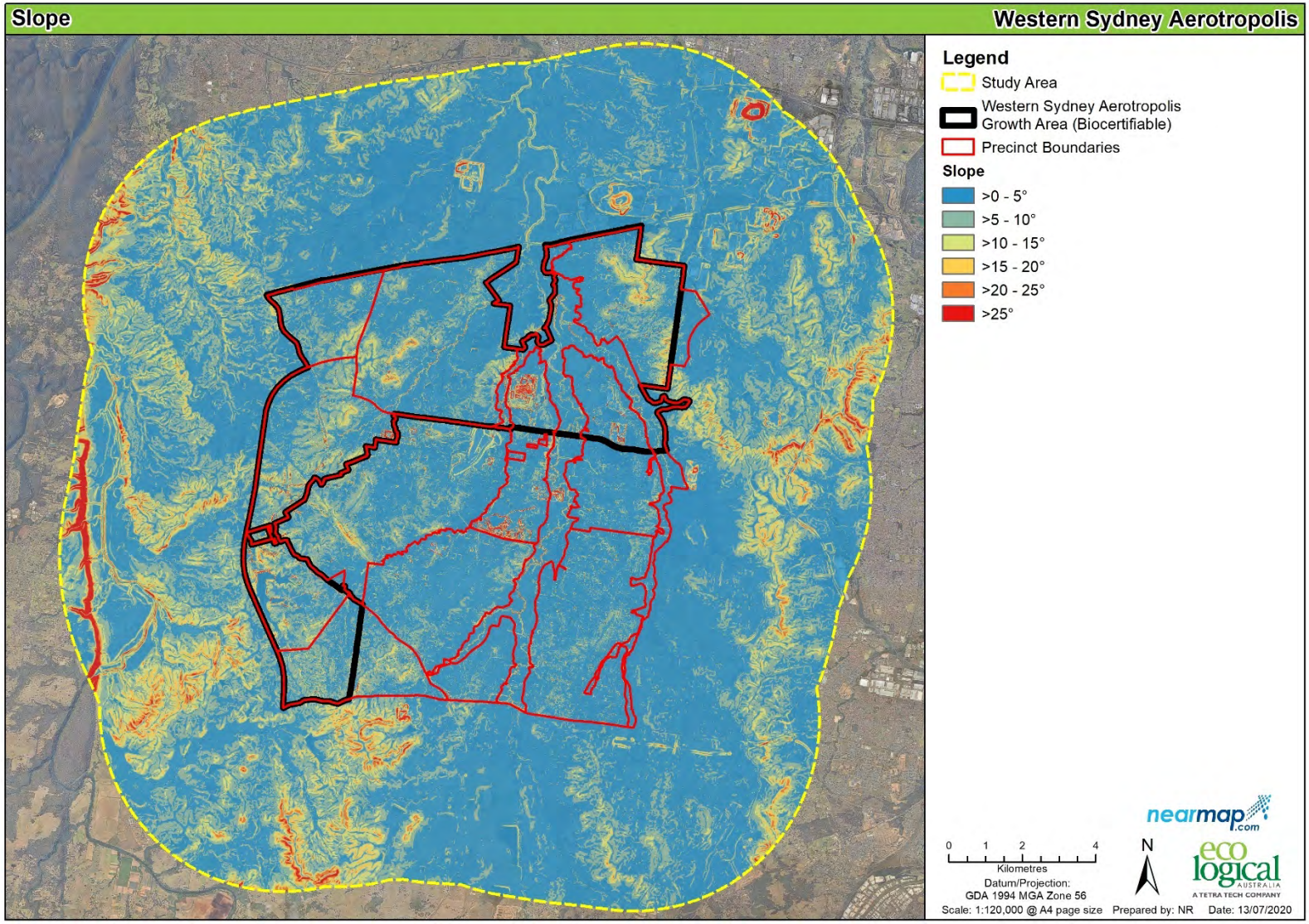

Figure 9: Slope of Aerotropolis and the surrounding landscape

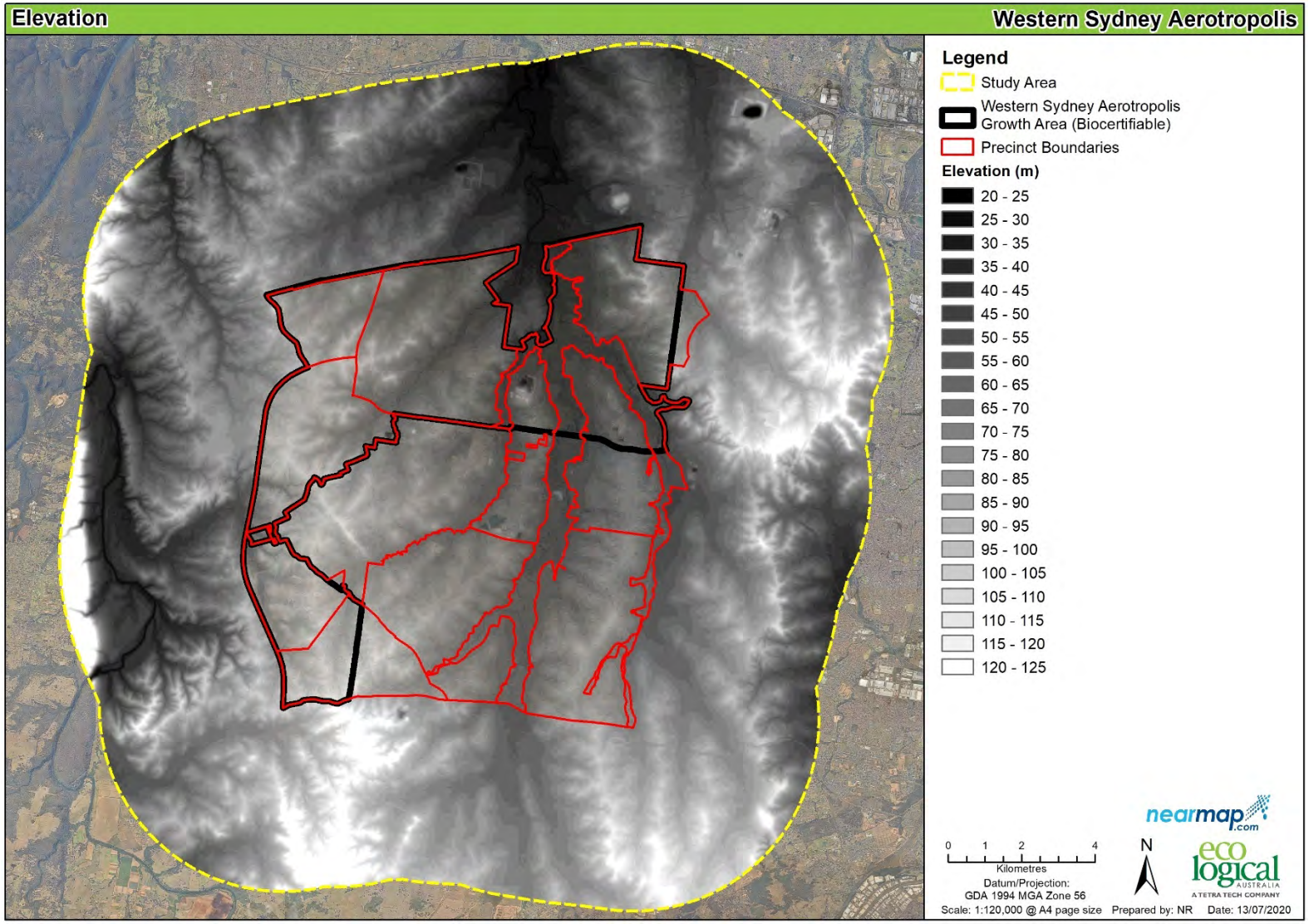

Figure 10: Elevation of Aerotropolis and the surrounding landscape

2.2 Potential Fire Behaviour

Bushfire intensity prediction models have been used to review major bushfire potential from various directions with the potential head fire intensity modelled using fire intensity formulae of McArthur (1966a,1967, 1973a, 1973b & 1977) for Forest and Grassland. A model was prepared for the bushfire attack scenario from all directions at Fire Danger Index 116 and Grassland Fire Danger Index 160 (**Figure 11**).

The model shows that the greatest intensities occur in Grassland vegetation throughout the Assessment area, which predominately occur to the north west and south west. The areas to the south east generally have lower predicted levels of bushfire intensity.

It is noted that each bushfire event is different, responding to changes in fuel, weather conditions and terrain. Thus, the model prediction is indicative of what conditions may be expected under a bushfire event likely to be experienced by the expected weather and fire spread through nearby fuels and terrain.

It is important to note that models of potential fire intensity do not provide ignition risk or the rate of spread of a bushfire; and these are important considerations in likelihood and evacuation risk (respectively). The prediction models also do not consider extreme fire behaviour / weather including such phenomena as:

- Spotting/Fire storm – ember attack and spread ahead of the head fire front;
- Fire tornado/whirls - occur when the turbulent wind conditions combine with the increasing heat from the fire to create a rotating eddy of air;
- Lateral vortices - arises due to wind-terrain-fire interactions that produce vertical vorticity, which rapidly propagates a fire across steep, leeward slopes in a direction nearly perpendicular to the ambient wind direction;
- Junction zones (Jump fires) - point or area where two separate fires meet up and become one fire. Also known as the area of coalescence. Fire intensity generally increases at a junction zone, due to combined convection forces;
- Eruptive fires – extreme acceleration of rate of spread and intensity of a fire in a limited space and time that can overwhelm and suppression capacity;
- Conflagrations - violent pyroconvective events in the atmosphere, that produce fire thunderstorms or pyrocumulonimbus;
- Downbursts - a strong downward current of air from a cumulonimbus cloud, which is usually accompanied by intense rain or a thunderstorm; or
- Pyro-convective events – when heat and moisture generated by bushfires create clouds and even thunderstorms.

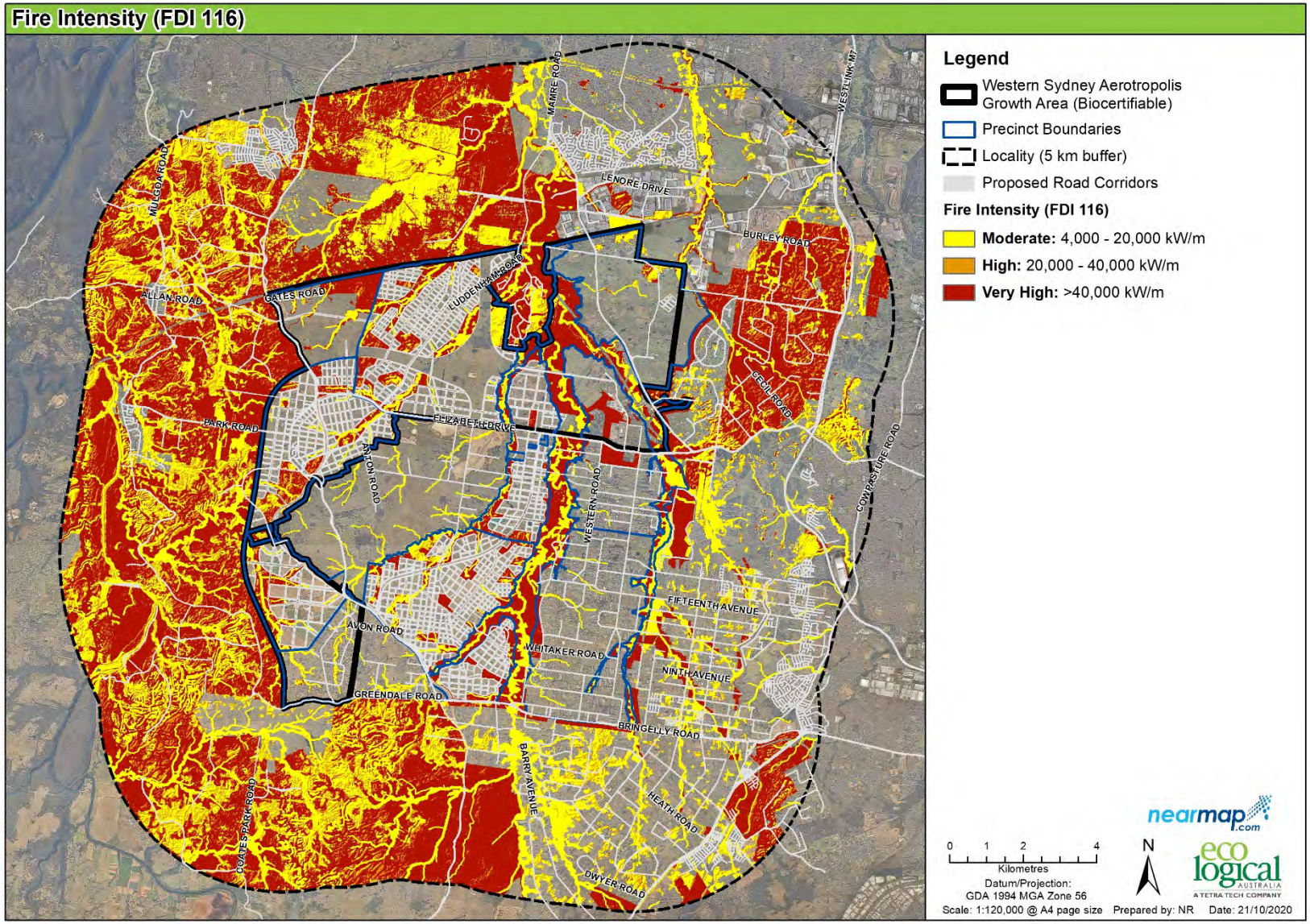

Figure 11: Potential Fire Intensity across the Assessment area (all directions, Fire Danger Index 116)

2.3 Bushfire History

The Cumberland and Macarthur Bush Fire Risk Management Plans identify that the *main* sources of ignition are:

- Illegal burning (rural areas);
- Car dumping (majority in Castlereagh and Londonderry areas);
- Lightning (summer thunderstorm activity in the southern areas);
- Escaped backburn (e.g. Cataract Fire);
- Powerlines arching (through National Parks and Wildlife Service Reserves)
- Arson (particularly Wilmot / Bidwill, Glenmore Park, Ropes Creek, O'Hares Creek, Woronora and Cataract catchments areas).

Figure 12 shows the fire history for the Assessment area from 1982 – 2019 for both prescribed burns and unplanned fire (wildfire) from the National Parks and Wildlife Service fire history mapping data set. No prescribed burning has occurred. As shown in **Figure 12** a large fire in the 2001-2002 fire season was the most significant fire in the area for the period, impacting on the north and west of the Aerotropolis. This fire burnt through the Nattai National Park and other forest, woodland and grassland vegetation, predominately west of the Assessment area, with the fire moving across agricultural areas on the east. A smaller fire in 2006-2007 to the west of the site is the only additional fire to occur within the Aerotropolis. Every fire poses a different suite of risks and control options and future fires within the landscape may reach the Aerotropolis.

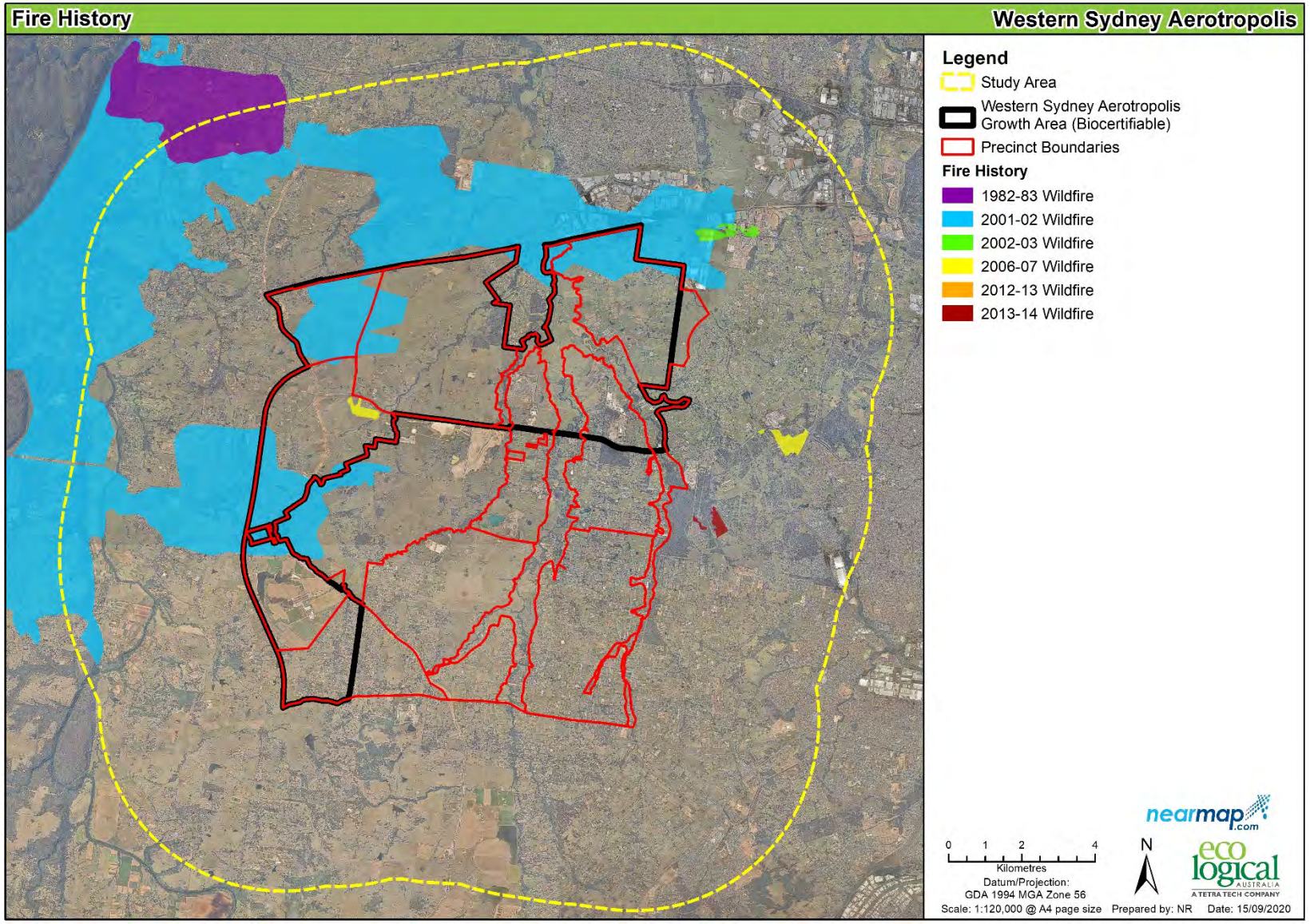

Figure 12: Fire history of Assessment area 1982 - 2019 (prescribed burns and wildfire)

2.4 Summary of landscape bushfire risk assessment

The landscape risk analysis indicates that the potential for attack by larger bushfires exists in most years, if not all, due to weather conditions and fuel continuity. It is also reasonably foreseeable that Bushfire Attack Levels under Catastrophic Fire Danger Rated days could occur and therefore assessment of individual allotment risks under the *Planning for Bushfire Protection 2019* benchmarks are appropriate to identify bushfire protection measures specific to individual allotments that cannot be achieved at this scale of assessment.

Bushfire Attack Levels are primarily a predictor of the potential consequence of bushfire attack on a building, however they do not adequately consider the likelihood of attack, which can be understood from:

- The likelihood and location of ignitions within the landscape coinciding with adverse fire weather conditions that move a fire toward the proposed development; and
- Factors related to wildfire mitigation and suppression such as reduced fuel areas, timing of fire runs compared to suppression deployment and capability, and the coincidence of these with landscape fire advantages such existing roads and infrastructure (i.e. powerline easement) as well as existing areas of development and land management.

Although fire history indicates the probability of a landscape-wide fire or major fire attack on the Aerotropolis is low, it is feasible to suggest a major attack is possible over the next 50 years, given the extent of Woodland and Grassland surrounding the site, and in light of climate change scenarios that indicate a harsher fire-weather climate in the future. In addition, minor fire attack on the precinct is much more likely and warrants risk mitigation.

Based on the fire history, landscape fire advantages and the proposed larger allotment size enabling appropriate bushfire protection measures, the Assessment does not consider increased development within the Aerotropolis as occurring within an unacceptable bushfire risk landscape, particularly given all development will be in accordance with the latest bushfire protection measures (currently those identified within *Planning for Bush Fire Protection 2019*).

The landscape risk analysis indicates a risk level where it is feasible to design and build resilience into the community that matches or exceeds the bushfire risk in the landscape. The total elimination of bushfire risk is not necessary or feasible; this is the situation for development on any bush fire prone land.

3. Land use assessment

The *Environmental Planning and Assessment Act* and the *Rural Fires Act 1997* are the primary legislative instruments relevant to bushfire planning for the site. As the Aerotropolis is mapped as Bush Fire Prone Land, *Planning for Bushfire Protection 2019* is called up by these instruments and is a critical guide in assessing the bushfire risk suitability of the proposal.

Planning for Bushfire Protection 2019 outlines broad principles and assessment considerations for strategic planning. It also specifies that bushfire protection measures need to be considered at the strategic planning stage to ensure that the future development can comply with *Planning for Bushfire Protection 2019* (as specified in Chapters 5-8 of *Planning for Bushfire Protection 2019*).

The aim and objectives of *Planning for Bushfire Protection 2019* below, provide additional guidance for land use assessment within a Strategic Bushfire Study:

> *The aim of Planning for Bushfire Protection is to provide for the protection of human life and minimise impacts on property from the threat of bush fire, while having due regard to development potential, site characteristics and protection of the environment.*
>
> *The objectives are to:*
>
> *i. afford buildings and their occupants protection from exposure to a bush fire*
>
> *ii. provide for a defendable space to be located around buildings*
>
> *iii. provide appropriate separation between a hazard and buildings which, in combination with other measures, minimises material ignition*
>
> *iv. ensure that appropriate operational access and egress for emergency service personnel and residents is available*
>
> *v. provide for ongoing management and maintenance of bush fire protection measures*
>
> *vi. ensure that utility services are adequate to meet the needs of firefighters.*

3.1 Risk Profile

The feasibility of the proposal to comply with the bushfire protection measures within *Planning for Bushfire Protection 2019* is a fundamental consideration of the Assessment. Whilst bushfire protection measures and their performance requirements are a benchmark for development approval, at a strategic level study needs also to evaluate these measures within the landscape risk context. This Assessment has therefore considered the:

- Footprint within the bushfire landscape and the need for adjustment of the protection measures given the landscape risks;
- Pattern and potential bushfire resilience of the development bushland interface;
- Potential cumulative risk associated with the protection measures;
- Risk profile of different areas and their appropriate land use; and
- Potential for application of innovative or emerging bushfire protection measures.

The following land use risk profile has been identified in the Assessment:

- The development site is very large; approximately 12 km wide by 15 km long, providing an area of 11,200 ha within which bushfire resilience can be incorporated;
- Over 75% of future development will be located within Bushfire Attack Level LOW i.e. large internal areas no longer classified as bushfire prone land. This provides the potential for a high bushfire resilience;
- The perimeter to area ratio of the development is low compared to most other development proposed on bushfire prone land in NSW and is a direct result of the large scale of the development. A low perimeter to area ratio reduces bushfire risk and helps increase community resilience;

- There is ample area to locate asset protection zones and other bushfire protection measures to meet the acceptable solutions within *Planning for Bushfire Protection 2019*;
- There is ample area to locate any Special Fire Protection Purpose Development well away from the hazard; and
- No unusual cumulative risks have been identified. Complementary and consistent risk management through landscape and building design, and community programs are also feasible.

3.2 Risk response - Bush Fire Protection Measures

The following bushfire protection measures are proposed by the development in response to the strategic level risks identified in **Section 2**. Bushfire protection measures are required to improve the community resilience to bush fire attack and improve property protection.

Application of the bushfire protection measures to the subject land, as described in *Planning for Bushfire Protection 2019* minimise the risks from bushfire and ensure that the aims and objectives of *Planning for Bushfire Protection 2019* can be met. This approach has been applied for the subject site.

The following key bushfire protection measures are addressed in this assessment:

- Asset protection zones;
- Water supplies;
- Infrastructure (including access road provisions and other services);
- Evacuation and emergency management (including emergency access/egress arrangements); and
- Landscape management and garden design principles.

3.3 Asset Protection Zones

Table 5 provides the asset protection zones dimensions, applied in line with *Planning for Bushfire Protection 2019* requirements for residential and Special Fire Protection Purpose development. Asset protection zones are typically refined during detailed design at the subdivision stage, with the structure plan at rezoning (the current stage) required to demonstrate that asset protection zones are achievable at subdivision. The asset protection zones dimensions cited in this assessment will be refined for future development as a more detailed assessment of slope, vegetation and bushfire attack is undertaken for each precinct. The required Asset Protection Zones must be located within the urban footprint, and specifically on land that is certified under the Cumberland Plain Conservation Plan.

Asset protection zones are managed areas located between bushfire hazards and development to provide a defendable space to facilitate emergency operations, and the provision of a buffer from direct flame contact, the impacts of radiant heat, smoke and embers. As per *Planning for Bushfire Protection 2019*, asset protection zones are to be contained wholly within the proposed lot or subject land for which they are benefitting or protecting, and located wholly within urban capable land. However, in some circumstances asset protection zones may consist of managed areas outside an allotment e.g. managed open space, managed service easements and roads. For the Aerotropolis, perimeter roads form part of the asset protection zones throughout the Assessment area as shown in relevant precinct plans.

The width of asset protection zones are based on a combination of:

- Predominant vegetation (using structural classification);
- Effective slope (i.e. slope most affecting fire behaviour adjacent to the interface);
- Fire Danger Index of 100 (a catastrophic fire weather day - **Figure 13**); and
- Fire Danger Index of 116 (climate change projection - **Figure 14**).

Figure 13 and **Figure 14** show the proposed asset protection zones for the subject land, with dimensions determined based on vegetation, slope and Fire Danger Index. **Table 5** and **Table 6** identify the slope and vegetation type used to determine asset protection zone requirements throughout the Assessment Area.

3.3.1 Assessment of impacts of climate change on Asset Protection Zones

The required under *Planning for Bushfire Protection 2019* are based on a Fire Danger Index of 100, whereas the results from the weather analysis indicate a higher Fire Danger Index setting is likely for the site. Radiant heat flux modelling was thus undertaken to determine the increase in asset protection zone distance required to account for a potential increase in the Fire Danger Index for the Aerotropolis, due to the impacts of climate change. The modelling undertaken explored the setback distances required under a higher Fire Danger Index to achieve a Bushfire Attack Level-29 (<29 kW/m^2) outcome, the setting utilised by *Planning for Bushfire Protection 2019* for residential development. The fuel loads prescribed by *Planning for Bushfire Protection 2019* were used in this modelling, as it is unclear what impact climate change may have vegetation fuel loads, if any.

The modelling of a climate change suitable asset protection zones uses a Fire Danger Index 116 and is consistent with the weather analysis undertaken for the overall Aerotropolis Bushfire Risk Assessment. Recent research by Douglas and He (2019) indicates that the weather values used in this analysis represent a reasonable estimate of potential future fire weather conditions under climate change and thus by extension, a reasonable basis to model climate change suitable asset protection zone distances. The results of the asset protection zone modelling are provided in **Figure 14** and **Table 6**.

3.3.2 Asset Protection Zones for Special Fire Protection Purpose Development

Asset protection zones for Special Fire Protection Purpose development, or sensitive uses, are larger than those applied to residential development and other developments or land uses due to the increased vulnerability of the occupants and the increased emergency management needs. These asset protection zones are required to provide an asset protection zones where radiant heat levels of greater than 10kW/ m² (calculated at 1200K) will not be experienced on any part of the building.

The following development is identified as Special Fire Protection Purpose in s100(b)(6) of the Rural Fires Act:

a. a school;
b. a childcare centre;
c. a hospital (including a hospital for the mentally ill or mentally disordered);
d. a hotel, motel or other tourist accommodation;
e. a building wholly or principally used as a home or other establishment for mentally incapacitated persons;
f. seniors housing within the meaning of State Environmental Planning Policy (Housing for Seniors or People with a Disability) 2004;
g. a group home within the meaning of State Environmental Planning Policy No 9—Group Homes,

h. a retirement village; or
i. any other purpose prescribed by the regulations.

In relation to point (i) above, the Rural Fires Regulations define the following as prescribed purposes:

*For the purposes of paragraph (i) of the definition of **special fire protection purpose** in section 100B (6) of the Act, the following purposes are prescribed:*

a. a manufactured home estate (within the meaning of State Environmental Planning Policy No 36—Manufactured Home Estates), comprising two or more caravans or manufactured homes, used for the purpose of casual or permanent accommodation (but not tourist accommodation);
b. a sheltered workshop, or other workplace, established solely for the purpose of employing persons with disabilities;
c. a respite care centre, or similar centre, that accommodates persons with a physical or mental disability or provides respite for carers of such persons
d. student or staff accommodation associated with a school, university or other educational establishment; or
e. a community bush fire refuge approved by the Commissioner.

Further, specific tourism uses including caravan parks, camping, primitive camping, bed and breakfast, farm stay accommodation, holiday lets and ecotourism, as well as residential based Special Fire Protection Purpose including manufactured home estates, home based childcare and tertiary institutions have specific requirements in *Planning for Bushfire Protection 2019*.

3.3.3 Asset protection zones for Non-Residential Development Types

It is recommended that development associated with employment lands, such as commercial and industrial development, be treated as residential development for the purpose of strategic planning. Whilst there is opportunity for non-habitable development of this kind (i.e. the proposed Enterprise zone for Aerotropolis) to have an asset protection zones less than that required for residential subdivision, this flexibility relies on the known use of the building, its design and construction standard, and can only be determined at the development application stage. Therefore, it is considered appropriate to assess residential sized asset protection zones for such development at this stage in the planning process.

Asset protection zones for the areas of development are all able to be achieved on the subject land as indicated on **Figure 13**.

3.4 Landscaping

Planning for Bushfire Protection 2019 (Table 5.3a RFS 2019) specifies the following in relation to landscaping:

> *Landscaping is designed and managed to minimise flame contact and radiant heat to buildings, and the potential for wind-driven embers to cause ignitions*

The 'acceptable solution' for landscaping is according to Appendix 4 of *Planning for Bushfire Protection 2019* which prescribes the standards for asset protection zones.

This matter is not relevant at the strategic planning phase of land use planning however will need to be considered during future development application stages.

4. Feasibility of Asset Protection Zones

Figure 13 and **Figure 14** shows the vegetation formation used to assess the asset protection zones requirements for the site and the resultant asset protection zone dimension. **Table 5** and **Table 6** identify the slope and vegetation type used to determine these asset protection zones under current requirements and a climate change scenario. It is concluded that the required asset protection zones (Bushfire Attack Level 29 for >29kW/m² radiant heat) for residential development, under existing *Planning for Bushfire Protection 2019* requirements and also considering future climate change scenarios are feasible, along with , and asset protection zones where radiant heat levels of greater than 10kW/ m² (calculated at 1200K) will not be experienced on any part of the building for Special Fire Protection Purpose development. The indicative Bushfire Attack Level ratings for the site as shown in **Figure 15** highlight that ample area exists within the site that would no longer be classified as bushfire prone land. This provides the potential for a high bushfire resilience. It also shows these can be achieved without the need for alternate solutions, even considering the climate change scenario assessed.

Table 5: Indicative asset protection zones for subject land for residential and Special Fire Protection Purpose

Slope[1]	Vegetation[2]	Planning for Bushfire Protection required APZ (residential)[3]	Planning for Bushfire Protection required APZ (SFPP) [4]	Comments
Downslope >0 to 5 degrees	Grassland	12 m	40 m	APZ provided between hazard and development. Where practical the APZ can be provided by the road network. All APZ will be on urban capable land and not within environmental protection or conservation areas
Downslope >5 to 10 degrees	Grassland	13 m	45 m	As above
Downslope >10 to 15 degrees	Grassland	15 m	50 m	As above
Downslope >15 to 20 degrees	Grassland	17 m	55 m	As above
Downslope >0 to 5 degrees	Forested Wetland	12 m	42 m	As above.
Downslope >5 to 10 degrees	Forested Wetland	16 m	51 m	As above
Downslope >10 to 15 degrees	Forested Wetland	20 m	62 m	As above
Downslope >15 to 20 degrees	Forested Wetland	26 m	73 m	As above
All upslope and flat land	Woodland	12 m	42 m	As above
Downslope >0 to 5 degrees	Woodland	16 m	50 m	As above
Downslope >5 to 10 degrees	Woodland	20 m	60 m	As above
Downslope >10 to 15 degrees	Woodland	25 m	72 m	As above

Slope[1]	Vegetation[2]	Planning for Bushfire Protection required APZ (residential)[3]	Planning for Bushfire Protection required APZ (SFPP) [4]	Comments
Downslope >15 to 20 degrees	Woodland	32 m	85 m	As above
Downslope >0 to 5 degrees	Forest	29 m	79 m	As above
Downslope >5 to 10 degrees	Forest	36 m	93 m	As above
Downslope >10 to 15 degrees	Forest	45 m	100 m	As above
Downslope >15 to 20 degrees	Forest	56 m	100 m	As above

[1] Slope most significantly influencing the fire behaviour of the site as per Planning for Bushfire Protection.

[2] Predominant vegetation is identified, according to Planning for Bushfire Protection.

[3] Assessment according to Table A1.12.2 of Planning for Bushfire Protection.

[4] Assessment according to Table A1.12.1 of Planning for Bushfire Protection.

Table 6: Modelled Asset Protection Zone requirements for increased Fire Danger Index resulting from climate change

Vegetation type	Slope category																			
	Upslope/flat				>0-5° downslope				>5-10° downslope				>10-15° downslope				>15-20° downslope			
	DtS (m)	Model (m)	% change	Adjusted APZ (m)	DtS (m)	Model (m)	% change	Adjusted APZ (m)	DtS (m)	Model (m)	% change	Adjusted APZ (m)	DtS (m)	Model (m)	% change	Adjusted APZ (m)	DtS (m)	Model (m)	% change	Adjusted APZ (m)
Forest	24	24.9	4%	25	29	31.3	8%	32	36	39.4	9%	40	45	49.8	11%	50	56	63.5	13%	64
Grassy Woodland	12	13.4	12%	14	16	17.5	9%	18	20	22.5	13%	23	25	28.8	15%	29	32	36.8	15%	37
Forested Wetland	10	10.1	1%	11	12	13.8	15 %	14	16	18.2	14%	19	20	23.7	19%	24	26	30.4	17%	31
Grassland	10	10.6	6%	11	12	12.8	7%	13	13	15.1	16%	16	15	17.7	18%	18	17	20.5	21%	21

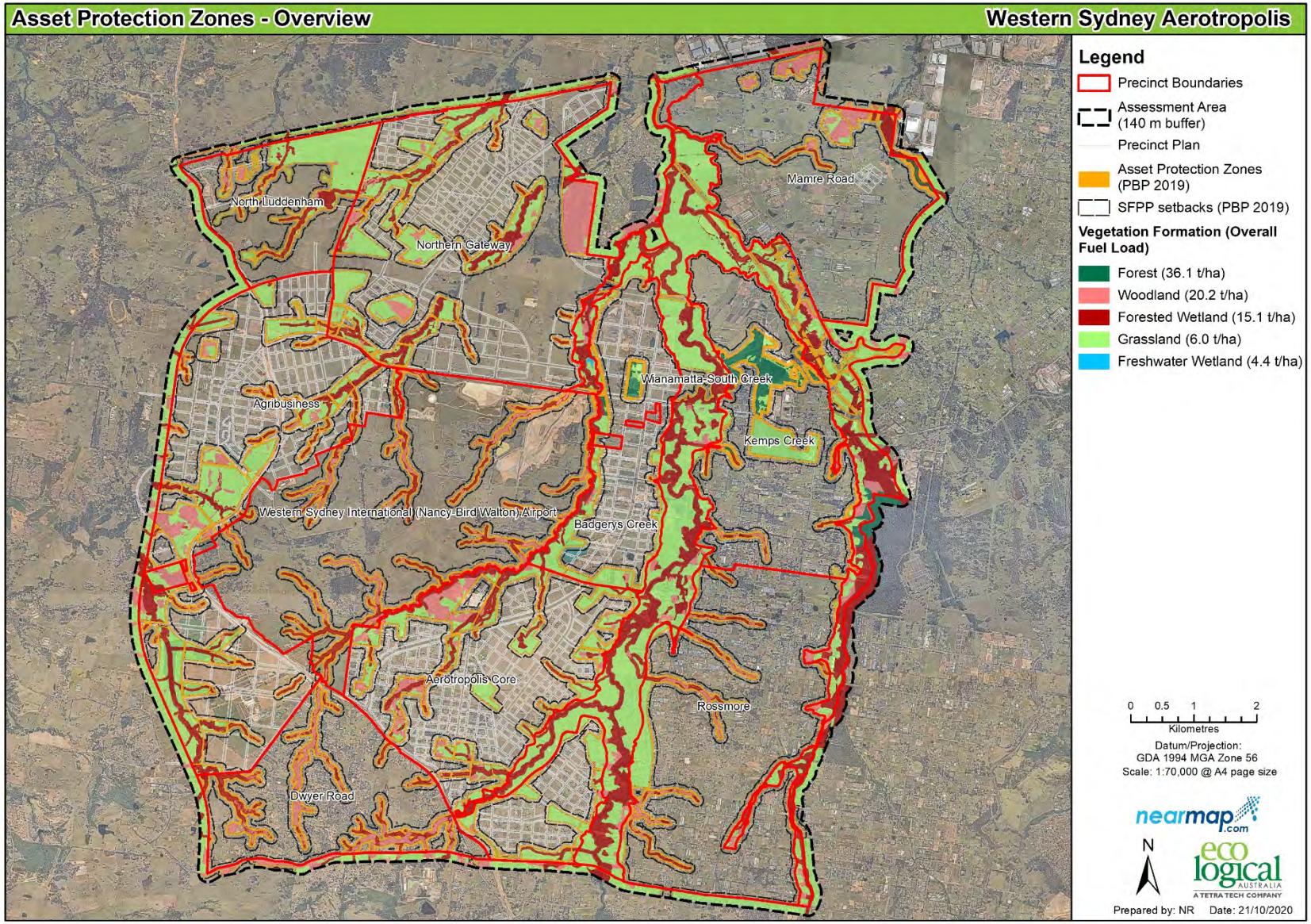

Figure 13: Asset Protection Zones for residential subdivision and Special Fire Protection Purpose (Planning for Bushfire Protection 2019 – Fire Danger Index = 100)

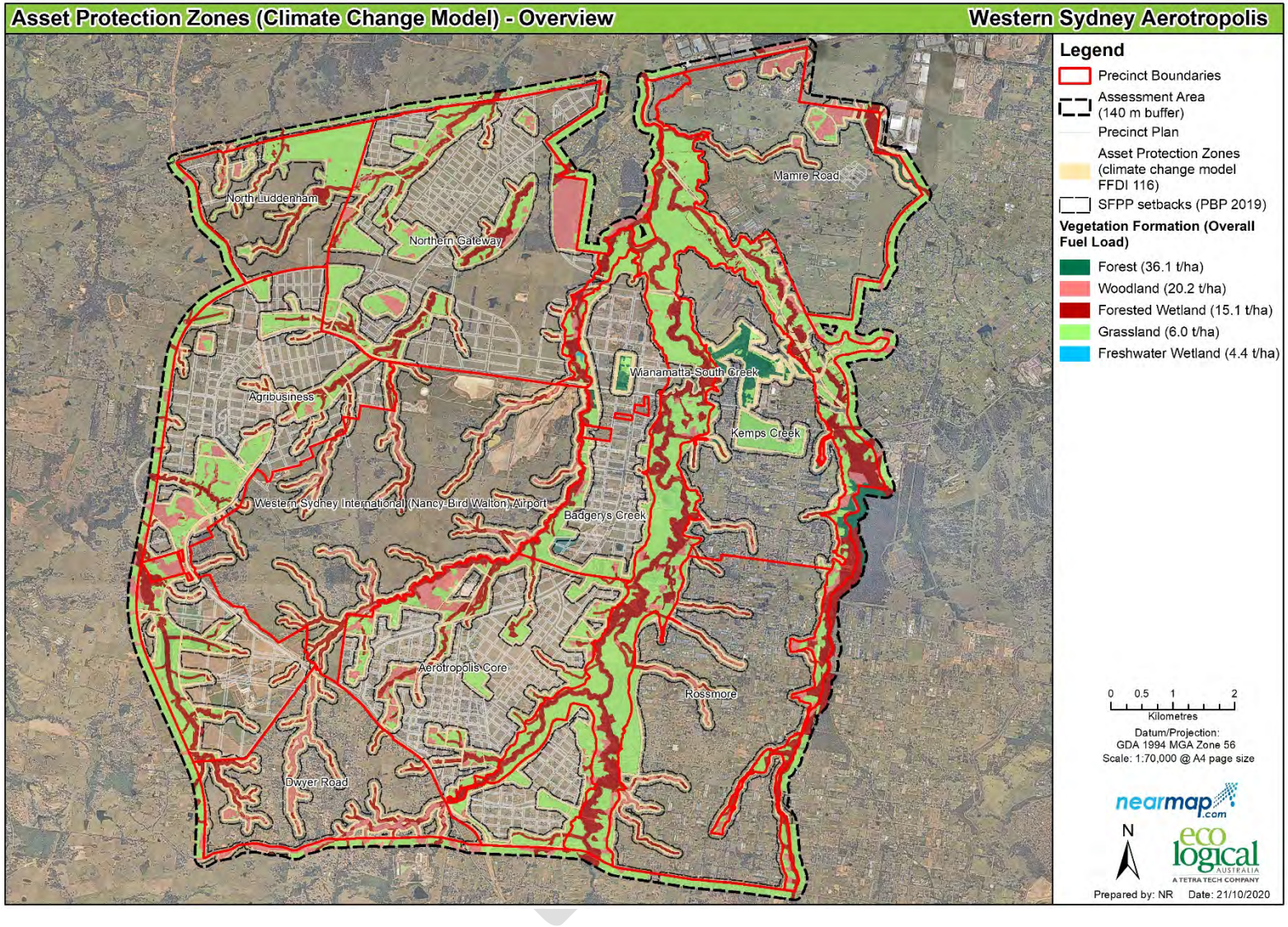

Figure 14: Asset Protection Zones based on climate change scenario (Fire Danger Index = 116)

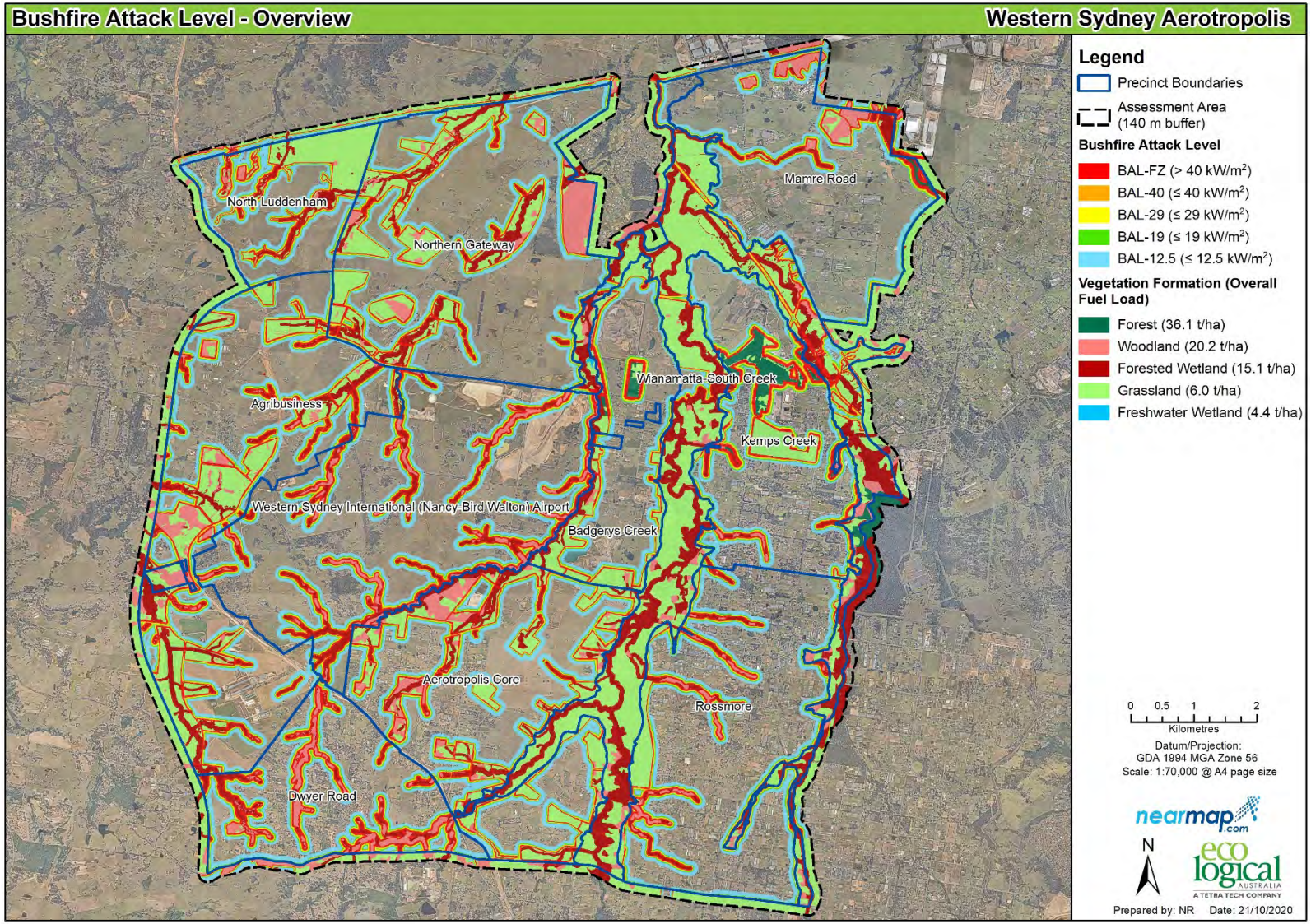

Figure 15: Bushfire Attack Levels (BAL) Planning for Bushfire Protection 2019

5. Access and Egress

Safe access, egress and defendable spaces are required for emergency services in all developments occurring within Bush Fire Prone Land. Proposed road corridors (**Figure 1**) across the site are comprehensive and provide for multiple access routes both east-west and north-south. The connections provide redundancy in the event of one major egress being restricted during a bushfire attack, and with the proposed secondary and perimeter roads the options for evacuation routes are expected to be adequate for any foreseeable bushfire attack scenario. Emergency management arrangements are also required such as procedures and routines for evacuation and consideration of safer places.

Specific management and evacuation plans may be required at a later stage especially for Special Fire Protection Purpose developments. The emergency management requirements and their capacity to meet response times and related safety measures is also critical.

The subject land aims to provide an economic hub interconnected with the Greater Sydney region. The subject land has the potential to comply with the *Planning for Bushfire Protection 2019* acceptable solutions but also is expected to provide a major linked network to achieve access throughout the Aerotropolis. Lower intensity fire may enter proposed green spaces, but the design of these spaces can minimise fire spread and any potential restriction of localised traffic movement. Furthermore, urban edge roads linked at short intervals to the secondary and major road network provide rapid egress to Bushfire Attack Level LOW areas and potential Neighbourhood Safer Places.

Multiple access points are an essential bushfire protection measure to be considered for the development as roads have the potential to be exposed to the bushfire hazard, predominately from the north west, and be cut off. The indicative road layout provides for multiple access routes both east-west and north-south across the site in the event of fires either approaching or burning within the Assessment area. The extent of vegetated riparian corridors proposed may result in increased risk to access options being cut off. However, this will be assessed in more detail at the precinct levels as access arrangements and riparian management are refined. It is expected that given the size of the site and number of access options indicated, the risk of isolation of the site or a precinct is negligible.

Detailed precinct planning will provide public roads that can readily incorporate the access requirements of *Planning for Bushfire Protection 2019* (see Appendix A) and achieve:

- A road design that facilitates the safe access and egress for residents and emergency service personnel, including multiple access/egress options for each area;
- Access that meets the acceptable solutions detailed in *Planning for Bushfire Protection 2019* (where relevant), especially the provision of perimeter roads (of sufficient width and capacity) separating developed land from bushfire prone vegetation and the provision of alternative access;
- A road design with adequate capacity to facilitate satisfactory emergency evacuation; and
- Provision of fire trail/s (if required) to support operational activities in strategic locations.

6. Emergency Services

The following is recommended for strategic land use planning to achieve the objectives and strategic planning principles of *Planning for Bushfire Protection 2019* relating to emergency management. Strategic emergency management planning is undertaken in collaboration with emergency service organisations within the strategic land use planning process, to establish preferred future outcomes (i.e. resource adequacy and emergency evacuation) that have implications for land use planning, including:

a. Consideration of the increase in demand for emergency services;
b. Emergency evacuation planning; and
c. Evacuation adequacy assessment.

Currently, there are limited emergency services in proximity to the Aerotropolis. Therefore, making provisions for additional capacity within or servicing the Aerotropolis is warranted. In this regard, liaison with relevant emergency service organisation is needed, along with the provision of funding mechanisms and the allocation of any land required for Brigade Stations or the like. There are currently four Rural Fire Service brigades within 10 minutes travel time of the subject site with current access arrangements:

- Luddenham Rural Fire Brigade (within subject land);
- Middleton Rural Fire Brigade (4.5 km, 5 minutes travel time to east of subject land);
- Horsley Park Rural Fire Brigade (7 km, 10 minutes travel time to north east of the subject land); and
- Leppington Rural Fire Brigade (3km, 3 minutes travel time to south of the subject land).

Improved access arrangements as part of Aerotropolis development is expected to facilitate improved levels of emergency access, even with the increased traffic associated with the development. It is recommended that any future development is consistent with Cumberland & Macarthur Bush Fire Risk Management Plan.

7. Evacuation adequacy

Initial assessment of emergency evacuation has occurred and includes the following:

- An analysis of the most relevant bushfire attack scenario;
- Identification of evacuation and refuge locations; and
- An evaluation of evacuation adequacy and option for the shortcomings identified.

7.1 Assessment of Neighbourhood Safer Places

Off-site evacuation is time consuming, causes a range of significant community disruptions and is resource demanding for emergency services. This Assessment has found that localised evacuation to Neighbourhood Safer Places is both feasible and highly desirable.

The potential for Neighbourhood Safer Places was assessed in accordance with the criteria and principles documented in RFS 2017 and is shown in **Table 7** and **Table 8**.

RFS (2017) defines a Neighbourhood Safer Places as follows:

A Neighbourhood Safer Place is a building or an open space that may provide for improved protection of human life during the onset and passage of a bush fire. It is a location where people facing an immediate threat to their personal safety can gather and seek shelter from the impact of a bush fire. Their function is to provide a place of last resort for a person to seek shelter at during the passage of the bush fire front.

Neighbourhood Safer Places are not to be confused with Fire Refuges, Recovery Centres, Assembly Areas, Evacuation Centres or Informal Places of Shelter

Table 7: Assessment Criteria for a Neighbourhood Safer Place (RFS 2017)

Factor	Performance Criteria	Acceptable Solution	Comment
Radiant Heat	Building is located and constructed to enhance the chance for survival for humans in attendance from the radiant heat of a bush fire.	Building is situated to prevent direct flame contact, material ignition and radiant heat level of 10kW/m²; or Provide 139 metres separation distance from a bush fire hazard.	All areas outside of the Special Fire Protection Purpose required APZ meet the acceptable solution requirement for radiant heat level.
	Open Space is located to enhance the chance for survival for humans in attendance from the radiant heat of a bush fire.	Open Space is situated and maintained to prevent direct flame contact, material ignition and radiant heat levels of 2kW/m²; or Provide 310 metres separation distance from a bush fire hazard	Substantial proportion of the development footprint available to provide for a maximum radiant heat level of 2kW/m² to meet these criteria.
Maintenance of the Site and the Land Adjacent	Area between bush fire hazard and the site is maintained to a level that ensures the radiant heat levels at the Building/Open Space meet the Performance Criteria for Radiant Heat.	The site and land adjacent to the site between the Building/Open Space and the bush fire hazard is managed land or maintained in accordance with NSW RFS document *Standards for Asset Protection Zones*	Landscape management practices will be determined at later stages in the development process; however all internal areas will meet the required standards for asset protection zones or be managed land.

Table 8: Principles for Site Identification (RFS 2017)

Consideration	Principles
Site Selection	An NSP should provide a safer place for the community.
	The community should be moving away from the bush fire hazard to access the NSP over short distances where possible.
	NSP locations should reflect community need and bush fire risk.
Moving to an NSP	An NSP should not be isolated from the community.
	The community should not be impeded from reaching the NSP area in a bush fire situation.
Capacity	Additional NSPs should be sought where it is likely current or potential NSPs cannot accommodate those likely to use it.
	Demand for use of an NSP reflect a community's level of bush fire preparedness.

There are a number of existing Neighbourhood Safer Places within or in close proximity to the subject land which exists as open space based on the nature of the surrounding landscape. These include:

- Luddenham Showground, Open Space, Luddenham (within subject land);
- Bringelly Park, Open Space, Bringelly (within subject land); and
- Wallacia Gold course Carpark, Open Space, Wallacia (8 km west);

Egress to each of these Neighbourhood Safer Places is dependent on access options remaining open, as discussed in **Section 5**.

As noted, given the overarching size and development of the Aerotropolis, it is expected further services and Neighbourhood Safer Places will be provided within the vicinity of the Aerotropolis.

8. Infrastructure

8.1 Water

The Aerotropolis is serviced by a reticulated water supply that will be extended across the site as part of future development works. **Table 10** identifies the acceptable solution requirements of Section 5.3.3 of *Planning for Bushfire Protection 2019*.

The *Planning for Bushfire Protection 2019* acceptable solution requirements for water is achievable.

8.2 Electricity and Gas

It is preferable that electrical transmission lines are underground where practical to reduce the risk of ignition. An existing network of powerlines is located across the development area and is managed and will continue to be managed in accordance with the *Guide for the Management of Vegetation in the Vicinity of Electricity Supply Infrastructure* (ISSC3 2016).

A number of the existing feeder lines will become part of the development footprint within managed open spaces. These open spaces will be of a design that will potentially lower the existing low ignition risk and will pose no risk bushfire impact to the power supply. Details for compliance with *Planning for Bushfire Protection 2019* are provided in **Table 10**.

9. Adjoining Land

Future development will not be reliant on any off-site bushfire mitigation measures. All development occurring on Bush Fire Prone Land will be required to be assessed at Development Application stage where appropriate bushfire protection measures will be identified and implemented. All asset protection zones will be within urban capable land.

Local Bushfire Management Committees will be updated annually on the bushfire protection measures in-built and proposed for development within the Aerotropolis.

Some areas to the north west and south west of the Assessment area, are identified as Strategic Fire Advantage Zones in the Cumberland & Macarthur Bush Fire Risk Management Plan, which aim 'to provide strategic areas of fire protection advantage which will reduce the speed and intensity of bush fires and reduce the potential for spot fire development' and Land Management Zones, which aims to 'meet relevant land management objectives in areas where asset protection zones or Strategic Fire Advantage Zones are not appropriate' (Map 2, Cumberland BFRMP, 2010). These management practices are expected to continue, with no additional impacts to the management regime as a result of development that will occur within the Aerotropolis.

The proposed land uses should not have a harmful impact on the ability for bushfire management activities to be undertaken on adjoining land. Given the adherence to *Planning for Bushfire Protection 2019* and other land use planning requirements, the proposed land uses should not increase bushfire management needs for retained and/or adjoining bushfire prone vegetation.

10. Conclusions

Several strategies have been provided in the form of planning controls to reduce the bushfire risk to an appropriate level. These planning controls are consistent with *deemed to satisfy* bushfire protection requirements outlined in *Planning for Bushfire Protection 2019,* and this report shows that all bushfire protection requirements can be achieved.

The Aerotropolis assessment area has been evaluated in relation to the feasibility of bushfire protection measures. The required bushfire protection measures in accordance with *Planning for Bushfire Protection 2019* are achievable within the Aerotropolis and reduce the bushfire risk associated with the development that will occur within the Aerotropolis.

Notable elements of the Assessment supporting this conclusion are:

- All *Planning for Bushfire Protection 2019* required bushfire protection measures can reasonably be accommodated within the large development footprint.
- Capacity exists to enhance the bushfire protection measures through the staged implementation of development in the Aerotropolis.
- The large development footprint can ensure the those who are more vulnerable in the community are in the safest bushfire locations.
- The large development footprint enables all major egress roads to be located where there is limited to no risk of impact by bushfire. Most secondary roads are also located on future non-bushfire prone land.
- Radiant heat modelling shows that the vast majority of the future development footprint will be not bushfire prone land. The models also show that Neighbourhood Safer Places can be strategically located to ensure 'out of area' evacuation is not required enabling substantial improvements to community resilience.
- Landscape design controls across the development footprint will further reduce the bushfire attack potential, particularly from burning debris.
- Underground electricity and gas services.
- Compliant water supplies.
- Emergency response planning.

More detailed bushfire assessment to accurately prescribe setbacks, roads and landscaping is required at the precinct planning level, however this initial strategic assessment will be used to inform this more detailed designed to occur smoothly and achieve the deemed to satisfy standards within NSW.

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Appendix A – Access Specifications

The following access specifications are reproduced from Planning for Bushfire Protection.

Intent of measures: To provide safe operational access to structures and water supply for emergency services while residents are evacuating an area.

Table 9: Performance criteria for access for residential and rural residential subdivisions

Performance Criteria	Acceptable Solutions
The intent may be achieved where:	
• **firefighting vehicles are provided with safe, all-weather access to structures and hazard vegetation**	• property access roads are two-wheel drive, all-weather roads, and • perimeter roads are provided for residential subdivisions of three or more allotments; and • subdivisions of three or more allotments have more than one access in and out of the development; and • traffic management devices are constructed to not prohibit access by emergency services vehicles; and • maximum grades for sealed roads do not exceed 15 degrees and an average grade of not more than 10 degrees or other gradient specified by road design standards, whichever is the lesser gradient; and • all roads are through roads; • Dead end roads are not recommended, but if unavoidable, dead ends are not more than 200 metres in length, incorporate a minimum 12 metres outer radius turning circle, and are clearly sign posted as a dead end; and • where kerb and guttering is provided on perimeter roads, roll top kerbing should be used to the hazard side of the road; and • where access/egress can only be achieved through forest, woodland or heath vegetation, secondary access shall be provided to an alternate point on the existing public road system. • One way only public access roads are no less than 3.5 metres wide and have designated parking bays with hydrants located outside of these areas to ensure accessibility to reticulated water for fire suppression.
• **the capacity of access roads is adequate for firefighting vehicles**	• the capacity of perimeter and non-perimeter road surfaces and any bridges/causeways is sufficient to carry fully loaded firefighting vehicles (up to 23 tonnes); bridges/causeways are to clearly indicate load rating.
• **there is appropriate access to water supply**	• hydrants are located outside of parking reserves and road carriageways to ensure accessibility to reticulated water for fire suppression; • hydrants are provided in accordance with AS 2419.1:2005 *Fire hydrant installations system design, installation and commissioning;* • there is suitable access for a Category 1 fire appliance to within 4m of the static water supply where no reticulated supply is available.

Performance Criteria	Acceptable Solutions
• **access roads are designed to allow safe access and egress for medium rigid firefighting vehicles while residents are evacuating as well as providing a safe operational environment for emergency service personnel during firefighting and emergency management on the interface**	• perimeter roads are two-way sealed roads; and • 8m carriageway width kerb to kerb; and • parking is provided outside of the carriageway width; and • hydrants are located clear of parking areas; and • there are through roads, and these are linked to the internal road system at an interval of no greater than 500m; and • curves of roads have a minimum inner radius of 6m; and • the maximum grade road is 15° and average grade is 10°; and • the road crossfall does not exceed 3°; and • a minimum vertical clearance of 4m to any overhanging obstructions, including tree branches, is provided.
• **access roads are designed to allow safe access and egress for medium rigid firefighting vehicles while residents are evacuating**	• minimum 5.5m width kerb to kerb; and • parking is provided outside of the carriageway width; and • hydrants are located clear of parking areas; and • roads are through roads, and these are linked to the internal road system at an interval of no greater than 500m; and • curves of roads have a minimum inner radius of 6m; and • the road crossfall does not exceed 3°; and • a minimum vertical clearance of 4m to any overhanging obstructions, including tree branches, is provided.
• **firefighting vehicles can access the dwelling and exit safely**	There are no specific access requirements in an urban are where an unobstructed path (no greater than 70 m) is provided the most distant external part of the proposed dwelling and the nearest part of the public access road (where the road speed limit is not greater than 70kph) that supports the operational use of emergency firefighting vehicles (i.e. a hydrant or water supply). In circumstances where this cannot occur, the following requirements apply: • minimum carriageway width of 4m; • in forest, woodland and heath situations, rural property access roads have passing bays every 200m that are 20m long by 2m wide, making a minimum trafficable width of 6m at the passing bay; and • a minimum vertical clearance of 4m to any overhanging obstructions, including tree branches; and • provide a suitable turning area in accordance with Appendix 3; and • curves have a minimum inner radius of 6m and are minimal in number to allow for rapid access and egress; and • the minimum distance between inner and outer curves is 6m; and • the crossfall is not more than 10°; and • maximum grades for sealed roads do not exceed 15° and not more than 10° for unsealed roads; and • a development comprising more than three dwellings has formalised access by dedication of a road and not by right of way. Note: Some short constrictions in the access may be accepted where they are not less than the minimum (3.5m), extend for no more than 30m and where the obstruction cannot be reasonably avoided or removed. the gradients applicable to public roads also apply to community style development property access roads in addition to the above.

Appendix B – Service specifications

The following services specifications (provision of water, gas and electricity) are reproduced from Planning for Bushfire Protection.

Intent of measures: provide adequate services of water for the protection of buildings during and after the passage of a bush fire, and to locate gas and electricity so as not to contribute to the risk of fire to a building.

Table 10: Performance criteria for services provision for residential and rural residential subdivisions

Performance Criteria	Acceptable Solutions
The intent may be achieved where:	
• **a water supply is provided for firefighting purposes**	• reticulated water is to be provided to the development, where available; • a static water and hydrant supply is provided for non-reticulated developments or where reticulated water supply cannot be guaranteed; and • static water supplies shall comply with Table 5.3d.
• **water supplies are located at regular intervals** • **the water supply is accessible and reliable for firefighting operations**	• fire hydrant spacing, design and sizing complies with relevant clauses of the Australian Standard AS 2419.1:2005; • hydrants are not located within any road carriageway; • reticulated water supply to urban subdivisions uses a ring main system for areas with perimeter roads.
• **flows and pressure are appropriate**	• fire hydrant flows and pressures comply with the relevant clauses of AS 2419.1:2005.
• **the integrity of the water supply is maintained**	• all above-ground water service pipes are metal, including and up to any taps. • Above-ground water storage tanks shall be of concrete or metal.

• **location of electricity services limits the possibility of ignition of surrounding bush land or the fabric of buildings**	• where practicable, electrical transmission lines are underground;
	• where overhead, electrical transmission lines are proposed as follows:
	  ◦ lines are installed with short pole spacing (30m), unless crossing gullies, gorges or riparian areas;
	  ◦ no part of a tree is closer to a power line than the distance set out in accordance with the specifications in ISSC3 Guideline for Managing Vegetation Near Power Lines.

• **location and design of gas services will not lead to ignition of surrounding bushland or the fabric of buildings.**	• reticulated or bottled gas is installed and maintained in accordance with AS/NZS 1596:2014 and the requirements of relevant authorities, and metal piping is used; • all fixed gas cylinders are kept clear of all flammable materials to a distance of 10m and shielded on the hazard side; • connections to and from gas cylinders are metal; • polymer-sheathed flexible gas supply lines to gas meters adjacent to buildings are not used; • above-ground gas service pipes are metal, including and up to any outlets.

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