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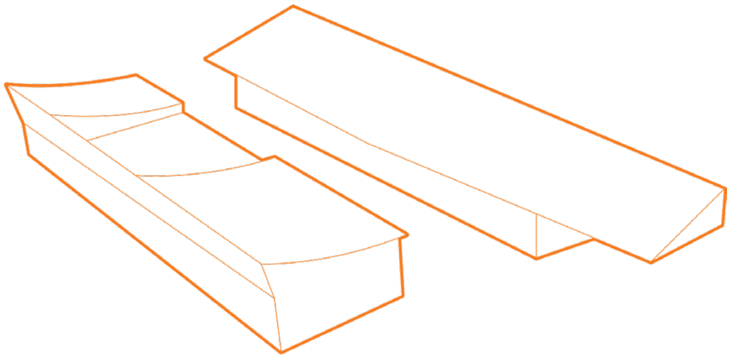

DESIGN SPECIFICATION: BLUE MOUNTAINS CITY COUNCIL PLANETARY HEALTH CENTRE BUSHFIRE SPRINKLER SYSTEM

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ABOUT THIS REPORT

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1 Introduction

This report presents design specifications for a bushfire sprinkler system to be installed at the Blue Mountains City Council Planetary Health Centre (PHC) building at 33 Acacia St Katoomba. It also presents a set of suggested 'passive' bushfire retrofits which would address a range of vulnerabilities to bushfire attack that the sprinkler system will not address.

The specifications in this report have been prepared based on the best evidence currently available, including the Australian Standard AS 5414-2012 'Bushfire water spray systems'. However, as outlined in our recent report[1], this existing evidence base is incomplete and uncertain in many respects. Factors that contribute to the remaining uncertainty in the predicted effectiveness of bushfire sprinkler systems in an actual bushfire include, but are not limited to: the intensity, duration and behaviour of the bushfire attack; intensity of associated winds, ember attack, etc; and the manner in which the sprinkler system is operated either remotely or manually/in-person.

The authors cannot therefore guarantee the effectiveness of the bushfire sprinkler system specified herein at protecting the PHC building from actual bushfires. Until a deeper scientific understanding of bushfire sprinkler effectiveness is developed, the sprinkler system specified in this report should be treated as an additional layer of protection on top of more conventional (i.e. 'passive') bushfire protection measures.

[1] Green, A., Cooper, P., 2022, Bushfire Sprinkler Systems for Increasing Bushfire Resilience of New and Existing Residential Buildings – Phase 1 Final Report, a report by the Sustainable Buildings Research Centre, University of Wollongong, for Forest and Wood Products Australia Ltd.

2 Passive Bushfire Retrofits

Several vulnerabilities to bushfire were identified during a site visit to the PHC building that are unlikely to be protected effectively by water sprays. It is therefore advisable to undertake additional retrofits of the building to mitigate the risk that these vulnerable building features could compromise the building during future bushfires. Suggestions for 'passive' bushfire retrofits, i.e. bushfire retrofits that do not rely on active systems such as water sprays, are provided in this section.

2.1 PROTECTION AGAINST EMBER INGRESS

A large proportion of buildings destroyed by bushfires are ignited by wind-borne embers. Extremely large numbers of embers can impinge on buildings during bushfires, often travelling long distances ahead of the fire front. The primary hazards posed by ember attack are:

1. Ingress of embers through the outer building envelope to the indoor environment, where they can start fires that can spread through the building; and
2. Accumulation of embers on or near combustible building elements outdoors, where they can ignite the building exterior.

The Australian standard for construction in bushfire-prone areas, AS 3959, requires new buildings in bushfire-prone areas to be built with no openings or gaps wider than 2 mm in the outer building envelope, to mitigate the risk of ember ingress.

2.1.1 Draught Seals

Several doors and windows with gaps larger than 2 mm were identified at the PHC building (e.g. see Figure 1). The risk of ember ingress through these gaps could be reduced by installing commercially available draught seal products with an appropriate BAL rating.

Figure 1: Examples of gaps around doors and windows.

2.1.2 Vent Openings

The PHC building has several vent openings that do not appear to have mesh ember protection installed (see Figure 2 for example). Metal mesh screens with openings no larger than 2 mm can be used to reduce the risk that embers could enter through these vents during a bushfire.

Figure 2: Examples of vent openings that appear to have no ember protection.

2.1.3 Other Gaps and Openings

Several other openings that could allow ember ingress were identified on the PHC building, as follows (and shown in Figure 3):

a) Sections of the lining on the underside the rear deck that have been removed.
b) Poorly sealed service penetrations.
c) Gaps around the corrugated steel cover to the pit near the south-east corner of the building.
d) Gaps in the slatted timber enclosure around the storage space on the ground floor at the north-west corner of the building.
e) Gaps at the edges of roof sheets near the gutters, valleys and ridge of the roof.

Covering these openings, leaving no gaps larger than 2 mm, would reduce the risk of ember ingress. Typical methods to seal such openings include the installation of steel flashings, fibre-cement sheets, silicone sealant, profiled BAL-rated foam inserts under corrugated roof sheet edges, 'gutter guard', or roof ventilation products such as Vent-A-Roof®. Care should be taken not to completely seal openings that are providing ventilation to spaces within the building; such openings can be protected from embers using metal mesh with apertures no larger than 2 mm.

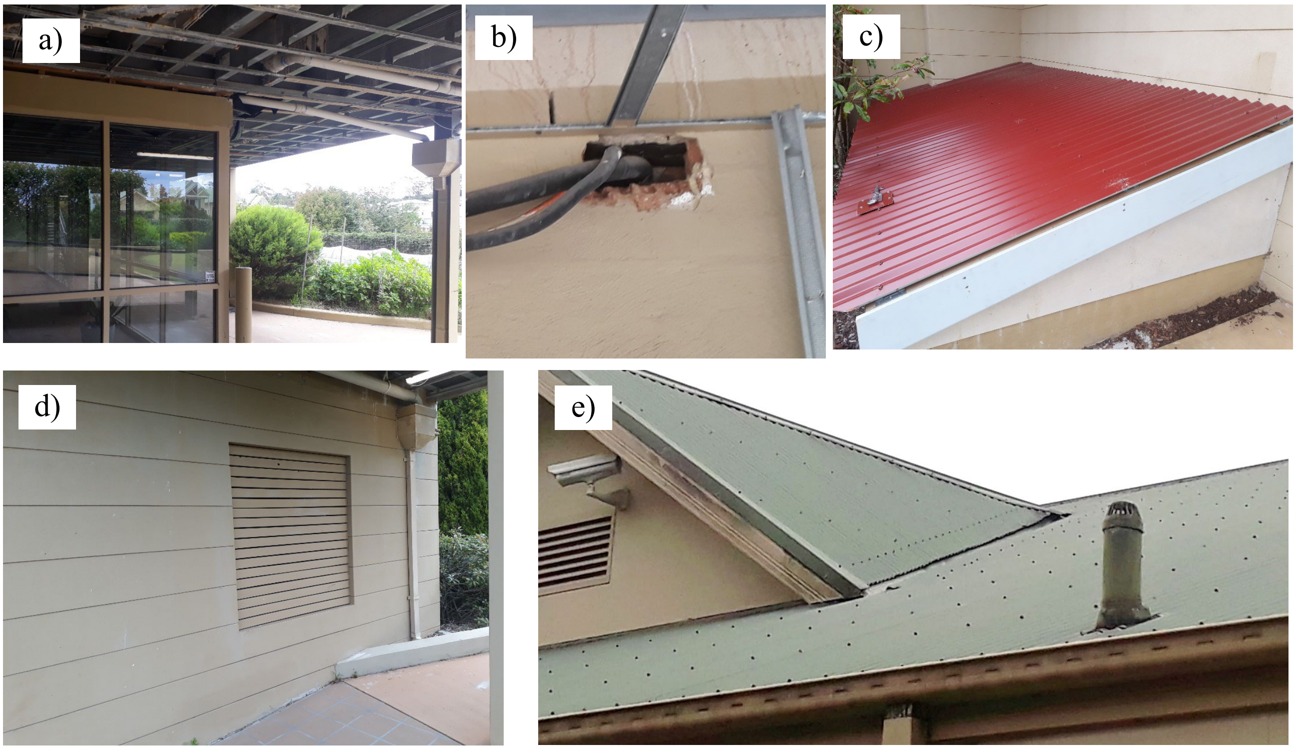

Figure 3: Examples of other gaps and openings vulnerable to ember ingress. Labels a–e correspond to items in the list near the top of this page.

2.2 REMOVAL OF COMBUSTIBLE MATERIALS NEAR THE BUILDING

Vegetation and other combustible material close to the building can be ignited during a bushfire, posing a direct hazard to the building. This can be especially hazardous when the combustible material is close to a vulnerable part of the building envelope, e.g. a window.

Several garden beds and combustible building features were identified when assessing the PHC building, as outlined below.

2.2.1 Garden Beds

Garden beds close to the PHC building could be removed to reduce the bushfire risk faced by the building. The hazard posed by the garden beds includes the vegetation itself, combustible mulch (e.g. bark chips), and combustible edging (e.g. timber sleepers).

Garden beds directly adjacent to windows or with plants growing under the eaves of the building are the highest priority to address (some examples of are shown in Figure 4), whereas garden beds further from the building (e.g. more than 5 m) could be treated as a lower priority.

The garden beds could be replaced with non-combustible ground coverings, such as concrete or pebbles, and/or with less combustible vegetation, e.g. succulents.

Figure 4: Examples of garden beds close to the building.

2.2.2 Other Combustible Materials

Several other combustible building features and items were identified at the PHC building, including the following (as shown in Figure 5):

a) Timber slatted enclosure around storage area at north-west corner of building.
b) Timber shelf below concertina windows on eastern side of the building.
c) Timber enclosure around HVAC equipment on eastern side of the building.
d) Timber stairs leading to the rear deck.
e) Tyres stored near eastern side of the building.

During a bushfire, these materials will pose a hazard to the building as they could be ignited by accumulated embers and/or radiant heat. To mitigate the risk, the combustible building materials (items a–d) could be replaced by non-combustible alternatives (e.g. fibre-cement), and the combustible items stored near the building (item e) could be removed.

Figure 5: Combustible materials posing a hazard to the building. Labels a–e correspond to items in the list near the top of this page.

3 Bushfire Sprinkler System

The sprinkler system has been specified with two primary aims:

1. Provide additional protection to the PHC building during future bushfires; and
2. Provide a platform to demonstrate bushfire sprinkler design and technology to the public.

3.1 SYSTEM SCOPE AND DESIGN

If the passive bushfire protection measures outlined in Section 2 are actioned, the remaining vulnerabilities to bushfire attack will primarily be windows. Moreover, we understand that it is planned to enclose the rear deck of the building during renovations in the near future. Such renovations should comply with AS 3959 'Construction of buildings in bushfire-prone areas', and any new windows on the enclosure should therefore be installed with types of glass and/or bushfire/ember screens that are appropriate for the Bushfire Attack Level determined for the building.

For these reasons, we have specified the sprinkler system to provide coverage only to the PHC building windows that are not located adjacent to the rear deck.

The system is specified with three 'zones':

1. A Primary Zone providing coverage to windows on the west and south facades;
2. A Secondary Zone providing coverage to windows on the east and north facades; and
3. A Demonstration Zone, which can be operated separately from the main system to demonstrate sprinkler technology to the public.

We understand that the Demonstration Zone will be an important feature of the system. For bushfire protection, the Primary Zone can be viewed as the highest priority, since it protects facades facing the steep forested areas to the west and south of the building. If the budget does not allow all three zones to be constructed, the system could be built with the Primary and Demonstration Zones only. However, this approach would not provide any additional protection to windows on the north and east facades of the building

3.2 SPRAY NOZZLES

The Primary and Secondary Zones are specified with Viking® model C-1 window sprinklers[2] (Figure 6) or equivalent flat-fan window sprinklers. Only one size of nozzle is required for the Primary Zone, with K-factor of 21.6 L min^{-1} bar$^{-0.5}$ (SIN VK790); and the Secondary Zone requires three sizes of nozzle, with K-factors of 21.6, 30.3 and 43.2 L min^{-1} bar$^{-0.5}$ (SIN VK790, VK791 and VK792).

Figure 6: Viking® model C-1 window sprinkler.

Further details on which nozzles are required in each location is provided in Section 3.3.

The Demonstration Zone can be fitted with a variety of nozzles, to demonstrate differences between the sprays they create, and potential uses for each spray in a home bushfire sprinkler system. Examples of nozzles that could be included in the Demonstration Zone include:

- Window-sprinklers, e.g. those in the Primary and Secondary Zones, which can be sprayed at the top of a window or wall to establish a film of water running down that surface.
- Full-cone or hollow-cone sprinklers, which can be installed under pergolas or awnings to wet decking below; suitable examples include Spray Nozzle Engineering N2W nozzles (which can be supplied with 'blow-off covers' that prevent insects from blocking the nozzles when not in use), and/or Spray Nozzle Engineering MaxiPass® MP218W nozzles.
- A deflector-plate/pendant sprinkler, e.g. Lechler 525.049, which can be mounted under the eaves of a building to wet the top of the wall and surrounding vegetation or decking.
- An impact sprinkler, e.g. Vyrsa VYR 35, which can be mounted at ground level or on risers near the building to wet vegetation and/or decking.

The selection of specific nozzles for inclusion in the Demonstration Zone, within each category listed above, could also be guided by the cost per nozzle, since members of the public will be seeking nozzles that are both effective and affordable.

[2] https://www.vikinggroupinc.com/databook/spraynozzles/051800.pdf

3.3 NOZZLE LOCATIONS

The spray nozzles should be installed according to the manufacturer's instructions. For window sprinklers, this typically ensures that they spray a horizontal fan of water along the top edge of the window glass. It is important that all window sprinklers wet the entire glazed surface, leaving no dry spots, to avoid the introduction of thermal stress.

Table 1 and Table 2 outline the type and number of nozzles specified to protect each window within the Primary and Secondary Zones respectively, as well as the minimum water flow rate needed to apply 10 L m^{-2} min^{-1}, to comply with AS 5414. The windows are listed from left to right in each zone. Where more than one spray nozzle is specified for a window, this is because the width of the window could not be covered by a single nozzle; the nozzles should be installed to provide even coverage to the entire width of the window.

The nominal flow rates of sprinklers covering each window are also presented in Tables 1 and 2, assuming a uniform supply pressure of 175 kPa. These values give an indication of the total water flow rate required for each zone; once the complete hydraulic design of system pipework is complete, a more accurate value of supply pressure at each nozzle can be determined.

The Demonstration Zone is not designed to protect any specific building features, so it can be installed in any location with appropriate access for viewing by the public.

Table 1: Primary Zone spray nozzle locations and minimum flow rates.

Façade	Window description	Nozzle SIN	Nozzle K-factor [L min^{-1} $bar^{-0.5}$]	Number nozzles	Minimum flow* [L min^{-1}]	Flow @175 kPa [L min^{-1}]
West	Tall narrow LHS	VK790	21.6	1	8.6	28.6
	Tall narrow RHS	VK790	21.6	1	8.6	28.6
	Horizontal slider	VK790	21.6	1	18.7	28.6
	Low horizontal slider	VK790	21.6	1	7.7	28.6
South	Horizontal slider	VK790	21.6	1	19.0	28.6
	Horizontal slider	VK790	21.6	1	19.0	28.6
	Wide slider LHS of doors	VK790	21.6	2	29.9	57.1
	Wide slider LHS of doors	VK790	21.6	2	29.9	57.1
	Slider RHS of doors	VK790	21.6	1	20.7	28.6
					Total:	314.3

* Minimum flow required by AS 5414 (i.e. surface area of window × 10 L min^{-1} m^{-2}).

Table 2: Secondary Zone spray nozzle locations and minimum flow rates.

Façade	Window description	Nozzle SIN	Nozzle K-factor [L min^{-1} bar$^{-0.5}$]	Number nozzles	Minimum flow* [L min^{-1}]	Flow @175 kPa [L min^{-1}]
East	Concertina windows	VK790	21.6	2	22.4	57.1
	Fixed glazing, NE corner	VK790	21.6	1	20.1	28.6
	Fixed glazing, NE corner	VK790	21.6	1	20.1	28.6
North	Fixed glazing, NE corner	VK791	30.3	1	25.9	40.1
	Fixed glazing, NE corner	VK791	30.3	1	25.9	40.1
	Fixed glazing, NE corner	VK791	30.3	1	25.9	40.1
	Fixed glazing	VK792	43.2	1	34.8	57.1
	Fixed glazing	VK792	43.2	1	34.8	57.1
	Fixed glazing	VK792	43.2	1	34.8	57.1
	Fixed glazing	VK792	43.2	1	34.8	57.1
	Door & fixed pane on LHS	VK790	21.6	1	17.9	28.6
	Fixed glazing RHS of door	VK791	30.3	1	24.3	40.1
	Small fixed glazing	VK790	21.6	1	4.1	28.6
	Small fixed glazing	VK790	21.6	1	4.1	28.6
	Small fixed glazing	VK790	21.6	1	4.1	28.6
	Small fixed glazing	VK790	21.6	1	4.1	28.6
	Small fixed glazing	VK790	21.6	1	4.1	28.6
	Small fixed glazing	VK790	21.6	1	4.1	28.6
	Small fixed glazing	VK790	21.6	1	4.1	28.6
	Small aluminium slider	VK790	21.6	1	8.3	28.6
	Small fixed glazing	VK790	21.6	1	4.1	28.6
	Small fixed glazing	VK790	21.6	1	4.1	28.6
	Screened glass louvres	VK790	21.6	1	15.5	28.6
	Hinged door	VK790	21.6	1	17.8	28.6
	Hinged door	VK790	21.6	1	21.0	28.6
	Fixed glazing RHS door	VK791	30.3	1	26.6	40.1
					Total:	943.3

* Minimum flow required by AS 5414 (i.e. surface area of window × 10 L min^{-1} m^{-2}).

3.4 WATER SUPPLY SYSTEM

A detailed flow network analysis will need to be undertaken to design the pipework and water supply system for each sprinkler zone. Requirements for the system are as follows:

- The system shall supply water to each nozzle with sufficient pressure to emit at least the minimum flow rates outlined in Tables 1 and 2, and at no less than 160 kPa at any nozzle.
- Pipework and fittings shall be galvanised steel, copper or stainless steel, except for fittings or pipe sections that are buried at least 300 mm underground, and shall comply with the requirements of AS 4118.2.1 as applicable to dry pipe systems.
- The system shall be capable of operation during bushfires without any mains electricity or mains water supply.

- Any pumps and other sensitive equipment shall be protected from bushfire attack.
- The pumpset and pipework shall be designed to allow easy inspection, testing and maintenance of the system.

3.5 POTENTIAL WATER RECYCLING

We understand that at least 50 kL of water will be retained in the PHC water tank for use by the sprinkler system. Given this quantity of water supply, ignoring any water recycling through stormwater drains near the building, and assuming each nozzle is supplied with water at 175 kPa, the system is estimated to be capable of continuous operation:

- For 159 minutes if only the Primary Zone is operated;
- For 40 minutes if both the Primary and Secondary Zones are operated.

If water sprayed by the system can be collected by stormwater drains around the building and redirected into the storage tank, that could significantly increase the duration that the system can operate.

If water is recycled in this manner, it is important that the water supply system is designed to manage any sediment and debris carried in the returning water stream, so that it does not cause malfunction of the system.

3.6 OTHER CONSIDERATIONS

The following considerations should also be addressed when developing the detailed design of the system:

1. The operation of the system should be incorporated into a written bushfire survival plan for the building, and this may reveal the need for an automatic or remote activation system for the sprinklers.
2. Signage should be installed as required by AS 5414, i.e. a plate bearing 25 mm reflective red letters ‘BWSS’ on a white background at the entry gate, labels at the stop valves of each zone, and detailed operating instructions at the pumpset.
3. It may be appropriate to install educational signage near the Demonstration Zone.
4. Fire hoses can optionally be included in the system, to assist in the protection of the building from bushfire.
5. Blow-off caps or plugs can be installed to prevent insects from blocking nozzle orifices.
6. Regular maintenance and testing of the system are essential.