From Bushfire Minimum Compliance to Best Practice: What role can you play

FPA Conference Perth 2024

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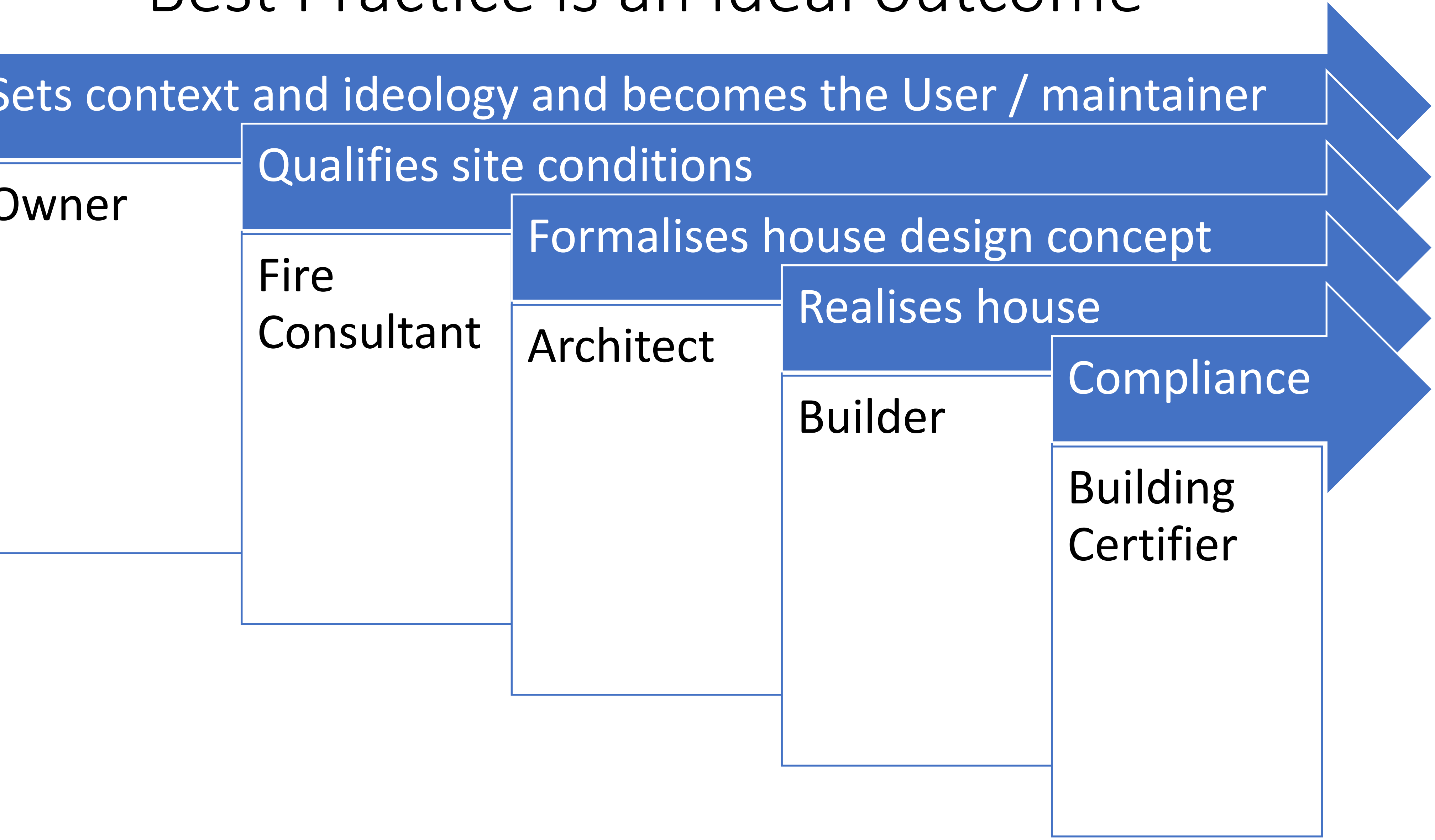
CSIRO

Compliance as a minimum foundation, Best Practice is an ideal outcome



For **Best Practice** to be realised everyone needs to be onboard, otherwise **Minimum Compliance** is inevitable.

V2.7.2 Buildings in bushfire prone areas

- (a) Compliance with P2.7.5 is verified if the ignition probability for a building exposed to a design bushfire does **not exceed 10%.**
- (b) Bushfire design actions must be determined in consideration of the annual probability of a design bushfire derived from—
  - (i) assigning the building or structure with an importance level in accordance with (c); and
  - (ii) determining the corresponding annual probability of exceedance in accordance with Table V2.7.2.

V2.7.2 Buildings in bushfire prone areas

- (c) A building or **structure's importance level** must be identified as one of the following:
  - (i) Importance level 1 — where the building or structure presents a low degree of hazard to life and other property in the case of failure.
  - (ii) Importance level 2 — where the building or structure is not of importance level 1 or 4 and is a Class 1a or 1b building accommodating 12 people or less.
  - (iii) Importance level 4 — where the building is a Class 10c building and is subject to a necessary 'defend in place' strategy. Table V2.7.2 Annual Probability of Exceedance (APE) for design bushfire actions Note to Table V2.7.2: Complex analysis must consider the probability of ignition, fire spread to the urban interface and penetration of the urban interface coincident with fire weather conditions.

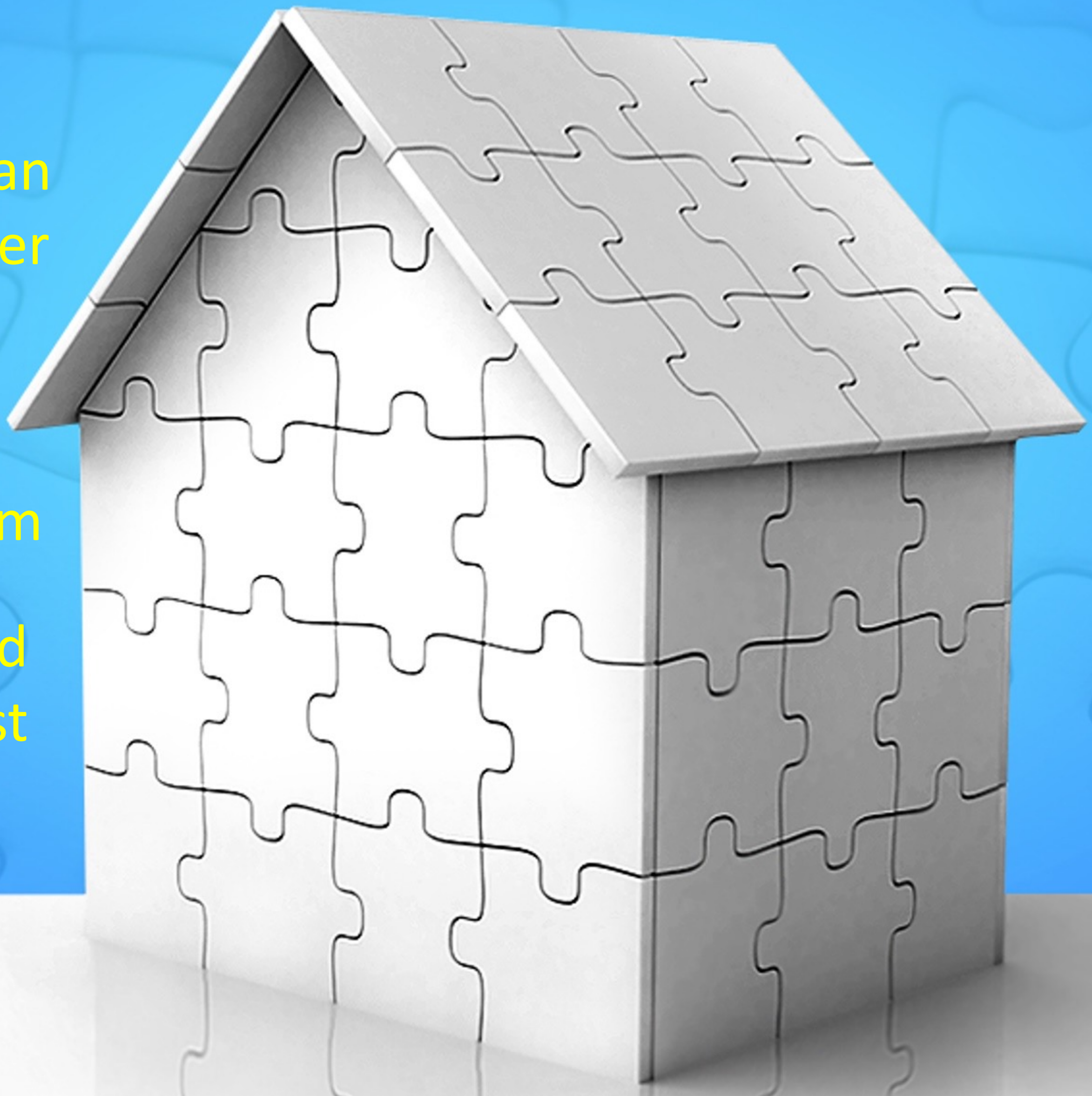
- (d) The ignition probability for a building must be assessed by application of the following:
  - (i) An event tree analysis of relevant bushfire scenarios.
  - (ii) Design bushfire conditions that include combinations of the following actions appropriate to the distance between the building and the bushfire hazard:
    - (A) Direct attack from **airborne burning embers**.
    - (B) **Burning debris and accumulated embers** adjacent to a building element.
    - (C) **Radiant heat** from a bushfire front.
    - (D) **Direct flame attack** from a bushfire front.

- (e) Applied fire actions must allow for reasonable variations in—
  - (i) fire **weather**; and
  - (ii) **vegetation**, including fuel load, burning behaviour of vegetation (including the potential for crown fires); and
  - (iii) the **distance** of the building from vegetation; and
  - (iv) topography, including **slopes** and features that may **shield**; and
  - (v) **ignition of adjacent** buildings, building elements, plants, mulch and other materials; and
  - (vi) effective **size of fire front**; and
  - (vii) **duration of exposure**; and
  - (viii) **flame height**; and
  - (ix) **flame tilt**; and
  - (x) **flame adhesion to** sloping land; and
  - (xi) the **height of the building** and its elements.

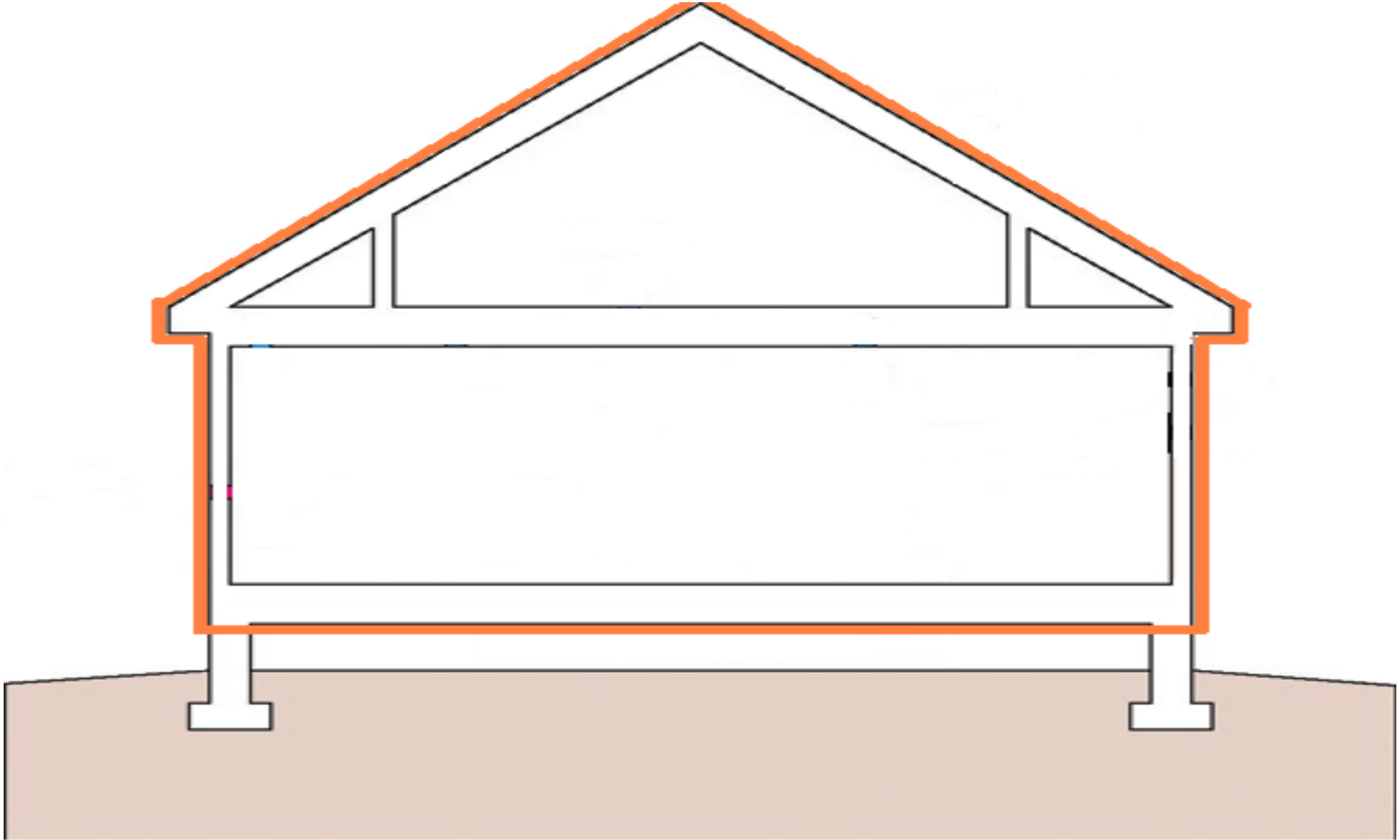
- (f) The assessment process must include consideration of—
  - (i) the **probability of non-complying construction of critical aspects** of an approved design; and
  - (ii) the **probability of critical aspects of an approved design being fully functional during the life of the building**; and
  - (iii) **inclusion of safety factors**; and
  - (iv) **sensitivity analysis** of critical aspects of a proposed design.

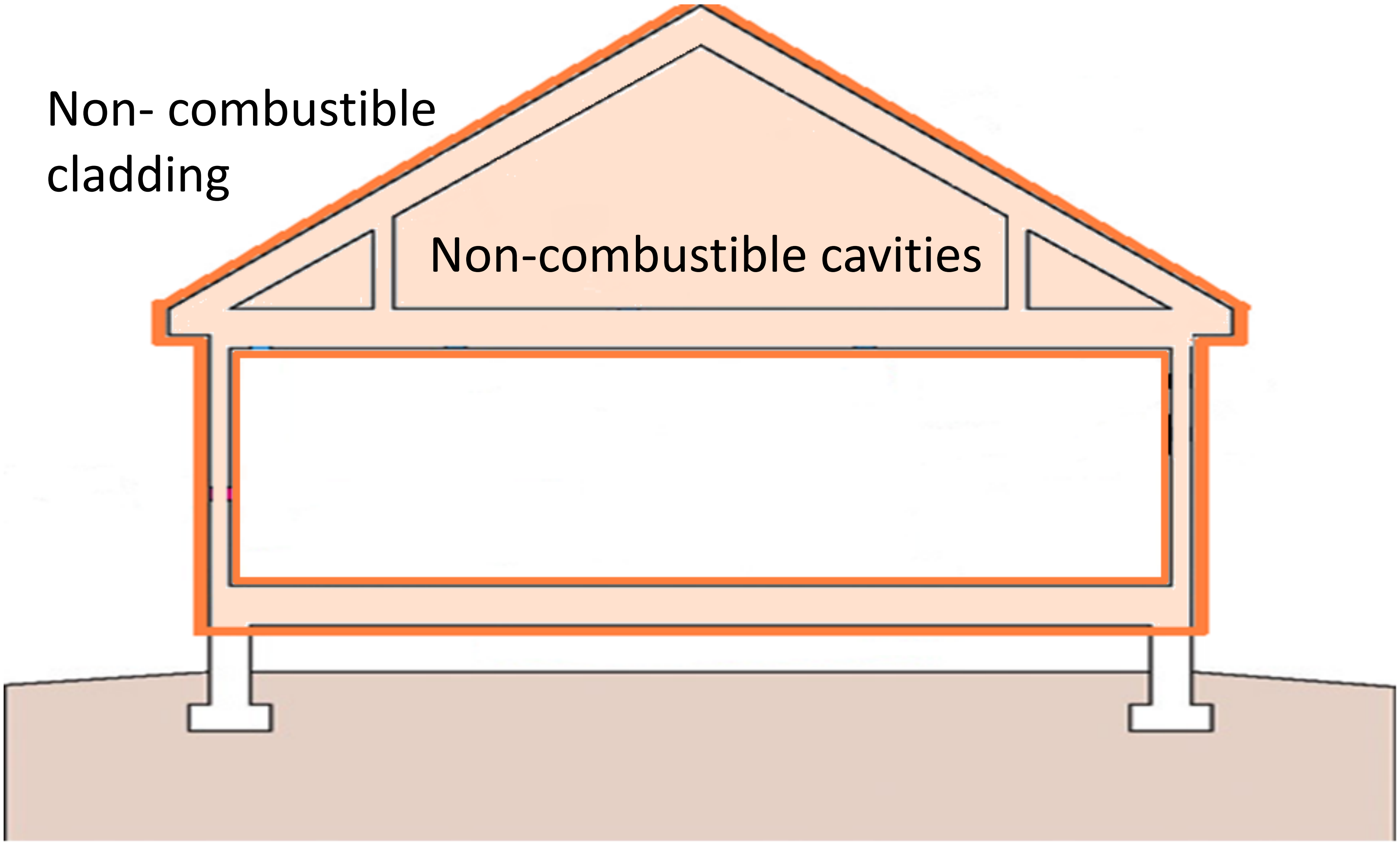
Building Design Challenges

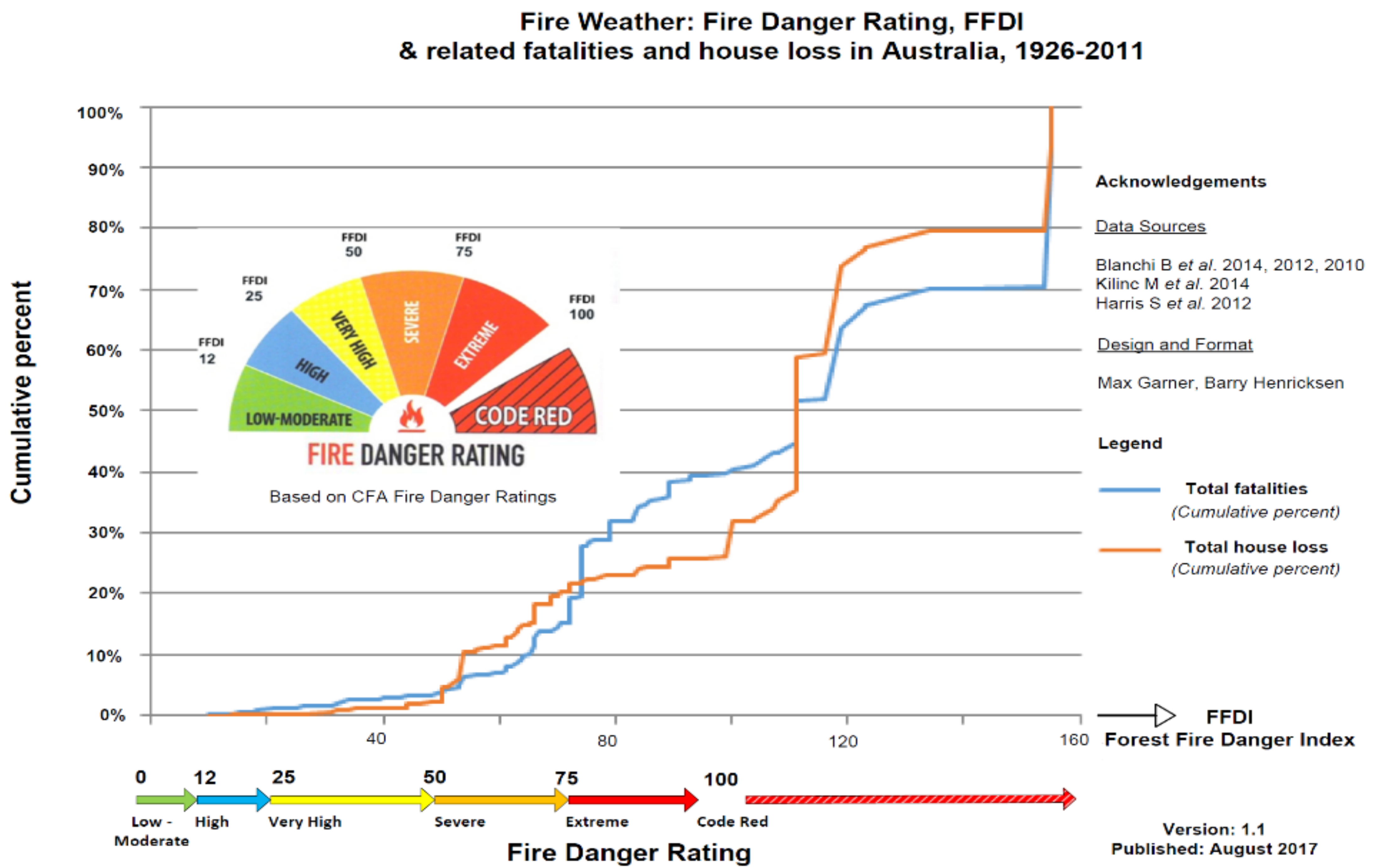
- Bushfires provide combined actions
- Building component can interact with each other
- Minor damage or modification can compromise the system
- Performance is as good as the systems weakest link



Conventional Minimum Compliance Bushfire Design – AS3959

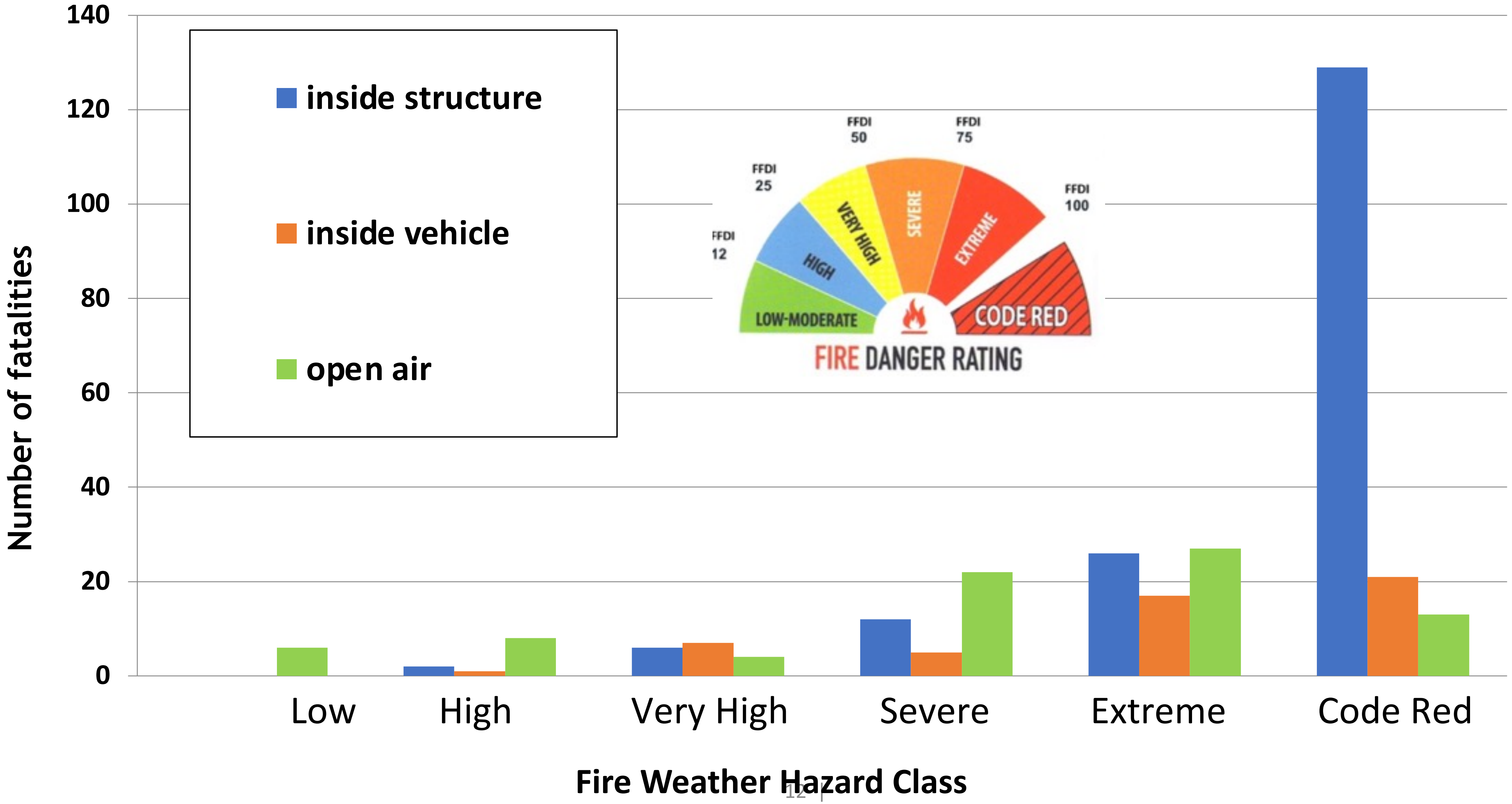



Non- combustible
cladding
Non-combustible cavities

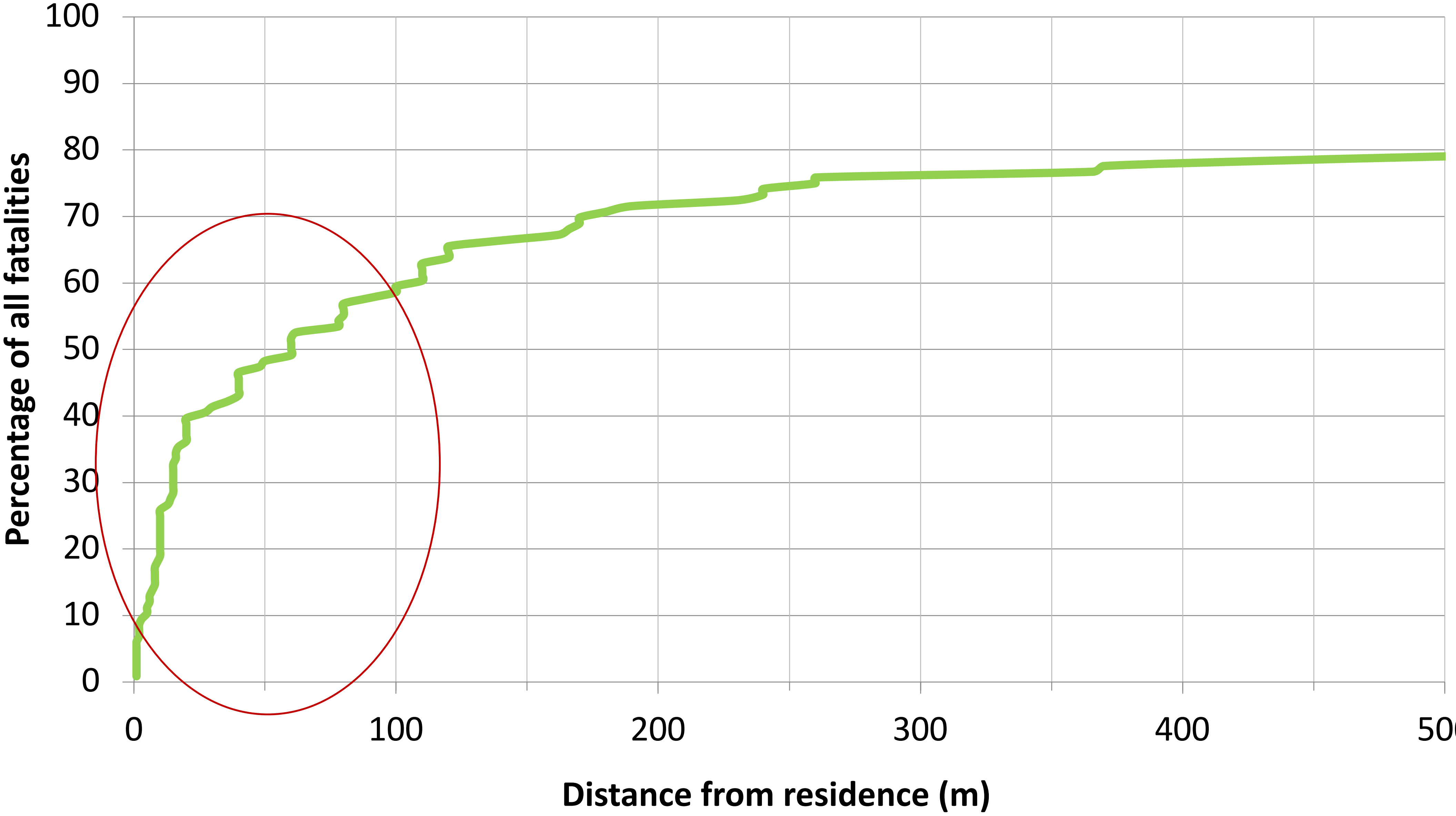


Fire Weather: Fire Danger Rating, FFDI
& related fatalities and house loss in Australia, 1926-2011
Cumulative percent
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
FFDI 12
FFDI 25
FFDI 50
FFDI 75
FFDI 100
LOW-MODERATE
HIGH
VERY HIGH
SEVERE
EXTREME
CODE RED
FIRE DANGER RATING
Based on CFA Fire Danger Ratings
40
80
120
160
FFDI
Forest Fire Danger Index
0
12
25
50
75
100
Low - Moderate
High
Very High
Severe
Extreme
Code Red
Fire Danger Rating
Acknowledgements
Data Sources
Blanchi B et al. 2014, 2012, 2010
Kilinc M et al. 2014
Harris S et al. 2012
Design and Format
Max Garner, Barry Henricksen
Legend
Total fatalities
(Cumulative percent)
Total house loss
(Cumulative percent)
Version: 1.1
Published: August 2017

Life Loss & Weather



Distance from Home to Occupant Fatality



Location of Fatality within Structures

Detail inside structure	Number of fatalities	Percentage of known
Bathroom	36	29%
Kitchen	26	21%
Bedroom	17	14%
Study	10	8%
Under house enclosure	9	7%
Entrance	5	4%
Lounge	4	3%
Cool-room	3	2%
Laundry	3	2%
Outdoor spa	3	2%
Toilet block	3	2%
Bunker	2	2%
Shed	2	2%
Independent garage	1	1%
Shack	1	1%
Total	**125**	**100%**

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Detail inside structure	Number of fatalities	Percentage of known
Bathroom	36	29%
Kitchen	26	21%
Bedroom	17	14%
Study	10	8%
Under house enclosure	9	7%
Entrance	5	4%
Lounge	4	3%
Laundry	3	2%
Total	**110**	**100%**

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Under house enclosure	9	7%
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Laundry	3	2%
Total	**110**	**100%**

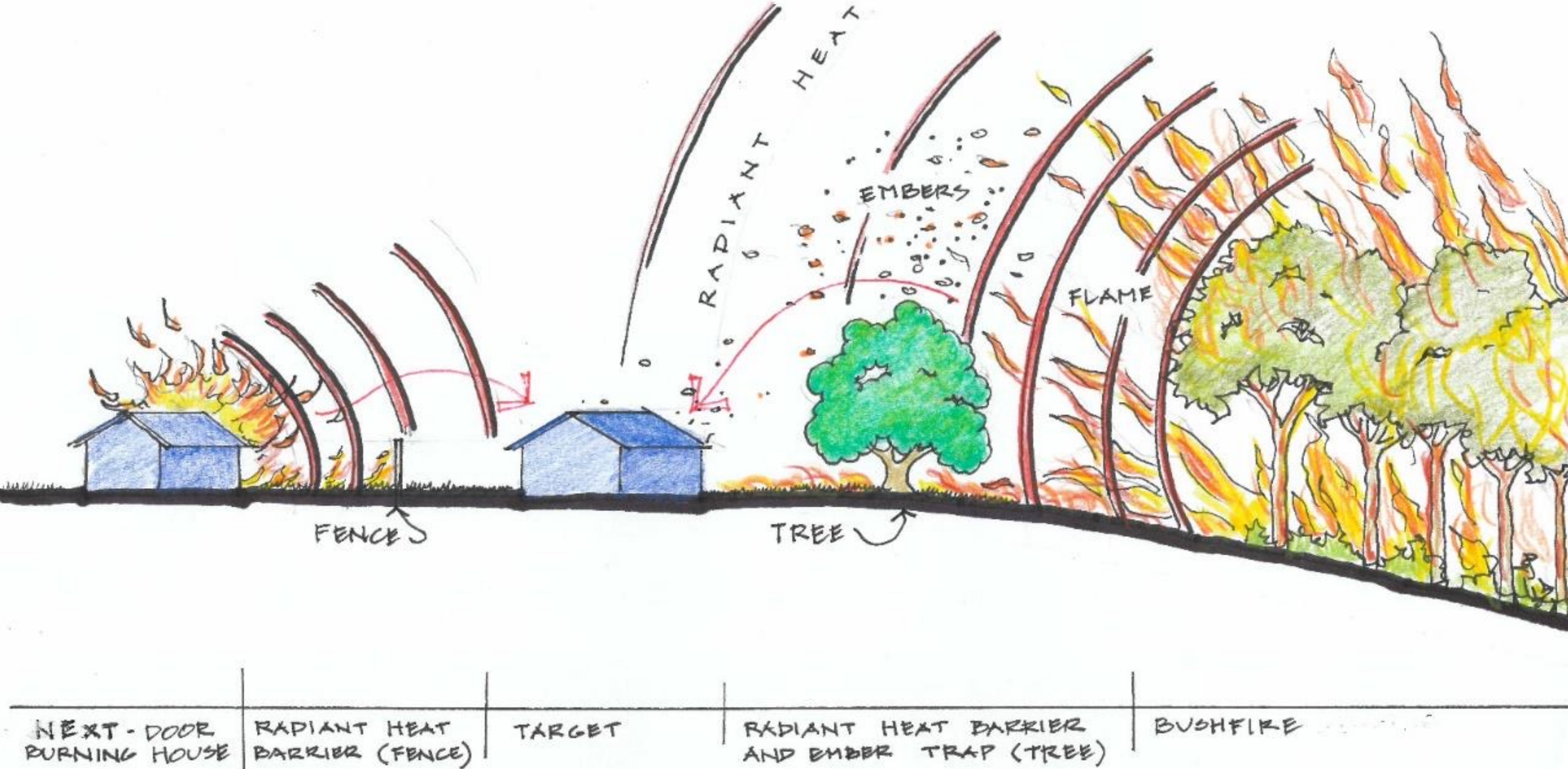
93% in a location with no direct exit

Egress Issues

- Pathways and Challenges
  - Decking
  - Stairs
  - Combustible surfaces
  - Visibility
  - Smoke
  - Trip hazards
  - Falling elements

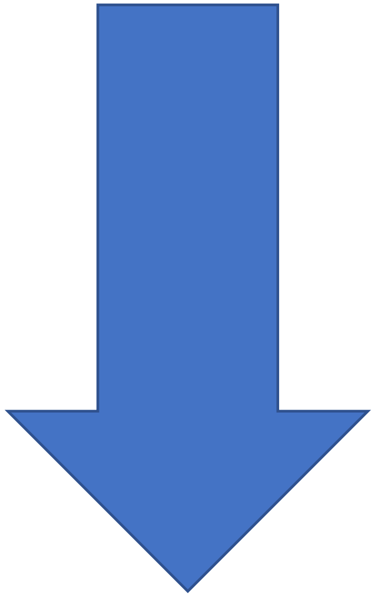
- External Combustible Elements
  - Vegetation
  - Houses
  - Vehicles
  - Fences
  - Retaining Walls
  - Gas cylinders

The complex urban interface



- Ember Attack
- Debris Accumulation
- Surface Fire
- Consequential fire
- Radiant Heat
- Flame Front contact
- Wind
- Tree strike

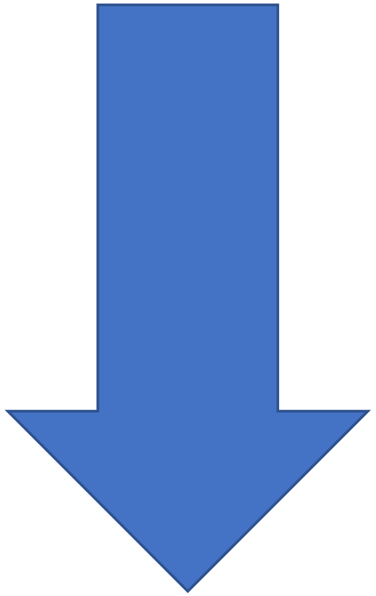
Most Prevalent cause of loss



Least Prevalent cause of loss

- Ember Attack
- Debris Accumulation
- Surface Fire
- Consequential fire
- Radiant Heat
- Flame Front contact
- Wind
- Tree strike

Highest Priority



Lowest Priority

- Ember Attack House X Landscape
- Debris Accumulation House X Landscape
- Surface Fire House X Landscape
- Consequential fire House X Landscape
- Radiant Heat House X Landscape
- Flame Front contact House X Landscape
- Wind House X Landscape
- Tree strike House X Landscape

- Ember Attack House X Landscape
- Debris Accumulation House X Landscape
- Surface Fire House X Landscape
- Consequential fire House X Landscape
- Radiant Heat House X Landscape
- Flame Front contact House X Landscape
- Wind House X Landscape
- Tree strike House X Landscape


Dulux

- Ember Attack House X Landscape
- Debris Accumulation House X Landscape
- Surface Fire House X Landscape
- Consequential fire House X Landscape
- Radiant Heat House X Landscape
- Flame Front contact House X Landscape
- Wind House X Landscape
- Tree strike House X Landscape

Post bushfire survey

- Ember Attack House X Landscape
- Debris Accumulation House X Landscape
- Surface Fire House X Landscape
- Consequential fire House X Landscape
- Radiant Heat House X Landscape
- Flame Front contact House X Landscape
- Wind House X Landscape
- Tree strike House X Landscape

Photo CSIRO


Photo CSIRO


TANKWORLD


216
2414NB

CYLINDER UPRIGHT
ELGAS
LP GAS
131 161
ELGAS
LP GAS


Gas


Source: abc.net.au

- Ember Attack House X Landscape
- Debris Accumulation House X Landscape
- Surface Fire House X Landscape
- Consequential fire House X Landscape
- Radiant Heat House X Landscape
- Flame Front contact House X Landscape
- Wind House X Landscape
- Tree strike House X Landscape


Tree Strike


28 APR


Understanding bushfires from a house's perspective: **Building best practice guides**

- Ember attack
- Radiant heat
- Bushfire flame front contact
- Surface fire
- Consequential fire
- Tree strike
- Wind
- Debris accumulation

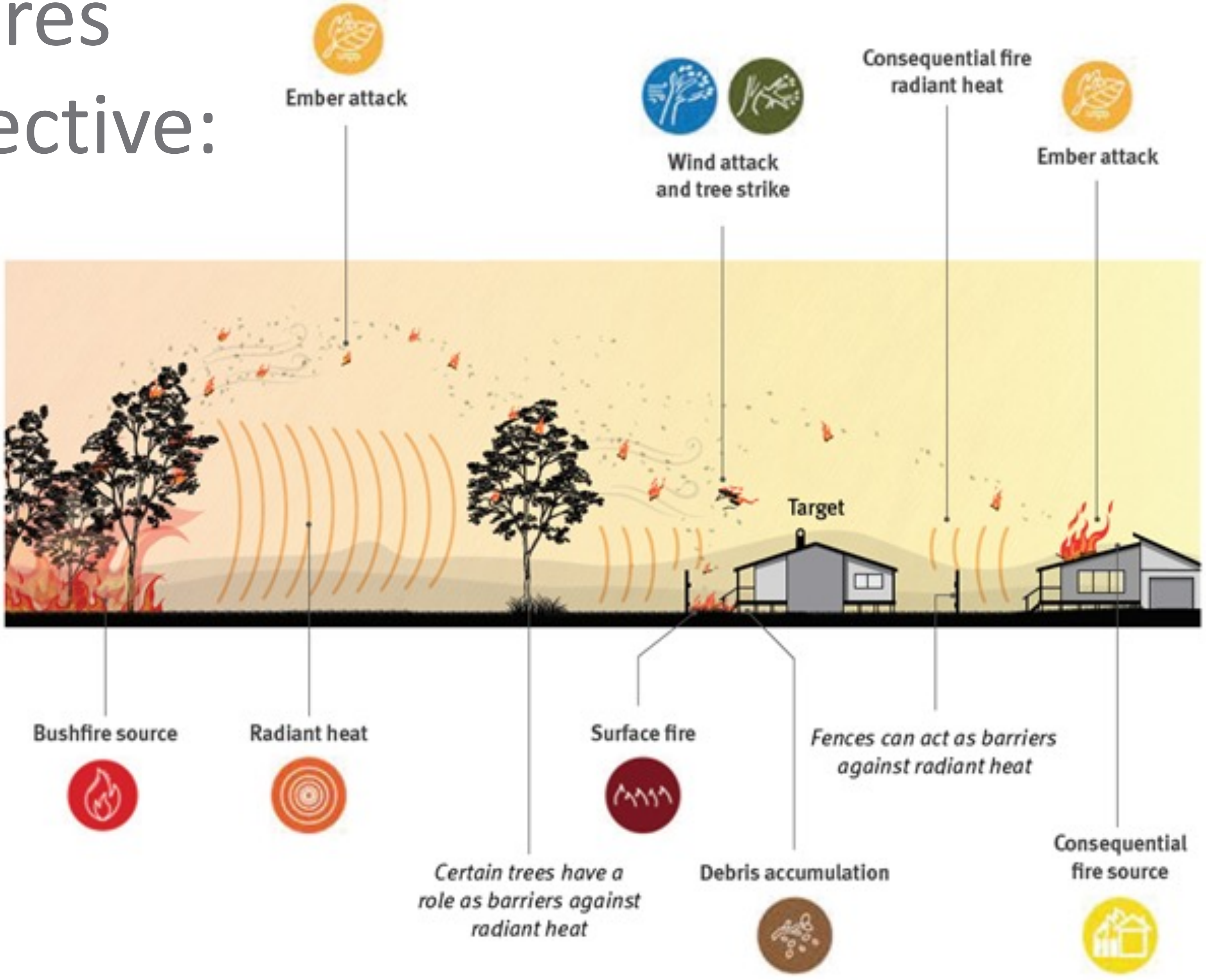
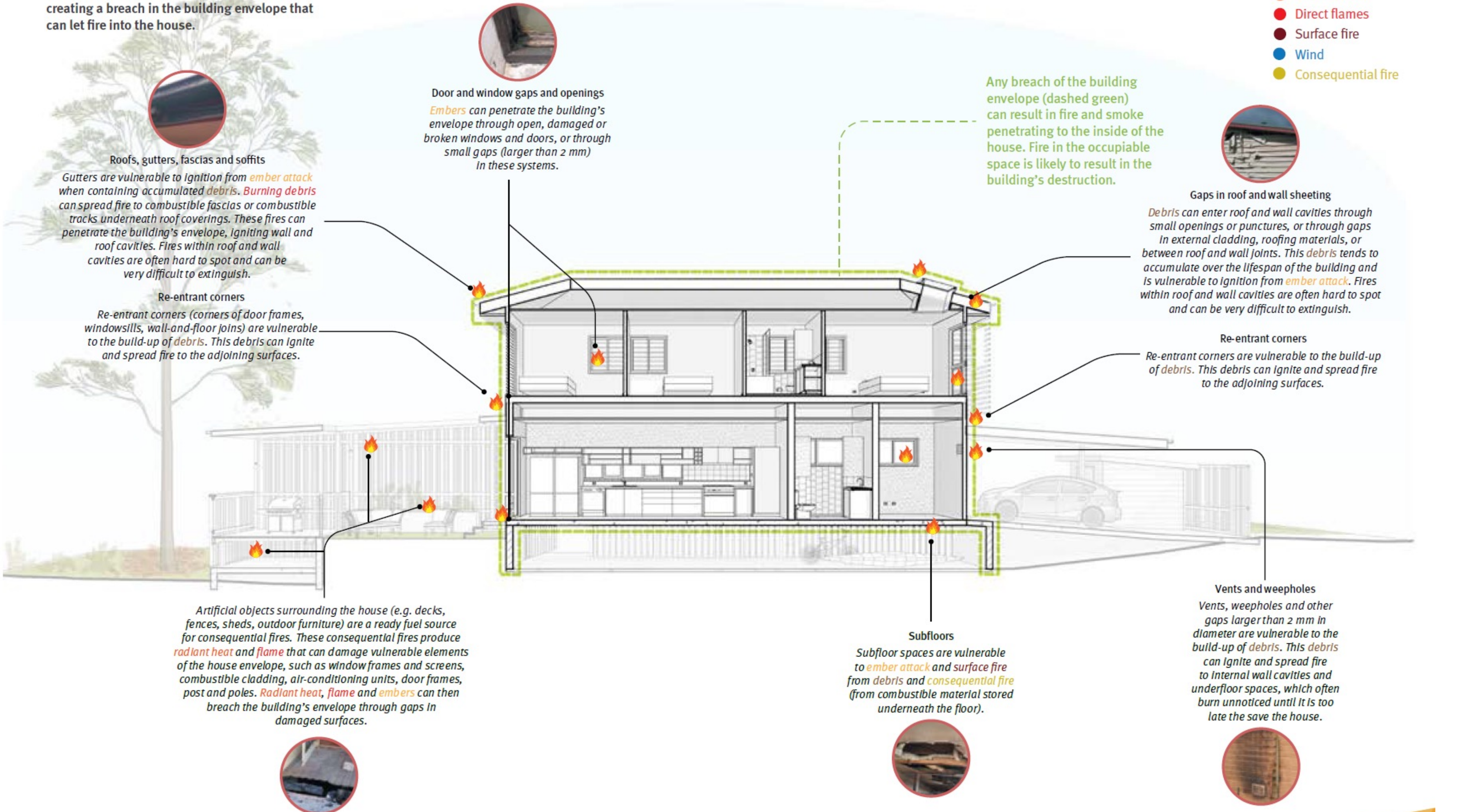


Diagram of bushfire attack mechanisms

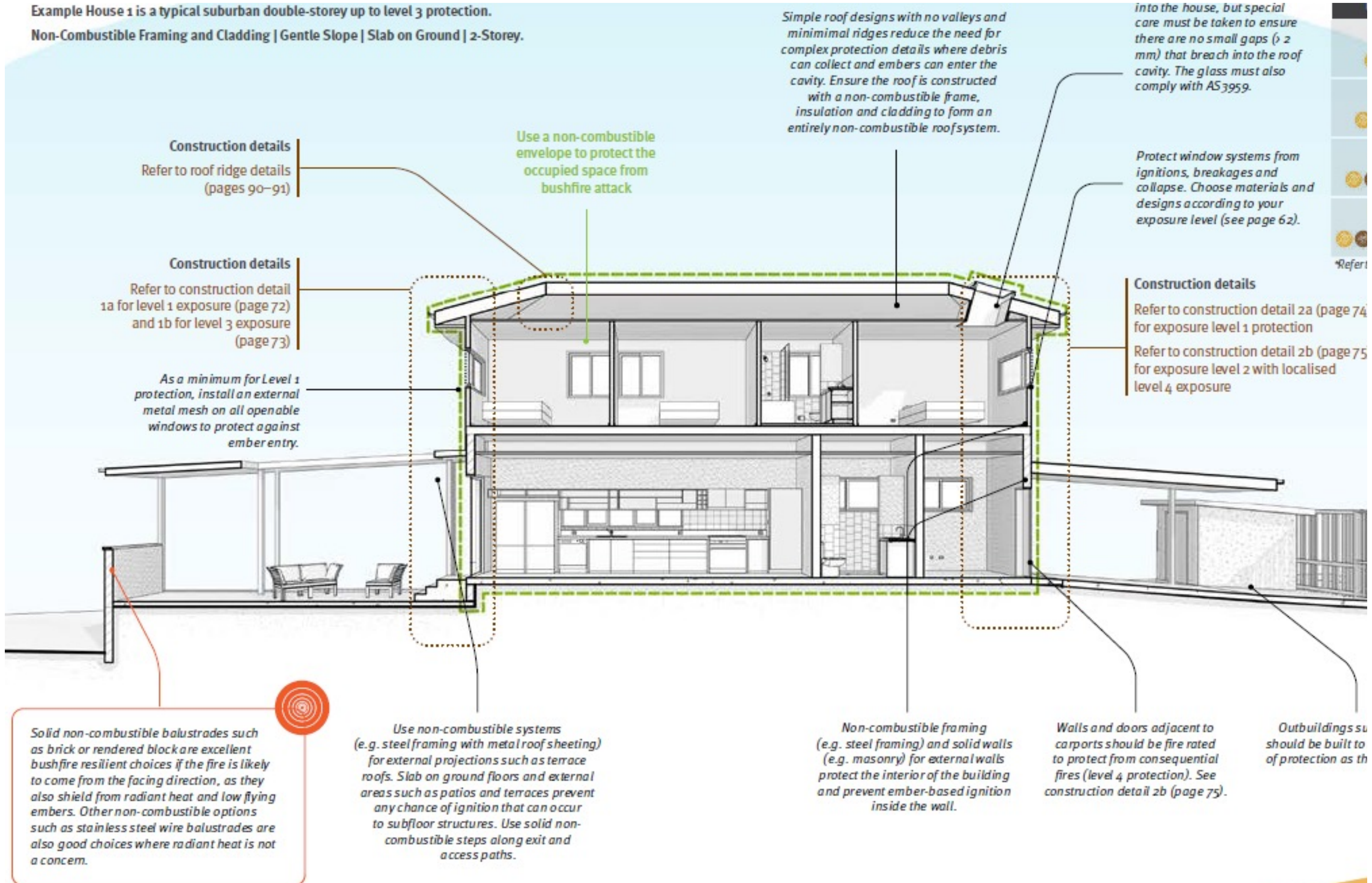
Vulnerability of the house

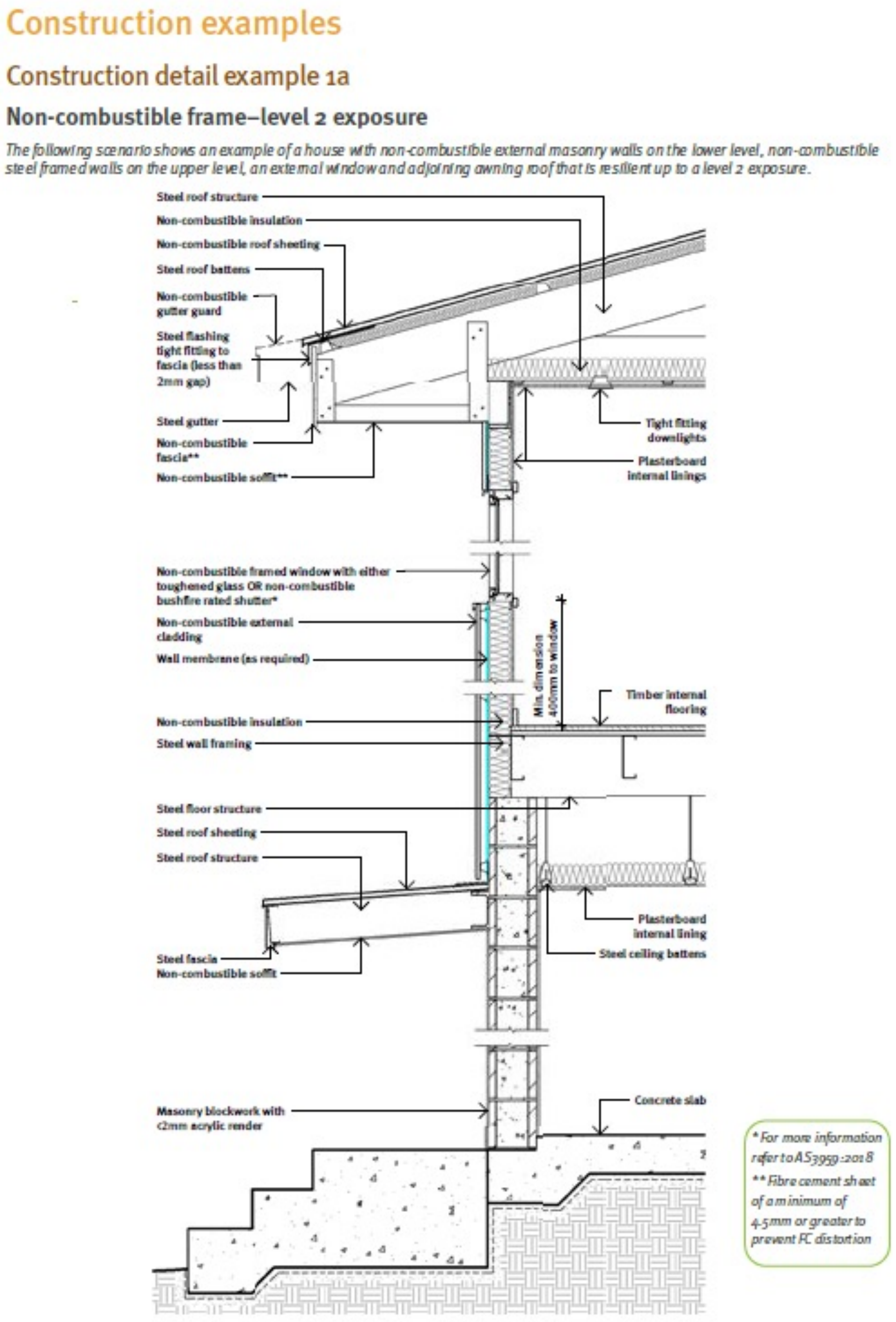
This diagram illustrates the vulnerabilities creating a breach in the building envelope that can let fire into the house.



Construction

- Robustness
- Redundancy
- Cost-effectiveness and sustainability





Design principles

	Hazard	Design principles	Ease of mitigation Siting vs construction
	Ember attack and the accumulation of unburnt debris.	Ember protection is primarily achieved by limiting the ember's ability to ignite any aspect of the house or its surrounding features. These may be external features, such as cladding and building fascias, or internal features, such as building cavities and internal furnishings. To mitigate ember attack: – use non-combustible construction materials, both externally and within building cavities – use designs that limit the ability for embers and unburnt debris to enter the house or its cavities, such as cavity-less construction (e.g. slab on ground flooring, solid masonry walls, skillion roofs) and tight-fitting cladding on roof and subfloors. – use designs that limit accumulation points for unburnt debris and embers (e.g. use a simple house shape and simple roof lines). A secondary strategy is to reduce the total exposure of embers and unburnt debris on the building by: – using screening plants to filter embers and other wind-driven debris – using proximal plants with low bark hazard – using non-combustible barriers (e.g. fences and earthworks) to shield buildings from ember attack – removing overhanging trees that may drop debris onto or around the house.	Siting Construction 

Materials

MASONRY

Brick veneer, double brick, concrete block, stones, mudbrick

Uses and level of protection	Advantages	Disadvantages
Used for wall systems for all levels, and in some cases may have a minimum thickness or joint requirements for level 3 and 4. The thickness requirements for the various materials or products can be provided by the suppliers or builder, to achieve either a 30-minute fire rating for level 3, or a 60-minute fire rating for level 4.	• Strong non-combustible material resists all bushfire actions. • Offers a reasonable degree of branch strike protection (depending on thickness). • Dimensionally stable when heated. • High thermal mass. • Building fire rating test performance translates well to effective performance in bushfires. • In many cases would only receive minor cosmetic damage in a bushfire. • Effective in protecting framing elements underneath from direct flame. • Thick masonry has a high fire rating.	• Vents and weepholes need to be carefully designed and maintained, especially when there are combustible framing elements in the cavity behind the masonry cladding system.

RENDER

Heavy and acrylic renders

HEAVY MASONRY RENDER

Uses and level of protection	Advantages	Disadvantages
Heavy masonry render can provide a level of protection similar to masonry cladding. The thickness requirements for the various materials or products can be provided by the suppliers or builder, to achieve either a 30-minute fire rating for level 3, or a 60-minute fire rating for level 4. Can be used to completely enclose and seal structural strawbale construction to create a bushfire resistant wall system.	• Strong non-combustible material resists all bushfire actions. • Offers a reasonable degree of branch strike protection (depending on thickness). • Dimensionally stable when heated. • High thermal mass. • Building fire rating test performance translates well to effective performance in bushfires. • In many cases would only receive minor cosmetic damage in a bushfire.	• Requires a combination of good render formulation and skilled application to achieve uniformity and appropriate thickness and finish around building details.

STEEL WALL AND ROOF CLADDING

Uses and level of protection	Advantages	Disadvantages
Steel wall and roof cladding are a durable non-combustible cladding system that is most effectively used over a non-combustible framing system. Is dimensionally stable for levels 1 and 2. Some distortion is possible for levels 3 and 4, requiring additional wall design details to account for possible cladding distortion.	• Cost effective non-combustible and dimensionally stable for levels 1 and 2. • Cost effective replaceable cladding for levels 3 and 4. • Common material used by conventional trades.	• Cladding will suffer cosmetic impact and some distortion if subjected to direct flame contact. Its long-term durability may also be affected.

STEEL FRAMING

Uses and level of protection	Advantages	Disadvantages
Steel framing is a durable, cost effective way to achieve light weight construction outcomes with wall and roof cavities that are non-combustible. Is dimensionally stable in the use cases described in the guide for all levels. Is dimensionally stable for steel temperatures up to 400 degrees Celsius, which are highly unlikely to be reached in the construction methods for housing. Can tolerate a reasonable degree of damage or modification to the wall system, as a breach of both outer cladding and inner wall plaster would be required to cause potential house ignition.	• Cost effective non-combustible and dimensionally stable for levels 1 and 2. • Cost effective replaceable cladding for levels 3 and 4. • Common material used by conventional trades. • Framing elements unlikely to exceed 400 degrees, therefore will be dimensionally stable and durable for future use.	• Some builders have limited experience with steel framing.

STEEL FLOOR AND DECKING SUPPORT

Uses and level of protection	Advantages	Disadvantages
Steel floor is a durable, cost effective support structure that is effective for levels 1 and 2 and requires shielding for levels 3 and 4 where direct flame contact over a significant duration may be possible.	• Cost effective non-combustible and dimensionally stable for levels 1 and 2. • Cost effective replaceable cladding for level 3 and 4. • Common material used by conventional trades. • Framing elements unlikely to exceed 400 degrees and in these cases will be dimensionally stable and durable for future use.	• Limited decking board fixing option.

TIMBER CLADDING, DECKING AND FRAMING

CLASS 1 (ABOVE GROUND) DURABILITY HARDWOODS USED AS TIMBER CLADDING (THAT HAVE NOT BEEN PRESERVATIVE TREATED)

Uses and level of protection	Advantages	Disadvantages
Is durable with a reasonable tolerance to ember attack and radiant heat appropriate to level 1. Timbers in this durability class tend to have higher resistance to ignition and lower tendency to support flame spread compared to lower durability timbers (compared at the same moisture content). Will degrade (emitting significant smoke) at temperatures in excess of 150 degrees Celsius and be at risk of spontaneous ignition at temperatures above 200 degrees Celsius.	• High durability timber will last longer than other timber species as a cladding. Fortunately, timber durability is also a good predictor of bushfire performance compared to other timbers (a significantly better metric for bushfire performance compared to other generalised metrics like timber density class).	• Dimensional stability is subject to moisture content. • Can still ignite and support fire spread at low moisture content levels that are possible in some bushfire circumstances. Will ignite if exposed to high radiation levels or direct flame contact. • Is commonly treated with oils or painted which is likely to increase its ignitability.

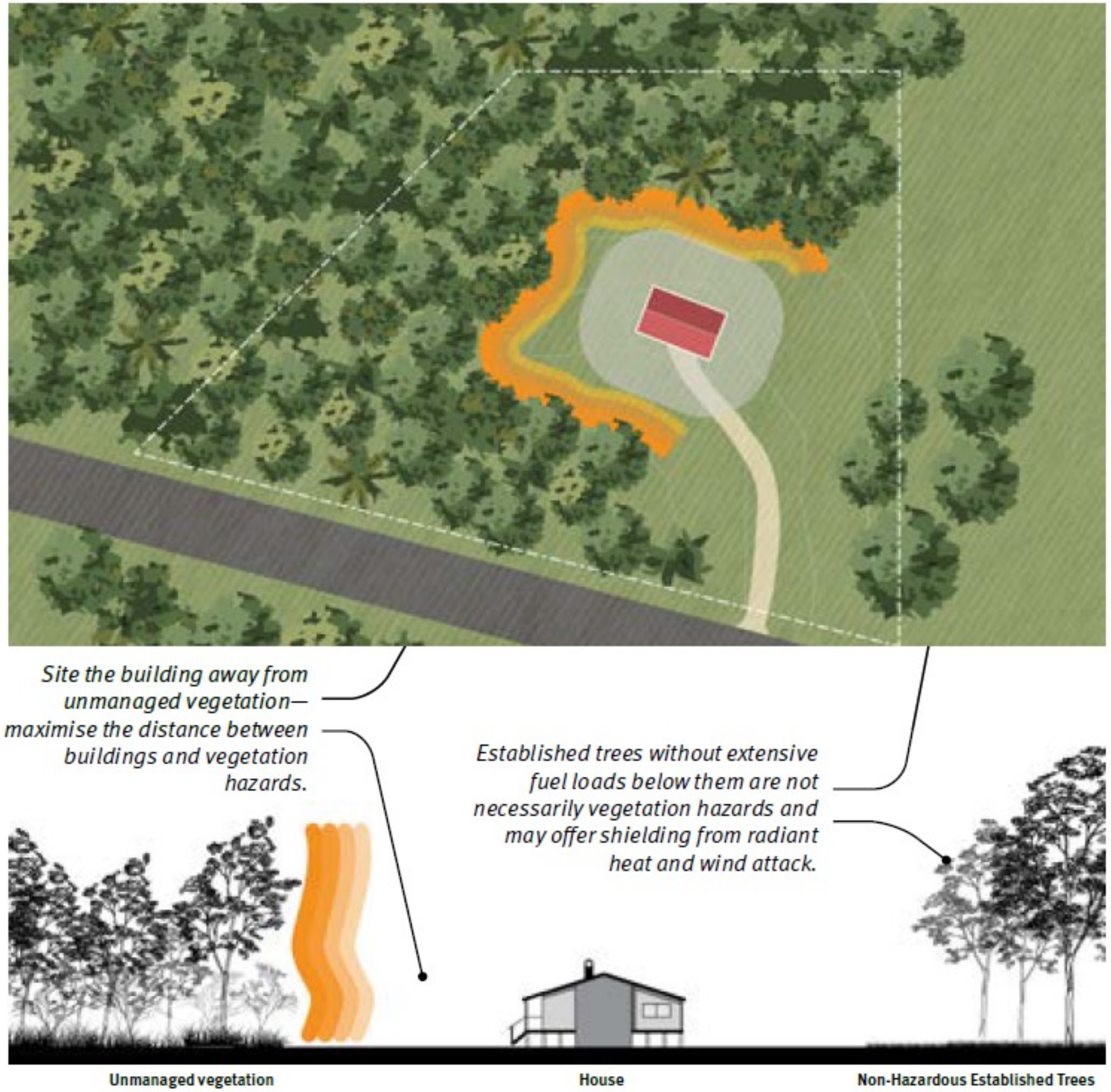
Siting

- Finding the best location for the house, away from unmanaged vegetation
- Integrating access and pathways to minimise exposure to fire to support egress
- Reducing exposure to large combustible objects, such as neighbouring homes and outbuildings

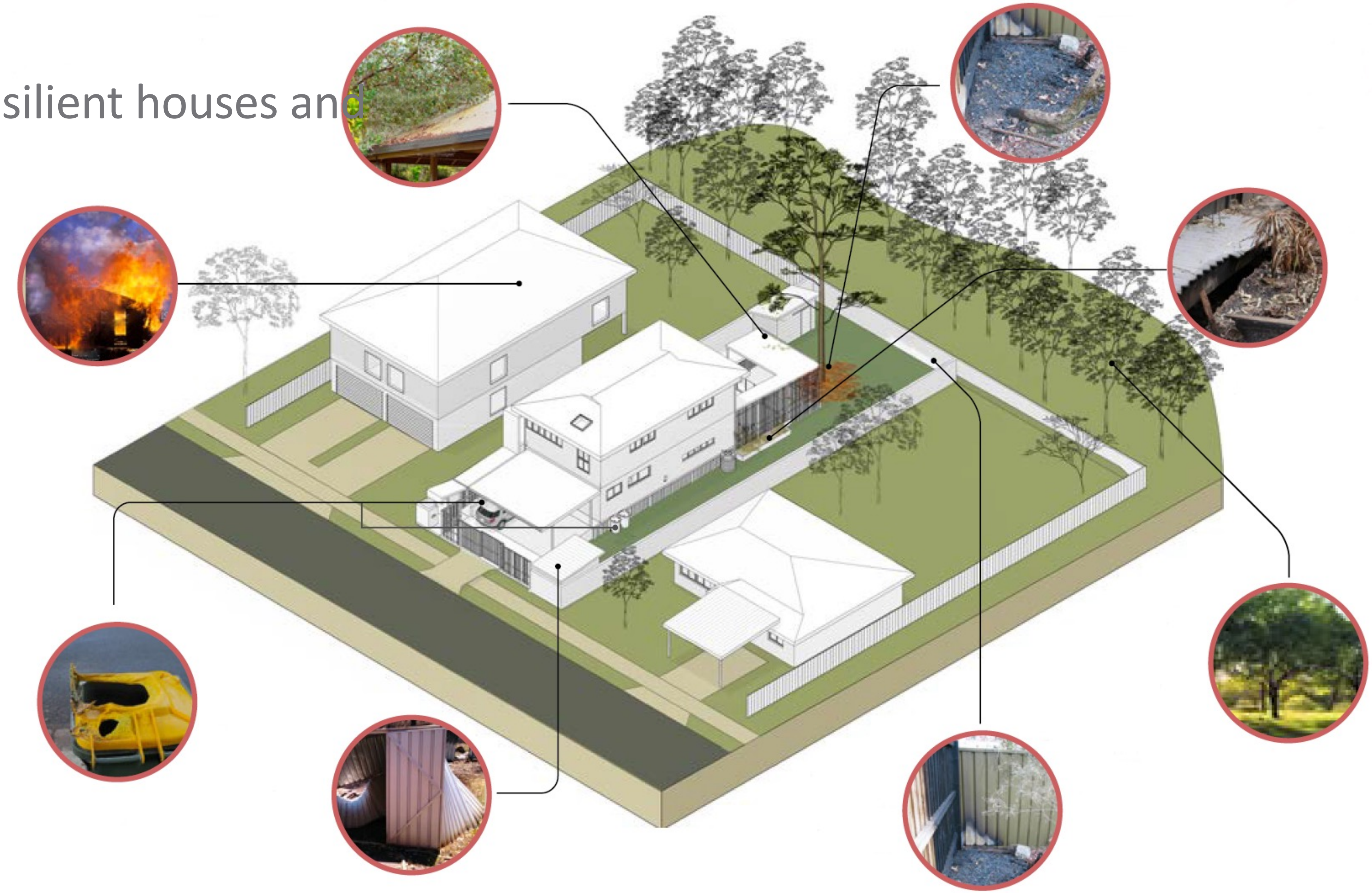
Siting for vegetation hazards

Design principle: Site to reduce exposure from vegetation hazards.

Figure 7 Siting for vegetation [18]



Building bushfire resilient houses and garden



(illustration James Davidson Architect)

Questions?

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Bushfire Adaptation

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