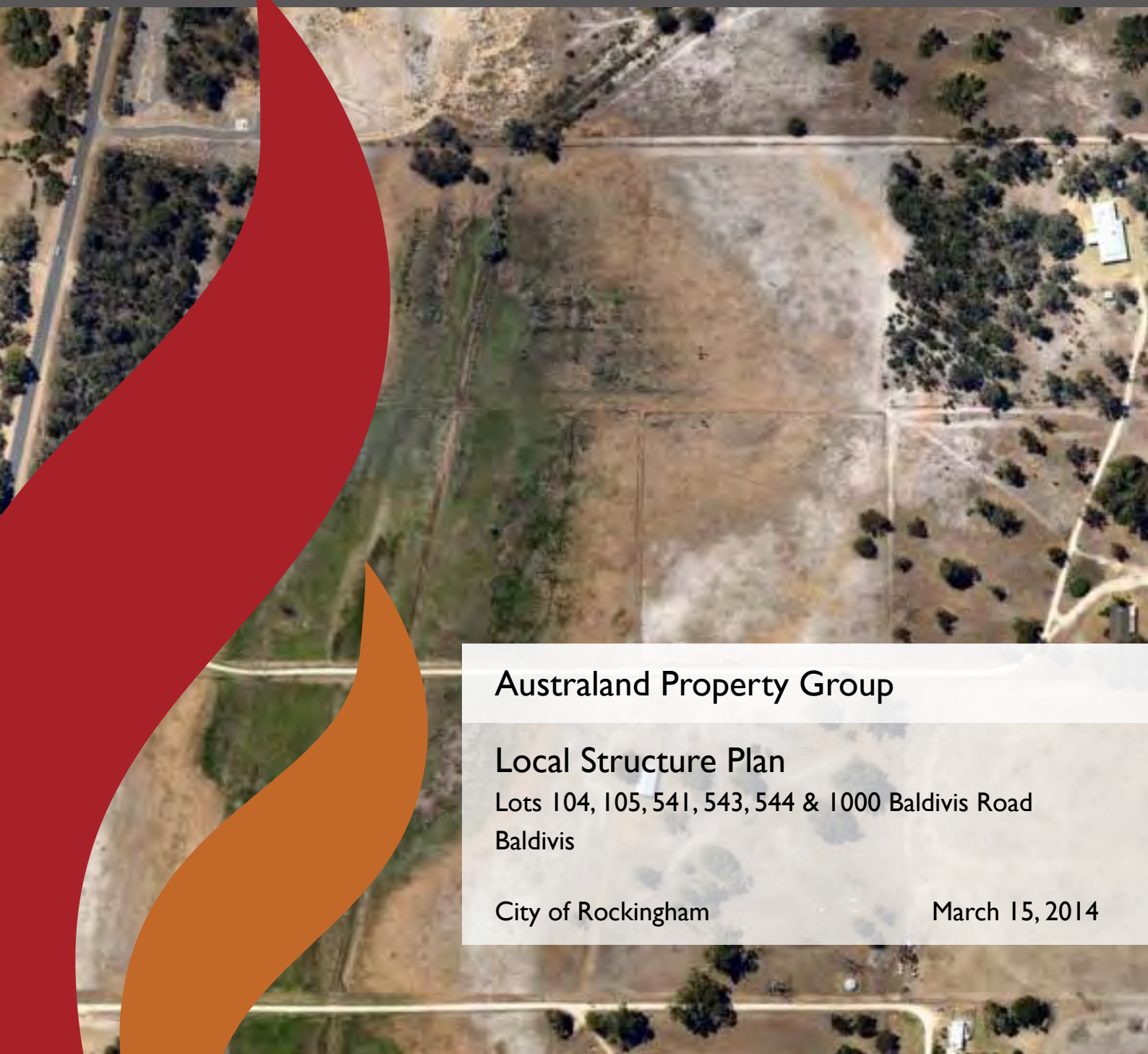
Bushfire Safety
CONSULTING

Fire Management Plan



Australand Property Group

Local Structure Plan

Lots 104, 105, 541, 543, 544 & 1000 Baldivis Road
Baldivis

City of Rockingham

March 15, 2014

East Baldivis Local Structure Plan
Lots 104, 105, 541, 544 and 1000 Baldivis Road
Baldivis
CITY OF ROCKINGHAM

March 15, 2014

Report prepared for: Australand Property Group

Report prepared by:

Rohan Carboon B. App. Sci. G. Cert. (Bushfire Protection)
Bushfire Safety Consulting Pty Ltd
P O Box 84
STONEVILLE WA 6081

Mobile: 0429 949 262
Email: enquiries@bushfiresafety.net
Website: www.bushfiresafety.net

Cover Photo: Aerial Photograph of the Study Site

Disclaimer

This report has been prepared in good faith, and is derived from sources believed to be reliable and accurate at the time of publication. Nevertheless, this publication is distributed on the terms and understanding that the author is not responsible for results of any actions taken based on information in this publication or for any error in or omission from this publication

Table of Contents

Executive Summary

This Fire Management Plan (FMP) has been prepared following the assessment of Lots 104, 105, 541, 543, 544 and 1000 Baldivis Road, Baldivis in the City of Rockingham.

The FMP has been prepared to support the Local Structure Plan process.

The development site has been assessed for vegetation class and bushfire hazard rating levels. **It has been determined that the proposed development will fall within the acceptable level of risk.**

This Plan includes a table on page 30 showing responses to the Performance Criteria outlined in the Planning for Bushfire Protection Guidelines - Edition 2 (WAPC et al. 2010).

The site's bushfire hazard levels are rated predominantly as low. Extreme hazard occurs in some adjoining areas such as the Tramway Reserve and strips of vegetation in the Kwinana Freeway Reserve. The residual hazard in the Tramway Nature Reserve will pose the greatest threat to the development.

Public Open Space areas will landscaped and managed as parklands and reserves. Neighbouring sites to the north, south and west of Baldivis Road have been identified and zoned for future urban development and pose only a low bushfire hazard.

An assessment of the Local Structure Plan (LSP) confirms that access and egress from all the proposed lots will adequately service residents and fire fighters within the development. The development design has two access options from Baldivis Road and connecting roads to developments north and south of the site. Water supplies will comply with minimum standards for residential needs and fire suppression purposes.

This plan demonstrates the site is suitable for residential development. It outlines a building protection zone to separate bushfire hazard from buildings. Predicted radiant heat flux exposure levels on exposed dwellings will be mitigated with the implementation of bushfire construction standards consistent with AS3959-2009 Construction of buildings in bushfire-prone areas.

The site is suitable for land intensification.

1. Introduction

The site comprises lots 104, 105, 541, 543, 544 and 1000 Baldivis Road, Baldivis in the City of Rockingham. It is bounded by the Tramway Nature Reserve in the west and Kwinana Freeway Reserve to the east. Adjacent lots to the north and south are rural lots proposed for development. The City of Rockingham has requested that the Bushfire Hazard Assessment (previously completed for the site) be upgraded to a Fire Management Plan to support the Local Structure Plan. The FMP is to be prepared to the satisfaction of Local Government and the Department of Fire and Emergency Services (DFES).

The site is located 45kms south of the Perth Central Business District (CBD) and 10kms east of Rockingham CBD (Appendix A). The site is vegetated in predominantly grassland with some degraded woodland in the north east corner of the site. There are shelter belt trees on property boundaries and driveways which access existing dwellings. Land management includes predominantly grazing by horses and cattle and there is some evidence of cropping and grass cutting for hay.

Surrounding the site, extreme bushfire exists in the Tramway and Kwinana Freeway Reserve which contains areas of woodland, open forest and scrub. Low bushfire hazard generally exists on the rural land north and south of the site and west of Baldivis Road.

The site is held in ownership by Australand and a joint venture partnership. It is zoned “Development” under the City of Rockingham’s Town Planning Scheme No. 2. This report provides responses to the performance criteria that fulfil the intent of the bushfire hazard management issues outlined in the Planning for Bushfire Protection Guidelines - Edition 2 (WAPC et al. 2010).

Community bushfire safety is a shared responsibility between governments, fire agencies, communities and individuals. The planning and building controls outlined in this Plan, when implemented, will reduce the risk to people and property. How people interpret the risk, prepare and maintain the property and buildings and what decisions and actions they take (i.e. evacuate early, stay and defend or other) greatly influence the outcome in a bushfire.

1.1 The Proposal

The LSP process provides a statutory framework to guide use, subdivision and development of the site.

The East Baldivis LSP (Appendix B) outlines the LSP spatial arrangement including residential zones, road access and eight public open space (POS) areas. It represents the spatial arrangement of what will occur once appropriate approvals are in place. The proposed development fits within a broader context of facilities, infrastructure and residential development in surrounding areas identified in the District Structure Plan (Appendix C).

1.2 Objectives

The purpose of this FMP is to address bushfire management issues within the site. If there is a bushfire within or near the site, implementing the FMP will reduce the threat to residents, property and emergency response personnel.

Achievable and measurable goals of this Plan include ensuring:

- The development is located in an area where the bushfire hazard does not present an unreasonable level of risk to life and property;
- Vehicular access to the development is safe if there is a bushfire occurring;
- Water is available to the development so that life and property can be protected from bushfire;
- The development is sited to minimise the effects of a bushfire; and
- The development design will minimise the effects of a bushfire.

This document sets out the roles and responsibilities of the developer, residents and tenants, the City of Rockingham, DFES and the Water Corporation. It is important that the measures and procedures outlined in this FMP are reviewed as necessary.

This FMP includes:

- A description of the site, the surrounding area, fire climate and bushfire history;
- A summary of research into the related effects of a bushfire;
- A bushfire hazard assessment;
- Means of addressing vehicular access;
- Siting of buildings to include building protection and hazard separation zones;
- Water supply; and
- Maps and plans of fire reduction measures.

2. Statutory and Policy Framework

Relevant key legislation, policy and guidelines include the following:

2.1 Bush Fires Act

The Act sets out provision to diminish the dangers resulting from bushfires, prevent, control and extinguish bushfires and for other purposes. The Act addresses various matters including prohibited burning times, enabling Local Government to require land owners/occupiers to plough or clear firebreaks, to control and extinguish bushfires and establish and maintain Bush Fire Brigades.

The Act also applies to land throughout Western Australia that is managed by the Department of Environment and Conservation (DEC). Sections 39 and 45 provide authorised CALM Act officers with powers to suppress fires in and near forests and Crown Land. Other sections provide for authorised CALM Act officers to enforce the provisions of the Bush Fires Act. The Bush Fires Act does not affect the provisions of the CALM Act and the Bush Fires Act does not generally bind the DEC. The provisions of the Bush Fires Act can be enforced in addition to this FMP.

2.2 State Planning Policy No. 3.4 Natural Hazards and Disasters

The objectives of this Policy are to:

- Include planning for natural disasters as a fundamental element when preparing all statutory and non-statutory planning documents, specifically town planning schemes and amendments, and local planning strategies, and
- Use these planning instruments to minimise the adverse effects of natural disasters on communities, the economy and the environment.

The Policy determines those areas that are most vulnerable to bushfire and where development is appropriate and not appropriate. The provisions and requirements contained in Planning for Bush Fire Protection Guidelines - Edition 2 (WAPC et al. 2010) were used in this determination.

2.3 Planning for Bush Fire Protection Guidelines (2010)

These Guidelines were prepared by FESA, the Western Australian Planning Commission (WAPC) and the Department of Planning. The document is the foundation for fire risk management planning on private land in Western Australia.

The document addresses important fire risk management and planning issues and sets out performance criteria and acceptable solutions to minimise the risk of bushfires in new subdivisions and developments. It addresses management issues including the location, design and siting of the development, vehicular access and water.

3. Bushfire Impacts

Reliable records began in 1900 and since then there have been 729 civilian fatalities from bushfires in Australia, of those 21 (or 3 per cent of the national total) have occurred in Western Australia. Bushfires have killed more people in Australia than any other natural disaster.

3.1 Building Survival

Buildings survive bushfires due to a number of factors; some relate to the way a bushfire behaves at a site, others relate to the design and construction materials in the building and siting of surrounding elements. Infrastructure, utilities and human behaviour are also factors. Leonard (2009) identified the following factors:

- Terrain (slope)
- Vegetation - overall fuel load, steady state litter load, bark fuels, etc.
- Weather (temperature, relative humidity and wind speed)
- Distance of building from unmanaged vegetation
- Individual elements surrounding the building that are either a shield or an additional fuel source
- Proximity to surrounding infrastructure
- Building design and maintenance
- Human behaviour - ability to be present and capacity to fight the fire
- Access to the building and how that influences human behaviour
- Water supply for active and/or passive defence, and
- Power supply.

It is likely that buildings are lost because of their vulnerability to the mechanisms of bushfire attack. Buildings constructed to Australian Standard (AS 3959) are more likely to survive a bushfire compared to buildings with no construction standards.

Buildings constructed to AS3959 standards do not guarantee their survival. Building survival depends on the way vegetation is managed, the unpredictable nature and behaviour of fire, and extreme weather conditions (Standards Australia 2009).

3.2 Human Fatalities

The final report from the Victorian Bushfires Royal Commission (VBRC) into the Black Saturday bushfires handed down on 31 July 2010 is the most comprehensive evidence ever assembled about the circumstances surrounding fatalities in an Australian bushfire.

Where people died on Black Saturday contrasts strikingly with studies from previous bushfire fatalities (VBRC 2010). Historically about 32 per cent of people have died in late evacuations (Risk Frontiers et al. 2008); however, on Black Saturday the majority of people (113 out of 173) died inside or close to structures. In a “Black Saturday” type of bushfire, safety can only be assured if people leave early, well before any fire arrives. When the Fire Danger rating is “Catastrophic” most buildings cannot be defended.
Most people die in bushfires from being exposed to radiant heat. Protection is provided by wearing long sleeved natural fibre clothing, having solid barriers and maintaining a long distance between people and the fire (i.e. source of radiant heat).

Bushfires also generate enormous amounts of smoke and wind, and when these factors are combined with the fire, they usually cause many trees to come down.
If people evacuate late, road conditions can be extremely hazardous.

4. Description of the Area

Baldivis is a semi-rural residential suburb 45 kilometres south of the Perth CBD and 10 kms east of the centre of Rockingham. Development of the area dates from the 1920s, spurred by the Government's settlement scheme. Land was used mainly for farming. Significant development did not occur until the 1950s. Rapid growth took place from the mid 1990s, with the population more than trebling between 1996 and 2006, a result of new dwellings being added to the area. Growth has been mainly in

the western section of Baldivis (http://www.rockingham.wa.gov.au/City-and-community/About-Rockingham/Profile-and-statistics.aspx).

Land parallel to the eastern side of Baldivis Road was set aside for a tramway between Jandakot in the north and Karnup to the south. Only part of the tramway was constructed but not in the Baldivis area. The Tramway Reserve is now retained for open space.

Land in the western portion of Baldivis was zoned for urban development in the 1990s, and the suburb has been progressively developed as residential land. Australian Bureau Statistics Census data from 2006 indicate that there were 5,952 people residing in Baldivis in 2128 dwellings. Of the 5,952 people, 877 (or 14 %) were aged over 55 years (see http://www.abs.gov.au/).

4.1 Description of the Subject Land

The land has a history of agricultural uses and currently supports similar small scale agricultural management. This FMP focuses on the subject land and immediate surrounding area (Appendix D). In summary this land is:

- Predominantly grassland used for grazing of livestock and horses with minor cropping and hay production
- Sloping very gently from west (highest) to east with some slopes in the range of 1-2 degrees
- Adjoining the Tramway Nature Reserve on the western boundary and the Kwinana Freeway Reserve on the eastern boundary.
- Bordered by Baldivis Road on the western side of the Tramway Nature Reserve.
- Adjacent to the Tramway Nature Reserve along the western boundary which contains woodland and open forest vegetation in a disturbed condition
- Adjacent to revegetating scrub in the Kwinana Freeway Reserve

4.2 Fire Climate

The behaviour of bushfires is significantly affected by weather conditions and they burn more aggressively when high temperatures combine with low humidity and strong winds.

In Perth and surrounding areas, the fire risk is greatest from summer through autumn, when the moisture content in vegetation is low. Summer and autumn days with high temperatures, low humidity and strong winds are particularly conducive to the spread of fire. This threat is enhanced if thunderstorms develop accompanied by lightning and little or no rain.

Research indicates that virtually all house losses occur during severe, extreme or catastrophic conditions (i.e when the Fire Danger Index is over 50) (Blanchi et al. 2010).

The Bureau of Meteorology website (www.bom.gov.au/weather/wa/sevwx/perth/bushfires.shtml) states that extreme fire weather conditions in the Perth region typically occur with strong easterlies or north easterly winds associated with a strong high to the south of the state and a trough offshore. Easterly winds represent about 60 per cent of extreme fire weather days (events) compared to less than 5 per cent associated with southerly winds. About 15 per cent of Perth events occurred in a westerly flow following the passage of a trough. Very dangerous fire weather conditions often follow a sequence of hot days and easterly winds that culminate when the trough deepens near the coast and moves inland. Winds can change from easterly to northerly and then to westerly during this sequence of climatic events.

Data from the Bureau of Meteorology research station at Medina (5 km north west of the study site) indicate the area experiences warm dry summers and cool wet winters (Figure 1), and is classified as a Mediterranean climate. Mean maximum temperatures vary from 31 degrees Celsius in February to 18 degrees Celsius in July.

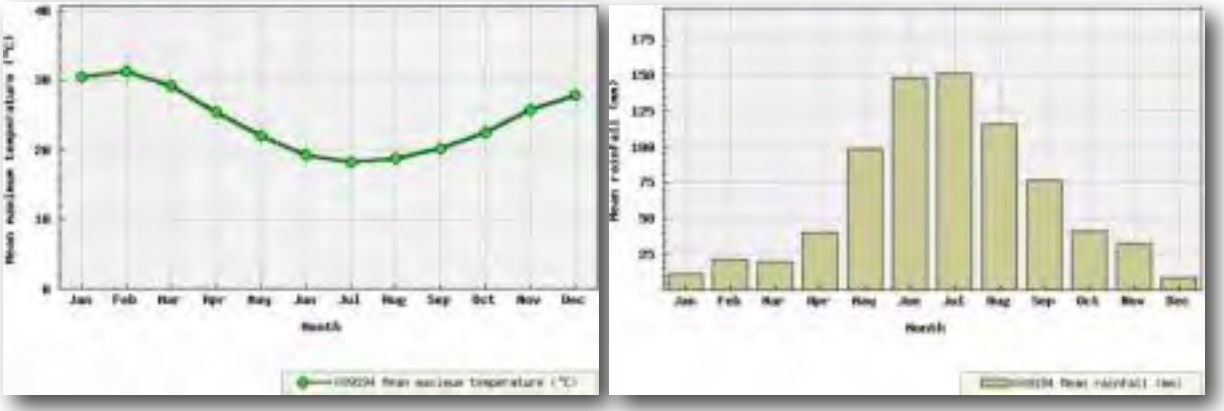


Figure 1: Mean maximum recorded temperatures and mean rainfall for Medina Meteorology Research Station between 1983 and 2010

The site is 8 km from the coast and is significantly influenced by land and sea breezes. These are created by the daily heating and cooling of the land surface next

to the ocean. The sea breeze occurs when the air over the land heats up and becomes more buoyant and rises, denser moist air over the ocean then flows inland. Sea breezes can strengthen prevailing wind, reduce it or even reverse it, depending on the strength and direction of the two airstreams (Cheney and Sullivan 2008).

Data from the Bureau of Meteorology weather station at Medina indicate that the predominant winds in the summer months at 3 pm near the study site are south-westerlies (Figure 2). Wind strength, direction and frequency of the south-west wind is clearly dominant and occurs 40-60 per cent of the time. Winds from the west and south occur < 10 per cent of the time.

Figure 2: Rose of wind direction and wind speed in km/hr for December, January and February between 1983 and 2010 at the Medina Bureau of Meteorology Research Station

Interpreting Figure 2 - Wind speed Vs Direction Plot

Wind roses summarise the occurrence of winds at a location, showing their strength, direction and frequency. The percentage of calm conditions is represented by the size of the centre circle - the bigger the circle, the higher is the frequency of calm conditions. Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. Eight directions are used. The branches are divided into segments of different thickness and colour, which represent wind speed ranges in that direction. Speed ranges of 10 km/hr are used. The length of each segment within a branch is proportional to the frequency of winds blowing within corresponding range of speeds from that direction (BOM 2010).

4.3 Bushfire Fuels

The site has predominantly managed grass fuels which reflects the agricultural use of the land. Degraded woodland vegetation occurs in the north east corner of the site where there is some shrubland and banksia vegetation under the Eucalypt canopy.

Other areas of open woodland occur where canopy foliage cover is <10% and is classified according to its understorey, which in most cases is managed grassland. The Tramway Reserve contains woodland and one small area of open forest, both areas are highly degraded and have introduced grass fuels and weeds. The scrub vegetation in the Kwinana Freeway Reserve which has resulted from revegetation works after the freeway was constructed includes strips of vegetation which are sited perpendicular to the site. The scrub is over 2 m in height in places.

Further discussions on bushfire fuels on the site can be found in Section 5.1 Vegetation Type, Structure and, Condition.

4.4 Assets

When the site is fully developed it will contain large residential areas. The most exposed dwellings will be located within 100 m of the Tramway Reserve.

4.5 Access

The LSP proposes two neighbourhood connector roads that link with Baldivis Road. Neighbourhood connector Roads will also link with residential areas to the north and south once they are completed. The road network has been planned at District Structure Plan stage to ensure integration with existing and proposed road networks.

The proposed internal loops roads provide all residents and emergency appliance vehicles with a minimum two access ways at all times.

4.6 Water Supply

Reticulated water will be provided to the entire development. Fire hydrants will be spaced to Water Corporation, DFES and City of Rockingham standards.

4.7 Bushfire History

A recent study has concluded that bushfires may have been in the Australian Landscape for 50 million years longer than previously thought. The adaption of eucalypts that allows them to recover from bushfires has been traced back more than 60 million years (Crisp et al. 2011), indicating fire has been in the Australian landscape since that time.

Anthropological and historical evidence suggests that much of the Swan Coastal Plain was regularly burnt by the Aborigines until the middle of the nineteenth century (Hallam 1975, Abbott 2003).

Bushfires are common in the City of Rockingham including a recent fire on the site. As urban development replaces the existing grasslands and woodlands the new urban environment will not support bushfire spread. Recent bushfire history includes:

- 13 December 2010, a fire started at 1.12pm between Baldivis Road and Kwinana Freeway north of Safety Bay Road and burn't through 20 hectares of bush. Fire crews saved four homes and several sheds. An area of grassland and part of the woodland vegetation in the Tramway Nature Reserve were burnt.
- 12 April 2009, (Easter Sunday) a bushfire began near Eighty and Fifty Road and FESA warned residents to close all doors and windows and turn off evaporative coolers. Fifty Road was closed between Baldivis Road and Safety Bay Road. This fire impacted on the adjoining land west of Baldivis Road and 780 ha in total were burnt. Surrounding woodland vegetation shows extensive signs of this event.

Areas of native vegetation surrounded by residential estates are susceptible to frequent bushfires due to the high risk of arson and great potential for accidental ignitions (Walker 1981, Burrows and Abbott 2003).

5. Bushfire Hazard Assessment

Assessing bushfire hazards at a strategic level takes into account the predominant class of vegetation on the site and surrounding area for a minimum of 100 metres. The vegetation class map for the site and surrounding area for a minimum of 100 m is shown in Appendices D. Fuel layers in a typical forest environment can be broken down into 5 obvious segments (Figure 3). These defined fuel layers are used in the following description regarding vegetation types, fuel structure and bushfire hazard levels.

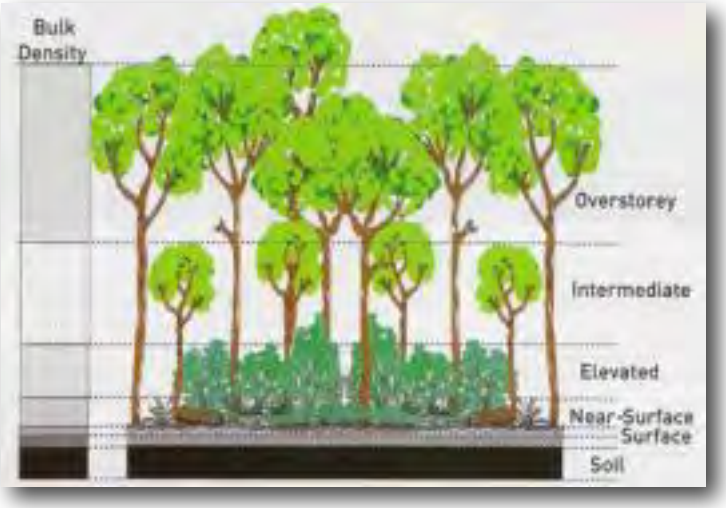


Figure 3 : The five obvious fuel layers in a forest environment that could be associated with fire behaviour (Gould et al. 2007)

5.1 Vegetation Type and Class

Native vegetation has been largely cleared from the site and remaining woodland vegetation is highly degraded. The entire site contains a near surface fuel layer of grasses, including under woodland trees (Figure 4). Where canopy foliage cover is <10% the vegetation is classed according to its understorey which is grassland on this site. In most areas, the grassland is grazed by cattle and horses (Figure 5) while in other areas paddocks were being rested and grass heights were increased.

The vegetation in the Tramway Nature Reserve falls in the Karrakatta vegetation complex (Heddle, 1980). This is dominated by Tuart (*Eucalyptus gomphocephala*), Marri (*Corymbia calophylla*) and Coast Banksia (*Banksia attenuata*). A bushfire in December, 2010 burn't some of the woodland in the Tramway Reserve, it is currently regenerating from that event and a shrub layer and epicormic growth from burnt Eucalypts is regenerating. Tree and Banksia canopy health appears to have been severely impacted (Figure 6).

Between Zig Zag Road and Serpentine Road, several strips of vegetation exists in the Reserve. These remnant patches have been highly disturbed and in most areas no understorey vegetation exists (Environmental Resources Management Australia, 2000). This is evident in the small area of adjoining open forest where a healthy overstorey canopy exists, but there is a complete absence of an intermediate or elevated fuel layer and the near surface fuel layer is grass (Figure 7).

On the east side of the site, the Kwinana Freeway Reserve has four strips of vegetation present. Three strips of scrub vegetation occur within 100 metres of the area proposed for dwellings. These strips of vegetation are an extreme area of

hazard (as discussed in Section 5.3 the Bushfire Hazard Assessment Levels) . The strips of vegetation are perpendicular to the site and are less than 20m in width and greater than 20 m from proposed dwellings (Figure 8). It is not a natural environment and is a result of revegetation adjacent to the freeway. It consists of predominantly scrub species (Figure 9) and some woodland trees. The regenerating vegetation occurs in strips because it is dissected by a bicycle path, and two double freeway vehicle lanes. Observed evidence of vegetation management in this system included the pruning of scrub vegetation along the bicycle path which has resulted in a vertical "hedge like" fuel arrangement on either side of the path (Figure 10). Scrub vegetation class has been created between the freeway lanes and a mixed woodland and scrub exists east of both freeway lanes.

The vegetation class map for the entire site and surrounding area for a minimum of 100 m is shown in Appendix D.

Figures 4 and 5: Degraded Woodland (left) where understorey vegetation is absent occurs on the site and in the Tramway Reserve and managed grassland (right) occupies nearly the entire site

Figures 6 and 7: Recent bushfire impacts on the Tramway Reserve vegetation (left) can be observed in poor canopy health and epicormic and shrub regrowth, while the small remaining area of disturbed open forest without intermediate and elevated fuel exists (right)

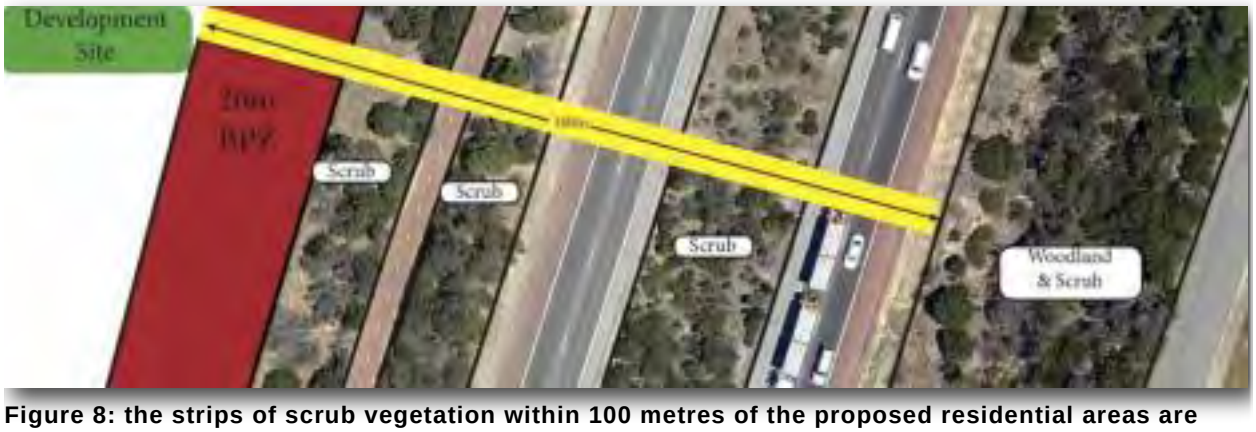


Figure 8: the strips of scrub vegetation within 100 metres of the proposed residential areas are less than 20m in width and will be greater than 20m from the site.

Figures 9 and 10: Scrub vegetation from revegetation activities in the Freeway Reserve (left) are managed by pruning on both sides of the bicycle path (right) to maintain safe access.

5.2 Slope

The site is undulating, generally it slopes gently from the west (highest) to the east and slopes are in the range of 1-2 degrees. This results in the strip of vegetation vegetation in the Tramway Reserve having an effective upslope relative to the development and the scrub vegetation in between the site and the double vehicle lane in the Freeway Reserve as generally having a gentle (0-5 degrees) effective downslope.

The effective slope in the two reserves is outlined in Appendix E.

5.3 The Bushfire Hazard Assessment Levels

The vegetation class map (Appendix D) outlines the dominant vegetation types on the study site and surrounding area for a minimum of 100 m. Descriptions of the

vegetation class structure and dominant species are outlined in section 5.1 Vegetation Type and Class. The bushfire hazard assessment levels were determined using Appendix 1 of the Planning for Bushfire Protection (PBP) guidelines - Edition 2 (WAPC et al.2010).

There is extreme hazard in the areas of woodland, open forest and scrub although they are highly disturbed environments without intermediate or elevated fuel layers. The Australian Standard (AS2959-2009) Construction of buildings in bushfire prone areas in table 2.3 (Classification of Vegetation), states that vegetation types with an overstorey of open woodland (i.e. < 10% foliage cover) are to be classified to the vegetation type on the basis of their understorey. Following this methodology, the open woodland is rated as grassland and is classified as low bushfire hazard.

The vegetation in the Freeway Reserve consists of open and closed scrub, some grassland and some areas of isolated woodland trees. Due to this mixture of vegetation types which has been artificially created,it is rated as extreme bushfire hazard for the purposes of this report.

The bushfire hazard rating map for the site and immediate surrounding areas is shown in Appendix F.

As the site develops, vegetation will be removed and managed in areas of POS and bushfire hazard will be further reduced.

In the broader context of proposed land development in surrounding areas, including west of Baldivis Road, the bushfire hazard will be reduced significantly in the long term. The site will ultimately be exposed to bushfire hazard in the 60 metre wide strip of vegetation in the Tramway Nature Reserve and from the strips of vegetation in the Freeway Reserve. Broad, landscape wide bushfires will not be able to impact on the development from the north, west or south direction after completion of surrounding developments

A fire ignited on the edge of the Kwinana Freeway would likewise only have a short run until the boundary of the site was impacted. In extreme fire weather conditions with strong, hot easterly winds a larger fire could impact on the east boundary by running through the grass and heavier fuel loads in woodland vegetation in the broader rural landscape and spotting over the freeway lanes. The freeway lanes do however provide good fire access for suppression purposes and there would only be short flare ups in the narrow strips of vegetation due to the distribution of fine fuels.

6. Fire Mitigation Strategies

This report provides an acceptable solution and performance-based system of control for each bushfire hazard management issue. It is consistent with Appendix 2 of the Planning for Bushfire Protection Guidelines - Edition 2 (WAPC et al. 2010). The management issues are:

- Location of the development
- Vehicular Access
- Water
- Siting of the development, and
- Design of the development.

Acceptable solutions are provided for four out of the five management issues and each illustrates one example of satisfactorily meeting the corresponding performance criteria. A performance-based approach is provided for one management issue.

6.1 Element: Siting of Development

Intent

To ensure that development and/or intensification of land use is located in areas where bushfire hazard does not present an unreasonable level of risk to life and property.

Acceptable Solution

The buildings adjacent to the Tramway Nature Reserve and the Kwinana Freeway Reserve will be sited with a minimum 20 m Building Protection Zone (BPZ) and predicted radiant heat flux exposure will not exceed 29 kW/m^2. The intensity of development is not suited to the inclusion of a Hazard Separation Zone (HSZ) and this is compensated for by an increase in bushfire construction standards for all lots within 100 m of the Tramway Nature Reserve and Kwinana Freeway Reserve. BAL-29 is not exceeded.

The site will be provided with a compliant water supply and has good perimeter vehicular access and internal access roads for fire appliances.

6.2 Element: Vehicular Access

Intent

To ensure vehicular access serving a subdivision development is safe if a bushfire occurs.

The performance criteria

The internal layout, design and construction of private vehicular access in the subdivision and/or development allows emergency and other vehicles to move through it easily and safely, at all times. The site is bound by the Kwinana Freeway on the east perimeter and Baldivis Road on the western side of the Tramway Nature Reserve.

One of the primary objectives of the LSP was to design a highly interconnected road network that promoted good pedestrian and vehicle movement within the site and connected to adjacent residential areas. The East Baldivis District Structure Plan identifies future district distributor roads located adjacent to the northern and southern perimeter of the site. Loop roads are common and provide two access routes for residents at all times. The interconnected roads create a permeable grid like pattern.

Vehicular access throughout the development is outlined in the LSP in Appendix B.

This proposal complies with the performance criteria by applying the following acceptable solutions:

Acceptable Solution A2.1: Two Access Routes

The LSP (Appendix B) outlines an interconnected loop road system throughout the site. The site will be bordered by a road system around most its perimeter. All individual lots will have two access options at all times.

Each development stage will have a minimum of two access roads into and out of the subdivision.

Acceptable Solution A2.2: Public Roads

Surrounding public roads comply with minimum standards and all new public roads within the site will comply with the minimum public road standards. The public road standards which will be achieved are:

- Minimum trafficable surface: 6 metres;
- Horizontal clearance: 6 metres;
- Vertical clearance: 4 metres;
- Maximum grades: 1 in 8;
- Maximum grades over <50 metres: 1 in 5;

- Maximum average grade: 1 in 7;
- Minimum weight capacity: 15 tonnes;
- Maximum crossfall: 1 in 33; and
- Minimum inner radius of curves: 12 metres.

6.3 Element: Water

Intent
To ensure water is available to the development to enable life and property to be defended from bushfire.

Acceptable Solution: Reticulated Area
The development is located within an ESL (Emergency Services Levy) Category 3 area. Emergency response is provided by the City of Rockingham via the Baldivis Volunteer Bush Fire Brigade.

The area is provided with a reticulated water supply, together with fire hydrants that will meet the specifications of the Water Corporation Design Standard DS 63 and DFES. Residential dwellings (Class 1a) require fire hydrants to be sited within (or every) 200 metres in land zoned residential.

The developer is to provide detailed hydrant plans to the City of Rockingham at subdivision stage and the Baldivis Bush Fire Brigade at subdivision stage. The City of Rockingham local staff are to conduct an initial inspection of hydrants as well as routine inspections. The Water Corporation is responsible for all hydrant repairs. Fire services require ready access to an adequate water supply during fire emergencies.

6.4 Element: Siting of the Development

Intent
To ensure the siting of the development minimises the level of bushfire impact.

Background
All eight POS areas located in the development will be landscaped and managed as “low threat” vegetation. Remnant vegetation will be retained in two areas of POS however these areas will become parklands and reserves that are managed and maintained and will only pose a low risk to surrounding residential areas. The following images provide examples of low risk managed environments (Figures 11-15).

Figures 11-15: Examples of managed landscapes in parklands and reserves

The retained and revegetated / plantings that will occur in all areas of POS will become maintained public reserves and parklands. When management of the POS is handed over to the City of Rockingham from the developer, formal advice will be provided with an agreed maintenance schedule outlining a range of maintenance issues including bushfire hazard considerations.

The landscape concept plans for POS C (Appendix G) and POS D (Appendix H) demonstrate broad planning considerations for bushfire hazard including using DFES recommended species, irrigated turf and hard pathways to reduce and break up the continuity of fine fuels.

There are two important bushfire setback issues this plan addresses. The first issue revolves around the entire site having an adequate perimeter Building Protection Zone (BPZ) to manage risk from long term residual hazard external to the site. The second issue involves the management of risk at each stage of subdivision. Each development stage is provided with acceptable setbacks from temporary hazards to reduce unnecessary bushfire attack mechanisms impacting on the completed dwellings.

Bushfire hazard in the form of woodland vegetation in the Tramway Nature Reserve and strips of predominately scrub vegetation in the Kwinana Freeway Reserve will

largely remain unmanaged and in such circumstances the provision of a building protection zone is required between dwellings and the vegetation.

The site will have an internal perimeter Building Protection Zone on the west and east perimeter to ensure a suitable setback distance occurs between unmanaged fuels and dwellings.

Vegetation that does not trigger a BAL assessment according to the Australian standard (AS3959-2009) includes one or a combination of the following:

- Vegetation of any type more than 100 metres from the site;
- Single areas of vegetation less than 1 hectare in area and not within 100 metres of other areas of vegetation being classified;
- Multiple areas of vegetation less than 0.25 hectares in area and not within 20 metres of the site or each other;
- Strips of vegetation less than 20 metres wide(measured perpendicular to the elevation exposed to the strip of vegetation) regardless of length and not within 20 metres of the site or each other, or other areas of vegetation being classified;
- Non-vegetated areas, including waterways, roads, footpaths, buildings and rocky outcrops, and
- Low threat vegetation, including grassland managed in a minimal fuel condition, maintained lawns, golf courses, maintained public reserves and parkland, vineyards, orchards, cultivated gardens, commercial nurseries, nature strips and wind breaks.

Acceptable Solution: Building Protection Zone (BPZ)

One of the most important fire protection measures influencing the safety of people and property is to create a BPZ between buildings and bushfire hazard. The BPZ is a low fuel area immediately surrounding a building. Non-flammable features such as managed landscapes and parklands, gardens, driveways, roads and maintained grassland can form parts of a BPZ.

World first research into land management and house losses during the Black Saturday Victorian bushfires concluded that the action of private landholders who managed fuel loads close to their houses was the single most important factor in determining house survival when compared with other land management practices such as broad scale fuel reduction burning remote from residential areas (Gibbons et al. 2012).

Creating a BPZ ensures that vegetation and fuels within close-proximity to dwellings on the perimeter of the site are managed to reduce predicted levels of radiant heat flux to acceptable levels and to improve the survival of buildings. Dwellings are required to be constructed with a minimum 4m setback from lot frontage on the Kwinana Freeway interface and 7m setback on the Tramway Reserve interface. A small number of lots require an 8m setback where they are adjacent to open forest in the Tramway Reserve.

Managing vegetation in the BPZ has two main purposes -

- to reduce direct flame contact and radiant heat from igniting the building during the passage of a fire front; and
- ember attack and provide a safer space for people to defend (if required) before, during and after a fire front.

The perimeter BPZ and the temporary staging BPZ must be established and maintained to the following standards:

- Staging BPZ Width: 100 metres and within the overall perimeter of the development boundary;
- Width: 20 m (21 m adjacent to forest) and located between hazard and proposed dwellings on the western perimeter of the site as indicated in Appendices I & L;
- Width: 20 m and located between hazard and proposed dwellings on the eastern perimeter of the site as indicated in Appendix I;
- Staging BPZ Width 100 metres and within the overall development boundary;
- Location: within the boundaries of the development lot on the eastern and western perimeter and will include a combination of road reserves, POS and either 4m or 7m minimum lot setbacks / frontages (as applicable) to achieve minimum widths as indicated in Appendix I;
- Fuel load: reduced to and maintained at 2 tonnes per hectare;
- All tree crowns are a minimum of 10 m apart;
- All trees to have lower branches pruned to a height of 2 m;
- All tall shrubs or trees are not to be located within 2 m of a building (including windows);
- No tree crowns or foliage is to be within 2 m of any building, this includes existing trees and shrubs and new plantings;
- All fences are constructed with non-combustible materials (i.e. colorbond, brick or limestone);
- All shrubs to contain no dead material within the plant;
- No tall shrubs are to be in clumps within 3 m of the building; and
- No trees are to contain dead material in the crown or on the bole.

The east and west perimeter BPZ can be largely established by the creation of the road network combined with a minimum lot setbacks requirements on perimeter facing lots and landscaping within some perimeter areas of POS. Residential gardens, road and road reserves will all combine to form the BPZ. The management of fine fuels immediately adjacent to residential dwellings in garden areas is very important to ensure ember attack does not ignite fine fuels adjacent to building envelopes. Localised flames and radiant heat from a fire a poorly designed or maintained garden can result in building loss. The BPZ starts at the walls of dwellings and extends away from the building.

Each development stage will require a 100 metre cleared zone surrounding the perimeter and located within the lot boundary. This will be achieved by managing vegetation in this zone as stages are developed.

It is the responsibility of the developer to establish and maintain the BPZ until such time as roads and POS areas are handed over the the City of Rockingham. The perimeter BPZ is clearly identified in Appendix I.

Alternative Solution: Hazard Separation Zone (HSZ)

A Hazard Separation Zone (HSZ) is a fuel managed zone to create further separation between dwellings and bushfire hazard. It is required to extend out to 100 metres from buildings. In the LSP, a HSZ does not fit within the design of the proposed development. The requirement for a HSZ is offset by an increase in construction standards and compliance with AS3959-2009.

The following Bushfire Attack Level (BAL) assessment demonstrates that the proposed BPZ scenarios combined with increased dwelling construction standards will achieve acceptable levels of risk for the development. By achieving this standard it will be possible to construct dwellings to an appropriate standard (i.e. BAL-29 or less) under the Australian Standard (AS 3959-2009: Construction of Buildings in Bushfire-Prone Areas).

6.4.1 Building Siting and Predicted Bushfire Attack Levels

The AS 3959-2009 has six categories of Bushfire Attack Level, namely BAL-LOW, BAL-12.5, BAL-19, BAL-29, BAL-40 and BAL-FZ. These categories are based on heat flux exposure thresholds.

The method for determining the BAL involves a site assessment of vegetation and local topography. The assumed Fire Danger Index (FDI) for Western Australia is 80. The BAL identifies the appropriate construction standard that applies as a minimum

standard in Construction of buildings in bushfire-prone areas (AS 3959-2009). The objective of the standard (AS 3959-2009) is "to prescribe particular construction details for buildings to reduce the risk of ignition from a bushfire while the front passes" (Standards Australia 2009).

Methodology and Assumptions

The following indicative assessment was determined using the methodology in Appendix A of AS 3959-2009. This methodology is also outlined in the PBP guidelines. The indicative BAL assessment was undertaken broadly across the entire site (Appendix J). A more site specific assessment of the fuel loads and structure using the complex methodology in AS3959 would result in more accurate ratings. The results of the indicative assessments are shown in Table 1.

The criteria to determine the BAL is outlined as follows:

Designated FDI : 80
Flame Temperature : 1090
Slope : 0-5 degrees (See Table 1)
Vegetation Class : Woodland, Forest and Scrub
Setback distances : 20 and 21 m (See Table 1)

Vegetation Class	Setback Distance	Effective Slope (degrees)	BAL Rating
Open Forest	21-31 metres	Upslope 0-5	BAL-29
Open Forest	31-42 metres	Upslope 0-5	BAL-19
Open Forest	42-100 metres	Upslope 0-5	BAL-12.5
Woodland	20-29 metres	Upslope 0-5	BAL-19
Woodland	29-100 metres	Upslope 0-5	BAL-12.5
Scrub	20 -< 27 metres	Upslope 0-5	BAL-19
Scrub	27 -100 metres	Upslope 0-5	BAL-12.5

Table 1: Indicative assessment for all exposed lots within 100 metres of classified vegetation in the Tramway Nature Reserve and Kwinana Freeway Reserve (See Appendix J for location)

A 21 m setback from open forest vegetation is sufficient to not exceed BAL-29 on effective upslope of 1-2 degrees. A 20 metre setback achieves a BAL rating of BAL-19 adjacent to woodland with a upslope of 1-2 degrees (Table 1).

The proposed design of the development at structure plan stage will incorporate a minimum 20 metres (21 metre adjacent to Open Forest) low fuel zone around the east and west perimeter of the site that is immediately adjacent to dwellings. As outlined in

table 1, this setback distance needs to reflect the vegetation class adjoining the development and the effective slope under the vegetation. Construction standards will be increased to mitigate the hazard on new dwellings.

This indicative assessment demonstrates that all proposed dwellings will easily fall within the acceptable level of risk (i.e. BAL-29 and lower) and if required will have construction standards increased to meet AS 3959 requirements. All proposed new dwellings within 100 metres of the Tramway Nature Reserve require a BAL assessment at subdivision approval or building licence application stage to confirm the BAL ratings.

Indicative BAL ratings on a proposed subdivision outcome arrangement is outlined in Appendix K.

6.4.2 Landscaping Considerations

Landscaping can both assist in the survival of the building and be a determining measure in its destruction. Landscaping can protect buildings by forming a barrier or deflector for windborne debris and radiant heat. It can also bring the fire directly to the building so a degree of care needs to be exercised when selecting and locating landscaping.

All plants will burn under the right conditions and plants do not achieve a “fire resistance level” to meet the Building Code of Australia (BCA). Placing plants too close to a building, under timber decks or next to windows will provide a direct threat to the building. Having a clearance around the building will achieve the desired effect of creating a break between the vegetation and the building. A pathway around the building may be one way to achieve this requirement. The landscaping can then be provided further out from the building.

Bark chips and combustible mulch near a building is not recommended and is a particular problem when the windows have low sill heights. The flames can have a direct connection with the glass which was identified as a major issue during the Canberra bushfires of 2003 where over 500 homes were destroyed. The DFES document titled “Plant Guide within the Building Protection Zone” provides a useful list of species and spacing requirements to achieve compliance with vegetation within a building protection zone in the Swan Coastal Plain. It will provide some guidance for appropriate revegetation of POS areas.

6.5 Design of the Development

Performance Criteria
The design of the development is appropriate to the level of bushfire hazard that applies to the site.

Acceptable Solution
All on-site development is to comply with the performance criteria or acceptable solutions 1 to 4 in “Planning for Bushfire Protection” Guidelines. The buildings are to comply with AS 3959-2009: Construction of Buildings in Bushfire-Prone Areas.

The predicted highest BAL level for any dwelling is BAL-29 which will be mitigated by compliance with the Australian Standard AS3959 for building construction. However the vast majority of dwellings within 100 metres of the Tramway Reserve will be exposed to BAL-12.5 level. All exposed dwellings (i.e. dwellings within 100 metres of classified vegetation – Appendices J & K) will have risk mitigated by compliance with the Australian Standard AS3959-2009.

6.6 Public Education and Community Awareness

Community bushfire safety is a shared responsibility between individuals, the community, government and fire agencies. DFES has an extensive Community Bushfire Education Program including a range of publications, a website and Bushfire Ready Groups. The 30 page booklet ‘Prepare, Act, Survive’ provides excellent advice on preparing for and surviving the bushfire season. Other downloadable brochures include ‘Fire Danger Ratings and what they mean for you’ and ‘Bushfire Warnings and what you should do’.

The City of Rockingham, their website and local bushfire brigades provide bushfire safety advice to residents and have produced a bushfire information pamphlet that can be downloaded from their website at http://www.rockingham.wa.gov.au/Residents/Home-safety-and-security/Fire-safety.aspx and local bushfire brigades provide bushfire safety advice to residents. Professional, qualified consultants also offer bushfire safety advice and relevant services to residents, schools and businesses in high risk areas.

6.7 Community Fire Refuges and Fire Safer Areas

There are no designated Community Fire Refuges in the City of Rockingham, However, at the time of an emergency, the relevant authorities can select an evacuation centre and DFES, the City and Police will provide this information to residents.

A predetermined centre cannot be nominated because there are no purpose built structures (such as bunkers) designed to withstand the impacts of a bushfire. This means the location of an evacuation centre is not determined until the position of the fire and the characteristics of a specific event are considered by authorities. There would be nothing more dangerous than sending residents to a centre which is in the direct path of a fire.

The safest place to be during a bushfire is away from it. Where to go is an important element when people are relocating during a time of emergency (NSW Rural Fire Service 2004). The preferred option for residents is to designate a destination that is not in a bushfire-prone area and will be safe to travel to before a bushfire attack.

Those who find themselves threatened by a bushfire, need options (VBRC 2009). This may be because their plan to leave is no longer possible because they cannot reach a place away from the fire front, or their plan to defend their property fails. Residents may also be caught away from their home when a bushfire threatens.

The concept of a “Neighbourhood Safer Place” and Neighbourhood Safer Precincts” has arisen from recommendations by the Victorian Bushfire Royal Commission into the Black Saturday bushfires.

There are many areas within the City of Rockingham including landscaped open spaces and urban areas that are not bushfire-prone, but they have not been declared. Obviously a non-bushfire-prone area can provide a safe location for people during a bushfire, but there i no official criteria in Western Australia to determine these areas. As there are no specific criteria to guide this process, DFES’s general advice for residents, when their household bushfire survival plans have failed, is to go to a safer place such as a local open space or building where people may seek shelter from a bushfire (DFES 2010).

7. Conclusion

This Plan provides acceptable solutions and responses to the performance criteria that fulfil the intent of the bushfire hazard management issues outlined in Planning for Bushfire Protection Guidelines - Edition 2 (WAPC et al. 2010). The site is bordered by strips of vegetation in the Baldivis Tramway Reserve and the Kwinana Freeway Reserve. It is unlikely that the site will be impacted on by a large fire front and as residential development continues to the north and south of the site the bushfire hazard will be further reduced.

Community bushfire safety is a shared responsibility between governments, fire agencies, communities and individuals.

The planning and building controls outlined in this Plan will reduce the risk of bushfire to people and property. It will not remove all risk. How people interpret the risk, prepare and maintain their properties and buildings and the decisions and actions they take (i.e. evacuate early or stay and defend or wait and see) greatly influence their personal safety. Residents need to be self-reliant and not expect warnings or assistance from emergency services.

7.1 Compliance Checklist for Performance Criteria

Element	Question	Answer
1: Location	Does the proposal comply with the performance criteria by applying acceptable solution A1.1?	Yes
2: Vehicular access	Does the proposal comply with the performance criteria by applying acceptable solution A2.1?	Yes

Element	Question	Answer
2: Vehicular access	Does the proposal comply with the performance criteria by applying acceptable solution A2.2?	Yes
	Does the proposal comply with the performance criteria by applying acceptable solution A2.3?	Not Applicable
	Does the proposal comply with the performance criteria by applying acceptable solution A2.4?	Not Applicable
	Does the proposal comply with the performance criteria by applying acceptable solution A2.5?	Not Applicable
	Does the proposal comply with the performance criteria by applying acceptable solution A2.6?	Not Applicable
	Does the proposal comply with the performance criteria by applying acceptable solution A2.7?	Not Applicable
	Does the proposal comply with the performance criteria by applying acceptable solution A2.8?	Not Applicable
	Does the proposal comply with the performance criteria by applying acceptable solution A2.9?	Not Applicable
	Does the proposal comply with the performance criteria by applying acceptable solution A2.10?	

Element	Question	Answer
3: Water	Does the proposal comply with the performance criteria by applying acceptable solution A3.1?	Yes
	Does the proposal comply with the performance criteria by applying acceptable solution A3.2?	Not Applicable
	Does the proposal comply with the performance criteria by applying acceptable solution A3.3?	Not Applicable

Element	Question	Answer
4: Siting of the Development	Does the proposal comply with the performance criteria by applying acceptable solution A4.1?	Yes - Construction standards are increased to align with site bushfire attack level.
	Does the proposal comply with the performance criteria by applying acceptable solution A4.2?	No however a BPZ is not required due to Low bushfire hazard rating levels and construction standards are increased to align with site bushfire attack level.
	Does the proposal comply with the performance criteria by applying acceptable solution A4.3?	Yes
	Does the proposal comply with the performance criteria by applying acceptable solution A4.4?	No - However the proposal does satisfactorily comply with performance criterion P4 because building construction standards are to be increased to comply with AS 3959-2009 to offset the removed Hazard Separation Zone. Construction standards will achieve a maximum of BAL-29.
	Does the proposal comply with the performance criteria by applying acceptable solution A4.5?	N/A - Shielding not applicable.

Element	Question	Answer
5: Design of the Development	Does the proposal comply with the performance criteria by applying acceptable solution A5.1?	No - However the proposal does comply with the performance criterion P5 because building construction standards will be increased to comply with AS 3959-2009 to offset the requirement for a HSZ. BAL-29 is not exceeded.
	Does the proposal comply with the performance criteria by applying acceptable solution A5.2?	Yes - The proposal complies as the development will meet the performance criteria because of compliance with AS 3959 and BAL-29 is not exceeded.

Applicant Declaration

I declare that the information provided is true and correct to the best of my knowledge.

Full name: Rohan Carboon

Applicant signature: 

Date: 15/3/2014

8. Implementing the Fire Management Plan

8.1 Developer's Responsibilities

To maintain a reduced level of risk from bushfire, the developer's responsibilities are to:

- Install public roads to standards outlined in Element 6.2 Vehicular Access
- Establish and maintain the building protection zone to standards and landscape all POS areas to "Low Threat Vegetation" standards
- Ensure 100 metres of vegetation is cleared or managed from the perimeter of each subdivision stage within the development boundary to ensure temporary hazard does not impact on dwellings
- Comply with the City of Rockingham's Fire Control Notice as published, on all vacant land
- Install reticulated water supply and hydrants to Water Corporation, DFES and City of Rockingham standards
- Provide detailed hydrant plans is to the City of Rockingham and DFES local fire station for monitoring at Subdivision Approval stage
- Supply a copy of this Fire Management Plan and The Homeowners Bush Fire Survival Manual, Prepare, Act, Survive (or similar suitable documentation) and the City of Rockingham's Fire Control Notice to each lot owner subject to AS 3959 construction standards, and
- Lodge a Section 70A Notification on the Certificate of Title exposed to AS 3959 construction standards, proposed by this development at subdivision approval stages. The notification shall alert purchasers and successors in title, to these exposed lots, of the responsibilities of the Fire Management Plan and bush fire building construction assessment requirements.

8.2 Property Owners' / Occupiers Responsibilities

The owners and/or occupiers of the site, as created by this proposal, are to maintain a reduced level of risk from bushfire, and will be responsible for undertaking, complying and implementing measures to protect their own assets (and people under their care) from the threat and risk of bushfire. The owners' will be responsible for:

- Maintain the property in good order to minimise potential bushfire fuels to mitigate the risk of fire on the property
- Comply with the City of Rockingham annual Fire Control notice
- Ensure that where hydrants are located, they are not to be obstructed and remain accessible at all times

- Ensure construction of buildings to meet AS 3959
- Maintain Building Protection Zones within the lot boundary at the property owners own cost
- As part of the building license application, the property owner of the City of Rockingham shall have the proposed buildings re-assessed for Bushfire Attack Level (at the time of construction) with results to be submitted as part of the Building License application, and
- If buildings are subject to additional construction in the future such as renovations, AS 3959 compliance is required.

8.3 City of Rockingham's Responsibilities

The responsibility for compliance with the law rests with individual property owners and occupiers and the following conditions are not intended to unnecessarily transfer some of the responsibilities to the City of Rockingham.

The City of Rockingham shall be responsible for:

- Providing fire prevention and preparedness advice to the property owner and/or occupier upon request
- Monitoring bush fuel loads in all surrounding areas of public open space, road reserve sites and liaise with relevant stakeholders to maintain fuel loads at safe levels
- Maintaining public roads to appropriate standards and ensuring compliance with the City of Rockingham's Fire Control Notice
- Ensuring buildings are constructed to AS 3959 where applicable, and
- Endorsing a Section 70A notification on each title affected by the Fire Management Plans at Subdivision Approval Stage.

8.4 DFES Responsibilities

The Department of Fire and Emergency Services will be responsible for developing and maintaining District Fire Fighting Facilities including fire hydrants under its control.

9. References

Abbott, I. (2003). Aboriginal fire regimes in south-west Western Australia: evidence from historical documents. Pages 119-146 in I. Abbott and N. Burrows, editors. Fire in ecosystems of south-west Western Australia: impacts and management. Backhuys, Leiden, The Netherlands.

Blanchi, R. Lucas, C. Leonard, J and Finkele K. (2010) Meteorological conditions and wildfire-related house loss in Australia. CSIRO Publishing, Melbourne.

Burrows, N., and I. Abbott. 2003. Fire in south-west Western Australia: synthesis of current knowledge, management implications and new research directions. Pages 437-452 in N. Burrows and I. Abbott, editors. Fire in ecosystems of south-west Western Australia: impacts and management. Backhuys, Leiden, The Netherlands.

Cheney P & Sullivan P (2008) Grassfires. Fuel, Weather and Fire Behaviour. 2nd edition CSIRO Publishing.

Crisp M. D, Burrows G. E, Cook L. G, Thornhil A. Hl & Bowman D (2011) Flammable biomes dominated by eucalypts originated at the Cretaceous–Palaeogene boundary. In Nature Communications 2. Article No 193.

Environmental Resources Management Australia (2000) Baldivis Tramway Reserve Management Plan (Report for City of Rockingham) unpublished report.

DFES (2010) PREPARE. ACT. SURVIVE. Your guide to preparing for and surviving the bushfire season booklet.

Gibbons P, van Bommel L, Gill AM, Cary GJ, Driscoll DA, et al. (2012) Land Management Practices Associated with House Loss in Wildfires. PLoS ONE 7(1): e29212. doi:10.1371/journal.pone.0029212.

Gould J. S, McCaw W. L, Cheeney N. P, Ellis P. F, Knight I. K, and Sullivan A. L (2007) Project Vesta - Fire in Dry Eucalypt Forest: Fuel Structure, fuel dynamics and fire behaviour. Ensis-CSIRO, Canberra ACT, and Department of Environment and Conservation, Perth WA.

Hallam, S. J. 1975. Fire and Hearth: A study of Aboriginal usage and European surpation in south-western Australia. Australian Institute of Aboriginal Studies, Canberra, Australia.

Leonard J. (2009) Report to the 2009 Victorian Royal Commission Building Performance in Bushfires. CSIRO Sustainable Ecosystems.

NSW Rural Fire Service (2004) Bushfire Evacuation Plans (see: www.rfs.nsw.gov.au)

Ramsay C, and Rudolf L (2003) Landscape and Building Design for Bushfire Areas. CSIRO Publishing, Collingwood. Australia.

Risk Frontiers, Bushfire CRC and RMIT University (2008). 100 Years of Australian civilian bushfire fatalities: exploring the trends in relation to the 'stay or go policy' Report for the Bushfire CRC http://www.bushfirecrc.com/research/downloads/Fatality-Report_final_new.pdf.

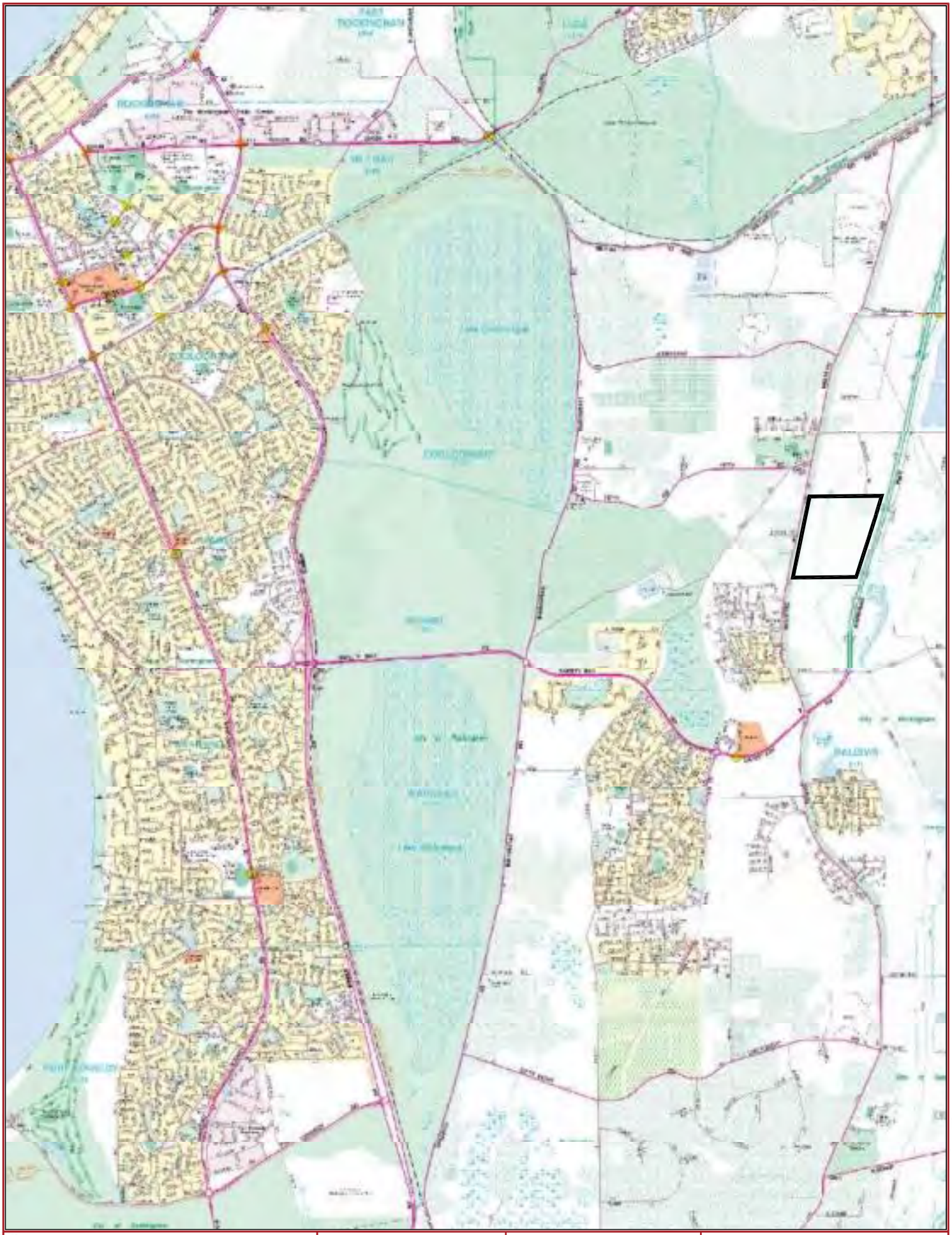
Standards Australia. (2009) Australian Standard AS 3959-2009 Construction of buildings in bushfire-prone areas.

Victorian Bushfires Royal Commission (VBRC) Interim Report (2009). Government Printer for the State of Victoria.

Victorian Bushfires Royal Commission (VBRC) Final Report (2010). Government Printer for the State of Victoria.

Western Australian Planning Commission (WAPC), FESA and Department of Planning and Infrastructure (2010), Planning for Bush Fire Protection - Edition 2. Western Australian Planning Commission, Perth.

Walker, J. 1981. Fuel dynamics in Australian vegetation. Pages 101-127 in A. M. Gill, R. H. Groves, and I. R. Noble, editors. Fire and the Australian biota. Australian Academy of Science, Canberra, Australia.



APPENDIX A:
SITE LOCATION PLAN

LOTS 104, 105, 541, 543, 544 & 1000
BALDIVIS ROAD, BALDIVIS
CITY OF ROCKINGHAM

LEGEND:
SUBJECT LAND.....

PREPARED FOR:
AUSTRALAND

NORTH

0 200 400 600 800 1000 1200 1400 1600m

SCALE 1:50 000 @ A4
DATE: JANUARY 2014
Base mapping supplied by Landgate

Bushfire Safety CONSULTING

BUSHFIRE SAFETY CONSULTING
PO BOX 84 STONEVILLE WA 6081
Mbl: 0429 949 262
www.bushfiresafety.net

LEGEND:

- Site Boundary
- Pump Station
- 30m Pump Station Buffer

ZONES

- Residential R25
- Residential R30
- Residential R40
- Residential R60

RESERVES

- Public Open Space (POS)
- Road Reserves

ROAD HIERARCHY

- Neighbourhood Connector B
- Access Street

Appendix B: East Baldivis Local Structure Plan

Lots 104, 105, 541, 543, 544, 1000 Baldivis Road, BALDIVIS

for: AUSTRALAND

NORTH

Scale 1:2000 @ A1 | 1: 4000 @ A3

0 50 100 150 200 metres

COMPILED: DPS		DRAWN BY:	RF
DATE:	22/03/2013	REVISED:	26/02/2014
GRID:	MGA 50	DATUM:	AHD
DRAWING NUMBER:	AUSEB-2-004k	JOBCODE:	AUSEBLSP
FILE ID:	M:\AUSEB\BASE\STRUCTURE PLANS\AUSEB-2-004k LSP.dgn		

Development Planning Strategies
28 Brown St, East Perth WA 6004
PO BOX 6697 EAST PERTH 6892
T (08) 9268 7900
F (08) 9268 7999
E dps@dpswa.com.au

Note:

1. Further investigation of the Resource Enhancement Wetland & Buffers to be undertaken as part of the preparation of Local Structure Plans.
2. Further investigation of the Noise Attenuation along Mundijong Road to be undertaken as part of the preparation of Local Structure Plans.
3. Further investigation of the Dampier to Bunbury pipeline buffer to be undertaken as part of the preparation of Local Structure Plans.
4. Bush Fire Strategy shall be prepared as part of the preparation of Local Structure Plans.

MILLER ROAD
DRAIN RESERVE
43Km to PERTH
BALDIVIS ROAD
1.0km
MILLER ROAD WEST
400m
PUG ROAD
POS
PS
TRAMWAY RESERVE
TRAMWAY
APPROX 2Km to MANDURAH ROAD
MUNDIJONG ROAD
400m
MUNDIJONG ROAD
KEROSENE LANE
1.0km
NAIRN ROAD (FUTURE)
400m
GAS PIPELINE EASEMENT
400m
PS
POS
HS
DOS
BALDIVIS ROAD
KWINANA FREEWAY
ZIG ZAG ROAD
FIFTY ROAD
East Baldivis LSP
PEMBERTON BVD
TRAMWAY
POS
PS
400m
1.0km
TAMWORTH BVD
KEY CLOSE
DISTRICT CENTRE
SAFETY BAY ROAD
APPROX 2Km to MANDURAH ROAD
23Km to MANDURAH

LEGEND

- SUBJECT LAND
- NEIGHBOURHOOD CONNECTOR ROADS
- DRAINAGE ROUTE
- PUMP STATION
- RESIDENTIAL
- FUTURE FREEWAY SERVICE CENTRE
- PRIMARY REGIONAL ROADS
- OTHER REGIONAL ROADS
- PS PRIMARY SCHOOL
- HS HIGH SCHOOL
- KEY PUBLIC OPEN SPACE (Must be shown on Local Structure Plans in this location and provided)
- TRAMWAY RESERVE
- RESOURCE ENHANCEMENT WETLAND (Indicative Buffer)
- * FUTURE STAGGERED T-JUNCTIONS (from Baldivis onto Mundijong Road, with Mundijong Road as the priority route.)

POS DISTRIBUTION

LOCAL @ 150 - 300m CATCHMENT

NEIGHBOURHOOD @ 400m CATCHMENT

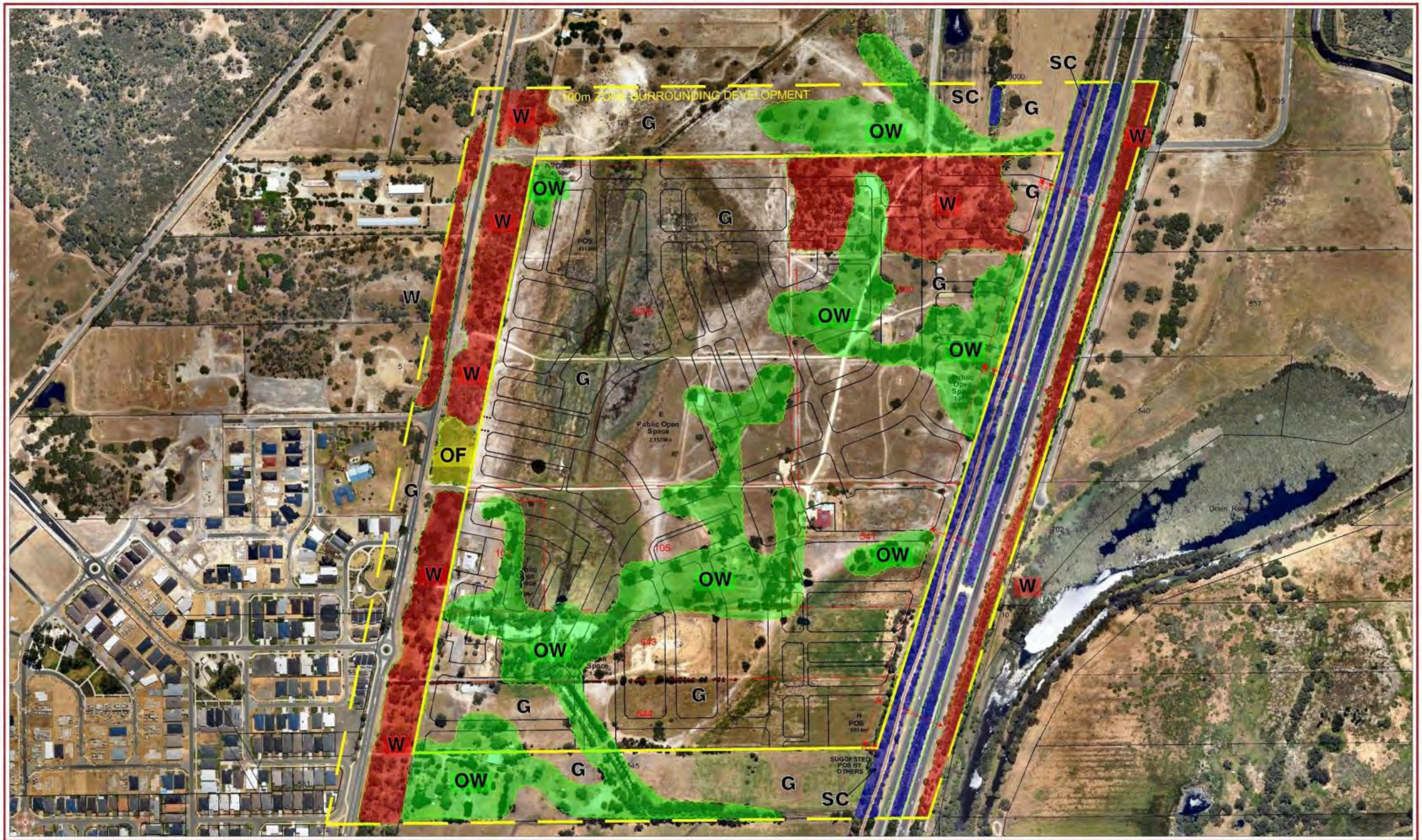
DISTRICT @ 600 - 1000m CATCHMENT

Appendix C

DISTRICT STRUCTURE PLAN (COMPROMISE)

East Baldivis, City of Rockingham

2304-74B-01 (26.11.2013), 1:20,000@A3



APPENDIX D
AS3959 VEGETATION CLASSIFICATION

LOTS 104, 105, 541, 543, 544 & 1000
BALDIVIS ROAD, BALDIVIS
CITY OF ROCKINGHAM

SOURCE:
PHOTOGRAPHY FROM NEARMAP

PREPARED FOR: AUSTRALAND

LEGEND

SUBJECT LAND			
WOODLAND	W		
OPEN WOODLAND (CLASED AS GRASSLAND)	OW	SCRUB	SC
OPEN FOREST	OF	GRASSLAND	G

NORTH

0 50 100 150 200 250m

SCALE 1:5000 @ A3
DATE: DECEMBER 2013
Base mapping supplied by Development Planning Strategies

Bushfire Safety CONSULTING
BUSHFIRE SAFETY CONSULTING
PO BOX 84 STONEVILLE WA 6081
Mbl: 0429 949 262
www.bushfiresafety.net

APPENDIX E

Effective Slope in the Tramway and Freeway Reserve

LOTS 104, 105, 541, 543, 544 & 1000
BALDIVIS ROAD, BALDIVIS
CITY OF ROCKINGHAM

SOURCE:
PHOTOGRAPHY FROM NEARMAP

PREPARED FOR: AUSTRALAND

LEGEND

SUBJECT LAND.....

UPSLOPE.....

DOWNSLOPE.....

NORTH

0 50 100 150 200 250m

SCALE 1:5000 @ A3
DATE: DECEMBER 2013
Base mapping supplied by Development Planning Strategies

Bushfire Safety
CONSULTING

BUSHFIRE SAFETY CONSULTING

PO BOX 84 STONEVILLE WA 6081
Mbl: 0429 949 262
www.bushfiresafety.net

APPENDIX F
BUSHFIRE HAZARD ASSESSMENT

LOTS 104, 105, 541, 543, 544 & 1000
BALDIVIS ROAD, BALDIVIS
CITY OF ROCKINGHAM

SOURCE:
PHOTOGRAPHY FROM NEARMAP

PREPARED FOR: AUSTRALAND

LEGEND

SUBJECT LAND

LOW

EXTREME

NORTH

0 50 100 150 200 250m

SCALE 1:5000 @ A3
DATE: DECEMBER 2013
Base mapping supplied by Development Planning Strategies

Bushfire Safety
CONSULTING
BUSHFIRE SAFETY CONSULTING
PO BOX IM STONEVILLE WA 6081
Mbl: 0429 949 252
www.bushfiresafety.net

Appendix G - POS C CONCEPT

INFORMAL PATH THROUGH EXISTING TREES

RETAINED MATURE TREES. UNDERSTOREY TO BE CLEARED OF WEEDS/DEBRI. PROPOSED UNDERSTOREY TO BE MAINTAINED LOW NATIVE SHRUB PLANTING AND POCKETS OF TURF (REFER IMAGE BELOW)

SHELTER IN CLOSE PROXIMITY TO PLAY AREA

SMALL TURF POCKETS

POS TYPOLOGY

- Neighbourhood Informal

SIZE (excluding verges)

- 7289 square metres

CONCEPT

- Provide a Neighbourhood Park to cater for residents within a 200-400m walkable catchment
- Provide a park for informal community gatherings, play and turf pockets around existing vegetation

FUNCTIONS

- Turf - Informal relaxing spaces
- Native waterwise planting with areas of dry gardens
- Retained vegetation where possible
- Picnic Facilities for family/friend gatherings
- Play elements for all age groups
- Path network connecting into broader path network

ENVIRONMENTAL CONSIDERATIONS

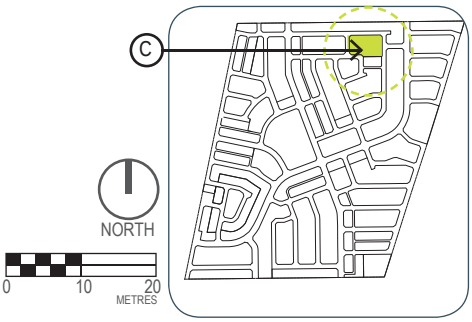
- Waterwise native planting
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to the informal turf playing area
- Plant species below existing trees is to be considered. Refer to the FESA planting guidelines for possible species to propose below mature trees
- Weed/prune and remove debris from area of existing vegetation
- Retain and protect areas of native vegetation
- Source local materials where possible
- Consider the long term maintenance requirements for all materials

DRAINAGE CONSIDERATIONS

- Not Applicable

Example - Retained mature trees within a maintained parkland

Note: Proposed vegetation below the retained mature trees is to preferably be low / groundcover native species from the current FESA planting guidelines. This area is to be maintained to ensure vegetation remains 'Low Threat' . Refer to the Bushfire Hazard Assessment for further detail.



Comfortable - Informal gathering spaces

Connection - Meandering pathways

Textural - Local material palette

Appendix H - POS D CONCEPT

POS TYPOLOGY

- Neigbourhood Passive Park (D)

SIZE (excluding verges)

- 10,656 square metres

CONCEPT

- Provide a Neighbourhood Park to cater for residents within a 200-400m walkable catchment
- Provide a park which caters for drainage with pedestrian linkages and seating opportunities.
- Retain existing native vegetation

FUNCTIONS

- Retain Existing vegetation
- Native waterwise planting with areas of dry gardens
- Maximise shade trees
- Limited picnic facilities
- Path network connecting into greenlink and broader path network.
- Drainage

ENVIRONMENTAL CONSIDERATIONS

- Waterwise native planting
- Planting design to be zoned according to irrigation requirement
- Retain and protect existing native vegetation where ever possible
- Planting within Building Protection Zone to be considered. Refer to the FESA planting guidelines
- Weed/prune and remove debris from area of existing vegetation
- Source local materials where possible
- Consider the long term maintenance requirements for all materials

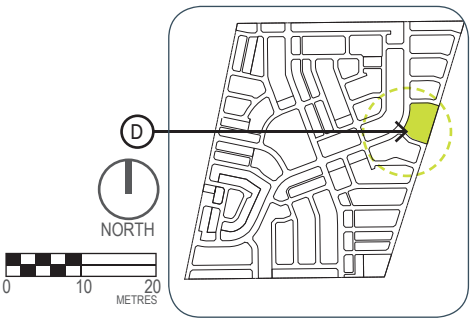
DRAINAGE CONSIDERATIONS

•	1:1	706 m3 storage required
•	1:5	1383 m3 storage required
•	1:10	1558 m3 storage required
•	1:100	2497 m3 storage required

Note: Figures to be finalised during detailed design.

Example - Retained mature trees within a maintained parkland

Note: Proposed vegetation below the retained mature trees is to preferably be low / groundcover native species from the current FESA planting guidelines. This area is to be maintained to ensure vegetation remains 'Low Threat' . Refer to the Bushfire Hazard Assessment for further detail.



Connectivity - Nodes along journey

Comfort - Shaded gathering spaces

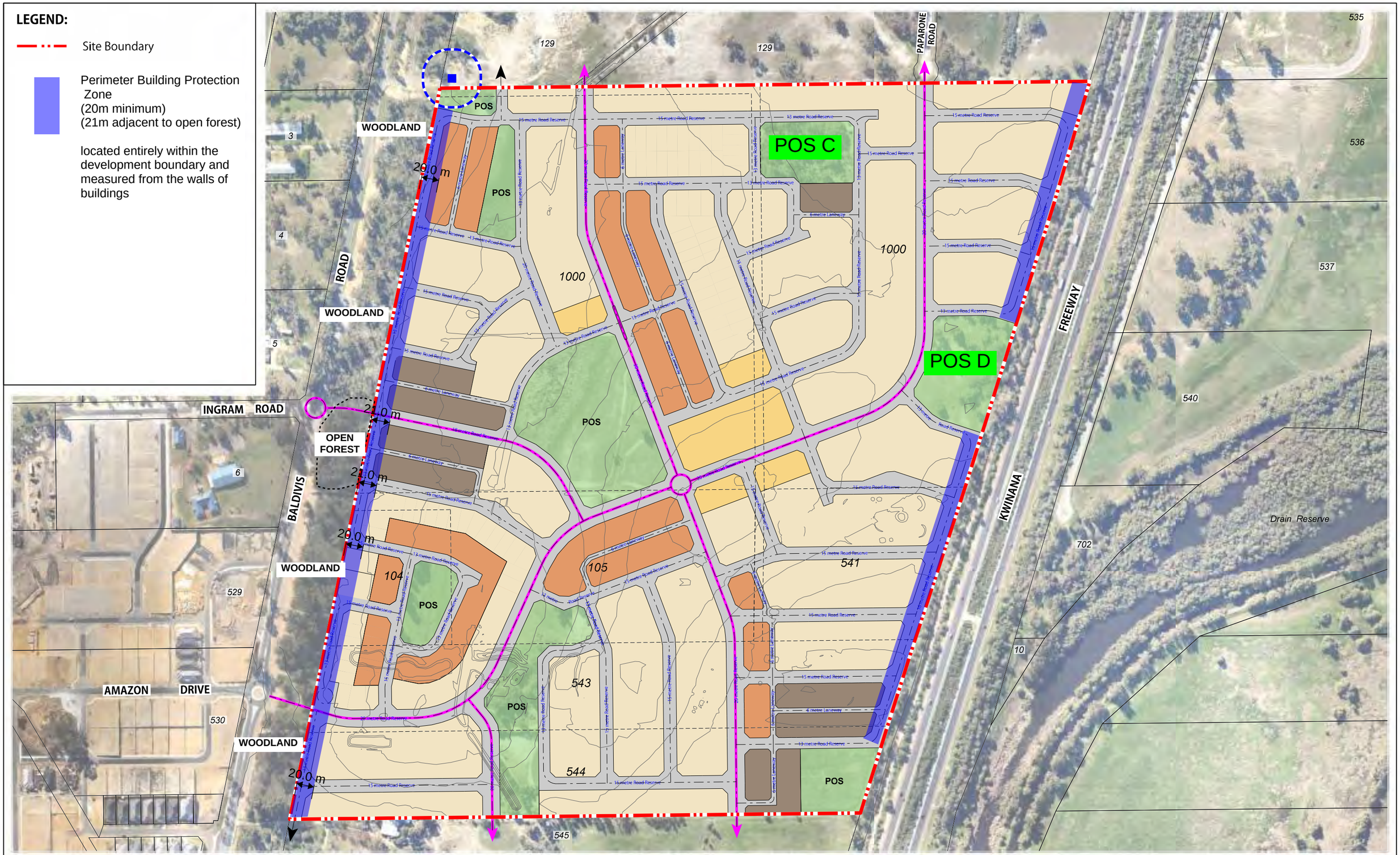
Interactive - All age facilities

LEGEND:

Site Boundary

Perimeter Building Protection Zone
(20m minimum)
(21m adjacent to open forest)

located entirely within the development boundary and measured from the walls of buildings



Appendix I: Perimeter Building Protection Zone

Lots 104, 105, 541, 543, 544, 1000 Baldivis Road, BALDIVIS

for: AUSTRALAND

NORTH

Scale 1:2000 @ A1 | 1: 4000 @ A3

0 50 100 150 200 metres

COMPILED: DPS		DRAWN BY:	RF
DATE:	22/03/2013	REVISED:	26/02/2014
GRID:	MGA 50	DATUM:	AHD
DRAWING NUMBER:	AUSEB-2-004k	JOBCODE:	AUSEBLSP
FILE ID:	M:\AUSEB\BASE\STRUCTURE PLANS\AUSEB-2-004k LSP.dgn		

Development Planning Strategies
28 Brown St, East Perth WA 6004
PO BOX 6697 EAST PERTH 6892
T (08) 9268 7900
F (08) 9268 7999
E dps@dpswa.com.au

LEGEND:

- Site Boundary
- BPZ — Perimeter Building Protection Zone
- BAL 29 — Indicative zone exposed to BAL-29 (21-31m from open forest)
- BAL 19 — Indicative zone exposed to BAL-19
  20-29 metres from woodland
  31-42 metres from open forest
  20-27 metres from Scrub
- BAL 12.5 — Indicative zone exposed to BAL-12.5
  29-100 metres from woodland &
  42-100 metres from open forest
  27-100 metres from scrub

Appendix J: Indicative BAL Ratings

Lots 104, 105, 541, 543, 544, 1000 Baldivis Road, BALDIVIS

for: AUSTRALAND

australand

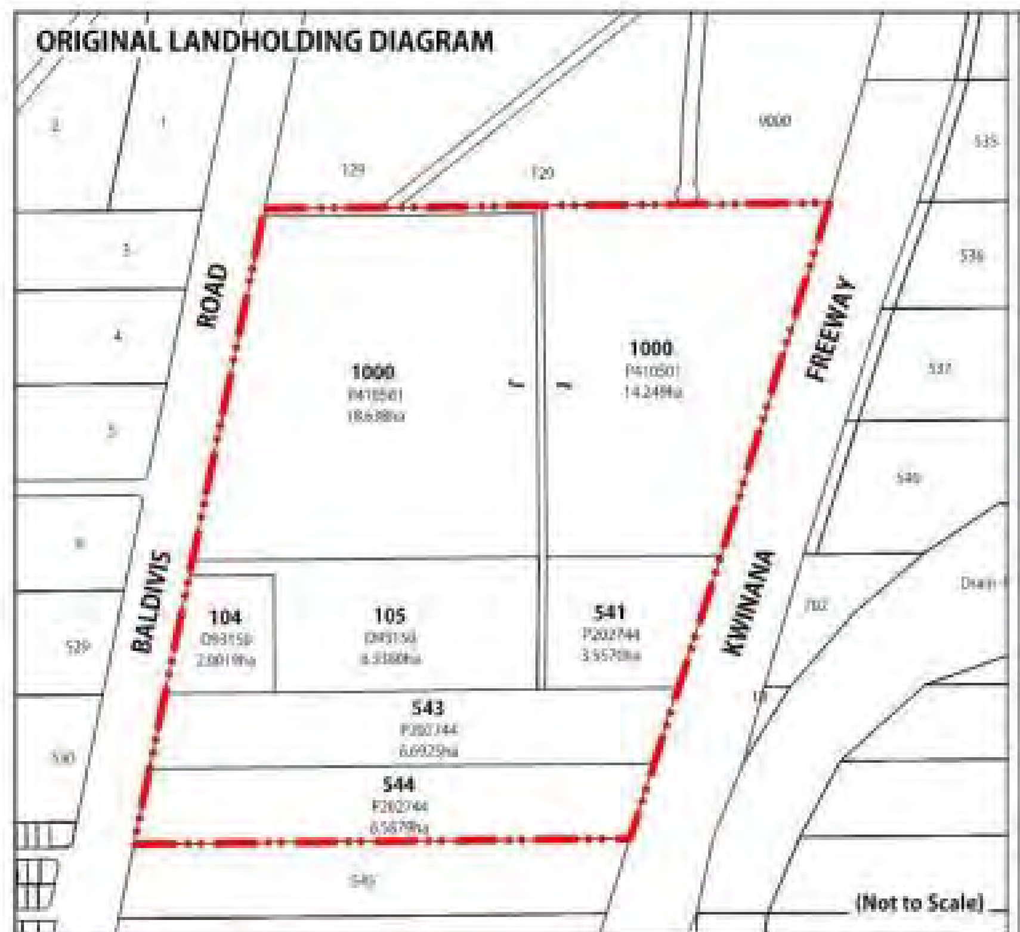
NORTH

Scale 1:2000 @ A1 | 1:4000 @ A3

0 50 100 150 200 metres

COMPILED: DPS		DRAWN BY:	RF
DATE:	22/03/2013	REVISED:	26/02/2014
GRID:	MGA 50	DATUM:	AHD
DRAWING NUMBER:	AUSEB-2-004k	JOBCODE:	AUSEBLSP
FILE ID: M:\AUSEB\BASE\STRUCTURE PLANS\AUSEB-2-004k LSP.dgn			

dps Development Planning Strategies
28 Brown St, East Perth WA 6004
PO BOX 6697 EAST PERTH 6892
T (08) 9268 7900
F (08) 9268 7999
E dps@dpswa.com.au



LEGEND

Subject Site	20m Building Protection Zone
Public Open Space	Bollards (Pedestrian Access Only)
Building To Be Retained	Poultry Farm Buffer
Potential Tree Retention	On Street Parking
Pump Station	2.0m Path
30m Pump Station Buffer	2.5m Dual Use Path

RESIDENTIAL LOT SUMMARY

LOT YIELD			LOT AREA		
Size	No. Lots	% Total Lots	Average Size	% of Total Area	Area
200m² - 300m²	96	11.09%	257m²	7.11%	24696m²
301m² - 400m²	442	51.04%	358m²	45.57%	158389m²
401m² - 500m²	288	33.26%	436m²	36.18%	125754m²
501m² - 600m²	31	3.58%	528m²	4.71%	16370m²
601m² - 700m²	3	0.35%	660m²	0.57%	1980m²
701m² - 800m²	2	0.23%	739m²	0.43%	1479m²
901m² - 1000m²	1	0.12%	971m²	0.28%	971m²
1001m² - 5000m²	1	0.12%	1407m²	0.40%	1407m²
5001m²+	2	0.23%	8245m²	4.75%	16491m²
Total Number of Lots	866 + 2 Retained Lots				

Minimum Lot Size 224m² Average Lot Size 401m²
Maximum Lot Size 8509m² Total Lot Area 347537m²

LAND USE SUMMARY

Subject Site	59.07ha
Residential Lot Area	34.75ha
Public Open Space Area	6.92ha
Retained Lots	2584m²
Road Reserve Area	17.14ha

Appendix K: Indicative BAL Ratings on proposed subdivision outcome

Lots 104, 105, 541, 543, 544, 1000 Baldivis Road, BALDIVIS

for: Australand

australand

Development Planning Strategies

Appendix L - TRAMWAY TYPOLOGY PLAN

CONCEPT

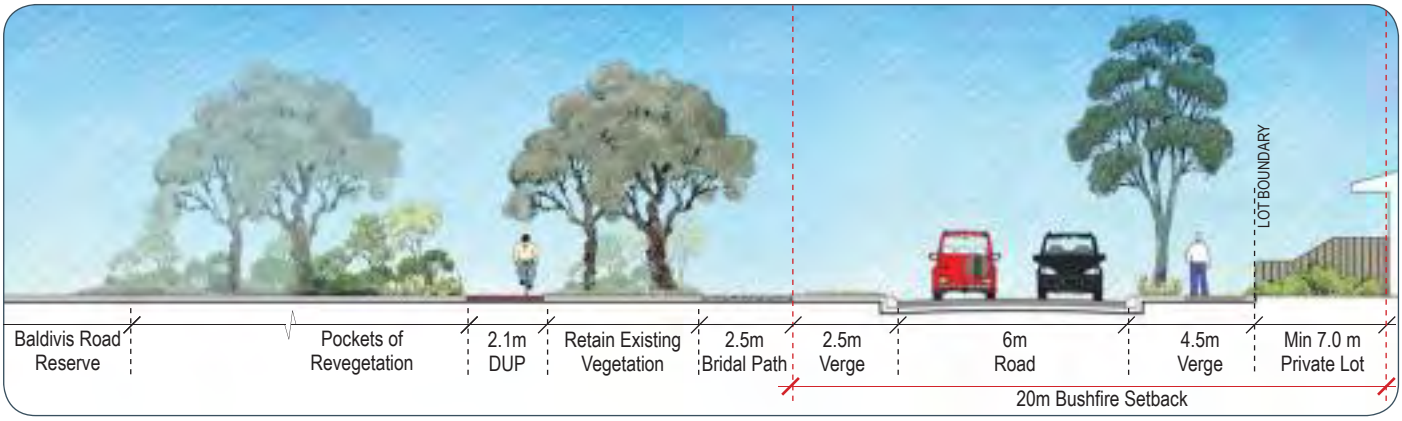
- Maintain and protect all existing vegetation within tramway reserve
- Meandering dual use path runs the length of the tramway and links to greater tramway path networks.
- Limestone Bridal trail runs adjacent to boundary
- Planting pockets of native re-vegetation

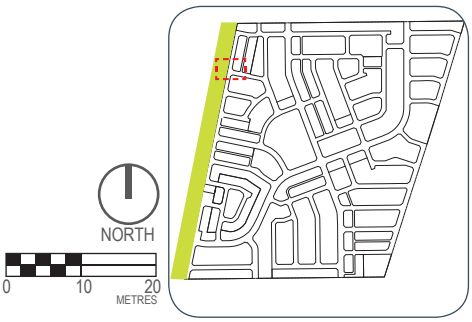
FUNCTIONS

- Native re-vegetation planting
- Crushed limestone bridal path
- Dual use path
- Entry Statement at Baldivis Road
- Provide linkages to pedestrian networks within and outside of the development area

ENVIRONMENTAL CONSIDERATIONS

- No irrigation
- Re-vegetation of native plant communities to strategic nodes. Locations to be determined in detailed design
- Removal of weed species





Linkage - Mark connection with East Baldivis

Meandering Pathway

Pockets of Native Re-vegetation