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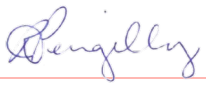
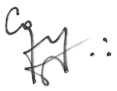
100 Eton Road, Lindfield

LINDFIELD LEARNING VILLAGE

BUSHFIRE DESIGN FIRE ENGINEERING REPORT

REPORT 2018/321 R8.0

REVISION CONTROL

Report No.	Issue Date	Report Details		
2018/321 R8.0	26/08/2020	Description:	Original Report	
		Prepared by:	Harriet Peel (Senior Fire Safety Engineer)	
		Approved by:	Rose Pengilly (Director)	
		Verified and Issued by:	Carlos Quaglia (Managing Director, C10 - BPB0334)	

EXECUTIVE SUMMARY

Lindfield Learning Village is situated at the former University of Technology Sydney site at 100 Eton Road, Lindfield. The project consists of converting the existing university buildings to school facilities for students from Kindergarten to Year 12. The school is located on bushfire prone land.

Stephen Grubits & Associates Pty Ltd have been engaged by NSW Department of Education and School Infrastructure NSW to support the preparation of a Bushfire Design Fire Engineering Report by the Bushfire Consultant, by providing fire engineering assessment and analysis of select bushfire protection strategies, to demonstrate compliance with GP5.1 of the Building Code of Australia 2019, as part of the Development Approval application. With regard to compliance with the NCC 2019 (the applicable version of the NCC as indicated by the BCA Consultant), further non-compliances from Sections C, D and E of the BCA 2019 within the buildings have been identified by the BCA Consultant. These non-compliances are listed in Appendix B, and are the subject of a separate fire engineering report, which is currently under preparation (including the preparation of Fire Engineering Documentation for submission to Fire & Rescue NSW).

Therefore, this Fire Bushfire Design Engineering Report (prepared at request of Mr. David Boverman of the Rural Fire Service following review of the Bushfire Hazard Assessment and Fire Engineering Brief) is intended to summarise the fire engineering basis to the strategies proposed to meet Performance Requirement GP5.1 of the BCA, which states:

A building that is constructed in a designated bushfire prone area must, to the degree necessary, be designed and constructed to reduce the risk of ignition from the bushfire appropriate to the:

- *(a) Potential for ignition caused by burning embers, radiant heat or flame generated by a bushfire; and*
- *(b) Intensity of the bushfire attack on the building*.

NSW BCA Clause G5.2 (the relevant DTS Provision) states that, *"In a designated bushfire prone area, a …Class 9 building or part that is a special fire protection purpose… must comply with*

- *(a) AS 3959 except-*
  - *(i) As amended by Planning for Bushfire Protection; and*
  - *(ii) For Section 9 Construction for Bushfire Attack Level FZ (BAL-FZ)., buildings subject to BAL-FZ with specific conditions of development consent for construction at this level and*
- *(b) The requirements of (a) above as modified by the development consent following consultation with the Rural Fire Service under Section 4.14 of the Environmental Planning and Assessment Act 1970 if required. "*

The benchmark for complying with G5.2 (and consequently GP5.1) is proposed to be compliance with AS 3959 in accordance with G5.2 (a) and the Performance Criteria described in Planning for Bushfire Protection 2019 (PBP) to meet G5.2 (b) as the development consent has not yet been issued. Most Performance Criteria in Planning for Bushfire Protection 2019 are proposed to be met by Acceptable Solutions stipulated in the PBP and are described in detail in Bushfire Hazard Assessment and Fire Engineering Brief (prepared by BlackAsh Consulting), and listed in Appendix C of this report. Two Performance Criteria of PBP, listed in Table 1, are the subject of specific fire engineering, and this report is intended to summarise the assessment undertaken to demonstrate the adequacy of the proposed strategies against those relevant Performance Criteria of PBP 2019, and therefore GP5.1 of the BCA 2019.

Table 1 – Performance Requirements address in this report

Performance Criteria (PBP)	Acceptable Solution (PBP*)	Performance-based Strategy	BCA Performance Requirement
Radiant heat levels of greater than 10kW/m² (calculated at1200K) are not experienced by emergency service personnel and occupants during firefighting and emergency management.	The building is provided with an Asset Protection Zone (APZ) in accordance with Planning for Bushfire Protection	- Establish and maintain APZ - Develop alert and evacuation procedure for early evacuation - Construct structures and develop procedure to support Shelter-in-Place as a last resort.	GP5.1
The proposed building can withstand bush fire attack in the form of wind, smoke, embers, radiant heat and flame contact	A construction level of BAL-12.5 under AS 3959 or NASH and Table 7.4b is applied.	- Upgrade all facades to BAL-FZ according to AS 3959-2018 -Where AS 3959-2018 does not have explicit requirements for particular features, develop protection measures to provide equivalent or better protection to BAL-FZ level.	GP5.1

To summarise the assessment findings in this report, the key features of the bushfire design to meet the Performance Criteria in Table 1 (and hence GP5.1 of the BCA 2019) include:

- Provision of an Asset Protection Zone (APZ) of sufficient dimensions to limit exposure of the facades closest to the bush to 10 kW/m^2, and that is safely maintainable over the life of the building, using the flame characteristics derived by the Bushfire Consultant in accordance with AS 3959,
- Provision of an egress strategy for school occupants and access strategy for the brigade that includes:
    - Facilities for warning and information gathering by school leadership to enable sound egress decisions;
    - Assessment of the likely duration of evacuation against the likely time taken for bushfires to reach the site and potential deterioration of conditions during egress;
    - Consideration and mitigation of the impact of school evacuation on brigade access, as well as the actions of the wider community, and vice versa, by selecting specific roadways for access and egress, and providing means of communicating the egress progress to the wider school community (parents and guardians);
    - Provision of a fire-separated Shelter-in-Place within the school to provide a last resort refuge to mitigate the risk of evacuees trapped in the open during egress that occurs too late.
    - Provision of road and fire trail fire brigade access around the entire site, as well as tanked water supply and hydrants for firefighting.
- Provision of BAL-FZ treatment (or equivalent where AS 3959 does not provide specific provisions) to the building. Treatment of the façades to BAL-FZ is anticipated to provide protection to higher levels of radiant heat flux than the calculated heat flux exposure, based on the proposed APZ distance. That is, the radiant heat assessment undertaken indicated a likely heat flux of 10 kW/m^2 at the building façade, while the BAL-FZ façade protection is designed to withstand heat fluxes of at least 40 kW/m^2, without causing ignition of the interior of the building. Therefore, the assessment demonstrates bushfire spread into the building is not likely to occur;
- As redundancy, provision of internal sprinkler protection and fire-resisting compartmentation to the building to contain fire and stop or delay its spread, should bushfire spread into the building
- On-going drills and staff training to support prompt and informed decision-making and action in a bushfire event.

Implementation of the Trial Design within Section 7, as well as the requirements of the documents named below, will provide compliance with Performance Requirement named above. This document should be read in conjunction with the following:

- Bushfire Hazard Assessment and Fire Engineering Brief (prepared by BlackAsh Consulting, dated 29th April 2020, this report documents the conformance of the proposed bushfire design with PBP 2019)
- Bushfire Emergency Management and Evacuation Plan (prepared by BlackAsh Consulting, dated 17th April 2020, this report documents the emergency planning undertaken to support egress and/shelter in the event of bushfire)
- SGA Report 2018/321 R1.3 Bushfire Measures Compliance Report (prepared by SGA, dated 15th May 2020, this report describes the measures for each façade and roof, and features to the façade to comply with AS 3959)
- SGA Report 2018/321 R4.0 Bushfire Evacuation Analysis Report (prepared by SGA, dated 9th September 2019, this report documents the assessment of the egress time for the entire school to reach the Emergency Refuge)
- SGA Report 2018/321 R5.1 Bushfire Radiation Assessment Report (prepared by SGA, dated 18th December 2019, this report documents the findings of the assessment of the radiant heat fluxes to the building from the edge of the proposed APZ)

Should a change in use or building alterations or additions occur in the future, a re-assessment will be needed to verify consistency with the analysis contained within this report.

TABLE OF CONTENTS

LIST OF ACRONYMS

AS	Australian Standard
ASET	Available Safe Evacuation Time
BCA	National Construction Code Series Volume One Building Code of Australia, 2019
DTS	Deemed-to-Satisfy
FEB	Fire Engineering Brief
FER	Fire Engineering Report
FRL	Fire Resistance Level
IFEG	International Fire Engineering Guidelines
PCA	Principal Certifying Authority
RSET	Required Safe Evacuation Time
SGA	Stephen Grubits & Associates Pty Ltd

1. INTRODUCTION

Lindfield Learning Village is situated at the former University of Technology Sydney site at 100 Eton Road, Lindfield. The project consists of converting the existing university buildings to school facilities for students from Kindergarten to Year 12. The proposed school is located on bushfire prone land.

Stephen Grubits & Associates Pty Ltd have been engaged by NSW Department of Education and School Infrastructure NSW to support the preparation of a Bushfire Design Report by the Bushfire Consultant, by providing fire engineering assessment and analysis of select bushfire protection strategies, where compliance with the Acceptable Solutions of the Planning for Bushfire Protection is not feasible.

Therefore, this Fire Engineering Report is intended to summarise the fire engineering basis to the strategies proposed to meet the select Performance Criteria described in Planning for Bushfire Protection 2019, listed in Table 1. The remaining Performance Criteria are proposed to be met by Acceptable Solution and are described in detail in Bushfire Hazard Assessment and Fire Engineering Brief (prepared by BlackAsh Consulting) , and listed in Appendix C of this report.

2. LIMITATIONS & ASSUMPTIONS

1. The scope of this report is limited to an assessment of the departures from the Acceptable Solutions identified in Table 8. Separate assessment on any other non-compliance issues in the building relating to C D and E of the NCC 2019 is currently underway and will be documented separately.

2. The assessment is based on the objectives of the BCA (being addressed via the application of the PBP 2019) being that of:
   - Occupant life safety;
   - Facilitation of the Fire Brigade intervention; and
   - Protection of adjoining property.

3. Should a change in use or building alterations or additions occur in the future, a re-assessment will be needed to verify consistency with the analysis contained within this report.

4. All of the fire safety systems are assumed to operate as designed unless specifically stated otherwise.

5. The fire safety measures specified within Section 7 do not necessarily reflect all of the required fire safety measures for the building.

6. This report does not address sections B, F, H, J of the BCA, nor does it address access provisions.

7. The Trial Design requirements are only minimum requirements. Nothing in this report restricts introduction of additional measures that would enhance safety.

3. BUILDING DESCRIPTION

3.1. GENERAL CHARACTERISTICS

Lindfield Learning Village is situated at the former University of Technology Sydney site at 100 Eton Road, Lindfield. The project consists of converting the existing university buildings to school facilities, in stages, for students from Kindergarten to Year 12, as well as administration and support facility including distant learning. Refer to Figure 1 and Figure 2 for the aerial view and the overall site plan/staging layout of the subject development.

The development comprises the conversion of the existing UTS site to the Lindfield Learning Village. The site comprises a number of existing buildings that are to be converted to school buildings over three stages described below. The majority of the buildings comprise concrete construction (i.e. concrete walls and roofs), with the remaining buildings including steel roofs.

There are two stages to the conversion Stages 1 and 2. Stage 1 has been completed in early 2019 to accommodate 354 students and 70 staff. Stage 1 included upgrades and refurbishment works of (but is not limited to) large multi-purpose auditorium, smaller lecture theatres, classrooms, administrative offices, cafeteria, kitchen and music rooms. Works in Stage 2 is to expand the school to accommodate more students and staff, up to a student population of 2,100. Stage 2 will include the conversion of the rest of the building to include (but is not limited to) further learning areas to accommodate more students, childcare facilities, educational research centre, conference centres and Department of Education offices. Under Stage 2, the construction work will be split into three different phases, namely Stage 2A, Stage 2B and Stage 2C, where the school is progressively developed and opened for populations of 700, 1050 and 2000 students respectively.

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Figure 1 – Aerial view of Lindfield Learning Village (maps.six.nsw.gov.au)

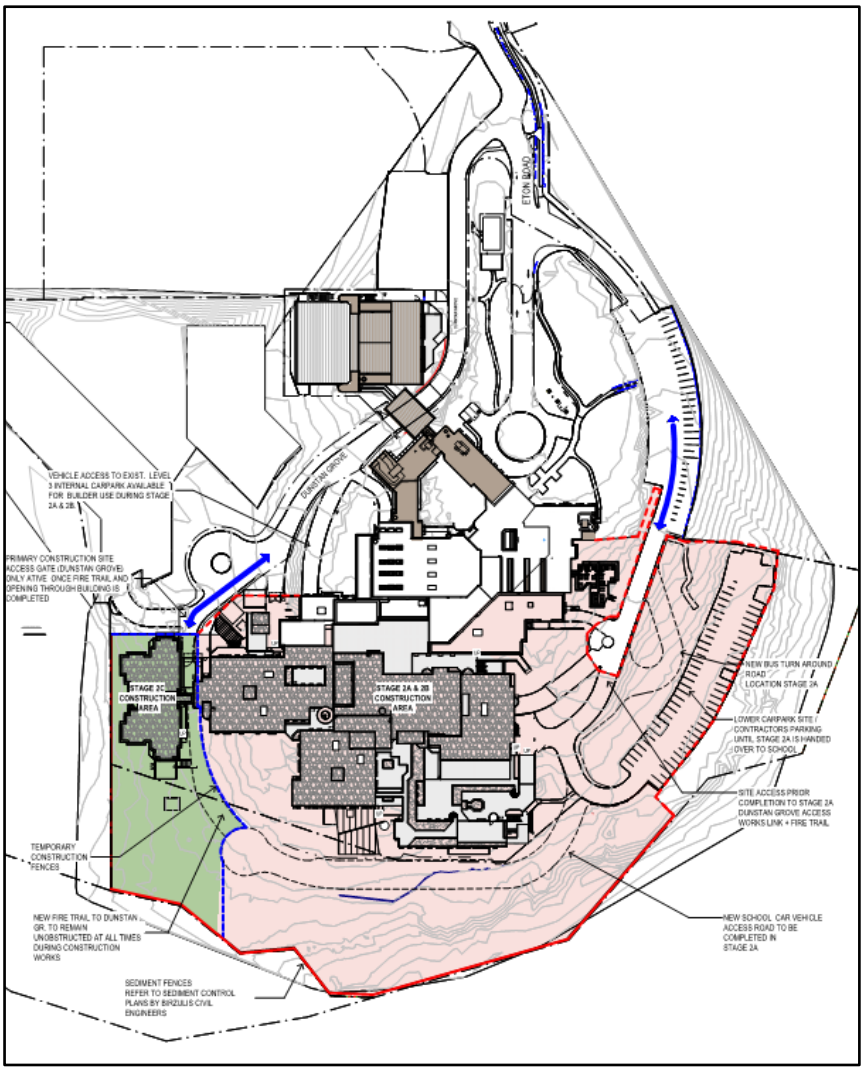

Figure 2 – Site Plan

3.2. OCCUPANT CHARACTERISTICS

The site is to have up to 2000 students, and at least 250 staff (an approximate 1 staff member for 8 students on average). The site may have visitors at the time of a fire incident.

Students will range in age from 4 years of age to 18 years of age, with corresponding variation in needs. Primary-age students will need assistance and close supervision to evacuate in an emergency, including where to go, how to crossroads, and may be distressed or confused. Older students may require less assistance and understand evacuation routes but still require guidance, and may feel distressed. Students are generally expected to be awake at the time of an event. Some students may be physically or mentally impaired and may require special assistance or one-on—one care to evacuate safely.

Staff are expected to be trained in bushfire evacuation, including how to assist students in their care and very familiar with escape routes.
Visitors to the site may be parents, students or staff from other facilities (e.g. distance learners), contractors or other visitors. These visitors may be a range of ages, including students and are not likely to be familiar with evacuation procedures or escape routes. Therefore, it is expected that visitors may require assistance to evacuate.

4. ISSUES FOR ASSESSMENT

This Fire Engineering Report is intended to summarise the fire engineering basis to the strategies proposed to meet the select Performance Criteria described in Planning for Bushfire Protection 2019, listed in Table 2. The remaining Performance Requirements are proposed to be met by Acceptable Solution and are described in detail in Bushfire Hazard Assessment and Fire Engineering Brief (prepared by BlackAsh Consulting), and listed in Appendix C of this report.

Table 2 – Performance Requirements addressed in this report

Performance Requirement	Acceptable Solution	Performance-based Strategy
Radiant heat levels of greater than 10kW/m² (calculated at1200K) are not experienced by emergency service personnel and occupants during firefighting and emergency management.	The building is provided with an Asset-Protection Zone (APZ) in accordance with Planning for Bushfire Protection	- Establish and maintain APZ - Develop alert and evacuation procedure for early evacuation - Construct structures and develop procedure to support Shelter-in-Place as a last resort.
The proposed building can withstand bush fire attack in the form of wind, smoke, embers, radiant heat and flame contact	A construction level of BAL-12.5 under AS 3959 or NASH and Table 7.4b is applied.	- Upgrade all facades to BAL-FZ according to AS 3959-2018 -Where AS 3959-2018 does not have explicit requirements for particular features, develop protection measures to provide equivalent or better protection to BAL-FZ level.

5. METHODOLOGY

The methodology adopted in formulating a Performance Solution is that described in the International Fire Engineering Guidelines[1]. The Guidelines provide guidance for the design of performance-based solutions for the BCA in order to achieve acceptable levels of safety so as to achieve compliance with the identified BCA Performance Requirements.

The fire safety engineering design process detailed in the Guidelines follows the general engineering design philosophy where an objective is identified, measurable performance objectives are established as expressions of that objective and solutions are analysed using appropriate techniques in order to measure the attainment of the performance objectives.

The specific method of analysis adopted for each Performance Solution is detailed in the relevant section of this report.

[1] International Fire Engineering Guidelines, Edition 2005, Australian Building Codes Board.

6. FIRE ENGINEERING BRIEF

6.1. GENERAL

The Fire Engineering Brief (FEB) is a documented process that defines the scope of work for the fire safety engineering analysis. Its purpose is to set down the basis, as agreed by all the relevant stakeholders, on which the fire safety engineering analysis will be undertaken. This includes agreement on the objectives, proposed trial designs, analysis methods and acceptance criteria.

6.2. PROJECT STAKEHOLDERS

The relevant stakeholders for the project are as follows:

Table 3 – Project Stakeholders

Stakeholder's Role	Company
Architect	DesignInc
Project Manager	Savills
Bush Fire Consultant	BlackAsh
Fire Safety Engineer	Stephen Grubits & Associates
State Rural Fire Authority	Rural Fire Service
State Fire Authority	Fire & Rescue New South Wales
School Principal (Building User)	Dept. of Education
Certifier	BCA Logic (Phase 1), Modern Building Certifiers (Stage 2)
Council	Ku-Ring-Gai Council
Building owner and user, maintainer	Department of Education
Building owner, user, responsible for maintenance	Department of Education – Peter Smith
Heritage Consultants	Urbis
Fire Services Engineer	Erbas
Neighbour and adjoining land manager	NSW National Parks and Wildlife Service

6.3. FEB PROCESS

The FEB was conducted by way of the following:

1. On-going design team, client and construction team meetings to identify fire engineering issues.
2. Meeting with Rural Fire Service, Office for the Environment and Heritage on 16th January 2019 to present the Bushfire Safety Design Strategy and brief, including proposed evacuation routes and assessment methods for discussion and feedback.
3. Further meeting with Office for the Environment and Heritage on 17th April 2019 to discuss undergrowth clearing
4. Meeting on 5th August 2019 with RFS to present initial bushfire radiation assessment results
5. Commentary to the bushfire assessment received from RFS on 11th December 2019, with written comment responses supplied on 12th December 2019.

6. Commentary received to the bushfire assessment from RFS via letter on Thursday 13th August (included in Appendix E with responses).
7. Meeting with RFS on 18th August 2020 to gather feedback on the submitted bushfire design report. As a result, a comprehensive fire engineering summary document was sought, hence the preparation of this document.

7. TRIAL DESIGN

The following design features and fire safety measures form part of the Performance Solutions documented in this report. These items are excerpted from the Trial Design documented in Bushfire Hazard Assessment and Fire Engineering Brief (prepared by BlackAsh Consulting, dated 29th April 2020), please refer to this document for details on the implementation of each measure.

7.1. GENERAL

1. The existing buildings will be upgraded, where relevant, as described in the RFS Building Best Practice Guideline – Upgrading Existing Buildings to meet BAL Flame Zone in accordance with AS3959.
2. All new and existing external facades and roofs of the school buildings are to comply with AS 3959-2009 Amendment 3.
3. All buildings are to be provided with internal sprinkler system complying with AS 2118.1 – 2017.
4. On-site water storage and pumping is to be provided where the use of water in a bushfire event (firefighting by Fire Brigades, or neighbouring properties) could result in a loss of flow or pressure to the Lindfield Learning Village.
5. The school buildings are to be subdivided into not less than three fire compartments, separated by fire-resisting construction achieving an FRL of at least -/120/120. Each compartment will have sufficient capacity for the entire school population (students and staff).
6. Sufficient egress width (2 x 1.2 m footpaths as a minimum) is to be provided so that school users travelling on footpaths can reach the corner of Austral Avenue and Eton Road within 15 minutes of the commencement of evacuation. Egress width must accommodate obstacles on footpaths such as powerboxes, telephone boxes and other amenities which would otherwise reduce the available egress width.
7. Any road crossings needed for evacuation must be provided with pedestrian crossings or be manned by assigned staff.
8. Live updates of fire weather and bushfire risk, as well as notification of any bushfires in Lane Cove is to be provided visually as well as directly to the School Principal. Mapping of bushfire “Evacuation” and “Defend-in-Place” regions is to be undertaken to inform bushfire response decisions. School management is to undergo regular training on the response to bushfire alerts.
9. Teachers are to undergo bi-annual (semi-annual) bush fire training, including egress routes, when to commence evacuating, any equipment or procedures to assist those needing assistance.
10. Students who may require special assistance in order to evacuate in a bushfire event must be allocated a supervisor (teacher, staff member) to assist their evacuation. A bushfire evacuation plan for each student requiring assistance is to be made.
11. A fire trail is to be provided to provide access to the south and east perimeter of the site. All roads are to comply with the fire brigade vehicular access requirements of Planning for Bushfire Protection 2019.
12. An APZ is to be provided to the extent indicated in Figure 3 (the green line indicating the necessary extent for 10 kW/m^2 exposure to the building. The entire site will be managed to IPA Standards. An Outer Protection Area of a maximum of 30m provided from the outer most extent of the APZ boundary.

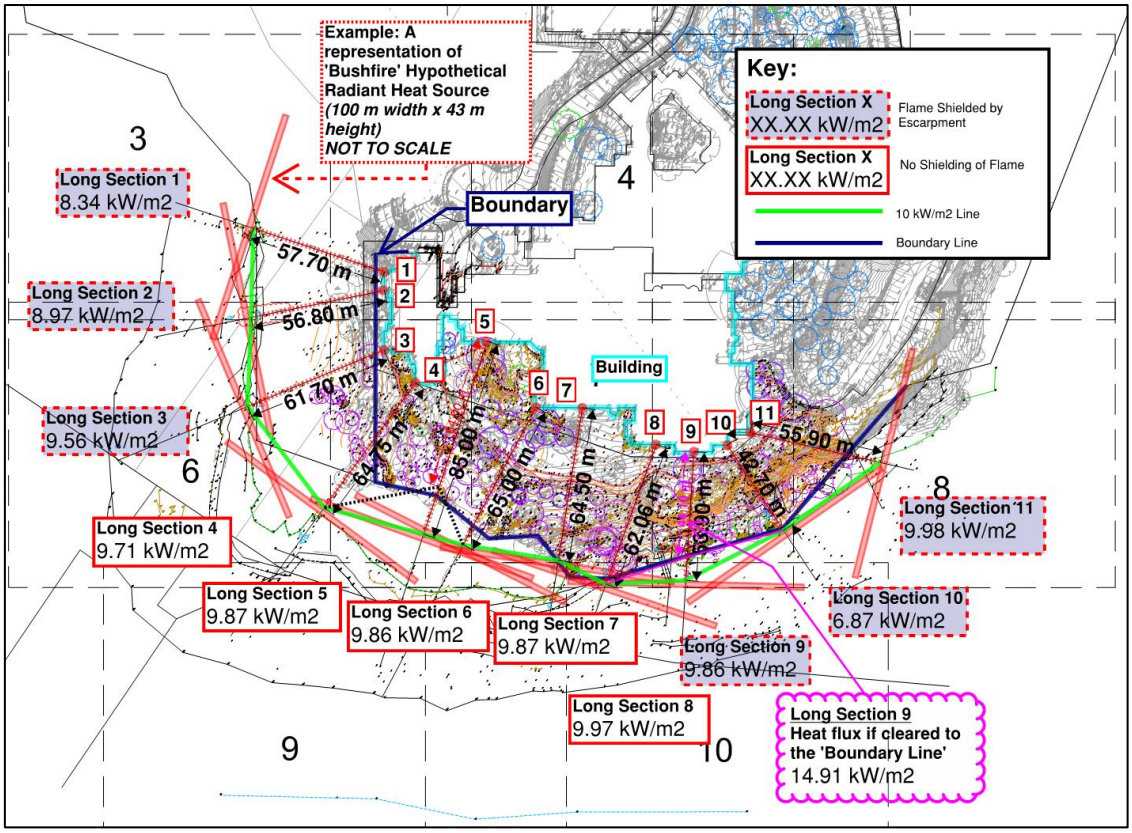

Figure 3 – APZ distance required to achieve 10 kW/m^2.

7.2. MANAGEMENT IN USE

1. This Fire Engineering Report, as well as the Bushfire Hazard Assessment and Bushfire Emergency Management and Evacuation Plan should form part of the Management-in-Use Documentation that the building owner / operator should use to manage the building.
2. If a change to the design should occur in the future, the Performance Solutions will have to be assessed for any impact that the changes may have on them, which may lead to re-assessment of the Performance Solutions. The assessment of the impact or the re-assessment of the Performance Solutions, if required, should be carried out by a qualified Fire Engineer.

7.3. STANDARDS OF CONSTRUCTION

3. The standard of construction should comply with the BCA and/or any relevant Australian Standard unless specifically stated otherwise within this report. Where the standard of construction has been specifically stated to not be in accordance with that required by the BCA and/or the relevant Australian Standard, the construction work should be checked and certified by an appropriately qualified Authority and checked against the requirements for construction as specified in this report.

7.4. COMMISSIONING

4. All fire safety services are required to be commissioned in accordance with the relevant Australian Standard, unless specifically stated otherwise within this report. All fire safety services and measures that are required by this report are recommended to be witnessed in operation by a Fire Engineer to check that the system(s) operates in accordance with the requirements of this report.

8. PERFORMANCE SOLUTION 1 – RADIANT HEAT EXPOSURE TO THE BUILDING FROM BUSHFIRE

8.1. RELEVANT PBP PROVISIONS

This section describes the fire engineering basis to the strategies proposed to meet the select Performance Criteria described in Planning for Bushfire Protection 2019, and hence GP 5.1 of the BCA listed in Table 4.

Table 4 – Performance Requirements addressed in this report

Performance Requirement	Acceptable Solution	Performance-based Strategy	Performance Requirement
Radiant heat levels of greater than 10kW/m² (calculated at1200K) are not experienced by emergency service personnel and occupants during firefighting and emergency management.	The building is provided with an Asset-Protection Zone (APZ) in accordance with Planning for Bushfire Protection	- Establish and maintain APZ - Develop alert and evacuation procedure for early evacuation - Develop brigade access strategy - Construct structures and develop procedure to support Shelter-in-Place as a last resort.	GP 5.1

8.2. METHODOLOGY

The approach used to formulate this Performance Solution is to develop an appropriate APZ and, using that APZ, quantitatively verify that the likely heat flux to the building will not exceed 10 kW/m^2 by adopting a temperature-height profile for the bushfire (bushfire flame height and characteristics provided by Bushfire consultant) using bushfire flame temperature correlations from literature. This method is effectively, verifying that the Performance Requirement of PBP 2019 is met (rather than comparing to the prescribed APZ).

Table 5 - Methodology

Performance Solution	BCA Clause A2.2 (1)(a) - Complies with the Performance Requirements
Assessment Method	BCA Clause A2.2 (2)(b) (ii) – Other Verification Methods accepted by the appropriate authority
Type of Analysis	Qualitative and Quantitative

8.3. ACCEPTANCE CRITERIA

The proposed design is considered acceptable if it can be demonstrated that Radiant heat levels of greater than 10kW/m² (calculated at1200K) are not likely to be experienced by emergency service personnel during firefighting and emergency management and occupants during egress. The radiant heat exposure will be measured at the building's façade.

8.4. FIRE SCENARIOS AND DESIGN FIRES

8.4.1. Identification of Hazards

The site is exposed to the bush (Lane Cove National Park) to the west, east and southern aspects. The bush is sclerophyll forest, with relatively steep geography. Therefore, there is the possibility of bushfire approaching the school from any of these three directions (noting that the western and southern aspects provide steeper slopes a greater extent of typically drier bush, hence these aspects post the greatest hazard.

There are internal fire hazards typical of school use, however the fire hazards within the building are to be assessed as part of the fire engineering assessment against Parts C D and E of the BCA, to be documented separately.

8.4.2. Design Fire Scenarios and Fire Characteristics

The following design fire scenario has been selected for this Performance Solution:

8.4.2.1. Fire Scenario 1

- Established bushfire to the South, West or East of the site

8.5. ASSESSMENT

The radiant heat fluxes to the building during an established bushfire to the South, West or East of the site has been determined quantitatively by modelling the likely flame characteristics (provided by the Bushfire consultant), and calculating the radiant heat flux from the flame profile. The complete assessment is documented in SGA Report 2018/321 R5.1, however, the key inputs, the methodology, and assessment outcomes are summarised as follows:

8.5.1. Key Inputs

8.5.1.1. Bushfire Characteristics

The flame height and temperature at the edge of the APZ is as determined by the bushfire consultant (BlackAsh Consulting), using Method 2 of the AS 3959-2009. The calculation provided by the bushfire consultant is repeated in Appendix D.

8.5.1.2. Topography

The site has been surveyed by Ussher & Co Land Surveyors to provide the relative heights and land form up to 100 m from the school buildings. The survey sections (11 Long sections) have been used to determine the relative height of the flame base to the school buildings, the location of any features such as shielding.

8.5.2. Methodology

This report determines the separation distance from a flame front of a bushfire to the subject building façade in order to limit the received radiant heat flux to 10 kW/m^2. The topography for each long section as well as the whole school premises has been identified by the land surveyor ("6076-LONGSECTIONS-10 & 6076-TREES-5", dated 29th July 2019 by Usher & Company). The emitted radiant heat flux is based upon experimentally measured flame temperatures.

The calculation methodology adopted for the radiation assessment is as follows:

1. Establish an appropriate flame temperature gradient using literature method outlined in a publication titled "Flame temperature and residence time of fires in dry eucalypt forest" by B. Mike Wotton et al., dated 12 November 2010 (2).
2. Determine the part of the bushfire front that is not obscured by cliffs and visible from the receiver location.
3. Model the flame front as a source of radiant heat taking into account of the characteristics of the topography of the building surroundings.
4. Calculate radiant heat received by the receiving structure using the computer program *"Radiation"* from the *"Firewind* (3)*"* suite of computer programs.
5. Repeat above calculation by changing parameters such as distance and other factors affected by geometrical configuration (e.g. offsets from the centre or shielding of flame) to achieve radiant heat flux received by the topmost opening of the building façade to 10 kW/m^2.
6. Repeat above steps for different locations (for each Long Section as shown in 6076-LONGSECTIONS-10 & 6076-TREES-5", dated 29th July 2019 by Usher & Company
7. Tabulate calculated radiant heat received as well as the distance from the building façade to the flame front.

8.5.3. Assessment Findings

Figure 4 indicates the distances of the APZ and the received radiation at the building from 100 m wide flame front at each location.

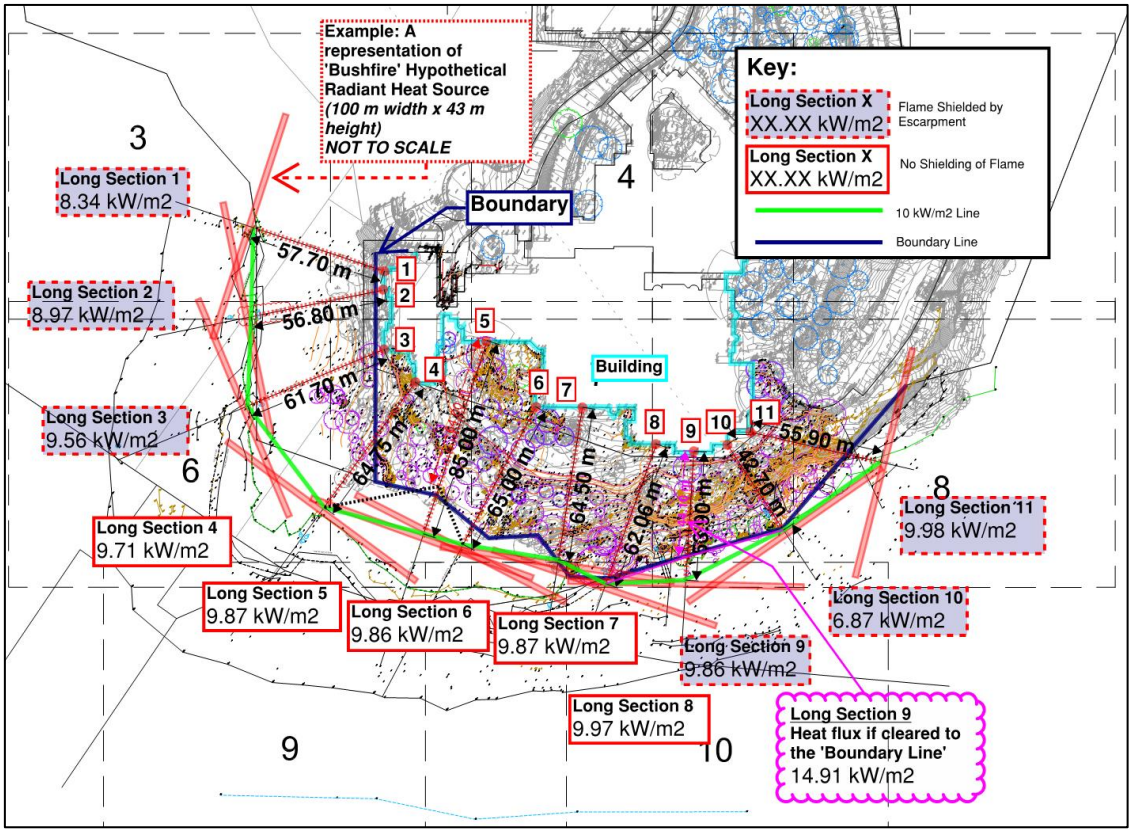

Figure 4 – Separation required to achieve 10 kW/m^2.

(2) B. M. Wotton et al, "Flame temperature and residence time of fires in dry eucalypt forest', International Journal of Wildland Fire 2012, 21, 270-281.
(3) *Radiation – Firewind 3.6,* Fire Modelling and Computing, NSW, Australia, Version 20, May 2005

Figure 4 demonstrates that exposure from bushfire at the edge of the APZ results in an exposure at the building façade of less than 10 kW/m^2, with the exception of one aspect (Long Section 9) where exposure is calculated as 14.9 kW/m^2. The following considerations are made as to why the shorter APZ aspect this is not considered to undermine compliance with the Performance Criteria of PBP (that is, that exposures of greater than 10 kW/m^2 are not experienced by emergency service personnel and occupants during firefighting and emergency management):

- The shorter APZ distance, and increased exposure is as a result of the reduced distance to the edge of the APZ. Due to the presence of a steep bluff and rocky area, the edge of the APZ is located closer to the school, as it is not practical for maintenance workers to safely maintain an APZ over the edge of this kind of terrain over the life of the structure.
- The rocky terrain and bluff itself provides some mitigation of the bushfire exposure. The shielding has been reflected in the radiation modelling, whereas the contribution of the cliffs to mitigating flame height (as there is reduced ground level fuel) is not reflected in the modelling and will likely benefit this aspect.
- Long Section 9 is exposed to the south eastern side of the site. This site overlooks a greater proportion of wet sclerophyll vegetation (Figure 5), and the majority of the Lane Cove bushland is located on the other side of the site. Bushfire is possible in this area to the south-east, but this risk is mitigated compared to other aspects by the reduced frequency of south-easterly wind direction during bushfire season (south and south-easterly winds occur less than 20-30% of the time between start of October and end of March, according to Bureau of Meteorology wind rose data in Appendix F)
- An early warning and evacuation/brigade access procedure, summarised as follows, as well as additional building protection (summarised in Section 10) to be designed to withstand more than 40 kW/m^2 in accordance with the intent of AS 3959, provides egress to occupants and shielding brigade to avoid exposure to greater than 10kW/m^2.

Figure 6 Vegetation Assessment

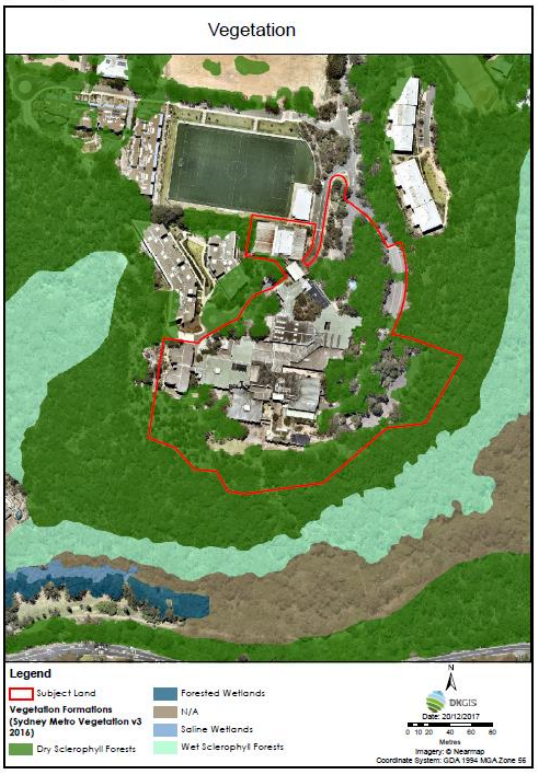

Figure 5 - Vegetation Assessment (extracted from Bushfire Hazard Assessment and Fire Engineering Brief)

8.5.4. Early Warning, Egress and Shelter-in-Place Strategy

The egress and brigade access strategy is prepared by the Bushfire Consultant, BlackAsh Consulting with input into egress modelling and behaviour by SGA, and is detailed in the BlackAsh report Bushfire Emergency Management and Evacuation Plan. The key points of the Early Warning, Egress and Brigade Access Strategy are summarised as follows:

The intent of the strategy is to provide the school leadership with sufficient forewarning of a bushfire event near to the school, as well as sufficient egress facilities and insight into the time needed for complete evacuation of the site to Lindfield Public School, near Pacific Highway and outside bushfire affected area well before a bushfire arrival near the site. Key considerations include:

- The time taken to complete evacuation - Evacuation must be completed before the site and egress routes are threatened by bushfire so evacuees are not caught in exposed roads or areas, which means that the strategy must consider the duration of egress must be understood, the likely fire conditions over the duration of egress (not just at the start of evacuation), and the certainty associated with the prediction of these two aspects;

- The effect of bushfire on the community is also considered in the bushfire response, because the community at large is also likely to be responding to the event, either by evacuating in a similar direction, or by approaching the school to collect children etc., both of which can impact on egress and brigade access by obstructing roads or delaying action;

- Vulnerable groups such as very young children or students with disabilities who require additional assistance can be provided with this assistance, without detriment to the overall evacuation.

As redundancy, in the event that evacuation is not initiated early enough, and to mitigate the risk of occupants being caught out in the open, the school buildings are designed to withstand bushfire to support “shelter-in-place” as a last resort (refer Section 10).

The egress strategy is as follows:

(a) **Early Warning -** Early Warning systems are in place to enable the school to cease operation during a bushfire so staff and students can leave before a bushfire occurs, if the risk is high, for example a Severe, Extreme or Catastrophic Fire Danger Rating (or Total Fire Ban, at the discretion of the Principal). These systems include notifications of parents and students via email, website and bushfire app, social media, as well as live reporting of the bushfire conditions in Lane Cove National Park from the “Fires near Me” app.

(b) **Evacuation**

(i) If there is an emerging bushfire, consult Emergency Services Fire Brigade before initiating school closure.

(ii) Any bushfire within the Lane Cove River Catchment and surrounding area will imitate the evacuation response, noting that evacuation must be completed (not just initiated) well prior to fire arrival.

(iii) If the bushfire is at least two hours away from impinging the site, and there are not spot fires occurring near the school, then evacuation to Lindfield Public School is proposed via the route shown in Figure 6. Egress modelling indicates that (once assembled) it takes 33.5 minutes for school occupants to reach Lindfield Public School on foot (including 3 min for roll call, and 1.5 min for road crossing),

assuming students generally walk two-abreast, via Grosvenor Lane (to use the upgraded footpaths) – after 16 minutes, students are at the corner of Eton Road, or more than 100 m from the bush. Modelling has indicated that the time taken for the school to gather is approximately 11 minutes (refer to SGA Report Bushfire Evacuation Report for egress time analysis to the Refuge).

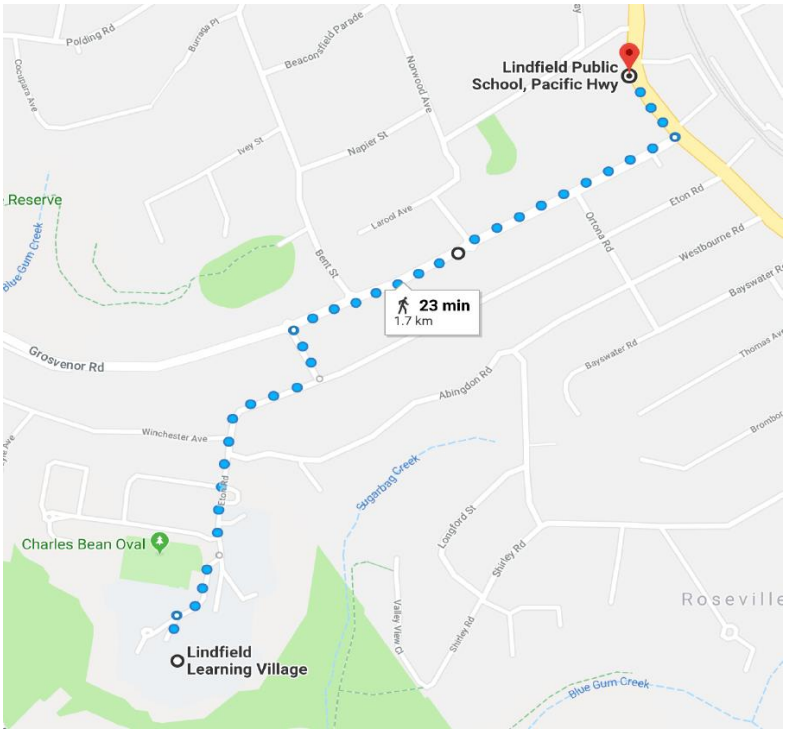

Figure 6 - Egress Route from Lindfield Learning Village to Lindfield Public School

(iv) It is likely that the whole school might not gather prior to evacuation, but would start to evacuate progressively as each sub-group (class or year gathers) therefore 33.5 + 11 min provides a reasonably conservative estimation of egress time to the final safe place. Therefore, initiating the 33.5 min egress procedure at least two hours before bushfire arrival provides buffer in the event of weather changes or unforeseen evacuation delays with the goal that evacuation should be able to be completed one hour before fire arrival.

(v) Egress is to occur via foot paths only (not on roadways) so that the risks of live traffic, as well as impinging on brigade access is avoided. It is recommended that older students, who can independently cross roads and way find are encouraged to egress first to avoid younger students slowing older students.

(vi) Egress by vehicles is not relied upon.

(vii) Specialised plans for students relying upon assistance to evacuate are to be made prior to an event.

Several other measures are proposed to manage the evacuation safely:

- Communication with parents and guardians – to prevent clogging of egress routes once evacuation has begun by parents trying to collect children, automatic updates via SMS and social media are proposed to advise parents of the bushfire situation as it evolves
- Drills are proposed to take place annually so that students are aware of the evacuation procedures and teachers are prepared

- Evacuation is modelled as occurring on footpaths only, and uses one out of three available street routes – this provides alternatives for brigade access (who would use the roadways, not the footpaths) as well as for surrounding occupants to evacuate.

(c) Shelter-in-Place as a last resort

If evacuation cannot be completed an hour ahead of bushfire arrival, and there is an unacceptable risk that evacuees are caught without shelter (as determined by the school leadership who are expected to liaise with Emergency Services), then the school buildings themselves are intended to provide temporary shelter within the Emergency Refuge (the school auditorium, adjoining cafeterias and offices). In addition to the APZ discussed above, the building is provided with the following facilities to protect the refuge until assistance is rendered by the brigade:

(i) BAL-FZ facades and roofs (refer Section 10) – The building's existing facades are concrete, with a likely fire-resistance level of more than 60 minutes. All openings are provided with ember mesh, and windows and doors provided with bushfire-resisting (BAL-FZ shutters), or fire-resisting (-/30/-) windows/doors, as permitted by AS 3959. These measures provide protection that is tested to higher heat fluxes (> 40 kW/m^2) than the heat fluxes that have been modelled as likely to be impinging the building (10 kW/m^2, up to 15 kW/m^2). The roofs are also concrete, with the top layer of waterproofing material (butynol) covered with ballast as addtioanl resistance to ignition.

(ii) Internal sprinkler protection - the building is provided with an AS2118.1 sprinkler system throughout. In the event of fire spread into the building, the sprinkler system is intended to contain ignition of materials within the building.

(iii) Compartmentation – the buildings are subdivided into not less than three fire compartments, separated by construction achieving an FRL of not less than -/120/120 to provide additional resilience to contain and delay fire spread.

8.5.5. Brigade Access Provisions

Brigade access provisions are provided in accordance with the Acceptable Solutions of Planning for Bushfire Protection, including provision of a "ring road" fire trail around the site, to avoid the need for brigade to U-turn, and provide two means of access or retreat from any point on the access route around the site. Additionally, a 150,000 l tank of firefighting water is provided at the front of the site, with hydrant coverage of the entire site to AS 2419.1 (connected to the tank and the reticulated water system) to provide additional water supply in the event that the reticulated supply is under high use due to bushfire. Figure 7 to Figure 9 include extracts from the Bushfire Hazard and Fire Engineering Brief report, which show the access masterplan for the site, the roadway access to the site via Eton, Grosvenor and Abingdon Roads (two of which, Eton and Abingdon Roads, are not used for school egress), and the tabulated access requirements of PBP, against their resolution.

.These APZ, construction and access provisions means that emergency services have the means to access the site, operate where the heat fluxes are less than 10 kW/m^2, and either mitigate the 15 kW/m^2 heat flux using hose streams, or safely and reliably retreat to areas where the heat flux is less than 10kW/m^2 and rely on the buildings' construction to provide additional shielding capable of withstanding the impending bushfire heat fluxes

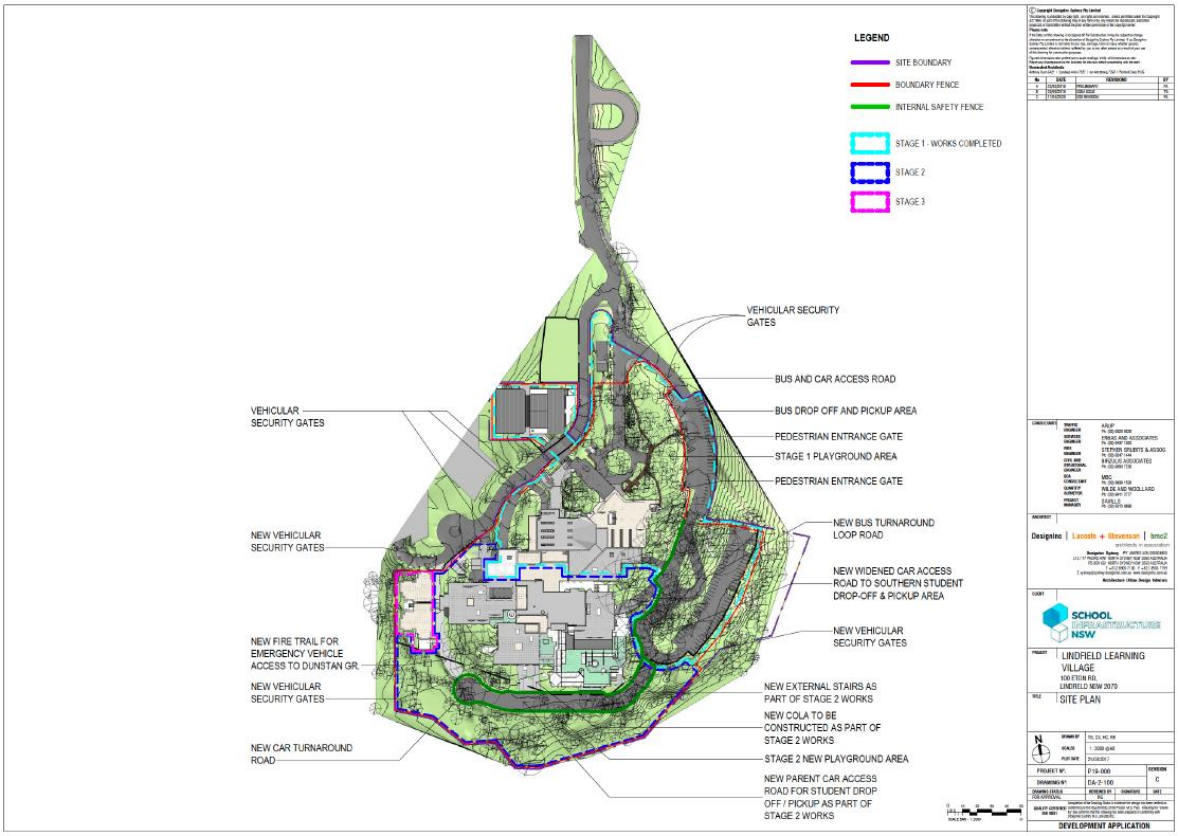

Figure 7 - Brigade Access "Master Plan" extracted from Bushfire Hazard Assessment and Fire Engineering Brief by BlackAsh Consulting, April 2020

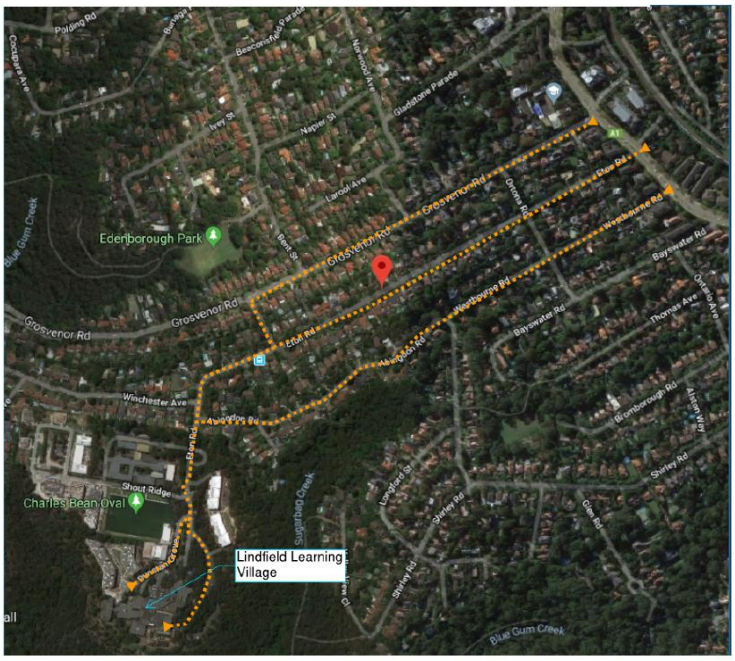

Figure 8 - Access roads intended from brigade use (from FEB Presentation January 2019)

Intent of Measures	To provide safe operational access for emergency services personnel in suppressing a bush fire, while residents are accessing or egressing an area (PBP p 34).	
Performance Criteria	Acceptable Solutions	Compliance
The intent may be achieved where:		
Internal road widths and design enable safe access for emergency services and allow crews to work with equipment about the vehicle.	internal roads are two-wheel drive, sealed, all-weather roads;	Achieved
	internal perimeter roads are provided with at least two traffic lane widths (carriageway 8 metres minimum kerb to kerb) and shoulders on each side, allowing traffic to pass in opposite directions;	**Achieved.** The extended driveway is 8m kerb to kerb and the fire trial exceeds the requirements of PBP 2006 for width.
	roads are through roads. Dead end roads are not more than 100 metres in length from a through road, incorporate a minimum 12 metres outer radius turning circle, and are clearly sign posted as a dead end;	**Achieved.** 12 metres outer radius turning circle provided at key turning locations. Dead end roads will be clearly sign posted. Perimeter access is provided to the south and south west of the site.
	traffic management devices are constructed to facilitate access by emergency services vehicles.	**Achieved.** No traffic management devices installed
	a minimum vertical clearance of four metres to any overhanging obstructions, including tree branches, is provided.	**Achieved.** The short construction between the buildings will comply with access requirements for a Category 1 fire appliance.
	curves have a minimum inner radius of six metres and are minimal in number to allow for rapid access and egress.	Achieved
	the minimum distance between inner and outer curves is six metres.	Achieved
	maximum grades do not exceed 15 degrees and average grades are not more than 10 degrees.	Achieved
	Cross fall of the pavement is not more than 10 degrees.	Achieved
	roads do not traverse through a wetland or other land potentially subject to periodic inundation (other than flood or storm surge).	Achieved
	roads are clearly sign-posted and bridges clearly indicate load ratings.	Achieved
	the internal road surfaces and bridges have a capacity to carry fully-loaded firefighting vehicles (15 tonnes).	Achieved

Figure 9 - Summary of PBP 2019 Access Requirements and their resolution from BlackAsh report Bushfire Hazard Assessment and Fire Engineering Brief, April 2020

8.6. CONCLUSION

The result of the assessment has demonstrated that radiant heat fluxes greater than 10 kW/m² (calculated at1200K) are not likely to be experienced by emergency service personnel and occupants during firefighting and emergency management.

Consequently, it is considered that compliance with the PBP Performance Criteria listed in Table 6 is achieved, subject to compliance with the Trial Design within Section 7, and the requirements of the Bushfire Hazard Assessment and the Bushfire Emergency Management and Evacuation Plan.

9. PERFORMANCE SOLUTION 2 – BUILDING TO WITHSTAND BUSHFIRE EXPOSURE

9.1. RELEVANT PBP PROVISIONS

This section describes the fire engineering basis to the strategies proposed to meet the select Performance Criteria described in Planning for Bushfire Protection 2019, and hence GP 5.1 of the BCA listed in Table 6.

Table 6 – Performance Requirements addressed in this report

Performance Requirement	Acceptable Solution	Performance-based Strategy	Performance Requirement
The proposed building can withstand bush fire attack in the form of wind, smoke, embers, radiant heat and flame contact	A construction level of BAL-12.5 under AS 3959 or NASH and Table 7.4b is applied.	• Upgrade all facades to BAL-FZ according to AS 3959-2018 • Where AS 3959-2018 does not have explicit requirements for particular features, develop protection measures to provide equivalent or better protection to BAL-FZ level.	GP5.1

9.2. METHODOLOGY

Table 7 - Methodology

Performance Solution	BCA Clause A2.2 (1)(a) - Complies with the Performance Requirements
Assessment Method	BCA Clause A2.2 (2)(b) (ii) – Other Verification Methods accepted by the appropriate authority
Type of Analysis	Qualitative and Quantitative

9.3. ACCEPTANCE CRITERIA

The proposed design is considered acceptable if all facades and roofs are designed to meet BAL-FZ, or where AS 3959-2018 does not have explicit requirements for particular features, develop protection measures to provide equivalent or better protection to BAL-FZ level (that is, equivalent resistant to fire ignition caused by ember attack, direct flame exposure, and heat fluxes greater than 40 kW/m^2).

9.4. FIRE SCENARIOS AND DESIGN FIRES

9.4.1. Identification of Hazards

The site is exposed to the bush (Lane Cove National Park) to the west, east and southern aspects. The bush is mostly sclerophyll forest, with relatively steep geography. Therefore, there is the possibility of bushfire approaching the school from any of these three directions (noting that the western and southern aspects provide steeper slopes a greater extent of typically drier bush, hence these aspects pose the greatest hazard.

There are internal fire hazards typical of school use, however the fire hazards within the building are to be assessed as part of the fire engineering assessment against Parts C, D, and E of the BCA, to be documented separately, subsequent to the Development Approval application.

9.4.2. Design Fire Scenarios and Fire Characteristics

The following design fire scenarios have been selected for this Performance Solution:

9.4.2.1. Fire Scenario 1

- Established bushfire to the South, West or East of the site

9.4.2.2. Fire Scenario 2

- Bushfire initiating on site (including spotting)

9.4.2.3. Fire Scenario 3

- Bushfire that spreads into the building

9.5. ASSESSMENT

The assessment conducted in and described in Section 8 of this report indicated that a likely radiant heat exposure to the building of 10 kW/m^2, up to 15 kW/m^2 from one aspect. However, it was a requirement from the RFS for Stage 1 that all facades are treated to BAL-FZ level of protection (as per AS3959-2009, now upgraded to 2018), and this has been incorporated into the design to assist in the function of the school, which can be used to Shelter-in-Place" as a last resort.

A complete assessment of all the façade features, and proposed treatment to increases the facades to BAL-FZ (while heeding heritage requirements to maintain the aesthetic of the building) is documented in the SGA Report Bushfire Measures Compliance Report. The key aspects are listed as follows:

- Existing facades are concrete, and exceed the requirements of AS 3959 (90 mm thick non-combustible walls)
- Openings for windows, skylights and doors are treated with bushfire shutters, or fire-resisting windows/doors where heritage considerations do not permit shutters
- All openings greater than 2 mm are treated with ember mesh or sealed, including into underfloor spaces.
- Roofs are concrete and anticipated to have an FRL of greater than 30 mins (so exceeding the comparable AS 3959 requirement for walls). The rubber waterproofing layer on top of the concrete roofs is further protected by 20 mm aggregate ballast to shield from ember attack and avoid melting or igniting the waterproofing.

The provision of BAL-FZ facades is considered sufficient to withstand the likely bushfire exposure for the following reasons:

- Radiant heat modelling (using the flame characteristics provided by the Bushfire Consultant) incorporating the proposed APZ indicated an anticipated heat flux to the building of 10 kW/m^2, up to 15 kW/m^2 (Refer Section 9 of this report), whereas the testing to AS 1530.8.2 for BAL-FZ tested shutters involves exposure of the shutters to radiant heat fluxes greater than 40 kW/m^2 (exposure to the standard fire curve for 30 mins results in heat fluxes greater than 80 kW/m^2) without permitting in radiant heat levels on the unexposed side that are likely to cause ignition of materials inside. In the subject building, the calculated radiant heat flux to the most exposed

sides is less than 15 kW/m^2 and generally less than 10 kW/m^2 therefore this is well within the tested limits of AS 1530.8.2.

- Where windows or doors are used (rather than shutters, to accommodate heritage protections to the façade), these comply with BAL-FZ by meeting the requirement for at least FRL -/30/- as per BAL-FZ requirements of AS 3959-2018. Even without the insulation rating, fire-resisting glass can be expected to attenuate ~30% of radiation exposure[4], so even if the anticipated calculated exposure to the building is doubled, the resulting heat flux on the non-exposed side is less than the Performance Criteria for AS 1530.8.2 shutters (15 kW/m^2 at 365 mm away from the glazing), and less than that required for non-piloted ignition of common combustibles (25 kW/m^2 for timber and cotton after a long time[5]).

- The performance of the roofs, walls, and exposed underfloor areas is intended to comply with AS 3959, and the performance of these aspects in bushfire is expected to equal or exceed that of the protected openings. That is, the roofs, walls and exposed underfloor areas are treated in accordance with BAL-FZ requirements, including non-combustible outer layers (at least) with fire-resisting structure beneath to provide resistance to radiant heat and ember attack to exceed -/30/30 where the structure forms a separating function (from inside to out).

- As redundancy, the building's interior is sprinkler-protected and sub-compartmented with fire separations, so that any local ignition that occurs within the building as a result of a bushfire outside, even with the above measures, is able to be contained to the enclosure of origin, while the Shelter-in-Place refuge (used only as a last resort) is located away from facades facing the bush. The design of the egress strategy is intended to support the complete egress of the school well before bushfire attack.

9.6. CONCLUSION

The result of the assessment has demonstrated that the building can withstand bush fire attack in the form of wind, smoke, embers, radiant heat and flame contact, commensurate with the likely bushfire exposure. That is, the radiant heat engineering assessment undertaken indicated a likely heat flux of 10 kW/m^2 at the building façade, while the BAL-FZ façade protection is designed to withstand heat fluxes of at least 40 kW/m^2, without causing ignition of the interior of the building. Therefore, the assessment demonstrates bushfire spread into the building is not likely to occur.

Consequently, it is considered that compliance with the PBP Performance Criterion listed in Table 6 is achieved, subject to compliance with the Trial Design within Section 7, and the requirements of the Bushfire Hazard Assessment and Evacuation and Emergency Plan.

[4] Cowles, G. (1997). Reducing Radiation from Building Fires with Fire Resistant Glazing. In *IPENZ Annual Conference 1997, Proceedings of: Engineering our nation's future; Volume 1; Papers presented in the technical programme of the IPENZ Annual Conference held in Wellington, February 7-10, 1997* (p. 187). Institution of Professional Engineers New Zealand.

[5] Table A3, AS 1530.4-2005, Standards Australia.

10. SUMMARY

The fire safety engineering assessment has demonstrated that the Performance Criteria of Planning for Bushfire Protection 2019 that are not proposed to be addressed by Performance Solution, have been subject to fire engineering analysis, with the measures considered adequate to meet the stated Performance Criteria, and hence compliance with the Performance Requirement GP5.1 of the BCA, subject to the following:

- The provisions listed in Section 7 of the Trial Design are to be strictly adhered to, as well as the requirements of Bushfire Hazard Assessment and Evacuation and Emergency Plan.
- Should a change in use or building alterations or additions occur in the future, a re-assessment will be needed to verify consistency with the analysis contained within this report.

11. REFERENCES

AS 3959-2018, Construction of Buildings in Bushfire-prone Areas, Standards Australia

AS1530.4-2005, Methods for fire tests on building materials, components and structures–Part 4: Fire resistance test of elements of construction, Standards Australia

International Fire Engineering Guidelines, Edition 2005, Australian Building Codes Board.

Bushfire Hazard Assessment and Fire Engineering Brief (prepared by BlackAsh Consulting, dated 29th April 2020)

Bushfire Emergency Management and Evacuation Plan (prepared by BlackAsh Consulting, dated 17th April 2020)

Flame temperature and residence time of fires in dry eucalypt forest, International Journal of Wildland Fire, M. Wotton et al, 21, 270-281, 2012

National Construction Code Series, Volume 1 Amendment 1, Building Code of Australia 2019, Australian Building Codes Board.

National Construction Code Series, *Guide to Volume 1, Building Code of Australia 2019,* Australian Building Codes Board.

Planning for Bushfire Protection 2019. Rural Fire Service, 2019

Pedestrian Planning and Design, Revised Edition, Fruin, John J, 1987.

Reducing Radiation from Building Fires with Fire Resistant Glazing. In *IPENZ Annual Conference 1997* Cowles, G. Proceedings of: Engineering our nation's future; Volume 1; Papers presented in the technical programme of the IPENZ Annual Conference held in Wellington, February 7-10, 1997 (p. 187). Institution of Professional Engineers New Zealand, 1997,

SGA Report 2018/321 R1.3 Bushfire Measures Compliance Report, dated 15th May 2020

SGA Report 2018/321 R4.0 Bushfire Evacuation Analysis Report, dated 9th September 2019

SGA Report 2018/321 R5.1 Bushfire Radiation Assessment Report, dated 18th December 2019.

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APPENDIX A. PERFORMANCE REQUIREMENTS

GP5.1 *A building that is constructed in a designated bushfire prone area must, to the degree necessary, be designed and constructed to reduce the risk of ignition from the bushfire appropriate to the:*

(a) Potential for ignition caused by burning embers, radiant heat or flame generated by a bushfire; and

(b) I*ntensity of the bushfire attack on the building*.

APPENDIX B. NON-COMPLIANCES FROM BCA 2019 SECTIONS C, D AND E

The following Table summarises the non-compliances from Section C, D and E of the BCA 2019 identified by the BCA Consultant (Modern Building Certifiers) that are proposed to be subject to fire engineering assessment (Performance Solutions). Because the internal design is still in progress, the fire engineering design is still in progress. At the time of issue of this report, a Fire Engineering Brief Questionnaire (FEBQ) regarding the below items has been submitted to Fire & Rescue New South Wales for comment.

Table 8 – Building Departures from the DTS Provisions of the BCA

DTS Provision	Description of Departures from the DTS Provisions	Performance Requirements
Clause C2.8 and Clause C2.9	The storage area within fire compartment B has a floor area greater than 10% of floor area of level 2. The use of this area is Class 7b (storage) which requires building element to achieve an FRL of not less than 240/240/240 or the area being fire-separated by a firewall which achieves an FRL of not less than 240/240/240.	CP1 and CP2
Clause C3.8(d)	Fire-isolated stairway M1 is provided with openings within the external wall of the fire-isolated stair M1 throughout Levels 1-4 of Zone M, which is not to be protected in accordance with Clause C3.4 of the BCA.	CP2
Clause D1.3	Level 3 Zone J – There is an existing internal stairway which currently connects four (4) storeys. It is proposed to fire-separate the stairway at Level 3 by a new wall, tempered glazing and fire-resisting curtain. The whole stairway is required to be contained within a fire-isolated shaft which discharges outside the building.	CP2 and DP5
Clause D1.4 and Clause D1.5	The following areas exceed the maximum allowable travel distance to an exit: • Level 2 Zone K – Travel distance to a point of choice from GA Store is greater than 20 m of up to 25 m; • Level 2 Zone N – Travel distance to a point of choice exceeds 20 m up to 25 m; • Level 3 Zone K – o Travel distance to required exit exceeds 40 m of up to 45 m; o Travel distance to point of choice exceeds 20 m of up to 35 m; • Level 3 Zone N – o Travel distance to a point of choice exceeds 20 m of up to 30 m; and o Travel distances to a required exit exceeds 40 m of up to 50 m. • Level 4 Zone K – o Travel distance to a point of choice exceeds 20 m of up to 47 m; and o Travel distance to the nearest exit exceeds 40 m of up to 60 m. • Level 4 Zone N – o Travel distance to a point of choice exceeds 20 m of up to 30 m; and o Travel distance to the nearest exit exceeds 40 m of up to 50 m. • Level 4 Zone P –Travel distance to a point of choice exceeds 20 m of up to 21 m. The following areas exceed the maximum allowable travel distance to an exit:	DP4 and EP2.2

DTS Provision	Description of Departures from the DTS Provisions	Performance Requirements
	• Level 3 Zone P - Travel distance between alternative exits exceed 60 m of up to 80 m. • Level 4 Zone F – Travel distance between alternative exits exceed 60 m of up to 65 m.	
Clause D1.5	The following area exceed the maximum allowable travel distance: • Level 3 Zone J (Carpark) – o Travel distance between alternative exits exceed 60 m of up to 72 m.	DP4 and EP2.2
Clause D1.6	• The required internal stairway Stair G3 connecting Level 4 and Level 5 on Zone G of the building has a reduced unobstructed width of 0.9 m in lieu of the required 1 m; • The required spiral stairway Stair P4 on Level 4 Zone P of the building has a reduced unobstructed width of 0.8 m in lieu of the required 1 m; and • The required spiral stairway on Level 6 Zone J of the building has a reduced unobstructed width of 0.8 m in lieu of the required 1 m.	DP6
Clause D1.7	Level 2 Zone K – The fire-isolated stairway discharges into public corridor before access to required exits that leads to the terrace. The path of travel to open space necessitates access past window and doorway opening.	DP5
Clause D1.10	• Level 2 – Zone P – Required exits that discharge onto external terraces (Level 2) where the path of travel to the public road, necessitates passing underneath covered area (shade sails) as it is not considered to be open to the sky. • Level 2 – Zone N – Required exit that discharge onto the outside necessitates passing underneath the COLA, which is considered not to be an open space. • Level 1 – Zone P – Required exit that discharge onto the outside necessitates passing underneath a covered Walkway N1.1, which is considered not to be an open space.	DP4
Clause D1.4 and Clause D1.5	**The following extended travels are in relation to the completion of construction phase Stage 2A, prior to completion of Stage 2B. Once Stage 2B is complete, the following extended travel distances will be compliant with DTS Provisions of the BCA:** • Level 4 Zone J External Terrace – o Travel distance to a point of choice exceeds 20 m of up to 25 m; and o Travel distance between alternative exits exceed 60 m of up to 80 m.	DP4 and EP2.2
Clause E1.3 (d)	Internal hydrants are to be omitted within the landings of Stair K5 on Levels 3-5 of Zone M. Therefore, hydrant coverage is proposed to be provided from other hydrants from Stair K1 throughout Levels 3-5 of Zone M, which would require hose length of up to 60 m.	EP1.3

APPENDIX C. PERFORMANCE CRITERIA OF PBP 2019 AND PROPOSED COMPLIANCE STRATEGY

The following table is extracted from the Bushfire Hazard Assessment and Fire Engineering Brief (prepared by BlackAsh Consulting) and summarises the Performance Criteria of PBP 2019 that are proposed to be met by Acceptable Solution. For details on the design to the Acceptable Solution, refer to Bushfire Hazard Assessment and Fire Engineering Brief (prepared by BlackAsh Consulting)

20. Project Specific Objectives – Addressing Specific Objectives

This section describes the Performance Requirements applicable to the site that are to be met. Table 1 provides a summary of the non-compliances to be addressed as part of the Bush Fire Performance Solutions.

Table 4 - Summary Table of Performance Criteria and Proposed Strategy

Performance Criteria	Acceptable Solution	Proposed Strategy	Proposed Solution
Radiant heat levels of greater than 10kW/m² (calculated at 1200K) are not experienced by emergency service personnel and occupants during firefighting and emergency management.	The building is provided with an APZ in accordance PBP	Establish and maintain APZ as per Figure 10.	Options for to mitigate the risk are provided in the Bushfire Evacuation Plan including; • closure of the school under local arrangements • early evacuation off site • seeking refuge in the designated refuge area within the school
Issues relating to slope are addressed: Maintenance is practical, soil stability is not compromised and the potential for crown fires is negated	Issues relating to slope are addressed: maintenance is practical, soil stability is not compromised and the potential for crown fires is negated	A management plan is to be prepared that describes the maintenance measures required to maintain the APZ, including management of sloping aspects.	An APZ management plan is to be prepared that describes the maintenance measures that the Department of Education will undertake to manage the APZ to the IPZ. The plan will include timings of any treatments, health and safety and access requirements.
APZs are managed and maintained to prevent the spread of a fire towards the building	The APZ is managed in accordance with the requirements of RFS Standards for APZS, and mechanisms are in place to provide for the maintenance of the APZ over the life of the development.	The APZ is partially within the subject site and partially on neighbouring property. The Dept of Education is to take responsibility for the management of all APZs to ensure these are adequately managed.	The APZ is partially within the subject site and partially on neighbouring property. Access is to be established to these areas to provide measures to manage the APZ to the level of IPZ A positive covenant under Section 88 of the Land Titles Act, is to be sought to broaden coverage to adjacent areas of APZ so that these areas can be maintained.
Landscaping is managed to minimise flame contact, reduce	Landscaping is in accordance with 'Asset protection zone standards' (see Appendix	A management plan is to be prepared that describes the	An APZ management plan is to be prepared that describes the

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Phase 2 & 3 School Lindfield Learning Village

Performance Criteria	Acceptable Solution	Proposed Strategy	Proposed Solution
radiant heat levels, minimise embers and reduce the effect of smoke on residents and firefighters	4)	maintenance measures required to maintain the APZ, including management of landscaping.	maintenance measures that the Department of Education will undertake to manage the landscaping around the school buildings, including removing fuel load close to buildings. The plan will include timings of any treatments, health and safety and access requirements.
The proposed building can withstand bush fire attack in the form of wind, smoke, embers, radiant heat and flame contact	A construction level of BAL-12.5 under AS 3959 or NASH and Table 7.4b is applied.	All new and existing facades and roofs are to achieve BAL-FZ in accordance with AS 3959	The existing concrete facades are to be retained, with windows/doors/openings treated with fire-resisting shutters or replaced with fire-resisting equivalents. Roofs are to achieve an FRL of at least -/30/- and the outer layer is to be noncombustible.
Firefighting vehicles are provided with safe, all-weather access to structures and hazard vegetation	▪ SFPP access roads are two-wheel drive, all-weather roads, and ▪ access is provided to all structures and hazard vegetation ▪ traffic management devices are constructed to not prohibit access by emergency services ▪ vehicles access roads must provide suitable turning areas in accordance with PBP	A new road is to provided to provide access to the site. The roads comply with the Acceptable Solution.	All existing roads within the site are 8m drivable surface. A extended driveway and fire trail is to provide access to the perimeter of the site. The roads comply with the Acceptable Solution.
The capacity of access roads is adequate for firefighting vehicles	▪ The capacity of road surfaces and any bridges/ causeways is sufficient to carry fully loaded firefighting vehicles (up to 23 tonnes); bridges and causeways are to clearly indicate load rating	Surfaces comply with the Acceptable Solutions.	Surfaces comply with the Acceptable Solutions.
There is appropriate access to water supply	▪ Hydrants are located outside of parking reserves and road	Hydrants are provided in accordance with AS 2419.1-2005.	Comply with acceptable solution Hydrants are provided in

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Performance Criteria	Acceptable Solution	Proposed Strategy	Proposed Solution
	carriageways to ensure accessibility to reticulated water for fire suppression, and ▪ hydrants are provided in accordance with AS 2419.1:2005 ▪ there is suitable access for a Category 1 fire appliance to within 4 m of the static water supply where no reticulated supply is available	Static water supply may be required to ensure sufficient pressures and flows in times of bushfire (high water use)	accordance with AS 2419.1-2005
Perimeter access roads are designed to allow safe access and egress for medium rigid firefighting vehicles while occupants are evacuating as well as providing a safe operational environment for emergency service personnel during firefighting and emergency management on the interface	▪ There are two-way sealed roads, and ▪ 8 m carriageway width kerb to kerb, and ▪ parking is provided outside of the carriageway width, and ▪ hydrants are to be 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	Comply with acceptable solution	Comply with acceptable solution
Non-perimeter access roads are designed to allow safe access and egress for medium rigid firefighting vehicles while occupants 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 ▪ there are through roads, and these are linked to the internal road system	All roads are to comply with the fire brigade vehicular access requirements of Planning for Bushfire Protection 2019.	Comply with acceptable solution

60

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Performance Criteria	Acceptable Solution	Proposed Strategy	Proposed Solution
	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.		
A water supply is provided for firefighting purposes	▪ reticulated water is to be provided to the development, where available, or ▪ a 10,000 litres minimum static water supply dedicated for firefighting purposes is provided for each occupied building where no reticulated water is available.	Complies with Acceptable Solution	Reticulated water is provided to the development.
Water supplies are located at regular intervals the water supply is accessible and reliable for firefighting operations	▪ fire hydrant spacing, design and sizing comply with the Australian Standard AS2419.1:2005, and ▪ hydrants are not located within any road carriageway, and ▪ reticulated water supply to SFPPs uses a ring main system for areas with perimeter roads, and	Complies with Acceptable Solution	Fire hydrants to be provided in accordance with AS 2419.1:2005.
Flows and pressure are appropriate	▪ fire hydrant flows and pressures comply with AS2419:2005, and	Complies with Acceptable Solution, however, additional onsite storage may be required to ensure that the sprinkler system achieves required pressure and flow during a bushfire.	
The integrity of the water supply is maintained	▪ all above-ground water service pipes external to the building are metal, including and up to any taps, and		
A static water supply is provided	▪ a connection for firefighting purposes	Comply with acceptable solution	Comply with acceptable solution

61

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Phase 2 & 3 School Lindfield Learning Village

Performance Criteria	Acceptable Solution	Proposed Strategy	Proposed Solution
for firefighting purposes in areas where reticulated water is not available	is located within the IPA or non hazard side and away from the structure; a 65mm Storz outlet with a ball valve is fitted to the outlet, and ▪ ball valve and pipes are adequate for water flow and are metal, and ▪ supply pipes from tank to ball valve have the same bore size to ensure flow volume, and ▪ underground tanks have an access hole of 200mm to allow tankers to refill direct from the tank, and ▪ a hardened ground surface for truck access is supplied within 4m of the access hole, and ▪ above-ground tanks are manufactured from concrete or metal, and ▪ raised tanks have their stands constructed from non-combustible material or bush fire-resisting timber (see Appendix F AS 3959), and ▪ unobstructed access can be provided at all times, and ▪ tanks on the hazard side of a building are provided with adequate shielding for the protection of firefighters, and ▪ underground tanks are clearly marked, and ▪ all exposed water pipes external to the building are metal, including any fittings, and ▪ where pumps are provided, they are a minimum 5hp or 3kW petrol or diesel-powered pump, and are shielded against bush fire attack; any hose and		

62

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Performance Criteria	Acceptable Solution	Proposed Strategy	Proposed Solution
	reel for firefighting connected to the pump shall be 19mm (internal diameter), and ▪ fire hose reels are constructed in accordance with AS/NZS 1221:1997 Fire hose reels, and installed in accordance with AS 2441:2005 Installation of fire hose reels		
The 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, and ▪ where overhead, electrical transmission lines are proposed as follows: o lines are installed with short pole spacing (30m), unless crossing gullies, gorges or riparian areas, and o 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	Complies with Acceptable Solution	Comply with acceptable solution
The 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, and ▪ all fixed gas cylinders are kept clear of all flammable materials to a distance of 10m and shielded on the hazard side, and ▪ connections to and from gas cylinders are metal, and ▪ if gas cylinders need to be kept close	Complies with Acceptable Solution	

63

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Phase 2 & 3 School Lindfield Learning Village

Performance Criteria	Acceptable Solution	Proposed Strategy	Proposed Solution
	to the building, safety valves are directed away from the building and at least 2m away from any combustible material, so they do not act as a catalyst to combustion, and ▪ polymer-sheathed flexible gas supply lines to gas meters adjacent to buildings are not used, and ▪ above-ground gas service pipes external to the building are metal, including and up to any outlets.		
A bush fire emergency and evacuation management plan is prepared	▪ bush fire emergency management and evacuation plan is prepared consistent with the: o The NSW RFS document: A Guide to Developing a Bush Fire Emergency Management and Evacuation Plan, NSW RFS Schools Program Guide (where applicable) o Australian Standard AS 3745:2010 Planning for emergencies in facilities, and o Australian Standard AS 4083:2010 Planning for emergencies – Health care facilities (where applicable), and ▪ The emergency and evacuation management plan should include a mechanism for the early relocation of occupants. Note: A copy of the bush fire emergency management plan should be provided to the Local Emergency Management Committee for its information prior to occupation of the development.	Complies with Acceptable Solution. Detailed bush fire emergency and evacuation management plans are to be prepared. Regular training provided to school staff.	Complies with Acceptable Solution

64

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Performance Criteria	Acceptable Solution	Proposed Strategy	Proposed Solution
Stable management arrangements are established for consultation and implementation of the bush fire emergency and evacuation management plan.	▪ an Emergency Planning Committee is established to consult with residents (and their families in the case of aged care accommodation and schools) and staff in developing and implementing an Emergency Procedures Manual, and ▪ Detailed plans of all emergency assembly areas including 'on-site' and 'off-site' arrangements as stated in AS 3745 are clearly displayed, and an annual (as a minimum) trial emergency evacuation is conducted.	Complies with Acceptable Solution. Detailed bush fire emergency and evacuation management plans are to be prepared. Regular training provided to school staff.	Complies with Acceptable Solution

65

APPENDIX D. FLAME HEIGHT CALCULATION AS PER BLACKASH ADVICE

Bushfire Attack Level calculator - AS3959-2009 (Method 2)			
Inputs		Outputs	
Fire Danger Index	100	Rate of spread	5.98 km/h
Vegetation classification	Forest	Flame length	43.07 m
Surface fuel load	25 t/ha	Flame angle	52 °
Overall fuel load	35 t/ha	Panel height	33.94 m
Vegetation height	n/a	Elevation of receiver	11.68 m
Effective slope	10 °	Fire intensity	108,159 kW/m
Site slope	10 °	Transmissivity	0.848
Distance to vegetation	30 m	Viewfactor	0.6462
Flame width	100 m	Radiant heat flux	61.26 kW/m²
Windspeed	n/a	Bushfire Attack Level	BAL-FZ
Heat of combustion	18,600 kJ/kg		
Flame temperature	1,200 K		

Rate of Spread - Mcarthur, 1973 & Noble et al., 1980

Flame length - NSW Rural Fire Service, 2001 & Noble et al., 1980

Elevation of receiver - Douglas & Tan, 2005

Flame angle - Douglas & Tan, 2005

Radiant heat flux - Drysdale, 1999, Sullivan et al., 2003, Douglas & Tan, 2005

APPENDIX E. RURAL FIRE SERVICE COMMENTARY AND RESPONSES

The following commentary was received from the Rural Fire Service to the proposed bushfire strategy on 13th August 2020. Comment response are provided at the end of this document

Subject: NSW Rural Fire Service Advice - Lindfield Learning Village SSD 8114 Phase 2 and 3

Good afternoon,

Thank you for seeking advice from the NSW Rural Fire Service (NSW RFS) on the proposed design for Stages 2 and 3 of the Lindfield Learning Village.

After working for some time during design development I feel it's now appropriate to provide our comments, recommendations and advice to you as requested.

This is the result of our current understanding of the design proposed for this project based on discussions the NSW RFS has had with the project team and bush fire and fire engineering consultants.

If our understanding is inconsistent with the current proposed design then I would please ask for clarification as appropriate and I would apologise.

NSW RFS staff who have been involved in ongoing bush fire protection and compliance advice include Corey Shackleton (previously the Director Community Resilience) and David Boverman (Manager Development Planning and Policy). NSW RFS development assessment and planning staff have also provided advice based on their assessment of the proposed design in terms of compliance with *Planning for Bush Fire Protection* (PBP).

At the time of this advice it is our understanding that there may still be some design decisions that remain, specifically the ability to provide asset protection zones (APZs) consistent with those used for our latest review. It is our understanding that these APZs were previously agreed and committed to by the relevant senior NSW government Executives responsible. It is also understood that because of site constraints the APZs that would be specified in accordance with PBP would not be achievable if the normal methodology, assumptions and criteria in PBP for determining APZ requirements had been followed.

Based on our involvement to date, the NSW RFS currently has no objection to the project proceeding if the bush fire protection strategy as understood and summarised below is assessed and demonstrated to comply with the criteria in section 100B of the *Rural Fires Act*.

This needs to be through a robust and thorough engineering approach which includes bush fire assessment and design and fire engineering.

It is my understanding that this in large part may have already occurred.

Legislative Context

It is understood that the consent authority for this project is the NSW Department of Planning, Industry and Environment (DPIE).

Accordingly, DPIE, as the consent authority, has requested advice from the NSW RFS on bush fire protection matters related to this proposed development.

The NSW RFS has also participated in and provided ongoing input to the design development process to assist project stakeholders in order to assist in achieving acceptable outcomes.

1

Scope of RFS Review

This advice is based on NSW RFS participation in the design development and compliance process and related studies undertaken to date and includes consideration and input into strategies for achieving the criteria specified in section 100B of the *Rural Fires Act* and PBP.

We have also assessed the proposed development in accordance with the provisions of PBP.

The NSW RFS review has not included any detailed modelling, site characteristics (and how they relate to the modelling details) or any theory and engineering which forms the basis of the modelling.

Our review has also been based on the APZs being provided as committed to and used for the radiant heat modelling provided for our review.

Proposed Bush Fire Protection Strategy

The following provides a summary of our current understanding of the bush fire protection strategy proposed for this project.

It is assumed that this will be underpinned by a reliance on maximising APZs to the greatest extent possible (as per previous agreements with departments such as NSW RFS, Parks, Education and DPIE) as well as a robust fire engineering approach which also addresses bush fire behaviour that could effect proposed buildings and occupants.

The advice to assess and demonstrate adequate performance through the engineering approach described above is due to the fact that the NSW RFS has assessed compliance with PBP and the APZs needed using the methods, assumptions and criteria in PBP have not been provided. Because of this, a reliance on providing redundancy in design and additional fire protection features and measures is needed.

The currently understood strategy includes:

- Provide the largest APZs possible so that minimal radiant heat levels are received at buildings used for Special Purpose Development Purposes;
- APZs are to be calculated and provided based on the actual geography, rock facings and vegetation characteristics of the site as well as flame temperatures to be expected, through a performance based approach;
- The radiant heat modelling solution will seek to demonstrate consistency with the 10 kw/sqm criteria of PBP;
- Fire separations for external walls and openings/penetrations are to be provided so that occupant safety is provided during bush fires (ie so that external walls successfully protect occupants from reasonable worst case bush fire scenarios as agreed by relevant stakeholders and design professionals);
- Horizontal exiting is to be provided into protected building and other areas outside of the 10kw/sqm radiant heat level footprints (calculated under the PBP approach) and these have adequate capacity to comfortably accommodate all occupants using these areas;
- Emergency evacuation planning is to be provided and implemented based on fire weather predictions, actual fire weather conditions and bush fire activity;
- Providing all other bush fire protection measures consistent with PBP requirements such as emergency access and evacuation roads, fire hydrants and water supplies.

Assessment for Compliance with *Planning for Bush Fire Protection*

The NSW RFS undertook an assessment of the proposed design to determine consistency with PBP.

It was found that the design complied with PBP for Special Fire Protection Purpose Developments with the exception of providing the APZs as described above.

Although PBP is used as the set of requirements for bush fire protection in the vast majority of situations, section 100B of the *Rural Fires Act* does not require compliance with PBP. The criteria in section 100B consists of providing standards of bush fire protection which the Commissioner of the RFS considers to be necessary for the protection of persons and property from bush fires.

Accordingly, reliance on fire engineering to assess and demonstrate adequacy and appropriateness of life safety and building protection provisioning for this project is considered to be needed.

If the methodologies, acceptance criteria and outcomes are acceptable then the NSW RFS would have no objections to the project proceeding on that basis.

Review of Detailed Radiant Heat Modelling

As part of the engineering process, radiant heat calculations have been provided to the NSW RFS for our review and comment (*Stephen Grubits Report 2018/321 R5.0*). These are predicated on evaluation and consideration of site-specific details and characteristics which influence bush fire behaviour and radiant heat that can be expected to be received at the buildings in question.

Based on our review we offer the following comments, noting that our review did not include the detailed modelling, site characteristics and how they relate to the modelling details or the detailed theory and engineering of the modelling. Our review is also based on the APZs being provided as assumed and used for the radiant heat modelling provided.

Accordingly, we offer the following:

- The basis for using reduced fire temperatures for radiant heat flux modelling needs to be established, demonstrated and documented to be appropriate;
- Flame length should be addressed as to whether flames would be expected to impinge on building elements;
- Should flame lengths indicate impingement on building elements then the design needs to accommodate this issue; and
- The radiant heat loads on buildings need to represent all exposures and should include Long Sections 1 to 11.

Recommendations and Advice

The NSW RFS recommends that the above strategy, compliance and bush fire protection engineering processes be undertaken and documented in a single document and that this be provided to DPIE before further formal advice is sought and provided.

This should address all of the criteria and issues identified above.

I hope this provides useful advice.

If you have any questions or wish to discuss just let myself at 0458 715 952) know.

Kind Regards,
David

David Boverman | Manager | Development Planning & Policy
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24 Hour Media Enquires 02 9898 1855
www.rfs.nsw.gov.au | www.facebook.com/nswrfs | www.twitter.com/nswrfs
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3

E.1.1. SGA Response to commentary

The bullet points on page 3 of the RFS commentary are responded to as follows, because these related to SGA 218/321 R5.1. We have adopted the recommendation for a single fire engineering document to capture the strategy and compliance, which has resulted in this document (SGA Report 2018/321 R8.0).

Specific Responses to Commentary to SGA Report from RFS Feedback:

- *The basis for using reduced fire temperatures for radiant heat flux modelling needs to be established, demonstrated and documented to be appropriate;*

SGA: The flame temperature at different heights is calculated using the correlation derived by B. Mike in 2010 for dry eucalypt fires, in order to develop a more precise flame temperature than an average temperature across an entire flame height. The basis and its justification is described in Section 7.4 of the report SGA 2018/321 R5.0. This basis is considered appropriate as it was developed for free-burning turbulent flames involving comparable fuel loads (NSW bush), and the data showed no strong deviation bias and was hence considered a good representation of realistic temperatures.

- *Flame length should be addressed as to whether flames would be expected to impinge on building elements;*

SGA: The flame height was 43 m from base to tip, as provided by the Bushfire Consultant (BlackAsh consulting). The closest APZ distance was 42.7 m, where the flaming region however, would start at the base on an ~11 m escarpment, leaving the school exposed to less than 32 m of flame height at that point. Therefore, flame impingement was considered unlikely.

- *Should flame lengths indicate impingement on building elements then the design needs to accommodate this issue; and*

SGA: Flame impingement is considered unlikely, nevertheless, all elevations are constructed to BAL-FZ, which is intended to withstand direct flame impingement.

- *The radiant heat loads on buildings need to represent all exposures and should include Long Sections 1 to 11.*

SGA: All elevations are BAL-FZ so onerous heat fluxes greater than 40 kW/m2 have been designed for. The flame width used to model radiative heat flux to the school in SGA Report 2018/321 R5.0 from any point is 100 m wide (which is often wider than the width of bush that that particular point is exposed to, or, within a 100 m snapshot, part of the exposure involves bush that is farther away than actually modelled). Beyond 100 m width, it is considered that little additional contribution to heat fluxes is made at the receiving point (the school building).

APPENDIX F. BUREAU OF METEOROLOGY WIND ROSE DATA (OBSERVATORY HILL)

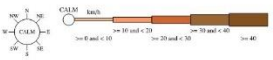
Rose of Wind direction versus Wind speed in km/h (01 Jan 1955 to 01 May 1992)

Custom times selected, refer to attached note for details

SYDNEY (OBSERVATORY HILL)

Site No: 066062 • Opened Jan 1858 • Still Open • Latitude: -33.8607° • Longitude: 151.205° • Elevation 39m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



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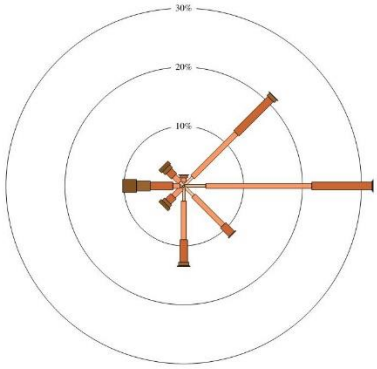

TCZMONTH Page 1

Rose of Wind direction versus Wind speed in km/h (01 Jan 1955 to 01 May 1992)

Custom times selected, refer to attached note for details

SYDNEY (OBSERVATORY HILL)

Site No: 066062 • Opened Jan 1858 • Still Open • Latitude: -33.8607° • Longitude: 151.205° • Elevation 39m

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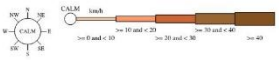

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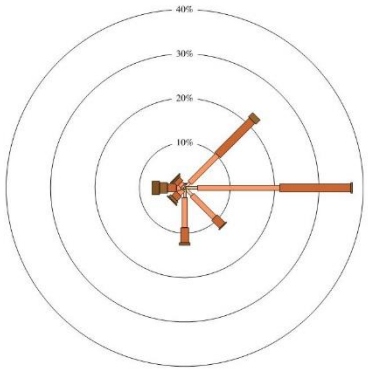
Calm 1%



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Contact us by phone on (03) 9669 4082, by fax on (03) 9669 4515, or by email on climatedata@bom.gov.au
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Rose of Wind direction versus Wind speed in km/h (01 Jan 1955 to 01 May 1992)

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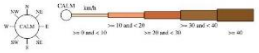

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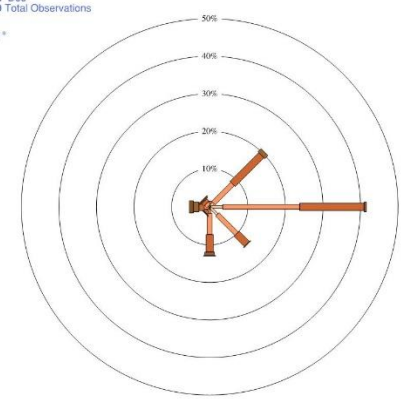

TCZMONTH Page 1

Rose of Wind direction versus Wind speed in km/h (01 Jan 1955 to 01 May 1992)

Custom times selected, refer to attached note for details

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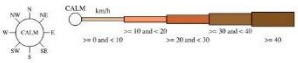

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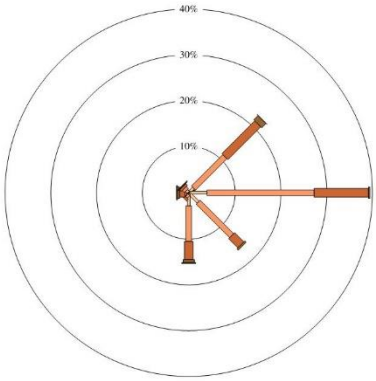

TCZMONTH Page 1

Rose of Wind direction versus Wind speed in km/h (01 Jan 1955 to 01 May 1992)

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An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

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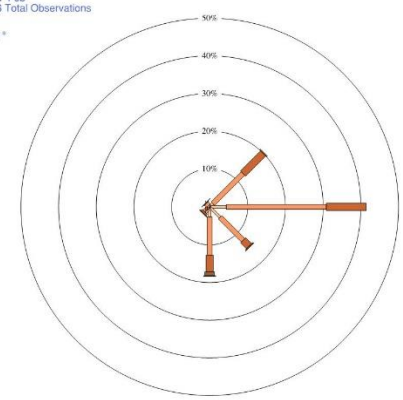

TCZMONTH Page 1

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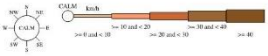

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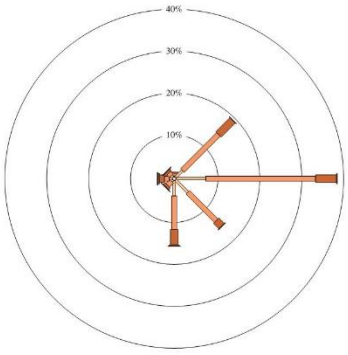

TCZMONTH Page 1

Rose of Wind direction versus Wind speed in km/h (01 Jan 1955 to 01 May 1992)

Custom times selected, refer to attached note for details

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An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

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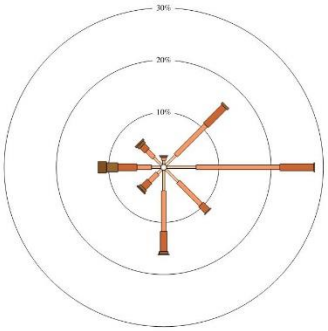
Calm 3%



TCZANNUAL Page 1