HATCH

Barfield Road

Structure Plan

AMENDMENT NO. 6

FEBRUARY 2025

City of Cockburn
wetlands to waves

vivente
HAMMOND PARK

GOLD ESTATES

RICHARDNOBLE
PROPERTY INTEGRITY COMMUNITY

Title:	Barfield Road Structure Plan
Project:	Barfield Road, Whiteman
Prepared for:	Richard Noble
Reference:	RIC HAM
Status:	Final with WAPC modifications dated February 2025
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ENDORSEMENT PAGE

This structure plan is prepared under the provisions of the City of Cockburn
Town Planning Scheme No. 3.

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON:

17 JULY 2014

In accordance with Schedule 2, Part 4, Clause 28 (2) and refer to Part 1, 2. (b) of the *Planning and Development (Local Planning Schemes) Regulations 2015*.

Date of Expiry: **19 OCTOBER 2035**

TABLE OF AMENDMENTS TO STRUCTURE PLAN

Amendment No.	Description of Amendment	Date Supported by Council	Date Endorsed by the WAPC
1	delete access street to Wattelup Rd, + BMP requirements to map	16 October 2015	n/a (not required prior to Deemed Provisions)
2	up-code area to R60 north of POS A2	9 March 2017	13 June 2017
3	Alterations to density and cul-de-sac of two east-west streets	29 June 2018	29 October 2018
4	Add Lot 15 + change to design in Lot 18	14 November 2019	17 June 2020
5	Down code area from R60 to R30 south of POS C	2 November 2021	6 May 2022
6	Amendments include Lot 16 in Structure Plan Area and to down code areas from R60 to R25-R30.	9 July 2024	10 March 2025

Executive Summary

The Barfield Road Structure Plan covers an area of 36.597ha in the locality of Hammond Park, which is within the jurisdiction of the City of Cockburn. The Structure Plan area is generally bound by Frankland Avenue to the west, Rowley Road to the south, a powerline easement to the east and rural properties (zoned for urban development) to the north.

The Structure Plan will provide for residential development, a local centre, a portion of a high school site and associated areas of open space.

An overview of the Structure Plan area and its key components is provided in the table below. Note that the "Total Area covered by the Structure Plan" stated in the table excludes Planning Control Area no.156 (0.9329 ha).

Item	
Total area covered by the structure plan	36.597 ha
Area of specified land use	Residential: 22.09 ha POS: 3.9 ha Road Reserve: 9.597 ha Local Centre: 0.15 ha High School Site: 0.86 ha
Estimated Lot Yield	545
Estimated number of dwellings	545
Estimated population	1400 people
Number of high schools (portion)	1
Number of primary schools	0
Estimated retail floor space	0
Estimated employment provided (no. of jobs)	5
Number and area of public open space	
: District parks	0
: Neighbourhood parks	3.9 ha

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Part One: Implementation Section

1.0 Structure Plan Area

This Part applies to the Barfield Road Structure Plan, being all land contained within the inner edge of the black line shown on the Structure Plan map (Plan 1).

2.0 Structure Plan Content

This Structure Plan comprises the:

- Implementation section (Part 1)
- Explanatory section (Part 2)
- Technical appendices (Part 3)

3.0 Interpretations and Use Class Permissibility

Land use permissibility within the Structure Plan area shall be in accordance with the Structure Plan Map and corresponding Zones and Reserves under the Scheme.

4.0 Operation Date

This Structure Plan is operative until 19 October 2035.

5.0 Residential Density

Plan 1 defines the residential density, in accordance with the Residential Design Codes, that applies to specific areas within the Structure Plan area.

6.0 General Subdivision and Development Requirements

6.1 Notifications on Title

In respect of applications for the subdivision of land the City of Cockburn may recommend to the Western Australian Planning Commission that a condition be imposed on the grant of subdivision approval for a notification to be placed on the Certificate(s) of Title(s) to advise of the following:

1. Lots deemed to be affected by a Bush Fire Hazard as identified in the Barfield Road Structure Plan Bushfire Management Plan prepared by Strategen at Appendix 3.
2. Building setbacks and construction standards required to achieve a Bushfire Attack Level -29 or lower in accordance with Australian Standards (AS3959-2009): Construction of buildings in bushfire prone areas.
3. Lots deemed to be affected by an identified noise impact as identified in the Noise Management Plan for Barfield Road Structure Plan prepared by Lloyd George Acoustics at Appendix 5.
4. Construction standards to achieve quiet housing design in accordance with State Planning Policy 5.4 Road and Rail Noise.
5. The road network connectivity in this area linking Barfield Road will be permanently closed in the future.

6.2 Local Development Plans

1. Local Development Plans (LDPs) are required for lots comprising one or more of the following site attributes:
    i. Lots with rear-loaded vehicle access;
    ii. Lots with direct boundary frontage (primary or secondary) to an area of Public Open Space;
    iii. Lots deemed to be affected by noise from Rowley Road and Kwinana Freeway, as identified spatially in the Noise Management Plan prepared by Lloyd George Acoustics at Appendix 5. This includes a requirement for noise modelling for ground floor and two-storey development as applicable.
2. LDPs are required to be prepared for all land zoned 'Local Centre' on the Structure Plan map (Plan 1).

6.3 Other provisions / standards / requirements

i. This Structure Plan is supported by a Bushfire Hazard Level Assessment (BFHA) and a Fire Management Plan (FMP). Any land falling within 100 metres of a bushfire hazard identified in the BFHA/ FMP is designated as a Bushfire Prone Area for the purpose of the Building Code of Australia.

ii. Proportional contributions being made towards DCA 9 (Hammond Park) and DCA 13 (Community Infrastructure) in accordance with clause 6.3 of the City of Cockburn Town Planning Scheme No. 3

iii. The Noise Management Plan for Barfield Road Structure Plan being updated / finalised at the subdivision stage (if updated or once final levels and road designs are known) to inform subdivision applications, and any mitigation measures being implemented via appropriate subdivision conditions.

iv. Rural fencing treatment to be provided along the boundary of road reserves and freehold lots within the Special Use 23 zoned area.

v. Preparation of a Wildfire Management Plan is required to address the management and relocation of fauna prior to clearing native vegetation.

Plan 1: Barfield Road Structure Plan



LEGEND

STRUCTURE PLAN AREA

ZONES
- RESIDENTIAL
- LOCAL CENTRE

RESERVES
- PARKS AND RECREATION
- PUBLIC PURPOSE - EDUCATION

OTHER ELEMENTS THAT INFORM THE LSP
- PROPOSED BUS ROUTE
- R25 RESIDENTIAL DENSITY CODE
- PLANNING CONTROL AREA No. 156
- WESTERN POWER EASEMENT

Part Two: Explanatory Section

Figure 15: Staging Plan

1.0 Planning Background

1.1 Introduction and purpose

This report has been prepared on behalf of Gold Estates Holdings Pty Ltd, in association with the Department of Housing in support of a Structure Plan (Structure Plan) for Lots 13, 14, 15, 16 and 18 Barfield Road and Lots 48-51 Rowley Road, Hammond Park (Structure Plan area). The Structure Plan will provide for residential development, a local centre, a portion of the high school site and associated areas of open space.

The project team responsible for the preparation of the Structure Plan are:

- Hatch RobertsDay - Town planning and design;
- Emerge - Landscape Architecture and Water Management;
- The Civil Group - Engineering;
- Emerge - Environmental;
- Kleyweg Consulting - Traffic and transport;
- Strategen - Bushfire Management
- Lloyd George - Acoustic Consultants

Figure 1: Location Plan



Figure 2: Context Plan



1.2 Land description

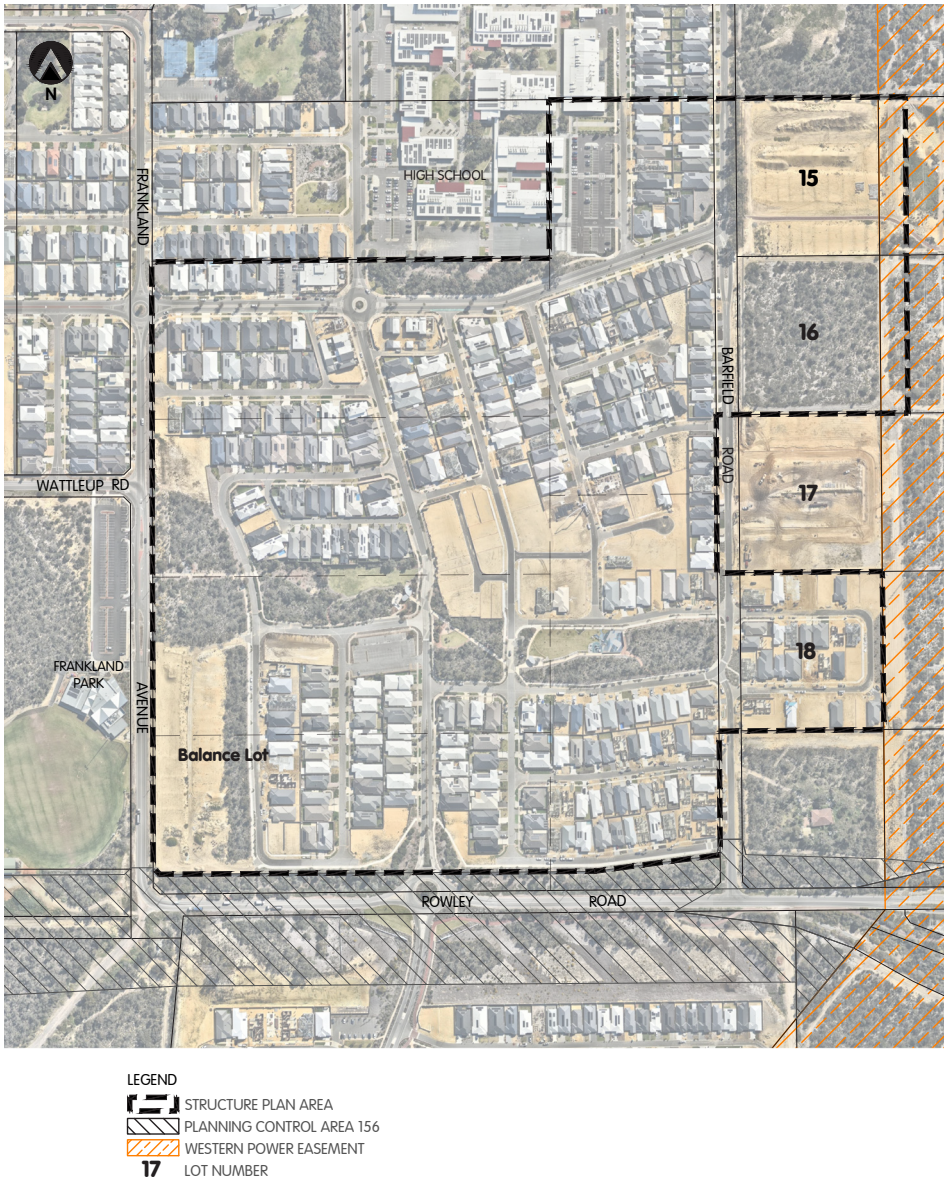
1.2.1 Location

The Structure Plan area is in the locality of Hammond Park which is approximately 25 kilometres south of the Perth Central Business District within the municipal boundaries of the City of Cockburn. The Structure Plan area is bounded by Frankland Avenue to the west, Rowley Road to the south and a powerline easement to the east and rural properties (zoned for urban development) to the north.

1.2.2 Area and land use

The Structure Plan area has a total area of 36.597 hectares and previously comprised a number of dwellings, outbuildings and cleared areas. Lot 18 was previously used for low intensity horse agistment.

Figure 3: Aerial Photograph (2023)



1.2.3 Legal description and ownership

The legal description of the subject land is provided in Table 1. Aerial photograph plan depicts the lots and their land use (Figure 3).

The Department of Housing previously owned some of the lots, but were eventually sold to Gold Estate Holdings Pty Ltd between 2013 and 2015.

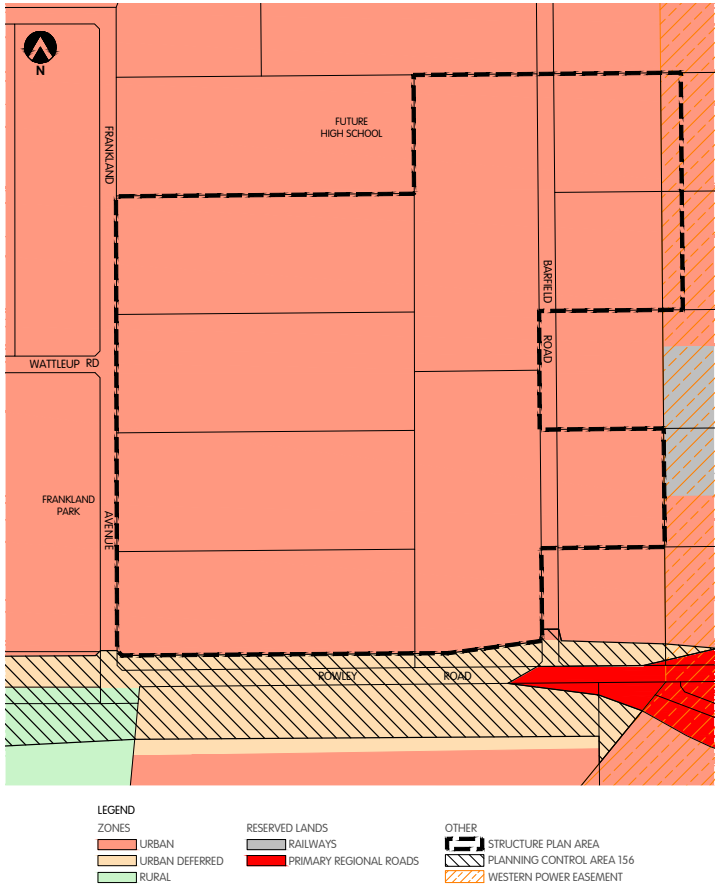


Figure 5: TPS Zoning

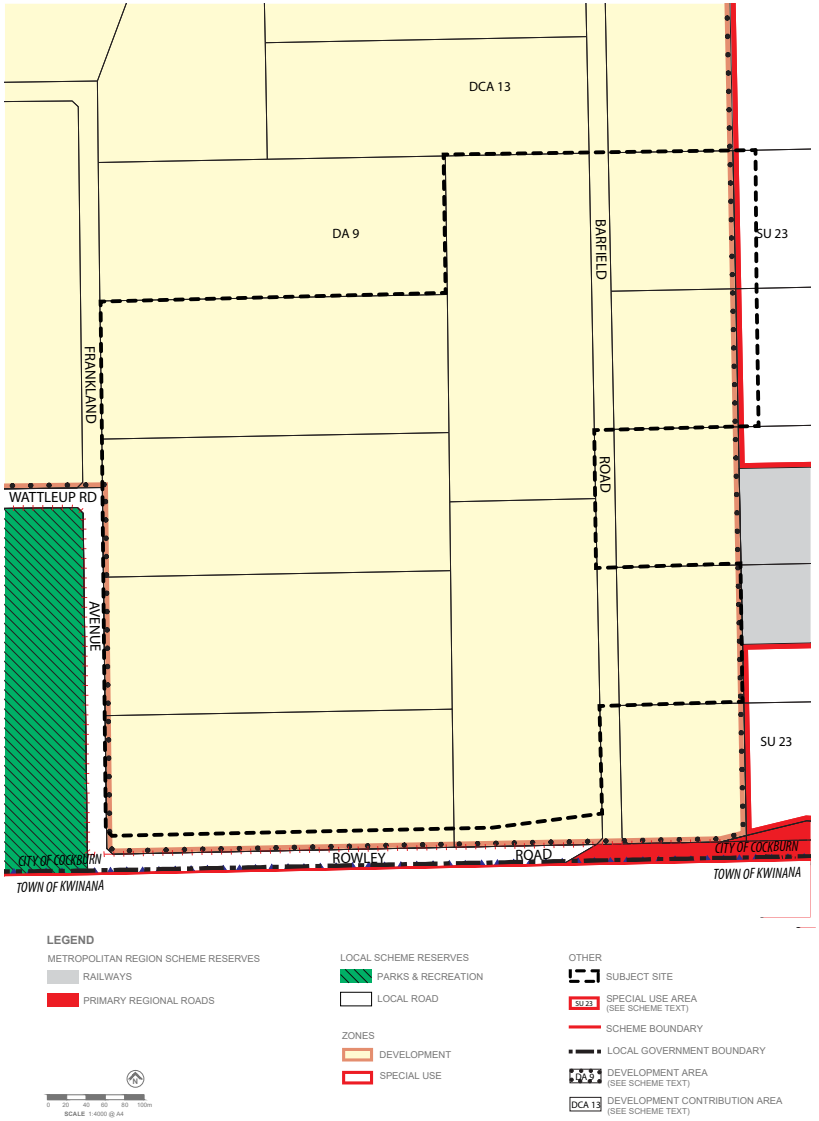


Table 1 - Lot Details and Ownership Summary

Lot No.	Street Address	Ownership	Volume & Folio (CT)	Plan No.	Area (ha)
15	171 Barfield	Gold Estates Holdings Pty Ltd	1913/170	30747	1.8650
16	Not Allocated	Gold Estates Holdings Pty Ltd	1913/48	30747	1.8606
18	205 Barfield	Gold Estates Holdings Pty Ltd	2058/447	30747	1.8614
Area Previously Subdivided					29.15
Total Area (not including portion of Barfield Road in Structure Plan area)					34.7370
Total Structure Plan Area					36.597

1.3 Planning framework

1.3.1 Zoning and reservations

1.3.1.1 Metropolitan Region Scheme

The Structure Plan area is zoned 'Urban' under the provisions of the Metropolitan Region Scheme (MRS). A portion of the Structure Plan area, being the Rowley Road Planning Control Area, is zoned 'Urban Deferred'.

1.3.1.2 City of Cockburn Town Planning Scheme No. 3

The Structure Plan area is zoned 'Development' (Development Area 9) under the provisions of the City of Cockburn Town Planning Scheme No.3 (TPS 3). Cl 4.2.1 provides the following objectives for the 'Development' zone:

i. Development Zone

To provide for future residential, industrial or commercial development in accordance with a comprehensive Structure Plan prepared under the Scheme.

As a requirement for land zoned 'Development' in TPS 3, a Structure Plan has to be prepared prior to Council providing comment on subdivision applications and determining development applications. This Structure Plan report has been prepared in accordance with requirements listed under Cl. 6.2.6 of TPS 3.

In addition, the Structure Plan area is subject to Development Area 9 (DA 9) where there is a requirement that in the event that retail uses are proposed in the Local Centre, these are not to exceed a maximum of 200m^2 NLA.

1.3.2 District Structure Plan

1.3.2.1 Southern Suburbs District Structure Plan Stage 3

The Structure Plan area is subject to the provisions of the Southern Suburbs District Structure Plan Stage 3 (SSDSP3) prepared by the City of Cockburn. The SSDSP3 was endorsed by the City of Cockburn Council and adopted in September of 2012.

The SSPDP3 provides a framework for urban land uses that integrates with the broader Sub-Regional context. Under the provisions of the SSDSP3 medium and high density residential development, a local centre and public open space network are identified for the Structure Plan area. The Structure Plan is consistent with the intent of the SSDSP3 providing a network of open spaces, medium density residential development, with higher densities and a childcare centre within the identified local centre.

1.3.3 State Policies

1.3.3.1 State Sustainability Strategy

The State Sustainability Strategy provides an overarching framework for the State Government to respond to the sustainability agenda. The Strategy identifies the following six broad goals and 42 strategy areas intended to fulfil these goals and to guide Government action towards achieving its vision for a sustainable Western Australia:

- Sustainability and governance;
- Contributing to global sustainability;
- Sustainable natural resource management;
- Sustainability and settlements;
- Sustainability and community; and
- Sustainability and business.

The policy objectives of the State Sustainability Strategy are incorporated into the planning system through State and Local Government policy and formally applied through planning decisions. The role of sustainability - economic, environmental and social - is fundamental to the planning of the site and is implicitly embodied in the content of this Structure Plan.

1.3.3.2 State Planning Strategy

The State Planning Strategy (1997) was prepared by the WAPC as a whole of Government approach to guide sustainable land use planning throughout the State up until 2029. The Strategy is aimed at developing a land use planning system to help the State achieve a number of key goals. These include generating wealth, conserving and enhancing the environment and building vibrant and safe communities for the enjoyment of this and subsequent generations of Western Australians. The Strategy was last audited in 2000- 2001. The Structure Plan is consistent with the goals and objectives of the State Planning Strategy.

1.3.3.3 Directions 2031 and Draft Outer Metropolitan Perth and Peel Sub-Regional Strategy

Directions 2031 and beyond (Directions 2031) is the high level spatial framework and strategic plan for metropolitan Perth and Peel regions. Directions 2031 provides a framework for the detailed planning and delivery of housing, infrastructure and services necessary for a variety of growth scenarios.

Directions 2031 identifies growth scenarios for low, medium (Connected City approach) and high-density rates of infill and greenfield development. The Connected City scenario, identified as the preferred growth scenario, was modelled to determine the area of greenfield land required to provide for a city of 3.5 million people. Consistent with the outcomes of this approach, Directions 2031 sets a target of 15 dwellings per gross urban zoned hectare land in development areas.

Directions 2031 is supported by a series of Sub-Regional Strategies. Each Sub-Regional Strategy provides information about the levels of expected population growth in individual local government areas. They also identify development opportunities and prospects for increased density within Greenfield areas, facilitating the housing targets outlined in Directions 2031.

The Structure Plan area is included within the South-West Sub-Region identified within the Draft Outer Metropolitan Sub-Regional Strategy for Perth and Peel (Draft OMPPSS). The South-West Sub Region is expected to supply 119,760 dwellings under the adopted 'Connected City' scenario. 18,280 of these dwellings are expected to come from greenfield sites within the City of Cockburn.

The Draft OMPPSS identifies the Southern Suburbs District Structure Plan area as 'urban zoned undeveloped' with an expectation to provide '3000+' dwellings. In proposing approximately 545 dwellings the Structure Plan provides for 18% of the estimated dwellings in this location.

1.3.3.4 Liveable Neighbourhoods

Liveable Neighbourhoods, Edition 3 (LN 3) is a Western Australian Planning Commission (WAPC) policy used to guide the design and assessment of structure plans (regional, district and local) and subdivision and development applications for new urban areas. Its aims include promoting the design of walkable neighbourhoods; places that support community and a sense of place; mixed uses and active streets; accessible and sustainable parks; energy efficient design; and housing choice.

The key initiatives of LN 3 are covered under eight design elements. The implementation of each of these elements and the fulfilment of the overall principles of LN 3 will be fundamental to ensuring that development of the structure plan area and the wider metropolitan region occurs in a thoughtful and sustainable manner. Application of the LN 3 principles is therefore relevant to all levels of planning for the site from the proposed Structure Plan through to detailed lot and building design.

By providing for a diverse range of housing within a connected and walkable neighbourhood, configured around a range of accessible open space areas, the Structure Plan reflects the requirements of LN 3. A comprehensive justification of the design in relation to the principles outlined in LN 3 is provided in Section 3.0.

1.3.3.5 State Planning Policy No.1: State Planning Framework

State Planning Policy No.1: State Planning Framework (SPP1) unites existing state and regional policies, strategies and statements under a central framework to provide a context for decision-making on land use planning and development matters in Western Australia. The Structure Plan is consistent with the primary aim of this overarching policy, which can be summarised as "…to provide for the sustainable use and development of land." The WAPC and local government will refer to the relevant planning instruments referred to under SPP1 for all planning decisions, including those concerning the Structure Plan and subsequent planning proposals presented for the site.

1.3.3.6 State Planning Policy No.2: Environmental and Natural Resources Policy

State Planning Policy No.2: Environment and Natural Resources (SPP2) sets out a planning response to environment and natural resource management issues within the framework of the State Planning Strategy.

Specific policy areas of relevance to the site include those relating to, soil and land quality, biodiversity, landscapes, greenhouse gas emissions and energy efficiency. Site responsive measures are detailed in Section 2.0.

1.3.3.7 State Planning Policy No.3 Urban Growth and Settlement

State Planning Policy No.3: Urban Growth and Settlement (SPP3) applies to the whole of the State in promoting sustainable and well planned settlement patterns that have regard to community needs and are responsive to environmental conditions. The objectives and principles of Directions 2031 and Liveable Neighbourhoods are enshrined in this Policy.

SPP3 recognises that a majority of new development in metropolitan Perth has been in the form of low-density suburban growth. This form of development intensifies pressure on valuable land and water resources; imposes costs in the provision of infrastructure and services; increases the dependence on private cars; and creates potential inequalities for those living in the outer suburbs where job opportunities and services are limited.

To promote growth that is sustainable, equitable and liveable, SPP3 encourages a more consolidated urban form. In general terms the proposal for the site is consistent with the high level principles of SPP3.

This Structure Plan will facilitate:

- access to public transport (bus and rail);
- suitable access to areas of high quality POS;
- the creation of cohesive and walkable communities through the application of traditional neighbourhood design principles; and
- a diversity of housing types and lot sizes.

1.3.3.8 State Planning Policy No. 5.4 Road and Rail Noise

State Planning Policy No.5.4: Road and Rail Noise (SPP5.4) addresses transport noise from within major transport corridors, including primary freight routes and their impact on sensitive land uses in close proximity. SPP5.4 is relevant as the Structure Plan represents:

- A proposed new noise-sensitive development in the vicinity of an existing or future major road, rail or freight handling facility.

Rowley Road has been identified as an important future strategic freight route and is expected to undergo significant redevelopment. SPP5.4 sets out the outdoor noise criteria that applies to proposals for new noise sensitive development and proposes a variety of possible noise management and mitigation measures including the use of:

- Noise attenuation barriers (noise walls); and
- Building design and construction techniques.

Details relating to noise and the treatment of the interface between Rowley Road and the Structure Plan area are provided in Section 3.4.

1.3.4 City of Cockburn Strategies and Policies

1.3.4.1 City of Cockburn Local Planning Strategy

The SSDPS3 states that the District Structure Plan is consistent with the following actions outlined in the City of Cockburn Local Planning Strategy (LPS):

- Promote higher density and mixed use developments to reduce car use and promote, walking and public transport;
- Ensure there is an appropriate housing and density mix to fulfil existing and potential demand from various groups;
- Promote medium and high density housing in and near regional and district centres and near public transport facilities;
- Provide a range of housing opportunities; and
- Promote mixed land uses in communities, especially through the location of housing in commercial centres.

The Structure Plan remains generally consistent with the SSDPS3 and as such is in accordance with the above actions within the LPS.

1.3.4.2 Local Planning Policy 5.19 - Structure Plans and Telecommunications Infrastructure (LPP 5.19)

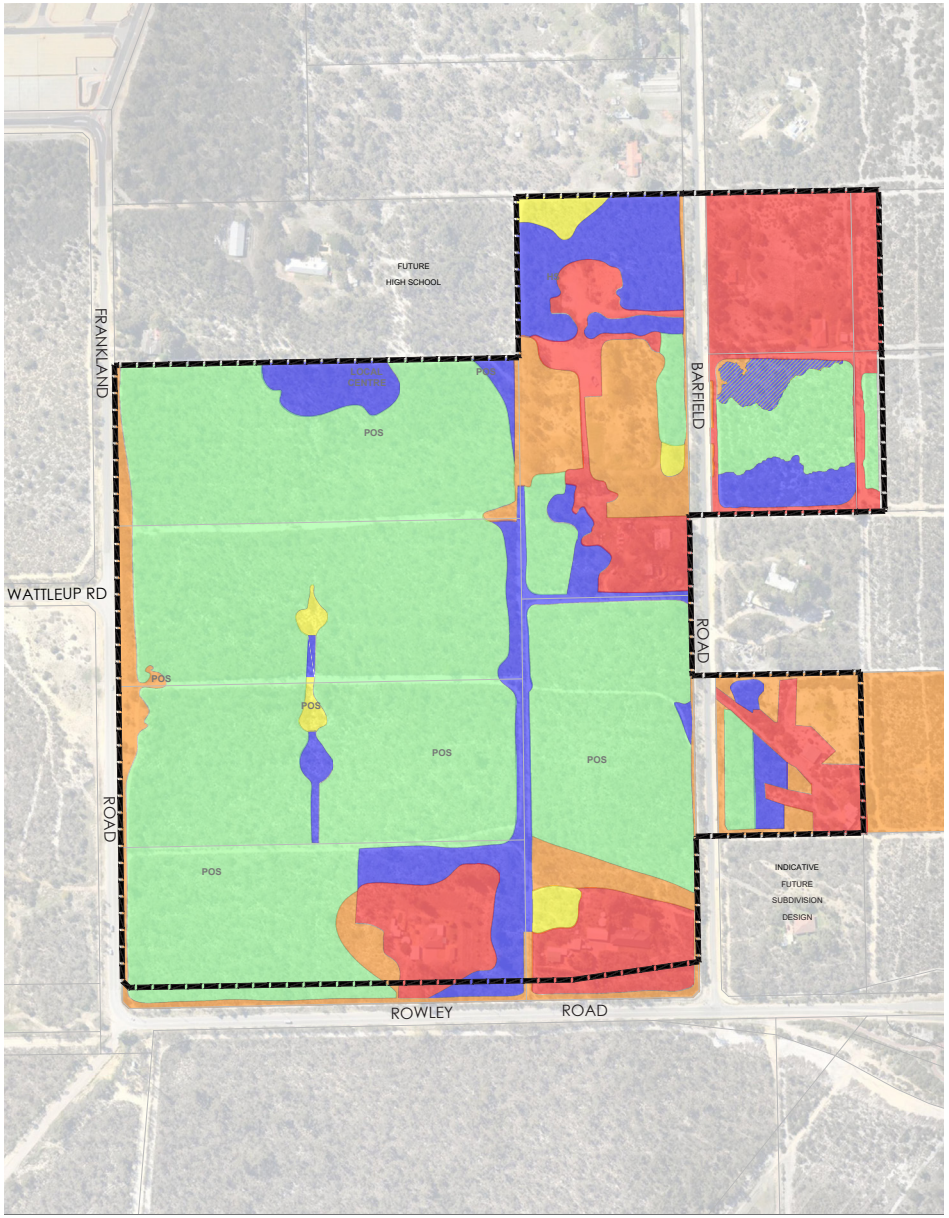
LPP 5.19 requires structure plans to provide evidence of consultation with telecommunications carriers responsible for operating mobile telecommunications infrastructure, to ensure infrastructure requirements are outlined at the earliest stage of planning. As identified within the Structure Plan, a fibre optic cable located along Rowley Road will service the proposed subdivision with Lot 16 being serviced through extending the existing network on Barfield Road. Mobile coverage from all major providers is available throughout the Structure Plan area.

Hatch have attempted to contact the major service providers to obtain written confirmation regarding the operation and potential upgrades of telecommunication services in the area, however, no direct line of contact has been possible. Every attempt to contact the providers directly, resulted in being referred to the general enquiry number. Through the coverage mapping provided on each providers website, confirmation of the provision of telecommunication services is provided, with all major providers (Optus, Telstra and Vodafone) providing the structure plan area with 4G, and Telstra and Vodafone providing 5G across the structure plan site.

1.3.4.3 Local Planning Policy 1.12 - Noise Attenuation (LPP 1.12)

Local Planning Policy 1.2 – Noise Attenuation (LPP1.12) requires structure plans to demonstrate that consideration has been given to future noise levels and proposes appropriate mitigation measures. Lloyd George Acoustics have prepared a Noise Management Report (Appendix 5) in support of this structure plan, in accordance the current version of LPP 1.12.

Figure 6: Vegetation Condition



2.0 Site Conditions And Environment

2.1 Environmental assets and constraints

2.1.1 Vegetation and Flora

A Level 2 flora and vegetation assessment was undertaken by Ecoscape during October and November 2008. The vegetation within the Structure Plan area is described as being predominantly Banksia and Jarrah-Banksia woodlands on Quaternary marine dunes of various ages, including the Bassendean System (Ecoscape, 2009a).

According to Heddle et al. (1980), the Structure Plan area is comprised of the Bassendean (Central and South) Vegetation Complex. The Complex is described as ranging from woodland of Eucalyptus marginata-Allocasuarina fraseriana-Banksia spp., to low woodland of Melaleuca spp. and sedgelands on moister sites (Ecoscape, 2009a).

While only one vegetation community was recorded on-site: Banksia spp. - Allocasuarina fraseriana Low Woodland, there was variation in the density of the various species within the community across the Structure Plan area.

The vegetation condition of the Structure Plan area was assessed and mapped using the Keighery (1994) Bushland Condition Scale and ranged from excellent (with few weeds and little sign of human disturbance) to completely degraded (associated with houses, gardens and areas of high disturbance). The condition of vegetation in the Structure Plan area is shown in Figure 6 and is described in more detail in the Environmental Assessment Report contained in Appendix 1.

2.1.1.1 Threatened Ecological Communities

A search of the Department of Environment and Conservation's (DEC) Threatened and Priority Ecological Communities (TECs and PECs) database was undertaken and four TECs were identified as occurring in the vicinity of the Structure Plan area:

- SCP 26a - Melaleuca huegelii - Melaleuca acerosa shrublands on limestone ridges (Endangered)
- SCP 10a - Shrublands on dry clay flats (Endangered)
- SCP 08 - Herb rich shrublands in clay pans (Vulnerable)
- SCP 30a - Callitris preissii (or Melaleuca lanceolata) forests and woodlands, Swan Coastal Plain (Vulnerable)

In addition, two Priority Ecological Communities are also known to occur in the vicinity of the Structure Plan area:

- SCP 24 - Northern Spearwood shrublands and woodlands
- 29a - Coastal shrublands on shallow soils

None of the TEC or PECs identified by the DEC's database search was found during the field survey of the Structure Plan area (Ecoscape, 2009a).

2.1.1.2 Flora

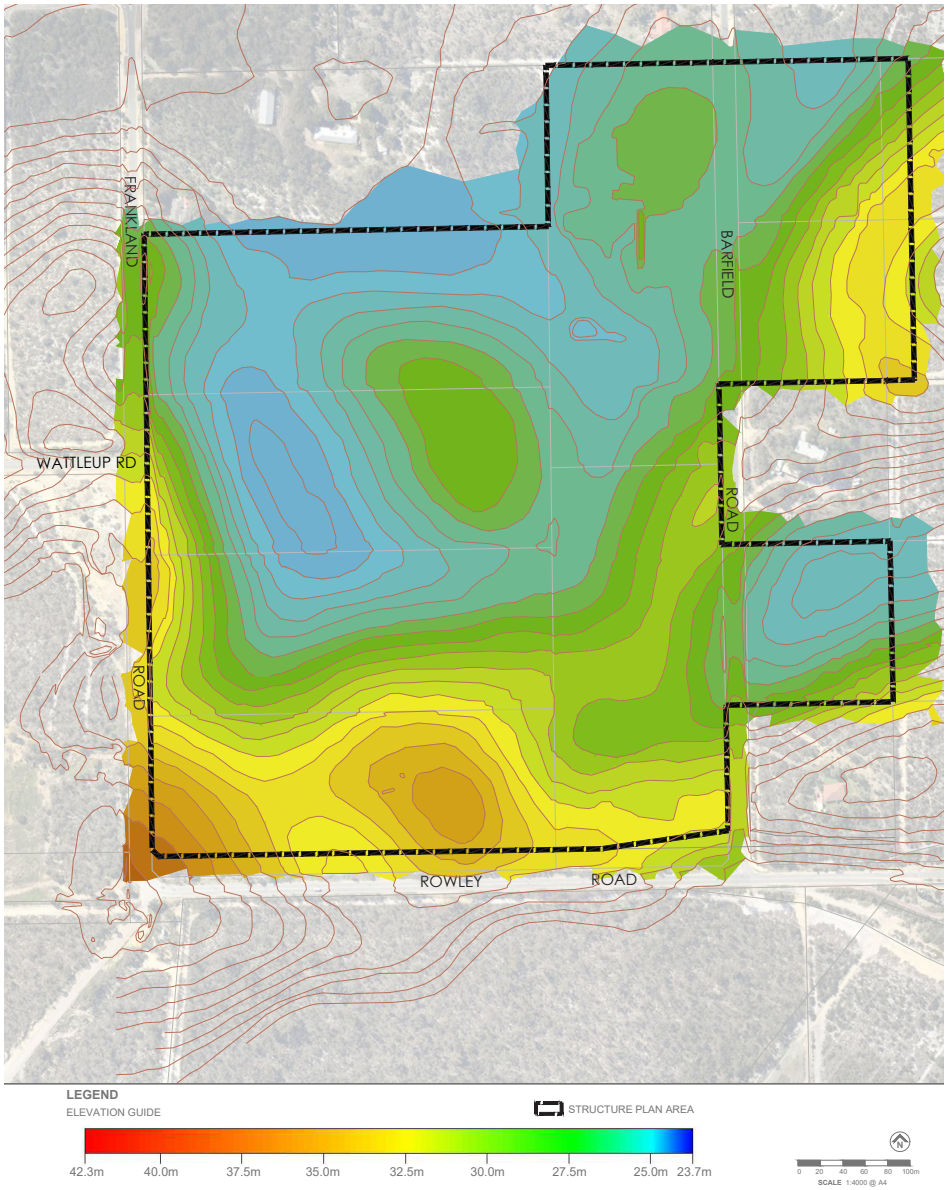
In total 149 vascular plant species were recorded from the Structure Plan area including 32 introduced weed species (Ecoscape, 2009a). The weeds recorded on-site include 10 species rated as high risk according to the Environmental Weed Strategy for Western Australia (Department of Conservation and Land Management, 1999), and one that is a Declared Plant (Department of Agriculture and Food Western Australia, 2008). Weeds that are high risk are those that have the ability to invade bushland that is in good to excellent condition, have a wide current or potential distribution, and have the ability to change the structure, composition and function of ecosystems, often forming monocultures (Ecoscape, 2009a).

During the field survey, a targeted search for Threatened and Priority Flora was conducted using a grid survey at 20m spacing 10m either side of a walked line. No Threatened Flora listed under the Western Australian Wildlife Conservation Act (1950), species listed under the EPBC Act (1999), or DEC Priority listed species were found to be located on-site during the spring survey (Ecoscape, 2009a).

The POS network has been designed to maximise the retention of vegetation identified as being in an excellent condition. There are no Threated or Priority Flora or Threatened or Priority Ecological Communities found on-site. Landscaping will focus on the retention of the overstorey canopy of Banksia woodland where possible in order to provide potential foraging habitat for Carnaby's Cockatoo.

The updated Environmental Assessment and Management Strategy concludes that Lot 16 consists of native regrowth vegetation with no threatened or priority flora species identified within the site.

Figure 7: Contour Plan



2.1.1.3 Fauna

A level 1 fauna assessment of the Structure Plan area was undertaken by Ecoscape in 2009. The assessment included a reconnaissance survey by suitably qualified personnel to undertake selective, low intensity sampling of the fauna and faunal assemblages in order to verify the accuracy of the desktop assessment and to further delineate and characterise the fauna and faunal assemblages present within the Structure Plan area.

None of the species identified on-site during the reconnaissance survey were conservation significant species (Ecoscape, 2009b).

The remnant vegetation of the Structure Plan area is predominantly Banksia Woodland which is a preferred foraging species for the Black Cockatoo species. Minor signs of Cockatoo feeding activity were observed on-site during the reconnaissance survey although the species could not be definitively identified (Ecoscape, 2009b). The site also contains some significant Jarrah (Eucalyptus marginata) trees, defined by the Department of Sustainability Environment Water Population and Communities as having a diameter at breast height (DBH) exceeding 0.5 m, or showing development of hollows suitable for cockatoo nesting.

The Structure Plan provides a network of POS areas which maximise the retention of vegetation identified as being in very good to excellent condition. In addition to the POS network, road reserves have been widened in places to retain significant trees. This will ensure that some habitat which may have the potential for Carnaby's Cockatoo foraging will be retained.

Due to the proposed clearing of potential foraging and nesting habitat, the proposed development is likely to have an impact on the Carnaby's Black Cockatoo species. An EPBC Act referral is therefore currently being prepared for the site for submission to the DSEWPaC.

2.2 Landform and soils

The Structure Plan area is located in the transition area between the Spearwood Dune System and the Bassendean Sands System (Gozzard, 1983), with the Spearwood Dune System overlying the older Bassendean Sands System that lies to the east (Churchward and McArthur, 1980). The topographic elevation at the site ranges from 24m AHD along the northern and eastern boundaries, to 40m AHD along the south-western corner with multiple ridge lines running through the site. The grade of the topography in some areas is up to 15%.

The site is identified as having a moderate to low risk of Acid Sulphate Soils occurring within 3m of natural soil surface or deeper (Western Australian Planning Commission, 2009a).

A search of the DEC's Contaminated Sites database confirmed that there are no known contaminated sites within the site.

As a result no management recommendations or commitments are required to be implemented with respect to either of these factors.

The site's topography is shown in Figure 7.

2.3 Groundwater and surface water

A desktop analysis of the Structure Plan area confirms that there are no wetlands identified in the DEC's Geomorphic Wetlands Swan Coastal Plain dataset as being located either on or adjacent to the site.

The Department of Water's (DoW) Perth Groundwater Atlas (2008) identifies that the groundwater flow beneath the Structure Plan area is generally in a westerly to south-westerly direction. Based on the groundwater monitoring, groundwater levels underlying the Structure Plan area range from 18.75 mAHD to 21 mAHD with a depth to groundwater ranging from 5m to 10m (Cardno WA)

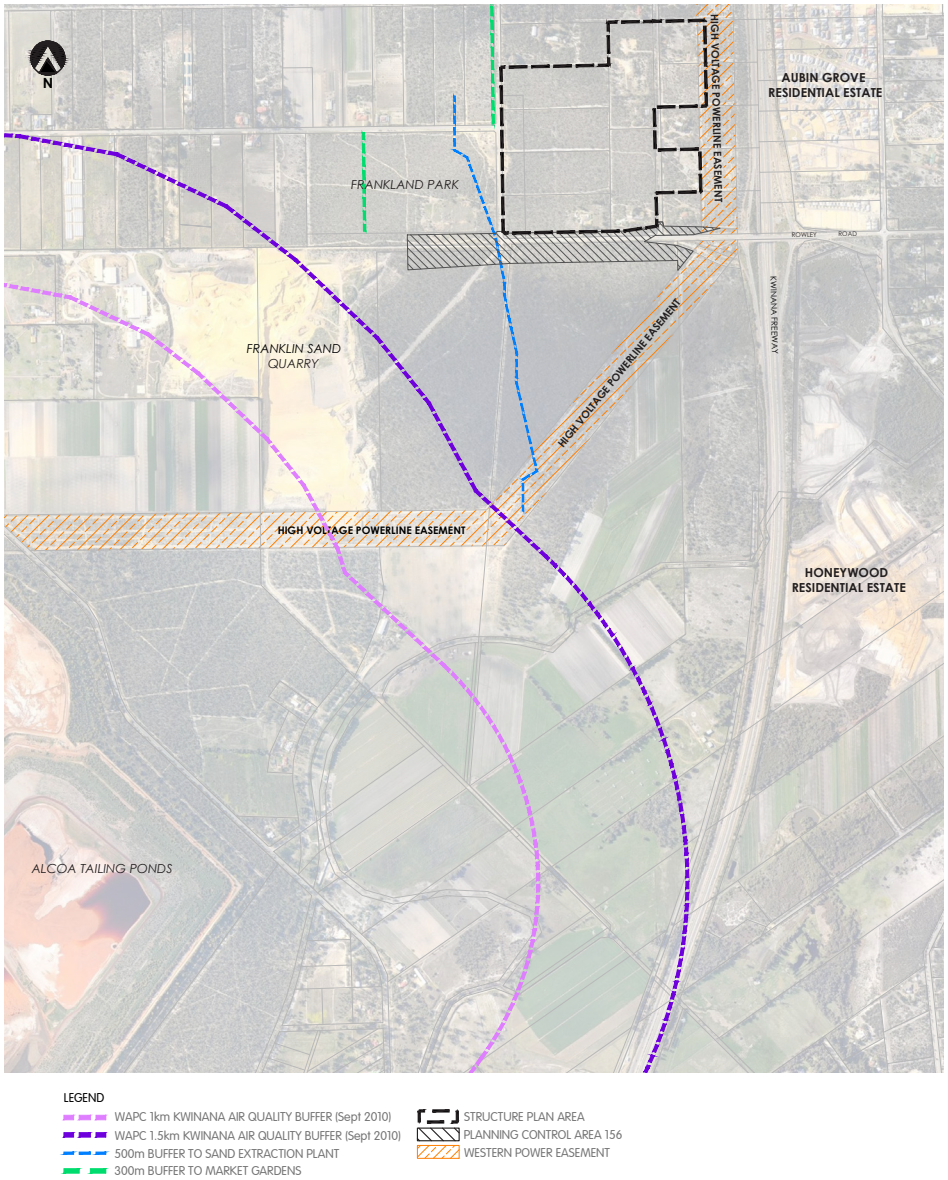
The EPBC Protected Matters Search Tool identifies the site as being located upstream from the Peel-Yalgorup System catchment (Australian Government, 2012), while two Ramsar wetlands are located within 10 km of the Structure Plan area: Forrestdale Lake is located approximately 7.45 km to the north-east and Thomsons Lake approximately 3.13 km to the north-west.

A search of the WA Atlas confirms that there are no wetlands identified in the DEC's Geomorphic Wetlands Swan Coastal Plain dataset as being located either on or adjacent to the Structure Plan area.

There are no defined watercourses, streamlines or floodways located on-site (Cardno, WA).

Surface water and drainage is addressed in the detail in the Local Water Management Strategy (LWMS) prepared by Emerge Associates following groundwater monitoring in accordance with agency requirements. The LWMS is provided in Appendix 2.

Figure 8: Context and Constraints Plan



2.4 Bushfire hazard

A Bushfire Management Plan has been prepared in order to address the requirements for bush fire preparedness and bush fire damage mitigation. The implications of the Bushfire Management Plan are outlined further in 3.7 and a copy of the report is contained in Appendix 3. An updated BMP has been prepared by JBS&G to include Lot 16.

2.5 Context and constraints analysis

A Western Power easement and the Kwinana Freeway are located directly east of the Structure Plan area with Rowley Road, which runs in an east west direction, abutting the site's southern boundary. Land on the southern side of Rowley Road is currently uncleared and zoned 'urban deferred'. A sand quarry and the ALCOA Mandogalup Residue Disposal Area are a further 540m and two kilometres respectively to the south west. Frankland Park is located immediately to the west of the Structure Plan area.

2.5.1 Western Power Easement

A Western Power easement abuts the Structure Plan area to the east. Subdivision will encroach into part of the Western Power easement on Lots 37 and 38 Barfield Road, to provide a subdivisional road.

2.5.2 Rowley Road

Rowley Road borders the Structure Plan area to the south and has been identified as a future strategic freight route and as such is designated as a Planning Control Area by the Western Australian Planning Commission (WAPC). With the planning and development of the Latitude 32 Industry Zone and the future Outer Harbour to the west, Rowley Road has been identified as an east-west freight link of strategic importance. Redevelopment of Rowley Road to a single carriageway in order to allow for efficient and safe truck movement is seen as a high priority in the SSDSP3. To maintain the viability of Rowley Road as a freight route and progress the development of the Structure Plan area, it is a requirement that the interface is treated appropriately (in accordance with SPP 5.4 outlined in Section 1.3.3.8). The treatment of this interface is outlined in Section 3.4 of this report.

Figure 9: Structure Plan



2.5.3 Sand Extraction Plant

A sand extraction plant is located on the southern side of Rowley Road approximately 540 metres southwest of the site and is identified in figure 8. The EPA's Guidance Statement 3: Separation Distance between Industrial and Sensitive Land Uses (Environmental Protection Authority, 2000) recommends a generic separation buffer of 500 m to protect sensitive land uses such as residential, from the impacts of noise and dust emissions.

Given that the separation distance between the sand extraction plant and the site exceeds the EPA's 500m buffer and the site is nearing completion as a sand source, the plant is not a constraint to development in the Structure Plan area.

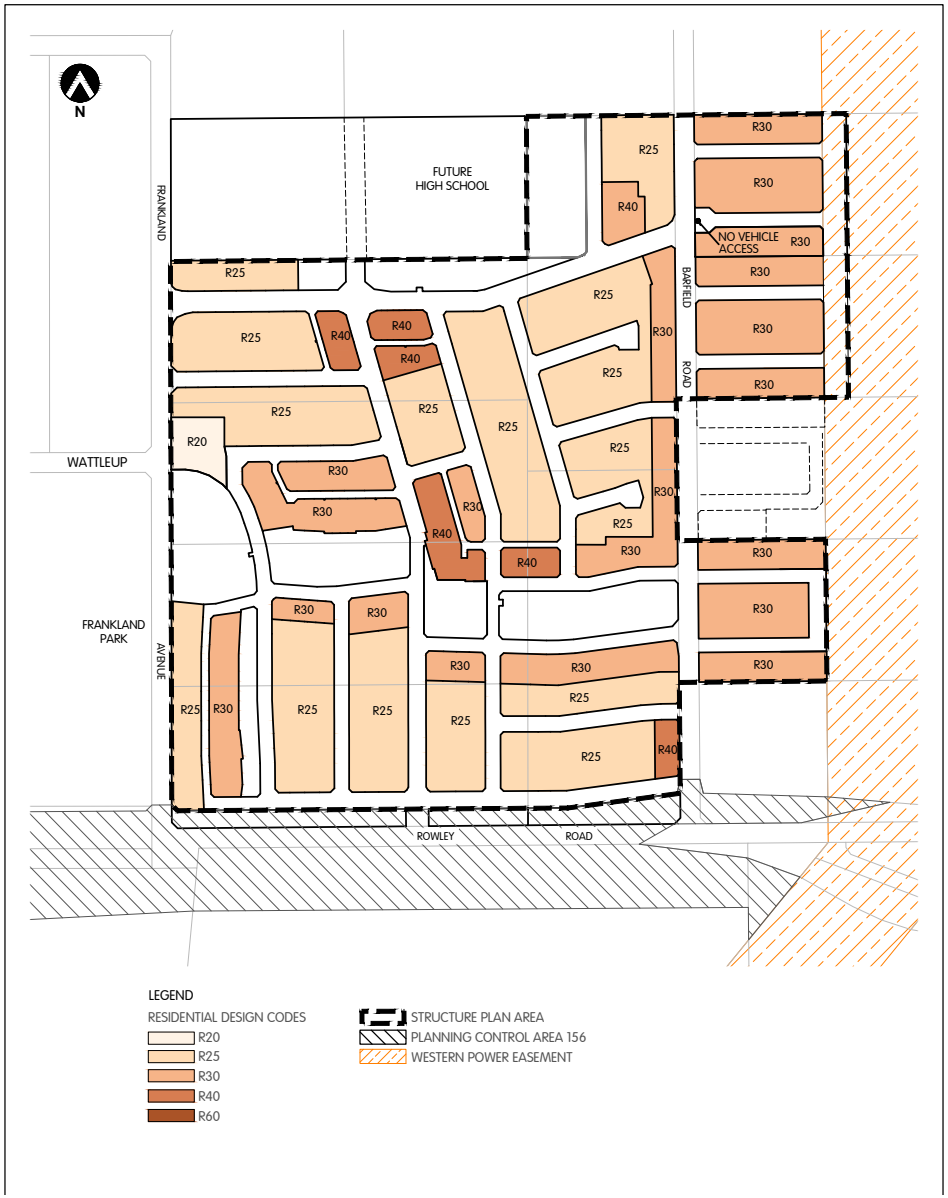
2.5.4 Mandogalup Residue Disposal Area

Alcoa's Mandogalup Residue Disposal Area (RDA) is located approximately two km to the south-west of the Structure Plan area (refer to figure 8). As detailed in the appended EAR a 1.5 kilometre buffer is provided for the RDA. Given that the separation distance between the RDA and the site exceeds the WAPC's 1.5 km buffer, the land use is not a constraint upon the proposed development of the site.

2.5.5 Frankland Park

Frankland Park is located to the west of the Structure Plan area. The land is reserved Parks and Recreation in TPS 3 to preserve and protect the existing vegetation and to provide district level playing fields in the southeast section of the Park.

Figure 10: Residential Density Plan



3.0 Structure Plan

3.1 General

In accordance with SSDPS3 the Structure Plan provides for a range of residential densities, a well-designed POS network and a local centre. The location of POS is generally consistent with that prescribed in the SSDSP3 with some areas configured to retain significant trees and Banksia woodland identified as very good to excellent in condition.

Whilst not formally part of the Structure Plan, provision has been made for an indicative future road layout over the adjacent properties located to the east of Barfield Road. A 'shared road' design off Barfield Road has been incorporated along property boundaries to ensure development opportunities apply to all landowners.

3.2 Land use

A child care premises is located in the local centre. A childcare centre facility would complement the high school and primary schools identified directly north of the Structure Plan area, providing a clustering of educational uses.

Medium density development has been positioned in areas of high amenity, specifically adjacent to high quality POS. In the south west corner and the central areas of the Structure Plan, medium density development has been configured around areas of POS featuring either retained vegetation or landscaped parks capitalising on the preserved amenity or enhanced landscaping.

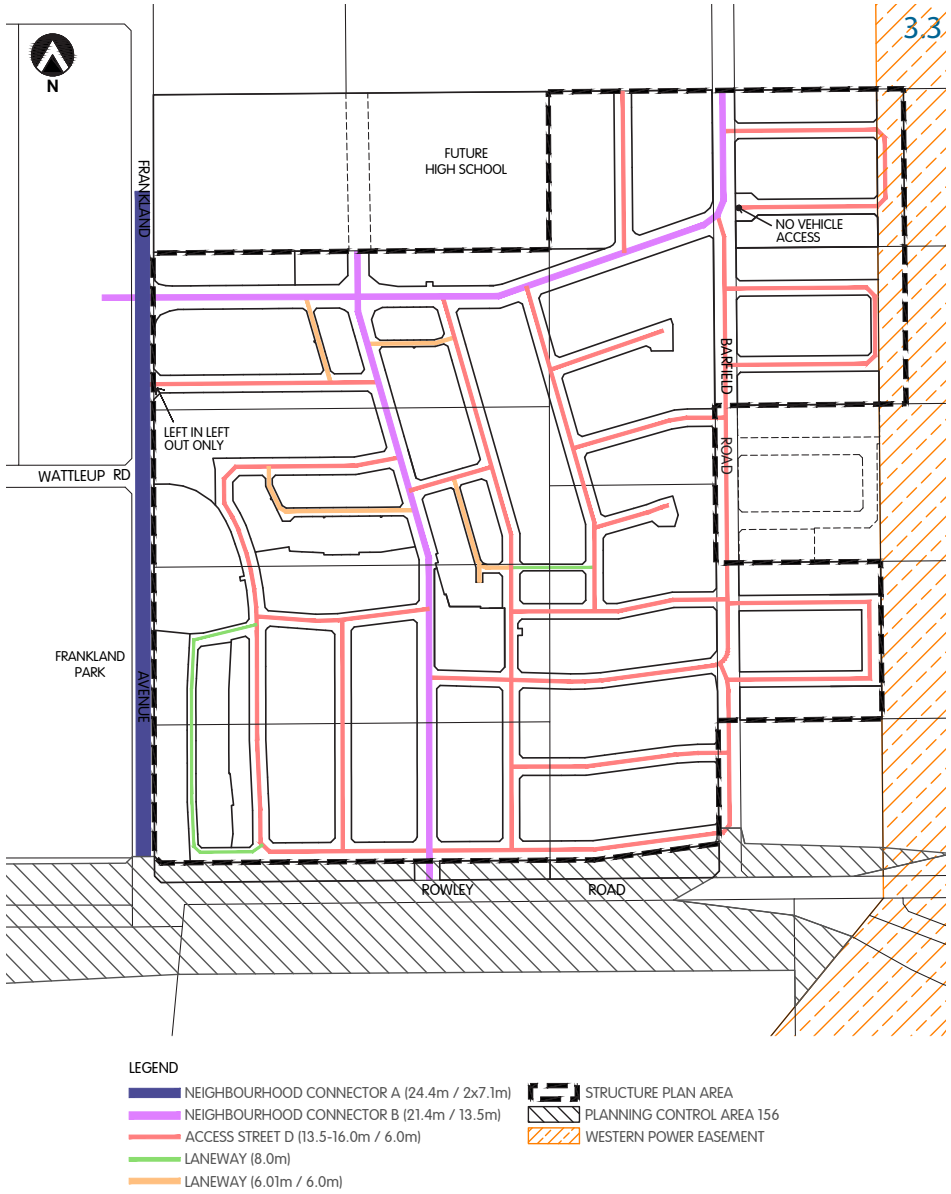
The proposed design for the Structure Plan is illustrated in Figure 9.

An overview of the Structure Plan and its key elements is provided in Table 2 below.

Table 2 - Structure Plan Summary Table

Item	
Total area covered by the structure plan	36.597 ha
Area of specified land use	Residential: 22.09 ha POS: 3.9 ha Road Reserve: 9.597 ha Local Centre: 0.15 ha High School Site: 0.86 ha
Estimated Lot Yield	545
Estimated number of dwellings	545
Estimated population	1400 people
Number of high schools (portion)	1
Number of primary schools	0
Estimated retail floor space	0
Estimated employment provided (no. of jobs)	5
Number and area of public open space	
: District parks	0
: Neighbourhood parks	3.9 ha

Figure 11: Movement Network Plan



Residential

The residential densities have been configured to reflect the requirements of SSDSP3. In this regard higher densities have been provided adjacent to POS areas and the local centre.

The densities proposed within the Structure Plan range from R25 to R60, based upon the specifications of SSDSP3 and the site's conditions and characteristics. The proposed mix will respond to a variety of demographics and cater for a range of household compositions (refer Figure 10).

A high point in the south west corner of the Structure Plan area provides an opportunity to elevate residential development and obtain views to the retained vegetation in the adjacent POS. Residential development in this corner will be retained with the objective of facilitating the gradient, retaining the vegetation and maximising view opportunities.

The proposed road network orientation north-south and east-west will ensure that all lots will be able to provide passive solar design opportunities for the built form and layout of future dwellings.

Table 3 provides a summary of the dwelling yield and number of dwellings per hectare. The average yield achieves the benchmarks advocated in Directions 2031, notwithstanding the combination of the provision of POS in excess of the standard requirements for POS contribution in order to facilitate a broad range of POS functions, and the accommodation of part of the proposed High School within the Structure Plan area. The Structure Plan exceeds the dwelling target provided in Liveable Neighbourhoods.

Lot 16 proposed lot sizes range from 302m^2 - 450m^2 with an approximate yield of 40 lots. This lot range in yield accords with the R30 coding proposed for the site.

Figure 12: Rowley Road Interface



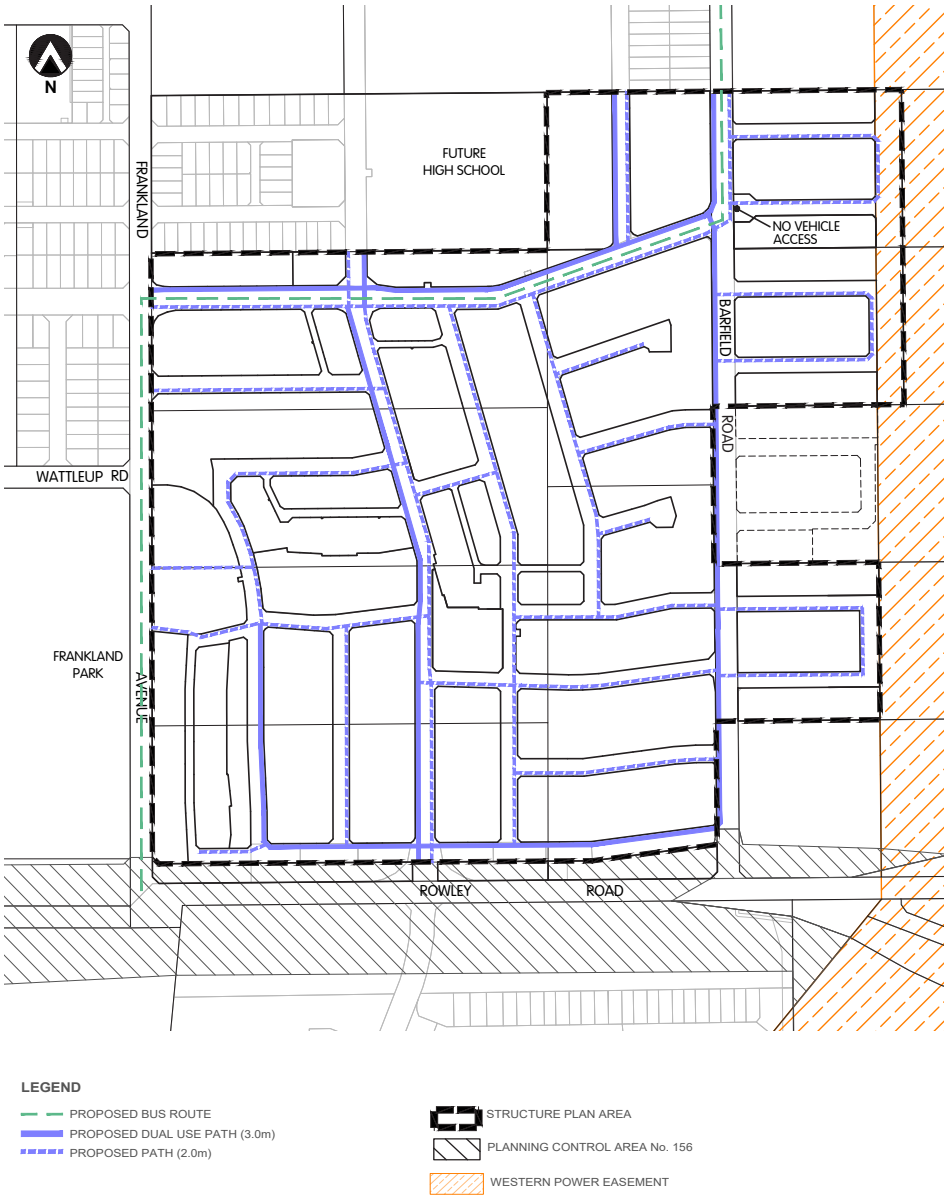
Table 3: Density Target Summary

Planning Document	Target	Proposed
Direction 2031	15 dwellings per hectare (urban zoned land: 36.597 ha)	15 dwellings per hectare
Liveable Neighbourhoods	22 dwellings per site hectare (residential land: 22.09 ha)	24.7 dwellings per hectare

3.4 Movement networks

The hierarchy of streets within and adjacent to the Structure Plan area is based on the hierarchy defined within Liveable Neighbourhoods. The proposed design provides for a permeable, interconnected road network that provides ease of movement for pedestrians, cyclists and motorists within the Structure Plan area. The below discussion on the proposed transport network relates to the Road Hierarchy Plan provided as Figure 11 and the Cycle/Footpath Plan provided as Figure 13.

Figure 13: Cycle/Footpath and Public Transport Plan



Connection to Rowley Road is proposed at two points, this being Frankland Avenue and the proposed Neighbourhood Connector B which runs north/south through the Structure Plan area. These connections are short-medium term only and subject to rationalisation in preparation for when Rowley Road is upgraded to a strategic freight route.

In this regard the following provides an access and staging strategy for Rowley Road:

- At first stage subdivision, full access provisions for an entry road to the estate (Neighbourhood Connector B) comprising a roundabout.
- At a time to be agreed between Main Roads WA and the proponent, the final intersection configurations will comprise the following:
  - Access to and from Rowley Road for the Neighbourhood Connector B being removed;
  - Barfield Road to be a cul-de-sac; and
  - Access to and from Rowley Road for Frankland Avenue will ultimately only allow for a Left In/Left Out intersection.

Future landowners will be made aware of the temporary nature of these connections through information packages made available during the sales process, notifications on title and signs at each of the intersections.

Rowley Road has been identified as an important east–west freight route, servicing the developing Latitude 32 Industry Zone (Latitude 32) and future Westport Infrastructure project. As such, Rowley Road is planned to be widened and redeveloped. It is not expected that Latitude 32 or the Outer Harbour will become operational in the short to medium term; however as a high volume of trucks use both Rowley and Frankland Roads it is expected that Rowley Road will be constructed on an alignment between Frankland and Mandogalup Roads as a first phase of upgrading works.

Because Rowley Road is designated as a major freight route, there will be a requirement to provide a three metre high noise wall along the southern boundary of the Structure Plan area. In accordance with the requirements of the SSDSP3, residential lots do not directly abut Rowley Road. The Structure Plan proposes lots that front an internal road, are configured adjacent to a nine metre landscape verge that effectively screens the road and noise wall whilst retaining existing vegetation. A conceptual cross-section depicting the manner in which the interface will be treated is shown in Figure 12.

Notifications will also be provided on Certificates of Title for all lots in the noise affected area as identified in the Noise Management Plan contained in Appendix 5.

The SSDSP3 identifies a 'bridge structure' to allow for vehicle access between the Structure Plan area and urban development to the south. In this regard the Structure Plan retains Barfield Road on its current alignment and within a 20m reserve, if this connection is required at some point in the future.

Access to the Structure Plan area will be achieved closer to the existing Rowley and Frankland Road intersection. This access road will ultimately act as a 'civic avenue' passing through the local centre and past a Primary School and a high school. Following a comprehensive traffic assessment the intersection at Rowley Road has been deemed suitable in the short-term with the provision of a 4-way roundabout.

The internal street network is premised on a north-south and east-west pattern, with regular intersections to allow a high level of accessibility for pedestrians, cyclists and vehicles. Due to the positioning of several areas of POS, the street network also provides view corridors to these POS parcels. The internal street network primarily comprises a series of Access Street 'D' roadways (as defined in Liveable Neighbourhoods). These streets have been designed in accordance with Liveable Neighbourhoods and include six metre kerb radii at intersections.

The detailed design of the local road network will be refined through the subdivision design process to the satisfaction of the City of Cockburn.

3.5 Open space

The location and configuration of POS within the Structure Plan design reflects the objectives of the SSDSP3 to provide a variety of POS opportunities facilitating informal or active recreation, drainage and tree retention.

The size and useability of POS areas varies across the site. POS Areas A1 and A2 in the south west corner preserve existing vegetation and provides an attractive outlook for the adjacent medium density development.

Medium density development will also border POS areas B and C, which will include some areas of retained banksia bushland areas for active play. POS area F is located in close proximity to the local centre and the future high school site and provides open turf areas for informal active recreation. POS H will provide a drainage function, a kick about area and provide an attractive view point from the Barfield Road view corridor.

The following street trees will be planted throughout the Structure Plan area:

- Corymbia ficifolia – Red Flowering Gum;
- Agonis flexuosa - WA Peppermint;
- Jacaranda mimosifolia – Jacaranda
- Eucalyptus torquate – Coral Gum
- Eucalyptus sideroxylon – Red Ironbark
- Melaluca quinquinervia - Paperbark

Liveable Neighbourhoods identifies the function of POS as: sport, recreation, and nature, which replaces the terms active and passive use. A balance between native vegetation retention and provision of urban water management is advocated through the provision of functional POS for sport, nature and recreation. Nature spaces provide a setting for people to enjoy and connect with nature. Nature spaces should be fully accessible to the public (i.e. not fenced off), although providing walking trails to prevent undue damage to vegetation is acceptable. POS Areas A1 and A2 seek to retain the

Figure 14: Public Open Space



existing native vegetation with walking trails (A1 walking path adjacent the proposed lots to also provide for front pedestrian access / A2 central walking path linking residents with Frankland Ave). Both POS area A1 & A2 accord with the principles of Liveable Neighbourhoods and thereby form part of the 10% provision as set out in Table 5.

Table 4: Public Open Space Summary

Public Open Space Typology	Description
Local Park Type 1	• Predominantly native planted areas with pockets of turf; • Small gathering nodes and basic picnic/BBQ facilities • Path network which links into the greater Hammond Park development; • Primary focus on active recreation
Local Park Type 2	• Predominantly retained vegetation; • Path network which links into greater Hammond Park development; • Primary focus on passive recreation
Neighbourhood Passive	• Balance of native planted pockets and open turf areas; • Large gathering nodes with BBQ/picnic facilitiesl • All age play areas • Pedestrian/Cycle path network which links into the greater Hammond Park development; • Primary focus informal active recreation spaces

The Structure Plan area provides 3.6747ha of POS (not including dedicated drainage areas which are excluded from the POS requirement), equating to 10.5% of the total gross subdivisible area. This represents an over provision 0.1747ha when assessed against the requirement for 10% POS.

Figure 14, Table 5 and Table 6 provide a detailed schedule of the provision of POS within the Structure Plan area.

Table 5: Public Open Space Calculations

Structure Plan Area		36.597 ha
Deductions:		
Local Centre High School Western Power high voltatge line easement Dedicated Drainage	0.15 ha 0.86 ha 0.29 ha 0.26 ha	
Gross Subdivisible Area (GSA)		35.037 ha
Public Open Space requirement @ 10% of GSA		3.5 ha
May comprise Minimum 80% Unrestricted Public Open Space Maximum 20% Restricted Open Space		 2.7995 ha 0.6998 ha
Unrestricted Public Open Space (minus 1 in 5 year)		
POS A1 POS A2 POS B POS C POS F POS H Total Unrestricted Public Open Space	0.3510 ha 0.9897 ha 0.3983 ha 0.6197 ha 0.3761 ha 0.7731 ha	 3.5129 ha
Restricted Public Open Space (1 in 5 year minus 1 in 1 year)		
POS A1 POS A2 POS B POS C POS F POS H Total Restricted Public Open Space	- - - 0.0716 ha 0.0460 ha 0.0442 ha	 0.1618 ha

Total Overall Public Open Space Provision		3.6747 ha (10.5%)

Table 6: Public Open Space Schedule

POS Area	Total Area (ha)	Unrestricted	Restricted	Dedicated Drainage (Deduction)
A1	0.3510 ha	0.3510 ha	-	
A2	0.9897 ha	0.9897 ha	-	
B	0.3983 ha	0.3983 ha	-	
C	0.7743 ha	0.6197 ha	0.0716 ha	0.0830 ha
F	0.5355 ha	0.3761 ha	0.0460 ha	0.1134 ha
H	0.8829 ha	0.7781 ha	0.0442 ha	0.0606 ha
Total	3.9317 ha	3.5129 ha	0.1618 ha	0.2570 ha

3.6 Water Management

A revised Water Management Strategy (LWMS) for the Structure Plan area has been developed in accordance with Better Urban Water Management (DOW 2008), State Planning Policy 2.9 Water Resources (WAPC 2006) and Planning Bulletin 92 Urban Water Management (WAPC 2008). Water will be managed using an integrated water cycle management approach, which has been developed using the philosophies and design approaches described in the Stormwater Management Manual for Western Australia (DOW 2007). The key principles of integrated water cycle management that have guided the water management approach in the Structure Plan area include:

- Considering all water sources, including wastewater, stormwater and groundwater
- Integrating water and land use planning
- Allocating and using water sustainably and equitably
- Integrating water use with natural water processes
- Adopting a whole of catchment integration of natural resource use and management.

The overall objective for integrated water cycle management for residential developments is to minimise pollution and maintain an appropriate water balance. The Structure Plan area LWMS design objectives seek to deliver best practice outcomes using a Water Sensitive Urban Design (WSUD) approach, including detailed management approaches for:

- Potable water consumption
- Flood mitigation
- Stormwater quality management
- Groundwater management.

The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving waters and their ecosystems. The LWMS provides a comprehensive summary of the existing environment, based on a number of National and State policies and guidelines and site specific studies undertaken in and around the site. The characteristics and environmental values of the site have guided the design criteria, which will achieve the design objectives for the key management areas discussed above.

The WSUD approach and measures that are proposed for the Barfield Road development include:

- Maintaining existing flow regimes by retaining all runoff within the site;
- Treatment of surface runoff prior to infiltration to groundwater;
- Bio-retention areas incorporated in POS areas;
- Major event flood storage requirements addressed by POS areas;
- Co-location of flood storage areas with natural landforms and native remnant vegetation wherever possible;
- Adopting appropriate non-structural best management practices;
- Adopting a fit-for-purpose water use approach; and
- Minimising use of both scheme and non-potable water.

The LWMS was approved by the City of Cockburn and Department of Water in July 2013. The modifications to the Structure Plan plan do not result in any changes to the water management approach detailed in the approved LWMS and as such amendments to the LWMS are not required (as detailed in Section 10.3 of the approved LWMS). Future Urban Water Management Plans (UWMP) are expected to be required to support subdivision of the development, thus providing a mechanism for detailing the changes to the Structure Plan. UWMPs will include detailed drainage designs demonstrating how the criteria detailed in the approved LWMS are being met, as required by Better Urban Water Management (DoW 2008).

The LWMS demonstrates that the design approach for the Structure Plan area is consistent with a best practice WSUD approach, that the water management objectives for the Structure Plan area can be achieved, and the requirements of the relevant State and local government policies and guidelines will be satisfied.

The LWMS is contained in Appendix 2 and Lot 16 LWMS conatined in Appendix 2C (refer Section 5.3).

3.7 Bush Fire Management

A revised Fire Management Plan (FMP) has been prepared for the proposed Structure Plan development (refer to Appendix 3) in accordance with the requirements of Planning for Bush Fire Protection Guidelines Edition 2 (the Guidelines, WAPC et al. 2010). The FMP details the approach to bush fire management for the proposed development and the measures to be implemented for protection from permanent and temporary bush fire risks in order to achieve an effective bush fire management outcome.

Detailed assessment of the on-ground fire environment, permanent and temporary bush fire hazards and the Bushfire Attack Level (BAL) was undertaken across the Structure Plan area and adjacent land to inform FMP recommendations and the level of application of AS 3959–2009 Construction of Buildings in Bushfire-prone Areas (SA 2009). This included assessment of the on-ground vegetation types and class, slope under classified vegetation and the distance between proposed development areas and the adjacent bushland extent.

The following is a summary of key bush fire issues that were considered as part of the FMP to inform development of specified bush fire risk treatment and mitigation measures:

- the Structure Plan Area has not been subject to fire for possibly more than 20 years
- common sources of ignition within the City of Cockburn include sus-

pected arson and accidental causes such as vehicle accidents

- response times in the event that the Structure Plan Area is threatened by bush fire is within 30 minutes from local bush fire brigades
- the Structure Plan Area contains bush fire hazards in the form of banksia-Sheoak low woodland ('Extreme' bush fire hazard level) with slopes of up to 15 degrees in some areas
- the on-site vegetation extent is proposed to be cleared or landscaped with on site POS not considered to pose a significant bush fire risk
- land adjacent to the Structure Plan Area contains bush fire hazards levels grading from 'Low' to 'Extreme'.
- a proportion of the proposed development cannot achieve the full 100 m hazard separation distance to surrounding bush fire prone areas and a comprehensive suite of bush fire risk treatment and mitigation measures will need to be implemented to mitigate the risk.
- performance criteria and associated acceptable solutions will be achieved for a moderate bush fire hazard level.

Based on the on-ground fire environment and BAL assessment, the following key bush fire risk treatment and mitigation measures have been recommended for the Structure Plan:

1. Implement the 20 m wide BPZ as depicted in the FMP.
2. Maintain on-site POS at less than 5 t/ha, or less than 2 t/ha in areas where the POS occurs within a designated Building Protection Zone (BPZ).
3. Maintain vacant areas of private property and undeveloped land at less than 2 t/ha.
4. Comply with the current City of Cockburn annual fire control order.
5. Undertake fuel inspections.
6. Apply BAL 19 and BAL 12.5 building construction standards as depicted in the FMP.
7. Clear and leave undeveloped all lots depicted in the FMP as being located within BAL FZ/BAL 40 areas or the 20m wide BPZ. The lots are to remain in this state until such time that the temporary bush fire hazard on adjoining land is removed. Once the affecting hazard has been removed, the BALs for these unconstructed lots are to be reassessed and new BALs assigned where applicable.
8. Revise the BALs currently depicted in the FMP that address temporary bush fire risk if the temporary bush fire hazards are removed prior to development of affected areas of the Structure Plan.
9. Construct the masonry walls depicted in the FMP.
10. Implement a 100 m wide on-site fuel reduced buffer around each stage subject to construction to address the temporary bush fire risk posed by future undeveloped stages of the site.
11. Ensure that all residents and visitors are provided with at least two public vehicular access routes for all stages of development that connect to the surrounding public road network.
12. Provide a reticulated water supply throughout the development.
13. Provide a network of hydrants along the internal road network.
14. In case of bush fire emergency, utilise the suggested muster point location at POS Area H, as depicted in the FMP.
15. Include Section 70 Notification on Title for all proposed lots located within the 100 m wide BAL assessment area to ensure prospective landowners are aware that an FMP exists over the site and that specified building construction requirements and/or building setbacks may apply.
16. Prepare DAPs as required for specified lots at the subdivision stage to address detailed fire planning requirements.

On the basis of the above, the FMP demonstrates compliance with the Guidelines and AS 3959–2009 and addresses the bush fire risk posed by both permanent and temporary hazard sources. The FMP also demonstrates that subject to careful design and future management an effective bush fire management outcome can be achieved for the site to ensure the ongoing protection from potential bush fire.

The determined worst-case BAL impact to habitable development for Lot 16 is BAL-29, which is an acceptable rating in accordance with SPP3.7 and Guideline requirements.

An updated bushfire assessment inclusive of a BAL assessment has been undertaken for Lot 16 Barfield Road. It has been determined that the worst-case BAL impact proposed to Lot 16 is BAL-29, which is deemed an acceptable rating in accordance with SPP3.7 and the Guidelines.

The BMP confirms that given the 20m road reserve no formal Asset Protection Zones (APZ's) or APZ setbacks will be required and that all proposed lots will be able to achieve BAL-29 or lower through standard low threat separation as provided for in the subdivision concept plan. On this basis there will be no additional management requirements for the City beyond those set out in the city's fire control order. In addition, the 'WA Planning Manual – Guidance for Structure Plans' only requires the identification of bushfire prone areas and to identify the need for a site-specific bushfire management plan at the time of subdivision.

3.8 Education Facilities

The SSDSP3 identifies a Private Primary School and High School directly north of the Structure Plan area. A portion of the High School site falls within the Structure Plan area and has been facilitated accordingly. A child care premises is located in the local centre and will complement the clustering of education facilities north of the Structure Plan area.

Operation Policy 2.4 School Sites (OP 2.4) indicates at the subdivision stage, ongoing consultation with the Department of Education, non-government education providers and the WAPC should be conducted to ensure the acceptability of proposed school sites. OP 2.4 requires one government primary school site for every 1,500 dwellings and one secondary school for every 4-5 government primary schools.

The structure plan indicates a projected population of approximately 1,400 people, with the SSDSP3 identifying a Private Primary School and High School directly north of the Structure Plan area. A portion of the High School site falls within the Structure Plan area and has been facilitated accordingly. A child care premises is located I the local centre and will complement the clustering education facilities north of the Structure Plan area.

3.9 Infrastructure coordination, servicing and staging

An Engineering Servicing Report prepared by the Civil Group concludes that there are no major impediments to development within the Structure Plan area. The Engineering Servicing Report is contained within Appendix 6.

Earthworks

Site clearing and bulk earthworks will be required over the majority of the site to fill low lying areas to ensure that proposed gravity sewerage infrastructure can be accommodated. Retaining walls will need to be constructed on the majority of the lots, particularly in the southern portion of the site, to provide level lots to minimise building costs to home-owners.

Stormwater Drainage

The drainage strategy generally comprises infiltration and recharge of ground water at source via open bottomed drainage pits and discharge to infiltration type swales in the POS areas, in accordance with the LWMS.

Sewer

To service the area, a 300mm diameter sewer and 225mm sewer will need to be extended southwards from the north through the privately

owned land comprising Lots 31 to 33.

Should access across the privately owned land not be feasible, an alternative alignment for a 225mm sewer along Barfield Road is possible as an interim measure, subject to Water Corporation agreement.

Water

To service the proposed site, the existing DN250 network in Frankland Avenue will need to be extended to the site and DN150 / DN100 reticulation mains laid to service the subdivision. Easements may be required over the proposed water mains until the road reserves are gazetted.

Power

Extension from either the 22kV overhead network in Rowley or Barfield Roads would service the initial stages of the proposed development. Some upstream power network reinforcement works may be required as the project develops subject to the current available spare capacity in the existing 22kV network.

Gas

To service the proposed site, it will be necessary to extend the existing gas infrastructure from Gaebler Road in the north.

Telecommunications

There is a fibre optic cable running along Rowley Road that would be sufficient to service the proposed subdivision. The telecommunications will need to comply with the requirements of the National Broadband Company.

3.10 Developer Contribution Arrangements

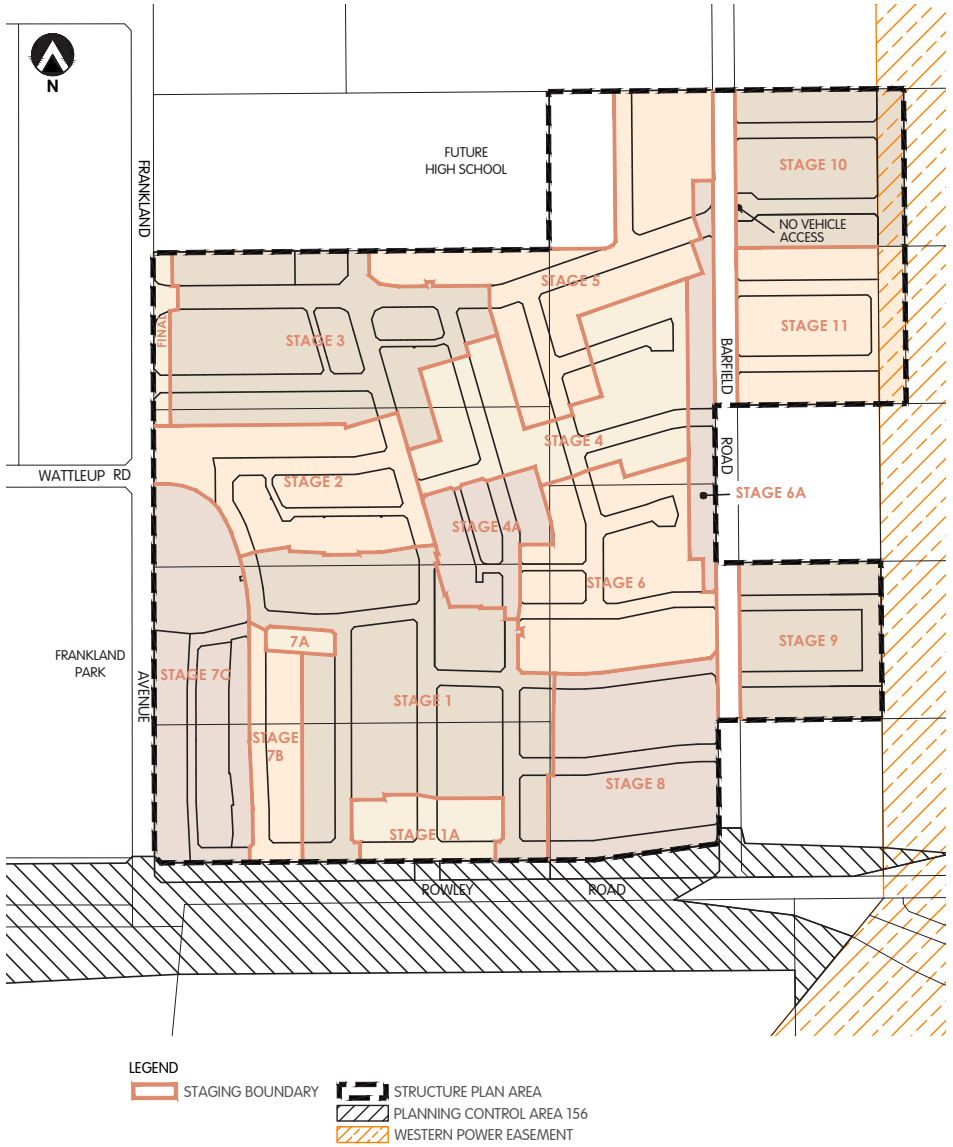
The Structure Plan area is located within two Development Contribution Areas (DCA) under Town Planning Scheme No. 3 being DCA 9 and DCA 13.

4.0 Implementation

4.1 Staging

An indicative staging plan has been prepared, with the release of lots for sale following the numerical order shown on Figure 15. It is important to note that this staging plan is indicative only and will be subject to sales rates and market trends.

Figure 15: Staging Plan



5.0 Amendments

5.1 Background

Hatch RobertsDay acts on behalf of Gold Estates Holdings Pty Ld c/- Richard Noble & Company in modifying the approved Barfield Road Structure Plan. The Barfield Road Structure Plan establishes the planning framework for Vivente Residential Estate, which is being developed by our client.

The Barfield Road LSP was first approved by the Council of the City of Cockburn on 14 November 2013 (prior to the introduction of the Deemed Provisions to Local Planning Schemes) and endorsed by the WAPC on 16 October 2014. As part of the original determination by the WAPC, some modifications were made to the Structure Plan, including changing the location of the Local Centre zone and tweaks to the road layout. The Barfield Road Structure Plan has been subject to six formal minor amendments since being endorsed in 2014, which are outlined below:

1. Amendment 1: Removal of unnecessary road connection to Wattleup Road
2. Amendment 2: Include the Stage 13 lots and Lot 414 located adjacent to Frankland Avenue.
3. Amendment 3: Updates to density codes and tweaks to road layout (cul-de-sacing two east-west streets
4. Amendment 4: Adding Lot 15 to the Structure Plan area and changing design over Lot 18 area
5. Amendment 5: Update density code over portion of land south of POS C from R60 to R30
6. Amendment 6: Introduce a new landholding into the Structure Plan area consisting of Lot 16. Update density code over portion of land south of POS C from R-60 to R30. Update density code for portion of land north of POS A2 from R60 to R30.

5.2 Amendment 6

5.2.1 Proposal Context

Previous amendments have included further land holdings, consistent with the inclusion of Lot 16 to the Structure Plan Area.

The proposed coding of the lots will offer further diversity to the scale and type of dwelling within the area. Amendments to the density and dwelling permissibility also allows for a reduction in house and land package price points, influencing the affordability of the area. Amendments to the density coding may also encourage a mix of commercial and residential developments within the area.

The modifications proposed will further improve the amenity for existing residents through the reduction of lots and houses along shared boundaries, whilst permitting compatible mixed-use developments. The specific lots were identified to be coded as they are positioned in areas of high amenity, located adjacent to or close to area of Public Open Space.

5.2.2 Modifications (Amendment No.6)

Modification 1:
It is proposed to introduce a new landholding into the Barfield Road Structure Plan area consisting of Lot 16, located along the eastern boundary of the Structure Plan area. Lot 16 has an area of 1.8606ha and is bound by Barfield Road to the west. It is proposed that this portion of land is zoned R30, consistent with the zoning of the surrounding land.

Lot 16 will result in an additional 40 lots.

Modification 2:
Modification 2 is a density code change from R60 to R30 for a portion of land north of POS A2.

Modification 3:
Modification 3 is a density code change from R60 to R25-R30 for a portion of land south of POS C.

Proposed Modifications 2 and 3 achieve the following outcomes:

- Responds to market demand for single residential dwellings.
- Lot sizes will remain consistent with the existing lots of the Vivente Structure Plan and the adjacent residential cells.
- There is no attempt to avoid delivering on the required lot / dwelling yield for the estate. The Barfield Road LSP when first approved in 2013 / 2014 comprised 364 lots. The overall lot yield currently built or approved is 500 lots (498 residential lots & 2 Group Housing lots). This Amendment to the Structure Plan increases the yield to 545 dwellings which equates to 24.7 dwellings per residential hectare,
- The current 500 dwellings account for 16.6% of this total. The increase to the 545 dwellings would account for 18% of the total being sought, consistent with the South Metropolitan Peel Sub-regional Planning Framework.

5.2.2 Public Open Space

The latest approved version of the Barfield Road LSP provides 3.6747ha of POS (not including dedicated drainage areas which are excluded from POS requirements), equating to 10.5% of the total gross subdivisible area. This represents an over provision of 0.1747ha when assessed against the requirements for 10% POS.

The current approved Structure Plan provides 11.22% POS. The inclusion of the Lot 16 still provides a POS allocation for the estate of 10.5% being above the 10% requirement. In terms of th location of POS to Lot 16, future residents will be within 180-200m of the central POS area (H). This being a 3-4 minute walk.

5.2.3 Overall Dwelling Yield

The original yield for the Barfield Road Structure Plan approved in 2014 was 364 lots, with the recent amendment 5 estimating the dwelling yield to be in the range of 470-490. The current approved dwelling yield estimate for the Structure Plan, after the previous and current amendments, is approximately 545 dwellings.

The inclusion of Lot 16 increases the total yield by 40 dwellings, this does not alter the intended yield for the estate by more than 10%.

5.3 Servicing

Infrastructure Coordination, Servicing and Staging

Traffic Engineering Report

An updated Traffic Engineering Report undertaken by KCTT concludes that the subdivision and development of Lot 16 will not have a negligible impact on the surrounding road network. Traffic modelling has determined that inclusive of the added traffic from the Structure Plan Area, Barfield Road will remain well under the maximum desirable traffic volume for Local Distributor Roads. The Traffic Engineering report is contained within Appendix 4B.

Local Water Management Strategy Addendum

An update to the Local Water Management Strategy Addendum by Emerges Associates stated that the flood storage areas (FSAs) within the POS on Whadjuk Drive (POS-F) have sufficient storage to accommodate the additional runoff resulting from the development of Lot 16. Updated XPSWMM modelling also indicates that FSAs meet relevant design criteria as well as City of Cockburn runoff and drainage requirements. The Local Water Management Strategy Addendum is enclosed in Appendix 2A.

Engineering Report

The Civil Group has prepared an Engineering Report for Lot 16. Existing services have been considered to assess whether Lot 16, Barfield Road has the capability of being subdivided to create residential lots. The full report can be found in Appendix 7. The following services have been considered:

Earthworks

The earthworks for Lot 16 include cutting and filing to create level lots. Retaining walls will also be constructed between the lots.

Stormwater Drainage

Emerge Associates have updated the XPSWMM modelling and have determined that existing Flood Storage Areas (FLS's)within the POS on Whadjuk drive (POS-F) have sufficient storage and is able to accommodate the additional runoff from Lot 16.

Roads

Barfield Road has been upgraded to urban standards, with Lot 16 fronting Barfield Road. Internal roads will connect with Barfield Road through the construction of two 'T' intersections.

Water Supply

Lot 16 will be supplied water through the connection of 100mm water mains to the existing 150mm water main located on Barfield Road.

Wastewater

Lot 16 will be serviced through the installation of 150mm diameter sewers connecting to the existing sewer in Barfield Road.

Underground Power

It is anticipated that residential developments on Lot 16 will initially connect into the existing LV underground cables which run along the western side of Barfield Road. However, with future development proposed for the area, a Transformer & Switchgear will likely be required to accommodate power demands. This will depend on volt drop calculations on the existing LV cables.

Gas

There is an ATCO Gas medium pressure gas pipe located on Barfield Road. By extending this pipe, this will adequately service the developments on Lot 16.

Telecommunications

Lot 16 will be serviced with NBN by extending the existing network on Barfield Road. The inclusion of Lot 16 into the Structure Plan area increases the total yield for the estate by 40, less than 10% of the intended yield and is only a minor amendment. Existing coverage of telecommunication services will service the whole of the structure plan area, inclusive of Lot 16, without the need of upgraded mobile telecommunication infrastructure within the area. Lot 16 is proposed for residential land and does not have the capacity to facilitate further infrastructure.

Transportation Noise Assessment

The subject site is located west of Kwinana Freeway, an identified Strategic Freight/Major Traffic Route, triggering a noise assessment against State Planning Policy No. 5.4 Road and Rail Noise. A Transportation Noise Assessment has been undertaken for Lot 16 by Lloyd George Acoustic consultants. It is noted that some developments on Lot 16, particularly on the eastern side, will exceed the outdoor noise targets. The reporting provides architectural packages that aim to mitigate noise control for the lots. The Transportation Noise Assessment is contained within Appendix 5.

Appendix 1

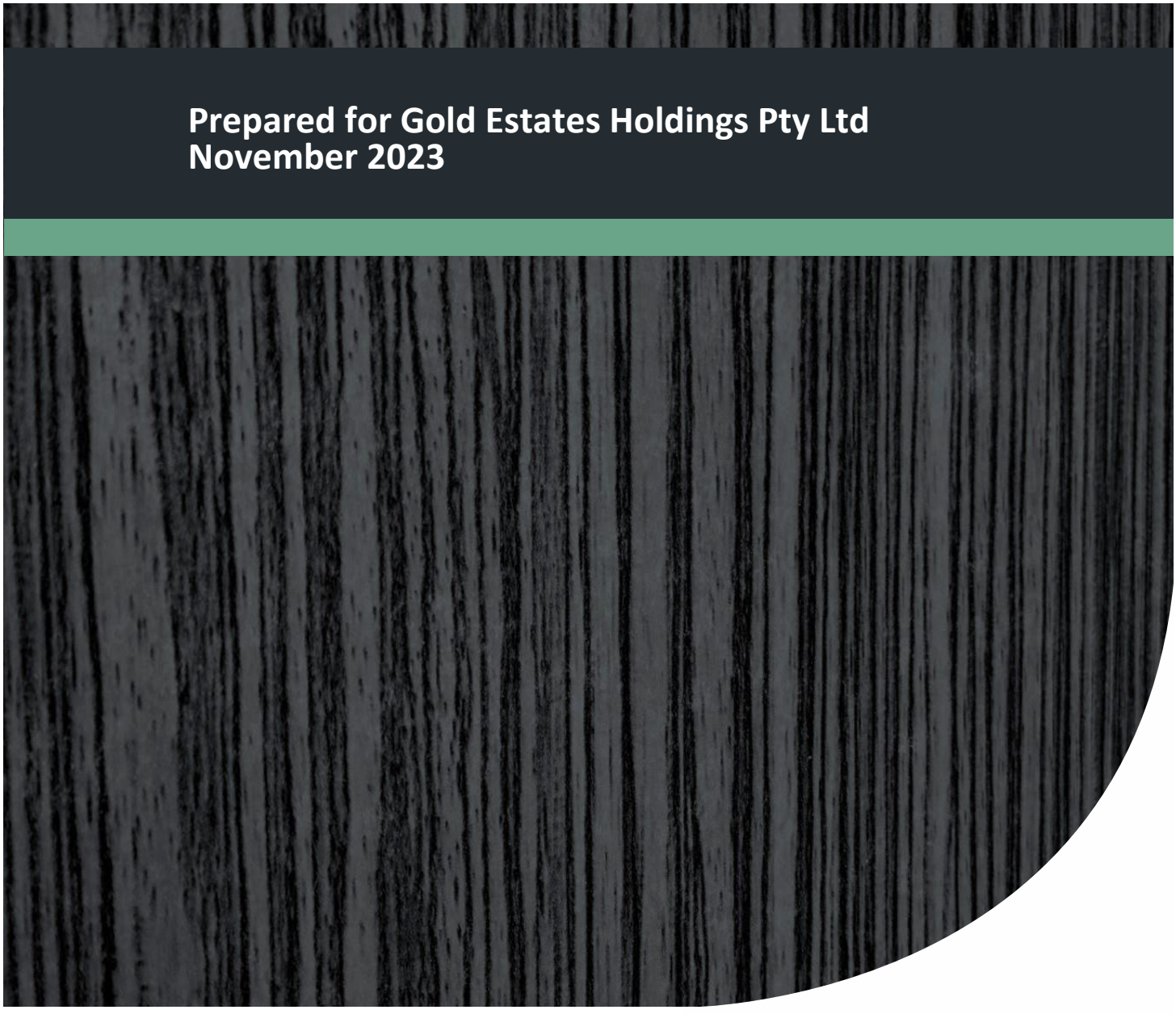
Environmental Assessment and Management Strategy

Environmental Assessment and Management Strategy

Barfield Road Structure Plan Amendment

Project No: EP22-099(04)

Prepared for Gold Estates Holdings Pty Ltd
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Executive Summary

This *Environmental Assessment Management Strategy* (EAMS) has been prepared on behalf of Gold Estates Holdings Pty Ltd (the proponent) to support an amendment to the existing Barfield Road structure plan (SPN/0467) to include Lot 16, Barfield Road and the adjacent 20 metre wide road reserve to the east within Lot 38 (herein referred to as 'the site'). This EAMS has been prepared to address the requirements of the Western Australian Planning Commission's (WAPC) *Structure Plan Framework* (WAPC 2015b). This EAMS provides a synthesis of information from a range of sources regarding the environmental features, attributes and values of the site. RobertsDay, on behalf of the proponent, have prepared a concept plan for the site, showing the proposed internal road network and development. The concept plan is attached in **Appendix A**.

The site comprises a total area of approximately 2.15 hectares (ha) and is located within the City of Cockburn (CoC). The site is bound by Barfield Road to the west, residential development to the north and native vegetation to the east and south.

The relevant environmental attributes and values of the site are summarised as follows:

- The majority of the site currently consists of native regrowth vegetation.
- Topography across the site ranges from 36 metres in relation to the Australian Height Datum (AHD) in the eastern portion of the site to 29 m AHD in the north-west corner of the site.
- The entirety of the site is classified as having a 'moderate to low risk' of acid sulfate soils (ASS) occurring within 3 m of the natural soil surface.
- The vegetation within the site has been identified as occurring in condition ranging from 'excellent' to 'completely degraded'. Only one native plant community was found to exist in the site being the **BaBm** plant community, which dominates the site and ranges in condition from 'excellent' to 'degraded'. The area of most intact and highest condition native vegetation found within the central portion of the site.
- Pursuant to the *Environmental Protection and Biodiversity Conservation Act* 1999 (EPBC act), one threatened ecological community (TEC), Banksia Woodlands of the Swan Coastal Plain, was identified within the site. Banksia Woodlands of the Swan Coastal Plain is also listed as a Priority 3 Priority Ecological Community (PEC) under the state *Biodiversity Conservation Act 2016* (BC act). No threatened or priority flora species, were identified within the site, nor are any likely to occur due to lack of suitable habitat and/or because they were not recorded within the field survey (Emerge Associates 2023b).
- One conservation significant fauna species, Carnaby's black cockatoo, was identified flying over the site during the field survey (Emerge Associates 2023a). It is considered possible that Forest red-tailed black cockatoos may also occur within the site (Emerge Associates 2023a). Nine other fauna species of conservation significance not recorded during the field survey may possibly occur in the site (Emerge Associates 2023a).
- A referral pursuant to the EPBC Act for a proposed action involving the future residential development of the site was submitted by Emerge Associates, on behalf of Gold Estates Holdings, in early 2023 for the proposed residential development of the site (EPBC ref: 2023/09450), based on potential impacts to Matters of National Environmental Significance (MNES), specifically two species of black cockatoo (Carnaby's black cockatoo and forest red-

tailed black cockatoo) and the Banksia Woodlands of the Swan Coastal Plain TEC. In March 2023, the Department of Climate Change, Energy, the Environment and Water (DCCEEW) determined the proposal was a 'controlled action' and required further assessment under the EPBC Act. This assessment is currently being progressed and is based on the concept plan for the site.

- Based on the *Geomorphic Wetlands of the Swan Coastal Plain* (DBCA-019) dataset, no wetlands occur within or nearby to the site.
- No PDWSA's intersect the site. One priority 3 PDWSA exists approximately 300 m to the east of the site, primarily occurring on the eastern side of Kwinana freeway.
- No registered Aboriginal or non-indigenous heritage sites were mapped within or nearby to the site.
- The site is mapped as occurring within the State Planning Policy 5.4 Rail and Noise corridor associated with Kwinana Freeway. Further assessment regarding acoustics and noise impacts/management for the future residential development of the site has been conducted by Lloyd George Acoustics (2023) and is attached in **Appendix E**.
- Areas of bushfire hazard, in a post-development scenario, have been identified outside the site. The areas of vegetation likely to present bushfire considerations as part of future development have been assessed and outlined by JBS & G (2023) and attached in **Appendix F**, and are described as Scrub (Class D) to the north-east, east and south-east and is associated with remnant native vegetation in surrounding lots.

The structure plan design (as expressed by the concept plan shown in **Appendix A)** has responded to site-specific environmental considerations where necessary and provides appropriate separation between future built form and areas of bushfire hazard within and external to the site.

This EAMS provides an outline of the future environmental management requirements that will need to be considered as part of the subdivision and development stages. The key management considerations are summarised as follows.

- **Acid sulfate soils:** ASS is not considered to pose a significant constraint to the proposed future residential development. It is only likely to require management where deep services extend below the permanent groundwater table and can be managed in accordance with the WAPC and Department of Water and Environmental Regulation (DWER) guidelines.
- **Native vegetation:** The concept plan layout does not propose any open space and therefore there are not any material opportunities for vegetation retention. Should bulk earthworks or any other works be commenced within the site that requires clearing of native vegetation before subdivision approvals are gained, a clearing permit pursuant to Part V of the EP Act will be required. Otherwise, subdivision approval and associated authorised subdivision works will provide an exemption from the requirements for a clearing permit. Any considerations associated with the impacts on the Banksia woodland TEC will be resolved through the EPBC Act assessment and approval process.
- **Native fauna:** As part of future subdivision within the site, there may be the requirement to prepare a management plan for any fauna prior to works commencing in order to minimise impacts to fauna through the clearing and construction process. These will be prepared (as required) as part of future subdivision works. Any considerations associated with the impacts on black cockatoo will be resolved through the EPBC Act assessment and approval process.

- **Hydrology:** stormwater and groundwater management requirements are to be implemented as outlined within the addendum to the Local Water Management Strategy (LWMS), and include preparation of an Urban Water Management Plan (UWMP) at the subdivision stage.
- **Bushfire risks:** The site is designated bushfire prone according to the Map of Bushfire Prone Areas (OBRM 2021). The identification of a site within an area declared as bushfire prone necessitates a further assessment of the determined bushfire risk affecting the site in accordance with *Australian Standard 3959:2018 Construction of buildings in bushfire prone areas* (AS 3959), and the satisfactory compliance of the proposal with the policy measures described in *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7) (WAPC 2015a) and the *Guidelines for Planning in Bushfire Prone Areas Version 1.4* (the Guidelines) (DPLH & WAPC 2021). On this basis a BMP addendum has been prepared by JBS & G (2023) and demonstrates that SPP 3.7 and the bushfire protection criteria (outlined within the Guidelines (WAPC and DFES 2021)) can be satisfied through an 'acceptable solution' approach. This will be achieved through the implementation of the proposed development concept plan and an Asset Protection Zone (APZ) that extends across the entirety of the site (which includes the 20 m wide road reserve within Lot 38). Going forward and based on satisfying the bushfire protection criteria, detailed design and construction will need to consider the four elements outlined in the Guidelines. A revised BMP may be required to support future subdivision applications and the BMP will need to respond to the subdivision design (and/or stage of development). Should vulnerable or high-risk land uses be proposed in the future, the requirements of SPP3.7 may need to be addressed at future development approvals (i.e. subdivision/development application) when specific detail on the land use is known and may include the preparation of and emergency evacuation plan and/or risk assessment for onsite flammable materials, where applicable.

Overall, the environmental attributes and values of the site have be accommodated through the structure plan design (as shown in the concept plan) or can be managed appropriately through the future subdivision and development phases in line with the relevant state and local government legislation, policies and guidelines and best management practices.

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Appendix A

Concept Plan, Lot 16 Barfield Road (RobertsDay 2023)

Appendix B

Detailed Flora and Vegetation Assessment (Emerge Associates 2023b)

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Basic Fauna and Targeted Black Cockatoo Assessment (Emerge 2023a)

Appendix D

Vivente Local Structure Plan - Local Water Management Strategy Addendum (Emerge Associates 2023c)

Appendix E

Transportation Noise Assessment (Lloyd George Acoustics 2023)

Appendix F

Bushfire Management Plan Addendum: Vivente Structure Plan Amendment (Lot 16 Barfield Road) (JBS&G 2023)

List of Abbreviations

Table A1: Abbreviations – General terms

General terms	
AHD	Australian Height Datum
AHIS	Aboriginal Heritage Inquiry System
ASS	Acid Sulfate Soil
ASSDMP	Acid Sulfate Soil and Dewatering Management Plan
DBH	Diameter at Breast Height
EAMS	Environmental Assessment and Management Strategy
ESA	Environmentally sensitive area
CC	Carnaby's Black Cockatoo
BC	Baudin's Black Cockatoo
FRTBC	Forest red-tailed black cockatoo
IBRA	Interim Biogeographic Regionalisation of Australia
LWMS	Local Water Management Strategy
PEC	Priority ecological community
PDWSA	Public drinking water source area
TEC	Threatened ecological community
UWMP	Urban Water Management Plan

Table A2: Abbreviations – Legislation and policies

Legislation and policies	
BC Act	Biodiversity Conservation Act 2016
EP Act	Environmental Protection Act 1986
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999

Table A3: Abbreviations – Organisations

Organisations	
DAWE	Department of Agriculture, Water and Environment (federal)
DBCA	Department of Biodiversity Conservation and Attractions
CoC	City of Cockburn
DoEE	Department of Environment and Energy (now known as Department of Agriculture, Water and Environment)
DoW	Department of Water (now known as Department of Water and Environmental Regulation)
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
WAPC	Western Australian Planning Commission

Table A4: Abbreviations – Planning and building terms

Planning and building terms	
MRS	Metropolitan Region Scheme
LSP	Local Structure Plan
TPS	Town Planning Scheme

1 Introduction

1.1 Background

Gold Estates Holdings Pty Ltd (the proponent) is proposing an amendment to the Barfield Road structure plan (SPN/0467), an approved structure plan in the Hammond Park area, to include Lot 16 Barfield Road and the adjacent 20 m wide road reserve to the east within Lot 38, both of which exist adjacent to the east of the existing structure plan area. Lot 16 Barfield Road and the adjacent 20 m wide road reserve to the east within Lot 38 (herein referred to as 'the site') is proposed to be included in the Barfield Road structure plan to support future residential development of the site. The site as shown in **Figure 1,** is 2.15 ha in size and supports no current active land use. The site is bound by Barfield Road to the west, residential development to the north and native vegetation to the east and south. The site is currently zoned 'Development' under the City of Cockburn Town Planning Scheme No. 3 (TPS 3) and 'Urban' under the Metropolitan Region Scheme (MRS), as shown in **Figure 2**. RobertsDay, on behalf of the proponent, has prepared a concept plan for the site (**Appendix A**), showing the proposed internal road network and development, which is the basis for the proposed structure plan amendment. There are six Public Open Space (POS) areas provided in the existing Barfield Road structure plan, all of which retain varying levels of native vegetation, however there is no POS proposed within the concept plan, and given the size of the size any required area of POS is likely to be very small.

The purpose of this Environmental Assessment and Management Strategy (EAMS) is to provide a synthesis of information regarding the environmental values and attributes of the site, to support the amendment of the Barfield Road structure plan to include the site. Specifically, this report:

- Identifies the existing environmental values and attributes of the site (**Section 2**).
- Discusses the land use and environmental planning context for the site in relation to the structure plan area (**Section 3**).
- Discusses how the structure plan layout responds to the existing environmental features and values, and future environmental management requirements as part of the future planning and development process (**Section 4**).
- Provides an implementation framework for future environmental management requirements as part of the future planning and development process (**Section 5**).

The EAMS is the key supporting environmental document for the structure plan, enabling the consideration of relevant environmental issues by the local government and various state government agencies and authorities. It is consistent with the requirements for environmental reporting as outlined in the Western Australian Planning Commission's (WAPC's) *Structure Plan Framework* (WAPC 2015b).

1.2 Assessment scope

Emerge Associates (Emerge) was engaged to undertake this environmental assessment to document the existing environmental attributes and values of the site and ensure that any relevant environmental values can be accommodated within the structure plan, and/or managed through future stages of planning and development of the site. This involved utilising a range of information

sources including local and regional reports (including reports that have been previously prepared for the first Barfield Road Local Structure Plan (LSP) and the broader landholding), databases, mapping and site-specific investigations, including:

- Various publicly available databases and information sources
- *Environmental Assessment Report - Lots 13, 14 and 18 Barfield Road and Lots 48-51 Rowley Road, Hammond Park (Endplan Environmental 2012)*
- *Bushfire Management Plan Addendum: Vivente Structure Plan Amendment (Lot 16 Barfield Road) – (JBS & G 2023)*
- *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning* WAPC (2009).
- *Transportation Noise Assessment - (Lloyd George Acoustics 2023)*
- *Draft Perth and Peel @ 3.5 Million* WAPC (2015).

Emerge have conducted a number of site-specific investigations (outlined further below), as well as a comprehensive desktop review of the available information on environmental conditions within and surrounding the site. The outcomes of these findings have provided context for the following within the site:

- Landforms, topography and soils
- Flora and vegetation
- Terrestrial fauna
- Surface and groundwater hydrology
- Aboriginal and non-indigenous heritage
- Historical and existing land uses within and surrounding the site
- Bushfire hazards.

The investigations undertaken by Emerge, to support the addition of Lot 16 Barfield Road into the existing Barfield Road LSP, include:

- *Vivente Local Structure Plan – Local Water Management Strategy Addendum - (Emerge Associates 2023c)*
- *Basic Fauna and Targeted Black Cockatoo Assessment* (Emerge Associates 2023a)
- *Detailed Flora and Vegetation Assessment – (Emerge Associates 2023b)*

2 Existing Environment

2.1 General location and site context

The site and proposed structure plan amendment area is located in the City of Cockburn, approximately 24 km south of the Perth CBD. The site generally is located in an area that has historically supported rural-residential development. Large areas of native vegetation exist approximately 1.1 km to the west of the site and is associated with Bush Forever Site 392. The site is situated at the eastern edge of the current Barfield Road structure plan area and associated residential development.

2.2 Summary of relevant environmental factors

Table 1 provides a summary of the environmental values/factors that have been investigated for the site and outlines those that will require further specific consideration as part of future development within the site, and if applicable these are discussed further in **Section 4**. Further details for each value/factor are provided in **Sections 2.3 to 2.8**

Table 1: Relevant environmental values/factors and considerations for the site

Environmental value/ factor	Relevant considerations
Landform and soils	A review of the DWER mapping indicates that the entirety of the site is classified as having a 'Moderate to low risk' of ASS occurring within 3 m of the natural soil surface. This factor requires further consideration and is addressed in **Section 2.3.3**.
Flora and vegetation	No conservation significant flora species were identified or considered likely to occur in the site (noting that Lot 38 was subject to survey in October 2023 and the results have not yet been formally documented, however it is assumed that not threatened or priority flora occur based upon surveys of the immediate neighbouring areas, as discussed further in **Section 2.4.1.6**). The **BaBm** plant community that covers the majority of the site has been found to represent the EPBC Act listed threatened ecological community 'banksia woodlands of the Swan Coastal Plain'. This factor and its relation to the structure plan is discussed further in **Section 2.4.1**.
Bush Forever	No Bush Forever sites occur within the site. Bush Forever Site 392 is situated to the north-west of the site.
Ecological linkages	No ecological linkages have been identified within the site. An ecological linkage exists to the west of the site, however the vegetation within the site is not mapped as being a part of the ecological linkage. Ecological linkages surrounding the site are outlined and discussed further in **Section 2.4.3**.
Environmentally sensitive areas (ESAs)	There are no ESAs mapped as being present within the site. Development within the site is not proposed to impact on any identified ESAs, and accordingly no further consideration of this is required as part of this EAMS.
Terrestrial fauna	The proposed development has the potential to impact conservation significant fauna species. Protection and management of these species and associated habitat is addressed further in **Section 4.3**.
Groundwater	*Perth Groundwater Map* (DWER 2023) indicates depth to groundwater ranges from approximately 7 m to 12 m across the site. Management of groundwater is considered as part of the Local Water Management Strategy (LWMS) and is discussed further in **Section 4.5.2.1**.

Table 1: Relevant environmental values/factors and considerations for the site (continued)

Environmental value/ factor	Relevant considerations
Surface water	The site is located in the Murray River catchment area as identified through the DWER *Hydrographic Catchments* dataset. At a local level, the majority of the site is located within the Bartram Road Catchment with a small portion of the eastern side of the site being located in the Serpentine River Catchment (DWER 2018). Management of stormwater will be a consideration for future development and is discussed further in the LWMS and **Section** Error! Reference source not found..
Wetlands	There are no wetlands within the site. One REW and MUW exists approximately 650 m to the south of the site and one CCW exists approximately 1 km to the north-west of the site. Wetlands are discussed further in **Section 2.5.3**.
PDWSAs	A review of the Perth Groundwater Map indicates that the site does not intersect any PDWSA areas. A priority 3 PDWSA exists approximately 313 m to the east of the site. PDWSA's are discussed in further detail in **Section 2.5.4**.
Indigenous heritage	In accordance with the *Aboriginal Heritage Due Diligence Guidelines* (DAA 2013), a search of the AHIS online database (DPLH 2020) was undertaken in June 2023. No 'Registered' or 'Other' Aboriginal heritage sites were found to exist within or nearby to the site. Therefore, no further consideration of this factor is provided as part of this EAMS. As of the 1st July 2023 the new Aboriginal Cultural Heritage Act 2021 has come into effect and has replaced the Aboriginal Heritage Act 1972. Under the new act, a proponent must progress a Due diligence Assessment (DDA) in relation to Aboriginal cultural heritage (ACH) in accordance with the associated guidelines. The DDA needs to be undertaken prior to undertaking an act that may cause harm to ACH and is not required to be undertaken at the earlier planning stages. A DDA will likely need to be undertaken in future prior to any activities being undertaken within the site.
Non-indigenous heritage	No non-indigenous heritage values have been identified within, or in close proximity to the site and therefore no further consideration of this factor is provided as part of this EAMS.
Historic and existing land uses	The site has historically had no land use and was historically cleared and allowed to regrow. The site currently hosts no land use. No further consideration of this factor is provided as part of this EAMS.
Potential site contamination	No registered contaminated sites were identified within or in proximity to the site. No further consideration of this factor is required as part of this EAMS.
Surrounding land uses	The site lies within 300 m of a Strategic freight and major traffic route, Kwinana Freeway, as mapped on the *State Planning Policy 5.4 Road and Rail Noise* noise level contour mapping. This is discussed further in **Section 4.7.1**.
Bushfire hazard	Classified vegetation has been identified within the site and surrounds. Management of bushfire hazards is further considered in the BMP and **Section 4.8**.

2.3 Landform and soils

2.3.1 Topography

The site ranges in elevation from 36 metres in relation to the Australian Height Datum (AHD) in the eastern portion of the site to 29 m AHD in the north-west corner of the site. The site has a westerly aspect and gentle slope (2 to 4°). Topographic contours across the site are shown in **Figure 3.**

2.3.2 Landform, soils and geology

The existing Barfield Road structure plan area was assessed by EndPlan Environmental in an Environmental Assessment Report (EAR) developed for the Barfield Road structure plan area in 2012

(Endplan Environmental 2012). The current Barfield Road structure plan area is described as being located on the transitional area between the Spearwood Dune System and the Bassendean Sands System (Endplan Environmental 2012).

Regional landform mapping by Gozzard (2011) places the site within the Bassendean dune system.

The Geological Survey of Western Australia, as documented in *Perth Metropolitan Region 1: 50,000 Environmental Geology Series* (Gozzard 1986), indicates the following soil unit within the site, and is shown in **Figure 3**:

- Sand (S8). This unit is described as 'very light grey at surface, yellow at depth, fine to medium-grained, sub-rounded quartz, moderately well sorted of aeolian origin'.

2.3.3 Acid sulfate soils

Acid sulfate soils (ASS) is the name commonly given to naturally occurring soils and sediment containing iron sulphide (iron pyrite) materials. In their natural state, ASS are generally present in waterlogged and/or anoxic conditions and do not present any risk to the environment. ASS can pose issues when oxidised, producing sulphuric acid, which can present a range of risks for the surrounding environment, infrastructure and human health.

The Endplan EAR (Endplan Environmental 2012) outlined the entirety of the previously assessed LSP area has a 'Moderate to Low Risk of ASS' occurring within 3m of natural soil surface or deeper (Endplan Environmental 2012).

The Department of Water and Environment Regulation (DWER) provides broad-scale mapping indicating areas of potential ASS risk. A review of the DWER mapping (DWER-055) indicates that the entirety of the site is classified as having a 'Moderate to low risk' of ASS occurring within 3 m of the natural soil surface, as shown within **Figure 4**.

2.4 Biodiversity and natural area assets

2.4.1 Flora and vegetation

2.4.1.1 Regional context

The site is contained within the Swan Coastal Plain IBRA region and within the 'SWA02' or Perth subregion. The Perth subregion is characterised by mainly banksia low woodland on leached sands with melaleuca swamps where ill-drained; and woodland of *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah) and *Corymbia calophylla* (marri) on less leached soils (Beard 1990).

At a regional scale, vegetation complex mapping undertaken by Heddle *et al.* (1980) indicates the site occurs within the 'Bassendean central and south complex', which is described as vegetation ranging from woodland of *Eucalyptus marginata - Allocasuarina fraseriana - Banksia* spp. to low woodland of *Melaleuca* spp. and sedgelands on the moister sites. The Bassendean central and south complex was determined to have 26.87% of its pre-European extent remaining on the SCP, of which 2.15% is protected for conservation purposes (Government of Western Australia 2019).

2.4.1.2 Site specific surveys and investigations

A detailed flora and vegetation assessment was carried out in September and October 2022 by Emerge Associates (Emerge Associates 2023b) and again in September and October 2023 by Emerge Associates . A copy of the *Detailed Flora and Vegetation Survey* (Emerge Associates 2023b) has been provided within **Appendix B** and the outcomes have been summarised in the following sections.

2.4.1.3 Vegetation communities

The flora and vegetation survey identified one native plant community within the site, being the **BaBm** plant community, which dominates the site. A Non-native plant community was also identified within the site, primarily being associated with the firebreak areas. A description of the plant communities identified within the site has been provided in **Table 2** and is also shown in **Figure 5.**

Table 2: Vegetation communities identified within the site.

Plant community	Description
BaBm	Low open woodland of Banksia menziesii, Banksia attenuata, Banksia ilicifolia, Eucalyptus marginata and Nuytsia floribunda over open shrubland of Adenanthos cygnorum (or absent), Xanthorrhoea preissii and Allocasuarina humilis over low shrubland of Eremaea pauciflora var. pauciflora, Hibbertia spp. and Scholtzia XX over forbland of Mesomelaena pseudostygia, Patersonia occidentalis and Lomandra spp. over open grassland *Ehrharta calycina and *Briza maxima and herbland Ursinia anthemoides.
Non-native	Heavily disturbed areas comprising predominantly bare ground and weeds with occasional native species.



*Plate 1: Plant community **BaBm** in 'excellent' condition.*



*Plate 2: Plant community **Non-native** in 'completely degraded' condition.*

2.4.1.4 Vegetation condition

Vegetation condition within the site was assessed using methods from Keighery (1994), which is the vegetation condition scale used for vegetation on the Swan Coastal Plain. The most intact native vegetation is associated with parts of the **BaBm** plant community located in the central portion of the site (Emerge Associates 2023b). This vegetation was mapped as being in 'excellent' condition as it retains the structure expected of a banksia woodland community and has high native species diversity and less than 10% weed cover (Emerge Associates 2023b). The southern portion of the **BaBm** plant community was mapped as being in 'very good' condition as vegetation structure was altered through repeated past disturbance which was evident through a very sparse tree canopy cover and a larger proportion of bare ground in combination with moderate native plant diversity and higher weed cover (10-20%) (Emerge Associates 2023b). The **BaBm** vegetation in the north-western portion of the site was mapped as being in 'good - very good' condition as it exhibited higher weed cover (20-50%) but still retained moderate native plant species diversity (Emerge Associates 2023b). Three small areas of the **BaBm** vegetation along the western boundary and in the north-western corner of the site were mapped as being in 'degraded' condition as they had very low native species diversity and high weed cover (Emerge Associates 2023b). The firebreak areas are in 'completely degraded' condition and predominantly comprises of bare ground associated with fire breaks and non-native species such as pasture grasses and weeds (Emerge Associates 2023b). The vegetation within the site that exists within Lot 38 was subject to the survey in October 2023, however the formal results have not yet been documented. It is assumed to be in 'excellent' condition based upon the neighbouring vegetation that was surveyed. Vegetation condition within the site is shown in **Figure 6**.

2.4.1.5 Threatened and priority ecological communities

Generally, ecological communities can be described as vegetation communities that are assemblages of species that occur together in a particular type of habitat. An ecological community's structure, composition and distribution are determined by a range of environmental factors. 'Threatened ecological communities' (TECs) are ecological communities that are recognised as rare or under threat and therefore warrant protection.

Selected TECs are afforded statutory protection at a Commonwealth level under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). TECs listed under the EPBC Act are categorised as either 'critically endangered', 'endangered' or 'vulnerable'. Any action likely to have a significant impact on a critically endangered or endangered TEC listed under the EPBC Act requires approval from the Commonwealth Minister for the Environment.

Within Western Australia, state-listed threatened flora and TECs (once declared) are statutorily protected through the *Biodiversity Conservation Act 2016* (BC Act), and licences (or similar) may be required where these values are proposed to be disturbed or modified.

In addition to the BC Act, impacts to TECs are considered under the EP Act. The Environmental Protection Authority (EPA) produces environmental factor guidelines to outline how environmental factors are considered by the EPA in the environmental impact assessment process. Under the flora and vegetation environmental factor guideline (EPA 2016) TECs are considered to be significant values, and approval may be required from the EPA in order to impact a TEC.

An ecological community under consideration for listing as a TEC in Western Australia, but which does not yet meet survey criteria or has not been adequately defined, or which is rare but not currently threatened, is referred to as a 'priority ecological community' (PEC). Whilst PECs are not afforded statutory protection in Western Australia, they are considered during the approval process.

Known locations of TECs and PECs within 10 km of the site were searched for using the publicly available *Weed and native flora dataset* (Keighery *et al.* 2012), *Protected Matters Search Tool (DAWE 2022a)* and the Department of Biodiversity, Conservation and Attraction's (DBCA) threatened and priority ecological communities' database (reference no. 15-1022EC). These search results indicate that 9 TECs and two PECs occur within 10 km of the site (Emerge Associates 2023b).

The vegetation survey conducted by Emerge Associates (Emerge Associates 2023b) determined that one TEC pursuant to the EPBC Act, Banksia Woodlands of the Swan Coastal Plain (which is also listed as a Priority 3 PEC under the BC Act), occurs within the site, as shown in **Figure 7**.

2.4.1.6 Significant flora

Certain flora species that are considered to be rare or under threat are provided protection under Commonwealth and/or State legislation. At a Commonwealth level, flora species may be listed as 'threatened' pursuant to the EPBC Act and any action likely to have a significant impact on a listed threatened species requires approval from the Commonwealth Minister for the Environment.

At a state level, plant species may also be classed as 'threatened' under the BC Act. Species which are potentially rare or threatened, or meet the criteria for near threatened, or have recently been removed from the threatened species list are classed as 'priority' flora species. However, priority flora species are not afforded any specific statutory protection.

A search was conducted for threatened and priority flora within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2022a), *NatureMap* (DBCA 2022) and DBCA's threatened and priority flora database (reference no. 15-1022EC). A total of 15 threatened and 26 priority flora species were identified as occurring or potentially occurring within a 10 km radius of the site.

No occurrences of threatened or priority flora species within the site during the field survey (Emerge Associates 2023b). None of the threatened and priority flora species identified in the desktop assessment are considered to occur in the site due to lack of suitable habitat and/or because they were not recorded during the field survey (Emerge Associates 2023b). The vegetation within the site that exists in Lot 38 was subject to survey in October 2023, however the results have not yet been formally documented. It is currently assumed that no threatened or priority flora occur within that portion of the site, due to the results of various surveys of the neighbouring lots.

2.4.2 Bush Forever

The Government of Western Australia's *Bush Forever Policy* (Government of WA 2000) is a strategic plan for conserving regionally significant bushland within the Swan Coastal Plain portion of the Perth Metropolitan Region. The objective of Bush Forever is to protect comprehensive representations of all original vegetation complexes by targeting a minimum of 10% of each for protection. Bush Forever sites are representative of regional ecosystems and habitat and have a role in the conservation of Perth's biodiversity.

The Endplan EAR (Endplan Environmental 2012) outlined the entirety of the previously assessed LSP area did not contain any Bush Forever (BF) sites, with the nearest being BF site 268 and BF site 392, which are located to the south-west and north-west, respectively.

The site contains no Bush Forever sites and has no Bush Forever sites existing adjacent or within immediate proximity of the site (DPLH 2019), as indicated by **Figure 8**.

2.4.3 Ecological linkages

Ecological linkages generally speaking are linear landscape elements that allow the movement of fauna, flora and genetic material between areas of remnant habitat. The movement of fauna and the exchange of genetic material between vegetation remnants improve the viability of those remnants by allowing greater access to breeding partners and food sources, refuge from disturbances such as fire and maintenance of genetic diversity of plant communities and populations. Ecological linkages are ideally continuous or near-continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

The Perth Biodiversity Project, supported by the Western Australia Local Government Association (WALGA), have identified and mapped regional ecological linkages across the Perth Metropolitan Region (WALGA and PBP 2004). The study was extended beyond the Perth Metropolitan Region through the South West Biodiversity Project, resulting in the identification and mapping of the South West regional ecological linkages (Molloy *et al.* 2009).

There are no mapped ecological linkages within the site. One regional ecological linkage (No. 50) occurs approximately 200 m west of the site running from north to south and intersects with another ecological linkage (No. 52) running east to west approximately 1.2 km north of the site. These ecological linkages connect areas of Bush Forever located in the wider local area. Ecological linkages surrounding the site are shown in **Figure 8**.

A review of aerial imagery indicates that the vegetation within the site is connected to a small patch of vegetation in the local area which extends to the east of the site. The majority of this patch is zoned for 'Urban' or is reserved for 'Primary regional roads' under the MRS. A small portion to the south-east of the site is also reserved for 'Railways' under the MRS. The CoC TPS 3 has zoned the majority of this patch 'Special Use' (SU23 more specifically). SU23 'Special Use' zoning under the CoC TPS 3 is given to all land within the CoC that is within transmission line corridors and allows for land uses including carparks, civic uses, community purposes, nurseries, public amusement and 'recreation-private', subject to the relevant conditions and/or discretionary approval. Due to the zoning under the CoC TPS 3 it is unlikely residential development will extend east in this area, however vegetation may be removed in future to develop land uses that are considered appropriate for an area zoned 'Special Use' (SU23).

2.4.4 Environmentally sensitive areas

'Environmentally sensitive areas' (ESAs) are prescribed under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* and have been identified to protect native vegetation values of areas surrounding significant, threatened or scheduled flora, vegetation communities or ecosystems. Exemptions under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* do not apply within ESAs. However, exemptions under Schedule 6 of the EP Act still

apply, including any clearing in accordance with a subdivision approval under the *Planning and Development Act 2005* (a recognised exemption under the Schedule 6 of the EP Act).

No ESAs occur within or in close proximity to the site based upon a review of the *Clearing Regulations – Environmentally Sensitive Areas* dataset (DWER 2021). Environmentally sensitive areas within close proximity to the site are shown in **Figure 8**.

2.4.5 Terrestrial fauna

2.4.5.1 Regional context

The site is located in central portion of the Swan Coastal Plain, which is typically characterised by urban areas and areas largely cleared of remnant vegetation to facilitate rural land uses. Notwithstanding, the region does contain some large areas of remnant vegetation, in addition to other environmental features such as mature trees, waterways and wetlands, all of which provide fauna habitat values.

A range of conservation significant fauna species are known to occur within the broader region encompassing the site. This includes three species of threatened black cockatoo, namely Carnaby's cockatoo (CC), forest red-tailed black cockatoo (FRTBC) and Baudin's cockatoo (BC).

Records of black cockatoo roosting sites across south-west Western Australia are maintained by Birdlife Australia, and are based on annual community surveys as part of the *Great Cocky Count* (GCC). Based on the most recently published 2019 GCC report, the site does not contain any confirmed black cockatoo roosting sites. The nearest known roost, displayed with a buffer in the DBCA-064 dataset, is located approximately 1.84 km to the south-east of the site. The nearest Black Cockatoo confirmed breeding site, as displayed in the DBCA-063 dataset, exists approximately 43km to the north-east of the site. Black cockatoo roost sites and remnant foraging habitat in the broader region is shown in **Figure 9**.

2.4.5.2 Site specific surveys and investigations

A basic fauna and targeted black cockatoo survey was carried out within the site by an ecologist from Emerge Associates on 22 December 2022 between the hours of 6:00 am to 8:30 am. The basic fauna and targeted black cockatoo assessment was designed to undertake a terrestrial vertebrate fauna assessment to the standard required of a 'basic' fauna survey and a 'targeted' black cockatoo survey with reference to the Environmental Protection Authority's (EPA's) technical guidance (EPA 2020) and the *Environment Protection and Biodiversity Conservation Act* black cockatoo referral guidelines (DAWE 2022b). A copy of the basic fauna and targeted black cockatoo assessment is provided in **Appendix C** and the outcomes summarised in the section below.

2.4.5.3 Species of conservation significance

Certain fauna taxa that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, fauna taxa may be listed as 'threatened' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action likely to have a significant impact on a taxon listed under the EPBC Act requires Ministerial approval.

In Western Australia fauna species may also be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act). It is an offence to 'take' or 'disturb' threatened fauna without Ministerial approval.

Fauna species that do not currently meet the criteria for listing as threatened but are potentially rare or threatened may be added to the DBCA's *Priority Fauna List*. These species are classified into 'priority' levels based on threat. Whilst priority species are not under direct statutory protection, they are considered during State approval processes.

The Basic Fauna and Targeted Black Cockatoo Assessment conducted by Emerge Associates (2023a) identified from database searches that 521 fauna species occur or potentially occur within 10 km of the site. Of these species 91 are conservation significant, including 40 threatened, 16 priority, 55 migratory fauna and two other specially protected species (Emerge Associates 2023a). One broad fauna habitat, Banksia Woodland, was identified within the site (Emerge Associates 2023a), as shown in **Figure 10**. Twelve native and one introduced fauna species, including one of conservation significance (Carnaby's black cockatoo), were identified within the site during the field survey. Additionally, eight other species of conservation significance not recorded during the field survey may possibly occur in the site: Pacific swift, peregrine falcon, quenda, Perth slider, black-striped snake, Swan Coastal Plain shield-backed trapdoor spider, graceful sun moth and stylet bush cricket. *Leioproctus contrarius* (a short tongued bee), which is a Priority 3 species under the BC Act, was also considered to possibly to occur within the site. The remainder of the conservation significant fauna species identified in the desktop assessment are considered unlikely to occur in the site due to lack of suitable habitat or because the site lies outside of the species known distribution (Emerge Associates 2023a).

Carnaby's black cockatoo (*Zanda latirostris*) was observed flying over the site in the field survey. The Banksia woodland vegetation within the site was found to contain no black cockatoo habitat trees (Emerge Associates 2023a). No roosts or evidence of roosting were observed within the site during the field survey, and no native or non-native trees that may provide potential roosting habitat for black cockatoos were identified in the site (Emerge Associates 2023a). All of the vegetation within the site was identified as Carnaby's black cockatoo foraging habitat (Emerge Associates 2023a).

Although not recorded within the field survey, forest red-tailed black cockatoo is possible to occur within the site as it lies within the species modelled distribution range and records of this species are known from the local area. However, the site contains no suitable foraging or breeding habitat so any sightings would likely be in the air space and independent from terrestrial habitat (Emerge Associates 2023a).

The site is located outside of the modelled distribution range of Baudin's black cockatoo (DoEE 2016) and while short incidental occurrences are possible, it is considered unlikely that the species would occur in the site (Emerge Associates 2023a).

A referral pursuant to the EPBC Act for the site was submitted by Emerge Associates, on behalf of Gold Estates Holdings, in early 2023 for the proposed action involving the future residential development of the site (EPBC ref: 2023/09450). In March 2023, the Department of Climate Change, Energy, the Environment and Water (DCCEEW) determined the proposal was a 'controlled action' and required further assessment under the EPBC Act. This will determine if there are any other

impact mitigation or other considerations in order to progress with the proposed residential development.

2.5 Hydrology

2.5.1 Groundwater

Information on the regional groundwater resources obtained from the *Water Register* (DoW 2023) indicates that the site is underlain by a multi-layered aquifer system comprised of the following resources:

- Perth - Superficial Swan (allocation available).
- Perth – Leederville (fully allocated).
- Perth - Yarragadee North (limited information).

Groundwater in the superficial aquifer (Perth – Superficial Swan) is recharged directly from rainfall, and is contained in sand and clay, which have an accumulated depth average saturated thickness of about 40 m (JDA 2009).

The Department of Water *Perth Groundwater Map* (DWER 2023) indicates historical maximum groundwater levels across the site range from approximately 22 m AHD in the south-west portion of the site to 23 m AHD across the rest of the site. Based on the topographic contours, depth to groundwater ranges from approximately 7 m to 12 m across the site. Groundwater is expected to generally flow in a south-westerly direction.

The EAR developed by Endplan to assess the current Barfield Road structure plan area (Endplan Environmental 2012) indicates that the current Barfield road structure plan area has groundwater that occurs at approximately 5-10 m below ground level, with groundwater levels underlying the Barfield Road structure plan area ranging from 18.75 mAHD to 21 mAHD.

Further information pertaining to groundwater conditions within the site can be found within the *Local Water Management Strategy* (LWMS)(Emerge Associates 2013) and the Emerge Associates (2023c) addendum to the LWMS (**Appendix D**).

2.5.2 Surface water

The site is located in the Murray River catchment area as identified through the DWER *Hydrographic Catchments* dataset. At a local level, the majority of the site is located within the Bartram Road Catchment with a small portion of the eastern side of the site being located in the Serpentine River Catchment (DWER 2018). The site is not located within the 100-year Average Recurrence Interval (ARI) floodplain development control area of the Swan River.

2.5.3 Wetlands

Wetlands are areas which are permanently, seasonally or intermittently waterlogged or inundated with water. Naturally occurring wetland features are common across the Swan Coastal Plain and can contain fresh or salty water, which may be flowing or still. Wetlands can be further categorised based on their hydrological characteristics and physical structure.

The location, mapped boundaries and management categories of wetlands across the Swan Coastal Plain were originally identified in the *Wetlands of the Swan Coastal Plain: Wetland Mapping, Classification and Evaluation* (Hill et al. 1996). This information was subsequently converted into the publicly available *Geomorphic Wetlands of the Swan Coastal Plain* database, which is maintained by the Department of Biodiversity, Conservation and Attractions (DBCA). The management categories of wetlands are conservation, resource enhancement and multiple use, and are detailed in **Table 3**.

Table 3: Geomorphic Wetlands of the Swan Coastal Plain management categories (Hill et al. 1996)

Management category	Description of wetland	Management objectives
Conservation (CCW)	Support high levels of attributes	Preserve wetland attributes and functions through reservation in national parks, crown reserves and state-owned land. Protection provided under environmental protection policies.
Resource Enhancement (REW)	Partly modified but still supporting substantial functions and attributes	Restore wetland through maintenance and enhancement of wetland functions and attributes. Protection via crown reserves, state or local government owned land, environmental protection policies and sustainable management on private properties.
Multiple Use (MUW)	Few wetland attributes but still provide important hydrological functions	Use, development and management considered in the context of water, town and environmental planning through land care.

The Endplan EAR (Endplan Environmental 2012), which was developed to assess the currently approved structure plan area, outlined that no geomorphic or Ramsar wetlands exist within or adjacent to the previously assessed LSP area.

A review of the current *Geomorphic Wetlands on the Swan Coastal Plain* dataset (DBCA 2020) indicates that no geomorphic wetlands exist within the site. One REW and MUW exists approximately 650 m to the south of the site and one CCW exists approximately 1 km to the north-west of the site. The geomorphic wetlands surrounding the site are shown in **Figure 11.** A review of the Ramsar sites dataset (DBCA 2017) indicates that no Ramsar wetlands are located within the site. One Ramsar wetland, Forrestdale & Thomsons Lakes, exists approximately 1.9 km to the north-west of the site.

2.5.4 Public drinking water source areas

Public drinking water source areas (PDWSAs) are proclaimed by the Department of Water and Environmentally Regulation (DWER) to protect identified drinking water sources, including surface water and groundwater sources (DoW 2009). They are proclaimed under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* or the *Country Areas Water Supply Act 1947* as Water Reserves, Catchment Areas or Underground Water Pollution Control Areas. PDWSAs provide the population with the majority of its drinking water supplies and can be vulnerable to contamination from a range of land uses. Once an area is identified as a PDWSA, consideration needs to be given to the intended land use and associated activities to ensure that they are appropriate in meeting the water protection quality objectives of the area.

The Endplan EAR, which was developed to assess the current Barfield Road structure plan area, indicates that no PDWSA's intersect the current Barfield Road structure plan area.

A review of the Perth Groundwater Map indicates that the site does not intersect any PDWSA areas. A priority 3 PDWSA exists approximately 300 m to the east of the site, as shown in **Figure 12**, primarily occurring on the eastern side of Kwinana Freeway.

2.6 Heritage

2.6.1 Indigenous heritage

The Aboriginal Heritage Inquiry System (AHIS) was maintained pursuant to Section 38 of the *Aboriginal Heritage Act 1972* (AHA) by the Department of Planning, Lands and Heritage, containing information on Registered Aboriginal Heritages Sites and Other Heritage Places throughout Western Australia.

The EAR developed by Endplan to assess the current Barfield Road structure plan area outlined that no registered Aboriginal heritage sites exist within the current structure plan area.

In accordance with the *Aboriginal Heritage Due Diligence Guidelines* (DAA 2013), a search of the AHIS online database (DPLH 2023) was undertaken in June 2023. No 'Registered' or 'Other' Aboriginal heritage sites were found to exist within or nearby to the site. Aboriginal heritage sites in the local area can be seen on **Figure 13**.

The site and surrounding area has been surveyed for Aboriginal heritage significance multiple times previously. The Aboriginal Heritage Survey Areas dataset (DPLH-080) indicates these surveys consisted of three ethnographic surveys conducted by O'Connor in 1985 and Machin in 2010 and 2014 and one archaeological survey conducted by the University of Western Australia in 1972.

2.6.2 Non-Indigenous heritage

A desktop search of the Australian Heritage Database (Department of Climate Change, Energy, the Environment and Water 2023), the State Heritage Office database (Heritage Council 2021) indicated there are no registered non-Indigenous heritage sites within the site.

2.7 Other land use considerations

2.7.1 Historic and existing land uses

Based on a review of publicly available historic aerial imagery (Landgate 2023), the entirety of the site was historically cleared between 1981 and 1985. The site has revegetated since this time and currently supports no active land use. The surrounding areas to the west of the site were largely cleared for residential development in 2015 and now are established residential areas.

The Kwinana freeway is aligned in a north-south direction approximately 180 m to the east of the site.

2.7.2 Potential site contamination

A review of the DWER *Contaminated Sites Database* indicates that the site is not registered as a contaminated site pursuant to the *Contaminated Sites Act 2003*, nor are other registered sites located nearby. In addition, a review of the Department of Defence Unexploded Ordinance (UXO) search tool did not identify any potential risk of UXO occurring within the site or surroundings (DoD 2023).

2.7.3 Surrounding land uses

The site is situated on the eastern edge of the existing Barfield Road Structure Plan area and is the eastern edge of extensive residential development. Land to the east of the site is zoned 'Special Use' (SU23 more specifically) under the CoC TPS 3, which is given to all land within the CoC that is within transmission line corridors. Land zoned SU23 may be developed for specific land uses outlined in the CoC TPS 3 (including carparks, civic uses, community purposes, nurseries, public amusement and 'recreation-private') subject to the relevant conditions and/or discretionary approval. Given the guiding planning objectives for the land to the east, it is expected that no further residential development will occur to the east of the site. Development in forms outlined as acceptable in the CoC TPS 3 may take place to the east of the site in future and therefore vegetation to the east that is likely similar to that within the site may or may not be retained long-term. A portion of land to the south-east of the site is also reserved for 'Railways' under the MRS.

The current land uses and zoning surrounding the site include:

- Land to the north, west and south of the site is zoned as 'residential' at a density of R30. The land to the west is currently being developed, with the land to the north and south of the site have been cleared in preparation for residential development.

- Land to the east of the site that buffers the western side of Kwinana Freeway has no current land use, apart from hosting pairs of lattice towers as part of electrical infrastructure, and is zoned for Special Use (SU23, as described above). A portion of land to the south-east of the site is zoned 'Special Use' under the CoC TPS 3 and is also zoned as 'Railways' under the MRS.
- Areas to the south and west zoned 'Development'.

The site is mapped by the *State Planning Policy 5.4 Rail and Noise* noise level contour map as occurring within 300 metres of a strategic freight and major traffic route, associated with Kwinana Freeway. Noise impact and management requirements should be considered at a structure plan level, with mitigation strategies to be deployed at the subdivision design. Noise impacts from the Kwinana Freeway has been assessed in the Transportation Noise Assessment (Lloyd George Acoustics 2023) conducted for the site. This is discussed further in **Section 4.7**.

There are no land uses identified surrounding the site that would be incompatible with the proposed future residential development within the site. Notwithstanding this, there are major roads in immediate proximity to the site that will require further consideration in relation to the potential for noise impacts on adjacent future residential dwellings or other sensitive land uses.

2.8 Bushfire hazards

The site and portions of the existing Barfield Road Structure Plan have been identified as bushfire prone under the *Map of Bush Fire Prone Areas* (OBRM 2021), as shown in **Plate 3**. The identification of a site within an area declared as bushfire prone necessitates a further assessment of the determined bushfire risk affecting the site in accordance with *Australian Standard 3959:2018 Construction of buildings in bushfire prone areas* (AS 3959), and the satisfactory compliance of the proposal with the policy measures described in *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7) (WAPC 2015a) and the *Guidelines for Planning in Bushfire Prone Areas Version 1.4* (the Guidelines) (DPLH & WAPC 2021).

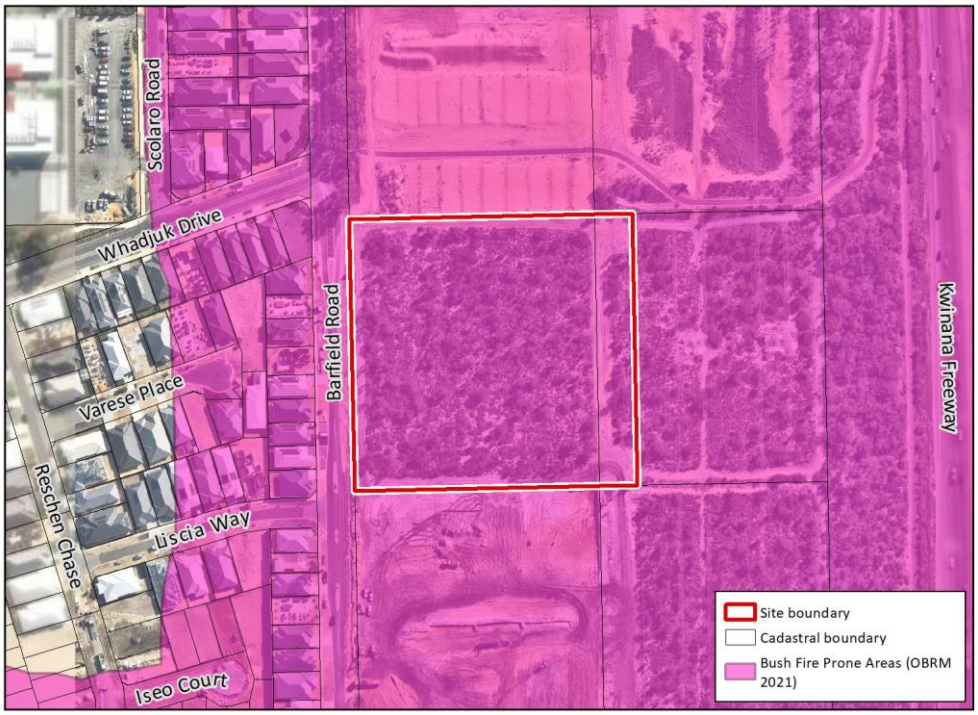


Plate 3: Areas within and surrounding the site identified as 'bushfire prone areas' (as indicated in purple) under the state-wide Map of Bush Fire Prone Areas (OBRM 2021).

All areas within the site and surrounding 150 m have been assessed for the presence of bushfire prone vegetation which has been classified as per Table 2.5 of *Australian Standard 3959-2018 Construction of buildings in bushfire prone areas* (AS 3959) (Standards Australia 2018) to determine the associated bushfire hazard rating levels in accordance with the Guidelines. The areas of vegetation likely to present bushfire considerations as part of future development have been assessed and outlined by JBS & G (2023) and are described as Scrub (Class D) to the north-east, east and south-east and is associated with remnant native vegetation in surrounding lots.

3 Planning Framework and Proposal

3.1 Historic planning and environmental assessment context

The site is currently zoned 'Urban' under the MRS and 'Development' and 'Special Use' under the CoC TPS 3.

The Barfield Road LSP exists to the west of the site across Barfield Road. The site is proposed to be included in the Barfield Road LSP area as an amendment to the LSP. An EAR was prepared by Endplan Environmental in 2012 to support the Barfield Road Structure Plan. The Barfield Road Structure Plan has been amended multiple times, with the most recent amendment to down code the area from R60 to R30 in an internal area within the structure plan area. The Lot 50 Barfield Road Hammond Park structure plan was developed by Rowe Group and covers the area of Lot 50 to the south of the site. Implementation of the Lot 50 Barfield Road structure plan has commenced with Lot 50 to the south of the site having been cleared in preparation for residential development.

The Barfield Road Structure Plan has already begun implementation with areas to the west of the site having undergone development and areas to the north of the site having been cleared in preparation to be developed.

3.2 Proposed local structure plan

The proposed LSP is an amendment to the currently approved Barfield Road Structure Plan (WAPC Reference SPN 0467M-4) and will be guided by the concept plan prepared by Hatch RobertsDay. This incorporates inputs from a multi-disciplinary project team and the outcomes of a wide range of site-specific technical studies and investigations. The amendment to the structure plan incorporates the entirety of the site and proposes a residential land use across the full extent of the site.

3.3 Future planning approval process

Subject to approval and endorsement of the structure plan by the CoC and the WAPC, urban development of the site would be progressed through subdivision and/or development approvals (collectively referred to as 'future planning stages').

The key environmental values and attributes that require further consideration as part of future planning stages have been outlined in **Section 4** of this report and include:

- Acid sulfate soils
- Flora and vegetation
- Native fauna
- Hydrology
- Land use considerations, namely potential acoustic impacts
- Bushfire risks.

The WAPC can impose conditions on subdivision applications to ensure subdivision incorporates all the appropriate environmental management measures. These conditions are usually determined in

accordance with WAPC's *Model Subdivision Conditions Schedule 2019* and include those relating to environmental considerations. It is envisaged that there would be future subdivision conditions applied for any subdivision within the site, that would address environmental, hydrological and bushfire related requirements.

4 Environmental Assessment and Management Strategy

This section outlines spatial layout considerations that have been accommodated within the structure plan amendment to respond to environmental attributes and values within the site, as well as any future environmental management requirements that will need to be accommodated within future planning and development stages. Only those environmental values and attributes that require specific consideration based on their presence within the site, and/or the applicable legislation and policy requirements have been included in this section.

4.1 Acid sulfate soils

4.1.1 Policy framework, site context and management objectives

The Department of Water and Environmental Regulation (DWER), through the WAPC, ensures ASS are adequately managed during the land use planning and development process. The objective of the DWER's ASS policy framework is to manage ASS appropriately to prevent the release of metals, nutrients and acidity into the soil and groundwater system that may adversely affect the natural and built environment and human health.

A review of the DWER Acid Sulfate Soils mapping (DWER-055) indicates that the entirety of the site is classified as having a 'Moderate to low risk' of ASS occurring within 3 m of the natural soil surface, as shown within **Figure 4.**

The principal management objective for acid sulfate soils within the site is to ensure that any future development that may disturb acid sulfate soils is appropriately managed to avoid impacts on the environment.

4.1.2 Structure plan layout considerations for acid sulfate soils

ASS management does not require any spatial consideration within the structure plan, and any ASS risk can be appropriately managed through future development.

4.1.3 Future acid sulfate soils management requirements

While the risk of ASS is 'moderate to low' within the site, ASS is only likely to be a consideration if excavation (primarily for services) extends below the permanent groundwater table. It is possible, depending upon the extent of fill within the site and location of services, that excavation could occur below the permanent groundwater table and if this is the case, ASS investigations may be required and could require the preparation of an Acid Sulfate Soils and Dewatering Management Plan (ASSDMP).

The requirement for further ASS management will be confirmed in accordance with any subdivision conditions as part of detailed design.

4.2 Flora and vegetation

4.2.1 Policy framework, site context and management objectives

In the context of environmental impact assessment, the EPA objective for flora and vegetation is '*to protect flora and vegetation so that biological diversity and ecological integrity are maintained*' (EPA 2016a). Where a proposal may potentially impact upon flora and vegetation values, the following mitigation hierarchy should be applied to minimise potential impacts:

1. **Avoid** impacts
2. **Minimise** impacts
3. **Offset** impacts.

The vegetation across the majority of the site is in 'excellent' and 'very good' condition, with the northern portion in 'very good – good' condition and the remainder of the site in a 'degraded' or 'completely degraded' condition (with the exception of the vegetation that exists within Lot 38, which was subject to survey in October 2023, however the results have not yet been formally documented, and therefore is currently assumed to be in 'excellent' condition based upon neighbouring vegetation). The **BaBm** plant community, which is the only native plant community found within the site, has been found to represent a state listed PEC and Commonwealth TEC 'banksia woodlands of the Swan Coastal Plain'. No threatened or priority flora species were recorded within the site and are not considered likely to occur due to the lack of suitable habitat or because they were not recorded during the field survey undertaken at the appropriate time of year (with the exception of the vegetation that exists within Lot 38, which was subject to survey in October 2023 of which the results have not yet been formally documented, however is currently assumed to not contain any threatened or priority flora based upon surveys of neighbouring vegetation).

Any action likely to have a significant impact on a critically endangered or endangered TEC listed under the EPBC Act requires approval from the Commonwealth Minister for the Environment. A referral pursuant to the EPBC Act for the site was submitted by Emerge Associates, on behalf of Gold Estates Holdings, in early 2023 for the proposed residential development of the site (EPBC ref: 2023/09450). In March 2023, the Department of Climate Change, Energy, the Environment and Water (DCCEEW) determined the proposal was a 'controlled action' and required further assessment under the EPBC Act. The assessment is progressing and will determine what mitigation or other actions are required to respond to the impacts on the Banksia woodland TEC.

4.2.2 Structure plan layout considerations for flora and vegetation

The site was determined to not contain any threatened or priority flora species (with the exception of the vegetation that exists within Lot 38, which was subject to a survey in October 2023 of which the results have not yet been formally documented, however is currently assumed to not contain any threatened or priority flora based upon surveys of neighbouring vegetation). The main floristic element of conservation significance within the site was the presence of the **BaBm** floristic community, which was found to represent the banksia woodlands of the Swan Coastal Plain threatened ecological community.

Given the generally small area/extent of the total site, there is no vegetation retention proposed within the site.

4.2.3 Future flora and vegetation management requirements

Should bulk earthworks or any other works be commenced within the site that requires clearing of native vegetation before subdivision approvals are gained, a clearing permit pursuant to Part V of the EP Act will be required. Otherwise, subdivision approval and associated authorised subdivision works will provide an exemption from the requirements for a clearing permit.

4.3 Native fauna

4.3.1 Policy framework, site context and management objectives

In the context of environmental impact assessment, the EPA's objective for terrestrial fauna is *'to protect fauna so that biological diversity and ecological integrity are maintained'* (EPA 2016b). The application of the mitigation hierarchy should be applied to avoid or minimise impacts to terrestrial fauna where possible.

The EPBC Act also provides protection for listed 'threatened' species, including black cockatoos, which may potentially use habitat within the site. In early 2023, the DCCEEW determined that the proposal was a controlled action and required further assessment under the EPBC Act.

While the conservation significant species have been identified as utilising habitat within the site, particularly Carnaby's Cockatoo, the site is not considered critical to Black Cockatoo populations due to other areas of habitat surrounding the site and the absence of breeding and roosting habitat within the site.

There is currently no proposed retention of vegetation within the site, however considerations have been made to avoid and mitigate against negative outcomes to native fauna within the implementation and post-implementation phases of the structure plan. The EPBC Act assessment will also resolve any mitigation or other measures to respond to the impact on black cockatoos.

4.3.2 Structure plan layout considerations for terrestrial fauna

No vegetation is currently proposed to be retained and therefore there are minimal site-specific considerations for terrestrial fauna.

The existing Barfield Road LSP was designed with terrestrial fauna in mind, with larger POS areas strategically placed to conserve areas of banksia overstorey canopy that is in 'very good' to 'excellent' condition. Additionally, road reserves have been widened along some roadways to enable the retention of an increased number of significant trees identified within the structure plan area.

4.3.3 Future terrestrial fauna management requirements

As part of future subdivision within the site, it is recommended that a management plan to avoid and minimise impacts on native fauna be prepared prior to works commencing, and address potential impacts to fauna during the clearing and construction process.

4.4 Waterways and Wetlands

4.4.1 Policy framework, site context and management objectives

In the context of environmental impact assessment, the EPA's objective for inland waters is *'to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected'* (EPA 2021).

No wetlands or registered waterways occur within the site or existing structure plan area, therefore no specific policy and/or management objectives are relevant to the site and the proposal can meet the EPA's inland waters objective.

4.4.2 Structure plan layout considerations for wetland and waterway values

The site, which is proposed to be included in the current Barfield Road structure plan layout, does not contain any known wetland or waterway values and therefore does not require specific spatial considerations to respond to these environmental features.

4.4.3 Future management requirements for the hydrological values

No future requirements are necessary as no registered wetland or hydrological features intersect the site or current structure plan area.

4.5 Hydrology

4.5.1 Policy framework, site context and management objectives

In the context of environmental impact assessment, the EPA's objective for inland waters is *'to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected'* (EPA 2021).

In addition, the *State Water Strategy for Western Australia* (Government of WA 2003) and *Better Urban Water Management* (WAPC 2008) endorses the promotion of integrated water cycle management and application of water sensitive urban design (WSUD) principles to provide improvements in the management of stormwater, and to increase the efficient use of other existing water supplies.

A Local Water Management Strategy (LWMS) was prepared by Emerge Associates (2013) for the existing Barfield Road structure plan. An addendum to this LWMS has been prepared by (Emerge Associates 2023c) to include the site.

4.5.2 Structure plan layout considerations for hydrological values

The structure plan, as indicated by the concept plan, responds to the requirements for flood mitigation, flow management and treatment of surface water within road reserves and public open space (Emerge Associates 2013).

4.5.2.1 Groundwater

Depth to groundwater across the site and existing structure plan area is significant and therefore the focus of the Local Water Management Strategy (LWMS) regarding groundwater is on groundwater quality. Groundwater quality within the existing Barfield Road structure plan area was outlined to be managed by managing nutrient inputs within surface runoff, aiming to ensure that groundwater leaving the site is ideally better than existing conditions (Emerge Associates 2013).

The underlying principles of the LWMS regarding the management of stormwater for the site are to retain and treat stormwater runoff using a treatment train approach and then allow the water to infiltrate as close to source as possible (Emerge Associates 2013).

To facilitate the stormwater management strategy, the existing structure plan provides for vegetated bio-retention areas within public open space, soakage pits and a variety of other strategies in order to treat, retain and re-infiltrate stormwater (Emerge Associates 2013).

An addendum to the original LWMS (Emerge Associates 2013) has been developed by Emerge Associates (2023c) to include the site. The addendum to the original LWMS outlines that stormwater storage capacity of POS areas that will receive flow from the site are sufficient and the site can be included in the Barfield Road structure plan and it's LWMS (Emerge Associates 2023c).

4.5.3 Future management requirements for the hydrological values

The LWMS provides a framework for the future delivery of a best practice approach to integrated water cycle management utilising water sensitive urban design (WSUD) principles and provides for the management of groundwater and surface water within the site. It has been prepared in accordance with relevant DWER requirements and considers the site-specific values. The LWMS, and the addendum to allow the inclusion of the site (Emerge Associates 2023c), will be a key document guiding future development within the site and can be referred to for further detail, particularly with regard to determined water management criteria and water quality management objectives.

The WAPC can include a standard condition on subdivision applications (model subdivision condition D2 (WAPC and DPLH 2019)), requiring the preparation of an Urban Water Management Plan (UWMP). Generally, an UWMP will address the following considerations:

- The detailed drainage design based on civil designs
- Imported fill specifications and requirements
- Implementation of water conservation strategies
- Non-structural water quality improvement measures
- Management and maintenance requirements
- Construction period management strategy
- Monitoring and evaluation program.

4.6 Indigenous heritage

4.6.1 Policy framework, site context and management objectives

No registered or known sites of significant Aboriginal or European heritage are listed on the state or Commonwealth registers as occurring within the site or current Barfield Road structure plan area as of June 2023. One 'Stored data / Not a Site' occurs approximately 590 m to the south-east of the site as indicated in (DPLH 2020).

No management recommendations or commitments are required to be implemented in regard to this factor as no Aboriginal or non-Indigenous heritage places exist within the site or current Barfield Road structure plan area.

4.7 Surrounding Land uses

4.7.1 Policy framework, site context and management objectives

The site is primarily surrounded by residential land uses (some currently under construction) to the north, west and south. East of the site currently has no active land use. The site is mapped on the *State Planning Policy 5.4 Rail and Noise* noise level contour map as occurring within 300 m of a strategic freight and major traffic route associated with Kwinana freeway, meaning an assessment must be undertaken to determine the likely level of transport noise and mitigation required.

4.7.2 Structure plan layout considerations for surrounding land uses

The primary consideration for the site in regard to surrounding land uses is noise generated by transport travelling on Kwinana Freeway. A Transportation Noise Assessment for the site was undertaken by Lloyd George Acoustics (2023) (attached in **Appendix E**). The Transportation Noise Assessment indicates that the site meets an acceptable level of noise for residential development, however certain proposed lots in the east of the site will be required to address noise, as their outdoor noise target was exceeded in the assessment. The Transportation Noise Assessment indicates that outdoor noise may be mitigated through a variety of quiet house packages. Noise mitigation strategies (quiet house packages as suggested in (Lloyd George Acoustics 2023)) will be implemented at future stages of planning and development and lots that require additional noise mitigation strategies will have a notification on title in relation to noise when they are created at the subdivision stage.

4.8 Bushfire management

4.8.1 Policy framework, site context and management objectives

State Planning Policy 3.7 Planning in Bushfire Prone Areas (SPP3.7) (WAPC 2015a) stipulates that any development proposal which occurs partly or wholly within a designated bushfire prone area is required to be accompanied by a bushfire management plan (BMP). The preparation of a BMP is required to incorporate the following tasks:

- Classification of existing vegetation types and effective slope within the site and surrounding 150 m, in accordance with *Australia Standard 3959-2018 Construction of buildings in bushfire-prone areas* (AS 3959) (Standards Australia 2018).
- Assessment of bushfire hazard levels within the site and surrounding 150 m, in accordance with the *Guidelines for Planning in Bushfire Prone Areas* (WAPC and DFES 2021).

- Completion of an indicative Bushfire Attack Level (BAL) assessment and preparation of an associated BAL contour plan.
- Assessment of the structure plan design against the bushfire protection criteria, in accordance with the *Guidelines for Planning in Bushfire Prone Areas* (WAPC and DFES 2021).

Policy objective 5.4 of SPP 3.7 specifies that development is required to:

'achieve an appropriate balance between bushfire risk management measures and biodiversity conservation values, environmental protection and biodiversity management and landscape amenity'.

This policy objective ensures that future development appropriately considers the bushfire risks, and provides appropriate separation from any identified risks without negatively impacting existing environmental values (or introduced values).

The principal management objective for the bushfire risk to the site is to ensure that the risk to future people, property and infrastructure is appropriately minimised without negatively impacting on environmental values within or surrounding the site.

4.8.2 Structure plan layout considerations for bushfire management

The BMP (JBS & G 2023) developed for the site outlines the areas of vegetation likely to present bushfire considerations as part of future development as Scrub (Class D) to the north-east, east and south-east of the site that is associated with remnant native vegetation in surrounding lots.

In accordance with the BMP (JBS & G 2023) prepared for the site, the structure plan has provided an appropriate spatial response to bushfire risk through:

- Ensuring future development areas will be able to accommodate the separation necessary to ensure built form is able to achieve a bushfire attack level (BAL) rating of BAL-29 or less. This has been achieved through the location of proposed roads between future lots and areas of bushfire hazard, providing lots of an appropriate size to accommodate necessary separation and through the provision of an APZ that covers the entirety of the site (which includes the road interface in east of the site within Lot 38).
- An integrated internal road network that connects with the existing external public road network and provides access to multiple destinations, supporting appropriate emergency evacuation and response.

4.8.3 Future bushfire management requirements

The BMP (JBS & G 2023) demonstrates that SPP 3.7 and the bushfire protection criteria (outlined within the Guidelines (WAPC and DFES 2021)) can be satisfied through an 'acceptable solution' approach. Going forward and based on satisfying the bushfire protection criteria, detailed design and construction will need to consider the following:

- *Element 1 Location*: all future built form should be located in an area subject to a low or moderate bushfire hazard, and should achieve a BAL rating of BAL-29 or less.
- *Element 2 Siting and Design*: provision of appropriate separation to ensure future built form can achieve a BAL rating of BAL-29 or less. This can be achieved through the location of road and public open space areas (assuming these will be designed and managed to achieve low threat in accordance with Section 2.2.3.2 of AS 3959), the provision of appropriately sized lots enabling in-lot setbacks and the provision of an APZ that extends across the entirety of the site.
- *Element 3 Vehicular Access*: provision of an integrated road network that provides access to at least two different destinations, with roads to comply with the technical requirements outlined in Table 6 of Appendix Four in the Guidelines (WAPC & DFES 2017), including roads with a trafficable surface width of at least 6 m. If development is staged, temporary turn-around areas and/or temporary emergency access ways may be required.
- *Element 4 Water*: the site is located within the current reticulated water supply network and therefore, will be provided with a permanent and secure reticulated water supply.

A revised BMP may be required to support future subdivision applications, particularly if vegetation management assumptions are different, or the development layout is significantly different to that assessed as part of the BMP (JBS & G 2023). The BMP will need to respond to the subdivision design (and/or stage of development).

Should vulnerable or high-risk land uses be proposed in the future, the requirements of SPP3.7 may need to be addressed at future development approvals (i.e. subdivision/development application) when specific detail on the land use is known and may include the preparation of and emergency evacuation plan and/or risk assessment for onsite flammable materials, where applicable. This is generally only a consideration where a BAL rating greater than BAL-LOW applies.

5 Implementation Framework

A summary of how the structure plan responds to the environmental values and attributes within the site is provided in **Table 4**. The table also outlines the future management likely to be required as part of the subdivision and development process.

Table 4: Environmental management framework implementation table

Factor	Structure plan phase (completed)	Subdivision phase	Part of development works
Acid sulfate soils	• Consider ASS Risk mapping as prepared by DWER. No spatial response in LSP required.	• If required, completion of the ASS self-assessment form (as prepared by the DPLH). • If required, preparation of an Acid Sulfate Soil and Dewatering Management Plan.	• If required, implementation of an Acid Sulfate Soil and Dewatering Management Plan.
Native vegetation	• Assessment of flora and vegetation values.	• No vegetation retention is proposed within the site and is therefore not a consideration at the subdivision phase.	• No vegetation retention is proposed within the site and is therefore not a consideration at the development phase.
Native fauna	• Assessment of fauna habitat.	• No vegetation retention is proposed within the site and is therefore not a consideration at the subdivision phase.	• Implement pre-clearance checks and/or management plan requirements to ensure fauna is managed appropriately to minimise harm. • If required, obtain and implement licences pursuant to the *Biodiversity Conservation Act 2016* to disturb/relocate fauna prior to works commencing.
Wetlands and Waterways	• The site, which is proposed to be included in the current Barfield Road structure plan layout, does not contain any registered wetland or waterway values and therefore does not require specific spatial considerations to respond to these environmental features.	• Not applicable.	• Not applicable.
Hydrology	• Preparation of a Local Water Management Strategy (addressed through the Emerge Associates (2023c)). • Spatial provisions providing for drainage features to accommodate stormwater.	• Preparation of an Urban Water Management Plan. • Provision for drainage features.	• Implementation of the UWMP. • Design and implementation of drainage features/management features as per the requirements of the UWMP.

Table 4: Environmental management framework implementation table (continued)

Factor	Structure plan phase (completed)	Subdivision phase	Part of development works
Cultural heritage	• In accordance with the *Aboriginal Heritage Due Diligence Guidelines* (DAA 2013), a search of the AHIS online database (DPLH 2023) was undertaken in June 2023. No 'Registered' or 'Other' Aboriginal heritage sites were found to exist within or nearby to the site. • At the structure plan phase there is no known ACH within the site.	• Not applicable.	• Not applicable.
Surrounding land uses	• The site is mapped by the *State Planning Policy 5.4 Rail and Noise* noise level contour map as occurring within 300 metres of a strategic freight and major traffic route requiring a noise assessment be undertaken for the site.	• At the subdivision phase implementation of noise mitigation strategies to address outdoor noise levels should be considered and undertaken. Lots that require additional noise mitigation strategies will have a notification on title in relation to noise when they are created at subdivision.	• Implementation of noise mitigation strategies outlined at the subdivision phase.
Bushfire risk	• Identify bushfire hazards surrounding the site and prepare a Bushfire Management Plan. • Provision for road and public open space areas, appropriately sized development areas and an APZ to accommodate setbacks to achieve BAL-29 or less. • Provision for a road network that connects the site to the public road network and provides access to at least two destinations.	• Complete detailed BAL assessment to determine the separation requirements necessary to achieve BAL-29 or less and confirm subdivision layout can accommodate this. • Provision for an appropriate road network that provides access to at least two destinations. • If required, prepare an updated BMP to support the subdivision application.	• Public open space and road reserves to be designed and maintained as low threat in accordance with Clause 2.2.3.2(f) of AS 3959. • Implement and maintain the APZ to a low-threat standard in accordance with Clause 2.2.3.2(f) of AS 3959. • If land use is likely to be considered 'vulnerable' (as per Clause 6.6 of SPP 3.7), development approval to be supported by a BMP and emergency evacuation plan.

6 Conclusions

This EAMS has been prepared on behalf of the proponent to assist with the amendment of the Barfield Road Structure Plan (SPN/0467) to include Lot 16 Barfield Road and the adjacent 20 m wide road reserve to the east within Lot 38. A concept plan, prepared by RobertsDay on behalf of the proponent, shows the proposed internal road network and development of the site and is attached in **Appendix A**.

This EAMS has been prepared to address the requirements of the Western Australian Planning Commission's (WAPC) *Structure Plan Framework* (WAPC 2015b) to support the preparation and implementation of the structure plan. The amendment to the Barfield Road Structure Plan is supported by the following documents:

- *Vivente Local Structure Plan - Local Water Management Strategy Addendum (Emerge Associates 2023c)*
- *Bushfire Management Plan Addendum: Vivente Structure Plan Amendment (Lot 16 Barfield Road) (JBS & G 2023)*
- *Transportation Noise Assessment (Lloyd George Acoustics 2023)*

The structure plan design has responded to site-specific environmental considerations where necessary and possible and provides appropriate separation between future built form and areas of bushfire hazard within and external to the site.

This document provides an outline of the management requirements that will need to be considered as part of future subdivision and development stages. The key management considerations are summarised as follows.

- **Acid sulfate soils:** ASS is not considered to pose a significant constraint to the proposed future residential development. It is only likely to require management where deep services extend below the permanent groundwater table and can be managed in accordance with the WAPC and Department of Water and Environmental Regulation (DWER) guidelines.
- **Native vegetation:** Should bulk earthworks or any other works be commenced within the site that require clearing of native vegetation before subdivision approvals are gained, a clearing permit pursuant to Part V of the EP Act will be required. Otherwise, subdivision approval and associated authorised subdivision works will provide an exemption from the requirements for a clearing permit.
- **Native fauna**: As part of future subdivision within the site, there may be the requirement to prepare a management plan for any fauna prior to works commencing in order to minimise impacts to fauna through the clearing and construction process. These will be prepared (as required) as part of future subdivision works. At the development phase pre-clearance checks and/or management plan requirements to ensure fauna is managed appropriately to minimise harm should be implemented. At development phase, if required, licences pursuant to the Biodiversity Conservation Act 2016 to disturb/relocate fauna should be obtained and implemented prior to works commencing.

- **Hydrology:** stormwater and groundwater management requirements are to be implemented as outlined within the addendum to the Local Water Management Strategy (LWMS), and will likely include preparation of an Urban Water Management Plan (UWMP) at the subdivision stage.
- **Cultural heritage:** At the structure plan phase desktop assessments indicate there is no known ACH within the site.
- **Surrounding land uses:** The site is mapped by the *State Planning Policy 5.4 Rail and Noise* noise level contour map as occurring within 300 metres of a strategic freight and major traffic route which triggers a requirement that a noise assessment be undertaken for the site. A noise assessment has been undertaken for the site and outlined that the outdoor noise levels exceed the acceptable limit for specific lots in the east (Lloyd George Acoustics 2023). Noise mitigation strategies will be considered and undertaken at the subdivision phase, with lots requiring additional noise mitigation strategies to have a notification on title when they are created.
- **Bushfire risks:** The BMP (JBS & G 2023) demonstrates that SPP 3.7 and the bushfire protection criteria (outlined within the Guidelines (WAPC and DFES 2021)) can be satisfied through an 'acceptable solution' approach. Going forward and based on satisfying the bushfire protection criteria, detailed design and construction will need to consider the four elements outlined in the Guidelines. A revised BMP may be required to support future subdivision applications and the BMP will need to respond to the subdivision design (and/or stage of development). Should vulnerable or high-risk land uses be proposed in the future, the requirements of SPP3.7 may need to be addressed at future development approvals (i.e. subdivision/development application) when specific detail on the land use is known and may include the preparation of an emergency evacuation plan and/or risk assessment for onsite flammable materials, where applicable.

Overall, the environmental attributes and values of the site can be accommodated through the structure plan design, or can be managed appropriately through the future subdivision and development phases in line with the relevant state and local government legislation, policies and guidelines and best management practices.

7 References

7.1 General references

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Figure 1: **Location Plan**

Project: Environmental Assessment and Management Strategy
Barfield Road Structure Plan Amendment

Client: Gold Estates Holdings Pty Ltd

Plan Number: EP22-099(04)--F21a

Drawn:	GAR
Date:	09/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

N

0 20 40
Metres

Scale: 1:2,000@A4

GDA 1994 MGA Zone 50

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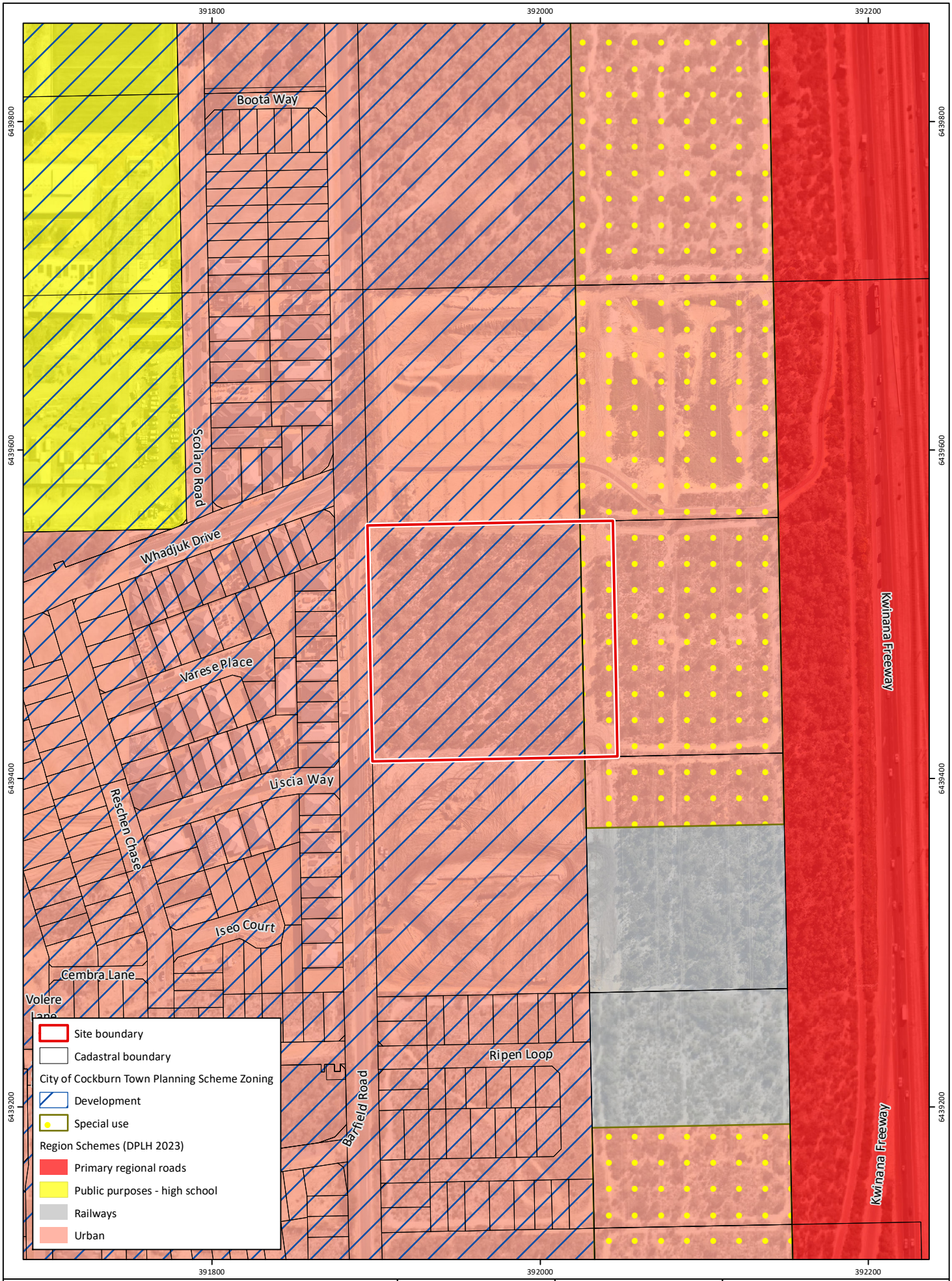


Figure 2: MRS and Town Planning Scheme Zoning

Project: Environmental Assessment and Management Strategy
Barfield Road Structure Plan Amendment
Client: Gold Estates Holdings Pty Ltd

Plan Number: EP22-099(04)--F22a
Drawn: WJC
Date: 09/10/2023
Checked: LSW
Approved: JDH
Date: 19/10/2023

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Metres

Scale: 1:3,000@A4

GDA 1994 MGA Zone 50

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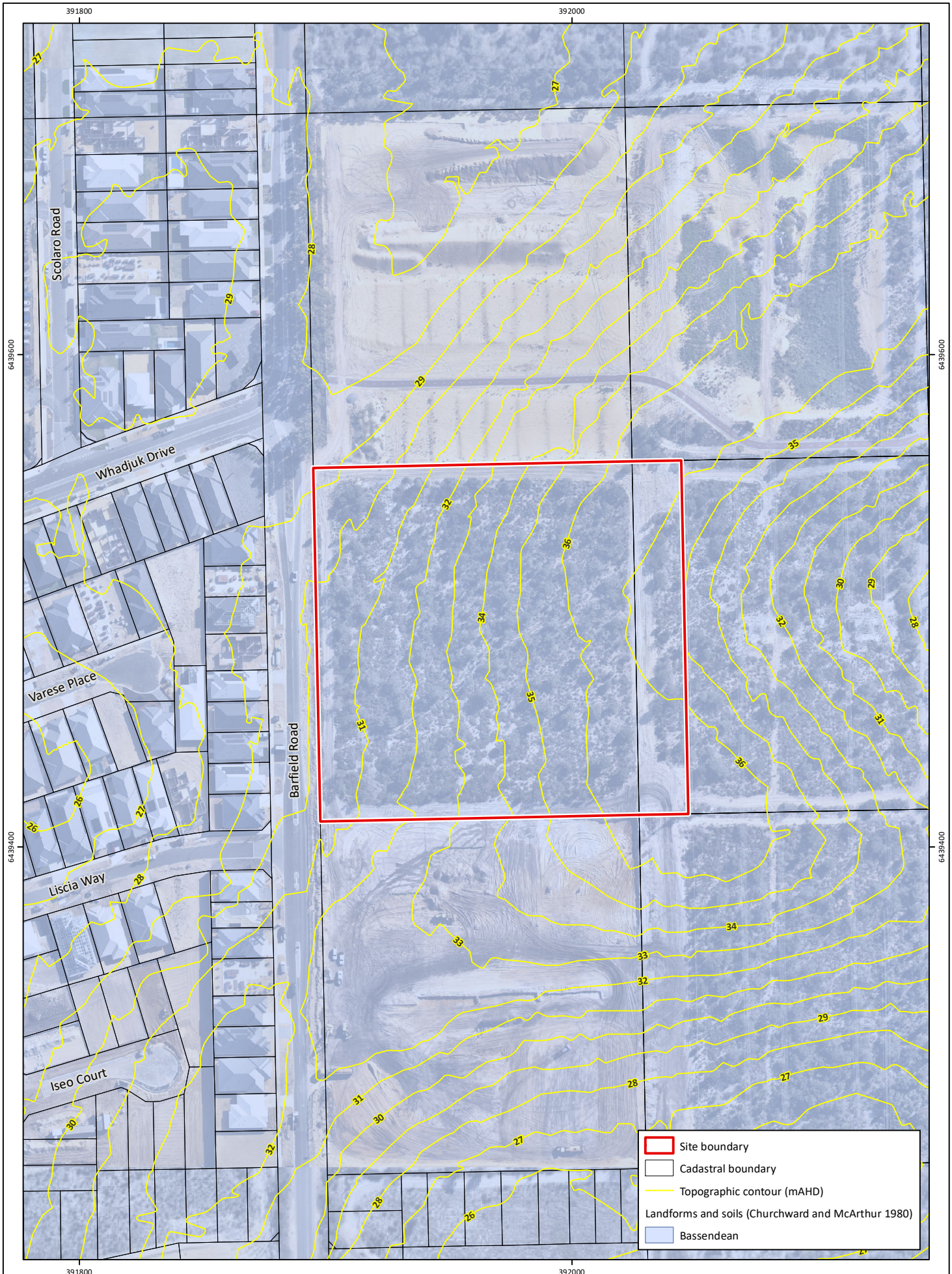


Figure 3: Soils and Topography

Project:	Environmental Assessment and Management Strategy Barfield Road Structure Plan Amendment
Client:	Gold Estates Holdings Pty Ltd

Plan Number:
EP22-099(04)--F23a

Drawn:	WJC
Date:	09/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

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Metres

Scale: 1:2,000@A4

GDA 1994 MGA Zone 50

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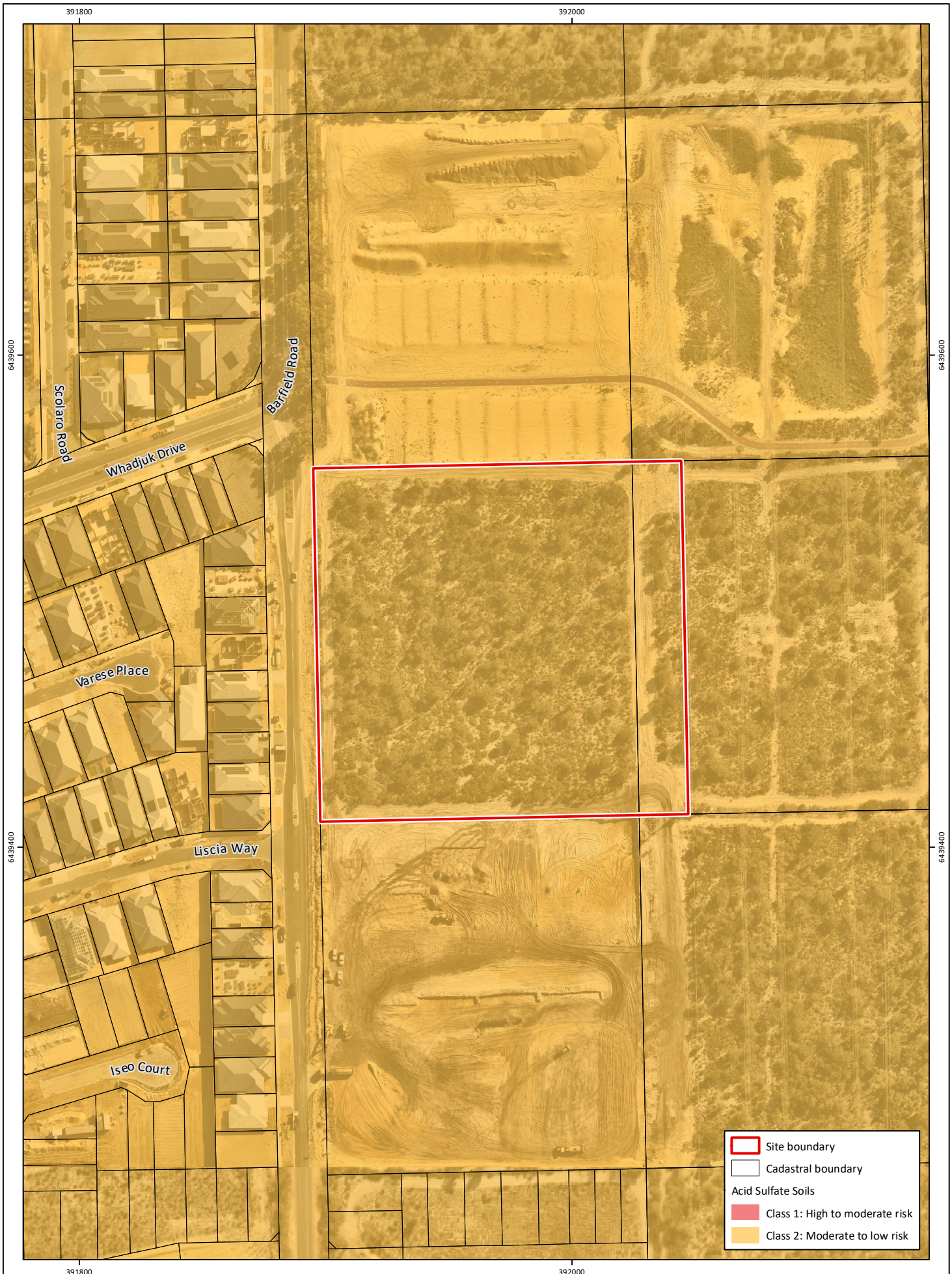


Figure 4: Acid Sulfate Soils

Project: Environmental Assessment and Management Strategy
Barfield Road Structure Plan Amendment

Client: Gold Estates Holdings Pty Ltd

Plan Number:
EP22-099(04)--F24a

Drawn:	WJC
Date:	09/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

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Metres

Scale: 1:2,000@A4

GDA 1994 MGA Zone 50

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Figure 5: **Plant Communities**

Project: Environmental Assessment and Management Strategy
Barfield Road Structure Plan Amendment

Client: Gold Estates Holdings Pty Ltd

Plan Number:
EP22-099(04)--F25a

Drawn:	WJC
Date:	09/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

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Metres

Scale: 1:1,000@A4

GDA 1994 MGA Zone 50

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Figure 6: Vegetation Condition

Project: Environmental Assessment and Management Strategy
Barfield Road Structure Plan Amendment

Client: Gold Estates Holdings Pty Ltd

Plan Number:
EP22-099(04)--F26a

Drawn:	WJC
Date:	09/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

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Metres

Scale: 1:1,000@A4

GDA 1994 MGA Zone 50

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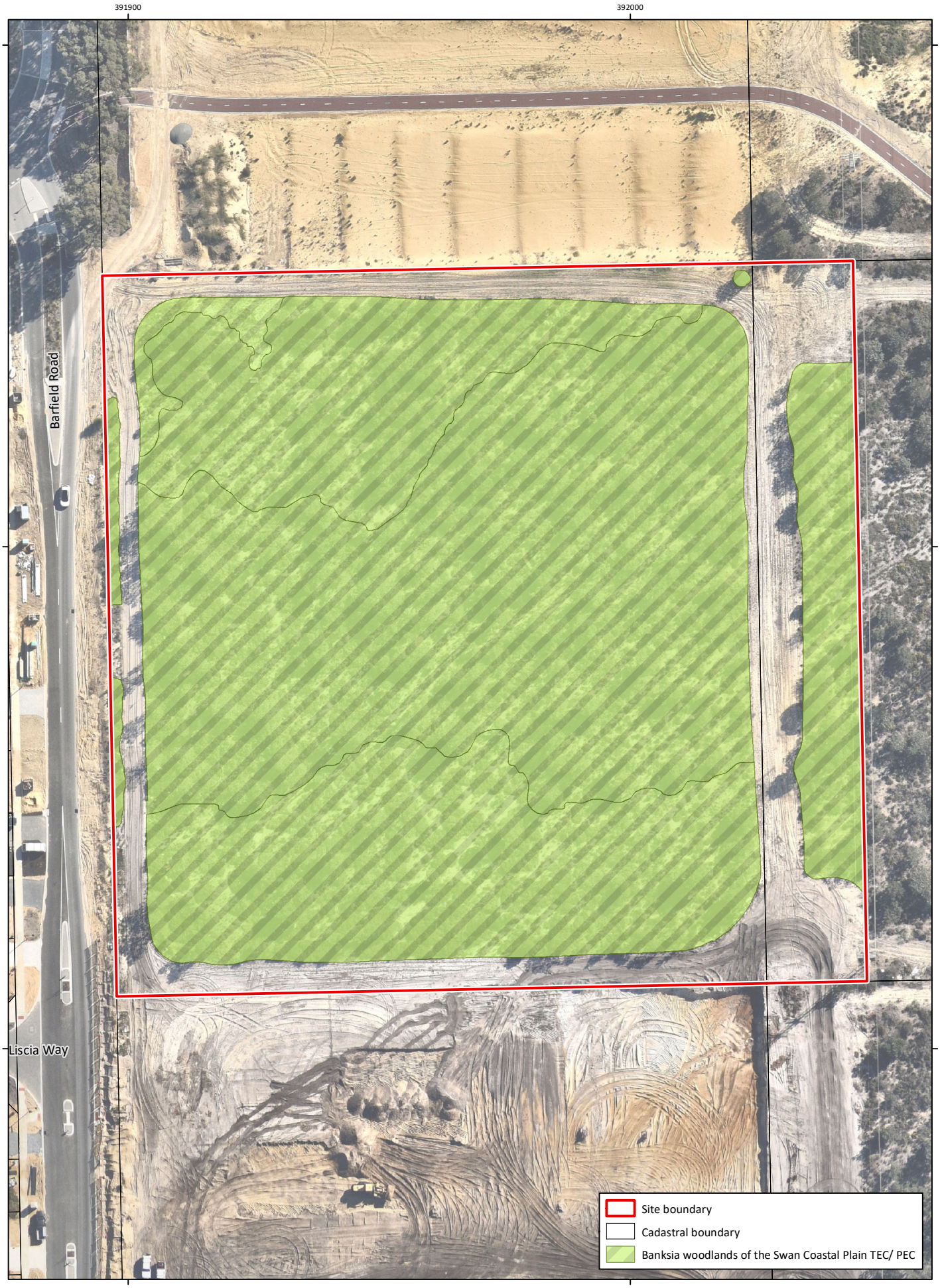


Figure 7: **Banksia Woodlands of the Swan Coastal Plain TEC**

Project: Environmental Assessment and Management Strategy
Barfield Road Structure Plan Amendment

Client: Gold Estates Holdings Pty Ltd

Plan Number: EP22-099(04)--F27a

Drawn:	WJC
Date:	10/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

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Metres

Scale: 1:1,000@A4

GDA 1994 MGA Zone 50

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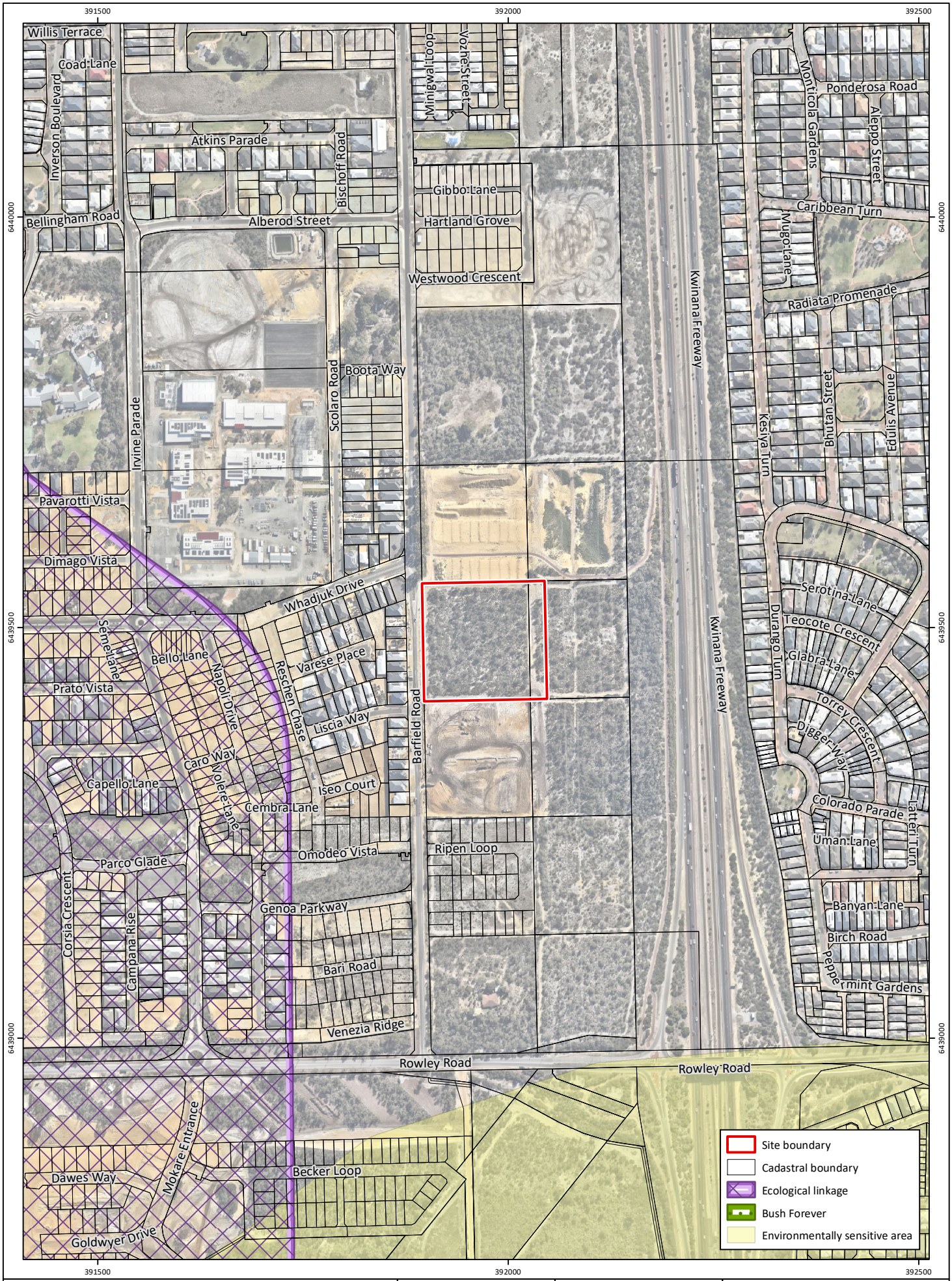


Figure 8: Environmental Features

Project:	Environmental Assessment and Management Strategy Barfield Road Structure Plan Amendment
Client:	Gold Estates Holdings Pty Ltd

Plan Number:
EP22-099(04)--F28a

Drawn:	WJC
Date:	10/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

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GDA 1994 MGA Zone 50

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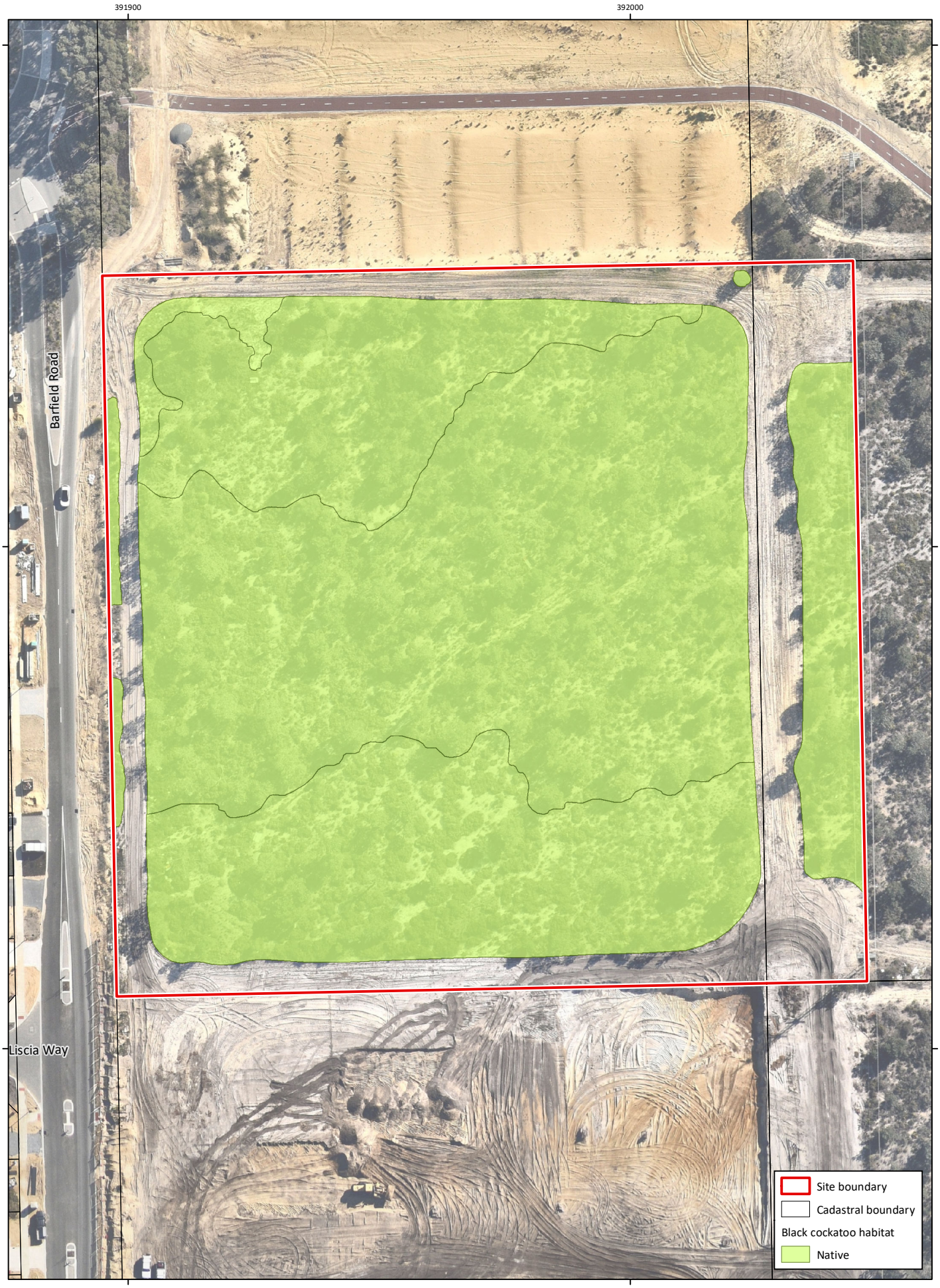


Figure 10: Black Cockatoo Habitat

Project: Environmental Assessment and Management Strategy
Barfield Road Structure Plan Amendment

Client: Gold Estates Holdings Pty Ltd

Plan Number:
EP22-099(04)--F29a

Drawn:	WJC
Date:	10/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

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Scale: 1:1,000@A4

GDA 1994 MGA Zone 50

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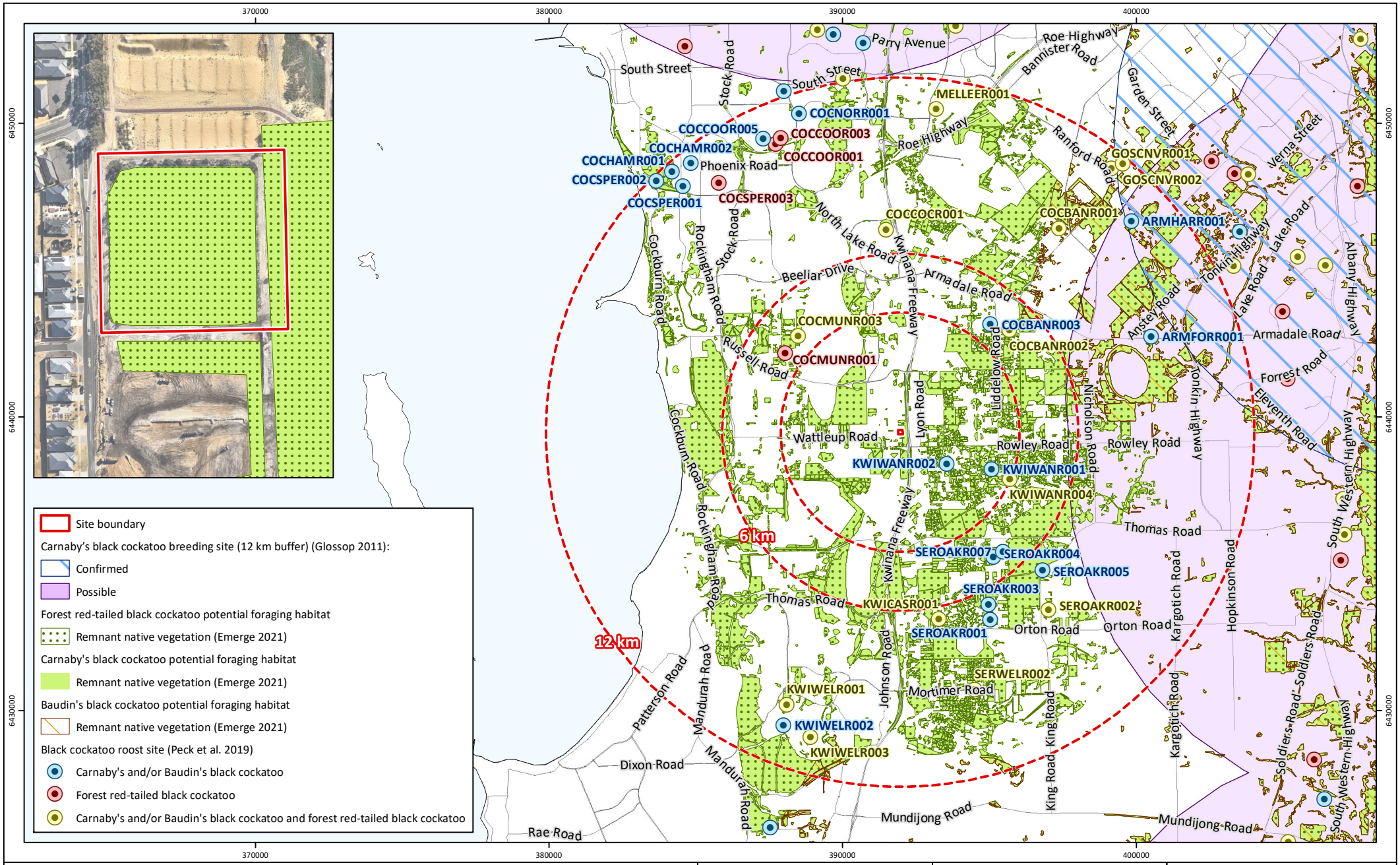


Figure 9: Regional Black Cockatoo Habitat Context

Project:	Environmental Assessment and Management Strategy Barfield Road Structure Plan Amendment
Client:	Gold Estates Holdings Pty Ltd

Plan Number:
EP22-099(04)--F30a

Drawn:	WJC
Date:	10/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

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Kilometers

Scale: 1:170,000@A4

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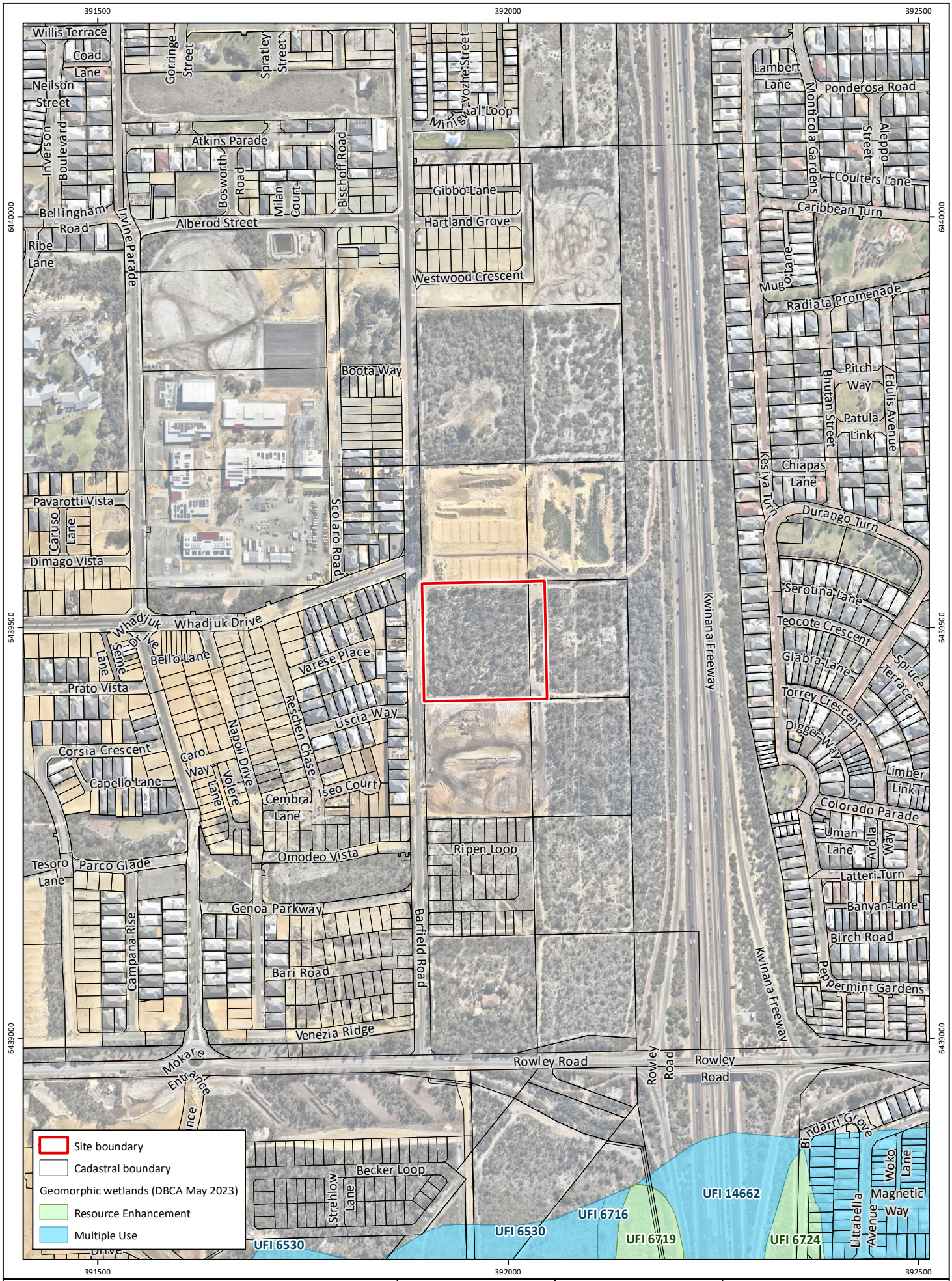


Figure 11: Geomorphic Wetlands

Project:	Environmental Assessment and Management Strategy Barfield Road Structure Plan Amendment
Client:	Gold Estates Holdings Pty Ltd

Plan Number:
EP22-099(04)--F31a

Drawn:	WJC
Date:	10/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

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Metres

Scale: 1:6,000@A4

GDA 1994 MGA Zone 50

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Figure 12: Hydrological Features

Project: Environmental Assessment and Management Strategy
Barfield Road Structure Plan Amendment

Client: Gold Estates Holdings Pty Ltd

Plan Number: EP22-099(04)--F32a

Drawn:	WJC
Date:	10/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

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Metres

Scale: 1:6,000@A4

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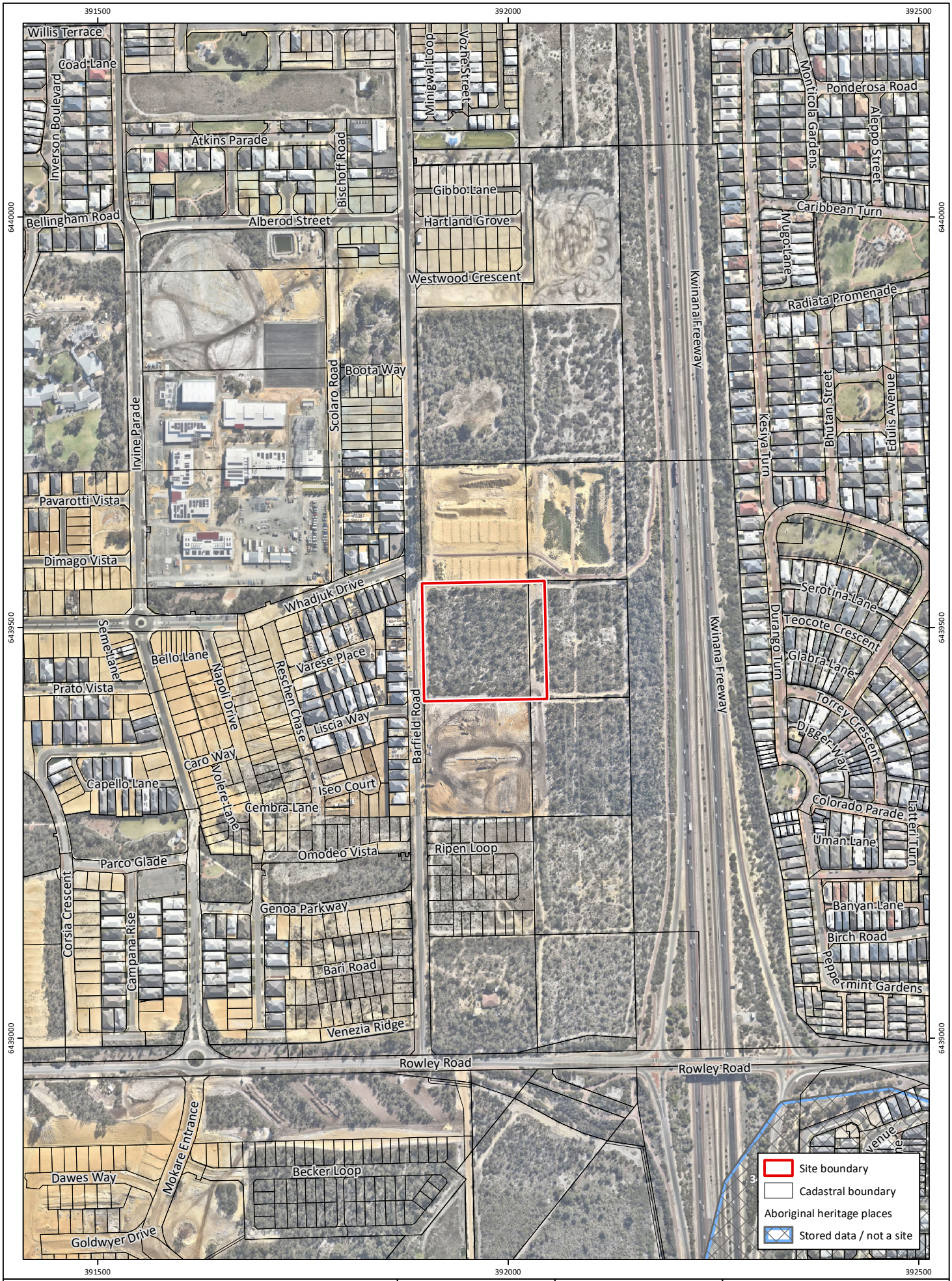


Figure 13: Aboriginal Heritage

Project:	Environmental Assessment and Management Strategy Barfield Road Structure Plan Amendment
Client:	Gold Estates Holdings Pty Ltd

Plan Number:
EP22-099(04)--F33a

Drawn:	WJC
Date:	10/10/2023
Checked:	LSW
Approved:	JDH
Date:	19/10/2023

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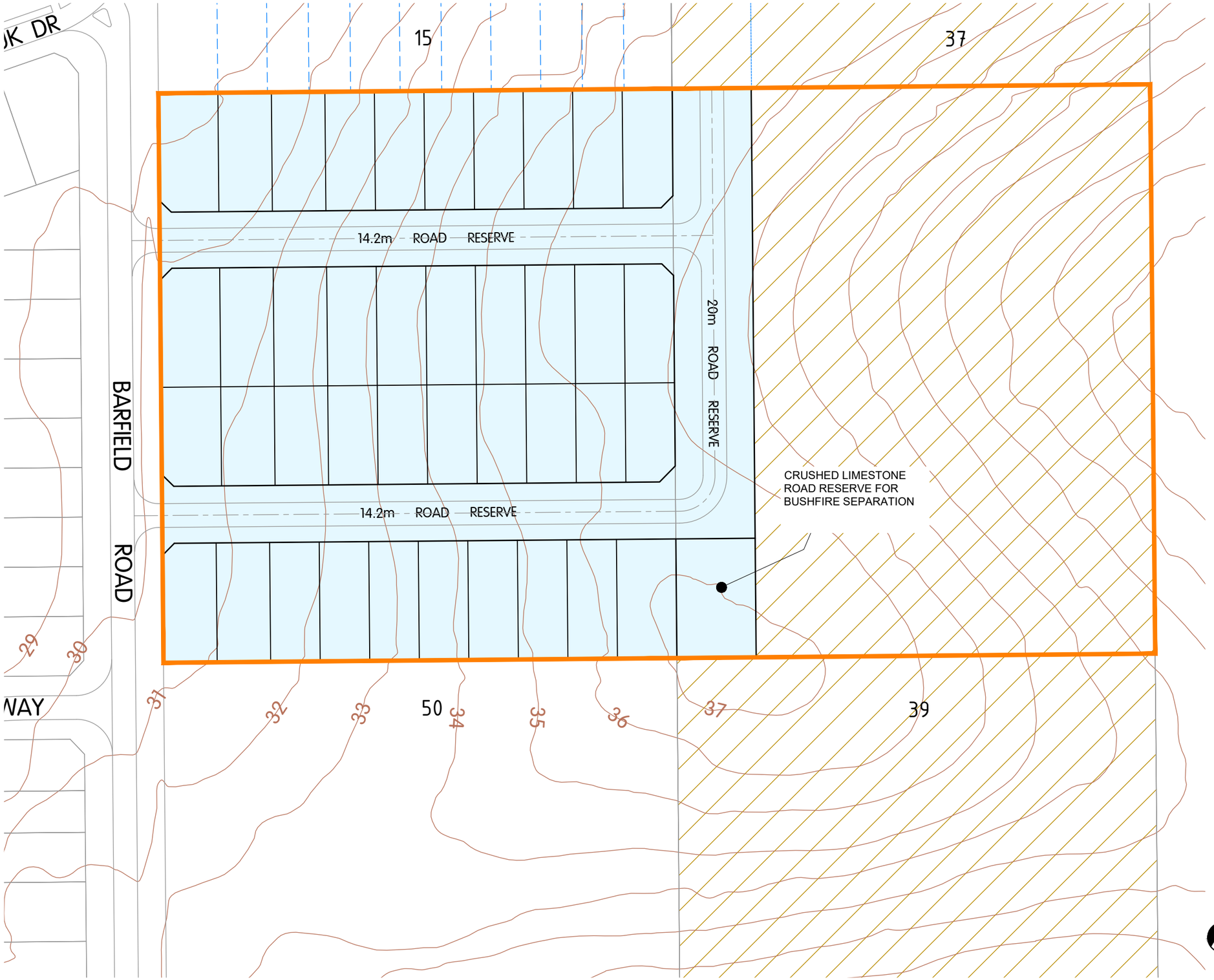
GDA 1994 MGA Zone 50

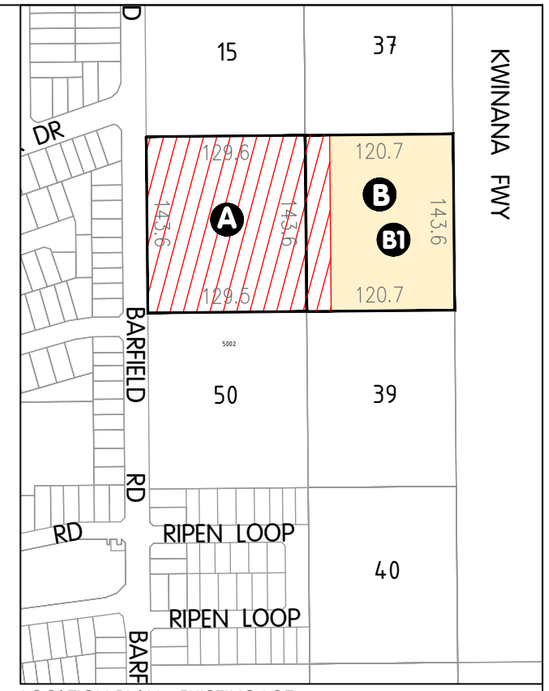
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Appendix A

Concept Plan, Lot 16 Barfield Road (RobertsDay 2023)





LOCATION PLAN - EXISTING LOT

EXISTING LOT 16
A 1.8606ha
EXISTING LOT 38
B 1.7326ha
PROPOSED SUBDIVISION
BALANCE LOT 38
B1 1.4454ha

LEGEND

- SUBJECT LOTS
- EXISTING LOT BOUNDARY
- 50 EXISTING LOT NUMBERS
- PROPOSED SUBDIVISION
- 52 EXISTING CONTOURS
- EXISTING EASEMENTS

YIELD TABLE	
Existing Lots	2
Proposed Lots	
Residential (Single)	40
Balance of Title	1
TOTAL	**41**

PROPOSED LAND USE/DEVELOPMENT

Zone	Lot Size	No. of Lots
Residential	235m² - 319m²	7
Residential	320m² - 449m²	32
Residential	450m² - 499m²	1
Other	1ha - 2ha	1
	TOTAL	**41**

RICHARDNOBLE
PROPERTY INTEGRITY COMMUNITY

CADASTRAL INFORMATION
SOURCE: MNG
YYMMDD: 220408
DWG REF: 96326lots-9999bn-PCG94
PROJECTION: PCG94

AERIAL PHOTOGRAPHY
SOURCE: NA
YYMMDD: NA

HATCH | RobertsDay

SIZE A3_ 1:1000
0 metres 10 20 30 40 50

SUBDIVISION PLAN
Lot 16 Barfield Road
City of Cockburn

REF NO. **RIC HAM**
DRAW NO. **RD1 412**
REV. **D**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY.

Appendix B

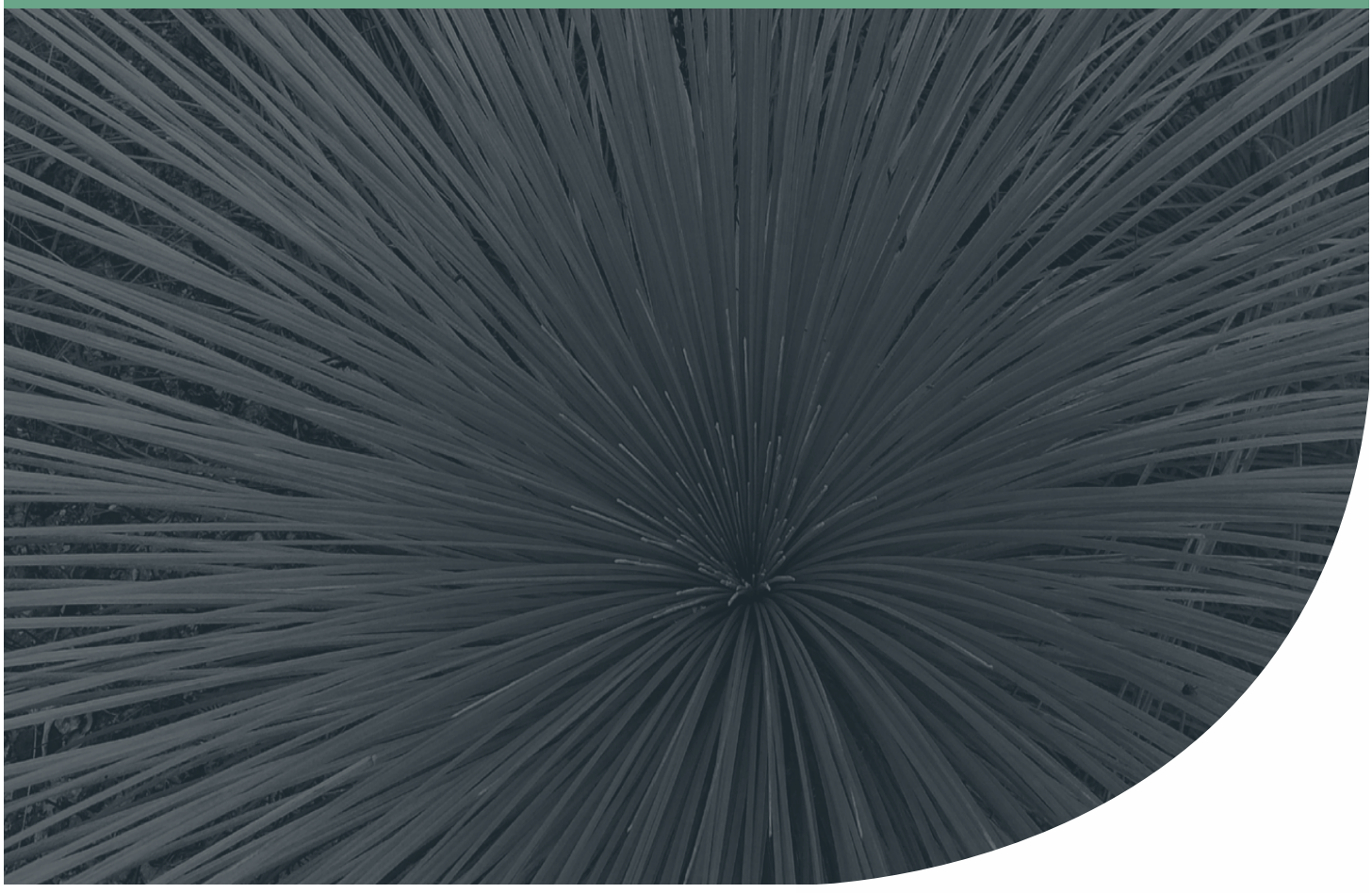
Detailed Flora and Vegetation Assessment (Emerge Associates 2023b)

Detailed Flora and Vegetation Assessment

Lot 16 Barfield Road, Hammond Park

Project No: EP22-099(01)

Prepared for Gold Estates Holdings Pty Ltd
January 2023



Document Control

Doc name:	Detailed Flora and Vegetation Assessment Lot 16 Barfield Road, Hammond Park				
Doc no.:	**EP22-099(01)--002A MS**				
Version	**Date**	**Author**		**Reviewer**	
1	January 2023	Melanie Schubert	MS	Tom Atkinson	TAA
	Submitted for client review				
A	January 2023	Melanie Schubert	MS	Tom Atkinson	TAA
	Updated following client comments				

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Executive Summary

Gold Estates Holdings Pty Ltd engaged Emerge Associates to conduct a detailed flora and vegetation assessment to provide information on the flora and vegetation values within Lot 16 Barfield Road in Hammond Park (referred to herein as the 'site').

As part of the assessment a desktop review of relevant background information was completed and a field survey was undertaken on 27 September and 31 October 2022. During the field survey an assessment was made on the type, condition and values of vegetation across the site.

Outcomes of the survey include the following:

- A total of 88 native and 24 non-native (weed) species were recorded in the site.
- No threatened or priority flora species were recorded or are considered likely to occur within the site due to lack of suitable habitat or because they were not recorded during the field survey.
- The native vegetation within the site was mapped as a single plant community (**BaBm**). The remainder of the site was mapped as plant community '**non-native**' which is predominantly comprises bare ground associated with firebreaks.
- The **BaBm** vegetation aligns closely with floristic community type (FCT) '23a - Central *Banksia attenuata - B. menziesii* woodlands'.
- The majority of the site contains relatively intact native vegetation in 'excellent' (0.86 ha), 'very good' (0.42 ha) and 'very good - good' (0.27 ha) condition. The remainder of the site is in 'degraded' or 'completely degraded' condition (0.3 ha).
- Based on the relevant criteria, the native vegetation within the site represents the Commonwealth listed threatened ecological community (TEC) and State listed priority ecological community (PEC) 'banksia Woodlands of the Swan Coastal Plain'. Approximately 1.6 ha of the banksia woodland of the Swan Coastal Plain TEC/PEC is present within the site.
- Given the presence of additional areas of 'banksia woodland' vegetation directly adjacent to the site, the **BaBm** vegetation within the site forms part of a much larger contiguous patch of the TEC/PEC.

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Appendix D

Conservation Significant Communities and Likelihood of Occurrence Assessment

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Species x Plant Community Matrix

Appendix F

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Appendix G

Cluster Dendrograms

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Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
EPA	Environmental Protection Authority
DBCA	Department of Biodiversity, Conservation and Attractions
DWER	Department of Water and Environmental Regulation
WALGA	Western Australia Local Government Association

Table A2: Abbreviations – General terms

General terms	
FCT	Floristic community type
IBRA	Interim Biogeographic Regionalisation of Australia
NVIS	National Vegetation Inventory System (ESCAVI 2003)
P3	Priority 3
P4	Priority 4
PEC	Priority ecological community
TEC	Threatened ecological communities

Table A3: Abbreviations – Legislation

Legislation	
BAM Act	*Biosecurity and Agriculture Management Act 2007*
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
BC Act	*Biodiversity Conservation Act 2016*
BC Regs	Biodiversity Conservation Regulations 2018

Table A5: Abbreviations – Units of measurement

Units of measurement	
ha	Hectare
m AHD	m in relation to the Australian height datum
mm	Millimetre

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1 Introduction

1.1 Project background

Emerge Associates (Emerge) were engaged by Gold Estates Holdings Pty Ltd to characterise the flora and vegetation values within Lot 16 Barfield Road in Hammond Park (referred to herein as the 'site'). The site is located approximately 25 kilometres (km) south of the Perth Central Business District within the City of Rockingham.

The site is approximately 1.86 hectares (ha) in size and is bounded by Barfield Road to the west, native vegetation to the east and future residential lots to the north and south. The location and extent of the site is shown in **Figure 1**.

1.2 Purpose and scope of work

The scope of work was specifically to undertake a flora and vegetation assessment within the site to the standard required of a detailed survey with reference to the Environmental Protection Authority's (EPA's) technical guidance (EPA 2016).

As part of this scope of work, the following tasks were undertaken:

- Desktop review of relevant background information pertaining to the site and surrounds, including database searches for threatened flora species and ecological communities.
- A field survey to record a comprehensive list of flora species and assess vegetation type and condition.
- Mapping of plant communities, vegetation condition and conservation significant flora and vegetation.
- Identification of potential habitat for conservation significant flora and vegetation and an assessment of likelihood of occurrence.
- Documentation of the desktop assessment, methodology, field survey and results into a report.

2 Environmental Context

2.1 Climate

Climate influences the types of vegetation that grow in a region and the life cycles of the flora present. Therefore, it is critical for a flora and vegetation survey to respond appropriately to climatic conditions to ensure that surveys are conducted during times when flora species are easiest to detect and identify.

The south-west of Western Australia experiences a Mediterranean climate of hot dry summers and cool wet winters. In Mediterranean type climates some flora species will typically spend part of their lifecycle as either underground storage organs or as seed. This is an adaptation to unfavourable environmental conditions such as excessive heat and drought that occur over the summer period. These species, known as 'geophytes' or 'annuals', tend to re-emerge during winter when favourable conditions return and are most visible during spring, which is the flowering period for a majority of plant species. Therefore, spring is the optimal time to complete flora and vegetation surveys in the south-west of WA.

An average of 801 millimetres (mm) of rainfall is recorded annually from the Anketell weather station (no. 009258), which is the closest weather station, located approximately 5 km south-east of the site. The majority of this rainfall is received between the months of May and September. Mean maximum temperatures at the Jandakot Aero weather station (no. 009172), which is the nearest temperature recording station approximately 9 km north-west of the site, range from 18.0°C in July to 31.6°C in February, while mean minimum temperatures range from 7.1°C in July and August to 16.9°C in February (BoM 2022).

A total of 670.8 mm of rain was recorded from May to September 2022 prior to the survey, which is approximately 10.37% higher than the mean of 607.8 mm for this period (BoM 2022). Therefore, the rainfall was considered sufficient to promote the flowering and emergence of native flora.

2.2 Geomorphology and soils

Landform and soils influence vegetation types at regional and local scales. The site occurs on the Swan Coastal Plain, which is the geomorphic unit that characterises much of the Perth metropolitan area. The Swan Coastal Plain is approximately 500 km long and 20 to 30 km wide and is roughly bound by the Indian Ocean to the west and the Darling Scarp to the east. Broadly the Swan Coastal Plain consists of two sedimentary belts of different origin. Its eastern side comprises the Pinjarra Plain which formed from the deposition of alluvial material washed down from the Darling Scarp, while its western side comprises three dune systems that run roughly parallel to the Indian Ocean coastline (Seddon 2004). These dune systems, referred to as Quindalup, Spearwood and Bassendean associations, represent a succession of coastal deposition that has occurred since the late Quaternary period (approximately two million years ago) (Kendrick *et al.* 1991) and, as a result, they contain soils at different stages of leaching and formation.

Examination of broad scale soil mapping places the site within the Bassendean association (Churchward and McArthur 1980). The Bassendean association comprises sand plains with low dunes and occasional swamps, iron or humus podzols and areas of complex steep dunes.

The soil types mapped within the site are shown in **Figure 2**.

The site is not known to contain any restricted landforms or unique geological features.

2.3 Topography

The elevation of the site ranges from 29 m in relation to the Australian height datum (mAHD) on the western side of the site to 36 mAHD on the eastern side of the site (DoW 2008) (**Figure 2**).

2.4 Hydrology and wetlands

Wetlands are areas of seasonally, intermittently or permanently waterlogged land such as poorly drained soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries (Wetlands Advisory Committee 1977). Wetlands can be recognised by the presence of vegetation associated with waterlogging or the presence of hydric soils such as peat, peaty sand or carbonate mud (Hill *et al.* 1996).

Wetlands of national or international significance may be afforded special protection under Commonwealth or international agreements. The following lists of important wetlands were checked as part of this assessment:

- *Ramsar List of Wetlands of International Importance* (DBCA 2017c)
- *A Directory of Important Wetlands in Australia* (DBCA 2018)

No Ramsar or listed 'important wetlands' are located within or near the site.

Examination of the Department of Water and Environmental Regulation (DWER) hydrography dataset (DWER 2018) shows that no wetland or water related features occur within the site.

The Department of Biodiversity, Conservation and Attractions (DBCA) has developed the *Geomorphic Wetlands of the Swan Coastal Plain* dataset (DBCA 2021). This dataset maps geomorphic wetland features and classifies them based on their landform shape and water permanence. Each feature is assigned to one of three management categories which guides land use and conservation.

Review of the *Geomorphic Wetlands, Swan Coastal Plain* dataset indicated that no wetland features occur within or near the site.

2.5 Regional vegetation

Native vegetation is described and mapped at different scales in order to illustrate patterns in its distribution. At a continental scale the *Interim Biogeographic Regionalisation of Australia* (IBRA) divides Australia into floristic subregions (Environment Australia 2000).

The site is contained within the Swan Coastal Plain IBRA region and within the 'SWA02' or Perth subregion. The Perth subregion is characterised by mainly banksia low woodland on leached sands with melaleuca swamps where ill-drained; and woodland of *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah) and *Corymbia calophylla* (marri) on less leached soils (Beard 1990). This subregion is recognised as a biodiversity hotspot and contains a wide variety of endemic flora and vegetation types.

Variations in native vegetation can be further classified based on regional vegetation mapping.

Heddle *et al.* (1980) mapping shows the site as comprising the 'Bassendean central and south complex', which is described as vegetation ranging from woodland of *Eucalyptus marginata* - *Allocasuarina fraseriana* - *Banksia* spp. to low woodland of *Melaleuca* spp. and sedgelands on the moister sites.

The Bassendean central and south complex was determined to have 26.87% of its pre-European extent remaining on the SCP, of which 2.15% is protected for conservation purposes (Government of Western Australia 2019).

2.6 Historical land use

Review of historical images available from 1953 onwards shows that the site was almost completely cleared of native vegetation prior to 1985 (**Plate 1**). Vegetation has subsequently regenerated. Since then, no further vegetation clearing is evident from aerial imagery.

The southern portion of the site appears to have been burnt between January and March 2015 which resulted in a reduction in vegetation cover in these areas but vegetation has since regrown (**Plate 2** and **Plate 3**) (WALIA 2022).



Plate 1: Aerial photography of the site in 1985 showing extensive clearing of native vegetation.



Plate 2: Aerial photography of the site in 2015 showing evidence of fire in the southern portion of the site.



Plate 3: Aerial photography of the site in 2015 showing reduction of vegetation canopy in the southern portion of the site.

2.7 Conservation significant values

2.7.1 Threatened and priority flora

Certain flora taxa that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, flora taxa may be listed as 'threatened' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Threatened flora species listed under the EPBC Act are assigned a conservation status according to attributes such as population size and geographic distribution. Any action likely to have a significant impact on a taxon listed under the EPBC Act requires Ministerial approval.

In Western Australia flora species may also be classed as 'threatened' under *the Biodiversity Conservation Act 2016* (BC Act). Similarly, it is an offence to 'take' or 'disturb' threatened flora listed under the BC Act without Ministerial approval.

Flora species that do not currently meet the criteria for listing as threatened but are potentially rare or threatened may be added to the DBCA's *Priority Flora List*. These species are classified into 'priority' levels based on threat. Whilst priority species are not under direct statutory protection, they are considered during State approval processes.

Further information on threatened and priority species and their categories is provided in **Appendix A**. An assessment of the likelihood of occurrence of threatened and priority flora within the site was undertaken (refer to **Sections 3.1** and **4.2.1**).

2.7.2 Threatened and priority ecological communities

An ecological community is a naturally occurring group of native plants, animals and other organisms that are interacting in a unique habitat. An ecological community's structure, composition and distribution are influenced by environmental factors such as soil type, position in the landscape, altitude, climate and water availability (DAWE 2021a). 'Threatened ecological communities' (TECs) are ecological communities that are recognised as rare or under threat and therefore warrant special protection.

Selected TECs are afforded statutory protection at a Commonwealth level under the EPBC Act. Similar to flora species, TECs listed under the EPBC Act are assigned a conservation status. Any action likely to have a significant impact on a community listed under the EPBC Act requires Ministerial approval.

TECs are also listed within Western Australia under the BC Act and the BC Regulations. Their significance is also acknowledged through other state environmental approval processes such as 'environmental impact assessment' pursuant to Part IV of *the Environmental Protection Act 1986* (EP Act) and the *Environmental Protection* (Clearing of Native Vegetation) *Regulations 2004*.

An ecological community that is under consideration for listing as a TEC in Western Australia but does not yet meet survey criteria or has not been adequately defined may be listed as a 'priority ecological community' (PEC). Listing as a PEC is similarly considered during State approval processes.

Further information on categories of TECs and PECs is provided in **Appendix A**. An assessment of the likelihood of occurrence of threatened and priority flora within the site was undertaken (refer to **Sections 3.1** and **4.3.1**).

2.8 Weeds and pests

The term 'weed' can refer to any plant that requires some form of action to reduce its effect on the economy, the environment, human health and amenity. Many non-native flora species and some native species are considered to be weeds. The likelihood of weeds occurring is higher in areas disturbed areas, especially areas that have been agricultural or urban landuse.

A particularly invasive or detrimental weed species may be listed as a 'declared pest' pursuant to *Western Australia's Biosecurity and Agriculture Management Act 2007* (BAM Act), indicating that it warrants special management to limit its spread.

The Commonwealth government has further compiled a list of 32 *Weeds of National Significance* (WoNS) (DAWE 2021b). Whilst the WoNS list is non-statutory, many WoNS are also listed under the BAM Act. Further information on weeds and declared pests is provided in **Appendix A**.

2.9 Bush Forever

The Government of Western Australia's *Bush Forever* policy is a strategic plan for conserving regionally significant bushland within the Swan Coastal Plain portion of the Perth Metropolitan Region. The objective of *Bush Forever* is to protect comprehensive representations of all original ecological communities by targeting a minimum of 10% of each vegetation complex for protection (Government of WA 2000). *Bush Forever* sites are representative of regional ecosystems and habitat and have a key role in the conservation of Perth's biodiversity. Flora considered to be 'significant', irrespective of Commonwealth and state conservation significance status, are listed in *Bush Forever* documentation.

No *Bush Forever* sites occur within or adjacent to the site. The closest Bush Forever site near the site is no. 392 (Harry Waring Marsupial Reserve, Wattleup) which is located 1.2 km north-west of the site. Multiple additional Bush Forever sites occur in the wider area of the site. The locations of the Bush Forever sites near the site are shown in **Figure 3**.

2.10 DBCA managed or legislated land

DBCA has tenure of or interests in numerous areas of land across the state for a range of purposes. Tenure categories include national parks, nature reserves, conservation parks, marine parks, marine nature reserves, marine management areas, section 5(1)(g) reserves, state forest and timber reserves. These areas are mapped within the *Legislated Lands and Waters* (DBCA 2017a) and *Lands of Interest* (DBCA 2017b) datasets. The *Legislated Lands and Waters* (DBCA 2017a) dataset includes lands subject to the following legislation; the *Conservation and Land Management Act 1984* (CALM Act 1984), *Swan and Canning Rivers Management Act 2006* (SCRM Act) and lands identified under the *Land Administration Act 1997* (LA Act). The *Lands of Interest* (DBCA 2017b) dataset includes all other lands of which DBCA is recognised as the manager but is not vested under any act. These lands

comprise of crown land and freehold land which DBCA has been acknowledged by the Department of Lands as the responsible agency.

No DBCA managed or legislated lands or lands of interest occur within or adjacent to the site. The closest DBCA managed land near the site is associated with Bush Forever Site 392 (Harry Waring Marsupial Reserve) which is located 1.2 km north-west of the site. Harry Waring Marsupial Reserve incorporates three areas denoted as DBCA legislated lands and waters. R15556 and R29241 are nature reserves and R48291 is a conservation park under the CALM Act 1984 (DBCA 2017a).

2.11 Ecological linkages

Ecological linkages are linear landscape elements that allow the movement of fauna, flora and genetic material between areas of remnant habitat. This exchange of genetic material between vegetation remnants improves the viability of those remnants by allowing greater access to breeding partners and food sources, refuge from disturbances such as fire and maintenance of genetic diversity of plant communities and populations. Ecological linkages are ideally continuous or near-continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

The Perth Biodiversity Project, supported by the Western Australia Local Government Association (WALGA), have identified and mapped regional ecological linkages within the Perth Metropolitan Region (WALGA and PBP 2004). This study was extended beyond the Perth Metropolitan Region through the South West Biodiversity Project, resulting in the identification and mapping of the South West regional ecological linkages (Molloy *et al.* 2009).

There are no mapped ecological linkages within or in close proximity to the site. One regional ecological linkage (No. 50) occurs approximately 200 m west of the site running from north to south and intersects with another ecological linkage (No. 52) running east to west approximately 1.2 km north of the site. These ecological linkages connect areas of Bush Forever located in the wider local area.

Review of aerial imagery indicates that the vegetation within the site is connected to multiple small areas of native vegetation within the local area.

2.12 Previous surveys

No previous surveys are known to have been undertaken over the site.

3 Methods

3.1 Database searches

A search was conducted for threatened and priority flora that may occur or have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2022), *NatureMap* (DBCA 2022) and DBCA's threatened and priority flora database (reference no. 45-1022FL).

A search was also conducted for TECs and PECs that may occur or have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2022), the *weed and native flora dataset* (Keighery *et al.* 2012) and DBCA's threatened and priority ecological communities' database (reference no. 15-1022EC).

Prior to undertaking the field survey, information on the habitat preferences of threatened and priority flora species and communities identified from database searches was reviewed. This was compared to existing environmental information available for the site, such as geomorphology, soils, regional vegetation and historic land use, to identify species and communities for which habitat may occur in the site.

3.2 Field survey

A botanist from Emerge visited the site on 27 September and 31 October 2022 to conduct the flora and vegetation field survey.

The site was traversed on foot and the composition and condition of vegetation was recorded. Photographs were taken throughout the field visit to show particular site conditions.

Plant specimens collected during the field survey were dried, pressed and named in accordance with requirements of the Western Australian Herbarium (2022). Identification of specimens occurred through comparison with named material and through the use of taxonomic keys. Flora species not native to Western Australia are denoted by an asterisk ('*') in text and raw data.

3.2.1 Sampling

Detailed sampling of the vegetation was undertaken using two permanent 10 x 10 m quadrats. The quadrats were established using fence droppers bound by measuring tape. The position of each sample was recorded with a hand-held GPS unit and is shown in **Figure 4**.

The data recorded within each sample included:

- site details (site name, site number, observers, date, location)
- environmental information (slope, aspect, bare-ground, rock outcropping soil type and colour class, litter layer, topographical position, time since last fire event)
- biological information (vegetation structure and condition, 'foliage projective cover' (FPC), degree of disturbance and species present).

Additional plant taxa not observed within samples were recorded opportunistically as the botanist traversed the site.

3.2.2 Targeted searches

The suitability of habitat within the site for conservation significant flora and communities identified in the desktop assessment was assessed (refer **Section 3.1**). Areas of suitable habitat were traversed along transects and searched for conservation significant species, as required.

3.2.3 Vegetation condition

Vegetation condition was assigned at each sample and changes in vegetation condition were also noted and mapped across the site. The condition of the vegetation was assessed using the Keighery (1994) scale (**Table 1**). For the vegetation in the site containing *Banksia* spp., the condition scale provided in the conservation advice for the 'banksia woodlands of the Swan Coastal Plain TEC' (DoEE 2016a) was applied in addition to the Keighery scale, as shown in **Table 1**.

Table 1: Vegetation condition scale applied during the field assessment

Condition category	Definition (Keighery 1994)	Indicator (DoEE 2016a)	
		Typical native vegetation composition	Typical weed cover
Pristine	Pristine or nearly so, no obvious signs of disturbance.	Native plant species diversity fully retained or almost so	Zero or close to
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.	High native plant species diversity	Less than 10%
Very good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	Moderate native plant species diversity	5-20%
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.	Low native plant species diversity	5-50%
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	Very low native plant species diversity	20-70%
Completely degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.	Very low to no native species diversity	Greater than 70%

3.3 Mapping and analysis

3.3.1 Conservation significant flora and communities

Based on the database searches and information recorded during the field survey, an assessment of the likelihood of occurrence of threatened and priority flora species and communities within the site was undertaken using the categories outlined in **Table 2**.

Table 2: Likelihood of occurrence assessment categories and definitions

Likelihood	Definition
Recorded	The species was recorded during the current field survey.
Likely	The site contains suitable habitat for the species and it is likely the species may occur based on presence of a recent historical record within or close to the site.
Possible	The site contains suitable habitat for the species but there is no other information to suggest that the species may occur within or close to the site.
Unlikely	The site does not contain suitable habitat for the species or the site contains suitable habitat for the species within which thorough targeted searches were completed and conclusion has been made that the species is unlikely to be present.

3.3.2 Plant community identification and description

The plant communities within the site were identified from the sample data collected during the field survey. The vegetation was described according to the dominant species present using the structural formation descriptions of the *National Vegetation Inventory System* (NVIS) (NVIS Technical Working Group 2017). The identified plant communities were mapped on aerial photography from the sample locations and boundaries were interpreted from aerial photography and notes taken in the field. Vegetation condition was mapped on aerial photography based on the samples and notes recorded during the field survey to define areas with differing condition.

3.3.3 Floristic community type assignment

The identified plant community was then compared to the regional 'floristic community type' (FCT) dataset *A floristic survey of the southern Swan Coastal Plain* (Gibson *et al.* 1994). Each sample was compared to Gibson *et al.* (1994) separately to limit the influence of spatial correlation when assigning an FCT. FCT analysis was not undertaken for samples located within disturbed vegetation with low native species diversity as the vegetation was considered unlikely to currently represent an FCT.

Sample data (presence/absence) was first reconciled with Gibson *et al.* (1994) by standardising the names of taxa with those used in the earlier study. This was necessary due to changes in nomenclature in the intervening period. Taxa that were only identified to genus level were excluded, while some infra-species that have been identified since 1994 were reduced to species level. The combined dataset was then imported into the statistical analysis package PRIMER v6 (Clarke and Gorley 2006).

A resemblance matrix was generated using the Bray-Curtis distance measure which provided the percentage similarity between all pairs of samples. Subsequently, a cluster analysis was undertaken using the resemblance matrix and hierarchical agglomerative clustering, to produce a dendrogram.

Where a sample tended to cluster with a grouping of different FCTs, the resemblance matrix was examined. Ultimately a combination of cluster analysis, resemblance matrix and contextual information relating to the soils, landforms and known FCTs within the region was considered in the final determination of an FCT for vegetation within the site.

3.3.4 Threatened and priority ecological communities

Areas of native vegetation potentially representing a TEC or PEC were assessed against key diagnostic characteristics and, if available, size and/or vegetation condition thresholds.

3.3.5 Species accumulation curve

A species accumulation curve was plotted from sample data by generating a trendline (log) in Microsoft Excel. The trendline was forecast to locate the asymptote of the curve (the point at which the curve flattens), which provides an indication of amount of sampling that would be required before it can be assumed few species remain undetected. PRIMER v6 also offers a range of estimators to predict minimum species richness (Clarke and Gorley 2006). Both the Jacknife1 and Chao2 non-parametric estimators are reported, as these are known to perform well in comparison to simulated and real data sets and are also recommended for small sample sizes (Gotelli and Colwell 2011). Comparison between actual and estimated species accumulation assists in evaluating the adequacy of sampling effort.

3.4 Survey limitations

It is important to note the specific constraints imposed on surveys and the degree to which these may have limited survey outcomes. An evaluation of the survey methodology against standard constraints outlined in the EPA document *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) is provided in **Table 3**.

Table 3: Evaluation of survey methodology against standard constraints outlined in EPA (2016)

Constraint	Degree of limitation	Details
Availability of contextual information	No limitation	The broad scale contextual information described in **Section 2** is adequate to place the site and vegetation in context.
	No limitation	Regarding assignment of FCTs, the authoritative Gibson *et al.* (1994) dataset was derived from a necessarily limited sample of vegetation from largely publicly owned land which is now more than 20 years out of date. Consequently, it is unknown to what degree official FCTs are appropriate reference to biodiverse vegetation across the Swan Coastal Plain. Furthermore, Gibson *et al.* (1994) collected data in the spring main flowering period and in many cases sampled plots multiple times to provide a complete species list. This survey only sampled the site twice during the spring main flowering period and so is considered comparable.

Table 3: Evaluation of survey methodology against standard constraints outlined in EPA (2016)(continued)

Constraint	Degree of limitation	Details
Experience level of personnel	No limitation	This flora and vegetation assessment was undertaken by a qualified botanist with nine years of botanical experience in Western Australia. Technical review was undertaken by a senior environmental consultant with 18 years' experience in environmental science in Western Australia.
Suitability of timing	No limitation	The survey was conducted in September and October and thus within the main flowering season. High rainfall was recorded from May to October 2022 in the months preceding the site visits. Therefore, it is likely that many plant species would have been in flower and/or visible at the time of survey, including native geophytic plants such as orchids. The survey timing was considered adequate to allow the detection of species for which seasonal timing is critical.
Temporal coverage	No limitation	Detailed flora and vegetation assessments can require multiple visits, at different times of year, and over a period of a number of years, to enable observation of all species present. The site was visited twice, in September and in late October 2022. The September and October visits coincided with the flowering period for many conservation significant flora species. The late October site visit also provided an insight into the vegetation condition and composition at the end of the main flowering period. Therefore, according to the EPA guidelines this survey is considered to meet the requirements of a 'detailed' survey.
Spatial coverage and access	No limitation	Site coverage was comprehensive (track logged).
	No limitation	All parts of the site could be accessed as required.
Sampling intensity	No limitation	A total of 113 species were recorded, of which 77 were recorded from two sample locations and 36 were recorded opportunistically. Minimum species richness within site is estimated at between 103 (Jacknife1) and 111 (Chao2) species (refer species accumulation curve and estimates shown in **Plate 6**). The number of species recorded in the site is higher than that estimated by the Jacknife1 and Chao2, suggesting that the survey effort was adequate to prepare a comprehensive species inventory for the site.
Influence of disturbance	Minor limitation	Time since fire is greater than 7 years as interpreted from aerial imagery and therefore short-lived species more common after fire may not have been visible.
	No limitation	Historical ground disturbance was evident in parts of the site and the majority native vegetation in the site is regrowth after clearing/fire. The disturbance history of the site was considered when undertaking field sampling.
Adequacy of resources	No limitation	All resources required to perform the survey were available.

4 Results

4.1 General site conditions

The site is located on a west facing slope that is comprised of sandy soils that are light grey to brown in colour. The majority of the site is vegetated with native vegetation in varying condition. A sandy track/firebreak exists around the perimeter of the site.

4.2 Flora

4.2.1 Desktop assessment

The database search results identified a total of 15 threatened and 26 priority flora species occurring or potentially occurring within a 10 km radius of the site. Information on these species including their habitat preferences and flowering period is provided in **Appendix B**.

Based on background information available for the site, suitable habitat was considered to potentially occur within the site for one threatened flora species and six priority flora species as shown in **Table 4**.

Table 4: Conservation significant flora species considered to have potential to occur in the site based on known habitat preferences

Species	Level of significance		Life strategy	Habitat	Flowering period
	State	EPBC Act			
Caladenia huegelii	CR	EN	PG	Well-drained, deep sandy soils in lush undergrowth in a variety of moisture levels.	Sep-early Nov
Jacksonia gracillima	P3	-	P	Sand, often adjacent to winter wet areas	Sep-Dec
Phlebocarya pilosissima subsp. *pilosissima*	P3	-	P	White or grey sand, lateritic gravel.	Aug-Oct
Styphelia filifolia	P3	-	P	Brown over pale yellow sand.	Feb-Apr
Dodonaea hackettiana	P4	-	P	Sand, outcropping limestone.	Jul-Oct
Drosera occidentalis	P4	-	P	Flat, brown/white/yellow moist sand/clay/peat, often near swamps.	Oct-Dec/Jan
Jacksonia sericea	P4	-	P	Calcareous and sandy soils on Swan Coastal Plain	Dec-Feb

CR=critically endangered, EN=endangered, VU=vulnerable, P3-P4=Priority 3-Priority 4, P=perennial, PG=perennial geophyte.

4.2.2 Species inventory

A total of 88 native and 24 non-native (weed) species were recorded within the site during the field survey, representing 41 families and 92 genera. The family containing the most taxa and the most native taxa was Fabaceae (12 native taxa and two weed taxa). The most common genera were *Acacia* (five taxa), *Caladenia* (four taxa) and *Banksia* (four taxa). Of the species recorded 76 were recorded in sample locations and 36 were recorded opportunistically.

A complete species list is provided in **Appendix C.**

4.2.3 Threatened and priority flora

No occurrences of threatened or priority flora species were recorded within the site.

None of the threatened and priority flora species identified in the desktop assessment are considered to occur in the site due to lack of suitable habitat and/or because they were not recorded during the field survey.

4.2.4 Locally and regionally significant flora

No locally or regionally significant flora species were recorded within the site.

4.2.5 Declared pests

No species listed as declared pests pursuant to the BAM Act or weeds of national significance (WoNS) were recorded in the site.

4.3 Vegetation

4.3.1 Desktop assessment

The database search results identified 9 TECs and two PECs occurring or potentially occurring within a 10 km radius of the site. Information on these communities is provided in **Appendix D**.

Based geomorphology, soils and regional vegetation patterns, two TECs/PECs and two PECs were considered to have potential to occur in the site:

- 'Banksia woodlands of the Swan Coastal Plain' TEC/PEC which is listed as 'endangered' under EPBC Act and as P3 in WA.
- 'Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' TEC/PEC which is listed as 'endangered' under EPBC Act and as P3 in WA.
- '*Banksia ilicifolia* woodlands, southern Swan Coastal Plain (floristic community type 22)' PEC which is listed as P3 in WA.
- 'Low lying *Banksia attenuata* woodlands or shrublands (floristic community type 21c)'

4.3.2 Plant communities

Two plant communities were identified within the site as shown in **Figure 4**. Plant community **BaBm** exists across the majority of the site and extends over 1.6 ha. The remainder of the site contains **non-native** vegetation comprising predominantly bare soil and pasture weeds (0.26 ha).

A description and the area of each plant community is provided in **Table 5** and representative photographs of each are provided in **Plate 4** and **Plate 5**. The location of each plant community is shown in **Figure 4**. A matrix of species recorded within each plant community is provided in **Appendix E** and raw sample data in **Appendix F**.

Table 5: Description and extent of plant communities identified within the site

Plant community	Description	Area (ha)
BaBm	Low open woodland of *Banksia menziesii, Banksia attenuata*, *Banksia ilicifolia*, *Eucalyptus marginata* and *Nuytsia floribunda* over open shrubland of *Adenanthos cygnorum* (or absent), *Xanthorrhoea preissii* and *Allocasuarina humilis* over low shrubland of *Eremaea pauciflora* var. *pauciflora*, *Hibbertia spp.* and *Scholtzia XX* over forbland of *Mesomelaena pseudostygia*, *Patersonia occidentalis* and *Lomandra spp.* over open grassland **Ehrharta calycina* and **Briza maxima* and herbland *Ursinia anthemoides* and (**Plate 4**).	1.6
Non-native	Heavily disturbed areas comprising predominantly bare ground and weeds with occasional native species (**Plate 5**).	0.26



*Plate 4: Plant community **BaBm** in 'excellent' condition*



*Plate 5: Plant community **non-native** in 'completely degraded' condition*

4.3.3 Vegetation condition

The most intact native vegetation is associated with parts of the **BaBm** plant community located in the central portion of the site (approximately 0.86 ha). This vegetation was mapped as being in 'excellent' condition as it retains the structure expected of a banksia woodland community and has high native species diversity and less than 10% weed cover. The southern portion of the **BaBm** plant community was mapped as being in 'very good' condition as vegetation structure was altered through repeated past disturbance (refer **Section 2.6**) which was evident through a very sparse tree canopy cover and a larger proportion of bare ground in combination with moderate native plant diversity and higher weed cover (10-20%). The **BaBm** vegetation in the north-western portion of the site was mapped as being in 'good - very good' condition as it exhibited higher weed cover (20-50%) but still retained moderate native plant species diversity. Three small areas of the **BaBm** vegetation along the western boundary and in the north-western corner of the site were mapped as being in 'degraded' condition as they had very low native species diversity and high weed cover. The remaining area is in 'completely degraded' condition and predominantly comprise bare ground associated with fire breaks and non-native species such as pasture grasses and weeds.

The extent of vegetation by condition category is detailed in **Table 6** and shown in **Figure 5**.

Table 6: Extent of vegetation condition categories within the site

Condition category (Keighery 1994)	Size (ha)
Pristine	0
Excellent	0.86
Very good	0.43
Very good - good	0.27
Good	0
Degraded	0.04
Completely degraded	0.26

4.3.4 Floristic community types

Plant community **BaBm** was determined to represent FCT 23a 'Central *Banksia attenuata – B. menziesii* woodlands'. This FCT is listed as 'well reserved' and 'low risk' by Gibson *et al.* (1994). Both quadrats grouped with FCT 23a in the cluster analysis. Quadrat 1 grouped with multiple Gibson *et al.* (1994) site representing FCT 23a with 47% similarity (**Table 7**). Quadrat 2 clustered with Gibson *et al.* (1994) multiple sites representing FCT 23a with 43% similarity. All of these Gibson *et al.* (1994) sites represent occurrences of FCT 23a (**Table 7**). The relevant portions of the cluster dendrograms showing Q1 and Q2 for **BaBm** are provided in **Appendix E**.

Plant community **non-native** was considered too degraded to assign to an FCT.

Table 7: Plant community and likely FCT represented within the site for each sample

Plant community	Sample unit	Most similar Gibson *et al.* (1994) sites	Similarity (%)	Most likely floristic community type (FCT)	Reservation and conservation status (Gibson *et al.* 1994)
BaBm	**Q1**	WARB-3 (FCT 23a)	47	FCT 23a: Central Banksia attenuata – B. menziesii woodlands	Well reserved Low risk
		WIRR-2 (FCT 23a)	47		
		WARB-1 (FCT 23a)	47		
	Q2	WAND-1 (FCT 23a)	43		
		HARRY-4 (FCT 23a)	43		
		BANK-32 (FCT 23a)	43		

4.3.5 Threatened and priority ecological communities

The structure, composition and patch size of plant community **BaBm** indicates that it represents the Commonwealth listed 'banksia woodlands of the Swan Coastal Plain' TEC, as outlined in **Table 7** and shown in **Figure 6**.

Table 8: Criteria for determining presence of Banksia Woodlands of the Swan Coastal Plain TEC adapted from DoEE (2016a)

Criteria	Requirements for meeting criteria	Site implications
1. Must meet key diagnostic characteristics	A variety of factors relating to: • Location • Soils • Structure • Composition	• Site meets location and soils criteria. • The **BaBm** vegetation includes the key diagnostic feature of a tree layer of *Banksia attenuata*, *Banksia menziesii* and *Banksia ilicifolia*. • The **BaBm** vegetation within site also meets structure and composition criterion. FCT 23a is identified as one of the FCTs comprising the banksia woodland TEC/PEC.
2. Must meet condition thresholds	• A patch should at least meet the 'good' condition category (see **Table 1**)	• The **BaBm** vegetation present in 'excellent', 'very good' and 'very good - good' condition individually meet this criterion. • The **BaBm** in 'degraded' condition does not individually meet this criterion. However, the conservation advice indicates that a single patch may include areas of variable condition, meaning parts of the **BaBm** vegetation in 'degraded' condition may still be considered the TEC/PEC.
3. Must meet minimum patch size	Minimum size of patch: • Pristine=no minimum size • Excellent=0.5 ha • Very Good=1 ha • Good=2 ha	• The **BaBm** vegetation in excellent condition comprises 0.86 ha and independently meets this criterion. • The **BaBm** vegetation in 'very good' (0.43 ha) and 'very good - good' (0.27 ha) condition does not independently meet this criterion. However, the **BaBm** vegetation in 'very good', 'very good-good' and 'degraded' condition would be viewed as contiguous and part of the same patch as the **BaBm** vegetation in excellent condition as no breaks in vegetation wider than 30 metres occur.
4. Must incorporate surrounding context	• Breaks (e.g. tracks) < 30 m do not separate vegetation into separate patches • Buffer zones may apply (20-50 m recommended from patch edge) • The site should be thoroughly sampled (2 surveys in same spring). • Survey timing should be appropriate. • Surrounding environment should be considered (e.g. connectivity, conservation values, fauna habitat)	• Small scale tracks (<30 m wide) exist within the patch. • Land surrounding the patch is a combination of residential, construction and native vegetation. • The survey was conducted once in September and once in October which lies within the spring main flowering period. • Intact native vegetation that is likely to meet criteria as banksia woodland is present to the east of the site and is separated from the **BaBm** vegetation within the site by less than 30m.
Result	The site supports 1.6 ha of the banksia woodland of the Swan Coastal Plain TEC.	

DBCA's *Priority Ecological Community* list indicates that the description, area and condition thresholds that apply to the Commonwealth-listed TEC of the same name also apply to the 'banksia woodlands of the Swan Coastal Plain' PEC (DBCA 2020). Therefore, total of 1.6 ha of this PEC occurs within the site as shown in **Figure 6**.

No other TECs or PECs occur within the site.

4.3.6 Locally and regionally significant vegetation

Multiple plant species within the site may provide habitat for threatened black cockatoos. In particular the *Eucalyptus marginata* and *Banksia* spp. trees would provide a foraging resource for black cockatoos.

4.4 Species richness

A total of 76 species were recorded from two samples. A species accumulation curve derived from sample data is presented in **Plate 6**. After the two samples the curve is still increasing and has not reached its asymptote, indicating that a proportion of species likely remain undetected by sampling.

Species richness was estimated in PRIMER v6 to be between 103 (Jacknife1) and 111 (Chao2). Based on the trend of the species accumulation curve approximately five to six samples would be required to capture that many species. However, including the 36 additional species recorded opportunistically, a total of 112 species were recorded in the site. This indicates that between 101 and 109 % of the estimated 103-111 species in the site were recorded, suggesting that the survey effort was sufficient to prepare a comprehensive species inventory.

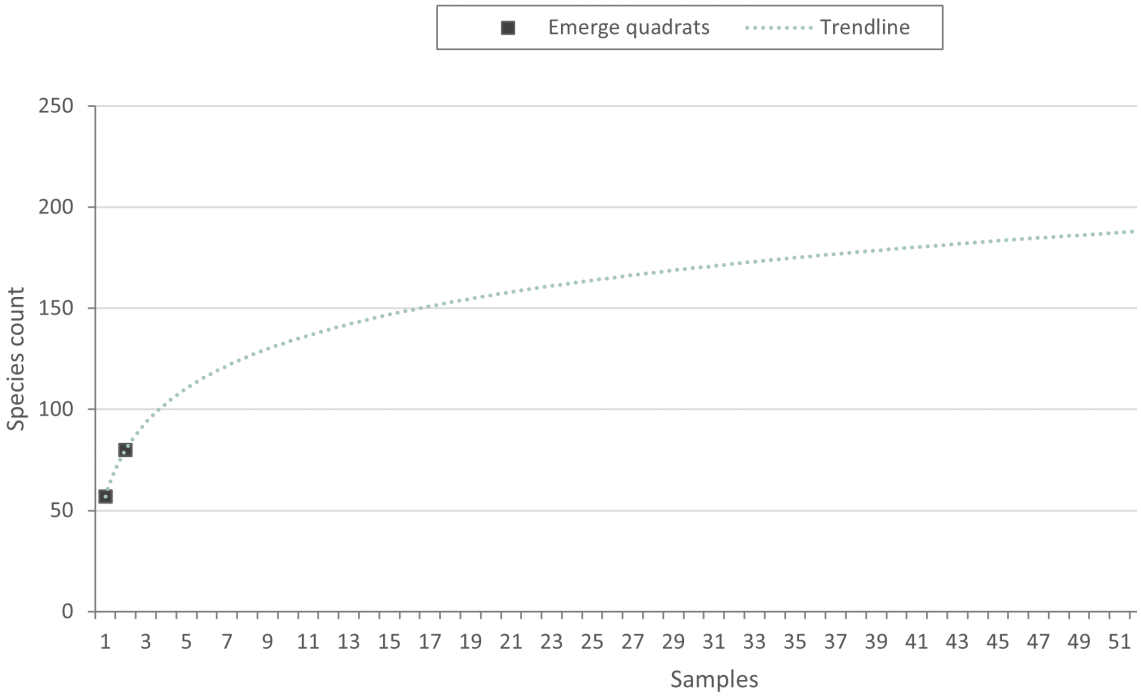


Plate 6: Species accumulation curve derived from sample data (y =33.182ln(x) + 57, R^2 = 1)

5 Discussion

5.1 Threatened and priority flora

Prior to the survey, based on background information, four threatened and 12 priority flora species were considered to potentially occur within the site. The field surveys in September and October were considered sufficient to determine that these species are unlikely to occur. This is because either suitable habitat does not occur or the species were not recorded during traverses within potentially suitable habitat. The timing of the surveys coincided with the main flowering period of the majority of the conservation significant flora identified in the desktop assessment and therefore they should have been visible, if present. The species with flowering periods outside of September and October are perennials and would be visible throughout the year. Since no unidentified specimens which had potential to comprise conservation significant species were collected, the survey effort is also considered sufficient to confirm the absence of these species.

5.2 Vegetation condition

Assigning condition using a categorical scale is always most difficult when vegetation qualities are close to the boundary between two categories. Categorical schemes may also invariably yield different results when applied by different assessors, because of differences in skill levels or personal bias. The method applied to assess vegetation condition was robust, as it combined the standard qualitative, categorical scheme of Keighery (1994), with the additional indicators for diversity and weed cover outlined in DoEE (2016b).

Due to historical clearing, the **BaBm** vegetation in the site currently lacks large eucalypt trees that would be expected as emergent canopy in an intact FCT 23a type banksia woodland community. The majority of **BaBm** in the site was mapped as being in excellent condition despite this lack of large eucalypts because it otherwise has very low weed cover and high native species diversity. However, 'excellent to very good' or even very good condition might also have been appropriate classification for this vegetation given structural modification that has occurred.

One compound condition category (good to very good) was included in the results of this survey for a portion of plant community **BaBm** that comprised characteristics from more than one of the DoEE (2016) indicators (shown in **Table 1**). This vegetation comprises moderate species diversity (indicative of very good condition) but a higher weed cover at 20-50% (indicative of good condition).

5.3 Floristic community type assignment

The results of the FCT cluster analysis were conclusive, with all samples within plant community **BaBm** showing high similarity to and clusting with Gibson *et al.* (1994) sites comprising FCT 23a. A record of this FCT was anticipated given that the closest Gibson *et al.* (1994) site to the site represents this FCT.

5.4 Threatened and priority ecological communities

Identifying the **BaBm** plant community as the banksia woodlands of the Swan Coastal Plain TEC/PEC was straightforward. The **BaBm** plant community includes the key diagnostic feature of a tree layer of *Banksia attenuata*, *B. ilicifolia* and *B. menziesii*. This vegetation was also considered most likely to represent 'FCT 23a - Central *Banksia attenuata – B. menziesii* woodlands', which is one of the regional FCTs identified in the banksia woodland TEC conservation advice (DoEE 2016b). However, to be considered the banksia woodland TEC a patch of banksia vegetation must also meet thresholds for condition and minimum patch size (refer to **Table 8**). The patch of **BaBm** vegetation in excellent condition individually meets condition and size thresholds. While the remaining **BaBm** in poorer condition does not individually meet minimum condition and/or size thresholds, it does meet these criteria in association with adjacent banksia woodland vegetation. Therefore, the entirety of the **BaBm** plant community in the site was determined to represent the banksia woodlands of the Swan Coastal Plain TEC/PEC (1.6 ha).

5.5 Locally and regionally significant flora and vegetation

Flora and vegetation may be significant irrespective of protection under policy or legislation. The vegetation in the site has value as habitat for threatened or priority fauna species. In particular, the **BaBm** vegetation contains multiple plant species that are known to provide foraging habitat for black cockatoos listed as threatened under the EPBC Act and BC Act, including *Eucalyptus marginata* and *Banksia* spp. trees.

6 Conclusions

The majority of the site contains relatively intact native vegetation in excellent (0.86 ha), very good (0.42 ha) and very good - good (0.27 ha) condition. The remainder of the site is in degraded or completely degraded condition (0.3 ha). No threatened or priority flora species were recorded within the site and none are considered likely to occur due to the lack of suitable habitat or because they were not recorded during the field survey.

The native vegetation within the site was mapped as a single plant community (**BaBm**) which aligns closely with floristic community type (FCT) '23a - Central *Banksia attenuata - B. menziesii* woodlands'. The **BaBm** vegetation was found to represent the State listed PEC and Commonwealth listed TEC 'banksia woodlands of the Swan Coastal Plain'. Approximately 1.6 ha of the banksia woodlands of the Swan Coastal Plain TEC/PEC is present within the site.

Vegetation within the site may provide habitat for conservation significant fauna. In particular, it provides a foraging resource for threatened species of black cockatoo.

7 References

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7.2 Online references

The online resources that have been utilised in the preparation of this report are referenced in **Section 7.1**, with access date information provided in **Table R 1**.

Table R 1 Access dates for online references

Reference	Date accessed	Website or dataset name
BoM (2022)	December 2022	Climate Data Online
DAWE (2021a)	November 2022	Threatened Ecological Communities
DAWE (2021b)	December 2022	Weeds of National Significance (WoNS)
DAWE (2022)	November 2022	Protected Matters Search Tool
DBCA (2022)	October 2022	NatureMap
WALIA (2022)	December 2022	Landgate Map Viewer

Figures

Figure 1: Site Location

Figure 2: Soils and Topography

Figure 3: Environmental Features

Figure 4: Plant Communities

Figure 5: Vegetation Condition

Figure 6: Conservation Significant Community



Figure 1: Site Location

Project:	Detailed Flora and Vegetation Assessment Lot 16 Barfield Road, Hammond Park
Client:	Richard Noble

Plan Number:
EP22-099(01)--F01

Drawn:	GAR
Date:	06/12/2022
Checked:	MS
Approved:	TAA
Date:	20/12/2022

N

0 20 40
Metres

Scale: 1:2,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used.
©Landgate (2021). Nearmap Imagery date: 30/08/2022



Figure 2: Soils and Topography

Project: Detailed Flora and Vegetation Assessment
Lot 16 Barfield Road, Hammond Park

Client: Richard Noble

Plan Number: EP22-099(01)--F02

Drawn:	GAR
Date:	06/12/2022
Checked:	MS
Approved:	TAA
Date:	20/12/2022

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Metres

Scale: 1:2,000@A4

GDA 1994 MGA Zone 50

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While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used.
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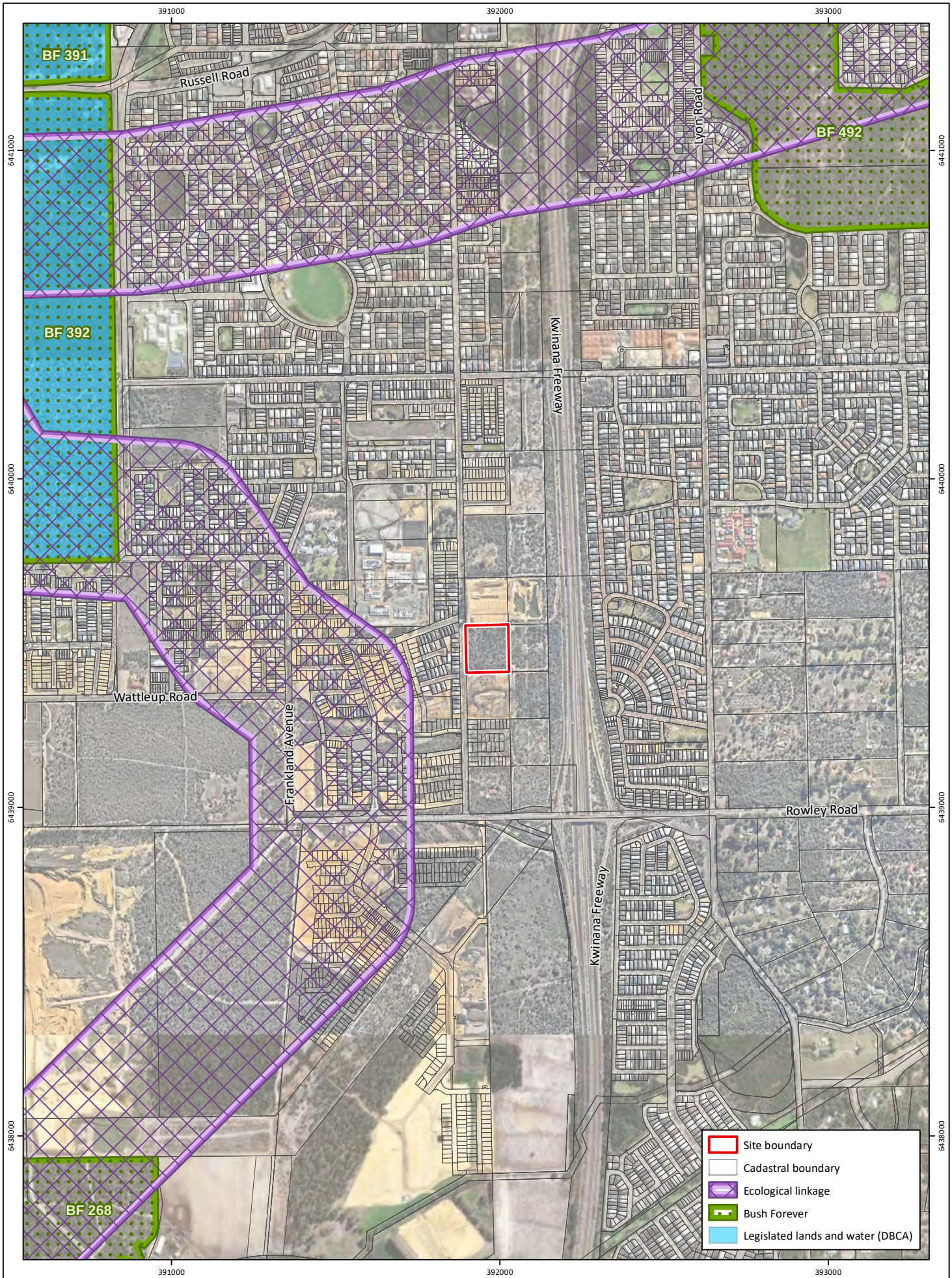


Figure 3: Ecological Linkages

Project: Detailed Flora and Vegetation Assessment
Lot 16 Barfield Road, Hammond Park

Client: Richard Noble

Plan Number:
EP22-099(01)--F03

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Checked:	MS
Approved:	TAA
Date:	20/12/2022

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Scale: 1:15,000@A4

GDA 1994 MGA Zone 50

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Figure 4: Plant Communities

Project: Detailed Flora and Vegetation Assessment
Lot 16 Barfield Road, Hammond Park

Client: Richard Noble

Plan Number:
EP22-099(01)--F04

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Date:	06/12/2022
Checked:	MS
Approved:	TAA
Date:	20/12/2022

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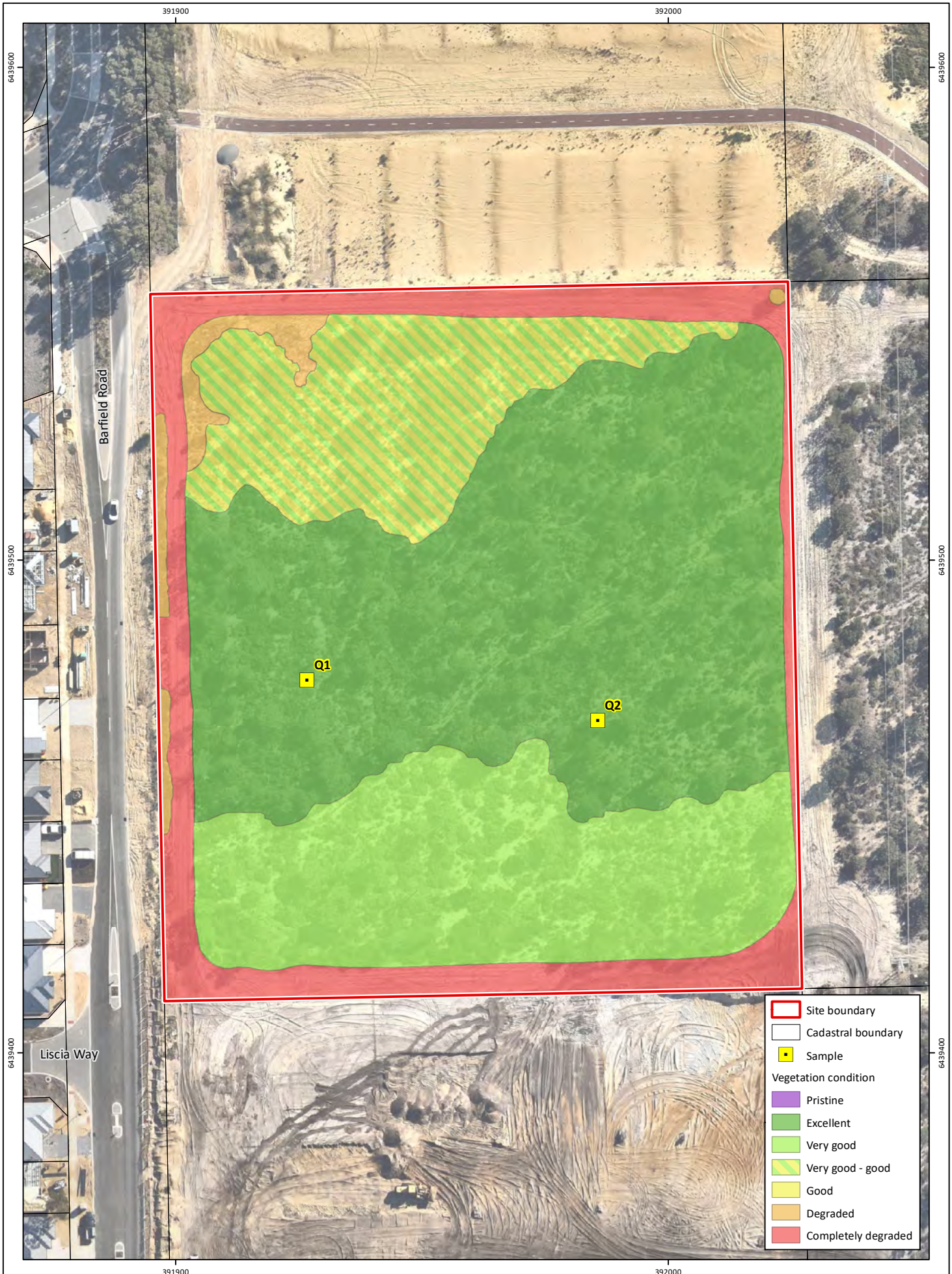


Figure 5: Vegetation Condition

Project:	Detailed Flora and Vegetation Assessment Lot 16 Barfield Road, Hammond Park
Client:	Richard Noble

Plan Number:
EP22-099(01)--F05

Drawn:	GAR
Date:	06/12/2022
Checked:	MS
Approved:	TAA
Date:	20/12/2022

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Metres

Scale: 1:1,000@A4

GDA 1994 MGA Zone 50

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Figure 6: Conservation Significant Features

Project: Detailed Flora and Vegetation Assessment
Lot 16 Barfield Road, Hammond Park

Client: Richard Noble

Plan Number:
EP22-099(01)--F06

Drawn:	GAR
Date:	06/12/2022
Checked:	MS
Approved:	TAA
Date:	20/12/2022

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Metres

Scale: 1:1,000@A4

GDA 1994 MGA Zone 50

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Appendix A

Additional Information

Conservation Significant Flora and Vegetation

Threatened and priority flora

Flora species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, flora species can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Flora species considered 'threatened' pursuant to Schedule 1 of the EPBC Act are assigned categories according to their conservation status, as outlined in **Table 1**.

In Western Australia, plant taxa may be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act) which is enforced by Department of Biodiversity Conservation and Attractions (DBCA). Threatened flora species are listed under sections 19(1) and 26(2) of the BC Act. It is an offence to 'take' or disturb threatened flora without Ministerial approval. Section 5(1)1 of the Act defines to take as including "… to gather, pluck, cut, pull up, destroy, dig up, remove, harvest or damage flora by any means" or to cause or permit the same to be done. The definition of threatened flora under the BC Act is provided in **Table 1**.

Section 43 of the BC Act requires that an occurrence of a threatened species or threatened ecological community is reported to DBCA where the occurrence has been identified as part of field work completed:

- as part of an assessment under Part IV of the *Environmental Protection Act 1986*; or
- in relation to an application for a clearing permit under the *Environmental Protection Act 1986* section 51E(1)(d).

Penalties apply to individuals and organisations that fail to provide accurate reports of threatened species or communities.

The *Biodiversity Conservation Regulations 2018* (BC Regulations 2018) came into effect on January 1 2019. The BC Regulations include provisions for licencing, charges, penalties and other provisions associated with the BC Act.

Flora species that may be threatened or near threatened but lack sufficient information to be listed under the BC Act may be added to the DBCA's *Priority Flora List* (DBCA 2018c). Priority flora species are considered during State approval processes. Priority flora categories and definitions are listed in **Table 1**.

Table 1: Definitions of conservation significant flora species pursuant to the EPBC Act and BC Act and on DBCA's Priority Flora List (DBCA 2018c)

Conservation code	Description
EX†	Threatened Flora – Presumed Extinct Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
T^†	Threatened Flora – Extant Taxa which are declared to be likely to become extinct or is rare, or otherwise in need of special protection.
CR^	Threatened Flora – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN^	Threatened Flora – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU^	Threatened Flora – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
P1	Priority One – Poorly Known Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat e.g. road verges, urban areas, farmland, active mineral leases etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P2	Priority Two – Poorly Known Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey.
P3	Priority Three – Poorly Known Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey.
P4	Priority Four – Rare Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

^pursuant to the EPBC Act, †pursuant to the BC Act, on DBCA's *Priority Flora List*

Threatened and priority ecological communities

'Threatened ecological communities' (TECs) are recognised as ecological communities that are rare or under threat and therefore warrant special protection. Selected TECs are afforded statutory protection at a Commonwealth level under section 181 of the EPBC Act. TECs nominated for listing under the EPBC Act are considered by the Threatened Species Scientific Committee and a final decision is made by the Commonwealth Minister for the Environment. Once listed under the EPBC Act, communities are categorised as either 'critically endangered', 'endangered' or 'vulnerable' as defined in **Table 2**. Any action likely to have a significant impact on a community listed under the EPBC Act requires approval from the Minister for the Environment.

Within Western Australia TECs are determined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee (WATECSAC) and endorsed by the State Minister for the Environment. The WATECSAC is an independent group comprised of representatives from organisations including tertiary institutions, the Western Australian Museum and DBCA. The TECs endorsed by the State Minister are published by DBCA (DBCA 2018b).

TECs are assigned to one of the categories outlined in **Table 2** according to their status (in relation to the level of threat). TECs are afforded direct statutory protection at a State level under the BC Act and BC Regulations. Ecological communities are listed under Section 27(1) and 33 of the BC Act. Their significance is also acknowledged through other state environmental approval processes such as 'environmental impact assessment' pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

Table 2: Categories of threatened ecological communities (English and Blyth 1997; DEC 2009)

Conservation code	Description
PD	Presumably Totally Destroyed An ecological community that has been adequately searched for but for which no representative occurrences have been located.
CE	Critically Endangered An ecological community that has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
E	Endangered An ecological community that has been adequately surveyed and is not critically endangered but is facing a very high risk of total destruction in the near future.
V	Vulnerable An ecological community that has been adequately surveyed and is not critically endangered or endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future.

An ecological community that is under consideration for listing as a TEC, but does not yet meet survey criteria or has not been adequately defined may be listed as a 'priority ecological community' (PEC). PECs are categorised as priority category 1, 2 or 3 as described in **Table 3**. Ecological communities that are adequately known and are rare but not threatened, or meet criteria for 'near threatened', or that have been recently removed from the threatened list, are placed in 'priority 4'. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in 'priority 5' (DEC 2013). Listed PECs are published by DBCA (DBCA 2017b).

Table 3: Categories of priority ecological communities (DEC 2013)

Priority code	Description
P1	Priority One: Poorly known ecological communities Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
P2	Priority Two: Poorly known ecological communities Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
P3	Priority Three: Poorly known ecological communities (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
P4	Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
P5	Priority Five: Conservation Dependent ecological communities Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Weeds

A number of legislative and policy documents exist in relation to weed management at state and national levels. The *Biosecurity and Agriculture Management Act 2007* (BAM Act) is the principle legislation guiding weed management in Western Australia and lists declared pest species. At a national level, the Australian government has compiled a list of 32 Weeds of National Significance (WoNS) (DoEE 2018), of which many are also listed under the BAM Act.

Declared Pests

Part 2.3.23 of the BAM Act requires a person must not; "*a) keep, breed or cultivate the declared pest; b) keep, breed or cultivate an animal, plant or other thing that is infected or infested with the declared pest; c) release into the environment the declared pest, or an animal, plant or other thing that is infected or infested with the declared pest; or d) intentionally infect or infest, or expose to infection or infestation, a plant, animal or other thing with a declared pest*".

Under the BAM Act, all declared pests are assigned a legal status, as described in **Table 7**. Species assigned to the 'declared pest, prohibited - s12' category are placed in one of three control categories, as described in **Table 8**.

The *Biosecurity and Agriculture Management Regulations 2013* specify keeping categories for species assigned to the 'declared pest - s22(2)' category, which relate to the purposes of which species can be kept, as well as the entities that can keep them. The categories are described in **Table 9**.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act (DPIRD 2020).

Table 4: Legal status of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
Declared Pest Prohibited - s12	May only be imported and kept subject to permits. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions.
Declared Pest s22(2)	Must satisfy any applicable import requirements when imported, and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia

Table 5: Control categories of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
C1	Exclusion Not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2	Eradication Present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3	Management Established in Western Australia but it is feasible, or desirable, to manage them in order to limit their

Category	Description
	damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Table 6: Keeping categories of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
Prohibited	Can only be kept under a permit for public display and education purposes, and/or genuine scientific research, by entities approved by the state authority.
Exempt	No permit or conditions are required for keeping.
Restricted	Organisms which, relative to other species, have a low risk of becoming a problem for the environment, primary industry or public safety and can be kept under a permit by private individuals.

Wetland Habitat

Geomorphic wetland types

On the Swan Coastal Plain DBCA (2017a) have used the geomorphic wetland classification system developed by Semeniuk (1987) and Semeniuk and Semeniuk (1995) to classify wetlands based on the landform shape and water permanence (hydro-period) as outlined in **Table 10**.

Table 7: Geomorphic Wetlands of the Swan Coastal Plain classification categories (DBCA 2017a)

Level of inundation	Geomorphology			
	Basin	Flat	Channel	Slope
Permanently inundated	Lake	-	River	-
Seasonally inundated	Sumpland	Floodplain	Creek	-
Seasonally waterlogged	Dampland	Palusplain	-	Paluslope

Wetland management categories

DBCA maintains the *Geomorphic Wetland of the Swan Coastal Plain* dataset (DBCA 2018a), which also categorises individual wetlands into specific management categories as described in **Table 11**.

Table 8: Geomorphic Wetlands of the Swan Coastal Plain classification categories (DBCA 2017a)

Management category	Description of wetland	Management objectives
Conservation (CCW)	Support high levels of attributes	Preserve wetland attributes and functions through reservation in national parks, crown reserves and state owned land. Protection provided under environmental protection policies.
Resource enhancement (REW)	Partly modified but still supporting substantial functions and attributes	Restore wetland through maintenance and enhancement of wetland functions and attributes. Protection via crown reserves, state or local government owned land, environmental protection policies and sustainable management on private properties.
Multiple use (MUW)	Few wetland attributes but still provide important hydrological functions	Use, development and management considered in the context of water, town and environmental planning through land care.

The management categories of wetland features are determined based on hydrological, biological and human use features. The DBCA document *A methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia* (DBCA 2017a) details the methodology by which wetlands on the Swan Coastal Plain are assigned management categories based on a two tiered evaluation system, with preliminary and secondary evaluation stages. The preliminary evaluation aims to identify any features of conservation significance that would immediately place the wetland within the CCW management category. Examples of these significant features include presence on significant wetland lists, presence of TECs or PECs (Priority 1 and 2), presence of threatened flora and

over 90% of vegetation in good or better condition based on the Keighery (1994) scale. If such environmental values are identified the wetland would be categorised as CCW without further evaluation.

Should the preliminary evaluation indicate that no such features occur, the secondary evaluation and site assessment are then applied. In the secondary evaluation, an appropriate management category is determined through the assessment of a range of environmental attributes, functions and values.

Wetland reclassification

DBCA have a protocol for proposing changes to the wetland boundaries and management categories of the existing geomorphic wetland dataset (DEC 2007). The procedure involves a wetland desktop evaluation and site assessment which culminates in a recommended management category. Relevant information should be obtained in the optimal season for vegetation condition and water levels, which is usually spring (DEC 2007). In the case of larger wetlands that have undergone a degree of disturbance, a separate management category may be assigned to parts of the wetland in order to reflect the current values.

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Appendix B

Conservation Significant Flora Species and likelihood of Occurrence Assessment

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Austrostipa jacobsiana	CR	-	P	Grey sandy clay.	Nov-Jan	Unlikely
Banksia mimica	VU	EN	P	Flat to gentle slopes in grey and white sand in open woodlands.	Dec-Jan	Unlikely
Caladenia huegelii	CR	EN	PG	Well-drained, deep sandy soils in lush undergrowth in a variety of moisture levels.	Sep-early Nov	Unlikely
Drakaea elastica	CR	EN	PG	Bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps. Typically in banksia woodland or thickets of Kunzea glabrescens.	late Sep-Oct/Nov, survey Jul-Aug	Unlikely
Eucalyptus x *balanites*	CR	EN	P	Light coloured sandy soils over laterite. Habitat consists of gently sloping heathlands; open mallee woodland over shrubland (Population 2) or heathland with emergent mallees (population 1)	Oct - Feb	Unlikely
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	CR	CR	P	Low woodland on grey, clayey sand with lateritic pebbles (Pinjarra Plain) near winter wet flats.	Sep-Nov	Unlikely
Synaphea sp. Pinjarra Plain (A.S. George 17182)	EN	CR	P	White grey clayey sand on edges of seasonally inundated low lying areas.	Sep-Oct	Unlikely
Synaphea sp. Serpentine (G.R. Brand 103)	CR	CR	P	Seasonally damp areas, loam - sand.	Sep-Oct	Unlikely
Andersonia gracilis	VU	EN	P	Seasonally damp, black sandy clay flats near or on the margins of swamps.	Sep-Nov	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Diuris purdiei	EN	EN	PG	Sand to sandy clay soils in areas subject to winter inundation.	late September to mid-October, but only after a summer or early autumn fire (Brown et al., 1998)	Unlikely
Drakaea micrantha	EN	VU	PG	Open sandy patches often adjacent to winter-wet swamps.	Sept- early Oct	Unlikely
Grevillea curviloba subsp. *incurva*	EN	EN	P	Sand, sandy loam. Winter-wet heath.	Aug-Sep	Unlikely
Lepidosperma rostratum	EN	EN	P	Peaty sand and clay amongst low heath, in winter-wet swamps.	May-Jun (survey late Jun-Aug)	Unlikely
Diuris drummondii	VU	VU	PG	In low-lying depressions in peaty and sandy clay swamps.	Nov-Jan	Unlikely
Diuris micrantha	VU	VU	PG	Dark grey-black sandy clay-loam in winter wet depressions or swamps. Often in shallow standing water.	Aug/Sep-early Oct	Unlikely
Eleocharis keigheryi	VU	VU	P	Clay or sandy loam in freshwater creeks and transient waterbodies such as seasonally wet clay pans.	Aug-Dec	Unlikely
Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)	P1	-	P	Grey or black sand over clay. Swampy areas, winter wet lowlands.	May or Aug	Unlikely
Netrostylis sp. Chandala (G.J. Keighery 17055)	P2	-	P	Peaty soils on edges of swamps.	Feb, July	Unlikely
Thelymitra variegata	P2	-	P	Sandy clay, sand, laterite.	Jun-Sep	Unlikely
Austrostipa mundula	P3	-	P	Grey sand over limestone.	Sept-Nov	Unlikely
Byblis gigantea	P3	-	P	Sandy-peat swamps. Seasonally wet areas.	Sep-Jan	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Cyathochaeta teretifolia	P3	-	P	Grey sand, sandy clay in swamps and creek edges.	Oct-Jan	Unlikely
Jacksonia gracillima	P3	-	P	Sand, often adjacent to winter wet areas	Sep-Dec	Unlikely
Meionectes tenuifolia	P3	-	P	Clay loam in seasonally wet areas.	Oct-Dec	Unlikely
Phlebocarya pilosissima subsp. *pilosissima*	P3	-	P	White or grey sand, lateritic gravel.	Aug-Oct	Unlikely
Pimelea calcicola	P3	-	P	Sand, limestone on coastal ridges.	Sep-Nov	Unlikely
Schoenus pennisetis	P3	-	A	Grey or peaty sand in swamps and winter-wet depressions.	Aug-Sep	Unlikely
Stylidium aceratum	P3	-	A	Sandy soils in swamp heathland.	Oct-Nov	Unlikely
Stylidium paludicola	P3	-	P	Peaty sand over clay. Winter wet habitats. Marri and Melaleuca woodland, Melaleuca shrubland	Oct-Dec	Unlikely
Styphelia filifolia	P3	-	P	Brown over pale yellow sand.	Feb-Apr	Unlikely
Aponogeton hexatepalus	P4	-	P	Mud. Freshwater: ponds, rivers, claypans.	Jul-Oct	Unlikely
Dodonaea hackettiana	P4	-	P	Sand, outcropping limestone.	Jul-Oct	Unlikely
Drosera occidentalis	P4	-	P	Flat, brown/white/yellow moist sand/clay/peat, often near swamps.	Oct-Dec/Jan	Unlikely
Eucalyptus foecunda subsp. *foecunda*	P4	-	P	Sand over limestone. Outcropping limestone.	Jan-Mar	Unlikely
Jacksonia sericea	P4	-	P	Calcareous and sandy soils on Swan Coastal Plain	Dec-Feb	Unlikely
Kennedia beckxiana	P4	-	P	Sand or loam on granite hills and outcrops.	Sep-Dec	Unlikely
Microtis quadrata	P4	-	PG	Sand, loam or peat in winter wet areas	Oct-Dec	Unlikely
Ornduffia submersa	P4	-	A	Sandy clay in inundated wetland/creek.	Aug-Nov	Unlikely
Stylidium ireneae	P4	-	P	Sandy loam in valleys near creeklines.	Oct-Dec	Unlikely
Stylidium longitubum	P4	-	A	Sandy clay, clay. Seasonal wetlands.	Oct-Dec	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Tripterococcus sp. Brachylobus (A.S. George 14234)	P4	-	P	Winter-wet areas on grey sand.	Oct-Feb	Unlikely
Verticordia lindleyi subsp. *lindleyi*	P4	-	P	Sand and sandy clay in winter wet areas.	May or Nov-Jan	Unlikely

Note: CR=critically endangered, EN=endangered, VU=vulnerable, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4, P=perennial, PG=perennial geophyte, A=annual.
Species considered to potentially occur within the site are shaded green.

Appendix C

Species List

Family	Status	Species
Aizoaceae		
	*	*Carpobrotus edulis*
Anarthriaceae		
		Lyginia barbata
Araliaceae		
		Trachymene pilosa
Asparagaceae		
		Chamaescilla corymbosa
		Laxmannia squarrosa
		Lomandra maritima
		Sowerbaea laxiflora
		Thysanotus sp.
Asteraceae		
	*	*Arctotheca calendula*
	*	*Hypochaeris glabra*
	*	*Hypochaeris radicata*
		Podotheca angustifolia
		Senecio condylis
	*	*Sonchus oleraceus*
	*	*Ursinia anthemoides*
Brassicaceae		
	*	*Brassica tournefortii*
Campanulaceae		
		Lobelia tenuior
	*	*Wahlenbergia capensis*
Casuarinaceae		
		Allocasuarina fraseriana
		Allocasuarina humilis
Centrolepidaceae		
		Centrolepis drummondiana
Colchicaceae		
		Burchardia congesta
Crassulaceae		
		Crassula exserta
Cyperaceae		
		Lepidosperma sp.
		Mesomelaena pseudostygia
		Schoenus clandestinus
Dasypogonaceae		
		Dasypogon bromeliifolius
Dilleniaceae		
		Hibbertia hypericoides
		Hibbertia racemosa
Droseraceae		
		Drosera erythrorhiza
		Drosera drummondii
Ericaceae		
		Conostephium pendulum

Family	Status	Species
		Lysinema ciliatum
		Styphelia conostephioides
		Styphelia insularis
		Styphelia pallidum
Euphorbiaceae		
	*	*Euphorbia terracina*
Fabaceae		
		Acacia huegelii
		Acacia iteaphylla
		Acacia pulchella subsp. *pulchella*
		Acacia stenoptera
		Acacia willdenowiana
		Bossiaea eriocarpa
		Daviesia triflora
		Gastrolobium capitatum
		Gompholobium tomentosum
		Hovea pungens
		Isotropis cuneifolia subsp. *cuneifolia*
		Jacksonia furcellata
	*	*Trifolium campestre* var. *campestre*
	*	*Vicia sativa*
Geraniaceae		
	*	*Pelargonium capitatum*
Goodeniaceae		
		Dampiera linearis
		Scaevola canescens
Haemodoraceae		
		Anigozanthos humilis
		Conostylis aculeata
		Conostylis setigera
		Haemodorum spicatum
		Phlebocarya ciliata
Hemerocallidaceae		
		Caesia micrantha
		Dianella revoluta
		Tricoryne elatior
Iridaceae		
	*	*Freesia alba* × *leichtlinii*
	*	*Gladiolus caryophyllaceus*
		Patersonia occidentalis var. *angustifolia*
Lamiaceae		
		Hemiandra pungens
Loganiaceae		
		Phyllangium paradoxum
Loranthaceae		
		Nuytsia floribunda
Molluginaceae		
		Macarthuria australis

Family	Status	Species
Myrtaceae		
		Calytrix flavescens
		Eremaea pauciflora
		Eucalyptus marginata
		Hypocalymma robustum
		Kunzea glabrescens
		Leptospermum laevigatum
		Scholtzia involucrata
Orchidaceae		*Caladenia arenicola*
		Caladenia discoidea
		Caladenia flava
		Caladenia nobilis
		Microtis media
Orobanchaceae		
	*	*Orobanche minor*
Phyllanthaceae		
		Poranthera microphylla
Poaceae		
		Amphipogon turbinatus
		Austrostipa compressa
	*	*Briza maxima*
	*	*Bromus diandrus*
	*	*Cenchrus setaceus*
	*	*Ehrharta calycina*
	*	*Ehrharta longiflora*
	*	*Lolium perenne*
		Rytidosperma occidentale
	*	*Vulpia* sp.
Proteaceae		
		Adenanthos cygnorum
		Banksia attenuata
		Banksia ilicifolia
		Banksia menziesii
		Banksia attenuata
		Petrophile linearis
		Stirlingia latifolia
		Synaphea spinulosa
Restionaceae		
		Desmocladus flexuosus
Rubiaceae		
		Opercularia vaginata
Rutaceae		
		Philotheca spicata
Santalaceae		
		Leptomeria empetriformis
Solanaceae		
	*	*Solanum nigrum*

Family	Status	Species
Stylidiaceae		
		Levenhookia stipitata
		Stylidium araeophyllum
		Stylidium piliferum
		Stylidium repens
Tropaeolaceae		
	*	*Tropaeolum majus*
Xanthorrhoeaceae		
		Xanthorrhoea preissii

*=non-native

Appendix D

Conservation Significant Communities and Likelihood of Occurrence Assessment

Code	Community name	TEC/ PEC	Level of significance		Likelihood of occurrence
			State	EPBC Act	
Mound Springs SCP	Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)	TEC	CR	EN	Unlikely
SCP08	Herb rich shrublands in clay pans (floristic community type 8 as originally described in Gibson et al. (1994))	TEC	VU	CR	Unlikely
Tuart wood-lands	Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain	TEC/ PEC	P3	CR	Unlikely
-	Clay Pans of the Swan Coastal Plain	TEC	-	CR	Unlikely
SCP19	Sedgelands in Holocene dune swales of the southern Swan Coastal Plain	TEC	EN	EN	Unlikely
SCP22	*Banksia ilicifolia* woodlands	TEC/ PEC	P3	EN	Unlikely
Banksia WL SCP	Banksia Woodlands of the Swan Coastal Plain ecological community	TEC/ PEC	P3	EN	Recorded
SCP21c	Low lying *Banksia attenuata* woodlands or shrublands	TEC/ PEC	P3	EN	Unlikely
SCP26a	*Melaleuca huegelii - Melaleuca systena* shrublands on limestone ridges (floristic community type 26a as originally described in Gibson et al. (1994))	TEC	EN	-	Unlikely
SCP24	Northern Spearwood shrublands and woodlands	PEC	P3	-	Unlikely
SCP25	Southern *Eucalyptus gomphocephala -Agonis flexuosa* woodlands	PEC	P3	-	Unlikely

Note: TEC=threatened ecological community, PEC=priority ecological community, CR=critically endangered, EN=endangered, VU=vulnerable, P3=priority 3

Appendix E

Species x Plant Community Matrix

Species	Plant community	
	BaBm	Cleared
Acacia huegelii	X	
Acacia iteaphylla	X	
Acacia pulchella subsp. *pulchella*	X	
Acacia stenoptera	X	
Acacia willdenowiana	X	
Adenanthos cygnorum	X	
Allocasuarina fraseriana	X	
Allocasuarina humilis	X	
Amphipogon turbinatus	X	
Anigozanthos humilis	X	
Arctotheca calendula	X	X
Austrostipa compressa	X	
Banksia attenuata	X	
Banksia ilicifolia	X	
Banksia menziesii	X	
Banksia attenuata	X	
Bossiaea eriocarpa	X	
Brassica tournefortii	X	X
Briza maxima	X	X
Bromus diandrus	X	X
Burchardia congesta	X	
Caesia micrantha	X	
Caladenia arenicola	X	
Caladenia discoidea	X	
Caladenia flava	X	
Caladenia nobilis	X	
Calytrix flavescens	X	
Carpobrotus edulis	X	
Cenchrus setaceus	X	
Centrolepis drummondiana	X	
Chamaescilla corymbosa	X	
Conostephium pendulum	X	
Conostylis aculeata	X	
Conostylis setigera	X	
Crassula exserta	X	
Dampiera linearis	X	
Dasypogon bromeliifolius	X	
Daviesia triflora	X	
Desmocladus flexuosus	X	
Dianella revoluta	X	
Drosera drummondii	X	
Drosera erythrorhiza	X	
Ehrharta calycina	X	X
Ehrharta longiflora	X	X
Eremaea pauciflora	X	
Eucalyptus marginata	X	
Euphorbia terracina	X	X

Species	Plant community	
	BaBm	Cleared
Freesia alba × leichtlinii	X	
Gastrolobium capitatum	X	
Gladiolus caryophyllaceus	X	X
Gompholobium tomentosum	X	
Haemodorum spicatum	X	
Hemiandra pungens	X	
Hibbertia hypericoides	X	
Hibbertia racemosa	X	
Hovea pungens	X	
Hypocalymma robustum	X	
Hypochaeris glabra	X	X
Hypochaeris radicata	X	X
Isotropis cuneifolia subsp. *cuneifolia*	X	
Jacksonia furcellata	X	
Kunzea glabrescens	X	
Laxmannia squarrosa	X	
Lepidosperma sp.	X	
Leptomeria empetriformis	X	
Leptospermum laevigatum	X	
Levenhookia stipitata	X	
Lobelia tenuior	X	
Lolium perenne	X	
Lomandra maritima	X	
Lyginia barbata	X	
Lysinema ciliatum	X	
Macarthuria australis	X	
Mesomelaena pseudostygia	X	
Microtis media	X	
Nuytsia floribunda	X	
Opercularia vaginata	X	
Orobanche minor	X	X
Patersonia occidentalis var. *angustifolia*	X	
Pelargonium capitatum	X	
Petrophile linearis	X	
Philotheca spicata	X	
Phlebocarya ciliata	X	
Phyllangium paradoxum	X	
Podotheca angustifolia	X	
Poranthera microphylla	X	
Rytidosperma occidentale	X	
Scaevola canescens	X	
Schoenus clandestinus	X	
Scholtzia involucrata	X	
Senecio condylis	X	
Solanum nigrum		X
Sonchus oleraceus	X	X
Sowerbaea laxiflora	X	

Species	Plant community	
	BaBm	Cleared
Stirlingia latifolia	X	
Stylidium araeophyllum	X	
Stylidium piliferum	X	
Stylidium repens	X	
Styphelia conostephioides	X	
Styphelia insularis	X	
Styphelia pallidum	X	
Synaphea spinulosa	X	
Thysanotus sp.	X	
Trachymene pilosa	X	
Tricoryne elatior	X	
Trifolium campestre var. *campestre*	X	
Tropaeolum majus	X	
Ursinia anthemoides	X	X
Vicia sativa	X	
Vulpia sp.	X	X
Wahlenbergia capensis	X	X
Xanthorrhoea preissii	X	

Appendix F

Sample Data

Vegetation Sample Data
Lot 16 Barfield Road, Hammond Park

Sample Name: Q1

Project no.: EP22-099
Date: 27/09/2022, 31/10/2022 **Status** Permanent
Author: MS, Q1: Page 1 of 3

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	391926.681	NW corner northing:	6439475.667
Altitude (m):	34	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	lower slope
Time since fire:	no evidence	Disturbance:	low - animal tracks, weeds
Soil type/texture	sand	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	white/brown
Litter:	7% (leaves,twigs,)	Vegetation condition:	excellent



Vegetation Sample Data
Lot 16 Barfield Road, Hammond Park

Sample Name: Q1

Project no.: EP22-099
Date: 27/09/2022, 31/10/2022 **Status** Permanent
Author: MS, Q1: Page 2 of 3

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia huegelii	opp
	Acacia stenoptera	0.1
	Adenanthos cygnorum	opp
	Allocasuarina humilis	opp
	Amphipogon turbinatus	1
	Anigozanthos humilis	opp
	Austrostipa compressa	0.1
	Banksia attenuata	opp
	Banksia menziesii	30
	Bossiaea eriocarpa	1
*	*Briza maxima*	0.1
	Burchardia congesta	0.1
	Caesia micrantha	0.1
	Caladenia arenicola	0.1
	Caladenia flava	0.1
	Calytrix flavescens	opp
	Chamaescilla corymbosa	0.1
	Conostephium pendulum	0.1
	Conostylis aculeata	0.1
	Conostylis setigera	0.1
	Dampiera linearis	0.1
	Dasypogon bromeliifolius	1
	Daviesia triflora	0.1
	Desmocladus flexuosus	0.1
	Dianella revoluta	0.1
	Drosera drummondii	0.1
	Drosera erythrorhiza	opp
*	*Ehrharta calycina*	0.1
	Eremaea pauciflora	35
	Gastrolobium capitatum	1
*	*Gladiolus caryophyllaceus*	0.1
	Gompholobium tomentosum	1
	Hemiandra pungens	1
	Hibbertia hypericoides	15
	Hibbertia racemosa	1
	Hovea pungens	opp

Vegetation Sample Data
Lot 16 Barfield Road, Hammond Park

Sample Name: Q1

Project no.: EP22-099
Date: 27/09/2022, 31/10/2022 **Status** Permanent
Author: MS, Q1: Page 3 of 3

	Hypocalymma robustum	1
	Laxmannia squarrosa	0.1
	Lepidosperma sp.	0.1
	Lobelia tenuior	opp
	Lomandra maritima	0.1
	Lyginia barbata	1
	Macarthuria australis	0.1
	Mesomelaena pseudostygia	0.1
	Nuytsia floribunda	opp
	Patersonia occidentalis var. *angustifolia*	0.1
	Petrophile linearis	0.1
	Philotheca spicata	opp
	Phlebocarya ciliata	0.1
	Phyllangium paradoxum	0.1
	Poranthera microphylla	0.1
	Scholtzia involucrata	1
	Stirlingia latifolia	0.1
	Stylidium araeophyllum	0.1
	Styphelia conostephioides	1
	Tricoryne elatior	opp
*	*Ursinia anthemoides*	0.1

Vegetation Sample Data
Lot 16 Barfield Road, Hammond Park

Sample Name: Q2

Project no.: EP22-099
Date: 27/09/2022, 31/10/2022 **Status** Permanent
Author: MS, Q2: Page 1 of 3

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	391985.702	NW corner northing:	6439467.427
Altitude (m):	35	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	upper slope
Time since fire:	no evidence	Disturbance:	low - animal tracks, weeds
Soil type/texture	sand	Bare ground (%):	7
Rocks (%) and type:	No rocks	Soil colour:	white/brown
Litter:	10% (leaves,twigs,)	Vegetation condition:	excellent



Vegetation Sample Data
Lot 16 Barfield Road, Hammond Park

Sample Name: Q2

Project no.: EP22-099
Date: 27/09/2022, 31/10/2022 **Status** Permanent
Author: MS, Q2: Page 2 of 3

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia huegelii	0.1
	Acacia pulchella subsp. pulchella	opp
	Acacia willdenowiana	0.1
	Allocasuarina humilis	7
	Amphipogon turbinatus	0.1
	Anigozanthos humilis	0.1
	Austrostipa compressa	0.1
	Banksia ilicifolia	opp
	Banksia attenuata	50
*	*Briza maxima*	0.1
	Burchardia congesta	0.1
	Caesia micrantha	opp
	Caladenia flava	0.1
	Caladenia nobilis	opp
	Chamaescilla corymbosa	0.1
	Conostephium pendulum	opp
	Conostylis aculeata	0.1
	Conostylis setigera	0.1
	Dasypogon bromeliifolius	0.1
	Daviesia triflora	opp
	Drosera erythrorhiza	0.1
	Drosera drummondii	opp
	Drosera sp.	opp
*	*Ehrharta calycina*	1
	Eremaea pauciflora	opp
	Gastrolobium capitatum	0.1
*	*Gladiolus caryophyllaceus*	0.1
	Gompholobium tomentosum	0.1
	Hibbertia hypericoides	10
	Hypocalymma robustum	opp
*	*Hypochaeris radicata*	0.1
	Kunzea glabrescens	0.1
	Laxmannia squarrosa	0.1
	Levenhookia stipitata	0.1
	Lobelia tenuior	opp
	Lomandra maritima	opp

Vegetation Sample Data
Lot 16 Barfield Road, Hammond Park

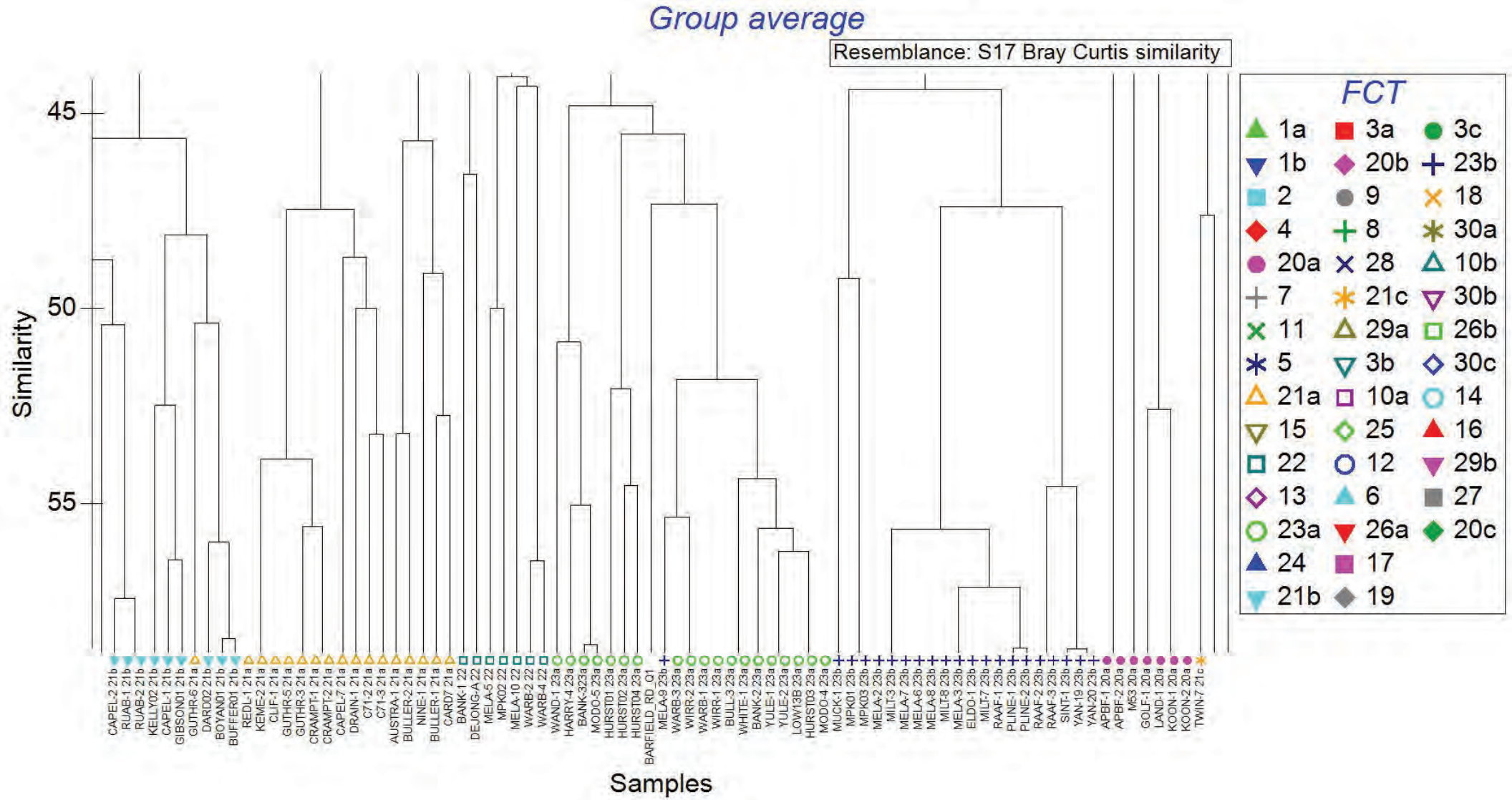
Sample Name: Q2

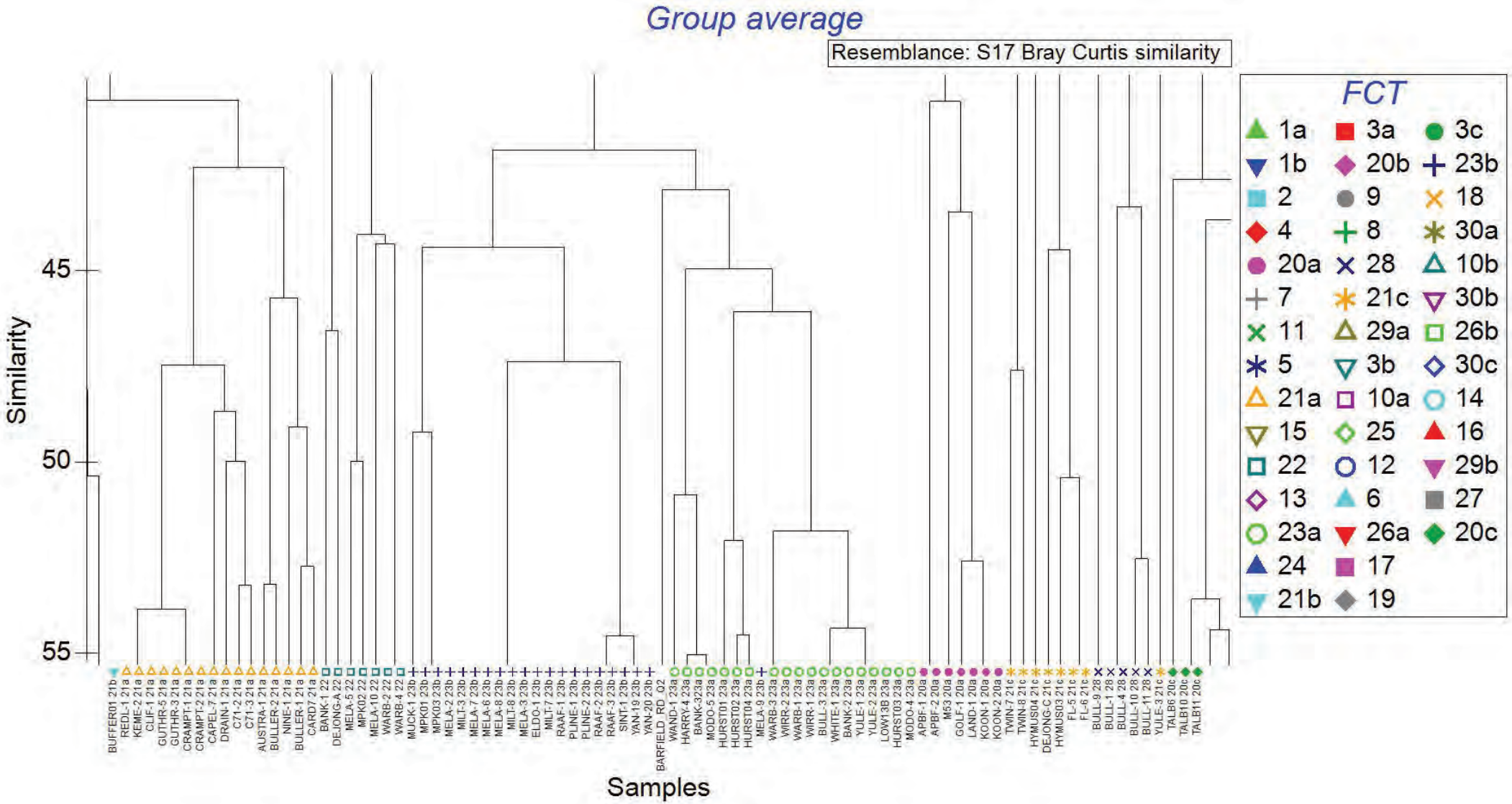
Project no.: EP22-099
Date: 27/09/2022, 31/10/2022 **Status** Permanent
Author: MS, Q2: Page 2 of 3

	Lysinema ciliatum	1
	Mesomelaena pseudostygia	5
	Microtis media	0.1
	Petrophile linearis	0.1
	Phlebocarya ciliata	0.1
	Poranthera microphylla	0.1
	Rytidosperma occidentale	0.1
	Scaevola canescens	0.1
	Scholtzia involucrata	2
	Stylidium araeophyllum	0.1
	Stylidium piliferum	0.1
	Stylidium repens	0.1
	Styphelia conostephioides	2
	Styphelia insularis	opp
	Synaphea spinulosa	1
	Thysanotus sp.	opp
	Trachymene pilosa	0.1
*	*Ursinia anthemoides*	1
	Xanthorrhoea preissii	2

Appendix G

Cluster Dendrograms


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
45
50
55
Samples
FCT
1a
1b
2
4
20a
7
11
5
21a
15
22
13
23a
24
21b
3a
20b
9
8
28
21c
29a
3b
10a
25
12
6
26a
17
19
3c
23b
18
30a
10b
30b
26b
30c
14
16
29b
27
20c
CAPEL-2 21b
RUAB-1 21b
RUAB-2 21b
KELLY02 21b
CAPEL-1 21b
GIBSON01 21b
GUTHR-6 21a
DARD02 21b
BOYAN01 21b
BUFFER01 21b
REDL-1 21a
KEME-2 21a
CLIF-1 21a
GUTHR-5 21a
GUTHR-3 21a
CRAMPT-1 21a
CRAMPT-2 21a
CAPEL-7 21a
DRAIN-1 21a
C71-2 21a
C71-3 21a
AUSTRA-1 21a
BULLER-2 21a
NINE-1 21a
BULLER-1 21a
CARD7 21a
BANK-1 22
DEJONG-A 22
MELA-5 22
MPK02 22
MELA-10 22
WARB-2 22
WARB-4 22
WAND-1 23a
HARRY-4 23a
BANK-323a
MODO-5 23a
HURST01 23a
HURST02 23a
HURST04 23a
BARFIELD_RD_Q1
MELA-9 23b
WARB-3 23a
WIRR-2 23a
WARB-1 23a
WIRR-1 23a
BULL-3 23a
WHITE-1 23a
BANK-2 23a
YULE-1 23a
YULE-2 23a
LOW13B 23a
HURST03 23a
MODO-4 23a
MUCK-1 23b
MPK01 23b
MPK03 23b
MELA-2 23b
MILT-3 23b
MELA-7 23b
MELA-6 23b
MELA-8 23b
MILT-8 23b
MELA-3 23b
ELDO-1 23b
MILT-7 23b
RAAF-1 23b
PLINE-1 23b
PLINE-2 23b
RAAF-2 23b
RAAF-3 23b
SINT-1 23b
YAN-19 23b
YAN-20 23b
APBF-1 20a
APBF-2 20a
M53 20a
GOLF-1 20a
LAND-1 20a
KOON-1 20a
KOON-2 20a
TWIN-7 21c


Group average
Resemblance: S17 Bray Curtis similarity
FCT
1a
1b
2
4
20a
7
11
5
21a
15
22
13
23a
24
21b
3a
20b
9
8
28
21c
29a
3b
10a
25
12
6
26a
17
19
3c
23b
18
30a
10b
30b
26b
30c
14
16
29b
27
20c
Similarity
45
50
55
Samples
BUFFER01 21b
REDL-1 21a
KEME-2 21a
CLIF-1 21a
GUTHR-5 21a
GUTHR-3 21a
CRAMPT-1 21a
CRAMPT-2 21a
CAPEL-7 21a
DRAIN-1 21a
C71-2 21a
C71-3 21a
AUSTRA-1 21a
BULLER-2 21a
NINE-1 21a
BULLER-1 21a
CARD7 21a
BANK-1 22
DEJONG-A 22
MELA-5 22
MPK02 22
MELA-10 22
WARB-2 22
WARB-4 22
MUCK-1 23b
MPK01 23b
MPK03 23b
MELA-2 23b
MILT-3 23b
MELA-7 23b
MELA-6 23b
MELA-8 23b
MILT-8 23b
MELA-3 23b
ELDO-1 23b
MILT-7 23b
RAAF-1 23b
PLINE-1 23b
PLINE-2 23b
RAAF-2 23b
RAAF-3 23b
SINT-1 23b
YAN-19 23b
YAN-20 23b
BARFIELD_RD_02
WAND-1 23a
HARRY-4 23a
BANK-3 23a
MODO-5 23a
HURST01 23a
HURST02 23a
HURST04 23a
MELA-9 23b
WARB-3 23a
WIRR-2 23a
WARB-1 23a
WIRR-1 23a
BULL-3 23a
WHITE-1 23a
BANK-2 23a
YULE-1 23a
YULE-2 23a
LOWY13B 23a
HURST03 23a
MODO-4 23a
APBF-1 20a
APBF-2 20a
M53 20a
GOLF-1 20a
LAND-1 20a
KOON-1 20a
KOON-2 20a
TWIN-7 21c
TWIN-8 21c
HYMUS04 21c
DEJONG-C 21c
HYMUS03 21c
FL-5 21c
FL-6 21c
BULL-9 28
BULL-1 28
BULL-4 28
BULL-10 28
BULL-11 28
YULE-3 21c
TALB6 20c
TALB10 20c
TALB11 20c

Appendix C

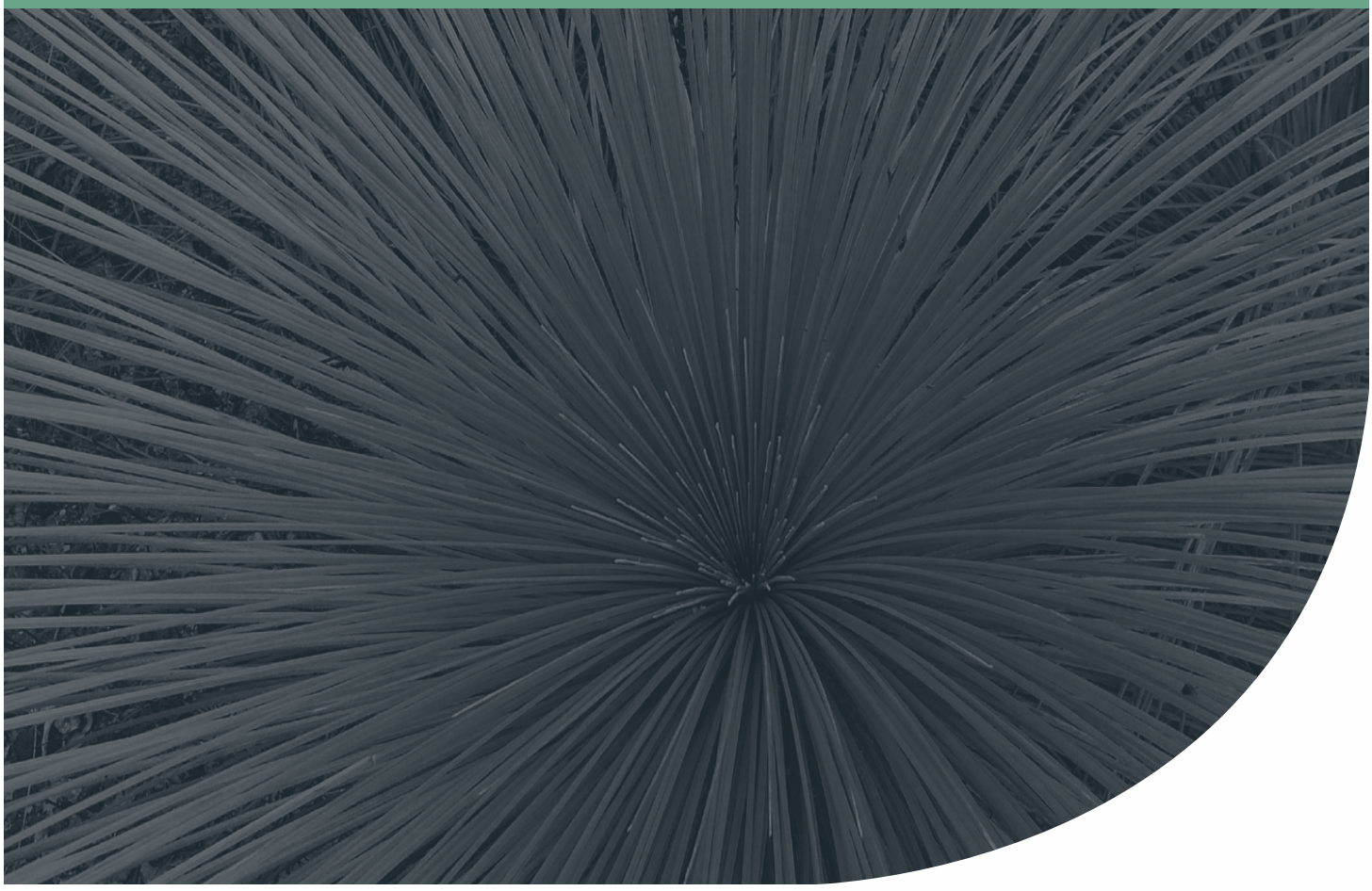
Basic Fauna and Targeted Black Cockatoo Assessment
(Emerge 2023a)

Basic Fauna and Targeted Black Cockatoo Assessment

Lot 16 Barfield Road, Hammond Park

Project No: EP22-099(02)

Prepared for Gold Estates Holdings Pty Ltd
January 2023



Document Control

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		Nick Watson	NAW		
	Submitted for client review				
A	January 2023	Tom Atkinson	TAA	Tom Atkinson	TAA
	Updated following client comments				

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Executive Summary

Gold Estates Holdings Pty Ltd engaged Emerge Associates to conduct a basic fauna and a targeted black cockatoo assessment within Lot 16 Barfield Road in Hammond Park (referred to herein as the 'site').

As part of the assessment a desktop review of relevant background information was completed and a field survey was undertaken on 14 December 2022. During the field survey opportunistic sightings of fauna were recorded and an assessment was made on the fauna habitat within the site and its suitability to provide habitat for conservation significant fauna. A targeted black cockatoo survey was also undertaken to determine the presence of habitat for threatened black cockatoo species.

Outcomes of the basic fauna survey include the following:

- The majority of the site (83.87%) supports **banksia woodland** habitat which provides high value to some fauna species of conservation significance and also many common native and non-native species. The remainder of the site comprises cleared areas (16.13%) with little habitat value.
- A total of 12 native fauna species were recorded within the site, including one species of conservation significance, Carnaby's black cockatoo. Carnaby's black cockatoo is listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999* and the *Biodiversity Conservation Act 2016*.
- While not recorded during the field survey, forest red-tailed black cockatoo (listed as vulnerable) could possibly occur in the site. Two other species of conservation significance not recorded during the field survey may possibly occur in the site; Pacific swift and Peregrine falcon. Any occurrence of Pacific swift would likely be independent from terrestrial habitat, in the air space above the site.

Outcomes of the targeted black cockatoo survey include the following:

- The site occurs within the modelled distribution of Carnaby's black cockatoo and forest red-tailed black cockatoo but outside of the modelled distribution of Baudin's black cockatoo. Carnaby's black cockatoo was recorded in the site during the field survey and forest red-tailed black cockatoo is likely to occur.
- The site contains no habitat trees. Therefore, the site does currently not provide breeding habitat for any species of black cockatoo.
- No roosts or evidence of roosting by any species of black cockatoo was recorded within the site during the field survey. No large trees associated with black cockatoo roosting occur within the site.
- A total of 1.56 ha of foraging habitat for Carnaby's black cockatoo was mapped within the site of which all is native vegetation.
- No foraging habitat suitable for forest red-tailed black cockatoo was mapped within the site.
- Additional areas of foraging habitat of similar or higher value occur adjacent to the site and in the wider local area.

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Appendix D

Conservation Significant Species and Likelihood of Occurrence Assessment

Appendix E

Species List

Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
EPA	Environmental Protection Authority
DBCA	Department of Biodiversity, Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPaW	Department of Parks and Wildlife (now DBCA)
DAWE	Department of Agriculture, Water and the Environment (now DCCEEW)
WA Museum	Western Australian Museum

Table A2: Abbreviations – General terms

General terms	
EN	Endangered
IBRA	*Interim Biogeographic Regionalisation of Australia*
MI	Migratory
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
UFI	Unique feature identifier
VU	Vulnerable

Table A3: Abbreviations –Legislation

Legislation	
BAM Act	*Biosecurity and Agriculture Management Act 2007*
EBPC Act	*Environment Protection and Biodiversity Conservation Act 1999*
BC Act	*Biodiversity Conservation Act 2016*

Table A4: Abbreviations – units of measurement

Units of measurement	
DBH	Diameter at breast height
cm	Centimetre
ha	Hectare
km	Kilometre
m	Metre
m AHD	m in relation to the Australian height datum
mm	Millimetre

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1 Introduction

1.1 Project background

Emerge Associates (Emerge) were engaged by Gold Estates Holdings Pty Ltd to characterise the fauna and black cockatoo values within Lot 16 Barfield Road in Hammond Park (referred to herein as the 'site'). This lot is located approximately 24 kilometres (km) south of the Perth Central Business District within the City of Cockburn.

The site is approximately 1.86 hectares (ha) in size and is bounded by Barfield Road to the west, native vegetation to the east and future residential lots to the north and south. The location and extent of the site is shown in **Figure 1**.

1.2 Purpose and scope of works

The scope of work was specifically to undertake a terrestrial vertebrate fauna assessment to the standard required of a 'basic' fauna survey and a 'targeted' black cockatoo survey with reference to the Environmental Protection Authority's (EPA's) technical guidance (EPA 2020) and the *Environment Protection and Biodiversity Conservation Act* black cockatoo referral guidelines (DAWE 2022).

As part of this scope of work, the following tasks were undertaken:

- Desktop assessment of relevant background information pertaining to the site and surrounds, including database and literature searches for fauna species.
- A field survey to identify fauna species and habitats within the site, including habitat for species of black cockatoo.
- Compilation of a list of fauna species with potential to occur within the site as identified from the desktop assessment and opportunistically recorded as part of the field survey.
- Identification of potential habitat for conservation significant fauna species and an assessment of likelihood of occurrence.
- Mapping of fauna and black cockatoo habitat.
- Documentation of the desktop assessment, survey methodology and results into a report.

2 Environmental context

2.1 Climate

Climate has a strong influence on the fauna habitat and species present in a region and a site. The south-west of Western Australia experiences a Mediterranean climate of hot dry summers and cool wet winters.

A total of 22.8 millimetre (mm) of rainfall was recorded during the month prior to the survey (November 2022) from the Jandakot weather station (no. 009172) which is the closest weather station located approximately 8.5 km north-east of the site (BoM 2023). This is slightly lower than the average rainfall of 27.7 mm for the same period and weather station (BoM 2023).

Temperatures recorded in November 2022 ranged from a mean maximum of 25.4°C to a mean minimum of 11.7°C, as recorded by the Jandakot weather station (no. 009172) which is the closest temperature recording weather station located approximately 8.5 km north-east of the site (BoM 2023). This is slightly lower to the average maximum temperature of 26.4°C and average minimum temperature of 12.7°C for the same period and weather station (BoM 2023).

On the day of the survey temperatures at the Jandakot weather station ranged from a daily maximum of 31.6°C to a daily minimum of 15.1°C (BoM 2023). Approximately 0.0 mm of rainfall was recorded on the day of the survey by the Jandakot weather station (BoM 2023).

2.2 Geomorphology and soils

Landform and soils influence fauna habitat and species at regional and local scales. The site occurs on the Swan Coastal Plain, which is the geomorphic unit that characterises much of the Perth metropolitan area. The Swan Coastal Plain is approximately 500 km long and 20 to 30 km wide and is roughly bound by the Indian Ocean to the west and the Darling Scarp to the east. Broadly the Swan Coastal Plain consists of two sedimentary belts of different origin. Its eastern side comprises the Pinjarra Plain which formed from the deposition of alluvial material washed down from the Darling Scarp, while its western side comprises three dune systems that run roughly parallel to the Indian Ocean coastline (Seddon 2004). These dune systems, referred to as Quindalup, Spearwood and Bassendean associations, represent a succession of coastal deposition that has occurred since the late Quaternary period (approximately two million years ago) (Kendrick *et al.* 1991) and, as a result, they contain soils at different stages of leaching and formation.

Examination of physiographic region mapping by (Gozzard 2011) places the site in the Bassendean Dunes which was later confirmed during the field survey. The Bassendean association comprises sand plains with low dunes and occasional swamps, iron or humus podzols and areas of complex steep dunes (Churchward and McArthur 1980). The physiographic regions mapped within the site are shown in **Figure 2**.

The site is not known to contain any restricted landforms or unique geological features.

2.3 Topography

The elevation of the site ranges from 29 m in relation to the Australian height datum (mAHD) on the western side of the site to 36 mAHD on the eastern side of the site (DoW 2008) (**Figure 2**).

2.4 Hydrology and wetlands

Wetlands are areas of seasonally, intermittently or permanently waterlogged land such as poorly drained soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries (Wetlands Advisory Committee 1977). Many wetlands provide important fauna habitat and support high levels of fauna biodiversity and endemism.

Wetlands of national or international significance may be afforded special protection under Commonwealth or international agreements. The following lists of important wetlands were checked as part of this assessment:

- *Ramsar List of Wetlands of International Importance* (DBCA 2017b)
- *A Directory of Important Wetlands in Australia* (DBCA 2018*)*.

No Ramsar or listed 'important wetlands' are located within or near the site.

Examination of the Department of Water and Environmental Regulation (DWER) hydrography dataset (DWER 2018) shows that no wetland or water related features occur within the site:

The Department of Biodiversity, Conservation and Attractions (DBCA) has developed the *Geomorphic Wetlands of the Swan Coastal Plain* dataset (DBCA 2021a). This dataset maps geomorphic wetland features and classifies them based on their landform shape and water permanence. Each feature is assigned to one of three management categories which guides land use and conservation.

Review of the *Geomorphic Wetlands, Swan Coastal Plain* dataset indicated that no wetland features occur within or near the site.

2.5 Regional vegetation

Vegetation types and resulting fauna habitats strongly influence the diversity and composition of fauna taxa present within an area. Native vegetation is described and mapped at different scales in order to illustrate patterns in its distribution. At a continental scale the *Interim Biogeographic Regionalisation of Australia* (IBRA) divides the Swan Coastal Plain into two floristic subregions (Environment Australia 2000).

The site is contained within the 'SWA02' or Perth subregion, which is characterised as mainly containing *Banksia* low woodland on leached sands with *Melaleuca* swamps where ill-drained; and woodland of *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah) and *Corymbia calophylla* (marri) on less leached soils (Beard 1990). This subregion is recognised as a biodiversity hotspot and contains a wide variety of endemic fauna species.

Variations in native vegetation can be further classified based on regional vegetation mapping.

Heddle *et al.* (1980) mapping shows the site as comprising the 'Bassendean central and south complex', which is described as vegetation ranging from woodland of *Eucalyptus marginata* -

Allocasuarina fraseriana - *Banksia* spp. to low woodland of *Melaleuca* spp. and sedgelands on the moister sites.

2.6 Historic land use

Review of historical images available from 1953 onwards shows that the site was almost completely cleared of native vegetation prior to 1985 (**Plate 1**). Vegetation has subsequently regenerated. Since then, no further vegetation clearing is evident from aerial imagery.

The southern portion of the site appears to have been burnt between January and March 2015 which resulted in a reduction in vegetation cover in these areas but vegetation has since regrown (**Plate 2** and **Plate 3**) (WALIA 2023).



Plate 1: Aerial photography of the site in 1985 showing extensive clearing of native vegetation.



Plate 2: Aerial photography of the site in 2015 showing evidence of fire in the southern portion of the site.



Plate 3: Aerial photography of the site in 2015 showing reduction of vegetation canopy in the southern portion of the site.

2.7 Significant fauna

2.7.1 Threatened fauna

Certain fauna taxa that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, fauna taxa may be listed as 'threatened' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action likely to have a significant impact on a taxon listed under the EPBC Act requires Ministerial approval.

In Western Australia fauna species may also be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act). It is an offence to 'take' or 'disturb' threatened fauna without Ministerial approval.

Threatened fauna species listed under the EPBC Act and/or BC Act are assigned a conservation status according to attributes such as population size and geographic distribution. Further information on threatened species and their categories is provided in **Appendix A**.

2.7.1.1 Black cockatoos

Three threatened species of black cockatoo occur in the south-west of WA (referred to herein collectively as 'black cockatoos'):

- *Zanda*[1] *latirostris* (Carnaby's black cockatoo) which is listed as 'endangered' under the EPBC Act and the BC Act.
- *Zanda*[2] *baudinii* (Baudin's black cockatoo) which is listed as 'endangered' under the EPBC Act and the BC Act.
- *Calyptorhynchus banksii naso* (forest red-tailed black cockatoo) which is listed as 'vulnerable' under the EPBC Act and the BC Act.

Black cockatoo habitat is conventionally separated into breeding, roosting and foraging categories:

- Black cockatoos nest in hollows that form in trees which are usually more than ~200 years old. 'Breeding habitat' comprises 'habitat trees' which are trees of a species known to support black cockatoo breeding and which either have a suitably large enough nest hollow or have a large enough diameter at breast height (DBH) to indicate that a suitable nest hollow could develop in time (DAWE 2022). A minimum DBH for a habitat tree is defined as ≥50 centimetres (cm) for most tree species used by black cockatoos and ≥30 cm for *Eucalyptus wandoo* (wandoo) and *Eucalyptus salmonophloia* (salmon gum) (DAWE 2022). Breeding habitat is also generally expected to be located within 6 km of food and water resources (DPaW 2013).
- Roosting refers to black cockatoos congregating in a tree or group of trees to rest overnight. 'Roosting habitat' consists of groups or individual tall trees used for roosting. Roosts generally comprise the tallest trees in an area and can include native and non-native trees (DAWE 2022). They are often located within 6 km of water and food resources, with additional foraging ranges within 12 km (Shah 2006; Le Roux 2017; DAWE 2022). The use of a particular roost may vary depending on availability of food and water resources.

[1] Previously *Calyptorhynchus*
[2] Previously *Calyptorhynchus*

- Black cockatoos feed on the fruit and seeds of a range of native and non-native plant species. 'Foraging habitat' is vegetation that contains plant species known to be foraged on by black cockatoos.

Each black cockatoo species has a defined breeding season, with Baudin's black cockatoo breeding from August/September to February/March and Carnaby's black cockatoo breeding from July/August to January/February (DAWE 2022). Forest red-tailed black cockatoo breeds in October/November but may breed in March/April if there is good autumn rainfall (DAWE 2022). There is also evidence that forest red-tail black cockatoos breed throughout the year, with peaks in April – June and August – October (Johnstone *et al.* 2013).

2.7.2 Priority fauna

Fauna species that do not currently meet the criteria for listing as threatened but are potentially rare or threatened may be added to the DBCA *Priority Fauna List*. These species are classified into 'priority' levels based on threat. Whilst priority species are not under direct statutory protection, they are considered during State approval processes. Further information on priority species and their categories is provided in **Appendix A**.

2.7.3 Migratory fauna

Some fauna species that migrate to Australia and its external territories or pass though or over Australian waters during their annual migrations are protected under Commonwealth and State legislation. At a Commonwealth level, migratory fauna taxa may be listed as 'migratory' under *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action likely to have a significant impact on a taxon listed under the EPBC Act requires Ministerial approval. Further information on migratory species is provided in **Appendix A**.

2.7.4 Specially protected fauna

In Western Australia, fauna species that are of special conservation interest, including migratory species and cetaceans, species subject to international agreement or species otherwise in need of special protection may be listed as 'specially protected' under the BC Act. Further information on specially protected species and their categories is provided in **Appendix A**.

2.8 Pest fauna

The term 'pest fauna' can refer to any animal that requires some form of action to reduce its effect on the economy, the environment, human health and amenity. Pest fauna species are generally not native but some Australian or Western Australian fauna may also be considered pests.

A particularly invasive or detrimental pest species may be listed as a 'declared pest' pursuant to Western Australia's *Biosecurity and Agriculture Management Act 2007* (BAM Act), indicating that it warrants special management to limit its spread. Current pest status and control categories for Western Australia are provided in the *Western Australian Organism List* (DPIRD 2022). Further information on categories of declared pests is provided in **Appendix A**.

2.9 Bush Forever

The Government of Western Australia's Bush Forever policy is a strategic plan for conserving regionally significant bushland within the Swan Coastal Plain portion of the Perth Metropolitan Region. The objective of *Bush Forever* is to protect comprehensive representations of all original ecological communities by targeting a minimum of 10% of each vegetation complex for protection (Government of WA 2000). *Bush Forever* sites are representative of regional ecosystems and habitat and have a key role in the conservation of Perth's biodiversity.

No *Bush Forever* sites occur within or adjacent to the site. The closest Bush Forever site near the site is no. 392 (Harry Waring Marsupial Reserve, Wattleup) which is located 1.2 km north-west of the site. Multiple additional Bush Forever sites occur in the wider area of the site. The locations of the Bush Forever sites near the site are shown in **Figure 3**.

2.10 DBCA managed or legislated land

DBCA has tenure of or interests in numerous areas of land across the state for a range of purposes. Tenure categories include national parks, nature reserves, conservation parks, marine parks, marine nature reserves, marine management areas, section 5(1)(g) reserves, state forest and timber reserves. These areas are mapped within the *Legislated Lands and Waters* (DBCA 2021c) and *Lands of Interest* (DBCA 2021b) datasets. The *Legislated Lands and Waters* (DBCA 2021c) dataset includes lands subject to the following legislation; the *Conservation and Land Management Act 1984* (CALM Act 1984), *Swan and Canning Rivers Management Act 2006* (SCRM Act) and lands identified under the *Land Administration Act 1997* (LA Act). The *Lands of Interest* (DBCA 2021b) dataset includes all other lands of which DBCA is recognised as the manager but is not vested under any act. These lands comprise of crown land and freehold land which DBCA has been acknowledged by the Department of Lands as the responsible agency.

No DBCA managed or legislated lands or lands of interest occur within or adjacent to the site. The closest DBCA managed land near the site is associated with Bush Forever Site 392 (Harry Waring Marsupial Reserve) which is located 1.2 km north-west of the site. Harry Waring Marsupial Reserve incorporates three areas denoted as DBCA legislated lands and waters. R15556 and R29241 are nature reserves and R48291 is a conservation park under the CALM Act 1984 (DBCA 2017a).

2.11 Ecological linkages

Ecological linkages are linear landscape elements that allow the movement of fauna, flora and genetic material between areas of remnant habitat. This exchange of genetic material between vegetation remnants improves the viability of those remnants by allowing greater access to breeding partners and food sources, refuge from disturbances such as fire and maintenance of genetic diversity of plant communities and populations. Ecological linkages are ideally continuous or near-continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

The Perth Biodiversity Project, supported by the Western Australia Local Government Association (WALGA), have identified and mapped regional ecological linkages within the Perth Metropolitan Region (WALGA and PBP 2004).

There are no mapped ecological linkages within or in close proximity to the site. One regional ecological linkage (No. 50) occurs approximately 200 m west of the site running from north to south and intersects with another ecological linkage (No. 52) running east to west approximately 1.2 km north of the site. These ecological linkages connect areas of Bush Forever located in the wider local area.

Review of aerial imagery indicates that the vegetation within the site is connected to multiple small areas of native vegetation within the local area.

2.12 Previous surveys

No previous surveys are known to have been undertaken on the site.

3 Methods

3.1 Desktop assessment

3.1.1 Basic fauna

A search was conducted for fauna species that have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DCCEEW 2023) and *NatureMap* (DBCA 2023).

3.1.2 Black cockatoo

A search was conducted for records of black cockatoos and potential black cockatoo habitat mapping occurring within 12 km of the site using a range of publicly available regional studies and datasets. Detailed information on each dataset considered as part of the desktop review is provided in **Appendix A**.

3.2 Field survey

An ecologist from Emerge visited the site on 14 December 2022 during the day to conduct the basic fauna survey and targeted black cockatoo field survey. The survey was conducted from approximately 6:00 am until 8:30 am.

The weather conditions prior to and during the survey were warm and dry (refer to **Section 2.1** for recorded weather conditions).

3.2.1 Basic fauna

Transects were traversed across the site, during the day, and the characteristics of fauna habitat and presence of fauna species was recorded. Microhabitats such as logs, rocks and leaf litter were investigated and evidence of species presence such as tracks, scats, skeletal remains, foraging evidence or calls was also noted.

An opportunistic fauna species list was compiled and fauna habitat values were described, with particular reference to conservation significant fauna species with potential to occur within the site.

3.2.2 Targeted black cockatoo

Transects were traversed across the site and the presence of potential black cockatoo breeding, night roosting and foraging habitat was recorded. If observed, the presence of black cockatoos within or near the site was noted. Active searches for evidence of breeding, roosting and foraging activity such as chew marks, branch clippings, droppings, moulted feathers and chewed marri or banksia fruit were conducted.

3.2.2.1 Breeding habitat

A 'habitat tree' was defined as a native eucalypt that is typically known to support black cockatoo breeding such as marri, jarrah, blackbutt, tuart, wandoo, salmon gum or to a lesser extent flooded gum, with a DBH ≥50 cm or DBH ≥30 cm for wandoo or salmon gum. As any tree that has a suitable hollow may provide breeding habitat for black cockatoos, other tree species were also considered to be habitat trees if they contained a suitable hollow.

To be suitable for use as breeding habitat by black cockatoos it was considered a hollow must:

- have an entrance opening of at least 10 cm but preferably 20-30 cm (Saunders *et al.* 1982; Groom 2010; Johnstone *et al.* 2013)
- be located at least 3 m from the ground (Saunders 1979b; Johnstone and Storr 1998; Groom 2010; Saunders 2014)
- be located in a trunk or branch that is generally large enough to contain a hollow that has a floor diameter of at least 40 cm and depth of 50-200 cm such that it could house an adult black cockatoo and nestlings (Saunders 1979a; Johnstone and Storr 1998; Saunders 2014; DPaW 2015)
- have vertical or near vertical orientation (Johnstone and Kirkby 2008; Johnstone *et al.* 2013).

Occasionally, native eucalypts were encountered that met DBH requirements but did not contain a trunk/branch of a sufficient size to support a hollow suitable for use by black cockatoos. For example, the tree may have been less than 3 m tall or had a trunk that forked between 1.3 m and 3 m in height and after the fork no limbs had a diameter of ≥50 cm or ≥30 cm for wandoo or salmon gum. These trees were not recorded as habitat trees as the likelihood they would form a suitable hollow was low.

Habitat trees were individually identified and the attributes outlined in **Table 1** were recorded for each tree.

Table 1: Attributes recorded for each habitat tree in the site

Attribute	Description
Image	Trees were individually photographed
GPS location	The location was recorded using a handheld GPS unit
Tree species	Species and common name were identified
Diameter at breast height (DBH) (cm)	DBH was measured at breast height (1.3 m) using a diameter tape
Hollows potentially suitable for breeding by a black cockatoo	Number of hollows potentially suitable for breeding by a black cockatoo recorded (assessed from ground level only)

Each habitat tree was assigned to a category based on current black cockatoo guidelines (DAWE 2022) listed in **Table 2**.

Table 2: Habitat tree categories (DAWE 2022)

Category	Specifications
Known nesting tree	Trees (live or dead but still standing) which contains a hollow where black cockatoo breeding has been recorded or which demonstrates evidence of breeding (i.e. showing evidence of use through scratches, chew marks or feathers).

Suitable nesting tree	Trees with suitable nesting hollows present, although no evidence of use. Note that any species of tree may develop suitable hollows for breeding. Hollow confirmed by internal hollow inspection^.
Potential nesting tree	Trees that have a suitable DBH to develop a nest hollow, but do not currently have hollows. Trees suitable to develop a nest hollow in the future are 300-500 mm DBH. Note that many species of eucalypt may develop suitable hollows for breeding.

^Hollow determined to be suitable for use as breeding habitat by black cockatoos as listed above in **Section 3.2.2.1**

3.2.2.2 Roosting habitat

The presence of active or historical roosts was determined through evidence of roosting activity, such as branch clippings, droppings or moulted feathers.

If present, groups of tall native and non-native trees were assumed to provide roosting habitat.

3.2.2.3 Foraging habitat

Foraging habitat was identified by assessing vegetation in the site for plant species known to provide food for black cockatoos (Davies 1966; Saunders 1980; Johnstone and Storr 1998; Johnstone and Kirkby 1999; Groom 2011; Johnstone *et al.* 2011; DAWE 2022). A list of plant species classified as primary or secondary food plants is provided as **Appendix C**.

Foraging habitat was classified as either 'native' or 'non-native'. Foraging habitat was then graded using the DCCEEW foraging quality scoring method (DAWE 2022).

As it is not always possible to separate out food plants from non-food plants, mapped foraging habitat may also include vegetation comprising non-food plants. The proportion of non-food plants in mapped foraging habitat was minimised as far as practicable.

Evidence of black cockatoo foraging, such as chewed fruits, was searched for within the site and allocated to a species where possible.

3.3 Data analysis

3.3.1 Desktop assessment

A total number of species that occur or potentially occur within the desktop assessment search area was calculated by adding the total count of non-conservation significant species provided by *NatureMap* to the combined number of conservation significant species provided by *NatureMap* and *Protected Matters Search Tool*. The habitat requirements of conservation significant vertebrate fauna were specifically reviewed to verify they did in fact have potential to occur in the site (that is marine mammals and fish were omitted).

3.3.2 Fauna habitat

Fauna habitats were described according to the dominant flora species and vegetation type present, as determined from observations made during the field survey and information provided in the '*Detailed Flora and Vegetation Assessment*' (Emerge Associates 2022).

The identified fauna habitats were mapped on aerial photography with the boundaries interpreted from aerial photography, (Emerge Associates 2022) plant communities and notes taken in the field.

3.3.3 Likelihood of occurrence

Information on habitat preferences and distribution of conservation significant fauna species with potential occur within the site or wider area was reviewed and assessed against the general site conditions and fauna habitat types recorded during the field survey.

Based on the results of the desktop assessment and information recorded during the field survey, an assessment of the likelihood of occurrence of conservation significant fauna within the site was undertaken using the categories outlined in **Table 3**.

Table 3: Likelihood of occurrence assessment categories and definitions

Likelihood of occurrence	Definition
Recorded	The species was recorded during the current field survey or during previous field surveys.
Likely	The site contains suitable habitat for the species and it is likely the species may occur based on presence of a recent historical record within or close to the site.
Possible	The site contains habitat of at least marginal quality and/or extent for the species and the site is located within the known distribution range of the species which is supported by recent literature records from near the site.
Unlikely	The site contains no or marginal habitat for the species and/or no recent literature records occur near the site.

3.3.4 Black cockatoo habitat

3.3.4.1 Habitat trees

Habitat trees were classified according to the scheme outlined in **Table 2** and mapped on aerial imagery. A complete summary of the recorded attributes of habitat trees was compiled in a tabular format.

3.3.4.2 Foraging habitat value

Foraging habitat was described according to the dominant flora species or vegetation type present and mapped using boundaries interpreted from aerial photography and notes taken in the field. The foraging value of each patch of foraging habitat was attributed separately for each species of black cockatoo likely to occur in the site. Foraging value was assigned as outlined in **3.2.2.3**.

3.4 Nomenclature and sources of information

Taxonomy and nomenclature of scientific and common names for mammals, reptiles and amphibians follow *the Western Australian Museum* (WAM) *Checklist of the Terrestrial Vertebrate Fauna of Western Australia* (WAM 2021). For birds taxonomy and nomenclature of scientific and common names follows the Australian Faunal Directory (AFD) (DoEE 2021). Where common names were not provided by the WAM or the AFD, these have been derived from other sources as noted.

Literature listed in **Appendix A** represent the main publications used to identify fauna species and habitats within the site.

3.5 Survey limitations

It is important to note the specific constraints imposed on surveys and the degree to which these may have limited survey outcomes. An evaluation of the survey methodology against standard constraints outlined in the EPA's document *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020) is provided in **Table 4**.

Table 4: Evaluation of survey methodology against standard constraints outlined in the EPA's Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020)

Constraint	Degree of limitation	Details
Level of survey	No limitation	A basic survey (desktop study and field survey) in combination with a targeted black cockatoo survey was undertaken. The level of survey and survey effort are considered adequate to assess the fauna and black cockatoo habitat values within the site.
Scope	No limitation	The survey focused on vertebrate fauna and habitat values, with particular focus on black cockatoos and other conservation significant taxa with potential to occur within the site.
Proportion of fauna identified, recorded and/or collected.	No limitation	All observed vertebrate fauna were identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	No limitation	Adequate information was available from database searches, previous surveys and literature references.
The proportion of the task achieved and further work which might be needed.	No limitation	The task was achieved in its entirety.
Experience level of personnel	No limitation	This fauna and black cockatoo assessment was undertaken by a qualified zoologist with over four years of zoological experience in Western Australia. Technical review was undertaken by a principle environmental consultant with over 10 years' experience in environmental science in Western Australia.
Suitability of timing, weather and season	No limitation	Survey timing is not considered to be of great importance for basic fauna assessments but the weather conditions during the survey were ideal for detecting fauna species. The survey was undertaken during the black cockatoo peak breeding season to maximise the chance of detecting breeding behaviour. However, many black cockatoo individuals leave the Swan Coastal Plain (SCP) during this time and migrate to breeding areas and as such the detectability of roosting activity was reduced.
Completeness	No limitation	The desktop assessment, field survey and targeted black cockatoo components of the survey were completed comprehensively.
Spatial coverage and access	No limitation	Site coverage was comprehensive (track logged).
	No limitation	All parts of the site could be accessed as required.

Table 4: Evaluation of survey methodology against standard constraints outlined in the EPA's Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020) (continued)

Constraint	Degree of limitation	Details
Survey intensity	No limitation	The intensity of the survey was adequate given the size of the site and the relatively low habitat value present.
Influence of disturbance	No limitation	Historical ground disturbance was evident in parts of the site and the majority native vegetation in the site is regrowth after clearing/fire. The disturbance history of the site was considered when undertaking field sampling.
Adequacy of resources	No limitation	All resources required to perform the survey were available. The guidance currently available from Commonwealth and State agencies on the assessment of black cockatoo habitat is limited and relies heavily on technical experts preparing their own methodology.
Compliance with EPA (2020) guidance	Minor limitation	The EPA guidance requires that a full list of all fauna species with potential to occur within the site is compiled. As part of this assessment a comprehensive list of fauna species of conservation significance was compiled. Non-conservation taxa with potential to occur within the site were not compiled into a list but are provided as raw data in **Appendix B**. Given that all species with potential to occur within the site are still identified within the relevant appendices this is not considered to affect the outcomes of this assessment.

4 Results

4.1 General site conditions

The site is located on a west facing slope that is comprised of sandy soils that are light grey to brown in colour. The majority of the site is vegetated with native vegetation in varying condition. A sandy track/firebreak exists around the perimeter of the site.

4.2 Fauna habitat

One broad fauna habitat was identified within the site, as listed in in **Table 5**.

A description and the area of each habitat is provided in **Table 5** and representative photographs of each are provided in **Plate 1** to **Plate 2**. The location of each habitat is shown on **Figure 5**.

Table 5: Fauna habitats identified within the site

Fauna habitat	Description	Area (ha)
Banksia woodland	Community of *Banksia attenuata* and *B. menziesii* woodland in good to excellent condition (**Plate 4**).	1.56
Cleared	Heavily disturbed area of bare sand and occasional native vegetation (**Plate 5**).	0.30



Plate 4: Banksia woodland habitat



Plate 5: Cleared habitat

4.3 Fauna

4.3.1 Desktop assessment

A total of 521 fauna species were identified from database searches as occurring or potentially occurring within 10 km of the site[3] as listed in **Appendix B.**

Of these species, 91 are conservation significant, including 40 threatened, 16 priority, 55 migratory fauna and two other specially protected species as listed in **Appendix D**.

4.3.2 Species inventory

A total of 12 native and one introduced fauna species, including one fauna species of conservation significance (Carnaby's black cockatoo), were directly or indirectly (from tracks and scats) recorded during the field survey.

A complete species list is provided in **Appendix E**.

4.3.3 Conservation significant fauna

One conservation significant fauna species was recorded within the site during the field survey: Carnaby's black cockatoo.

A small group of Carnaby's black cockatoo was observed flying over the site.

[3] Includes native and non-native species

Additionally, 10 fauna species of conservation significance were considered to possibly occur in the site based on habitat requirements, species distribution and site conditions, as shown in **Table 6**.

The remainder of the conservation significant fauna species identified in the desktop assessment (65 species) are considered unlikely to occur in the site due to lack of suitable habitat or because the site lies outside of the species known distribution. Fauna species classed as unlikely to occur are listed in **Appendix D**.

Table 6: Summary of conservation significant fauna species recorded or deemed possible or likely to occur within the site

Species name	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		BC Act	EPBC Act		
Birds					
Apus pacificus	Pacific swift	MI	MI	Aerial, migratory species that is most often seen over inland plains and sometimes above open areas, foothills or in coastal areas. Sometimes occurs over settled areas, including towns, urban areas and cities (Johnstone and Storr 1998).	**Possible**: May opportunistically occur in or fly over the site on commute but only for short periods of time.
Calyptorhynchus banksii naso	Forest red-tailed black cockatoo	VU	VU	*Eucalypt* and *Corymbia* forests, often in hilly interior. More recently also observed in more open agricultural and suburban areas including Perth metropolitan area. Attracted to seeding *Corymbia calophylla*, *Eucalyptus marginata*, introduced *Melia azedarach* and *Eucalyptus* spp. trees (Johnstone and Storr 1998).	**Possible**: No suitable habitat is present within the site. However, it may opportunistically occur in or fly over the site.
Falco peregrinus	Peregrine falcon	MI	MI	Mainly found around cliffs along coasts, rivers, ranges and around wooded watercourses and lakes (Johnstone and Storr 1998).	**Possible**: May opportunistically occur in or fly over the site on commute or while searching for prey but only for short periods of time.
Zanda latirostris	Carnaby's black cockatoo	EN	EN	Mainly proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests; also plantations of *Pinus* spp. Attracted to seeding *Banksia* spp., *Dryandra* spp., *Hakea* spp., *Eucalyptus* spp., *Corymbia calophylla*, *Grevillea* spp., and *Allocasuarina* spp. (Johnstone and Storr 1998).	**Recorded**: Suitable foraging habitat present.
Invertebrate					
Idiosoma sigillatum	Swan Coastal Plain shield-backed trapdoor spider	P3	-	Widely distributed in sandy areas on the Swan Coastal Plain and on Rottnest Island (Prince 2003).	**Possible**: Potential habitat present (sandy soils) and a recent record

Species name	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		BC Act	EPBC Act		
					occurs approximately 5.5 km south of the site.
Leioproctus contrarius	a short-tongued bee	P3	-	Life history and habits are poorly documented/ unknown. It has been recorded only on flowers of Goodeniaceae and possibly *Lechenaultia stenosepala* (Bamford 2003).	**Possible**: Suitable habitat (Goodeniaceae spp.) is present within the site.
Synemon gratiosa	Graceful sun-moth	P4	-	Coastal heathland on Quindalup dunes where it is restricted to secondary sand dunes due to the abundance of the preferred host plant *Lomandra maritima*. Banksia woodland on Spearwood and Bassendean dunes, where the second known host plant *L. hermaphrodita* is widespread (DEC 2011).	**Possible**: Suitable habitat (*Lomandra maritima*) is present within the site.
Throscodectes xiphos	Stylet bush cricket	P1	-	Species poorly understood and documented. Known from Jandakot area, where it was originally collected in the axial leaf bases of grass trees (*Xanthorrhoea preissii*) (Invertebrate Solutions 2019).	**Possible**: Suitable habitat (*Xanthorrhoea preissii*) is present within the site.
Mammal					
Isoodon fusciventer	Quenda	P4	-	Dense scrubby, often swampy, vegetation with dense cover up to one metre high (DEC 2012)	**Possible**: Suitable habitat (dense shrubs) is present within the site.
Reptile					
Lerista lineata	Perth slider	P3	-	Sandy coastal heath and low scrubland. Banksia spp. woodland, *Eucalyptus gomphocephala* open woodland over deep sands, and coastal dunes immediately adjacent to the beach (Wilson and Swan 2017).	**Possible**: Suitable habitat (Banksia woodland) present.
Neelaps calonotos	Black-striped snake	P3	-	Coastal and near-coastal dunes, sandplains supporting heathlands and Banksia spp. woodlands (Bush et al. 2002).	**Possible**: Suitable habitat (Banksia woodland) present.

4.4 Declared pests

One species listed as a declared pest (C3) pursuant to the BAM Act, **Trichoglossus haematodus* (rainbow lorikeet) was recorded on the site.

4.5 Black cockatoos

4.5.1 Desktop assessment

The site is located within the distribution range of Carnaby's black cockatoo and forest red-tailed black cockatoo but not within the extent of the Baudin's black cockatoo distribution range (DoEE 2016c, b, a).

The site is not located within the Carnaby's black cockatoo modelled breeding range (DoEE 2016b, a).

No breeding range information for forest red-tailed black cockatoo is provided in DoEE (2016c). However, on the Swan Coastal Plain the species is known to breed near Baldivis, Mundijong, Stake Hill, Karnup, Murdoch and possibly Perry Lakes (Johnstone *et al.* 2017).

A roost associated with white-tailed black cockatoos occurs approximately 2 km from the site and a roost site associated with both white-tailed black cockatoos and forest red-tailed black cockatoos occurs approximately 5 km north-west of the site.

The results of the black cockatoo desktop assessment are summarised in **Table 7** and shown in **Figure 6**.

Table 7: Summary of black cockatoo background review

Category		Site context	Source
Species distribution		• Site is located within the modelled distribution range of Carnaby's black cockatoo but not within its breeding range. • Site is not located within the modelled distribution range of Baudin's black cockatoo. • Site is located within the modelled distribution range of forest red-tailed black cockatoo.	(DoEE 2016a, b, c)
Carnaby's black cockatoo breeding areas (12 km radius surrounding breeding sites)		• No confirmed breeding areas intersect the site. • No possible breeding areas intersects the site.	(Glossop *et al.* 2011)
Important bird areas for Carnaby's black cockatoo		• The site is not located within an important bird area for Carnaby's black cockatoo and none occur nearby.	(DPaW 2013; BirdLife International 2022)
Roost site		• None within the site • 33 roost sites within 12 km of the site (**Table 9** and **Table 10)**: ◦ 27 associated with white-tailed^ black cockatoos only. ◦ 15 associated with forest red-tailed black cockatoos only. ◦ 9 associated with white^ and red-tailed black cockatoos.	(Peck *et al.* 2019)
Foraging habitat	Carnaby's black cockatoo	• Potential native foraging habitat is mapped within the site. • Additional areas of potential native foraging habitat mapped within the wider local area, including adjacent to the western side of the site.	(Emerge Associates 2021)

Category		Site context	Source
		• No pine plantations mapped within the site or within 12 km.	(Forest Products Commission 2020)
	Baudin's black cockatoo	• Site is not located within Baudin's black cockatoo modelled distribution range.	(Emerge Associates 2021)
	Forest red-tailed black cockatoo^	• Potential native foraging habitat is mapped within the site. • Additional areas of potential native foraging habitat mapped within the wider local area, including adjacent to the western side of the site.	(Emerge Associates 2021)

^Carnaby's and/or Baudin's black cockatoo

Table 8: White-tailed black cockatoos recorded in roosts within 12 km of the site (Peck et al. 2019)

Roost ID	Year and number of individuals									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
ARMFORR001	NS	NS	NS	0	0	18	0	0	NS	0
ARMHARR001	NS	0	0	NS	0	1	3	0	0	0
COCBANR001	NS	NS	NS	NS	NS	45	NS	0	20	0
COCBANR002	NS	NS	NS	NS	53	NS	0	0	0	0
COCBANR003	NS	NS	NS	NS	NS	NS	NS	6	16	0
COCCOOR005	NS	NS	NS	NS	NS	NS	NS	38	0	0
COCHAMR001	0	169	215	0	168	68	101	0	0	0
COCHAMR002	NS	NS	NS	NS	NS	263	194	0	369	506
COCMUNR003	NS	NS	NS	NS	NS	NS	0	0	0	3
COCSPER001	0	2	NS	323	NS	0	0	40	0	NS
COCSPER002	NS	5	0	NS	NS	0	24	0	NS	NS
GOSCNVR001	0	19	NS	NS	0	0	0	0	NS	80
GOSCNVR002	NS	NS	26	52	0	0	151	0	0	0
KWICASR001	2	NS	NS	0	19	NS	NS	0	59	0
KWIWANR001	63	0	0	1	0	0	0	0	0	NS
KWIWANR002	NS	NS	NS	0	0	0	0	5	0	0
KWIWANR004	NS	NS	NS	NS	NS	NS	NS	73	0	0
KWIWELR001	NS	NS	15	50	0	62	0	0	4	40
KWIWELR002	NS	NS	NS	NS	NS	NS	NS	NS	4	133
MELLEER001	0	0	12	0	70	0	0	0	15	2
SEROAKR001	0	110	NS	0	0	NS	NS	0	0	NS
SEROAKR002	0	0	0	2	NS	NS	NS	0	0	0

SEROAKR003	167	0	0	0	0	0	NS	NS	0	0
SEROAKR004	45	3	0	0	50	0	26	2	33	NS
SEROAKR005	31	0	NS	0	0	0	0	0	0	NS
SEROAKR007	NS	NS	NS	NS	NS	NS	NS	2	0	NS
SERWELR002	NS	NS	NS	NS	NS	NS	NS	298	75	0

NS = not surveyed

Table 9: Forest red-tailed black cockatoo recorded in roosts within 12 km of the site (Peck et al. 2019)

Roost ID	Year and number of individuals					
	2014	2015	2016	2017	2018	2019
COCBANR001	NS	0	NS	6	17	0
COCBANR002	3	NS	32	24	109	15
COCCOCR001	NS	NS	NS	NS	15	102
COCCOOR001	NS	13	0	0	8	0
COCCOOR003	NS	NS	57	6	71	33
COCMUNR001	92	NS	73	0	365	259
COCMUNR003	NS	NS	38	0	108	0
COCSPER003	NS	NS	NS	35	12	0
GOSCNVR001	2	0	0	0	NS	0
GOSCNVR002	0	4	0	0	0	0
KWICASR001	0	NS	NS	75	16	0
KWIWELR001	0	0	9	0	0	0
KWIWELR003	NS	NS	NS	NS	14	0
MELLEER001	0	0	11	25	5	0
SEROAKR002	NS	NS	NS	4	15	0

NS = not surveyed

4.5.2 Habitat

4.5.2.1 Breeding

A total of zero black cockatoo habitat trees were recorded within the site.

A summary of the habitat trees recorded within the site is provided in **Table 10**.

Table 10: Habitat trees recorded within the site

Category	No. trees
Known nesting tree	0
Suitable nesting tree	0

Potential nesting tree	0
Total	0

4.5.2.2 Roosting

No roosts or evidence of roosting were observed within the site during the survey.

No native or non-native trees were present in the site to provide potential roosting habitat for black cockatoos.

4.5.2.3 Foraging

A total of 1.56 ha of foraging habitat for Carnaby's black cockatoo was recorded in the site as shown in **Figure 6**. No foraging habitat was recorded for forest red-tailed black cockatoo.

The majority of the foraging habitat occurs as a contiguous area of banksia woodland vegetation and comprises a combination of primary, secondary and non-food plants. Dominant primary food plants are *Banksia menziesii* (firewood banksia) and *Banksia attenuata* (candle stick banksia).

The extent of foraging habitat by value category is detailed in **Table 11**.

Table 11: Foraging habitat values recorded within the site

Foraging habitat quality	Black cockatoo species and area of foraging habitat (ha)	
	Carnaby's	Forest red-tailed
Native	1.56	0
Non-native	0	0
Total	1.56	0

5 Discussion

5.1 Fauna and fauna habitat

The 12 native fauna species recorded within the site are all generally common and widespread across the Swan Coastal Plain and therefore records for these species were not unexpected. The relatively small number fauna species recorded during the survey is likely due to the size and location of the site.

Habitat values in the site are greatest with respect to areas of **banksia woodland** habitat, which covers approximately 83.87% of the site. This habitat provides a contiguous cover of predominantly native shrubs that provides value to many common and conservation significant fauna species.

The remainder of the site (approximately 16.13%) comprises cleared area which contains no to minimal vegetation and may be used occasionally by common and widespread native and non-native fauna species.

5.2 Conservation significant fauna

Carnaby's black cockatoo was recorded within the site and forest red-tailed black cockatoo is considered possibly to occur within the site. Both species are discussed further in **Section 5.3**.

An additional nine fauna species of conservation significance were considered to possibly occur in the site.

Pacific swift and peregrine falcon are highly mobile species that may opportunistically fly over or forage in the site for short periods of time as part of a much larger home range. Neither of these species would breed within the site. Any occurrence of Pacific swift and peregrine falcon in the site would likely be in the air space and largely independent from terrestrial habitat.

Quenda are small ground dwelling marsupials that prefer dense shrubland vegetation. Suitable habitat is found within the banksia woodland habitat within the site. However, the site is only large enough to accommodate a small number of individuals that would likely also use areas of suitable habitat available outside the site.

The Perth slider and black-striped snake are both found in Banksia woodland on sandy soils which occur in the site. Likewise the Swan Coastal Plain shield-backed trapdoor spider prefers sandy soils. While there are no records of these species in the immediate area, it is possible that these species occur within the site given the suitable habitat.

The remaining possible conservation significant Invertebrates (graceful sun moth, *Leioproctus contrarius* (a short-tongued bee) and stylet bush cricket) have all been recorded on plants that are found within the site. However, these are mobile species and with the small relative size of the site, impacts would likely be minimal.

5.3 Black cockatoo habitat values

Carnaby's black cockatoo was recorded flying over the site. Records for this species were not unexpected as the site is located within its modelled distribution range and suitable habitat occurs within the site and the local area.

Although not recorded within the field survey, forest red-tailed black cockatoo is possible to occur within the site as it lies within the species modelled distribution range and records of this species are known from the local area. However, the site contains no suitable foraging or breeding habitat so any sightings would likely be in the air space and independent from terrestrial habitat.

The site is located outside of the modelled distribution range of Baudin's black cockatoo (DoEE 2016b) and while short incidental occurrences are possible, it is considered unlikely that the species would occur in the site.

5.3.1 Breeding

As no habitat trees were recorded, the site does not currently provide breeding habitat for black cockatoos. The small number of eucalypts within the site have the potential to form suitable hollows in the future. However, it will take many decades for hollows to form that are large enough to be suitable for use by black cockatoos for breeding.

5.3.2 Roosting

No large trees associated with black cockatoo roosting were observed within the site. This was supported by the lack of secondary evidence of roosting such as branch clippings, droppings or feathers. Therefore, there is no reason to suspect that roosting by black cockatoos occurs in the site.

5.3.3 Foraging

The site contains native foraging habitat for Carnaby's black cockatoo but not for forest red-tailed black cockatoo. This foraging habitat is associated with the banksia trees within the site which is a primary foraging source for Carnaby's black cockatoo. While not insignificant in size, the foraging habitat mapped is a relatively small resource in comparison to extensive areas of similar value foraging resource that occur adjacent to site and in the wider local area particularly west in the Thompson Lake and Harry Waring reserves.

6 Conclusions

6.1 Fauna and fauna habitat

The majority of the site (83.87%) supports **banksia woodland** habitat which provides high value to some fauna species of conservation significance and also many common native and non-native species. The remainder of the site comprises cleared areas (16.13%) with little habitat value.

A total of 12 native fauna species were recorded within the site, including one species of conservation significance, Carnaby's black cockatoo (endangered).

While not recorded during the field survey, forest red-tailed black cockatoo (listed as vulnerable) could possibly occur in the site. Nine other species of conservation significance not recorded during the field survey may possibly occur in the site: Pacific swift, peregrine falcon, quenda, Perth slider, black-striped snake, Swan Coastal Plain shield-backed trapdoor spider, graceful sun moth, stylet bush cricket and *Leioproctus contrarius* (a short tongued bee).

6.2 Black cockatoos

The site occurs within the modelled distribution of Carnaby's black cockatoo and forest red-tailed black cockatoo but outside of the modelled distribution of Baudin's black cockatoo. Carnaby's black cockatoo was recorded in the site during the field survey and forest red-tailed black cockatoo is possible to occur.

The site contains no habitat trees. Therefore, the site does currently not provide breeding habitat for any species of black cockatoo.

No roosts or evidence of roosting by any species of black cockatoo was recorded within the site during the field survey. No large trees associated with black cockatoo roosting occur within the site.

A total of 1.56 ha of foraging habitat for Carnaby's black cockatoo was mapped within the site of which all is native vegetation.

No foraging habitat suitable for forest red-tailed black cockatoo was mapped within the site.

Additional areas of foraging habitat of similar or higher value occur adjacent to the site and in the wider local area.

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7.2 Online references

The online resources that have been utilised in the preparation of this report are referenced in **Section 7.1**, with access date information provided in **Table R 1**.

Table R 1 Access dates for online references

Reference	Date accessed	Website or dataset name
Atlas of Living Australia (2023)	6 January 2023	The Atlas of Living Australia's Spatial Portal
BirdLife International (2023)	6 January 2023	Important Bird Areas
BoM (2023)	4 January 2023	Climate Data Online
DAWE (2023)	4 January 2023	Protected Matters Search Tool
DBCA (2023)	4 January 2023	NatureMap
WALIA (2023)	4 January 2023	Landgate Map Viewer

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Figures

Figure 1: Site Location

Figure 2: Soils and Wetlands

Figure 3: Fauna Habitat

Figure 4: Black Cockatoo Habitat Context

Figure 5: Carnaby's Black Cockatoo Foraging Habitat



Figure 1: Site Location

Project: Basic and Targeted Fauna Assessment
Lot 16 Barfield Road Environmental Support
Client: Richard Noble

Plan Number:
EP22-099(02)--F16

Drawn:	WJC
Date:	06/01/2023
Checked:	NAW
Approved:	TAA
Date:	09/01/2023

N

0 25 50
Metres

Scale: 1:1,250@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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Figure 2: Soils and Topography

Project: Basic and Targeted Fauna Assessment
Lot 16 Barfield Road Environmental Support

Client: Richard Noble

Plan Number:
EP22-099(02)--F17

Drawn:	WJC
Date:	06/01/2023
Checked:	NAW
Approved:	TAA
Date:	09/01/2023

N

0 25 50
Metres

Scale: 1:1,250@A4

GDA 1994 MGA Zone 50

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Figure 3: Fauna Habitat

Project:	Basic and Targeted Fauna Assessment Lot 16 Barfield Road Environmental Support
Client:	Richard Noble

Plan Number:
EP22-099(02)--F18

Drawn:	WJC
Date:	06/01/2023
Checked:	NAW
Approved:	TAA
Date:	09/01/2023

N

0 25 50
Metres

Scale: 1:1,250@A4

GDA 1994 MGA Zone 50

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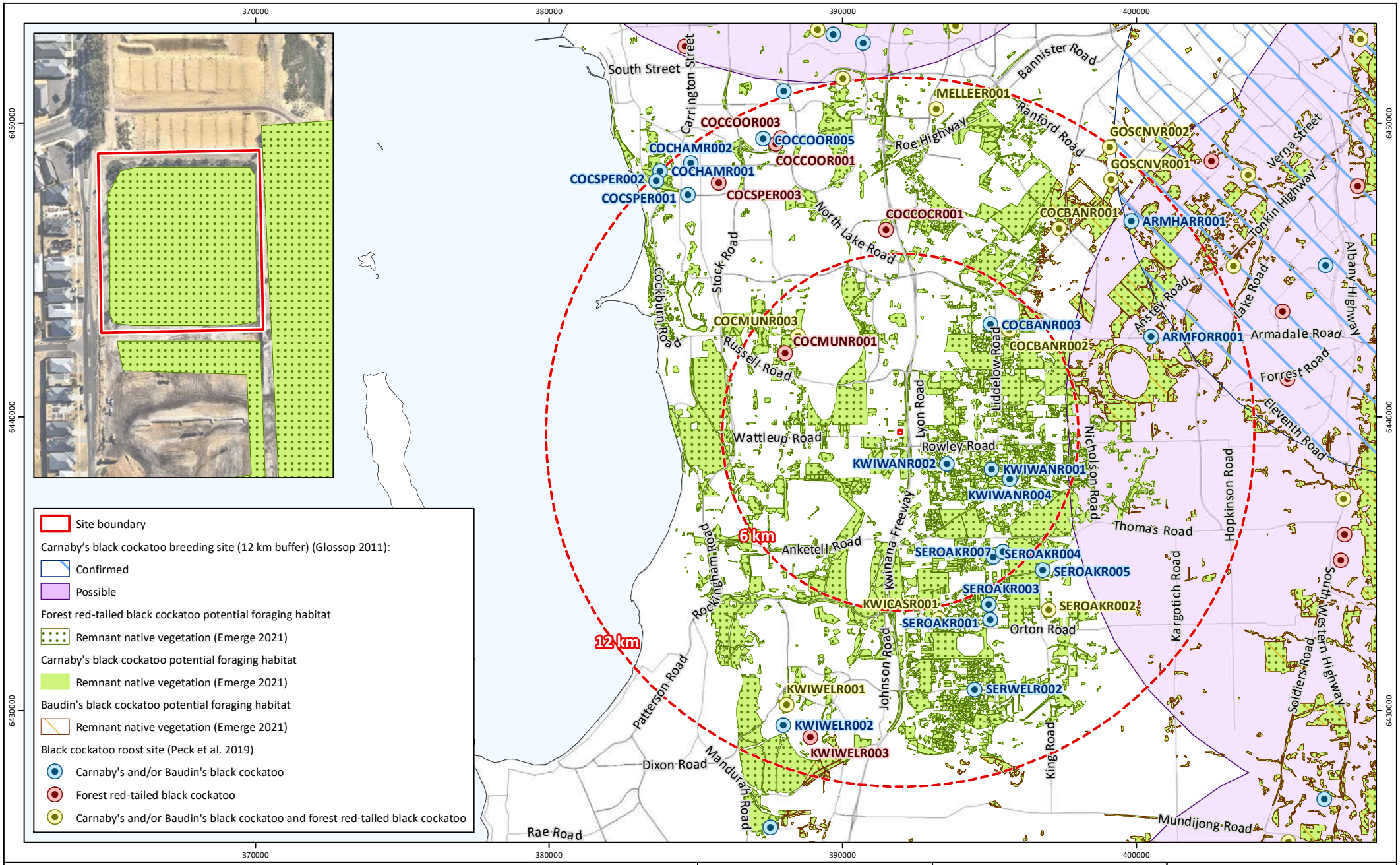


Figure 4: Black Cockatoo Habitat Context

Project:	Basic and Targeted Fauna Assessment Lot 16 Barfield Road Environmental Support
Client:	Richard Noble

Plan Number:
EP22-099(02)--F19

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Date:	06/01/2023
Checked:	NAW
Approved:	TAA
Date:	09/01/2023

N

0 2 4 6
Kilometers

Scale: 1:170,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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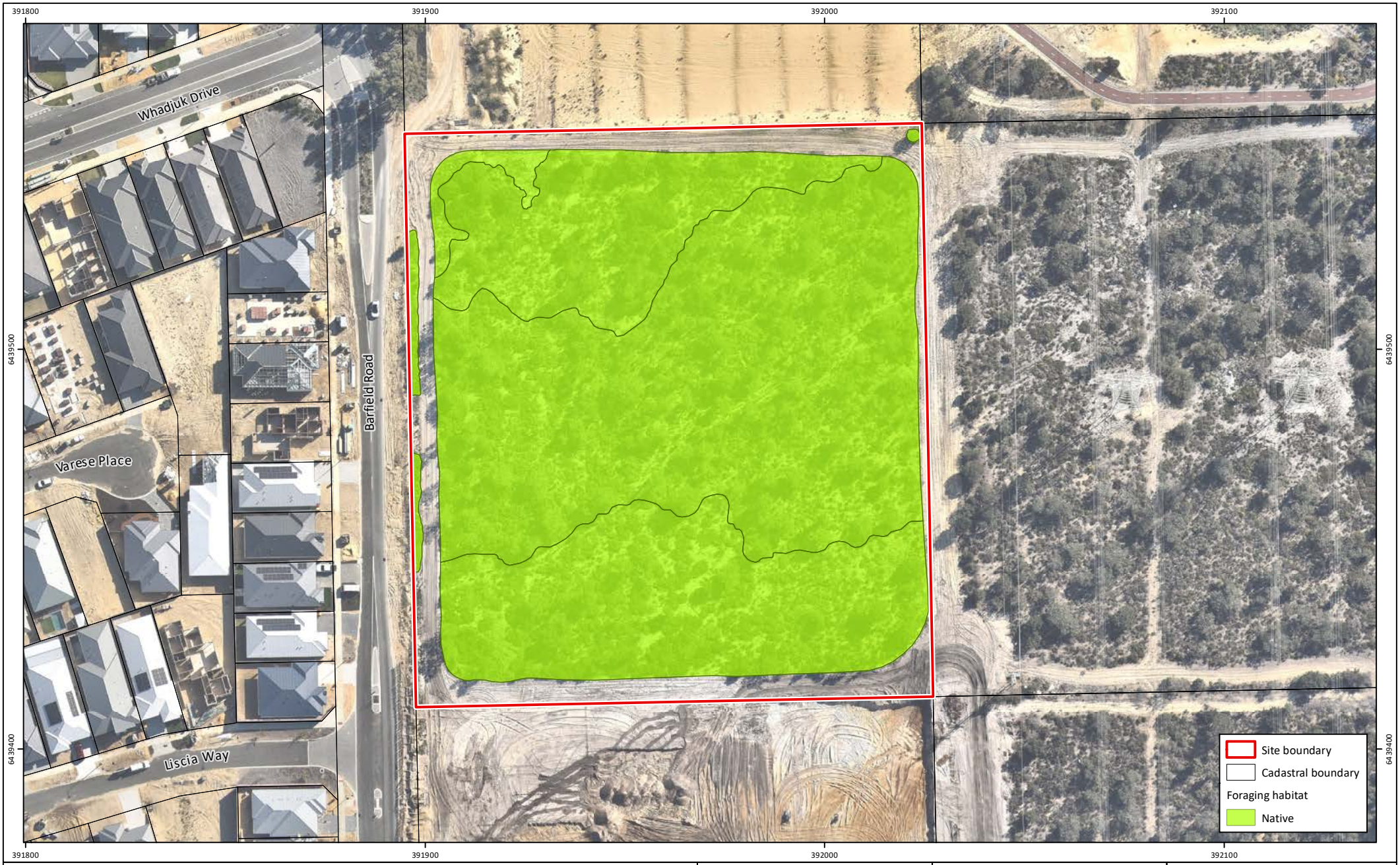


Figure 5: Carnaby's Cockatoo Foraging Habitat

Project:	Basic and Targeted Fauna Assessment Lot 16 Barfield Road Environmental Support
Client:	Richard Noble

Plan Number:
EP22-099(02)--F20

Drawn:	WJC
Date:	06/01/2023
Checked:	NAW
Approved:	TAA
Date:	09/01/2023

N

0 25 50
Metres

Scale: 1:1,250@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
©Landgate (2022). Nearmap Imagery date: 30/08/2022

Appendix A

Additional Information

Conservation Significant Fauna

Threatened and priority fauna

Fauna species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, fauna species can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as 'threatened', 'migratory' or 'marine' as described in **Table 1**.

Migratory species comprise birds recognised under international treaties including:

- *Japan Australia Migratory Bird Agreement 1981* (JAMBA)
- *China Australia Migratory Bird Agreement 1998* (CAMBA)
- *Republic of Korea-Australia Migratory Bird Agreement 2007* (ROKAMBA)
- *Bonn Convention 1979* (The Convention on the Conservation of Migratory Species of Wild Animals).

Fauna species listed as threatened and migratory are protected in Australia as 'matters of national environmental significance' (MNES) under the EPBC Act.

Table 1: Definitions of conservation significant fauna species pursuant to the EPBC Act

Conservation Code	Category
X	Threatened Fauna –Extinct There is no reasonable doubt that the last member of the species has died.
EW#	Threatened Fauna –Extinct in the Wild Taxa which are known only to survive in cultivation, captivity or as a naturalised population outside its past range, or taxa which have not been recorded in its known and/or expected habitat despite appropriate exhaustive surveys.
CR#	Threatened Fauna – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN#	Threatened Fauna – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU#	Threatened Fauna – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
Migratory#	Migratory Fauna All migratory species that are: (i) native species; and (ii) from time to time included in the appendices to the Bonn Convention; and (b) all migratory species from time to time included in annexes established under JAMBA, CAMBA and ROKAMBA; and All native species from time to time identified in a list established under, or an instrument made under, an international agreement approved by the Minister.
Ma	Marine Fauna Species in the list established under s248 of the EPBC Act

#matters of national environmental significance (MNES) under the EPBC Act

In Western Australia, fauna taxa may be classed as 'threatened', 'extinct', or 'specially protected' under the *Biodiversity Conservation Act 2016* (BC Act), which is enforced by Department of Biodiversity Conservation and Attractions (DBCA) (DBCA 2019a). The definitions of these categories are provided in **Table 2**.

Table 2: Definitions of specially protected fauna schedules under the BC Act (DBCA 2019a)

Category	Conservation Code	Definition
Threatened	CR	Critically endangered Threatened species considered to be facing an extremely high risk of extinction in the wild in the immediate future.
	EN	Endangered Threatened species considered to be facing a very high risk of extinction in the wild in the near future.
	VU	Vulnerable Threatened species considered to be facing a high risk of extinction in the wild in the medium-term future.
Extinct	EX	Extinct Species where there is no reasonable doubt that the last member of the species has died.
	EW	Extinct in the wild Species that is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form. Note that no species are currently listed as EW.
Specially protected	MI	Migratory species Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth Includes birds that subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds.
	CD	Species of special conservation interest (conservation dependent fauna) Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
	OS	Other specially protected species Fauna otherwise in need of special protection to ensure their conservation.

Fauna species that may be threatened or near threatened but lack sufficient information to be legislatively listed may be added to the DBCA's *Priority Fauna List* (DBCA 2018b). Species listed under priorities 1-3 comprise possible threatened species that do not meet survey criteria or are otherwise data deficient. Species listed under priority 4 are those that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons (DBCA 2019a).

Priority fauna species are considered during State approval processes. Priority fauna categories and definitions are listed in **Table 3** (DBCA 2019a).

Table 3: Definitions of priority fauna categories on DBCA's Priority Fauna List (DBCA 2019a)

Conservation Code	Category
P1	Priority 1 – Poorly known Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2	Priority 2 – Poorly known Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3	Priority 3 – Poorly known Species that are known from several locations and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4	(a) Priority 4 – Rare species Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. (b) Priority 4 – Near Threatened Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Priority 4 – Other Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Black cockatoos

Three threatened species of black cockatoo occur on the Swan Coastal Plain (referred to herein collectively as 'black cockatoos'):

- *Zanda*[1] *latirostris* (Carnaby's black cockatoo) which is listed as 'endangered' under the EPBC Act and the BC Act.
- *Zanda*[1] *baudinii* (Baudin's black cockatoo) which is listed as 'endangered' under the EPBC Act and the BC Act.
- *Calyptorhynchus banksii naso* (forest red-tailed black cockatoo) which is listed as 'vulnerable' under the EPBC Act and the BC Act.

There are a range of regional studies and spatial datasets available which provide information on black cockatoo records and potential habitat mapping. These are detailed below.

Species distribution and breeding range

Broad-scale maps are available for the modelled distribution of Baudin's black cockatoo, Carnaby's black cockatoo and forest red-tailed black cockatoo (DSEWPaC 2011; DoEE 2016a, b).

The modelled distribution maps also include 'known breeding areas' and 'predicted breeding range' for Baudin's black cockatoo and 'breeding range' and 'non-breeding range' for Carnaby's black cockatoo.

No breeding range modelling is available for forest red-tailed black cockatoo but the species is known to breed mainly in the jarrah forest region (DBCA 2017a) and in small populations on the Swan Coastal Plain within the Baldivis, Stake Hill, Lake McLarty and Capel area and increasingly in the Perth metropolitan area (DAWE 2020).

Breeding habitat

Department of Environment and Conservation (DEC, now Department of Biodiversity, Conservation and Attractions (DBCA)) and fauna experts, have identified and mapped Carnaby's black cockatoo habitat on the Swan Coastal Plain and Jarrah Forest regions (Glossop *et al.* 2011). This dataset includes mapping of Carnaby's black cockatoo breeding sites based on point records of breeding from a range of sources. Breeding sites were classified as 'confirmed' where eggs or chicks were recorded and 'possible' where observations relating to Carnaby's black cockatoo breeding that did not include actual records of eggs or chicks (e.g. chewed hollows or records of breeding or nesting behaviour by an expert observer).

A 12 km buffer applies to each site to 'reflect the flexible use of these areas by cockatoos and to indicate the important zone for access to potential feeding habitat' (Glossop *et al.* 2011). Glossop *et al.* (2011) state that the areas mapped in the dataset are not a comprehensive record of Carnaby's black cockatoo breeding and that many nesting sites are not known.

While this dataset only applies to Carnaby's black cockatoo, the information it contains is also applicable for Baudin's black cockatoo and forest red-tailed black cockatoo as they have similar

[1] Previously *Calyptorhynchus*

breeding habitat requirements. That is, breeding sites that are suitable for Carnaby's black cockatoo may also be suitable for Baudin's black cockatoo and forest red-tailed black cockatoo, if located within their distribution/breeding ranges.

BirdLife Australia also maintain a database of confirmed black cockatoo breeding sites which is accessible via a paid search system. BirdLife Australia have advised that their database is comprised of data collected during surveys by staff and volunteers of which most (>99%) surveys are of Carnaby's black cockatoo. They have also advised that the dataset is not comprehensive and that an absence of known nests does not necessarily indicate a lack of breeding activity.

The Carnaby's black cockatoo recovery plan also identifies 13 'important bird areas' for Carnaby's black cockatoo, which are identified as 'sites of global bird conservation importance' (DPaW 2013). These 'important bird areas' comprise sites supporting at least 20 breeding pairs or 1% of the population regularly utilising an area in the non-breeding part of the range.

Confirmed roost sites

BirdLife Australia undertakes annual monitoring of black cockatoo overnight roost sites as part of the annual 'Great Cocky Count' community-based survey. Information gathered from these monitoring events provides roost locations and recorded black cockatoo numbers (Peck *et al.* 2019).

Native foraging habitat

Glossop et al. (2011) also mapped 'areas requiring investigation as Carnaby's black cockatoo feeding habitat' for the Swan Coastal Plain and Jarrah Forest regions, based on regional vegetation mapping that may contain plant species known to be foraged upon by Carnaby's black cockatoo. Note that this dataset does not include observations or point records of Carnaby's black cockatoo feeding. This dataset represents areas of vegetation that may potentially provide foraging habitat for Carnaby's black cockatoo.

In order to account for clearing of native vegetation that has occurred since the Glossop et al. (2011) dataset was created and to incorporate updated vegetation mapping and information on foraging behaviour of Carnaby's black cockatoo, Emerge have revised this dataset to represent the most up to date information available. Furthermore, Emerge have used a similar methodology to Glossop et al. (2011) to define potential foraging habitat for Baudin's black cockatoo and forest-red tailed cockatoos.

Specifically, DBCA (2021), DBCA (2019b) and DPIRD (2018) regional vegetation complex mapping was used to determine which areas of remnant vegetation support plant species known to be foraged upon by Carnaby's black cockatoo, Baudin's black cockatoo or forest red-tailed cockatoos. Where these vegetation complexes intersect remnant vegetation mapped by DPIRD (2020) they were considered to represent potential foraging habitat for Carnaby's black cockatoo, Baudin's black cockatoo and/or forest red-tailed cockatoo.

Pine plantations also provide an important food source for Carnaby's black cockatoo, but were not included in the original Glossop et al. (2011) dataset. Mapping of pine plantations is available from the Forest Products Commission (Forest Products Commission 2020) and was considered in the assessment of Carnaby's black cockatoo foraging habitat.

Pest fauna

A number of legislative and policy documents exist in relation to pest fauna management at state and national levels. The *Biosecurity and Agriculture Management Act 2007* (BAM Act) is the principle legislation guiding pest fauna management in Western Australia and lists declared pest species.

Declared Pests

Part 2.3.23 of the BAM Act requires a person must not; "*a) keep, breed or cultivate the declared pest; b) keep, breed or cultivate an animal, plant or other thing that is infected or infested with the declared pest; c) release into the environment the declared pest, or an animal, plant or other thing that is infected or infested with the declared pest; or d) intentionally infect or infest, or expose to infection or infestation, a plant, animal or other thing with a declared pest*".

Under the BAM Act, all declared pests are assigned a legal status, as described in **Table 4**. Species assigned to the 'declared pest, prohibited - s12' category are placed in one of three control categories, as described in **Table 5**.

The *Biosecurity and Agriculture Management Regulations 2013* specify keeping categories for species assigned to the 'declared pest - s22(2)' category, which relate to the purposes of which species can be kept, as well as the entities that can keep them. The categories are described in **Table 6**.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act (DAFWA 2016).

Table 4: Legal status of declared pest species listed under the BAM Act (DAFWA 2016)

Category	Description
Declared Pest Prohibited - s12	May only be imported and kept subject to permits. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions.
Declared Pest s22(2)	Must satisfy any applicable import requirements when imported, and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia

Table 5: Control categories of declared pest species listed under the BAM Act (DAFWA 2016)

Category	Description
C1	Exclusion Not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2	Eradication Present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3	Management Established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Table 6: Keeping categories of declared pest species listed under the BAM Act (DAFWA 2016)

Category	Description
Prohibited	Can only be kept under a permit for public display and education purposes, and/or genuine scientific research, by entities approved by the state authority.
Exempt	No permit or conditions are required for keeping.
Restricted	Organisms which, relative to other species, have a low risk of becoming a problem for the environment, primary industry or public safety and can be kept under a permit by private individuals.

Wetland Habitat

Geomorphic wetland types

On the Swan Coastal Plain DBCA (2017b) have used the geomorphic wetland classification system developed by Semeniuk (1987) and Semeniuk and Semeniuk (1995) to classify wetlands based on the landform shape and water permanence (hydro-period) as outlined in **Table 7**. DBCA maintains a dataset of the *Geomorphic Wetlands of the Swan Coastal Plain* (DBCA 2018a).

Table 7: Geomorphic Wetlands of the Swan Coastal Plain classification categories (DBCA 2017b)

Level of inundation	Geomorphology			
	Basin	Flat	Channel	Slope
Permanently inundated	Lake	-	River	-
Seasonally inundated	Sumpland	Floodplain	Creek	-
Seasonally waterlogged	Dampland	Palusplain	-	Paluslope

Literature

The main literature used for identifying fauna and fauna habitats is listed in **Table 8** below.

Table 8: Standard literature used for identifying fauna species and habitats.

Conservation Code	Category
Birds	Johnstone and Storr (1998b), Johnstone and Storr (1998a), Pizzey and Knight (2012), Slater *et al.* (2003)
Mammals	Menkhorst and Knight (2011), Triggs (2003)
Amphibia	Tyler and Doughty (2009), Bush *et al.* (2002)
Reptiles	Bush *et al.* (2002)

References

General references

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Appendix B

Database Search Results

Category	Status	Taxon
AMPHIBIAN		Crinia georgiana
		Crinia glauerti
		Crinia insignifera
		Heleioporus eyrei
		Heleioporus sp.
		Limnodynastes dorsalis
		Litoria adelaidensis
		Litoria adelaidensis (Slender Tree Frog)
		Litoria moorei
		Litoria moorei (Motorbike Frog)
		Litoria sp.
		Myobatrachus gouldii
		Pseudophryne guentheri
BIRD		Acanthiza apicalis
		Acanthiza chrysorrhoa
		Acanthiza inornata
		Acanthorhynchus superciliosus
		Accipiter cirrocephalus
		Accipiter fasciatus
		Accipiter fasciatus subsp. fasciatus
		Acrocephalus australis
		Acrocephalus australis subsp. gouldi
	MI	Actitis hypoleucos
		Anas castanea
		Anas gracilis
		Anas platyrhynchos
		Anas platyrhynchos subsp. domesticus
		Anas rhynchotis
		Anas superciliosa
		Anhinga melanogaster
		Anhinga novaehollandiae
		Anser anser
		Anthochaera carunculata
		Anthochaera lunulata
	MI	Apus pacificus
		Aquila audax
		Aquila morphnoides
		Aquila morphnoides subsp. morphnoides
		Ardea alba subsp. modesta
		Ardea garzetta subsp. nigripes
		Ardea ibis
		Ardea intermedia
		Ardea modesta
		Ardea novaehollandiae
		Ardea pacifica
	MI	Arenaria interpres
		Artamus cinereus
		Artamus cinereus subsp. melanops

Category	Status	Taxon
		Artamus cyanopterus
		Aythya australis
		Barnardius zonarius
		Biziura lobata
	EN	Botaurus poiciloptilus
		Cacatua galerita
		Cacatua pastinator
		Cacatua roseicapilla
		Cacatua sanguinea
		Cacatua tenuirostris
		Cacomantis flabelliformis
		Cacomantis pallidus
	MI	Calidris acuminata
	MI	Calidris alba (Crocethia alba)
	EN	Calidris canutus
	CR	Calidris ferruginea
	MI	Calidris melanotos
		Calidris minuta
	MI	Calidris ruficollis
	MI	Calidris subminuta
	CR	Calidris tenuirostris
	VU	Calyptorhynchus banksii subsp. naso
	MI	Charadrius dubius
	VU	Charadrius leschenaultii
		Charadrius melanops
		Charadrius ruficapillus
		Chenonetta jubata
		Cheramoeca leucosterna
		Cheramoeca leucosternus
	MI	Chlidonias leucopterus
		Chroicocephalus novaehollandiae
		Chrysococcyx basalis
		Chrysococcyx lucidus
		Cincloramphus cruralis
		Cincloramphus mathewsi
		Circus approximans
		Circus assimilis
		Cladorhynchus leucocephalus
		Colluricincla harmonica
		Columba livia
		Coracina novaehollandiae
		Corvus bennetti
		Corvus coronoides
		Corvus coronoides subsp. perplexus
		Coturnix pectoralis
		Coturnix ypsilophora
		Coturnix ypsilophora subsp. australis
		Cracticus nigrogularis

Category	Status	Taxon
		Cracticus tibicen
		Cracticus tibicen subsp. dorsalis
		Cracticus torquatus
		Cygnus atratus
		Cygnus olor
		Dacelo novaeguinea
		Dacelo novaeguineae
		Daphoenositta chrysoptera
		Daption capense
		Dicaeum hirundinaceum
		Egretta garzetta
		Egretta novaehollandiae
		Egretta sacra
		Elanus axillaris
		Elanus caeruleus
		Elseyornis melanops
		Eolophus roseicapillus
		Eopsaltria georgiana
		Epthianura albifrons
		Erythrogonys cinctus
		Eurostopodus argus
		Falco berigora
		Falco cenchroides
		Falco longipennis
	OS	Falco peregrinus
		Fulica atra
		Fulica atra subsp. australis
	MI	Gallinago hardwickii
		Gallinula tenebrosa
		Gallinula tenebrosa subsp. tenebrosa
		Gallinula ventralis
		Gallirallus philippensis
		Gavicalis virescens
	MI	Gelochelidon nilotica
		Geopelia cuneata
		Gerygone fusca
		Gerygone fusca subsp. fusca
		Glossopsitta porphyrocephala
		Glyciphila melanops
		Grallina cyanoleuca
		Haematopus fuliginosus
		Haematopus longirostris
		Haliaeetus leucogaster
		Haliastur sphenurus
		Hieraaetus morphnoides
		Himantopus himantopus
		Himantopus himantopus subsp. leucocephalus
		Hirundo neoxena

Category	Status	Taxon
		Hirundo nigricans
	MI	Hydroprogne caspia
	P4	Ixobrychus dubius
		Lalage tricolor
		Larus novaehollandiae subsp. novaehollandiae
		Lichenostomus ornatus
		Lichenostomus virescens
		Lichmera indistincta
		Lichmera indistincta subsp. indistincta
	MI	Limosa limosa
		Lonchura castaneothorax
		Lophoictinia isura
	MI	Macronectes giganteus
		Malacorhynchus membranaceus
		Malurus elegans
		Malurus lamberti
		Malurus splendens
		Malurus splendens subsp. splendens
		Manorina flavigula
		Megalurus gramineus
		Melanodryas cucullata
		Melithreptus brevirostris
		Melithreptus chloropsis
		Melithreptus lunatus
		Melopsittacus undulatus
		Merops ornatus
		Microcarbo melanoleucos
		Microeca fascinans
		Milvus migrans
		Morus serrator
		Myiagra inquieta
		Neophema elegans
		Neophema petrophila
		Ninox connivens
		Ninox novaeseelandiae
		Ninox novaeseelandiae subsp. boobook
		Nycticorax caledonicus
		Nymphicus hollandicus
		Ocyphaps lophotes
	P4	Oxyura australis
		Pachycephala pectoralis
		Pachycephala rufiventris
	MI	Pandion haliaetus
		Pandion haliaetus subsp. cristatus
		Pardalotus punctatus
		Pardalotus punctatus subsp. xanthopyge
		Pardalotus striatus
		Passer montanus

Category	Status	Taxon
		Pelecanus conspicillatus
		Petrochelidon ariel
		Petrochelidon nigricans
		Petroica boodang
		Petroica goodenovii
	MI & P4	Phaethon rubricauda
		Phalacrocorax carbo
		Phalacrocorax fuscescens
		Phalacrocorax melanoleucos
		Phalacrocorax sulcirostris
		Phalacrocorax varius
		Phaps chalcoptera
		Phaps elegans
	MI	Philomachus pugnax
		Phylidonyris niger
		Phylidonyris nigra
		Phylidonyris novaehollandiae
		Phylidonyris novaehollandidae
		Platalea flavipes
		Platalea regia
		Platycercus icterotis
		Platycercus spurius
		Platycercus zonarius
		Platycercus zonarius subsp. semitorquatus
	MI	Plegadis falcinellus
	MI	Pluvialis fulva
	MI	Pluvialis squatarola
		Podargus strigoides
		Podiceps cristatus
		Poliocephalus poliocephalus
		Polytelis anthopeplus
		Porphyrio porphyrio
		Porphyrio porphyrio subsp. bellus
		Porzana fluminea
		Porzana pusilla
		Porzana pusilla subsp. palustris
		Porzana tabuensis
		Psittacula krameri
		Purpureicephalus spurius
		Recurvirostra novaehollandiae
		Rhipidura albiscapa
		Rhipidura fuliginosa
		Rhipidura fuliginosa subsp. alisteri
		Rhipidura leucophrys
	EN	Rostratula australis
		Sericornis frontalis
		Smicrornis brevirostris
	MI	Stercorarius longicaudus

Category	Status	Taxon
		Sterna hybrida subsp. javanica
		Sternula nereis
		Stictonetta naevosa
		Strepera versicolor
		Streptopelia chinensis
		Streptopelia senegalensis
		Streptopelia senegalensis subsp. senegalensis
		Sugomel niger
		Tachybaptus novaehollandiae
		Tachybaptus novaehollandiae subsp. novaehollandiae
		Tadorna radjah
		Tadorna tadornoides
	MI	Thalasseus bergii
	P4	Thinornis rubricollis
		Threskiornis molucca
		Threskiornis spinicollis
		Todiramphus sanctus
		Todiramphus sanctus subsp. sanctus
		Tribonyx ventralis
		Trichoglossus haematodus
	MI & P4	Tringa brevipes
	MI	Tringa glareola
		Tringa hypoleucos
	MI	Tringa nebularia
	MI	Tringa stagnatilis
		Turnix varia
		Turnix varius
		Turnix velox
		Tyto alba subsp. delicatula
	P3	Tyto novaehollandiae subsp. novaehollandiae
		Vanellus miles
		Vanellus tricolor
	MI	Xenus cinereus
	EN	Zanda baudinii
	EN	Zanda latirostris
FISH		Zosterops lateralis
		Afurcagobius suppositus
INVERTEBRATE		Pterygotrigla polyommata
		Afraflacilla huntorum
		Allothereua maculata
		Aname mainae
		Aname tepperi
		Antichiropus variabilis
		Arachnura higginsi
		Araneus cyphoxis
		Araneus eburneiventris
		Araneus senicaudatus
		Argiope protensa

Category	Status	Taxon
		Artema atlanta
		Artoria flavimana
		Artoria linnaei
		Artoria taeniifera
		Artoriopsis expolita
		Austracantha minax
		Backobourkia brounii
		Backobourkia heroine
		Badumna insignis
		Ballarra longipalpus
		Bianor maculatus
		Cercophonius sulcatus
		Cherax cainii
		Cherax destructor
		Cherax preissii
		Cherax quinquecarinatus
		Cherax sp.
		Clynotis albobarbatus
		Cormocephalus aurantiipes
		Cormocephalus novaehollandiae
		Cormocephalus rubriceps
		Crustulina bicruciata
		Cryptoerithus quobba
		Cyclosa trilobata
		Cyrtophora parnasia
		Daphnia carinata
		Dingosa serrata
		earthworm sp.
		Eodelena convexa
		Eriophora biapicata
		Erythracarus decoris
		Hasarius adansoni
		Heurodes turritus
		Hogna crispipes
		Holasteron perth
		Holoplatys dejongi
		Idiommata blackwalli
	P3	Idiosoma sigillatum
		Isopeda leishmanni
		Kangarosa properipes
		Lampona cylindrata
		Latrodectus hasseltii
	P3	Leioproctus contrarius
	EN	Leioproctus douglasiellus
		Longepi woodman
		Lycosa ariadnae
		Lycosa australicola
		Lycosa gilberta

Category	Status	Taxon
		Maratus mungaich
		Maratus pavonis
		Missulena granulosa
		Missulena occatoria
		Mituliodon tarantulinus
		Mitzoruga insularis
		Nanometa gentilis
	EN	Neopasiphae simplicior
		Nephila edulis
		Nicodamus mainae
		Ocrisiona parmeliae
		Ommatoiulus moreletii
		Phenasteron longiconductor
		Phryganoporus candidus
		Pinkfloydia harveii
		Podykipus collinus
		Prionosternum scutatum
		Raveniella cirrata
		Raveniella peckorum
		Scolopendra laeta
		Servaea melaina
		Servaea spinibarbis
		Simaetha tenuior
		Smeringopus natalensis
		Steatoda capensis
		Steatoda grossa
		Supunna funerea
		Supunna picta
	P4	Synemon gratiosa
		Synothele michaelseni
		Tamopsis distinguenda
		Tamopsis perthensis
		Tetragnatha valida
	P1	Throscodectes xiphos
		Tinytrema yarra
		Urodacus novaehollandiae
		Venator immansueta
		Venatrix pullastra
	VU	Westralunio carteri
MAMMAL		Zebraplatys fractivittata
		Austronomus australis
		Chalinolobus gouldii
		Chalinolobus morio
	VU	Dasyurus geoffroii
	P4	Falsistrellus mackenziei
		Felis catus
	P4	Hydromys chrysogaster
	P4	Isoodon fusciventer

Category	Status	Taxon
		Macropus fuliginosus
		Macropus irma
		Mus musculus
	EN	Myrmecobius fasciatus
	P4	Notamacropus eugenii subsp. derbianus
	P4	Notamacropus irma
		Nyctophilus geoffroyi
		Nyctophilus major
		Nyctophilus major major
		Nyctophilus timoriensis
		Nyctophilus timoriensis subsp. timoriensis
		Oryctolagus cuniculus
		Ozimops kitcheneri
	VU	Perameles bougainville
		Phascogale tapoatafa subsp. tapoatafa
		Rattus fuscipes
		Rattus rattus
		Rattus sp.
	VU	Setonix brachyurus
		Sus scrofa
		Tachyglossus aculeatus
		Tarsipes rostratus
		Trichosurus vulpecula
		Trichosurus vulpecula subsp. vulpecula
		Tursiops truncatus
		Vespadelus regulus
REPTILE		Vulpes vulpes
		Acritoscincus trilineata
		Acritoscincus trilineatum
		Acritoscincus trilineatus
		Anilios australis
		Aprasia repens
		Brachyurophis semifasciatus
	EN	Caretta caretta
		Chelodina colliei
		Chelodina oblonga
		Christinus marmoratus
		Cryptoblepharus buchananii
		Cryptoblepharus plagiocephalus
		Cryptoblepharus sp.
		Ctenophorus adelaidensis
		Ctenotus australis
		Ctenotus fallens
		Ctenotus gemmula
		Delma fraseri
		Delma grayii
		Delma sp.
		Demansia psammophis subsp. reticulata

Category	Status	Taxon
	VU	Dermochelys coriacea
		Egernia kingii
		Egernia napoleonis
		Elapognathus coronatus
		Gehyra variegata
		Hemiergis quadrilineata
		Heteronotia binoei
		Hydrophis elegans
		Hydrophis ornatus
		Hydrophis platurus
		Lerista christinae
		Lerista distinguenda
		Lerista elegans
	P3	Lerista lineata
		Lialis burtonis
		Menetia greyii
		Menetia sp.
		Morethia lineoocellata
		Morethia obscura
		Neelaps bimaculatus
	P3	Neelaps calonotos
		Notechis scutatus
		Parasuta gouldii
		Pletholax gracilis
		Pletholax gracilis subsp. gracilis
		Pogona minima
		Pogona minor
	VU	Pogona minor subsp. minima
		Pogona minor subsp. minor
		Pseudonaja affinis
		Pseudonaja affinis subsp. affinis
	P4	Pseudonaja affinis subsp. exilis
		Pseudonaja mengdeni
		Pygopus lepidopodus
		Ramphotyphlops australis
		Simoselaps bertholdi
		Simoselaps littoralis
		Strophurus spinigerus subsp. spinigerus
		Tiliqua occipitalis
		Tiliqua rugosa
		Tiliqua rugosa rugosa
		Tiliqua rugosa subsp. aspera
		Tiliqua rugosa subsp. rugosa
		Varanus gouldii
		Varanus rosenbergi

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 01-Nov-2022

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	65
Listed Migratory Species:	66

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	58
Commonwealth Heritage Places:	None
Listed Marine Species:	94
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	17
Regional Forest Agreements:	None
Nationally Important Wetlands:	4
EPBC Act Referrals:	105
Key Ecological Features (Marine):	None
Biologically Important Areas:	13
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar Wetlands) [Resource Information]

Ramsar Site Name	Proximity	Buffer Status
Forrestdale and thomsons lakes	Within Ramsar site	In feature area
Peel-yalgorup system	20 - 30km upstream from Ramsar site	In buffer area only

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain	Endangered	Community known to occur within area	In buffer area only
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area	In feature area
Clay Pans of the Swan Coastal Plain	Critically Endangered	Community likely to occur within area	In buffer area only
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain	Endangered	Community likely to occur within area	In buffer area only
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area	In feature area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Anous tenuirostris melanops			
Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area	In feature area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area	In feature area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area	In feature area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area	In buffer area only
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area	In buffer area only
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area	In buffer area only
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area	In buffer area only
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In buffer area only
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area	In feature area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Thalassarche carteri			
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Thalassarche cauta			
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche impavida			
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thalassarche melanophris			
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche steadi			
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Zanda baudinii listed as Calyptorhynchus baudinii			
Baudin's Black-Cockatoo, Long-billed Black-cockatoo [87736]	Endangered	Roosting known to occur within area	In buffer area only
Zanda latirostris listed as Calyptorhynchus latirostris			
Carnaby's Black Cockatoo, Short-billed Black-cockatoo [87737]	Endangered	Breeding known to occur within area	In feature area
FISH			
Thunnus maccoyii			
Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area	In buffer area only
INSECT			
Leioproctus douglasiellus			
a short-tongued bee [66756]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
Neopasiphae simplicior			
A native bee [66821]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
MAMMAL			
Balaenoptera musculus			
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat may occur within area	In buffer area only
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area	In feature area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area	In buffer area only
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur within area	In buffer area only
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat may occur within area	In buffer area only
OTHER			
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
PLANT			
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat likely to occur within area	In feature area
Austrostipa jacobsiana [87809]	Critically Endangered	Species or species habitat may occur within area	In buffer area only
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat known to occur within area	In feature area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat known to occur within area	In feature area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat known to occur within area	In feature area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat known to occur within area	In feature area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat known to occur within area	In feature area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat may occur within area	In buffer area only
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat known to occur within area	In buffer area only
Synaphea sp. Fairbridge Farm (D. Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat likely to occur within area	In buffer area only
Synaphea sp. Pinjarra Plain (A.S. George 17182) [86878]	Endangered	Species or species habitat may occur within area	In buffer area only
Synaphea sp. Serpentine (G.R. Brand 103) [86879]	Critically Endangered	Species or species habitat may occur within area	In buffer area only
REPTILE			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Caretta caretta			
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area	In buffer area only
Chelonia mydas			
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only
Dermochelys coriacea			
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area	In buffer area only
Natator depressus			
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only
SHARK			
Carcharias taurus (west coast population)			
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Carcharodon carcharias			
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Pristis pristis			
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area
Rhincodon typus			
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Sphyrna lewini			
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat known to occur within area	In buffer area only

Listed Migratory Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area	In buffer area only
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area	In buffer area only
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area	In buffer area only
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area	In buffer area only
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area	In buffer area only
Hydroprogne caspia Caspian Tern [808]		Foraging, feeding or related behaviour known to occur within area	In buffer area only
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In buffer area only
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Onychoprion anaethetus](#) Bridled Tern [82845]		Foraging, feeding or related behaviour likely to occur within area	In buffer area only
[Sterna dougallii](#) Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area	In buffer area only
[Sternula albifrons](#) Little Tern [82849]		Species or species habitat may occur within area	In buffer area only
[Thalassarche carteri](#) Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
[Thalassarche cauta](#) Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
[Thalassarche impavida](#) Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area	In buffer area only
[Thalassarche melanophris](#) Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
[Thalassarche steadi](#) White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Migratory Marine Species			
[Balaenoptera edeni](#) Bryde's Whale [35]		Species or species habitat may occur within area	In buffer area only
[Balaenoptera musculus](#) Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Caperea marginata](#) Pygmy Right Whale [39]		Species or species habitat may occur within area	In buffer area only
[Carcharhinus longimanus](#) Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area	In buffer area only
[Carcharodon carcharias](#) White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area	In buffer area only
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area	In buffer area only
[Eubalaena australis as Balaena glacialis australis](#) Southern Right Whale [40]	Endangered	Breeding known to occur within area	In buffer area only
[Lamna nasus](#) Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area	In buffer area only
[Megaptera novaeangliae](#) Humpback Whale [38]		Species or species habitat known to occur within area	In buffer area only
[Mobula alfredi as Manta alfredi](#) Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat may occur within area	In buffer area only
[Mobula birostris as Manta birostris](#) Giant Manta Ray [90034]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Natator depressus](#) Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only
[Orcinus orca](#) Killer Whale, Orca [46]		Species or species habitat may occur within area	In buffer area only
[Pristis pristis](#) Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area	In feature area
[Rhincodon typus](#) Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Migratory Terrestrial Species			
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area	In feature area
Migratory Wetlands Species			
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
[Arenaria interpres](#) Ruddy Turnstone [872]		Species or species habitat known to occur within area	In buffer area only
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Roosting known to occur within area	In feature area
[Calidris alba](#) Sanderling [875]		Species or species habitat known to occur within area	In buffer area only
[Calidris canutus](#) Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area	In feature area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area	In feature area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area	In buffer area only
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area	In buffer area only
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area	In buffer area only
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area	In feature area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area	In buffer area only
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area	In buffer area only
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area	In buffer area only
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area	In buffer area only
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area	In buffer area only
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area	In buffer area only
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area	In buffer area only
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area	In buffer area only
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area	In buffer area only
Pluvialis squatarola Grey Plover [865]		Species or species habitat known to occur within area	In buffer area only
Tringa brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area	In buffer area only
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area	In buffer area only
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area	In feature area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area	In buffer area only
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat known to occur within area	In buffer area only

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State	Buffer Status
Unknown		
Commonwealth Land - [51899]	WA	In buffer area only
Commonwealth Land - [50796]	WA	In buffer area only
Commonwealth Land - [50779]	WA	In buffer area only
Commonwealth Land - [50794]	WA	In buffer area only
Commonwealth Land - [50795]	WA	In buffer area only
Commonwealth Land - [51153]	WA	In buffer area only
Commonwealth Land - [51151]	WA	In buffer area only
Commonwealth Land - [51152]	WA	In buffer area only
Commonwealth Land - [51412]	WA	In buffer area only
Commonwealth Land - [51150]	WA	In buffer area only
Commonwealth Land - [50736]	WA	In buffer area only
Commonwealth Land - [50666]	WA	In buffer area only
Commonwealth Land - [50755]	WA	In buffer area only
Commonwealth Land - [50731]	WA	In buffer area only
Commonwealth Land - [50684]	WA	In buffer area only
Commonwealth Land - [50751]	WA	In buffer area only
Commonwealth Land - [51975]	WA	In buffer area only
Commonwealth Land - [51148]	WA	In buffer area only
Commonwealth Land - [51495]	WA	In buffer area only
Commonwealth Land - [51497]	WA	In buffer area only
Commonwealth Land - [51149]	WA	In buffer area only
Commonwealth Land - [50793]	WA	In buffer area only

Commonwealth Land Name	State	Buffer Status
Commonwealth Land - [50792]	WA	In buffer area only
Commonwealth Land - [51896]	WA	In buffer area only
Commonwealth Land - [50762]	WA	In buffer area only
Commonwealth Land - [50790]	WA	In buffer area only
Commonwealth Land - [51126]	WA	In buffer area only
Commonwealth Land - [50740]	WA	In buffer area only
Commonwealth Land - [51143]	WA	In buffer area only
Commonwealth Land - [50789]	WA	In buffer area only
Commonwealth Land - [51499]	WA	In buffer area only
Commonwealth Land - [50725]	WA	In buffer area only
Commonwealth Land - [51146]	WA	In buffer area only
Commonwealth Land - [50788]	WA	In buffer area only
Commonwealth Land - [50708]	WA	In buffer area only
Commonwealth Land - [51147]	WA	In buffer area only
Commonwealth Land - [51496]	WA	In buffer area only
Commonwealth Land - [50785]	WA	In buffer area only
Commonwealth Land - [50737]	WA	In buffer area only
Commonwealth Land - [50782]	WA	In buffer area only
Commonwealth Land - [51128]	WA	In buffer area only
Commonwealth Land - [50780]	WA	In buffer area only
Commonwealth Land - [50781]	WA	In buffer area only
Commonwealth Land - [50786]	WA	In buffer area only
Commonwealth Land - [50787]	WA	In buffer area only
Commonwealth Land - [50784]	WA	In buffer area only
Commonwealth Land - [51979]	WA	In buffer area only
Commonwealth Land - [51897]	WA	In buffer area only
Commonwealth Land - [50734]	WA	In buffer area only

Commonwealth Land Name	State	Buffer Status
Commonwealth Land - [50749]	WA	In buffer area only
Commonwealth Land - [51980]	WA	In buffer area only
Commonwealth Land - [51514]	WA	In buffer area only
Commonwealth Land - [51900]	WA	In buffer area only
Commonwealth Land - [51901]	WA	In buffer area only
Commonwealth Land - [51144]	WA	In buffer area only
Commonwealth Land - [50832]	WA	In buffer area only
Commonwealth Land - [50686]	WA	In buffer area only
Commonwealth Land - [50745]	WA	In buffer area only

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
Anous stolidus			
Common Noddy [825]		Species or species habitat likely to occur within area	In buffer area only
Anous tenuirostris melanops			
Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Ardenna carneipes as Puffinus carneipes			
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area	In buffer area only
Arenaria interpres			
Ruddy Turnstone [872]		Species or species habitat known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area	In feature area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area	In buffer area only
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area overfly marine area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area	In feature area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area	In buffer area only
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area overfly marine area	In buffer area only
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area overfly marine area	In buffer area only
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area overfly marine area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Charadrius leschenaultii](#) Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area	In feature area
[Charadrius mongolus](#) Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area	In buffer area only
[Charadrius ruficapillus](#) Red-capped Plover [881]		Roosting known to occur within area overfly marine area	In buffer area only
[Diomedea amsterdamensis](#) Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area	In buffer area only
[Diomedea dabbenena](#) Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area	In buffer area only
[Diomedea epomophora](#) Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area	In buffer area only
[Diomedea exulans](#) Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
[Diomedea sanfordi](#) Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area	In buffer area only
[Gallinago megala](#) Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area	In buffer area only
[Gallinago stenura](#) Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area	In buffer area only
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area	In buffer area only
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Foraging, feeding or related behaviour known to occur within area	In buffer area only
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour may occur within area	In buffer area only
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area overfly marine area	In buffer area only
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area	In buffer area only
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area overfly marine area	In buffer area only
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In buffer area only
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area	In buffer area only
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area	In buffer area only
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area	In buffer area only
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area	In buffer area only
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area overfly marine area	In buffer area only
Pluvialis squatarola Grey Plover [865]		Species or species habitat known to occur within area overfly marine area	In buffer area only
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Puffinus assimilis Little Shearwater [59363]		Foraging, feeding or related behaviour known to occur within area	In buffer area only
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area overfly marine area	In buffer area only
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area overfly marine area	In feature area
Stercorarius skua as Catharacta skua Great Skua [823]		Species or species habitat may occur within area	In buffer area only
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Sternula albifrons as Sterna albifrons Little Tern [82849]		Species or species habitat may occur within area	In buffer area only
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thinornis cucullatus as Thinornis rubricollis Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area	In buffer area only
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area	In buffer area only
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area overfly marine area	In buffer area only
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area overfly marine area	In feature area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area	In buffer area only
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat known to occur within area overfly marine area	In buffer area only
Fish			
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area	In buffer area only
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area	In buffer area only
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area	In buffer area only
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area	In buffer area only
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area	In buffer area only
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area	In buffer area only
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area	In buffer area only
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area	In buffer area only
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area	In buffer area only
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area	In buffer area only
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area	In buffer area only
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area	In buffer area only
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area	In buffer area only
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area	In buffer area only
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area	In buffer area only
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area	In buffer area only
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area	In buffer area only
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area	In buffer area only
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area	In buffer area only
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area	In buffer area only
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area	In buffer area only
Mammal			
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area	In buffer area only
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur within area	In buffer area only
Reptile			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area	In buffer area only
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area	In buffer area only
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area	In buffer area only
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only

Whales and Other Cetaceans			[Resource Information]
Current Scientific Name	Status	Type of Presence	Buffer Status
Mammal			
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area	In buffer area only
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area	In buffer area only
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area	In buffer area only
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area	In buffer area only

Current Scientific Name	Status	Type of Presence	Buffer Status
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area	In buffer area only
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area	In buffer area only
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area	In buffer area only
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area	In buffer area only
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area	In buffer area only
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area	In buffer area only
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area	In buffer area only

Extra Information

State and Territory Reserves			[Resource Information]
Protected Area Name	Reserve Type	State	Buffer Status
Banksia	Nature Reserve	WA	In buffer area only
Forrestdale Lake	Nature Reserve	WA	In buffer area only
Gibbs Road	Nature Reserve	WA	In buffer area only
Harry Waring Marsupial Reserve	Nature Reserve	WA	In buffer area only
Leda	Nature Reserve	WA	In buffer area only
Modong	Nature Reserve	WA	In buffer area only
Piara	Nature Reserve	WA	In buffer area only
Thomsons Lake	Nature Reserve	WA	In buffer area only

Protected Area Name	Reserve Type	State	Buffer Status
Unnamed WA39584	Conservation Park	WA	In buffer area only
Unnamed WA39752	Conservation Park	WA	In buffer area only
Unnamed WA42469	Nature Reserve	WA	In buffer area only
Unnamed WA48291	Conservation Park	WA	In buffer area only
Unnamed WA49220	Conservation Park	WA	In buffer area only
Unnamed WA49561	Conservation Park	WA	In buffer area only
Unnamed WA53313	Conservation Park	WA	In buffer area only
Unnamed WA53632	Conservation Park	WA	In buffer area only
Wandi	Nature Reserve	WA	In buffer area only

Nationally Important Wetlands		[Resource Information]
Wetland Name	State	Buffer Status
Forrestdale Lake	WA	In buffer area only
Gibbs Road Swamp System	WA	In buffer area only
Spectacles Swamp	WA	In buffer area only
Thomsons Lake	WA	In buffer area only

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Cockburn Surf Park	2022/09267		Completed	In buffer area only
Residential Development, Wattleup Road, Hammond Park, WA	2021/8933		Approval	In buffer area only
Controlled action				
Alcoa Bauxite Residue Storage Area Extension	2011/5878	Controlled Action	Further Information Request	In buffer area only
Clearing of Lots 2 and 10 Rowley Road, Mandogalup WA	2018/8182	Controlled Action	Assessment Approach	In buffer area only
Construction of a Deepwater, General Container Port	2009/5178	Controlled Action	Proposed Decision	In buffer area only
Construction of Fiona Stanley Hospital	2008/3970	Controlled Action	Post-Approval	In buffer area only

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Development of Kwinana Quay port facility	2008/4387	Controlled Action	Completed	In buffer area only
Develop three sites into residential housing and mixed use developments, Western Australia	2013/6916	Controlled Action	Post-Approval	In buffer area only
Extension of Beeliar Drive between the junction of Mayor and Fawcett Roads an...	2003/1029	Controlled Action	Completed	In buffer area only
Extraction of sand from Lot 6 Banksia Road & lots 300 & 301 Boomerang Road, WA	2010/5622	Controlled Action	Post-Approval	In buffer area only
Hammond Park Secondary School development, WA	2016/7741	Controlled Action	Post-Approval	In feature area
Honeywood Estate Development	2010/5476	Controlled Action	Post-Approval	In buffer area only
Industry Zone	2010/5337	Controlled Action	Post-Approval	In buffer area only
Jandakot Airport Expansion, Commercial Development and Clearing of Vegetation	2009/4796	Controlled Action	Post-Approval	In buffer area only
Keane Road Strategic Link, proposed construction central portion of Keane Road	2009/5035	Controlled Action	Completed	In buffer area only
Latitude 32-industrial development of various lots, Ashley and Sayer Roads, Hope Valley, WA	2016/7695	Controlled Action	Post-Approval	In buffer area only
Lot 2 Corner Durrant Avenue and Sicklemore Road - Residential Development	2011/5882	Controlled Action	Completed	In buffer area only
Lots 13, 14 & 18 Barfield Rd & Lots 48-51 Rowley Rd, Hammond Park	2012/6524	Controlled Action	Post-Approval	In feature area
Mandogalup Urban Development, Mandogalup, WA	2014/7308	Controlled Action	Post-Approval	In buffer area only
Natural Gas Pipeline Expansion	2006/2813	Controlled Action	Post-Approval	In buffer area only
Ranford Road Residential Development	2002/549	Controlled Action	Post-Approval	In buffer area only
Residential development, Bertram, WA	2017/7887	Controlled Action	Further Information Request	In buffer area only

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Residential Development, Lot 123 Mortimer Road, Casuarina, WA	2018/8379	Controlled Action	Assessment Approach	In buffer area only
Residential development, Village of Wellard, City of Kwinana, WA	2013/6986	Controlled Action	Post-Approval	In buffer area only
Residential development and bushfire protection within part Lot 9006 Reilly Road, Harrisdale, WA	2016/7846	Controlled Action	Post-Approval	In buffer area only
Residential Development Lot 131 Jandakot Road, Treeby WA	2018/8205	Controlled Action	Further Information Request	In buffer area only
Residential development of various lots	2019/8500	Controlled Action	Proposed Decision	In buffer area only
Residential developmnt, Lots 11 and 74 Beenyup Road, Banjup, WA	2017/7923	Controlled Action	Post-Approval	In buffer area only
Residential Estate Development, Lot 682 Rowley Road, Mandogalup, Western Australia	2014/7126	Controlled Action	Post-Approval	In buffer area only
Roe Highway extension, Kwinana Freeway to Stock Road, WA	2009/5031	Controlled Action	Post-Approval	In buffer area only
Roe Hwy Extension	2003/972	Controlled Action	Post-Approval	In buffer area only
Sand Mining 70/915 Banksia Road, Wellard, WA	2015/7438	Controlled Action	Post-Approval	In buffer area only
Thornlie-Cockburn Link Project, WA	2018/8188	Controlled Action	Post-Approval	In buffer area only
Vegetation clearing (Cwlth land), Jandakot Airport, Cockburn, WA	2013/7032	Controlled Action	Post-Approval	In buffer area only
Wellard Village Primary School development, part Lot 9074 Lambeth Circle, Wellard	2020/8732	Controlled Action	Post-Approval	In buffer area only
Not controlled action				
'Looping 10' gas transmission pipeline from Kwinana to Hopelands	2005/2212	Not Controlled Action	Completed	In feature area
Armadale Road Duplication - Tapper to Anstey Road	2017/7972	Not Controlled Action	Completed	In buffer area only
Armadale Road to North Lake Road Bridge development, Jandakot, WA	2018/8284	Not Controlled Action	Completed	In buffer area only
Bibra Lake Aboriginal Cultural Centre Development	2020/8642	Not Controlled Action	Completed	In buffer area only

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
Bushfire hazard reduction, Lot 37 Barfield Road, Hammond Park, WA	2018/8204	Not Controlled Action	Completed	In feature area
Calleya Residential Development, Banjup, WA	2016/7708	Not Controlled Action	Completed	In buffer area only
Clearing and development of 220 and 234 Wattleup Rd, Wattleup, WA	2016/7738	Not Controlled Action	Completed	In buffer area only
Clearing of Native Vegetation, Hammond Park, WA	2011/6041	Not Controlled Action	Completed	In buffer area only
Commercial development of Lot 106 Wright Road, Forrestdale WA	2003/1255	Not Controlled Action	Completed	In buffer area only
Construction of Hammond Road Primary School, Hammond Park, WA	2012/6619	Not Controlled Action	Completed	In buffer area only
Construction of international rowing course and commercial/residential areas	2003/1034	Not Controlled Action	Completed	In buffer area only
Development of Lots 100-101 Sayer Road, Hope Valley, WA	2019/8399	Not Controlled Action	Completed	In buffer area only
Eradication of the European House Borer, Perth metropolitan area, WA	2009/5027	Not Controlled Action	Completed	In buffer area only
Expansion of berthing facilities at Kwinana Bulk Terminal	2006/2509	Not Controlled Action	Completed	In buffer area only
Expansion of existing Ammonium Nitrate Production Facility	2005/1941	Not Controlled Action	Completed	In buffer area only
Frankland Parks Oval project, Hammond Park, WA	2018/8369	Not Controlled Action	Completed	In buffer area only
Gas-fired Power Station	2005/2213	Not Controlled Action	Completed	In feature area
Hammond West Urban Development, Hammond Park, WA	2017/7917	Not Controlled Action	Completed	In buffer area only
Hazard reduction and site access, Lot 682 Rowley Road, Mandogalup, WA	2018/8186	Not Controlled Action	Completed	In buffer area only
Highschool and Primary development, Wellard, WA	2016/7639	Not Controlled Action	Completed	In buffer area only
Hope Valley-Wattleup Redevelopment Project	2020/8644	Not Controlled Action	Completed	In buffer area only
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed	In feature area
Industrial development 105 Sayer Road, Hope Valley, WA	2014/7261	Not Controlled Action	Completed	In buffer area only
Industrial Development Lot 64 Ashley Road, Hope Valley, WA	2014/7238	Not Controlled Action	Completed	In buffer area only
Jandakot Road Widening, Solomon Road to Berrigan Drive, Jandakot, WA	2020/8728	Not Controlled Action	Completed	In buffer area only
Kwinana Depot Upgrade	2011/6035	Not Controlled Action	Completed	In buffer area only
Kwinana Fwy southbound widening Roe Hwy to Armadale Rd and construction of farrington Rd off-ramp	2013/7062	Not Controlled Action	Completed	In buffer area only
Kwinana Gas-Fired Power Station	2005/2101	Not Controlled Action	Completed	In feature area
Latitude 32 industrial development 6A, Cockburn, WA	2018/8193	Not Controlled Action	Completed	In buffer area only
Lot 170 Hope Valley Road, Hope Valley	2020/8830	Not Controlled Action	Completed	In buffer area only
Lot 28 157 Barfield Road, Hammond Park - Proposed Residential Development	2021/9063	Not Controlled Action	Completed	In feature area
Lot 29 Barfield Road, Hammond Park	2017/7948	Not Controlled Action	Completed	In feature area
Lot 2 Nicholson Road, Forrestdale	2012/6561	Not Controlled Action	Completed	In buffer area only
Lots 12, 13 and 18 Hammond Road, Lot 80 Beeliar Drive and Lot 500 Hird Road	2012/6576	Not Controlled Action	Completed	In buffer area only
Murdoch University Sports Precinct, Melville, WA	2016/7823	Not Controlled Action	Completed	In buffer area only
Oakford Village development, Shire of Serpentine-Jarrahdale, WA	2018/8157	Not Controlled Action	Completed	In buffer area only
Perth Desalination Plant 2	2019/8454	Not Controlled Action	Completed	In buffer area only
Perth Seawater Desalination Project: Thomsons Lake to Kogolup Pipeline	2005/1971	Not Controlled Action	Completed	In buffer area only

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
Residential Development, Lot 12 Lyon Road, Aubin Grove, WA	2013/6852	Not Controlled Action	Completed	In buffer area only
Residential development, Lot 13 Lyon Road, Aubin Grove, WA	2014/7151	Not Controlled Action	Completed	In buffer area only
Residential development, Lot 33 Barfield Road, Hammond Park, WA	2015/7548	Not Controlled Action	Completed	In feature area
Residential development, Lot 74 Wattleup Road, Hammond Park, WA	2018/8273	Not Controlled Action	Completed	In buffer area only
Residential development, Lots 124 and 125, Wattleup Road, Hammond Park, WA	2015/7519	Not Controlled Action	Completed	In buffer area only
Residential development, Lots 1 and 7-11 Lyon Rd and Lot 88 De Haer Rd, Wandi, WA	2017/7908	Not Controlled Action	Completed	In buffer area only
Residential development of Lot 7 Anketell Rd, Anketell, WA	2018/8281	Not Controlled Action	Completed	In buffer area only
Residential Development of Lots 76 and 107 Wattleup Road, Hamond Park	2020/8865	Not Controlled Action	Completed	In buffer area only
Residential development on part of Lot 2 Fanstone Avenue, Beeliar, WA	2016/7726	Not Controlled Action	Completed	In buffer area only
Residential estate, multiple lots, Mandogalup, WA	2018/8264	Not Controlled Action	Completed	In buffer area only
Roe Highway - Karel Avenue to Hope Road Bridge Project	2005/2061	Not Controlled Action	Completed	In buffer area only
Sand extraction operation, Lot 1 Thomas Road, Oakford, WA	2017/8136	Not Controlled Action	Completed	In buffer area only
Sand quarry, Lot 102 King Road, Oldbury, WA	2015/7439	Not Controlled Action	Completed	In buffer area only
South Metropolitan Crop Research Hub, Murdoch WA	2018/8201	Not Controlled Action	Completed	In buffer area only
Stages 2-5 of primary school and assoc facilities development, Hammond Park, WA	2015/7407	Not Controlled Action	Completed	In buffer area only
Subdivision, Lot 4 Anketell Road, Anketell, WA	2018/8145	Not Controlled Action	Completed	In buffer area only
Tonkin Highway Extension	2001/470	Not Controlled Action	Completed	In buffer area only

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
Urban development, Lot 109 Wattleup Road, Hammond Park, WA	2015/7425	Not Controlled Action	Completed	In buffer area only
Urban development Lots 3, 1199 and 650 Thomas Road, Casuarina, WA	2016/7659	Not Controlled Action	Completed	In buffer area only
Urban development of Lot 107 Wattleup Road, Hammond Park, WA	2017/7890	Not Controlled Action	Completed	In buffer area only
Urban developmnet & associated infrastructure, Lot 4 Armadale Road, Banjup WA	2013/7049	Not Controlled Action	Completed	In buffer area only
Wandi South residential development Kenby Close & Lyon Rd, Wandi, WA	2014/7198	Not Controlled Action	Completed	In buffer area only
Wellard Farms Urban Development, Baldivis WA	2020/8634	Not Controlled Action	Completed	In buffer area only
Wentworth West residential development, Bartram Road, Success, WA	2014/7245	Not Controlled Action	Completed	In buffer area only
Wungong Transfer Mains Project	2007/3532	Not Controlled Action	Completed	In buffer area only
Not controlled action (particular manner)				
City of Cockburn Sporting Facilties	2005/2139	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Extension of Spearwood Ave, from Barrington Rd to Miguel Rd	2009/5140	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
South West Metropolitan Railway Project	2003/1175	Not Controlled Action (Particular Manner)	Post-Approval	In feature area
Referral decision				
AIC Forrestdale Campus, Educational Establishment	2021/9134	Referral Decision	Referral Publication	In buffer area only
Rezoning of Crown Reserve 39181 to facilitate future residential development	2005/2096	Referral Decision	Completed	In feature area

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Referral decision				

Biologically Important Areas

Scientific Name	Behaviour	Presence	Buffer Status
Seabirds			
Ardenna pacifica Wedge-tailed Shearwater [84292]	Foraging (in high numbers)	Known to occur	In buffer area only
Eudyptula minor Little Penguin [1085]	Foraging (provisioning young)	Known to occur	In buffer area only
Hydroprogne caspia Caspian Tern [808]	Foraging (provisioning young)	Known to occur	In buffer area only
Larus pacificus Pacific Gull [811]	Foraging (in high numbers)	Former Range	In buffer area only
Onychoprion anaethetus Bridled Tern [82845]	Foraging (in high numbers)	Known to occur	In buffer area only
Puffinus assimilis tunneyi Little Shearwater [59363]	Foraging (in high numbers)	Known to occur	In buffer area only
Sterna dougallii Roseate Tern [817]	Foraging	Known to occur	In buffer area only
Sternula nereis Fairy Tern [82949]	Foraging (in high numbers)	Known to occur	In buffer area only
Seals			
Neophoca cinerea Australian Sea Lion [22]	Foraging (male)	Likely to occur	In buffer area only
Whales			
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Distribution	Known to occur	In buffer area only

Scientific Name	Behaviour	Presence	Buffer Status
Eubalaena australis Southern Right Whale [40]	Calving buffer	Known to occur	In buffer area only
Eubalaena australis Southern Right Whale [40]	Seasonal calving habitat	Known to occur	In buffer area only
Megaptera novaeangliae Humpback Whale [38]	Migration (north and south)	Known to occur	In buffer area only

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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Appendix C

Black Cockatoo Foraging Plants

		Foraging category as assigned by Emerge			
Species name	**Common name**	**CBC**	**BBC**	**FRTBC**	**Literature references**
Acacia baileyana	Cootamundra wattle	Secondary	-	-	Groom 2011
Acacia pentadenia	Karri wattle	Secondary	-	-	Groom 2011
Acacia saligna	Orange wattle	Secondary	-	-	Groom 2011
Agonis flexuosa	Peppermint tree	Secondary	-	-	Groom 2011
Allocasuarina fraseriana	Sheoak	-	Secondary	Secondary	Johnstone & Storr 1998; Johnstone et al. 2010; Johnstone 2017; DoEE 2017
Allocasuarina spp.		Secondary	-	Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Anigozanthos flavidus	Tall kangaroo paw	-	Secondary	-	Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Araucaria heterophylla	Norfolk island pine	Secondary	-	-	Groom 2011; DoEE 2017
Banksia ashbyi	Ashby's banksia	Primary	Secondary	-	Saunders 1980; Groom 2011; DoEE 2017
Banksia attenuata	Slender banksia	Primary	Secondary	-	Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia baxteri	Baxter's banksia	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia carlinoides	Pink dryandra	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia coccinea	Scarlet banksia	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia dallanneyi	Couch honeypot dryandra	Primary	Secondary	-	Groom 2011; DoEE 2017
Banksia ericifolia	Heath-leaved banksia	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia fraseri		Primary	Secondary	-	Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia gardneri	Prostrate banksia	Primary	Secondary	-	Groom 2011; DoEE 2017
Banksia grandis	Bull banksia	Primary	Secondary	-	Saunders 1980; Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia hookeriana	Hooker's banksia	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia ilicifolia	Holly banksia	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011; Johnstone & Storr 1998; DoEE 2017
Banksia kippistiana		Primary	Secondary	-	Groom 2011; DoEE 2017
Banksia leptophylla		Primary	Secondary	-	Groom 2011; DoEE 2017
Banksia lindleyana	Porcupine banksia	Primary	Secondary	-	Johnstone et al. 2010; DoEE 2017

		Foraging category as assigned by Emerge			
Species name	**Common name**	**CBC**	**BBC**	**FRTBC**	**Literature references**
Banksia littoralis	Swamp banksia	Primary	Secondary	-	Saunders 1980; Groom 2011Johnstone & Storr 1998; Johnstone et al. 2010; DoEE 2017
Banksia menziesii	Firewood banksia	Primary	Secondary	-	Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia mucronulata	Swordfish dryandra	Primary	Secondary	-	Groom 2011; DoEE 2017
Banksia nivea	Honeypot dryandra	Primary	Secondary	-	Saunders 1980; Groom 2011; DoEE 2017
Banksia nobilis	Golden dryandra	Primary	Secondary	-	Saunders 1980; Groom 2011; DoEE 2017
Banksia praemorsa	Cut-leaf banksia	Primary	Secondary	-	Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia prionotes	Acorn banksia	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia prolata		Primary	Secondary	-	Johnstone et al. 2010; DoEE 2017
Banksia quercifolia	Oak-leaved banksia	Primary	Secondary	-	Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia sessilis	Parrot bush	Primary	Secondary	-	Saunders 1980; Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia speciosa	Showy banksia	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia spp.		Primary	Secondary	-	Saunders 1979; DSEWPaC 2012; DoEE 2017
Banksia squarrosa	Pingle	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia tricuspis	Pine banksia	Primary	Secondary	-	Groom 2011; DoEE 2017
Banksia undata	Urchin dryandra	Primary	Secondary	-	Groom 2011; DoEE 2017
Banksia verticillata	Granite banksia	Primary	Secondary	-	Saunders 1980; Groom 2011; DoEE 2017
Brassica campestris	Canola	Secondary	-	-	Groom 2011; DoEE 2017
Callistemon spp.		Secondary	Secondary	-	Johnstone et al. 2010; DoEE 2017
Callistemon viminalis	Captain cook bottlebrush	Secondary	-	-	Groom 2011
Callitris sp.		Secondary	-	-	Johnstone et al. 2010; Groom 2011
Carya illnoinensis	Pecan	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011; Groom 2014; DoEE 2017
Casuarina cunninghamiana	River sheoak	Secondary	-	-	Groom 2011
Citrullus lanatus	Pie or afghan melon	Secondary	-	-	Johnstone et al. 2010; Groom 2011

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Corymbia calophylla	Marri	Primary	Primary	Primary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone 2017; Saunders 1979; Johnstone & Kirkby 2008
Corymbia citriodora	Lemon scented gum	Secondary	Secondary	Secondary	Johnstone et al. 2010; DSEWPaC 2012; Groom 2011; Johnstone 2017
Corymbia ficifolia	Red flowering gum	Secondary	-	-	Groom 2011
Corymbia haematoxylon	Mountain marri	Secondary	-	Secondary	Groom 2011; DoEE 2012; DoEE 2017
Corymbia maculata	Spotted gum	-	-	-	-
Darwinia citriodora	Lemon-scented darwinia	Secondary	Secondary	-	Groom 2011; Johnstone et al. 2010
Diospryros sp.	Sweet persimmon	Secondary	Secondary	-	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eremophila glabra	Tarbush	Secondary	-	-	Groom 2011
Erodium aureum		Secondary	-	-	Groom 2011
Erodium botrys	Long storksbill	Secondary	Secondary	-	Groom 2011; Johnstone & Storr 1998; Johnstone et al. 2010
Erodium spp.		Secondary	Secondary	-	Johnstone et al. 2010; DoEE 2017
Eucalyptus caesia	Silver princess	Secondary	-	Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017; Johnstone 2017
Eucalyptus camaldulensis	River red gum	-	-	Secondary	DoEE 2012; DoEE 2017
Eucalyptus decipiens	Red heart/moit	-	-	Secondary	Johnstone 2017
Eucalyptus diversicolor	Karri	-	-	Primary	Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone & Storr 1998
Eucalyptus erythrocorys	Illyarrie	Secondary	-	Secondary	DSEWPaC 2012; DoEE 2017; Johnstone 2017, Johnstone et al. 2010
Eucalyptus gomphocephala	Tuart	Secondary	-	Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eucalyptus grandis	Flooded gum, rose gum	-	-	Secondary	DoEE 2012; DoEE 2017
Eucalyptus lehmannii	Bushy yate	-	-	Secondary	Johnstone 2017
Eucalyptus leucoxylon	Yellow gum	Secondary	-	-	Groom 2014

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Eucalyptus loxophleba	York gum	Secondary	-	-	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eucalyptus marginata	Jarrah	Primary	Secondary	Primary	Saunders 1980; Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017; Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone 2017
Eucalyptus patens	Blackbutt	Primary	-	Primary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone 2017; Groom 2011
Eucalyptus pleurocarpa	Tallerack	Secondary	-	-	Groom 2011
Eucalyptus preissiana	Bell-fruited mallee	Secondary	-	-	Groom 2011
Eucalyptus robusta	Swamp mahogany	Secondary	-	-	Johnstone et al. 2010; Groom 2011
Eucalyptus salmonophloia	Salmon gum	Primary	-	-	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DSEWPaC 2012; DoEE 2017
Eucalyptus staeri	Albany blackbutt	-	-	Secondary	Johnstone & Storr 1998
Eucalyptus todtiana	Coastal blackbutt	Secondary	-	-	Saunders 1980; Johnstone et al. 2010; Groom 2011; Johnstone & Kirkby 2008
Eucalyptus wandoo	Wandoo	Primary	Secondary	Primary	Saunders 1980; Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Ficus sp.	Fig	Secondary	-	-	Groom 2011
Grevillea armigera	Prickly toothbrushes	Primary	-	-	Groom 2011
Grevillea bipinnatifida	Fuschia grevillea	Primary	-	-	Groom 2011
Grevillea hookeriana	Red toothbrushes	Primary	-	-	Groom 2011
Grevillea hookeriana subsp. api	Black toothbrushes	Primary	-	-	Groom 2011
Grevillea paniculata	Kerosene bush	Primary	-	-	Groom 2011
Grevillea paradoxa	Bottlebrush grevillea	Primary	-	-	Groom 2011
Grevillea petrophiloides	Pink poker	Primary	-	-	Groom 2011
Grevillea robusta	Silky oak	Primary	-	-	Johnstone et al. 2010; Groom 2011

		Foraging category as assigned by Emerge			
Species name	**Common name**	**CBC**	**BBC**	**FRTBC**	**Literature references**
Grevillea spp.		Primary	-	-	Saunders 1979; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Grevillea wilsonii	Native fuchsia	-	Secondary	-	Johnstone et al. 2010
Hakea auriculata		Primary	-	-	Saunders 1980; Groom 2011
Hakea candolleana		Primary	-	-	Groom 2011
Hakea circumalata	Coastal hakea	Primary	-	-	Groom 2011
Hakea commutata		Primary	-	-	Groom 2011
Hakea conchifolia	Shell-leaved hakea	Primary	-	-	Groom 2011
Hakea costata	Ribbed hakea	Primary	-	-	Groom 2011
Hakea cristata	Snail hakea	Primary	Secondary	-	Groom 2011; Johnstone et al. 2010
Hakea cucullata	Snail hakea	Primary	-	-	Groom 2011
Hakea cyclocarpa	Ramshorn	Primary	-	-	Saunders 1980; Groom 2011
Hakea eneabba		Primary	-	-	Groom 2011
Hakea erinacea	Hedgehog hakea	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011
Hakea falcata	Sickle hakea	Primary	-	-	Groom 2011
Hakea flabellifolia	Fan-leaved hakea	Primary	-	-	Groom 2011
Hakea gilbertii		Primary	-	-	Saunders 1980; Groom 2011
Hakea incrassata	Golfball or marble hakea	Primary	-	-	Johnstone et al. 2010; Groom 2011
Hakea lasiantha	Woolly flowered hakea	Primary	-	-	Johnstone et al. 2010; Groom 2011
Hakea lasianthoides		Primary	Secondary	-	Johnstone et al. 2010; Groom 2011
Hakea laurina	Pin-cushion hakea	Primary	-	-	Johnstone et al. 2010; Groom 2011
Hakea lissocarpha	Honeybush	Primary	Secondary	-	Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea marginata		-	Secondary	-	Johnstone et al. 2010
Hakea megalosperma	Lesueur hakea	Primary	-	-	Groom 2011
Hakea multilineata	Grass leaf hakea	Primary	-	-	Groom 2011
Hakea neospathulata		Primary	-	-	Groom 2011
Hakea obliqua	Needles and corks	Primary	-	-	Saunders 1980; Groom 2011
Hakea oleifolia	Dungyn	Primary	-	-	Groom 2011

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Hakea pandanicarpa subsp. crassifolia	Thick-leaved hakea	Primary	-	-	Groom 2011
Hakea petiolaris	Sea urchin hakea	Primary	-	-	Groom 2011
Hakea polyanthema		Primary	-	-	Groom 2011
Hakea preissii	Needle tree	Primary	-	-	Groom 2011
Hakea prostrata	Harsh hakea	Primary	Secondary	-	Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea psilorrhyncha		Primary	-	-	Groom 2011
Hakea ruscifolia	Candle hakea	Primary	Secondary	-	Saunders 1980; Groom 2011; Johnstone et al. 2010
Hakea scoparia	Kangaroo bush	Primary	-	-	Groom 2011
Hakea smilacifolia		Primary	-	-	Groom 2011
Hakea spp.		Primary	Secondary	-	Saunders 1979; DSEWPaC 2012; DoEE 2017
Hakea stenocarpa	Narrow-fruited hakea	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011
Hakea sulcata	Furrowed hakea	Primary	-	-	Groom 2011
Hakea trifurcata	Two-leaved hakea	Primary	Secondary	-	Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea undulata	Wavy-leaved hakea	Primary	Secondary	-	Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea varia	Variable-leaved hakea	Primary	Secondary	-	Saunders 1980; Groom 2011
Harpephyllum caffrum	Kaffir plum	-	-	Secondary	Johnstone 2017
Helianthus annuus	Sunflower	Secondary	-	-	Johnstone et al. 2010; Groom 2011
Hibiscus sp.	Hibiscus	Secondary	-	-	Groom 2011
Isopogon scabriusculus		Secondary	-	-	Groom 2011
Jacaranda mimosifolia	Jacaranda	Secondary	Secondary	-	Johnstone et al. 2010; Groom 2011
Jacksonia furcellata	Grey stinkwood	Secondary	-	-	Groom 2011
Kingia australis	Kingia	-	Secondary	-	Johnstone et al. 2010
Lambertia inermis	Chittick	Secondary	-	-	Johnstone & Storr 1998; Groom 2011
Lambertia multiflora	Many-flowered honeysuckle	Secondary	-	-	Saunders 1980; Groom 2011

		Foraging category as assigned by Emerge			
Species name	**Common name**	**CBC**	**BBC**	**FRTBC**	**Literature references**
Liquidamber styraciflua	Liquid amber	Primary	-	Secondary	Johnstone et al. 2010; Groom 2011; Groom 2014; Personal observation
Lupinus sp.	Lupin	Secondary	-	-	Saunders 1980; Groom 2011
Macadamia integrifolia	Macadamia	Primary	Secondary	-	Johnstone et al. 2010; Grooms 2011; Groom 2014
Malus domestica	Apple	Secondary	Secondary	-	Johnstone et al. 2010; Johnstone & Storr 1998; DSEWPaC 2012; DoEE 2017; Groom 2011
Melaleuca leuropoma		Secondary	-	-	Saunders 1980; Groom 2011
Melia azedarach	Cape lilac or white cedar	Secondary	-	Primary	Johnstone et al. 2010; Groom 2011
Mesomeleana spp.		Secondary	-	-	Johnstone et al. 2010; Groom 2011
Olea europea	Olive	-	-	Secondary	Johnstone 2017
Persoonia longifolia	Snottygobble	-	-	Secondary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Pinus canariensis	Canary island pine	Primary	-	-	Johnstone et al. 2010; Groom 2011
Pinus caribea	Caribbean pine	Primary	-	-	Johnstone et al. 2010; Groom 2011
Pinus pinaster	Pinaster or maritime pine	Primary	-	-	Groom 2011
Pinus radiata	Radiata pine	Primary	Secondary	-	Johnstone et al. 2010; Groom 2011
Pinus spp.		Primary	Secondary	-	Johnstone & Storr 1998; Saunders 1979; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Protea 'Pink Ice'		Secondary	-	-	Groom 2011
Protea repens		Secondary	-	-	Groom 2011
Protea spp.		Secondary	-	-	Johnstone et al. 2010
Prunus amygdalus	Almond tree	Secondary	-	-	Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Pyrus communis	European pear	-	Secondary	-	Johnstone & Storr 1998; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Quercus spp.	Oak	-	Secondary	-	Johnstone et al. 2010

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Raphanus raphanistrum	Wild radish	Secondary	-	-	Groom 2011; DoEE 2017
Reedia spathacea		-	Secondary	-	Johnstone et al. 2010
Rumex hypogaeus	Doublegee	Secondary	-	-	Saunders 1980
Stenocarpus sinuatus		Secondary	-	-	Johnstone et al. 2010
Syzygium smithii	Lilly pilly	Secondary	-	-	Groom 2014
Tipuana tipu	Tipu or rosewood tree	Primary	-	-	Groom 2011, Groom 2014
Xanthorrhoea preissii	Grass tree	Secondary	Secondary	-	Groom 2011; Johnstone et al. 2010
Xylomelum occidentale	Woody pear	Secondary	-	-	Groom 2014

CBC=Carnaby's black cockatoo, BBC=Baudin's black cockatoo and FRTBC=Forest red-tailed black cockatoo

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Appendix D

Conservation Significant Species and Likelihood of Occurrence Assessment

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Birds					
Actitis hypoleucos	Common sandpiper	MI	MI	Edge of sheltered waters salt or fresh, e.g. estuaries, mangrove creeks, rocky coasts, near-coastal saltlakes (including saltwork ponds), river pools, lagoons, claypans, drying swamps, flood waters, dams and sewage ponds. Preferring situations where low perches are available (Johnstone & Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Anous stolidus	Common noddy	MI	MI	Tropical and subtropical seas, cayes, reefs, buoys and piles (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Anous tenuirostris melanops	Australian lesser noddy	EN	VU	Very common in blue-water seas around the Abrolhos (endemic to this area, accidental occurrences on lower west coast of Australia) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Apus pacificus	Fork-tailed swift	MI	MI	Aerial, migratory species that is most often seen over inland plains and sometimes above open areas, foothills or in coastal areas. Sometimes occurs over settled areas, including towns, urban areas and cities (Pizzey & Knight 2012).	**Possible** May opportunistically occur in or fly over the site on commute or while searching for prey.
Ardenna carneipes	Flesh-footed shearwater	VU	MI	Marine species that breeds on islands off south coast from near Cape Leeuwin (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Arenaria interpres	Ruddy turnstone	MI	MI	Tidal mud and reef flats, sheltered rocky coasts, stony and seaweedy beaches and sandpits, dry coral ridges (Abrolhos) and pebbly shores of near-coastal saltlakes (including saltwork ponds) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Botaurus poiciloptilus	Australasian bittern	EN	EN	In or over water, in tall reedbeds, sedges, rushes, cumbungi, lignum. Also occurs in ricefields, drains in tussocky paddocks and occasionally in saltmarshes and brackish wetlands.	**Unlikely** No suitable habitat occurs in the site.
Calidris acuminata	Sharp-tailed sandpiper	MI	MI	Occurs in tidal mudflats, saltmarshes and mangroves, as well as, shallow fresh, brackish or saline inland wetlands. It is also known from floodwaters, irrigated pastures and crops, sewage ponds, saltfields.	**Unlikely** No suitable habitat occurs in the site.
Calidris alba	Sanderling	MI	MI	Mainly steeply shelving sandy beaches exposed to ocean swell. Also sandy inlets, estuarine sandbanks and near-coastal saltlakes (including saltwork ponds) (Johnstone & Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Calidris canutus	Red knot	EN	EN (MI)	Mud and sand flats in estuaries and on sheltered coasts. Also near-coastal saltlakes, including saltwork ponds.	**Unlikely** No suitable habitat occurs in the site.
Calidris ferruginea	Curlew sandpiper	CR	CR (MI)	Mainly shallows of estuaries and near-coastal saltlakes (including saltwork ponds) and drying near-coastal freshwater lakes and swamps. Also beaches and near-coastal sewage ponds.	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Calidris melanotos	Pectoral sandpiper	MI	MI	Mainly fresh waters (swamps, lagoons, river pools, irrigation channels and sewage ponds); also samphire flats around estuaries and saltlakes (Johnstone & Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Calidris ruficollis	Red-necked stint	MI	MI	Tidal mudflats, saltmarshes, sandy or shelly beaches, saline and freshwater wetlands (coastal and inland), saltfields, sewage ponds (Pizzey and Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Calidris subminuta	Long-toed stint	MI	MI	Mainly freshwater swamps (especially when drying and where vegetation is short), river pools, lagoons and claypans; also brackish pools, sewage ponds and samphire flats around estuaries and saltlakes.	**Unlikely** No suitable habitat occurs in the site.
Calidris tenuirostris	Great knot	CR	CR (MI)	Mud or sand flats in estuaries and on sheltered coasts. Also near-coastal saltlakes, including saltwork ponds.	**Unlikely** No suitable habitat occurs in the site.
Calyptorhynchus banksii naso	Forest red-tailed black cockatoo	VU	VU	Eucalypt and Corymbia forests, often in hilly interior. More recently also observed in more open agricultural and suburban areas including Perth metropolitan area. Attracted to seeding *Corymbia calophylla* , *Eucalyptus marginata* , introduced *Melia azedarach* and *Eucalyptus* spp. trees.	Possible
Charadrius dubius	Little ringed plover	MI	MI	Open, muddy or sandy shores of lakes, swamps, tidal areas, sewage ponds or farm dams. Rare but regular summer migrant to Australia (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Charadrius leschenaultii	Great sand plover	VU	VU (MI)	Wide sandy or shelly beaches, sandpits, tidal mudflats, reefs, sand cays, mangroves, saltmarsh, dune wilderness, bare paddocks, seldom far inland (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Charadrius mongolus	Lesser sand plover	EN	EN (MI)	Sandy beaches and tidal estuarine flats. Also near-coastal saltlakes, including saltwork ponds (Johnstone & Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Chlidonias leucopterus	White-winged black tern	MI	MI	Vegetated and open wetlands, brackish and saline lakes, saltfields, irrigated lands, sewage ponds and occasionally offshore.	**Unlikely** No suitable habitat occurs in the site.
Diomedea amsterdamensis	Amsterdam Island albatross	CR	EN (MI)	The Amsterdam albatross is a marine, pelagic seabird. It nests in open patchy vegetation (among tussocks, ferns or shrubs) near exposed ridges or hillocks (Weimerskirch et al. 1985). It sleeps and rests on ocean waters when not breeding (Marchant and Higgins 1990)	**Unlikely** No suitable habitat occurs in the site.
Diomedea dabbenena	Tristan albatross	CR	EN (MI)	The Tristan albatross is a marine, pelagic seabird. It forages in open water in the Atlantic Ocean near the Cape of Good Hope, South Africa. It sleeps and rests on ocean waters when not breeding (Marchant and Higgins 1990).	**Unlikely** No suitable habitat occurs in the site.
Diomedea epomophora	Southern royal albatross	VU	VU (MI)	Rare visitor to Western Australian seas; it breeds on subantarctic islands south of New Zealand (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Diomedea exulans	Wandering albatross	VU	VU (MI)	Marine, pelagic and aerial species. It breeds on Macquarie Island and feeds in Australian portions of the Southern Ocean (DoE 2018).	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Diomedea sanfordi	Northern royal albatross	EN	EN	Species is marine, pelagic and aerial. Habitat includes subantarctic, subtropical, and occasionally Antarctic waters (Marchant & Higgins 1990). Rare visitors to south-western Australian waters.	**Unlikely** No suitable habitat occurs in the site.
Falco peregrinus	Peregrine falcon	OS	-	Mainly found around cliffs along coasts, rivers, ranges and around wooded watercourses and lakes (Johnstone and Storr 1998).	**Possible** May opportunistically occur in or fly over the site on commute or while searching for prey.
Gallinago megala	Swinhoe's snipe	MI	MI	Wet, grassy ground; edges of reedy swamps (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Gallinago stenura	Pin-tailed snipe	MI	MI	Boggy edges of vegetated wetlands; sewage and other ponds; stubbles, grasslands with shrubs, pastures (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Halobaena caerulea	Blue petrel	MI	VU (MI)	Marine species that breeds on southern subantarctic and northern artic islands. Only an accidental or uncommon visitor to Western Australian waters (Johnstone & Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Hydroprogne caspia	Caspian tern	MI	MI	Mainly sheltered areas, estuaries (when not laden with silt) and tidal creeks; occasionally near-coastal saltlakes (including saltwork ponds) and brackish pools in lower courses of rivers; rarely fresh waters.	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Ixobrychus dubius	Australian little bittern	P4	-	Dense vegetation surrounding/within freshwater pools, swamps and lagoons, well screened with trees. Shelters in dense beds of Typha spp., Baumea spp. and tall rushes in freshwater swamps around lakes and along rivers (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Leipoa ocellata	Malleefowl	VU	VU	Scrubs and thickets of Eucalyptus spp., Melaleuca lanceolata and *Acacia linophylla* ; also other dense litter-forming shrublands. Attracted to fallen wheat in stubbles and along roads (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Limicola falcinellus	Broad billed sandpiper	-	MI	May be regular in small numbers at scattered locations, from Warden Lake Nature Reserve and Coramup Creek to Guraga Lake Nature Reserve and Hurstview Lake.	**Unlikely** No suitable habitat occurs in the site.
Limosa lapponica	Bar-tailed godwit	MI (& VU or CR at subsp. level)	MI	Estuarine sand and mudflats and sandy beaches with loads of seaweed; also reef flats and near-coastal saltlakes (including saltwork ponds) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Limosa limosa	Black-tailed godwit	MI	MI	Tidal mudflats, estuaries, sewage ponds, shallow river margins, brackish or saline inland lakes, flooded pastures, airfields (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Macronectes giganteus	Southern giant-petrel	MI	EN (MI)	Breeds on southern subantarctic and antarctic islands. May visit Western Australian waters from February to December (mostly June to September) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Macronectes halli	Northern giant petrel	MI	VU (MI)	Breeds on subantarctic islands. May visit Western Australian water from February to September (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Motacilla cinerea	Grey wagtail	MI	MI	In Australia mostly near running water in disused quarries, sandy and rocky streams in escarpments and rainforests, sewage ponds, ploughed fields and airfields (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Ninox connivens connivens	Barking owl (southwest subpop.)	P2	-	Open forests, woodlands, dense scrubs, foothills, river red gums, and other large trees near watercourses penetrating otherwise open country. Also Melaleuca woodlands, mangroves, rainforests and deciduous vine scrubs (Johnstone and Storr 1998; Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Numenius madagascariensis	Eastern curlew	CR	CR (MI)	Mainly tidal mudflats; also reef flats, sandy beaches and rarely near-coastal lakes (including saltwork ponds) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Numenius minutus	Little curlew	MI	MI	Dry grasslands, floodplains, margins of drying swamps; tidal mudflats, airfields, playing fields, crops, commercial saltfields, sewage ponds (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Numenius phaeopus	Whimbrel	MI	MI	Estuaries, mangroves, tidal flats, coral cays, exposed reefs, flooded paddocks, sewage ponds, bare grasslands, sportsgrounds and lawns.	**Unlikely** No suitable habitat occurs in the site.
Onychoprion anaethetus	Bridled tern	MI	MI	Tropical and subtropical seas, offshore islands, rarely coasts (Pizzey & Knight).	**Unlikely** No suitable habitat occurs in the site.
Oxyura australis	Blue-billed duck	P4	-	Mainly deeper freshwater swamps and lakes; occasionally saltlakes and estuaries freshened by flood waters (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Pachyptila turtur subantarctica	Fairy prion	-	VU	Breeds on subantarctic islands and is presumed to frequent subtropical waters during non-breeding period (TSSC 2015).	**Unlikely** No suitable habitat occurs in the site.
Pandion haliaetus	Osprey	MI	MI	Coasts, estuaries, bays, inlets, islands, and surrounding waters; coral atolls, reefs, lagoons, rock cliffs, stacks (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Phaethon rubricauda	Red-tailed tropicbird	P4 (MI)	MI	Spend most of their lives at sea and rarely venture near land. This bird is normally found in tropical and subtropical seas around northern Australia. Though rarely seen in colder areas, a few pairs breed on Sugarloaf Rock, south of Cape Naturaliste (DPAW 2017b).	**Unlikely** No suitable habitat occurs in the site.
Philomachus pugnax	Ruff	MI	MI	Fresh, brackish and saline wetlands; tidal mudflats, saltfields, sewage ponds (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Plegadis falcinellus	Glossy Ibis	MI	MI	Well-vegetated wetlands, wet pasture, ricefields, floodwaters, floodplains, brackish or occasionally saline wetlands, mangroves, mudflats and occasionally dry grassland (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Pluvialis fulva	Pacific golden plover	MI	MI	Estuaries, mudflats, saltmarshes, mangroves; rocky reefs and stranded seaweed on ocean shores; margins of shallow open inland swamps; sewage ponds, short-grass paddocks, sportsgrounds, airfields, ploughed land (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Pluvialis squatarola	Grey Plover	MI	MI	Mudflats, saltmarsh, tidal reefs and estuaries, rarely inland (Pizzey and Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Pterodroma mollis	Soft-plumaged petrel	MI	VU (MI)	Marine species that breeds on temperate and subantarctic islands in south Atlantic and south Indian Ocean. Visitor to West Australian waters from March to September. Rarely observed inshore (Johnstone & Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Rostratula australis	Australian painted snipe	EN	EN	Mainly shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans (Marchant and Higgins 1993).	**Unlikely** No suitable habitat occurs in the site.
Sterna dougallii	Roseate tern	MI	MI	Offshore waters, islands, coral reefs, sand cays, beaches, tidal inlets (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Sternula albifrons	Little tern	MI	MI	Species is mainly coastal, being found on beaches, sheltered inlets, estuaries, lakes, sewage farms, lagoons, river mouths and deltas.	**Unlikely** No suitable habitat occurs in the site.
Sternula nereis nereis	Australian fairy tern	VU	VU	Sheltered blue-water seas close to land, estuaries (when free of silt) and near-coastal lakes (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Thalassarche carteri	Indian yellow-nosed albatross	EN	VU (MI)	Marine species that inhabits seas of south and west coast of Western Australia and breeds on islands in the south Indian Ocean and in the south Atlantic (Johnstone & Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Thalassarche cauta	Shy albatross	VU	VU (MI)	Scarce visitor (late May to mid-October) to southwestern and western seas. Breeds on islands off Tasmania and south New Zealand (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Thalassarche impavida	Campbell albatross	VU	VU (MI)	Scarce visitor to south-western and western Australian seas. Breeds on Campbell Island.	**Unlikely** No suitable habitat occurs in the site.
Thalassarche melanophris	Black-browed albatross	EN	VU (MI)	Seas of south and west coasts. Visitor to Western Australian mainland from January to early November (mostly May to September). Breeds on southern subantarctic and antarctic islands (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Thalassarche steadi	White-capped albatross	VU	VU (MI)	Scarce visitor (late May to mid-October) to southwestern and western seas. Breeds on islands off Tasmania and south New Zealand (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Thalasseus bergii	Crested tern	MI	MI	Mainly blue-water seas (especially within 3 km of land), including southern estuaries in summer and autumn (when free of silt); also tidal creeks in north, but not penetrating far into larger estuaries.	**Unlikely** No suitable habitat occurs in the site.
Thinornis cucullatus	Hooded plover	P4	VU	Margins and shallows of saltlakes, sandy and seaweedy beaches and estuaries; also dams (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Tringa brevipes	Grey-tailed tattler	P4 (MI)	MI	Tidal mud and reef flats, sheltered rocky coasts, stony and seaweedy beaches and sandpits, dry coral ridges (Abrolhos) and pebbly shores of near-coastal saltlakes (including saltwork ponds) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Tringa glareola	Wood sandpiper	MI	MI	Mainly shallow fresh waters (lagoons, swamps, claypans, river pools, dams, bore overflows and sewage ponds); occasionally brackish swamps, rarely saltlakes and estuaries (Pizzey & Knight).	**Unlikely** No suitable habitat occurs in the site.
Tringa nebularia	Common greenshank	MI	MI	Mudflats, estuaries, saltmarshes, margins of lakes, wetlands, claypans (fresh and saline), commercial saltfields, sewage ponds (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Tringa stagnatilis	Marsh sandpiper	MI	MI	Mainly shallow fresh or brackish waters: swamps, lakes, river pools, soaks, sewage ponds and bore overflows. Occasionally estuaries and salt ponds, and rarely coasts.	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Tyto novaehollandiae novaehollandiae	Australian masked owl	P3	-	Forests, open woodlands, farmlands with large trees. E.g. river red gums, adjacent cleared country, timbered watercourses, paperbark woodlands and caves (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Xenus cinereus	Terek sandpiper	MI	MI	Tidal mudflats, estuaries; shores and reefs of islands; coastal swamps, commercial saltfields (Pizzey & Knight 2012).	**Unlikely** No suitable habitat occurs in the site.
Zanda baudinii	Baudin's black cockatoo	EN	EN	Mainly eucalypt forests. Attracted to seeding *Corymbia calophylla* , *Banksia* spp., *Hakea* spp., and to fruiting apples and pears (Johnstone and Storr 1998).	**Unlikely** No suitable habitat occurs in the site.
Zanda latirostris	Carnaby's black cockatoo	EN	EN	Mainly proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests; also plantations of *Pinus* spp. Attracted to seeding *Banksia* spp., *Hakea* spp., *Eucalyptus* spp., *Corymbia calophylla* , *Grevillea* spp., and *Allocasuarina* spp. (Johnstone and Storr 1998).	**Recorded** Observed flying over site. Suitable foraging habitat within site.
Invertebrates					
Idiosoma sigillatum	Swan Coastal Plain shield-backed trapdoor spider	P3	-	Widely distributed in sandy areas on the Swan Coastal Plain and on Rottnest Island (Prince 2003).	**Possible** Suitable habitat (sandy soils) within site.
Leioproctus contrarius	a short-tongued bee	P3	-	Life history and habits are poorly documented/ unknown. It has been recorded only on flowers of Goodeniaceae and possibly *Lechenaultia stenosepala* (Bamford 2003).	**Possible** Suitable habitat (Goodeniaceae spp.) within site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Leioproctus douglasiellus	a short-tongued bee	EN	CR	Life history and habits are poorly documented/ unknown. It has been recorded only on the flowers of *Goodenia filiformis* and *Anthotium junciforme* (Houston 2000).	**Unlikely** No suitable habitat occurs in the site.
Neopasiphae simplicior	a short-tongued bee	EN	CR	This species of native bee has been collected on flowers of *Goodenia filiformis* , *Lobelia tenuior* , *Angianthus preissianus* and *Velleia* sp. (Houston 2000).	**Unlikely** No suitable habitat occurs in the site.
Synemon gratiosa	Graceful sun-moth	P4	-	Coastal heathland on Quindalup dunes where it is restricted to secondary sand dunes due to the abundance of the preferred host plant *Lomandra maritima* . Banksia woodland on Spearwood and Bassendean dunes, where the second known host plant *L. hermaphrodita* is widespread (DEC 2011).	**Possible** Suitable habitat (*Lomandra maritima*) within site.
Throscodectes xiphos	Stylet bush cricket	P1	-	Species poorly understood and documented. Known from Jandakot area, where it was originally collected in the axial leaf bases of grass trees (*Xanthorrhoea preissii*) (Invertebrate Solutions 2019).	**Possible** Suitable habitat (*Xanthorrhoea preisii*) within site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Westralunio carteri	Carter's freshwater mussel	VU	VU	Occurs in greatest abundance in slower flowing streams with stable sediments that are soft enough for burrowing amongst woody debris and exposed tree roots. Also occupies lentic systems including large water supply dams and even on-stream farm dams. Salinity tolerance quite low (Morgan et al. 2011).	**Unlikely** No suitable habitat occurs in the site.
Mammals					
Bettongia penicillata ogilbyi	Woylie	CR	EN	Woodlands and adjacent heaths with a dense understorey of shrubs, particularly *Gastrolobium* spp. (TSSC 2018).	**Unlikely** Site occurs outside current distribution.
Dasyurus geoffroii	Chuditch	VU	VU	Wide range of habitats from woodlands, dry sclerophyll forests, riparian vegetation, beaches and deserts. Appears to utilise native vegetation along roadsides in the wheatbelt (DEC 2012b).	**Unlikely** Site occurs outside current distribution.
Falsistrellus mackenziei	Western false pipistrelle	P4	-	High rainfall forests dominated by jarrah, karri, marri, and tuart. Occupies hollow logs for breeding and resting (Van Dyck and Strahan 2008). Also known to utilise Banksia woodland on the Swan Coastal Plain (Hosken and O'Shea 1995).	**Unlikely** Most recent sighting in area from 1993.
Hydromys chrysogaster	Rakali	P4	-	Areas with permanent water, fresh, brackish or marine. Likely to occur in all major rivers and most of the larger streams as well as bodies of permanent water in the lower south-west (Christensen et al. 1985).	**Unlikely** No suitable habitat occurs in the site.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Isoodon fusciventer	Quenda	P4	-	Dense scrubby, often swampy, vegetation with dense cover up to one metre high (DEC 2012)	**Possible** Suitable habitat (dense shrubs) within site.
Myrmecobius fasciatus	Numbat	EN	EN	Generally dominated by *Eucalyptus* spp. that provide hollow logs and branches for shelter and termites for food (van Dyck & Strahan 2008).	**Unlikely** Site occurs outside current distribution.
Notamacropus eugenii derbianus	Tammar wallaby	P4	-	Dry sclerophyll forest, *Banksia* spp. woodlands and shrublands, typically favouring dense low vegetation that provides dense cover (Christensen and Strahan 1983).	**Unlikely** Site occurs outside current distribution.
Notamacropus irma	Western brush wallaby	P4	-	Dry sclerophyll forest, *Banksia* spp. woodlands and shrublands, typically favouring dense low vegetation that provides dense cover (Christensen and Strahan 1983).	**Unlikely** Suitable habitat however site too small and isolated.
Phascogale tapoatafa wambenger	South-western brush-tailed phascogale	CD	-	Dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover (Triggs 2003).	**Unlikely** No suitable habitat occurs in the site.
Pseudocheirus occidentalis	Western ringtail possum	CR	CR	On the Swan Coastal Plain in *Agonis flexuosa* woodlands and *Agonis flexuosa* / *Eucalyptus gomphocephala* forests. Also *Eucalyptus marginata* forests (DBCA 2017).	**Unlikely** No suitable habitat and species occurs further south.
Setonix brachyurus	Quokka	VU	VU	On the mainland mostly dense streamside vegetation or shrubland and heath areas, particularly around swamps (Cronin 2007).	**Unlikely** Site occurs outside current distribution.

Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Reptiles					
Lerista lineata	Perth slider	P3	-	Sandy coastal heath and low scrubland. Banksia spp. woodland, *Eucalyptus gomphocephala* open woodland over deep sands, and coastal dunes immediately adjacent to the beach (Wilson and Swan 2017).	**Possible** Suitable habitat (Banksia woodland) within site.
Neelaps calonotos	Black-striped snake	P3	-	Coastal and near-coastal dunes, sandplains supporting heathlands and *Banksia* spp. woodlands (Bush et al. 2002).	**Possible** Suitable habitat (Banksia woodland) within site.

Note: CE=critically endangered, EN=endangered, VU=vulnerable, CD=conservation dependent, MI=migratory, OS=other specially protected, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4. Species recorded or considered to potentially occur within the site are shaded green.

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Species name	Common name	Level of		Habitat	Likelihood of occurrence
		WA	EPBC Act		

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Appendix E

Species List

Fauna List
Lot 16 Barfield Road, Hammond Park

Category	Status	Species name	Common name	Record type
Birds		*Corvus coronoides*	Australian raven	Sight
		Threskiornis moluccus	Australian white ibis	Sight
		Coracina novaehollandiae	Black-faced cuckoo-shrike	Sight
		Lichmera indistincta	Brown honeyeater	Call
	EN	*Zanda latirostris*	Carnaby's black cockatoo	Sight
		Eolophus roseicapilla	Galah	Sight
		Phylidonyris novaehollandiae	New Holland honeyeater	Call
	DP	*Trichoglossus haematodus*	Rainbow lorikeet	Call
		Anthochaera carenculata	Red wattlebird	Call
		Gavicalis virescens	Singing honeyeater	Call
		Hirundo neoxena	Welcome swallow	Sight
Mammals		*Macropus fulignosus*	Western grey kangaroo	Tracks
Reptiles		*Tiliqua rugosa*	Bobtail	Tracks

Note: DP = Declared pest, EN = Endangered

Appendix D

Vivente Local Structure Plan - Local Water Management Strategy Addendum (Emerge Associates 2023c)

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Document Reference: EP14-023(04)—034 AJI

Emerge contact: David Coremans

8 February 2023

Attention: Peter Dockett
Richard Noble
Level 1, 189 Hay Street
Subiaco WA 6008

Delivered by email to: pdockett@rnoble.com.au

Dear Peter

VIVENTE LOCAL STRUCTURE PLAN – LOCAL WATER MANAGEMENT STRATEGY ADDENDUM

Emerge Associates have prepared this letter report as an addendum to the approved *Barfield Road Local Structure Plan (LSP) Local Water Management Strategy (LWMS)* (Emerge Associates 2013) and previous *LWMS addendum* (Emerge Associates 2015a) to incorporate the proposed amendments to the Barfield Road LSP. Since further subdivision approval, the LSP area has been renamed to '*Vivente*', therefore from herein, the LWMS addendum will be referring to the Vivente LSP area.

1 BACKGROUND

Vivente is located in Hammond Park in the City of Cockburn (CoC), as illustrated in the attached **Figure 1**. The current, approved LSP incorporates Lots 13, 14, 15, and 18 Barfield Road and 48 - 51 Frankland Avenue. The proposed amendment of the Vivente LSP facilitates the inclusion of Lot 16 Barfield Road, as illustrated in the attached **Figure 2**. The 'site' refers to the amended Vivente LSP area, inclusive of Lot 16. A copy of the proposed amendment to the LSP is provided in **Attachment A**.

Emerge Associates have prepared this letter report to provide a summary of the changes to water management across the site required to incorporate the proposed LSP amendments. This letter report should only be read in conjunction with the approved *Barfield Road LSP LWMS* (Emerge Associates 2013) and the previous *LWMS addendum* (Emerge Associates 2015a).

The water conservation and groundwater management criteria and measures for the amended LSP area are consistent with those detailed in the approved *Barfield Road LSP LWMS* (Emerge Associates 2013) and are therefore not detailed in this letter report.

The storm water management criteria for the site are detailed in the approved *Barfield Road LSP LWMS* (Emerge Associates 2013). The stormwater management measures proposed for the amended LSP are consistent with those presented in the LWMS.

The key stormwater management parameters related to drainage design are to:

Criteria SW1 Retain runoff from the 1% Annual Exceedance Probability (AEP) event on site.

Criteria SQ1 Retain and treat the 1 event per year (EY) rainfall event on site.

2 SURFACE RUNOFF MODELLING

As detailed in the *Barfield Road LSP LWMS* (Emerge Associates 2013), XPSWMM (hydrological and hydraulic modelling software) was used to determine the runoff volumes required to be retained on site in accordance with the stormwater management criteria.

The inclusion of Lot 16 will result in additional runoff being directed to the two basins located within CtF (see **Figure 3**). The configuration of these two basins were designed and constructed based on modelling assumptions provided in the *Barfield Road LSP Modelling Report* (Emerge Associates 2015b). The modelling was conceptual and not based on the final landscape design (which at that stage had not been completed). The final landscaped construction of these basins within Ct-F, resulted in two co-located bio-retention areas (BRA) and flood storage areas (FSA) within the Ct-F1 public open space (POS) area. The inclusion of Ct-F5 (Lot 16) increases the total catchment area of Ct-F to 17 ha (approximately 2 ha larger), and therefore the purpose of this addendum is to confirm that the already constructed BRAs and FSAs have capacity to provide the required treatment and flood storage for the existing and amended sub-catchments within Ct-F.

Given the original sizing of BRAs and FSAs were modelled using the 1987 Australian Rainfall and Runoff (ARR) guidelines (Engineers Australia 1987) and respective rainfall patterns, and adopted the conceptual approach which models a square basin, it is appropriate to update the XPSWMM model to be consistent with the most recent 2019 ARR guidelines (Ball J *et al.* 2019) and updated rainfall patterns, as well as to include the design contours of the already constructed BRAs/FSAs. Updating the model and resizing the FSAs with the actual design contours will better reflect the flood storage likely to occur and determine if additional capacity is required to accommodate the addition of sub-catchments Ct-F.

The lot assumptions for all single residential lots within Ct-F5 will retain the 20% AEP event within soakwells, as required by the CoC. All additional runoff from lots will either be infiltrated on lot in pervious garden areas or discharged to downstream retention areas. The runoff from lots assumed in the hydrological modelling (detailed in the modelling report, provided in **Appendix B**) equates to a runoff co-efficient of 0.2, required by CoC (S Hussain [CoC] 2015, pers. comm., July 13).

Since the *Barfield Road LSP Modelling Report* (Emerge Associates 2015b), a geotechnical investigation within Stage 3 (including the basin locations) was undertaken and found that the existing soils are capable of achieving very high infiltration rates, with results ranging between 63 m/day and 200 m/day. Therefore, the updated modelling report adopted the following infiltration rates for POS-F basin, as outlined within the *Modelling Assumptions Report* (Emerge Associates 2017) prepared to support the *Vivente Stage 3 UWMP addendum* (Emerge Associates 2018), which include:

- An infiltration rate of 25 m/day has been assumed in the FSA areas of the basin based on infiltration testing carried out in POS C post-landscape completion (detailed in the *Vivente Stage 3 UWMP addendum* (Emerge Associates 2017)).
- An infiltration rate of 3.5 m/day has been assumed in the BRA based on infiltration testing carried out in POS C post-landscape completion.

Based on the updated XPSWMM model results, the FSAs provide sufficient storage to accommodate the additional catchment Ct-F5 (Lot 16) and still meet the relevant design criteria. This outcome was to be expected as the original modelled volume and area of FSAs were designed using conservative assumptions, and the additional contributing area within Ct-F5 is relatively minor (0.73 ha).

As shown in **Table 1**, the addition of Ct-F5 (Lot 16) increases the depth of the BRA (1 EY event) in Basin 1 to 20 mm higher than the depth without the inclusion of Ct-F5. This additional volume will spill over into the BRA of Basin 2 and due to the shallow depth, large surface area and high infiltration rates (25 m/day) of Basin 2, the additional volume will readily be infiltrated.

The flood storage requirements can be achieved within the existing FSAs, as shown in **Figure 3** and **Table 1**, which also indicates that the required flood storage is less than the 1,750 m^3 of storage achieved by the POS-F basin design.

Table 1: Updated bio-retention and flood storage requirements for management of small, minor and major rainfall event

Basin location	Basin type	Small – First 15 mm/1EY			Minor – 20% AEP			Major – 1% AEP		
		Depth (m)	Surface area (m^2)	Volume (m^3)	Depth (m)	Surface area (m^2)	Volume (m^3)	Depth (m)	Surface area (m^2)	Volume (m^3)
POS F	Basin 1	0.52	1273	465	0.66	1792	683	0.97	2557	1367
	Basin 2	0.00	270.60	0.01	0.46	462	167	0.77	555	326
	Total	0.52*	1544	465	1	2253	850	2	3112	1692

**Maximum water depth*

Summary and closing

Based on the updated XPSWMM modelling, the already constructed FSAs within POS-F have sufficient storage to accommodate the additional runoff resulting from the minor amendment to the Vivente LSP. The summary of updated flood storage requirements, as shown in **Table 1** and **Figure 3**, demonstrates that the criteria presented in the approved *Barfield Road LSP LWMS* (Emerge Associates 2015b) and previous *LWMS addendum* (Emerge Associates 2015a) can be achieved, and that the inclusion of Lot 16 can be accommodated within the Vivente LSP area and specifically within POS-F.

Yours sincerely
Emerge Associates



David Coremans
DIRECTOR AND PRINCIPAL ENVIRONMENTAL CONSULTANT - HYDROLOGY

Figure: Figure 1 - Site location
Figure 2 - Proposed LSP amendments
Figure 3 – Stormwater Management Plan

Attachments: Amended Barfield Road LSP
Vivente Updated LSP Modelling Report

General References

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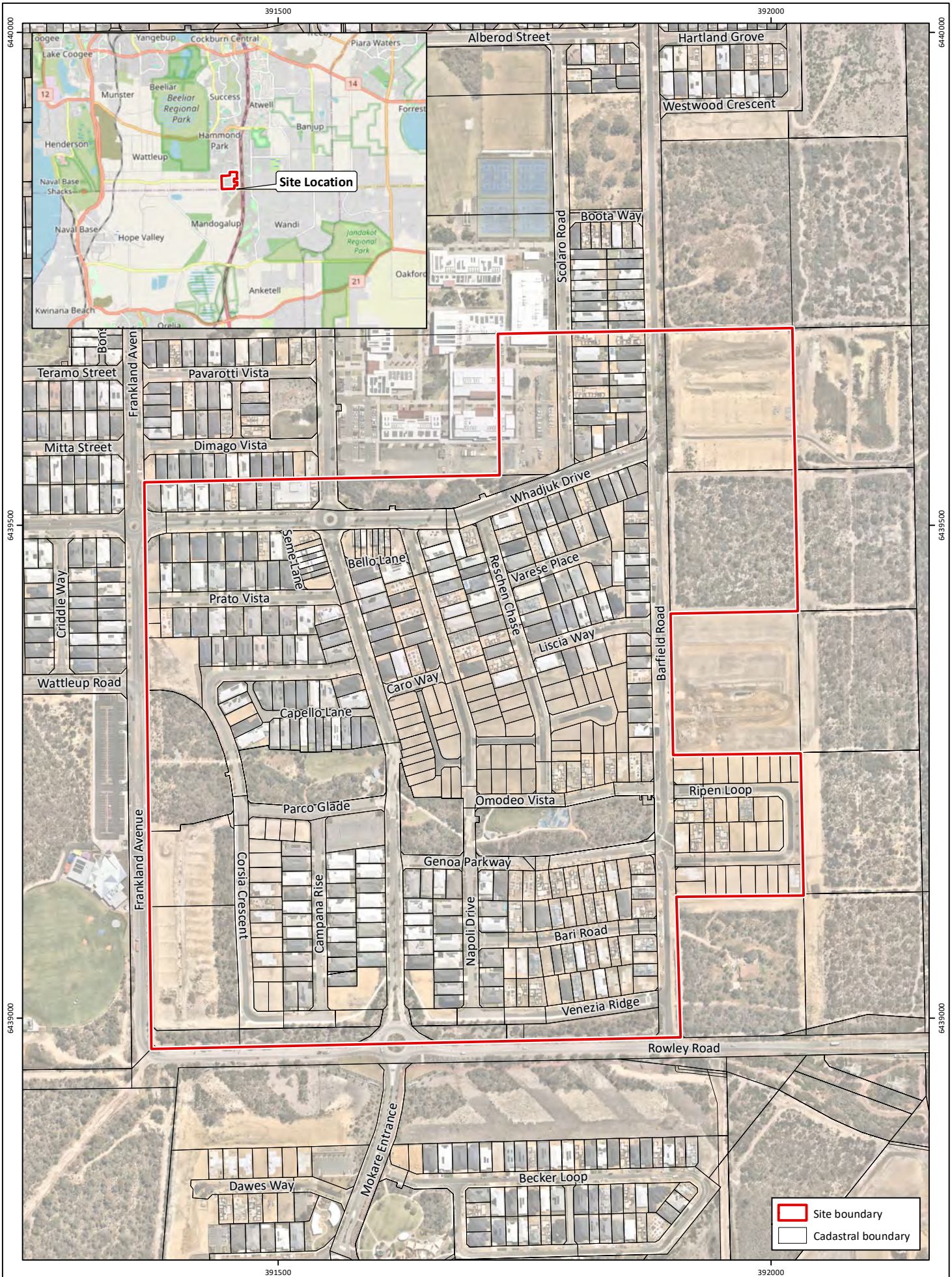


Figure 1: Site Location

Project:	Local Water Management Strategy Addendum Vivente Structure Plan Support
Client:	Richard Noble

Plan Number:
EP14-023(04)--F40

Drawn:	GAR
Date:	02/02/2023
Checked:	AJI
Approved:	DPC
Date:	08/02/2023

N

0 50 100
Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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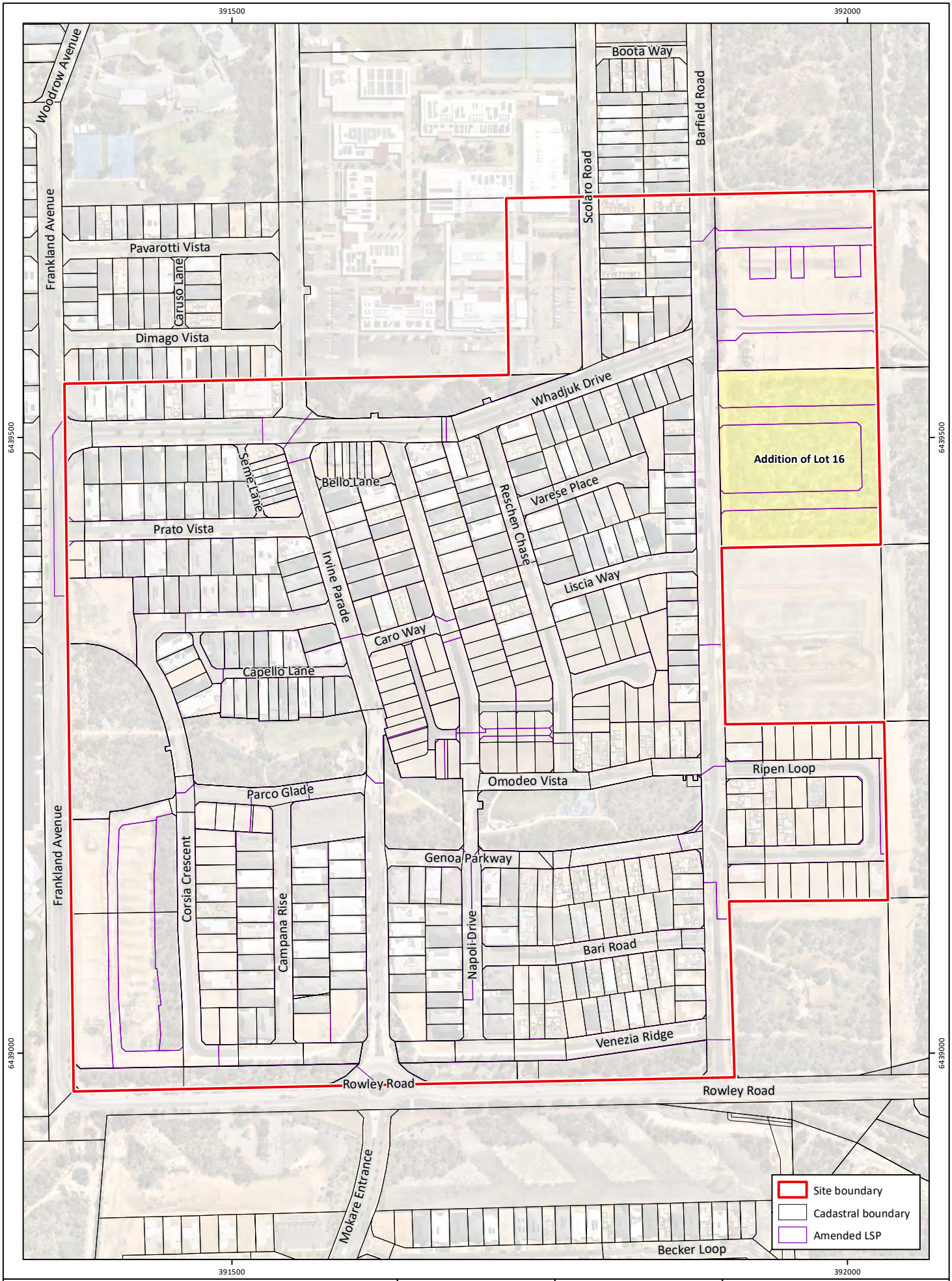


Figure 2: Site Boundary with LSP Amendments

Project: Local Water Management Strategy Addendum
Vivente Structure Plan Support

Client: Richard Noble

Plan Number: EP14-023(04)--F41

Drawn:	GAR
Date:	02/02/2023
Checked:	AJI
Approved:	DPC
Date:	08/02/2023

N

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Metres

Scale: 1:4,000@A4

GDA 1994 MGA Zone 50

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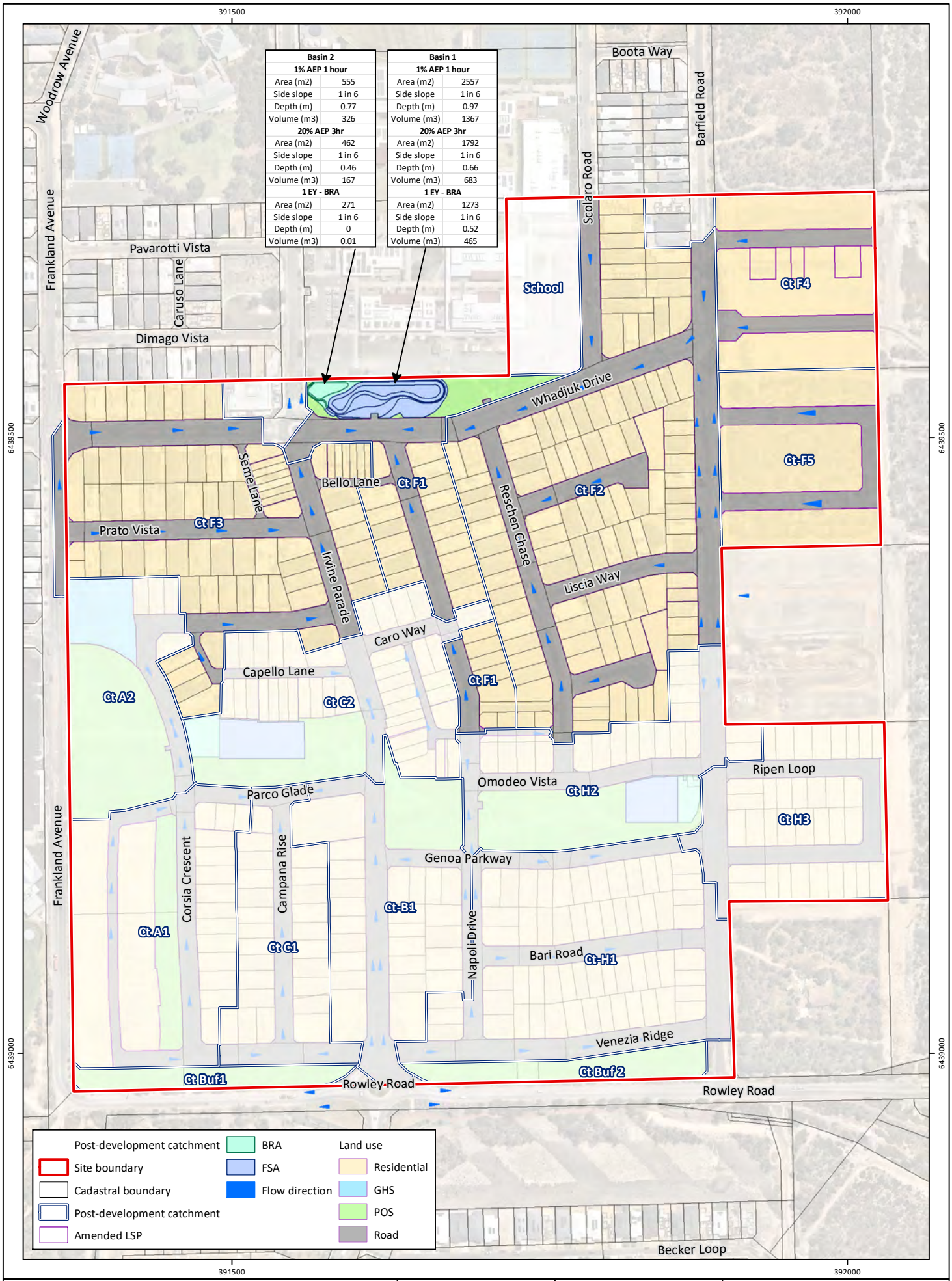


Figure 3: Stormwater Management Plan

Project: Local Water Management Strategy Addendum
Vivente Structure Plan Support

Client: Richard Noble

Plan Number: EP14-023(04)--F42

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Date:	02/02/2023
Checked:	AJI
Approved:	DPC
Date:	08/02/2023

N

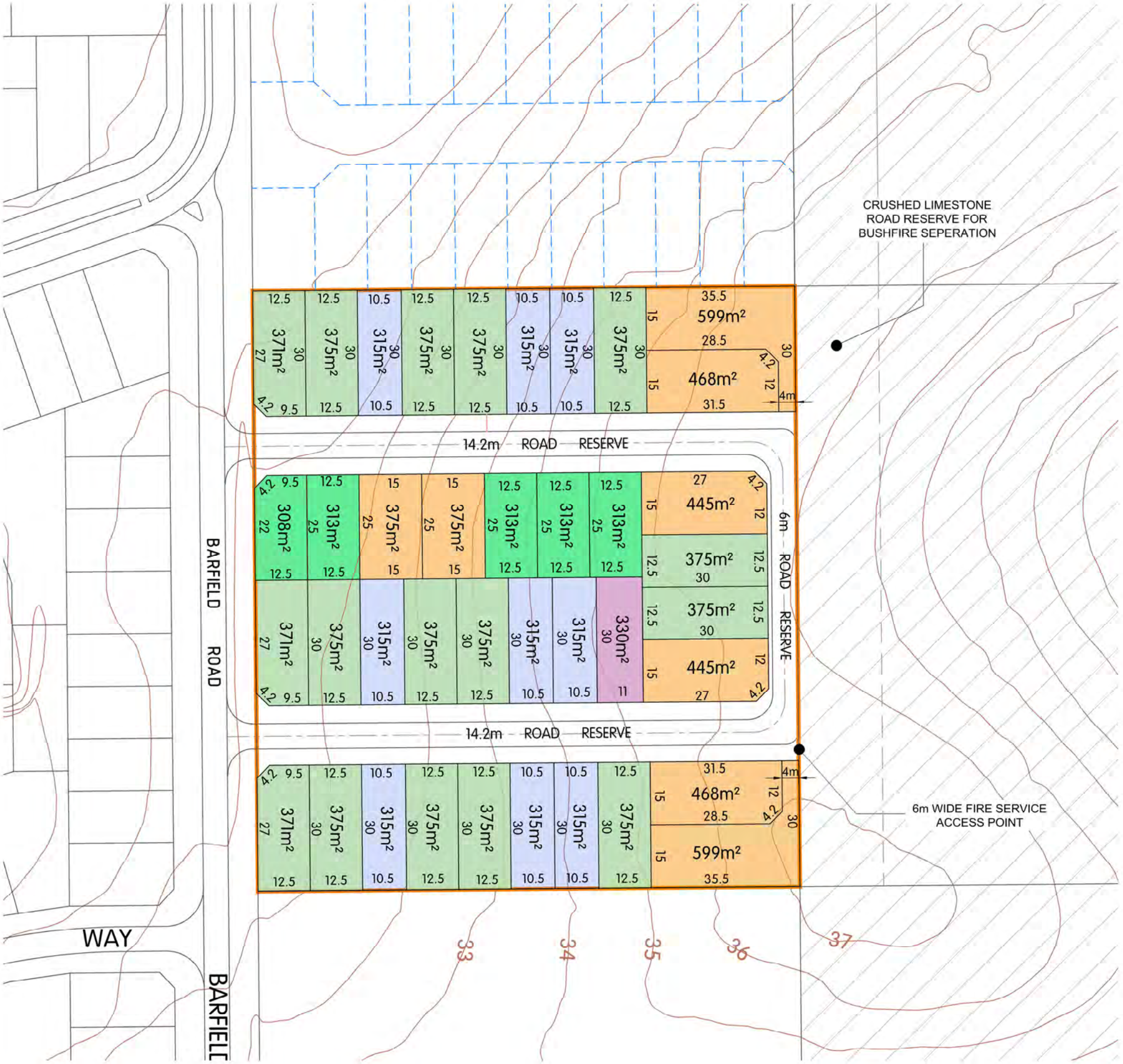
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GDA 1994 MGA Zone 50

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YIELD TABLE	
Existing Lots	1
Proposed Lots	
Residential (Single)	39
Balance of Title	0
TOTAL	**39**

PROPOSED LAND USE/DEVELOPMENT

Zone	Lot Size	No. of Lots
Residential	308m² - 369m²	15
Residential	370m² - 444m²	18
Residential	445m²-600m²	6
	TOTAL	**39**

RICHARDNOBLE
PROPERTY INTEGRITY COMMUNITY

CADASTRAL INFORMATION
SOURCE: MNG
YYMMDD: 220408
DWG REF: 96326lots-9999bn-PCG94
PROJECTION: PCG94

AERIAL PHOTOGRAPHY
SOURCE: NA
YYMMDD: NA

HATCH | RobertsDay

SIZE A3_1:1000

0 metres 10 20 30 40 50

DRAFT

REV	DESCRIPTION	YYMMDD	DRAWN	APPR'D
C	PROPOSED LOT CHANGES	230113	MC	TT
B	LOT MODS - BAL RATINGS	221219	SB	TT
A	FIRST ISSUE	220503	SB	DW

CONCEPT PLAN
Lot 16 Barfield Road
City of Cockburn

REF NO.	DRAW NO.	REV.
RIC HAM	**RD1 410**	**C**

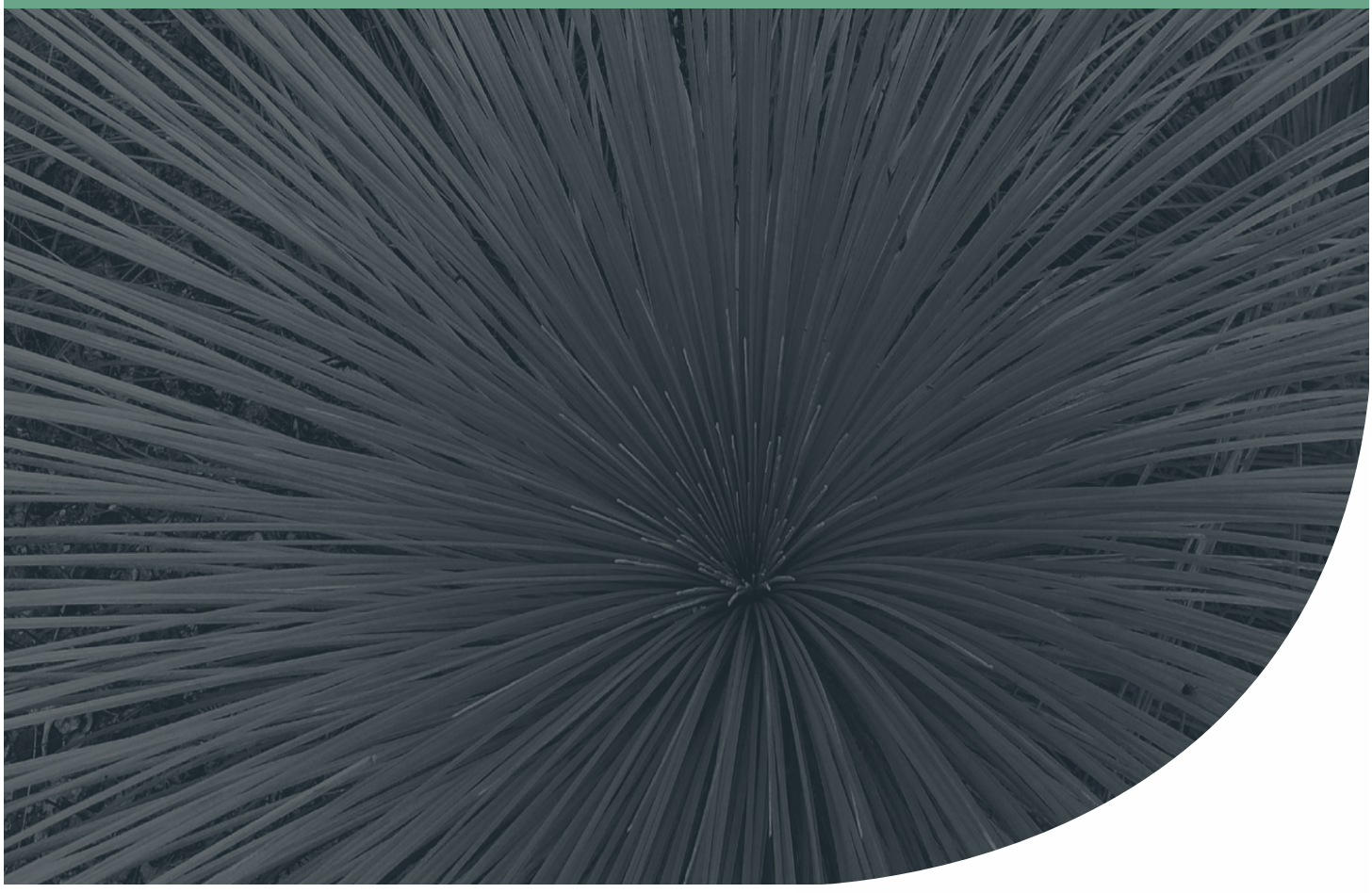
DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY

Modelling Assumptions Report

Vivente, Hammond Park

Project No: EP14-023(03)

Prepared for Richard Noble
February 2023



Document Control

Doc name:	Modelling Assumptions Report Vivente, Hammond Park				
Doc no.:	**EP14-023(03)--035**				
Version	**Date**	**Author**		**Reviewer**	
1	February 2023	April Irwin	AJI	Dave Coremans	DPC
	For inclusion as appendix to LWMS addendum				

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Table 2: Post-development catchment parameters 4

1 Background

This report provides a summary of the detailed hydrological and hydraulic modelling that was undertaken to inform the Vivente Local Structure Plan Area (LSP) Local Water Management Strategy (LWMS) addendum. The current, approved LSP incorporates Lots 13, 14, 15, and 18 Barfield Road and 48 - 51 Frankland Avenue. The proposed amendment of the Vivente LSP facilitates the inclusion of Lot 16 Barfield Road, and the inclusion of Lot 16 will increase the LSP area to 38.24 ha.

2 Methodology

XPSWMM hydrological and hydraulic modelling software was used to calculate the surface water runoff volumes. The hydrological component of the software uses the Laurenson non-linear runoff-routing method to simulate runoff from design storm events. Key assumptions regarding the hydrological model include:

- Runoff is proportional to slope, area, infiltration and percentage of imperviousness of a catchment.
- Sub-catchment areas and slopes are determined from surveyed topographical data and earthworks plans.
- Infiltration rates and percentage imperviousness have been selected based on experience with model preparation for similar soil conditions.

Runoff from each sub-catchment is routed through the catchment using the hydraulic component of XPSWMM. Assumptions associated with the hydraulic component of the model include:

- Virtual links (i.e. purely for model construction, not equivalent to flow path onsite) between nodes within a sub-catchment are given the length of 10 m and slope of 0.05 to minimise the lag time of conveying the water from a sub-catchment node to a 'storage' node, a 'dummy intermediate' node or a conduit/link.
- Links between sub-catchment storages act as conveyance channels (e.g. sheet flow within roads in a 1% annual exceedance probability (AEP)). These links are given lengths and slopes that are representative of the site conditions and actual pathway lengths between catchments.
- All channels are designed with a width of 5 m, roughness of 0.014 (Manning's n) and are trapezoidal in shape. This allows for easy conveyance and represents concrete pipes and road surfaces within the model.
- Soakwells are modelled as nodal-reservoirs with infiltration depth-rating curves.
- Minimum ponding conditions of less than the 5% from the total volume have been allowed within 1 event per year (EY) event storage nodes for events greater than the 1 EY event.
- Where relevant roadside swales, bio-retention areas (BRAs), and flood storage areas (FSAs) are modelled as nodal-reservoirs with infiltration depth-rating curves to account for differential infiltration rates with changing depth.

2.1 Rainfall

The superceded 1987 Australian Rainfall and Runoff (AR&R) (Engineers Australia 1987) rainfall patterns used in previous model revisions were updated to include the 2019 ensemble temporal patterns obtained from the AR&R Data Hub (AR&R 2019) to perform the rainfall analysis.

Up to eight durations ranging between 1 hour and 72 hours were tested, with the peak flood elevation being assessed as the determining result.

Following the process suggested by AR&R (Ball J et al. 2019), the highest mean duration was selected as the critical duration. AR&R also recommends that when it is not practical to run the entire ensemble array, the ensemble that produces the result closest to the mean (for the critical duration) should be adopted. The 1 hour duration ensemble 7 and the 3 hour duration ensemble 1 was adopted for the 1% AEP and 20% AEP events respectively.

3 Post-development Model

A breakdown of the existing post-development catchments within the site are shown within **Table 1**, including the additional land types due to the inclusion of Ct-F5.

Table 1: Post-development catchment areas

Catchment	Road (ha)	POS (ha)	Lots > 300 (ha)	Lots ≤ 300 (ha)	Group housing (ha)
CtA1	0.720	0.352	1.756	0.062	0.000
CtA2	0.278	0.965	0.217	0.000	0.258
CtB1	0.694	0.398	1.224	0.000	0.217
CtC1	0.586	0.000	1.075	0.015	0.000
CtC2	0.481	0.774	1.336	0.262	0.000
CtF1	0.684	0.564	0.911	0.048	0.000
CtF2	2.629	0.000	4.056	0.000	0.604
CtF3	1.306	0.000	2.780	0.048	0.000
CtF4	0.406	0.000	1.230	0.000	0.161
CtF5	**0.49**	**0.000**	**1.411**	**0.000**	**0.000**
Ct H1	1.267	0.000	2.254	0.125	0.066
Ct H2	0.542	0.864	0.371	0.108	0.000
Ct H3	0.522	0.000	1.010	0.000	0.525
BUF1	0.000	0.393	0.000	0.000	0.000
BUF2	0.000	0.490	0.000	0.000	0.000
Rd 2	0.066	0.000	0.000	0.000	0.000
Total	10.671	4.800	19.631	0.668	1.830

**Highlight indicates the additional catchment and land types from the inclusion of CTF5 (Lot 16)*

An “initial loss - continual loss” infiltration model was adopted to represent the post-development environment, with loss values chosen based on project team experience with similar land types to those found within the site. Post-development catchment parameters are provided in **Table 2**.

Table 2: Post-development catchment parameters

Land type	Initial loss (mm)	Continual loss (mm/h)	Manning's number (n)
Road surface	1	0.1	0.14
Road verge	12	2.0	0.05
Roof	1	0.1	0.14
Lot impervious	1	0.1	0.02
Gardens	25	3.5	0.05
POS	20	3	0.05

The infiltration rates used in the post-development model were predominantly based upon the following assumptions:

- Land use assumptions
  - Residential lots > 300 m^2 will have 50% roof areas, 20% front yard and 30% back yard. The front yard has been assumed to be 100% impervious with all flows from this area being directed to downstream drainage areas. This assumption is in response to the City of Cockburn (CoC) requirement for a 0.2 runoff co-efficient from lots of this size (S. Hussain [CoC] 2015, pers. comm. 22nd July).
  - Group housing and high density lots (lots ≤ 300 m^2) will have 50% roof areas with the remainder of the lots paved (45%) and pervious garden (5%).
  - Road reserve contains 60% pervious verge and 40% impervious bitumen areas with road verges having an initial loss of 12 mm (i.e. overall road reserve has an equivalent runoff coefficient of approximately 0.9).
  - The road verge area is similar in characteristics to POS areas except that it will also have an impervious footpath and some driveway crossovers. Therefore the average initial loss will be lower than POS initial loss rates.
- Lot retention assumptions
  - Residential lots > 300 m^2 will provide onsite retention for roof and back garden runoff from the 1% AEP event, with soakwells sized to retain the 20% AEP event consistent with CoC building design guidelines. Runoff from the front garden will be conveyed to downstream retention areas within the road drainage network and public open space (POS) areas.
  - High density lots (≤ 300 m^2) will retain the 1% AEP event from the rear pervious garden areas (5%) with soakwells sized to retain the 20% AEP storm event consistent with CoC building design guidelines. All additional runoff will be conveyed to downstream retention areas via the road network.
  - Group housing lots will provide retention for the 1 EY event onsite. Pervious areas of group housing lots will retain the 1% AEP event runoff within the lot.
- Catchment infiltration assumptions
  - There will be no infiltration on roads, pavements and driveways. There will however be some minor absorption storage loss and this is accounted for in the initial and continuing loss values.
  - Garden areas will have high infiltration rates as it is likely that sand or mulch will be used.

  - POS areas will likely contain dense vegetation or turf over a sand-based landscape mix. It is anticipated that the infiltration losses allowed for in the initial loss and continual loss will be higher than the rate of runoff accumulation from the 1 EY event.
- Storage assumptions
  - Side entry soakage pits (SEP), bio-retention areas (BRAs) and the first two rows of subsurface storage cells (within catchment H) will retain runoff from the 1 EY event from road reserves, residential lot drive ways and high density lots.
  - Major event runoff (up to the 1% AEP event) will be retained within flood storage areas (FSAs).
  - The existing basin designs have been accounted for within the model and has indicated a maximum depth of 1.2 m.
- Storage infiltration assumptions
  - POS F
    - An infiltration rate of 25 m/day has been assumed in the FSA areas of the basin based on infiltration testing carried out in POS C post-landscape completion (detailed in the *Vivente Stage 3 UWMP addendum* (Emerge Associates 2017a)).
    - An infiltration rate of 3.5 m/day has been assumed in the BRA based on infiltration testing carried out in POS C post-landscape completion.
- Volumes leaving the system through evapotranspiration are assumed to be negligible when compared to the total runoff volume and since the duration of model run is comparatively short. XPSWMM default evapotranspiration assumptions are therefore used.

4 References

Emerge Associates 2015, *Vivente Stage 1 Urban Water Management Plan*, August 2015.

Emerge Associates 2017a, *Vivente Stage 3 Urban Water Management Plan Addendum*, November 2017.

Emerge Associates 2017b, *Vivente Stage 8 Urban Water Management Plan Addendum*, November 2017.

Engineers Australia 1987, *Australian Rainfall and Runoff*, National Committee for Water Engineering, Canberra.

Appendix E

Transportation Noise Assessment
(Lloyd George Acoustics 2023)

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Transportation Noise Assessment

Lot 16 Barfield Road, Hammond Park

Reference: 22117711-01A

Prepared for:
Gold Estates C/- Richard Noble

Association of Australasian Acoustical Consultants

Reference: 22117711-01A

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Date	Rev	Description	Author	Verified
15-Dec-22	0	Issued to Client	Terry George	Matt Moyle
18-Jan-23	A	Updated layout	Terry George	-

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1. INTRODUCTION

It is proposed to subdivide land at Lot 16 Barfield Road, Hammond Park (refer *Figure 1-1*) with the proposed subdivision plan shown in *Figure 1-2*. The site is in the vicinity of Kwinana Freeway, which is considered a 'Strategic Freight/Major Traffic Route in accordance with the PlanWA Maps, such that a noise assessment is required against *State Planning Policy No. 5.4 Road and Rail Noise*, being the subject of this report.

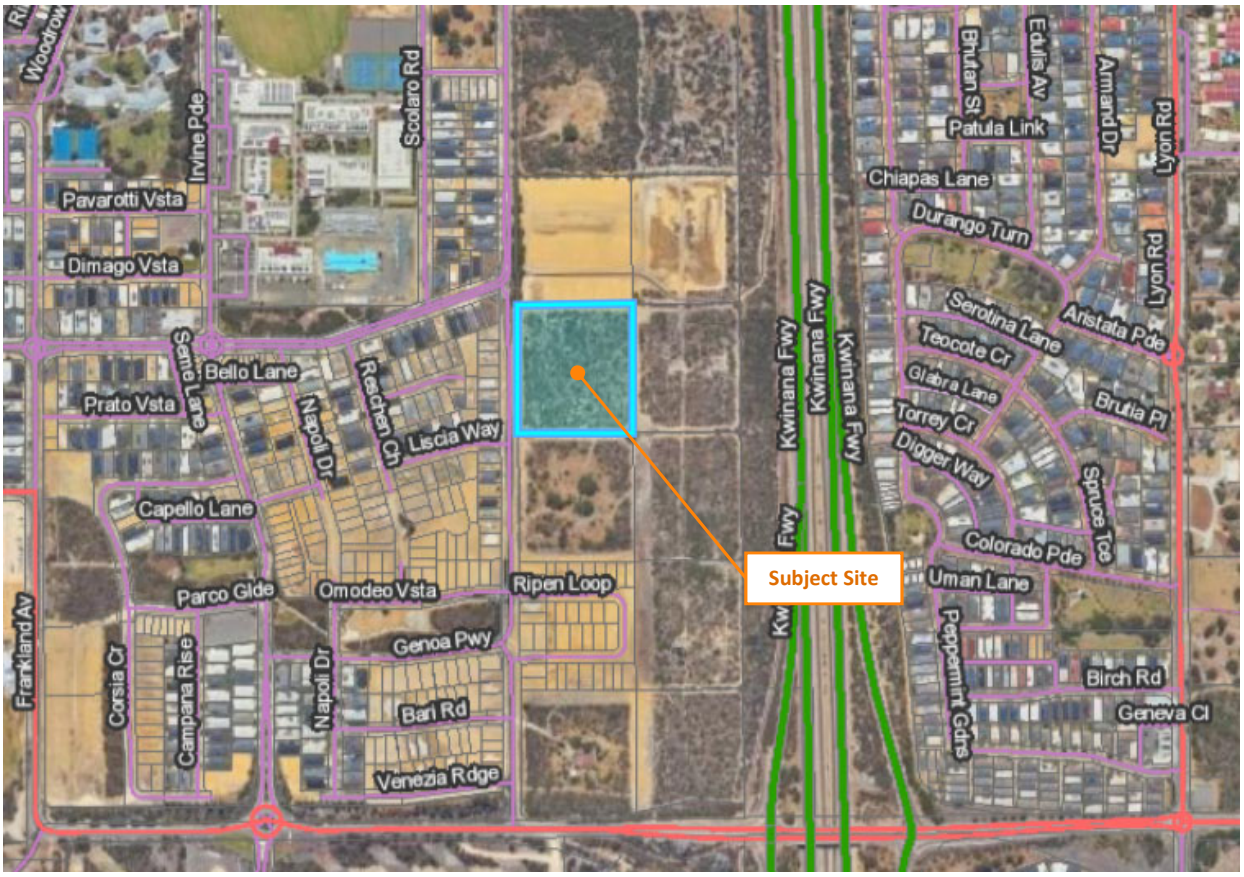


Figure 1-1: Subdivision Location (Source: DPLH PlanWA)

Appendix B contains a description of some of the terminology used throughout this report.

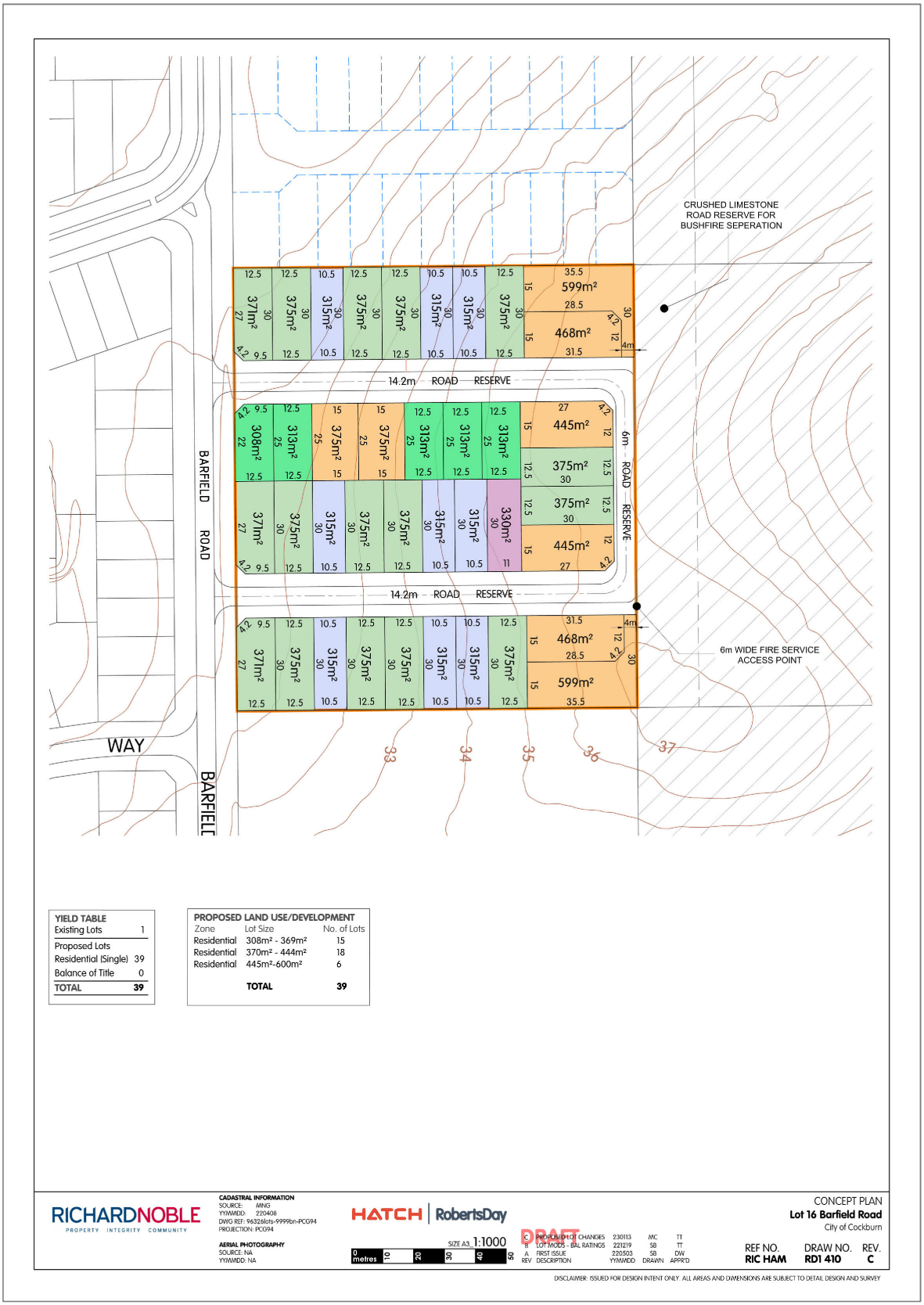


Figure 1-2: Subdivision Layout

2. CRITERIA

The criteria relevant to this project is provided in *State Planning Policy No. 5.4 Road and Rail Noise* (hereafter referred to as SPP 5.4) produced by the Western Australian Planning Commission (WAPC). SPP 5.4 is supported by the *Road and Rail Noise Guidelines* (the Guidelines) and the Department of Planning, Lands and Heritage mapping. The objectives of SPP 5.4 are to:

- Protect the community from unreasonable levels of transport noise;
- Protect strategic and other significant freight transport corridors from incompatible urban encroachment;
- Ensure transport infrastructure and land-use can mutually exist within urban corridors;
- Ensure that noise impacts are addressed as early as possible in the planning process; and
- Encourage best practice noise mitigation design and construction standards.

Table 2-1 sets out noise targets that are to be achieved by proposals under which SPP 5.4 applies. Where the targets are exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.

Table 2-1: Noise Targets for Noise Sensitive Land-Use

Scenario	Outdoor Noise Target		Indoor Noise Target	
Noise-sensitive land-use and/or development	55 dB $L_{Aeq(Day)}$	50 dB $L_{Aeq(Night)}$	40 dB $L_{Aeq(Day)}$ (Living and Work Areas)	35 dB $L_{Aeq(Night)}$ (Bedrooms)

Notes:

- Day period is from 6am to 10pm and night period from 10pm to 6am.
- The outdoor noise target is to be measured at 1-metre from the most exposed, habitable[1] facade of a noise sensitive building.
- For all noise-sensitive land-use and/or development, indoor noise targets for other room usages may be reasonably drawn from Table 1 of Australian Standard/New Zealand Standard AS/NZS 2107:2016 *Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors* (as amended) for each relevant time period.
- Outdoor targets are to be met at all outdoor areas as far as is reasonable and practicable to do so using the various noise mitigation measures outlined in the Guidelines.

The application of SPP 5.4 is to consider anticipated traffic volumes for the next 20 years from when the noise assessment has been undertaken.

[1] *A habitable room is defined in State Planning Policy 3.1 as a room used for normal domestic activities that includes a bedroom, living room, lounge room, music room, sitting room, television room, kitchen, dining room, sewing room, study, playroom, sunroom, gymnasium, fully enclosed swimming pool or patio.*

3. METHODOLOGY

Noise measurements and modelling have been undertaken in accordance with the requirements of SPP 5.4 and associated Guidelines, as described in *Section 3.1* and *Section 3.2*.

3.1. Site Measurements

Noise monitoring was undertaken alongside Kwinana Freeway using an Acoustic Research Laboratories (ARL) Noise Data Logger (S/N: 15-301-468) (refer *Figure 3-1*). The logger was programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. The logger complies with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The logger was field calibrated before and after the measurement session and found to be accurate to within ± 1 dB. Lloyd George Acoustics holds current laboratory calibration certificate for the logger.

The microphone was approximately 1.4 metres above existing ground level and approximately 30 metres from the edge of the northbound Kwinana Freeway main carriageway. The measurements were recorded between 12 October 2021 and 22 October 2021 and are still considered valid for model calibration.



Figure 3-1: Photograph of Noise Logger on Site

3.2. Noise Modelling

The computer program *SoundPLAN 7.3* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Class 1 and 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two source heights at 1.5 metres and 3.6 metres above road level;
- A -0.8 dB correction has been applied to the lower level heavy vehicle noise source and -8.0 dB to the higher level noise source based on the *Transportation Noise Reference Book*; Paul Nelson (1987), so as to provide consistent results with the CoRTN algorithms;
- Adjustments of -0.8 dB and -1.7 dB have been applied to the predicted levels for the 'free-field' and 'at façade' cases respectively, based on the findings of *An Evaluation of the U.K. DoE Traffic Noise Prediction*; Australian Road Research Board, Report 122 ARRB – NAASRA Planning Group (March 1983).

Predictions are made at heights of 1.4 metres above ground floor level, representing single storey houses. The noise is predicted at 1-metre from an assumed building façade, resulting in a + 2.5 dB correction due to reflected noise.

Various input data are included in the modelling and these are discussed in *Section 3.2.1* to *Section 3.2.5*.

3.2.1. Ground Topography and Buildings

Topographical and road design data was on file with regard to previous developments in the area and combined with the expected finished lot levels provided by Richard Noble and shown in *Figure 3-2*.

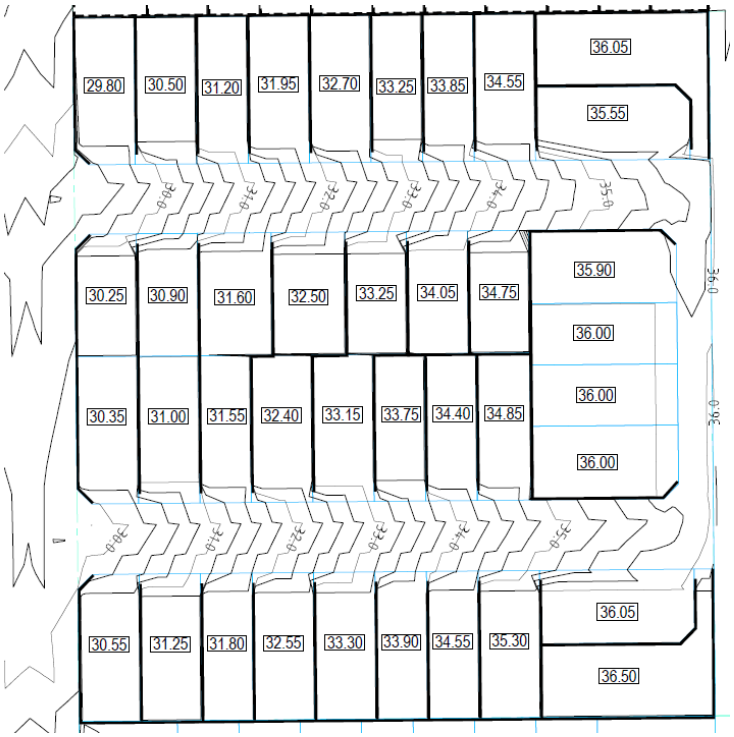


Figure 3-2: Expected Finished Lot Levels

Indicative building outlines have been included as these can provide barrier attenuation when located between a source and a receiver, in much the same way as a hill or wall. All buildings are assumed to be single storey with heights of 3.5 metres.

3.2.2. Road Surface

The corrections applied for different road surface finishes are provided in *Table 3-1*.

Table 3-1: Noise Relationship Between Different Road Surfaces

Chip Seal				Asphalt			
14mm	10mm	5mm	Slurry	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	+1.0 dB	0.0 dB	-0.2 dB	-1.5 dB	-2.5 dB

The existing road surface for Kwinana Freeway is open graded asphalt and assumed to remain unchanged into the future.

3.2.3. Vehicle Speed

The existing posted speed is 100 km/hr for Kwinana Freeway and assumed to remain unchanged into the future.

3.2.4. Traffic Volumes

Existing traffic volumes were obtained from Main Roads WA Traffic Map. A modelled Validation Plot and Forecast 2041 traffic volumes were obtained from Main Roads WA (Thomas Ng, Traffic Modelling Analyst, Reference: #42030). The validation plot allows the forecast volumes to be calibrated with *Table 3-2* providing the traffic volumes used in the noise modelling. Note that the percentage heavy vehicles are assumed to be the same in the future as existing.

Table 3-2: Traffic Information Used in Noise Modelling

Road	Scenario			
	Existing – 2020/21		Future – 2041	
	Northbound	Southbound	Northbound	Southbound
Kwinana Freeway – north of ramps	50,773 (16.0)	49,803 (12.5)	78,300 (11.0)	82,700 (10.0)
Kwinana Freeway – south of ramps	45,428 (13.6)	45,614 (13.1)	72,400 (9.0)	74,100 (9.0)
Ramps – north of Rowley Road	5,345 (36.4)	4,189 (6.0)	5,900 (25.0)	8,600 (20)

Numbers in brackets are percentage heavy vehicles.

3.2.5. Ground Absorption

The ground absorption has been assumed to be 0.0 (0%) for the roads, 0.5 (50%) outside of the roads and 1.0 (100%) for public open spaces, noting that 0.0 represents hard reflective surfaces such as water and 1.0 represents absorptive surfaces such as grass.

4. RESULTS

4.1. Noise Monitoring

The results of the noise monitoring are summarised in *Table 4-1* and shown graphically in *Figure 4-1*.

Table 4-1: Measured Average Noise Levels at Logger

Date	Parameter			
	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
Wednesday, 13 October 2021	72.0	70.5	70.9	69.7
Thursday, 14 October 2021	70.4	68.3	69.1	66.4
Friday, 15 October 2021	70.9	68.7	69.6	65.9
Saturday, 16 October 2021	69.7	66.7	67.8	63.0
Sunday, 17 October 2021	69.0	66.1	67.5	60.5
Monday, 18 October 2021	69.9	67.7	68.6	65.4
Tuesday, 19 October 2021	72.9	70.8	71.4	69.5
Wednesday, 20 October 2021	72.1	69.5	70.3	67.1
Thursday, 21 October 2021	70.6	68.6	69.2	67.3
Average	**70.4**	**68.3**	**69.1**	**66.2**

Shaded cells not used in average due to poor weather or not being a weekday.

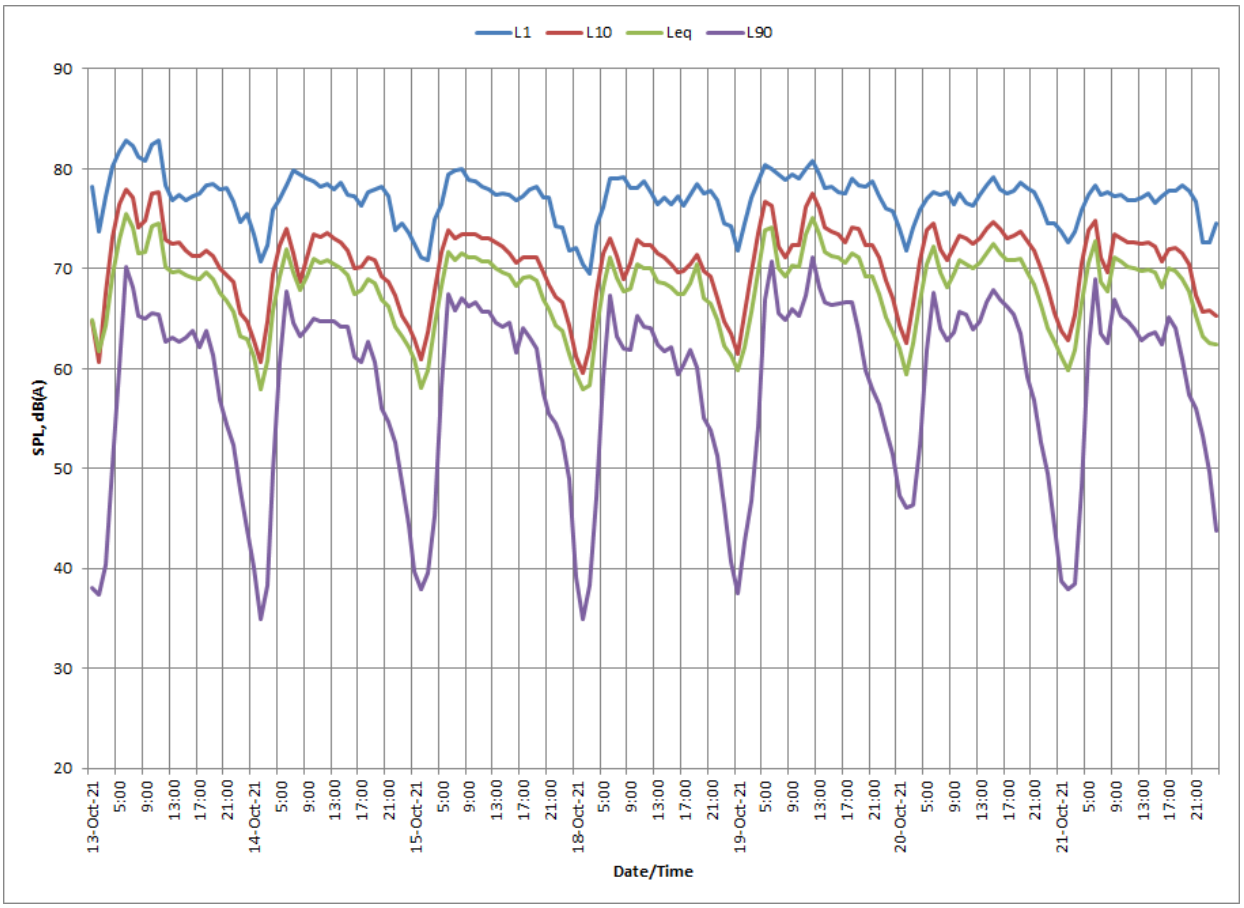


Figure 4-1: Hourly Noise Measurement Results at Noise Logger

The average difference between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 2.9 dB and this same difference has been assumed to exist in future years. As the difference between these two parameters is less than 5 dB, it is the night-time noise that will dictate compliance or otherwise (refer *Section 2*).

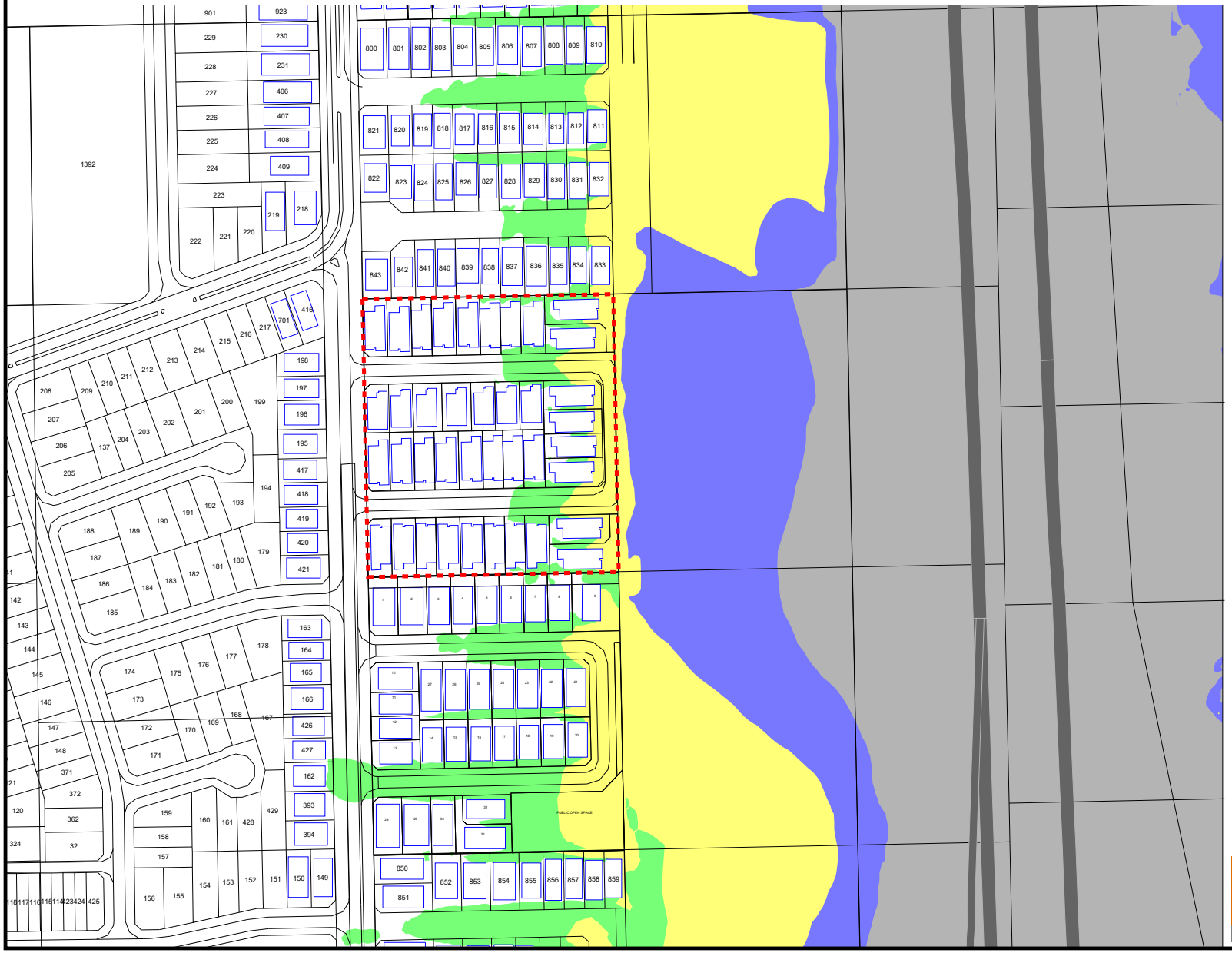
4.2. Noise Modelling

The noise model was initially set-up for existing conditions and calibrated to the noise measurement location. The model is then updated to include the proposed subdivision, indicative buildings and future traffic volumes, maintaining the same model calibration. The results of the noise modelling is provided as a noise contour plot in *Figure 4-2*.

Lot 16 Barfield Road, Hammond Park - Proposed Subdivision

$L_{Aeq(Night)}$ Noise Level Contours - Future

Figure 4-2



Noise levels

$L_{Aeq(Night)}$ dB

<=	50	
<=	51	Exposure A
<=	52	
<=	53	
<=	54	Exposure B
<=	55	
<=	56	
<=	57	
<=	58	Exposure C
<=	59	
<=	60	
<=	61	
>	61	Exposure D+

N

Signs and symbols

- Road Lanes
- Building
- Subject Site

18 January 2023

Length Scale 1:3000

0 15 30 60 90 120 m

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by Terry George
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5. ASSESSMENT

The objectives of SPP 5.4 are to achieve:

- Indoor noise levels specified in *Table 2-1* in noise-sensitive areas (e.g. bedrooms and living rooms or houses); and
- A reasonable degree of acoustic amenity for outdoor living areas on each residential lot.

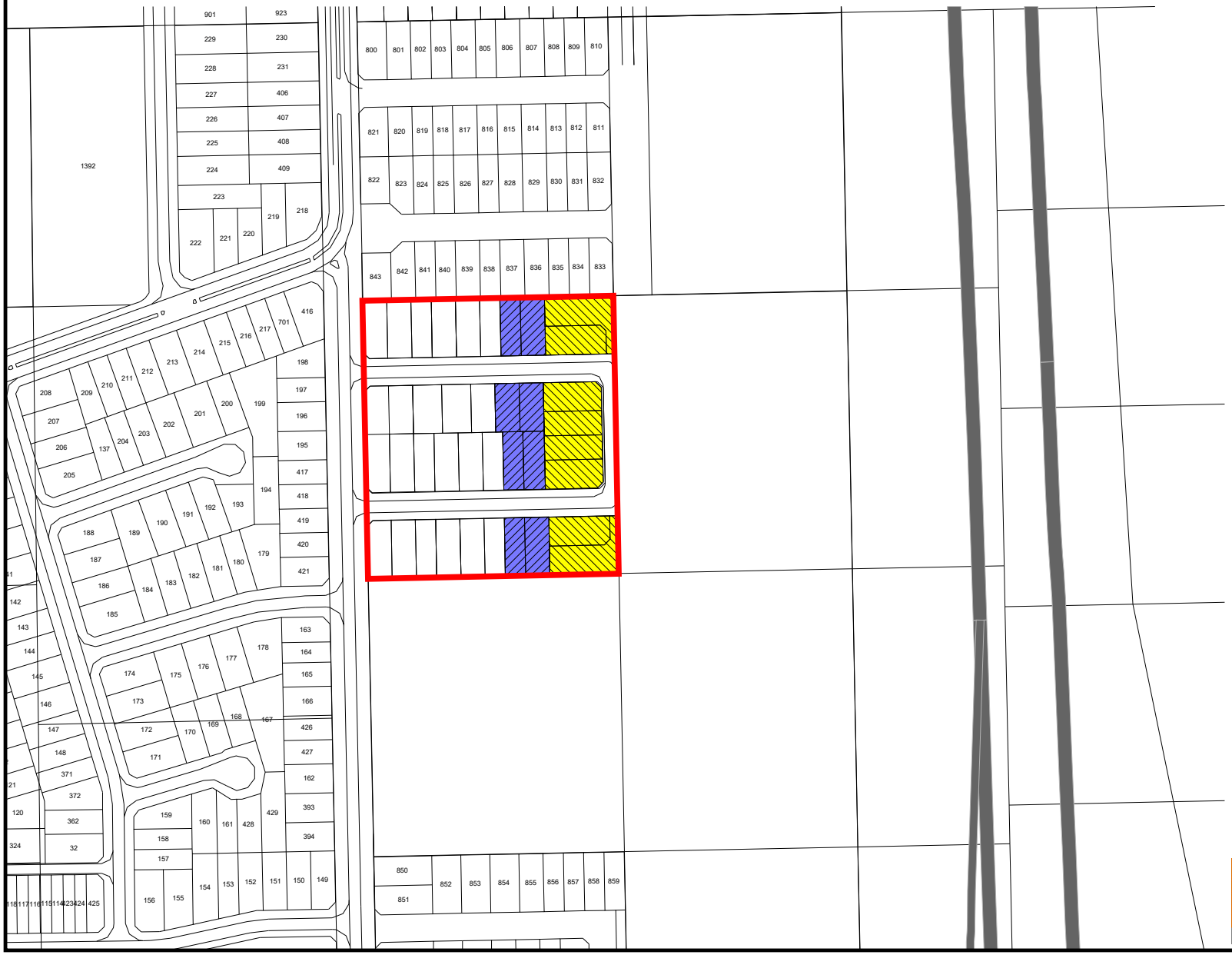
Where the outdoor noise targets of *Table 2-1* are achieved, no further noise controls are necessary. With reference to *Section 4.2*, it is evident the outdoor noise target will be exceeded at some lots.

The noise control will be via architectural packages (refer *Appendix A*) whereby the first row of houses will implement Package B with other lots identified as requiring Package A as shown on *Figure 5-1* being for ground floor. Alternatives to the provided Packages can be accepted if supported by a report from a suitably qualified acoustical consultant (member firm of the Association of Australasian Acoustical Consultants (AAAC)) once the specific house plans for the lot are available. In addition, each of these lots will require a notification on title in accordance with SPP 5.4. Any lot within the subdivision that is two storey dwelling shall be subject to an individual house assessment when plans are available.

Lot 16 Barfield Road, Hammond Park - Proposed Subdivision

Proposed Noise Mitigation

Figure 5-1



Signs and symbols

- Road Lanes
- Subject Site
- Package A (Kwinana Fwy)
- Package B (Kwinana Fwy)

18 January 2023

Length Scale 1:3000

0 15 30 60 90 120 m

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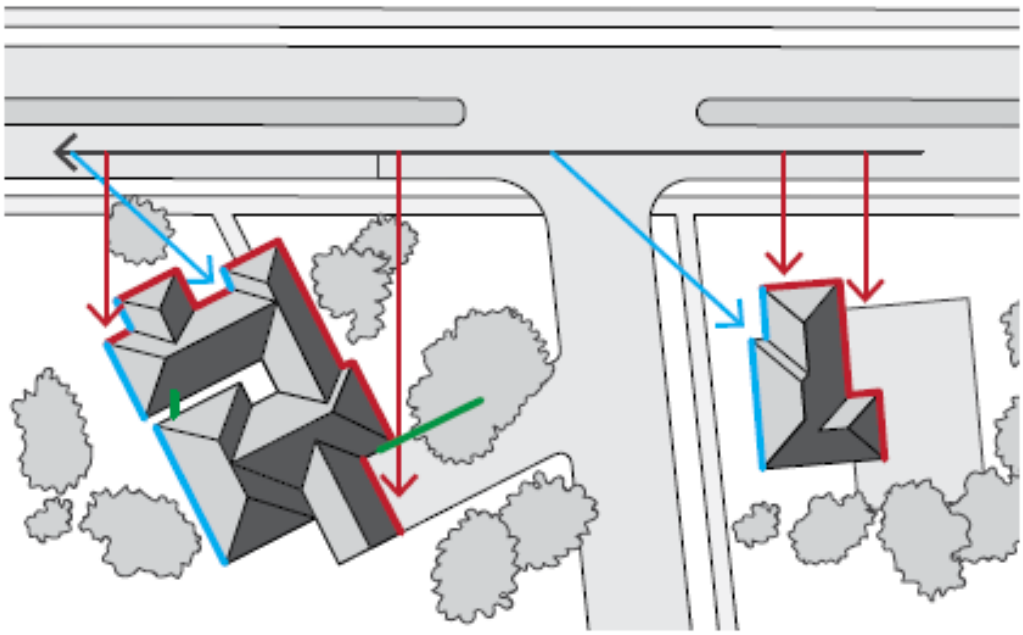
Appendix A – Quiet House Packages

The packages and information provided on the following pages are taken from *Road and Rail Noise Guidelines* (September 2019).

Where outdoor and indoor noise levels received by a noise-sensitive land-use and/or development exceed the policy's noise target, implementation of quiet house requirements is an acceptable solution.

With regards to the packages, the following definitions are provided:

- **Facing** the transport corridor (red): Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular (at a 90 degree angle) to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).
- **Side-on** to transport corridor (blue): Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line, at any angle, can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).
- **Opposite** to transport corridor (green): Neither 'side on' nor 'facing', as defined above.



Quiet House Package A

56-58 dB $L_{Aeq(Day)}$ & 51-53 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): – Sliding or double hung with minimum 10mm single or 6mm-12mm-10mm double insulated glazing; – Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$): – Sealed awning or casement windows with minimum 6mm glass.	• Up to 40% floor area ($R_w + C_{tr} \geq 25$): – Sliding or double hung with minimum 6mm single or 6mm-12mm-6mm double insulated glazing; • Up to 60% floor area ($R_w + C_{tr} \geq 28$); • Up to 80% floor area ($R_w + C_{tr} \geq 31$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	No specific requirements	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.	• Doors to achieve $R_w + C_{tr} \geq 25$: – 35mm Solid timber core hinged door and frame system certified to R_w 28 including seals; – Glazed sliding door with 10mm glass and weather seals.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less.	
	Opposite	No specific requirements	
External Walls	All	• $R_w + C_{tr} \geq 45$: – Two leaves of 90mm thick clay brick masonry with minimum 20mm cavity; or – Single leaf of 150mm brick masonry with 13mm cement render on each face; or – One row of 92mm studs at 600mm centres with: ▪ Resilient steel channels fixed to the outside of the studs; and ▪ 9.5mm hardboard or fibre cement sheeting or 11mm fibre cement weatherboards fixed to the outside; ▪ 75mm thick mineral wool insulation with a density of at least 11kg/m^3; and ▪ 2 x 16mm fire-rated plasterboard to inside.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: • Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2 metres height above ground level.	

Quiet House Package B

59-62 dB $L_{Aeq(Day)}$ & 54-57 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): – Sliding or double hung with 6mm-12mm-10mm double insulated glazing; – Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$); • Up to 80% floor area ($R_w + C_{tr} \geq 34$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass.	• Doors to achieve $R_w + C_{tr} \geq 28$: – 40mm Solid timber core hinged door and frame system certified to R_w 32 including seals; – Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: – Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester (24kg/m³). Resilient ties used where required to connect leaves. – Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). – Single leaf of 220mm brick masonry with 13mm cement render on each face. – 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. – Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m³) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: – Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling with R3.0+ fibrous insulation.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2.4 metres height above ground level.	

Quiet House Package C

63-66 dB $L_{Aeq(Day)}$ & 58-61 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 20% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 40% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Not recommended.	• Doors to achieve $R_w + C_{tr} \geq 30$: – Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass; – 40mm Solid timber core side hinged door, frame and seal system certified to R_w 32 including seals. Any glass inserts to be minimum 6mm.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: – Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). Resilient ties used where required to connect leaves. – Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). – Single leaf of 220mm brick masonry with 13mm cement render on each face. – 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. – Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m³) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 40$: – Concrete or terracotta tile roof with sarking, or metal sheet roof with foil backed R2.0+ fibrous insulation between steel sheeting and roof battens; – R3.0+ insulation batts above ceiling; – 2 x 10mm plasterboard ceiling or 1 x 13mm sound-rated plasterboard affixed using steel furring channel to ceiling rafters.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2.4 metres height above ground level.	

Mechanical Ventilation requirements

In implementing the acceptable treatment packages, the following mechanical ventilation / air-conditioning considerations are required:

- Acoustically rated openings and ductwork to provide a minimum sound reduction performance of R_w 40 dB into sensitive spaces;
- Evaporative systems require attenuated ceiling air vents to allow closed windows;
- Refrigerant based systems need to be designed to achieve National Construction Code fresh air ventilation requirements;
- Openings such as eaves, vents and air inlets must be acoustically treated, closed or relocated to building sides facing away from the corridor where practicable.

Notification

Notifications on title advise prospective purchasers of the potential for noise impacts from major transport corridors and help with managing expectations.

The Notification is to state as follows:

This lot is in the vicinity of a transport corridor and is affected, or may in the future be affected, by road and rail transport noise. Road and rail transport noise levels may rise or fall over time depending on the type and volume of traffic.

Appendix B – Terminology

The following is an explanation of the terminology used throughout this report:

- **Decibel (dB)**

The decibel is the unit that describes the sound pressure levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

- **A-Weighting**

An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A, dB.

- **L_{eq}**

The L_{eq} level represents the average noise energy during a measurement period.

- **L_1**

The L_1 level represents the noise level exceeded for 1 percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

- **L_{10}**

The L_{10} level represents the noise level exceeded for 10 percent of the measurement period and is considered to represent the "intrusive" noise level.

- **L_{90}**

The L_{90} level represents the noise level exceeded for 90 percent of the measurement period and is considered to represent the "background" noise level.

- **$L_{Aeq(Day)}$**

The $L_{Aeq(Day)}$ level is the logarithmic average of the L_{Aeq} levels from 6.00am to 10.00pm.

- **$L_{Aeq(Night)}$**

The $L_{Aeq(Night)}$ level is the logarithmic average of the L_{Aeq} levels from 10.00pm to 6.00am.

- **$L_{A10,18hour}$**

The $L_{A10,18hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00am and midnight.

- **$L_{Aeq,24hour}$**

The $L_{Aeq,24hour}$ level is the logarithmic average of the L_{Aeq} levels from over an entire day.

- **Noise-sensitive land use and/or development**

Land-uses or development occupied or designed for occupation or use for residential purposes (including dwellings, residential buildings or short-stay accommodation), caravan park, camping ground, educational establishment, child care premises, hospital, nursing home, corrective institution or place of worship.

- **R_w**

This is the weighted sound reduction index. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

- **C_{tr}**

This is a spectrum adaptation term for airborne noise and provides a correction to the R_w value to suit source sounds with significant low frequency content such as road traffic or home theatre systems. A wall that provides a relatively high level of low frequency attenuation (i.e. masonry) may have a value in the order of – 4 dB, whilst a wall with relatively poor attenuation at low frequencies (i.e. stud wall) may have a value in the order of -12 dB.

- **About the Term 'Reasonable'**

An assessment of reasonableness should demonstrate that efforts have been made to resolve conflicts without comprising on the need to protect noise-sensitive land-use activities. For example, have reasonable efforts been made to design, relocate or vegetate a proposed noise barrier to address community concerns about the noise barrier height? Whether a noise mitigation measure is reasonable might include consideration of:

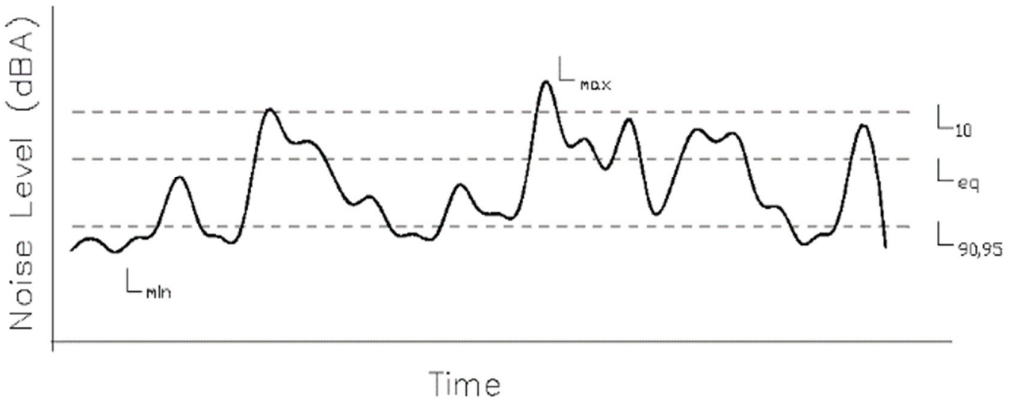
  - The noise reduction benefit provided;
  - The number of people protected;
  - The relative cost vs benefit of mitigation;
  - Road conditions (speed and road surface) significantly differ from noise forecast table assumptions;
  - Existing and future noise levels, including changes in noise levels;
  - Aesthetic amenity and visual impacts;
  - Compatibility with other planning policies;
  - Differences between metropolitan and regional situations and whether noise modelling requirements reflect the true nature of transport movements;
  - Ability and cost for mobilisation and retrieval of noise monitoring equipment in regional areas;
  - Differences between Greenfield and infill development;
  - Differences between freight routes and public transport routes and urban corridors;
  - The impact on the operational capacity of freight routes;
  - The benefits arising from the proposed development;
  - Existing or planned strategies to mitigate the noise at source.

- **About the Term 'Practicable'**

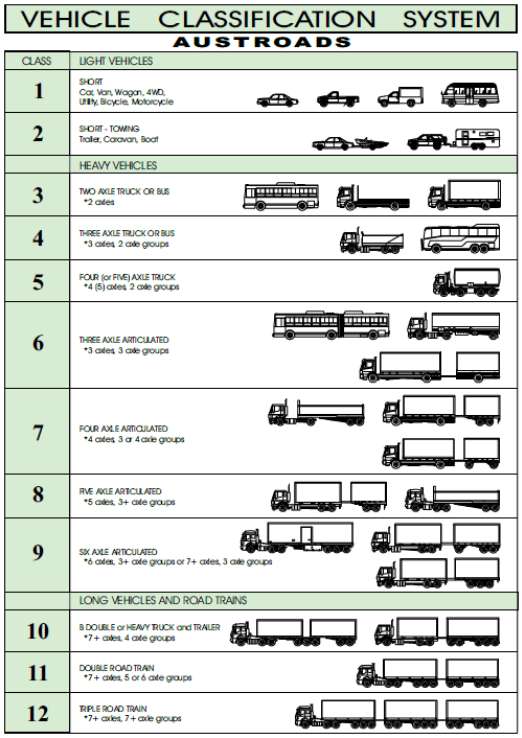
'Practicable' considerations for the purposes of the policy normally relate to the engineering aspects of the noise mitigation measures under evaluation. It is defined as "reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge" (*Environmental Protection Act 1986*). These may include:

- Limitations of the different mitigation measures to reduce transport noise;
- Competing planning policies and strategies;
- Safety issues (such as impact on crash zones or restrictions on road vision);
- Topography and site constraints (such as space limitations);
- Engineering and drainage requirements;
- Access requirements (for driveways, pedestrian access and the like);
- Maintenance requirements;
- Bushfire resistance or BAL ratings;
- Suitability of the building for acoustic treatments.

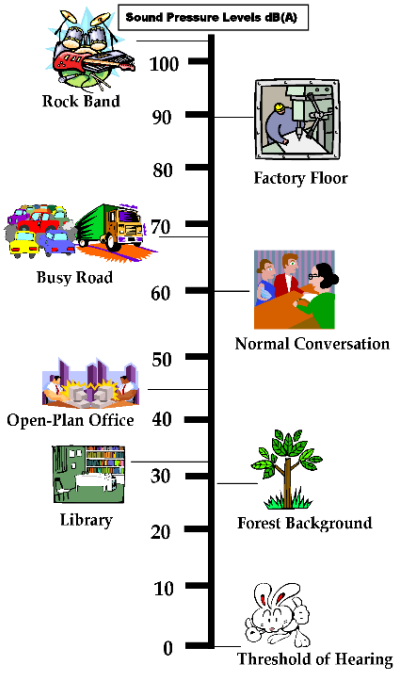
- **Chart of Noise Level Descriptors**



- **Austroads Vehicle Class**



- **Typical Noise Levels**



Appendix F

Bushfire Management Plan Addendum: Vivente Structure Plan Amendment (Lot 16 Barfield Road) (JBS&G 2023)

FPA AUSTRALIA | Fire Protection Association Australia | Life. Property. Environment.

BPAD Bushfire Planning & Design

Bushfire Management Plan Coversheet

This Coversheet and accompanying Bushfire Management Plan has been prepared and issued by a person accredited by Fire Protection Association Australia under the Bushfire Planning and Design (BPAD) Accreditation Scheme.

Bushfire Management Plan and Site Details

Site Address / Plan Reference: Vivente Structure Plan Amendment (Lot 16 Barfield Road)

Suburb: Hammond Park **State:** WA **P/code:** 6164

Local government area: City of Cockburn

Description of the planning proposal: Structure Plan Amendment

BMP Plan / Reference Number: 64203/149,088 **Version:** M01 Rev 0 **Date of Issue:** 19/01/2023

Client / Business Name: Gold Estates Holdings Pty Ltd

Reason for referral to DFES	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?	☐	☒
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the BPC elements)?	☐	☒
Is the proposal any of the following special development types (see SPP 3.7 for definitions)?		
Unavoidable development (in BAL-40 or BAL-FZ)	☐	☒
Strategic planning proposal (including rezoning applications)	☒	☐
Minor development (in BAL-40 or BAL-FZ)	☐	☒
High risk land-use	☐	☒
Vulnerable land-use	☐	☒

If the development is a special development type as listed above, explain why the proposal is considered to be one of the above listed classifications (E.g. considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

The proposal is a Structure Plan Amendment, which is a strategic planning proposal.

Note: The decision maker (e.g. local government or the WAPC) should only refer the proposal to DFES for comment if one (or more) of the above answers are ticked "Yes".

BPAD Accredited Practitioner Details and Declaration

Name	Accreditation Level	Accreditation No.	Accreditation Expiry
Zac Cockerill	Level 2	BPAD 37803	31/08/2023
Company		**Contact No.**	
JBS&G		(08) 9792 4797	

I declare that the information provided within this bushfire management plan is to the best of my knowledge true and correct

Signature of Practitioner  **Date** 19/01/2023

Name:	Peter Dockett	Date:	19 January 2023
Company:	Gold Estate Holdings Pty Ltd	Job/Doc. No.:	64203/149,088
Email:	pdockett@rnoble.com.au	Inquiries:	Zac Cockerill

Bushfire Management Plan Addendum: Vivente Structure Plan Amendment (Lot 16 Barfield Road)

1.1 Introduction

Hatch Roberts Day, on behalf of Gold Estate Holdings Pty Ltd, is lodging a Structure Plan Amendment over Vivente Estate to facilitate inclusion of Lot 16 Barfield Road, Hammond Park into the development area. Inclusion of Lot 16 (hereon referred to as the project area) will provide for additional residential development and an internal road network, as depicted in the indicative development concept plan (Figure 1). A 20 m wide road reserve is proposed adjacent east of the project area, consistent with Stage 10 Structure Plan provisions adjacent north of the project area.

Strategen-JBS&G (now JBS&G) prepared a comprehensive Bushfire Management Plan (BMP) in May 2020 to support the previous Structure Plan Amendment that incorporated Stages 9 and 10 into the development area of Vivente Estate. This report has been prepared as an addendum to the 2020 BMP to accompany the Structure Plan Amendment relating to Lot 16.

This BMP addendum provides an updated strategic level bushfire assessment specific to the project area (appropriate to the Structure Plan stage of development) and should be read in conjunction with the original BMP (Strategen-JBS&G 2020a). This BMP addendum includes the following information:

1. A revised bushfire assessment including:
    a. indicative development concept plan for the project area (Figure 1)
    b. updated pre- and post-development Vegetation Classification and Effective Slope maps specific to the project area and current/proposed vegetation conditions (Figure 2 and Figure 3)
    c. updated pre-development Bushfire Hazard Level Assessment map specific to the project area and current vegetation conditions, as mapped from Item 1b above (Figure 4)
    d. updated post-development Bushfire Attack Level (BAL) Assessment map specific to the project area and proposed vegetation conditions, as mapped from Item 1b above (Figure 5).
2. A revised assessment against the bushfire protection criteria of the *Guidelines for Planning in Bushfire-Prone Areas Version 1.4* (the Guidelines; WAPC 2021), demonstrating that compliance will be achieved at subsequent planning stages (Table 5).

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1.2 Purpose

The project area is designated bushfire prone on the Map of Bush Fire Prone Areas (refer to Plate 1; DFES 2021); therefore, bushfire risk considerations and assessment are required to inform the development proposal in accordance with Policy Measure 6.2 of *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP3.7; WAPC 2015).

This BMP addendum has been prepared to accompany the proposed Structure Plan Amendment and address strategic planning requirements under Policy Measure 6.3 of SPP3.7 in accordance with the Guidelines.

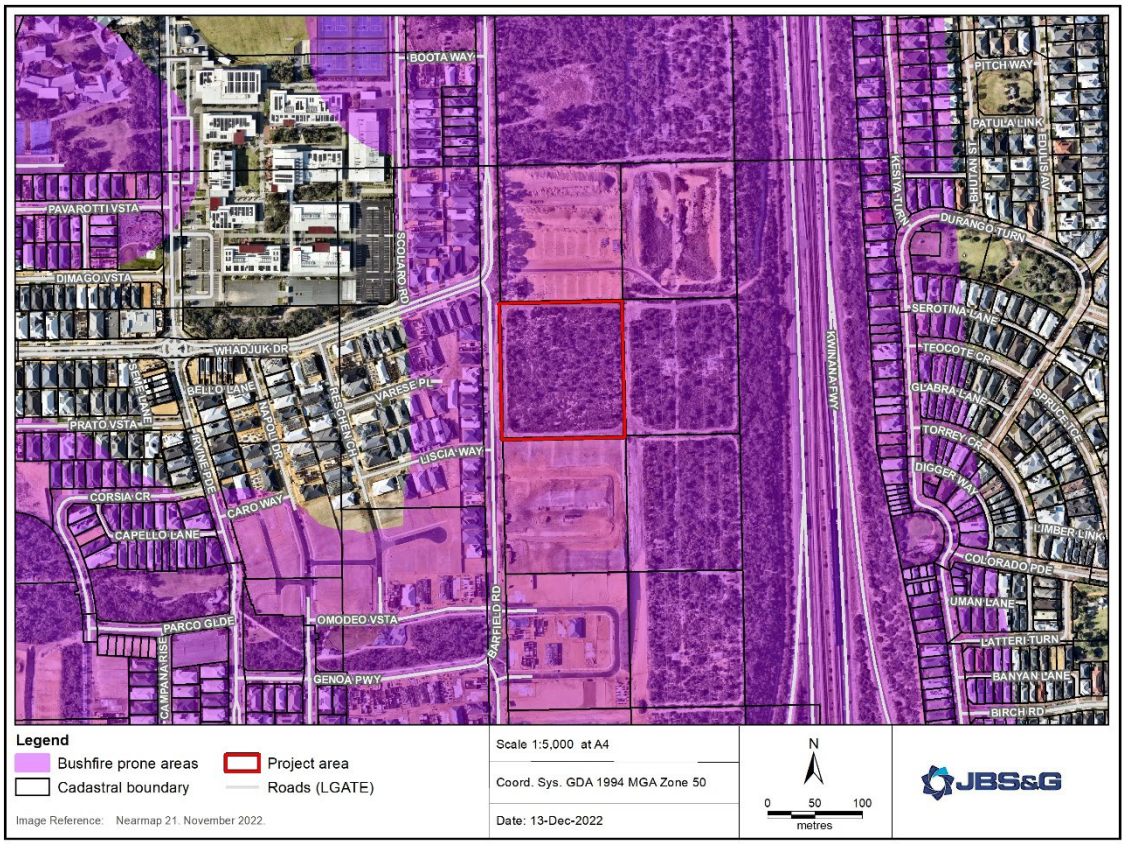
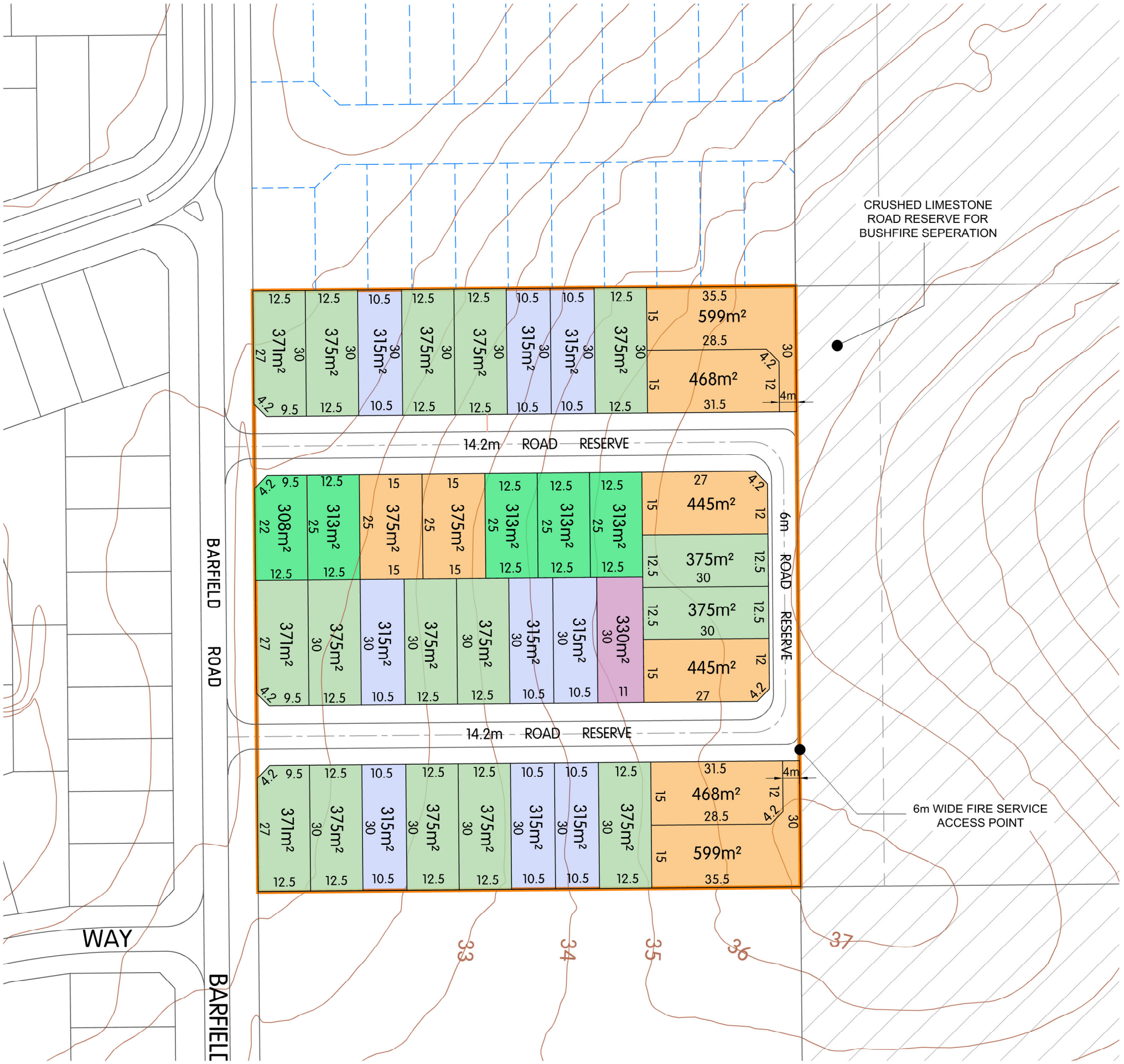


Plate 1: Designated bushfire prone status of the project area (DFES 2021)



YIELD TABLE	
Existing Lots	1
Proposed Lots	
Residential (Single)	39
Balance of Title	0
TOTAL	**39**

PROPOSED LAND USE/DEVELOPMENT

Zone	Lot Size	No. of Lots
Residential	308m² - 369m²	15
Residential	370m² - 444m²	18
Residential	445m²-600m²	6
	TOTAL	**39**

RICHARDNOBLE
PROPERTY INTEGRITY COMMUNITY

CADASTRAL INFORMATION
SOURCE: MNG
YYMMDD: 220408
DWG REF: 96326lots-9999bn-PCG94
PROJECTION: PCG94

AERIAL PHOTOGRAPHY
SOURCE: NA
YYMMDD: NA

HATCH | RobertsDay

SIZE A3_1:1000

0 metres 10 20 30 40 50

DRAFT

REV	DESCRIPTION	YYMMDD	DRAWN	APPR'D
C	PROPOSED LOT CHANGES	230113	MC	TT
B	LOT MODS - BAL RATINGS	221219	SB	TT
A	FIRST ISSUE	220503	SB	DW

CONCEPT PLAN
Lot 16 Barfield Road
City of Cockburn

REF NO.	DRAW NO.	REV.
RIC HAM	**RD1 410**	**C**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY

1.3 Bushfire assessment results (assessment inputs)

1.3.1 Vegetation classification

JBS&G assessed vegetation classifications and exclusions within the project area and adjacent 150 m (i.e. the assessment area) through on-ground verification on 12 June 2018, 15 May 2019, 23 July 2020, 12 October 2021, 17 May 2022 and 7 September 2022 to support previous BMPs and BAL certification processes.

Vegetation classifications have been assigned in accordance with *AS 3959—2018 Construction of Buildings in Bushfire-Prone Areas* (AS3959; SA 2018) and the *Visual Guide for Bushfire Risk Assessment in Western Australia* (DoP 2016). Georeferenced site photos and a description of the vegetation classifications and exclusions are contained in Figure 3 and Appendix 2 of the previous Structure Plan Amendment BMP for Vivente Estate (Strategen-JBS&G 2020a), as well as Figure 1 and Appendix B of the BAL Compliance Report for Stage 4 Vivente Estate (Strategen-JBS&G 2020b). Vegetation classification results are outlined in Table 1 and Figure 2 for existing pre-development conditions; and Table 2 and Figure 3 for anticipated post-development conditions.

Site and desktop observations indicate that where vegetated, the project area and adjacent 150 m comprises consistent coverage of Class D scrub containing a predominant banksia/sheoak fuel profile less than 6 m in height over a low shrub understorey. Vegetation previously classified as Class B woodland under the Strategen-JBS&G (2020a) BMP has been updated to Class D scrub, which is a more accurate representation of the vegetation and potential bushfire behaviour in accordance with AS3959.

The area of non-vegetated and low threat managed land excluded under Clauses 2.2.3.2 (e) and (f) has also been updated throughout the assessment area to reflect current on-ground conditions and the latest clearing/earthworked extent adjacent to the project area, particularly to the north and south.

1.3.2 Effective slope

Effective slope under classified vegetation was assessed through on-ground verification on 12 June 2018, 15 May 2019, 23 July 2020, 12 October 2021, 17 May 2022 and 7 September 2022 in accordance with AS 3959. Results were cross referenced with DPIRD 2m contour data.

Effective slope under classified vegetation was assessed to be downslope (>0–5°) to the east and southeast of the project area, associated with a slight incline from Kwinana Freeway to the site; and flat/upslope to the north and northeast.

Effective slope results are outlined in Table 1 and Figure 2 for existing pre-development conditions; and Table 2 and Figure 3 for anticipated post-development conditions.

1.3.3 Pre-development inputs

A summary of the assessed pre-development classified vegetation, exclusions and effective slope within the project area and adjacent 150 m are listed in Table 1 and illustrated in Figure 2.

Table 1: Summary of pre-development vegetation classifications/exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope	Comments
1	Class D Scrub	Downslope >0–5°	Continuous banksia/sheoak fuel profile 2–6 m high over low shrubs to the east and southeast of the project area.
2	Class D Scrub	Flat/Upslope (0°)	Continuous banksia/sheoak fuel profile 2–6 m high over low shrubs to the north and northeast of the project area.
3	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	Existing non-vegetated land (i.e. buildings, roads, footpaths, sealed areas, mineral earth, etc) and low threat managed vegetation (i.e. urban street verges, managed turf, managed gardens, managed POS, etc).

1.3.4 Post-development inputs

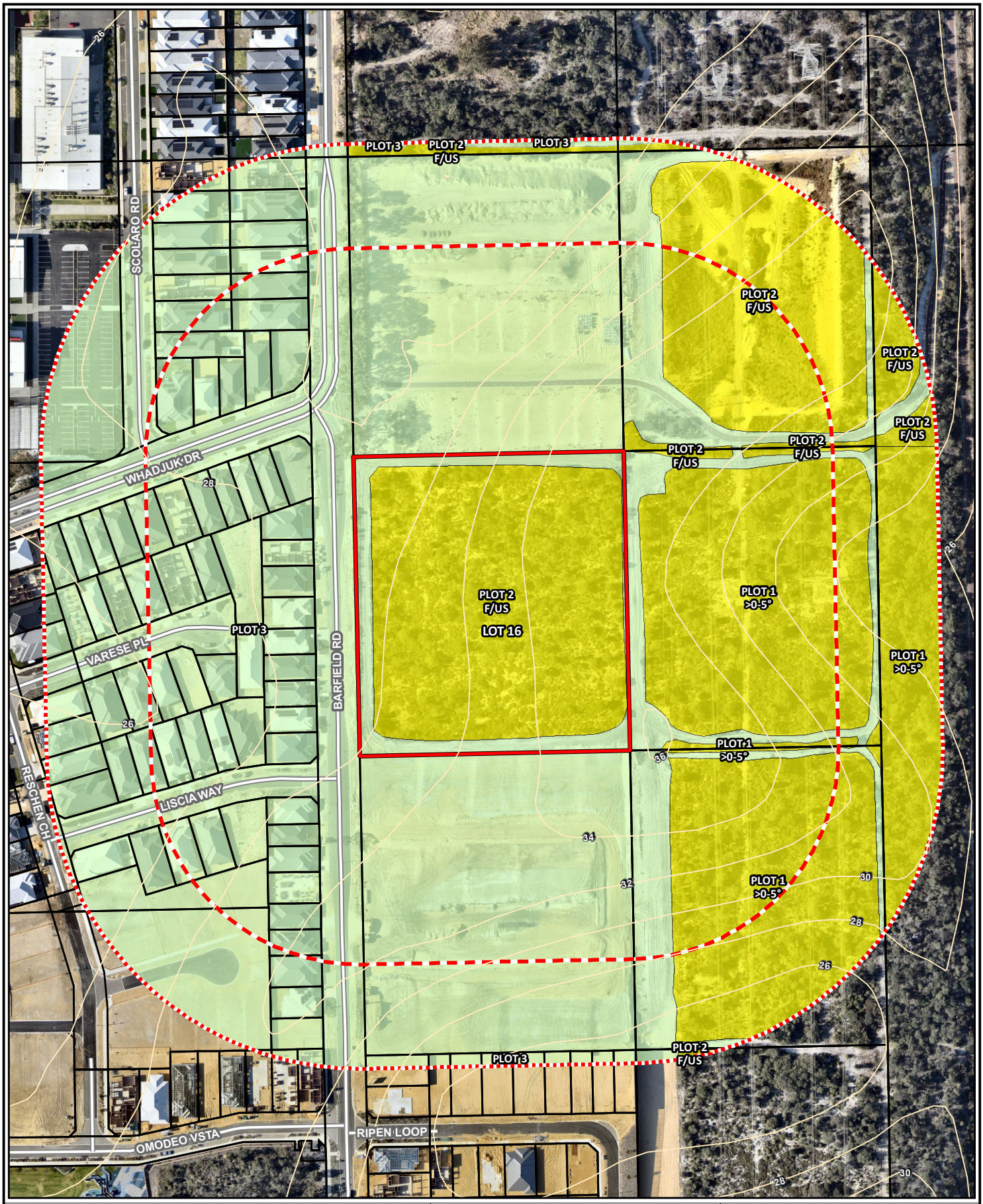
A summary of the expected post-development classified vegetation, exclusions and effective slope within the assessment area are listed in Table 2 and illustrated in Figure 3.

The entire project area is expected to be modified to a non-vegetated/low threat managed state in accordance with Clauses 2.2.3.2 (e) and (f) to facilitate the proposed urban built footprint as per the indicative development concept plan (Figure 1).

Vegetation classifications and exclusions for all land external to the project area are expected to remain the same as for pre-development conditions, except for removal of vegetation within a 20 m wide road reserve adjacent east of the project area as per the indicative development concept plan (Figure 1).

Table 2: Summary of post-development vegetation classifications, exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope	Comments
1	Class D Scrub	Downslope >0–5°	Continuous banksia/sheoak fuel profile 2–6 m high over low shrubs to the east and southeast of the project area.
2	Class D Scrub	Flat/upslope (0°)	Continuous banksia/sheoak fuel profile 2–6 m high over low shrubs to the north and northeast of the project area.
3	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	Existing non-vegetated land (i.e. buildings, roads, footpaths, sealed areas, mineral earth etc) and low threat managed vegetation (i.e. urban street verges, managed turf, managed gardens, managed POS, etc).
4	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	Areas within and adjacent to the project area that are to be modified to a non-vegetated/low threat managed state as part of the proposed development.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- Roads
- Topographic contours (mAHD)

Vegetation classification

- Class D Scrub
- Clause 2.2.3.2 (e) & (f)

Scale 1:2,400 at A4 — 0 25 50 metres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 64203

Client: Richard Noble

Version: A | Date: 15-Dec-2022

Drawn By: jcrute | Checked By: CT

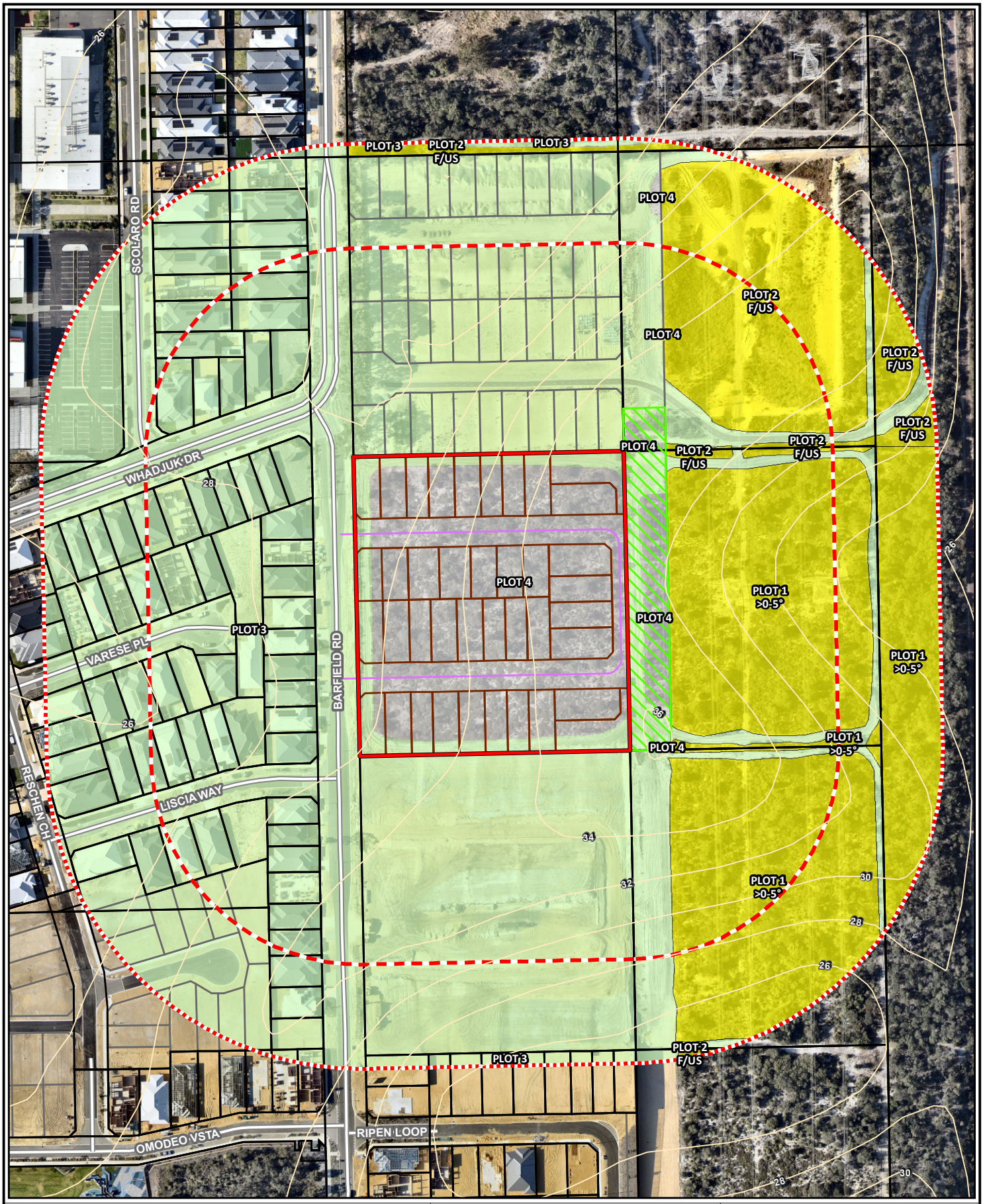
Vivente Lot 16 Barfield Road, Hammond Park, WA

PRE-DEVELOPMENT VEGETATION CLASSIFICATION AND EFFECTIVE SLOPE

FIGURE 2

JBS&G

File Name: W:\Projects\1)Open\Richard Noble\64203 Vivente Estate LSP BMP Addendum\GIS\Maps\M01_Rev_A\64203_02_PreDevVeg.mxd
Image Reference: www.nearmap.com© - Imagery Date: 21. November 2022.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- 20m wide road reserve
- Proposed carriageway
- Proposed lots
- Future subdivisions on adjacent stages

Vegetation classification

- Class D Scrub
- Clause 2.2.3.2 (e) & (f)
- Area to be modified to non-vegetated and low threat state
- Roads
- Topographic contours (mAHD)

Scale 1:2,400 at A4

0 25 50 metres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 64203

Client: Richard Noble

Version: A | Date: 17-Jan-2023

Drawn By: jcrute | Checked By: CT

Vivente Lot 16 Barfield Road, Hammond Park, WA

POST-DEVELOPMENT VEGETATION CLASSIFICATION AND EFFECTIVE SLOPE

FIGURE 3

JBS&G

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1.4 Bushfire assessment results (assessment outputs)

1.4.1 Bushfire Hazard Level (BHL) assessment

Pre-development vegetation extents have been assigned a bushfire hazard level in accordance with the methodology detailed in Appendix 2 of the Guidelines, as outlined in Table 3.

Table 3: BHL assessment results

Bushfire hazard level	Characteristics*
Extreme	• Class A Forest • Class B Woodland (05) • Class D Scrub • Any classified vegetation with a greater than 10° slope.
Moderate	• Class B Low Woodland (07) • Class C Shrubland • Class E Mallee/Mulga • Class G Grassland, including sown pasture and crops • Class G Grassland: Open woodland (06), Low open woodland (08), Open shrubland (09) • Vegetation that has a low hazard level but is within 100 metres of vegetation classified as a moderate or extreme hazard, is to adopt a moderate hazard level.
Low	• Low threat vegetation may include areas of maintained lawns, golf courses, public recreation reserves and parklands, vineyards, orchards, cultivated gardens, commercial nurseries, nature strips and windbreaks • Managed grassland in a minimal fuel condition (insufficient fuel is available to significantly increase the severity of the bushfire attack). For example, short-cropped grass to a nominal height of 100 millimetre • Non-vegetated areas including waterways, roads, footpaths, buildings and rock outcrops.
*Vegetation classifications from AS 3959-2018 Table 2.3.	

1.4.1.1 Pre-development BHL

JBS&G has mapped the pre-development BHLs within the project area and adjacent 150 m wide assessment area. The BHLs have been assessed on the basis of the vegetation discussed in Section 1.3.3 (i.e. the current pre-development extent of vegetation within and surrounding the project area).

The pre-development BHL assessment (refer to Figure 4) shows that based on the existing vegetation extent, the project area contains land with Moderate and Extreme BHLs.

1.5 Post-development Bushfire Attack Level (BAL) Contour Assessment

Figure 1 depicts an indicative subdivision concept with a proposed lot layout and internal road network for the project area. Therefore, JBS&G has undertaken a BAL contour assessment for the project area in accordance with the expected post-development conditions discussed in Section 1.3.4 and Method 1 of AS 3959 (refer to Figure 5). The Method 1 procedure incorporates the following factors:

- state adopted FDI 80 rating
- vegetation classification
- effective slope
- distance maintained between proposed development areas and the classified vegetation.

The BAL rating gives an indication of the level of bushfire attack (i.e. the radiant heat flux) that may be received by proposed development and subsequently informs the standard of building construction and/or setbacks required for proposed habitable development to potentially withstand such impacts and deliver compliance with relevant bushfire protection criteria of the Guidelines.

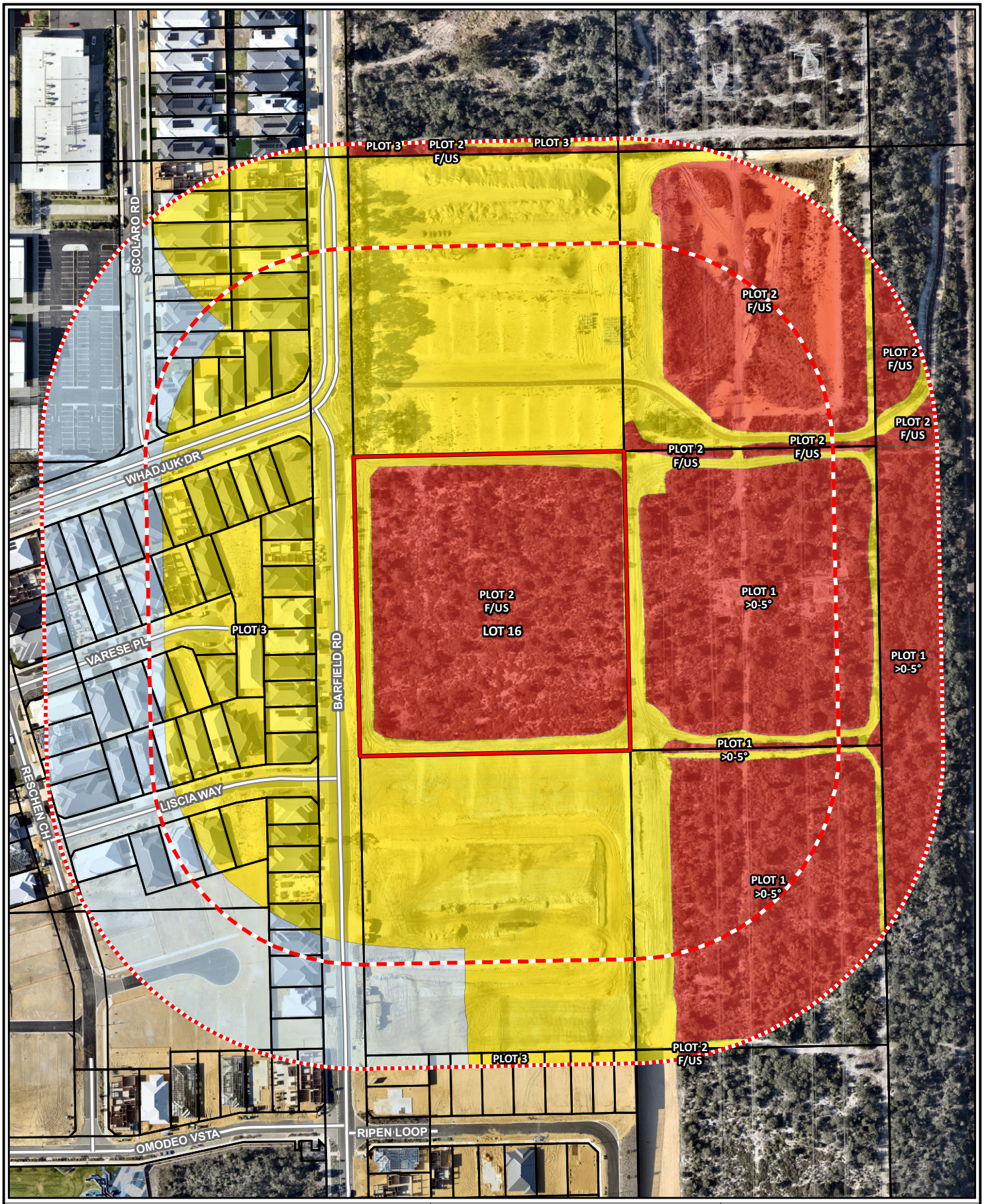
The BAL contours depicted in Figure 5 are based on:

- the vegetation classifications and effective slope observed during the various site inspections undertaken to capture current on-ground conditions
- the expected post-development vegetation extent in consideration of the areas to be modified to a non-vegetated/low threat managed state in accordance with the indicative development concept plan in Figure 1.

Results of the BAL contour assessment are detailed in Table 4 and illustrated in Figure 5. The determined worst-case BAL impact to proposed habitable development within the project area is BAL-29, which is deemed an acceptable rating in accordance with SPP3.7 and the Guidelines.

Table 4: Post-development BAL contour assessment results

Method 1 BAL determination				
Vegetation plot	**Vegetation classification**	**Effective slope**	**Separation distance**	**Highest BAL**
1	Class D Scrub	Downslope >0–5°	20 m	BAL-29
2	Class D Scrub	Flat/upslope (0°)	20 m	BAL-19
3	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	N/A	N/A
4	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	N/A	N/A



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- Roads

Hazard level
- Extreme
- Moderate
- Low

Scale 1:2,400 at A4 (0 25 50 metres)

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 64203

Client: Richard Noble

Version: A | Date: 16-Dec-2022

Drawn By: jcrute | Checked By: CT

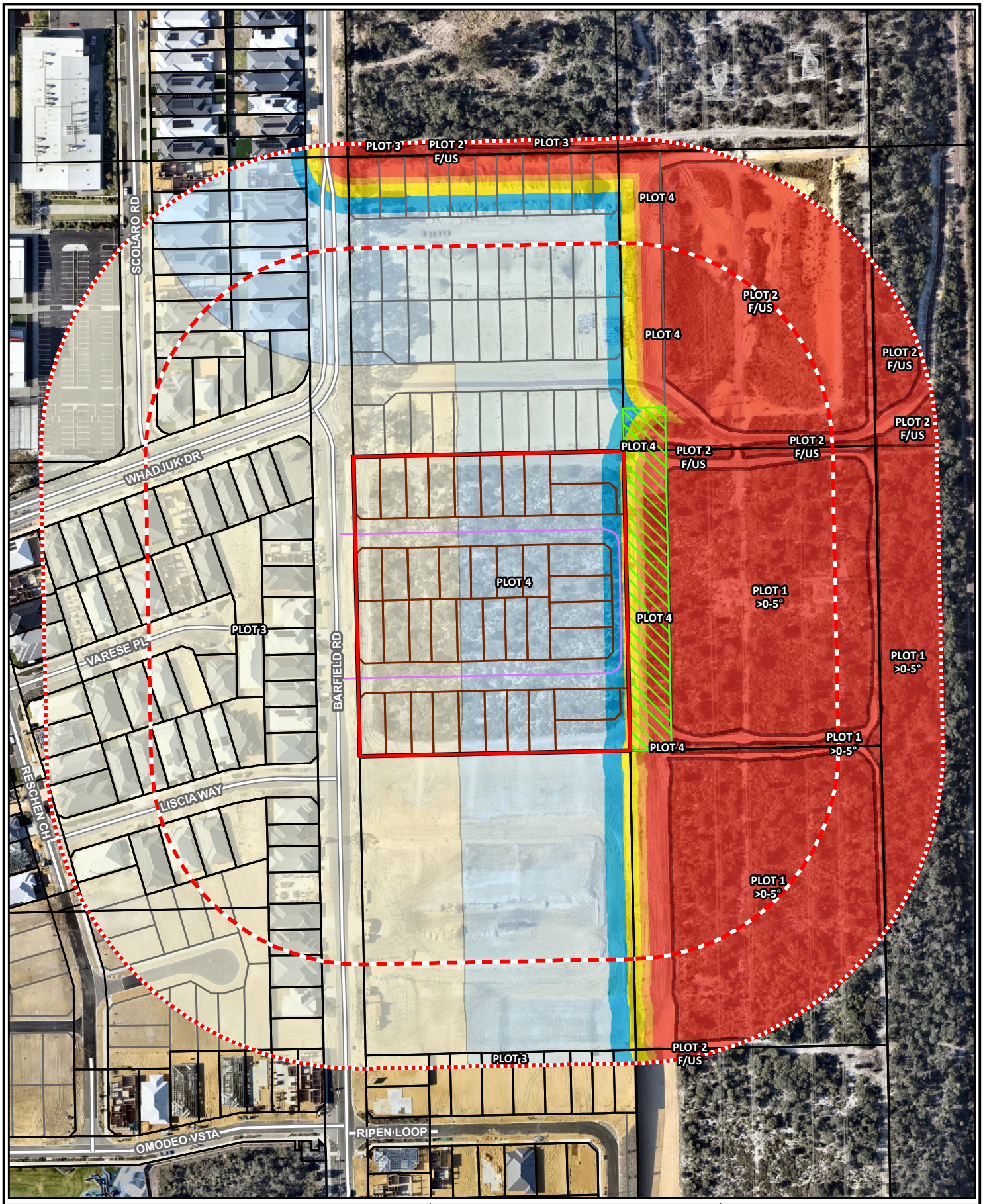
Vivente Lot 16 Barfield Road, Hammond Park, WA

PRE-DEVELOPMENT BUSHFIRE HAZARD LEVELS

FIGURE 4

JBS&G

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Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- 20m wide road reserve
- Proposed carriageway
- Proposed lots
- Future subdivisions on adjacent stages
- Classified vegetation

BAL contours

- BAL FZ
- BAL 40
- BAL 29
- BAL 19
- BAL 12.5
- BAL Low
- Roads

Scale 1:2,400 at A4 (0, 25, 50 metres)	**Vivente Lot 16 Barfield Road, Hammond Park, WA**
Coord. Sys. GDA 1994 MGA Zone 50	**POST-DEVELOPMENT BAL CONTOUR MAP**
Job No: 64203	
Client: Richard Noble	**FIGURE 5**
Version: A — Date: 17-Jan-2023	JBS&G
Drawn By: jcrute — Checked By: CT	

File Name: W:\Projects\1)Open\Richard Noble\64203 Vivente Estate LSP BMP Addendum\GIS\Maps\M01_Rev_A\64203_05_PostDevBALs.mxd
Image Reference: www.nearmap.com© - Imagery Date: 21. November 2022.

1.6 Assessment against bushfire protection criteria

1.6.1 Compliance with Elements 1–4

Compliance with Elements 1–4 of the bushfire protection criteria of the Guidelines (Version 1.4) will be demonstrated by meeting the acceptable solutions, as detailed in Table 5.

Table 5: Compliance with the bushfire protection criteria of the Guidelines (Elements 1–4)

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Statement of development compliance	Compliance achieved
Element 1: Location	**Performance Principle P1** The strategic planning proposal, subdivision and development application is located in an area where the bushfire hazard assessment is or will, on completion, be moderate or low, or a BAL–29 or below, and the risk can be managed. For unavoidable development in areas where BAL–40 or BAL–FZ applies, demonstrating that the risk can be managed to the satisfaction of the decision-maker.	**A1.1 Development location** The strategic planning proposal, subdivision and development application is located in an area that is or will, on completion, be subject to either a moderate or low bushfire hazard level, or BAL–29 or below.	The post-development BAL contour map (see Figure 5) demonstrates that the project area will, on completion, be subject to BAL-29 or lower for all proposed lots.	✓
Element 2: Siting and design	**Performance Principle P2** The siting and design of the strategic planning proposal, subdivision or development application, including roads, paths and landscaping, is appropriate to the level of bushfire threat that applies to the site. The proposal incorporates a defendable space and significantly reduces the heat intensities at the building surface thereby minimising the bushfire risk to people, property and infrastructure, including compliance with AS 3959 if appropriate.	**A2.1 Asset Protection Zone** Every habitable building is surrounded by, and every proposed lot can achieve, an APZ depicted on submitted plans, which meets the requirements set out in Schedule 1.	None of the proposed lots are to be adjoined by classified vegetation so it is expected that no formal Asset Protection Zones (APZs) or APZ setbacks will be required and that all proposed lots will be able to achieve BAL-29 or lower through standard low threat separation provided in line with the proposed development concept plan, including through provision of a 20 m wide crushed limestone road reserve adjacent east of the project area, consistent with Stage 10 Structure Plan provisions adjacent north of the project area. Any land to be modified to a low threat state as part of proposed development is to comply with Schedule 1 APZ standards of the Guidelines (refer to Attachment A).	✓
Element 3: Vehicular access	**Performance Principle P3i** The design and capacity of vehicular access and egress is to provide for the community to evacuate to a suitable destination before a bushfire arrives at the site, allowing emergency services personnel to attend the site and/or hazard vegetation.	**A3.1 Public roads** *The minimum requirements under this acceptable solution are applicable to all proposed and existing public roads.* Public roads are to meet the minimum technical requirements in Table 6, Column 1. The trafficable (carriageway/pavement) width is to be in accordance with the relevant class of road in the Local Government Guidelines for Subdivisional Development (IPWEA Subdivision Guidelines), Liveable Neighbourhoods, Austroad standards and/or any applicable standards for the local government area.	All proposed public roads will be constructed to the technical requirements of the Guidelines (see Attachment B) and in accordance with relevant federal, State and local government requirements.	✓
		A3.2a Multiple access routes Public road access is to be provided in two different directions to at least two different suitable destinations with an all-weather surface (two-way access). If the public road access to the subject site is via a no-through road which cannot be avoided due to demonstrated site constraints, the road access is to be a maximum of 200 metres from the subject lot(s) boundary to an intersection where two-way access is provided. The no-through road may exceed 200 metres if it is demonstrated that an alternative access, including an emergency access way, cannot be provided due to site constraints and the following requirements are met: • the no-through road travels towards a suitable destination; and • the balance of the no-through road, that is greater than 200 metres from the subject site, is wholly within BAL-LOW, or is within a residential built-out area – Figure 23.	The project area forms an extension to the existing Vivente Estate and based on indicative development design, two separate access connections will be provided to the surrounding public road network. These connections will enable access and egress to Barfield Road to the west, which provides broader access to Russell Road in the north and Rowley Road in the south. Rowley Road provides broader access to multiple suitable destinations via Kwinana Freeway to the east of the development. The proposed internal access provisions will prevent any permanent no-through roads.	✓

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Statement of development compliance	Compliance achieved
		A3.2b Emergency access way *Where it is demonstrated that A3.2a cannot be achieved due to site constraints, or where an alternative design option does not exist, an emergency access way can be considered as an acceptable solution.* An emergency access way is to meet all the following requirements: • requirements in Table 6, Column 2; • provides a through connection to a public road; • be no more than 500 metres in length; and • must be signposted and if gated, gates must open the whole trafficable width and remain unlocked.	Based on indicative development design, no permanent Emergency Access Ways (EAWs) will be required as part of the proposed development, and no EAWs are proposed. Any temporary EAWs required to manage compliance during internal staging of development will be constructed to the technical requirements of the Guidelines (see Attachment B).	✓
		A3.3 Through-roads All public roads should be through-roads. No-through roads should be avoided and should only be considered as an acceptable solution where: • it is demonstrated that no alternative road layout exists due to site constraints; and • the no-through road is a maximum length of 200 metres to an intersection providing two-way access, unless it satisfies the exemption provisions in A3.2a of this table. A no-through road is to meet all the following requirements: • requirements of a public road (Table 6, Column 1); and • turn-around area as shown in Figure 24.	Based on indicative development design, all proposed public roads will be through roads. Any temporary no-through roads required to manage compliance during internal staging of development will be constructed to the technical requirements of the Guidelines (see Attachment B).	✓
	Performance Principle P3ii The design of vehicular access and egress provides: • access and egress for emergency service vehicles while allowing the community to evacuate; • a defendable space for emergency services personnel on the interface • between classified vegetation and development site; and • hazard separation between classified vegetation and the subject site to reduce the potential radiant heat that may impact a lot(s).	**A3.4a Perimeter roads** A perimeter road is a public road and should be provided for greenfield or infill development where 10 or more lots are being proposed (including as part of a staged subdivision) with the aim of: • separating areas of classified vegetation under AS3959, which adjoin the subject site, from the proposed lot(s); and • removing the need for battle-axe lots that back onto areas of classified vegetation. A perimeter road is to meet the requirements contained in Table 6, Column 1. A perimeter road may not be required where: • the adjoining classified vegetation is Class G Grassland; • lots are zoned for rural living or equivalent; • it is demonstrated that it cannot be provided due to site constraints; or • all lots have frontage to an existing public road.	A 20 m wide crushed limestone road reserve is proposed to be installed at the only interface with classified vegetation to the east of the project area, consistent with Stage 10 Structure Plan provisions adjacent north of the project area. This road reserve will be non-vegetated, and provide adequate separation to deliver a BAL-29 or lower rating for proposed residential lots within the project area. No other development interfaces contain classified vegetation.	✓
	Performance Principle P3iii Vehicular access is provided which allows: • access and egress for emergency service vehicles;	**A3.4b Fire service access route** *Where proposed lots adjoin classified vegetation under AS3959, and a perimeter road is not required in accordance with A3.4a, a fire service*	N/A. As previously mentioned, perimeter roads have been provided where required in accordance with acceptable solution A3.4a.	N/A

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Statement of development compliance	Compliance achieved
	• defendable space for emergency services • personnel on the interface between classified vegetation and development; and • hazard separation between classified vegetation and the site to reduce the potential radiant heat that may impact a lot(s).	*access route can be considered as an acceptable solution to provide firefighter access, where access is not available, to the classified vegetation.* A fire service access route is to meet all the following requirements: • requirements in Table 6, Column 3; • be through-routes with no dead-ends; • linked to the internal road system at regular intervals, every 500 metres; • must be signposted; • no further than 500 metres from a public road; • if gated, gates must open the required horizontal clearance and can be locked by the local government and/or emergency services, if keys are provided for each gate; and • turn-around areas designed to accommodate type 3.4 fire appliances and to enable them to turn around safely every 500 metres.		
	Performance Principle P3iv Vehicular access is provided which allows emergency service vehicles to directly access all habitable buildings and water supplies and exit the lot without entrapment.	**A3.5 Battle-axe access legs** *Where it is demonstrated that a battle-axe cannot be avoided due to site constraints, it can be considered as an acceptable solution.* There are no battle-axe technical requirements where the point the battle-axe access leg joins the effective area of the lot, is less than 50 metres from a public road in a reticulated area. In circumstances where the above condition is not met, or the battle-axe is in a non-reticulated water area, the battle-axe is to meet all the following requirements: • requirements in Table 6, Column 4; and • passing bays every 200 metres with a minimum length of 20 metres and a minimum additional trafficable width of two metres (i.e. the combined trafficable width of the passing bay and constructed private driveway to be a minimum six metres).	N/A. Not applicable to the strategic planning stage. Notwithstanding, based on indicative development design, two battle-axe lots are proposed in the northeast and southeast corners of the site. The following site constraints are listed to demonstrate why the battle-axe lots cannot be avoided (this will be further demonstrated at the subdivision stage of planning): • an east-west orientation of these lots responds to the existing site levels and future road reserve to the east as contemplated and consistent with the adjacent Structure Plan areas • an east-west orientation of these lots improves separation of the future dwellings to the adjacent east bushfire hazards • the battle-axe legs are approximately 15 m long, which is the same length of driveway access as the larger, non-battle-axe lots with 35–40 m depth. With regards to compliance with acceptable solutions A3.5, there are no battle-axe technical requirements where the point the battle-axe access leg joins the effective area of the lot, is less than 50 metres from a public road in a reticulated area.	N/A
		A3.6 Private driveways There are no private driveway technical requirements where the private driveway is: • within a lot serviced by reticulated water; • no greater than 70 metres in length between the most distant external part of the development site and the public road measured as a hose lay; and • accessed by a public road where the road speed limit is not greater than 70 km/h. In circumstances where all of the above conditions are not met, or the private driveway is in a non-reticulated water area, the private driveway is to meet all the following requirements: • requirements in Table 6, Column 4; • passing bays every 200 metres with a minimum length of 20 metres and a minimum	N/A. Not applicable to the strategic planning stage. Notwithstanding, the proposed development will be located within a reticulated area where road speeds will be lower than 70 km/hr and proposed lots are of size where all future habitable development will be located within 70 m of a public road. In this regard, there will be no private driveway compliance requirements for the proposed development.	N/A

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Statement of development compliance	Compliance achieved
		• additional trafficable width of two metres (i.e. the combined trafficable width of the passing bay and constructed private driveway to be a minimum six metres); and • turn-around area as shown in Figure 28 and within 30 metres of the habitable building.		
Element 4: Water	No performance principle applies	**A4.1 Identification of future water supply** Evidence that a reticulated or sufficient non-reticulated water supply for bushfire fighting can be provided at the subdivision and/or development application stage, in accordance with the specifications of the relevant water supply authority or the requirements of Schedule 2. Where the provision of a strategic water tank(s) is required a suitable area within a road reserve or a dedicated lot the location should be identified, should be identified on the structure plan, to the satisfaction of the local government.	Arrangements will be made to connect the proposed development to a reticulated water supply via extension of existing services from adjacent areas.	✓
	Performance Principle P4 Provide a permanent water supply that is: • sufficient and available for firefighting purposes; • constructed from non-combustible materials (e.g. steel), or able to maintain its integrity throughout a bushfire; and • accessible, with legal access for maintenance and re-filling by tankers and emergency service vehicles.	**A4.2 Provision of water for firefighting purposes** Where a reticulated water supply is existing or proposed, hydrant connection(s) should be provided in accordance with the specifications of the relevant water supply authority. Where these specifications cannot be met, then the following applies: • The provision of a water tank(s), in accordance with the requirements of Schedule 2; and • Where the provision of a strategic water tank(s) is applicable, then the following requirements apply: – land to be ceded free of cost to the local government for the placement of the tank(s); – the lot or road reserve where the tank is to be located is identified on the plan of subdivision; – tank capacity, construction, and fittings, provided in accordance with the requirements of Schedule 2; and – a strategic water tank is to be located no more than 10 minutes from the subject site (at legal road speeds). Where a subdivision includes an existing habitable building(s) that is to be retained, a water supply should be provided to this existing habitable building(s), in accordance with the requirements listed above.	N/A. Not applicable to the strategic planning stage. Notwithstanding, the proposed development will be connected to a reticulated water supply via extension of services from adjacent areas in accordance with Water Corporations Design Standard 63 requirements.	N/A

1.7 Responsibilities for implementation and management of the bushfire measures

This BMP addendum has been prepared as a strategic guide to demonstrate how development compliance will be delivered at future planning stages in accordance with the Guidelines. Aside from the preparation of future BMPs/addendums to accompany future subdivision/development applications where appropriate, there are no further items to implement, enforce or review at this strategic stage of the planning process.

Future BMPs/addendums prepared to accompany future subdivision/development applications are to meet the relevant commitments outlined in this strategic level BMP addendum, address the relevant requirements of SPP 3.7 (i.e. Policy Measures 6.4 and 6.5 respectively) and demonstrate in detail how the proposed development will comply with the relevant acceptable solutions of the Guidelines. Future BMPs/addendums prepared to accompany future subdivision/development applications are to include the following detailed information:

- confirmation of final lot layout in accordance with a plan of subdivision
- confirmation of the anticipated post-development classified vegetation extent, effective slope and separation distances
- confirmation of areas to be modified to a non-vegetated/low threat managed state as part of proposed development, including provision for the proposed 20 m wide crushed limestone road reserve to the east of the project area
- confirmation of how BAL management will be addressed during development staging, including management of temporary bushfire hazards resulting from staged clearing (i.e. provision of low threat staging buffers or temporary quarantining of lots where required)
- confirmation of how vehicular access provisions will be addressed during development staging, including demonstration that a minimum of two access routes will be achieved for each stage of development (i.e. provision of public roads in advance and/or temporary compliant access provisions such as no-through roads and EAWs)
- confirmation of water supply provisions regarding reticulated water
- provisions for notification on Title for any proposed lots situated within a designated bushfire prone area containing a rating of BAL-12.5 or greater
- compliance requirements with the annual City of Cockburn firebreak notice (see Attachment C)
- assessment against the acceptable solutions of Elements 1–4 of the bushfire protection criteria of the Guidelines
- proposed audit and compliance program outlining all measures requiring implementation prior to lot title and the appropriate timing and responsibilities for implementation.

Based on the information contained in this BMP, JBS&G considers the bushfire hazards within and adjacent to the project area and the associated bushfire risks to the proposed development are readily manageable through adoption of standard acceptable solution management responses outlined in the Guidelines. JBS&G considers that the project area can be developed with a manageable level of bushfire risk whilst maintaining full compliance with SPP3.7 and the Guidelines, which will be demonstrated through future BMPs/addendums prepared to accompany future subdivision/development applications.

1.8 References

Department of Fire and Emergency Services (DFES) 2021, *Map of Bush Fire Prone Areas*, [Online], Government of Western Australia, available from: https://maps.slip.wa.gov.au/landgate/bushfireprone/, [21/12/2022].

Department of Planning (DoP) 2016, *Visual guide for bushfire risk assessment in Western Australia*, Department of Planning, Perth.

Standards Australia (SA) 2018, Australian Standard *AS 3959–2018 Construction of Buildings in Bushfire-prone Areas*, Standards Australia, Sydney.

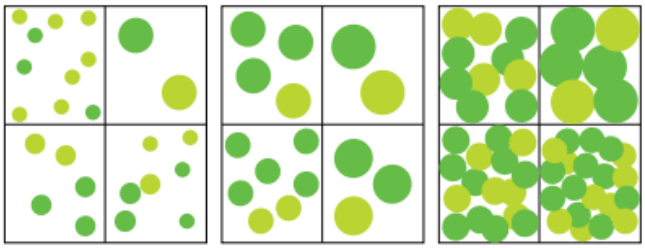
Strategen-JBS&G 2020a, *Bushfire Management Plan Vivente Estate Structure Plan Amendment, including Stages 9 and 10*, report prepared for Gold Estate Holdings Pty Ltd, May 2020.

Strategen-JBS&G 2020b, *Bushfire Attack Level (BAL) Compliance Report Stage 4 Vivente, Hammond Park,* report prepared for Gold Estate Holdings Pty Ltd, August 2020.

Western Australian Planning Commission (WAPC) 2015, *State Planning Policy 3.7 Planning in Bushfire Prone Areas*, Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WAPC) 2021, *Guidelines for Planning in Bushfire Prone Areas*, Version 1.4 December 2021, Western Australian Planning Commission, Perth.

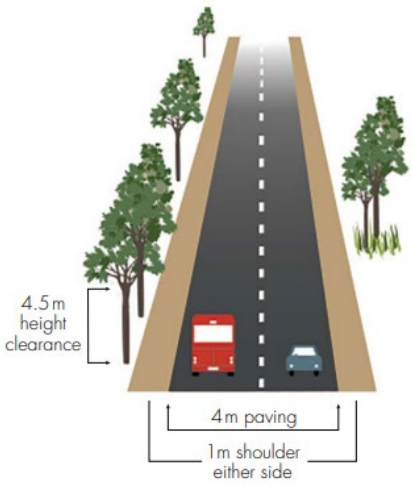
Attachment A APZ standards (Schedule 1 of the Guidelines)

Schedule 1: Standards for Asset Protection Zones	
Object	**Requirement**
Fences within the APZ	• Should be constructed from non-combustible materials (for example, iron, brick, limestone, metal post and wire, or bushfire-resisting timber referenced in Attachment F of AS 3959).
Fine fuel load (Combustible, dead vegetation matter <6 millimetres in thickness)	• Should be managed and removed on a regular basis to maintain a low threat state. • Should be maintained at <2 tonnes per hectare (on average). • Mulches should be non-combustible such as stone, gravel or crushed mineral earth or wood mulch >6 millimetres in thickness.
Trees* (>6 metres in height)	• Trunks at maturity should be a minimum distance of six metres from all elevations of the building. • Branches at maturity should not touch or overhang a building or powerline. • Lower branches and loose bark should be removed to a height of two metres above the ground and/or surface vegetation. • Canopy cover within the APZ should be <15 per cent of the total APZ area. • Tree canopies at maturity should be at least five metres apart to avoid forming a continuous canopy. Stands of existing mature trees with interlocking canopies may be treated as an individual canopy provided that the total canopy cover within the APZ will not exceed 15 per cent and are not connected to the tree canopy outside the APZ. **Figure 19:** Tree canopy cover – ranging from 15 to 70 per cent at maturity 
Shrub* and scrub* (0.5 metres to six metres in height). Shrub and scrub >6 metres in height are to be treated as trees.	• Should not be located under trees or within three metres of buildings. • Should not be planted in clumps >5 square metres in area. • Clumps should be separated from each other and any exposed window or door by at least 10 metres.
Ground covers* (<0.5 metres in height. Ground covers >0.5 metres in height are to be treated as shrubs)	• Can be planted under trees but must be maintained to remove dead plant material, as prescribed in 'Fine fuel load' above. • Can be located within two metres of a structure, but three metres from windows or doors if >100 millimetres in height.
Grass	• Grass should be maintained at a height of 100 millimetres or less, at all times. • Wherever possible, perennial grasses should be used and well-hydrated with regular application of wetting agents and efficient irrigation.

Schedule 1: Standards for Asset Protection Zones	
Defendable space	Within three metres of each wall or supporting post of a habitable building, the area is kept free from vegetation, but can include ground covers, grass and non-combustible mulches as prescribed above.
LP Gas Cylinders	• Should be located on the side of a building furthest from the likely direction of a bushfire or on the side of a building where surrounding classified vegetation is upslope, at least one metre from vulnerable parts of a building. • The pressure relief valve should point away from the house. • No flammable material within six metres from the front of the valve. • Must sit on a firm, level and non-combustible base and be secured to a solid structure.

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Attachment B Vehicular access technical standards of the Guidelines

Acceptable Solution A3.1 – Public Roads
Explanatory Note E3.1
These Guidelines do not prescribe values for the trafficable (carriageway/pavement) width of public roads as they should be in accordance with the class of road as specified in the IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards and/or any applicable standard in the local government area. The IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards do not prescribe a horizontal clearance. However, it is recommended that a traversable verge is provided to allow for emergency services vehicles to stop and operate on the side of the public road, specifically where the public road may traverse large areas of classified vegetation. Where local government roads are proposed to be widened by the proponent, they must obtain approval from the local government.    Figure 20: Example of a public road

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.2a – Multiple access routes
Explanatory Note E3.2a

Two-way public road access is public road access from a lot in at least two different directions to two suitable destinations, and provides residents and the community, as well as emergency services, with access and egress from both the subdivision and individual habitable buildings/development in the event of a bushfire emergency. A single road provides no alternative route if the access becomes congested or is unable to be traversed due to smoke and/or fallen trees during a bushfire.

Two-way public road access applies to access/egress routes leading into a subdivision, as well as those within a subdivision. A road that loops back onto itself does not constitute the option of two different directions.

Two-way public road access should always be the first option. Where the site is not able to achieve two-way access within 200 metres of the lot boundary, due to demonstrated site or environmental constraints, the proponent should identify options for an emergency access way from the subject site to a suitable destination. Where an emergency access way cannot be provided, the proponent should demonstrate compliance with the performance principle.

Subject sites or proposed lots greater than 200 metres from an intersection, which provides two-way access, do not satisfy the requirement for two-way access unless they meet the provisions which allow for no-through roads greater than 200 metres in A3.2a.

To demonstrate compliance with the performance principle for two-way access, the bushfire planning practitioner may have regard to:

a. the extent of the bushfire hazard, location and vegetation classification, the likelihood, potential severity and impact of bushfire to the subject site and the road network;
b. time between fire detection and the onset of conditions in comparison to travel time for the community to evacuate to a suitable destination;
c. available access route(s) travelling towards a suitable destination; and
d. turn-around area for a fire appliance for no-through roads.



Figure 21: Example of compliant and non-compliant two-way

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.4a – Perimeter roads
Explanatory Note E3.4a

Where a planning proposal includes the creation of 10 or more lots adjacent to each other, which adjoin classified vegetation under AS 3959 with the exception of Class G Grassland, as part of a greenfield development or large urban infill site, hazard separation and defendable space should be provided in the form of a perimeter road. Greenfield is 'undeveloped or minimally developed areas that have been identified for urban development'; and urban infill is 'the redevelopment of existing urban areas at a higher density than currently exists'. The creation of 10 or more lots includes cumulative subdivision applications where the subdivision application may be part of a staged subdivision.

A perimeter road should be in accordance with the class of road as specified in the IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards and/or any applicable standard in the local government area as per the requirements of a public road in Table 6, Column 1.

As the road is likely to function as a key neighbourhood distributor, or similar, consideration should be given to the provision of additional width to allow for emergency services vehicles to stop and operate on the side of the perimeter road, whilst simultaneously proving for the evacuation of the community (Figure 20).

When designing a strategic planning proposal and/or subdivision, creating a large setback between classified vegetation and proposed lots with a perimeter road, and orientating habitable buildings to front onto (rather than back onto) areas of vegetation has many benefits, including:

- passive surveillance;
- defendable space for firefighting and emergency management purposes;
- reducing the potential radiant heat that may impact a habitable building in a bushfire event;
- reducing the need for battle-axe lots; and
- unconstrained public access/egress for the community in the event of a bushfire.

In developments where no perimeter road exists, property defence in a bushfire event is difficult and can be impossible. Where proposed lots have frontage to an existing public road and abut the hazard at the rear or side, it may be an undesirable planning outcome to create lots which front the existing public road and back onto a perimeter road. In this instance, consideration should be given to a fire service access route. Refer to E3.4b.

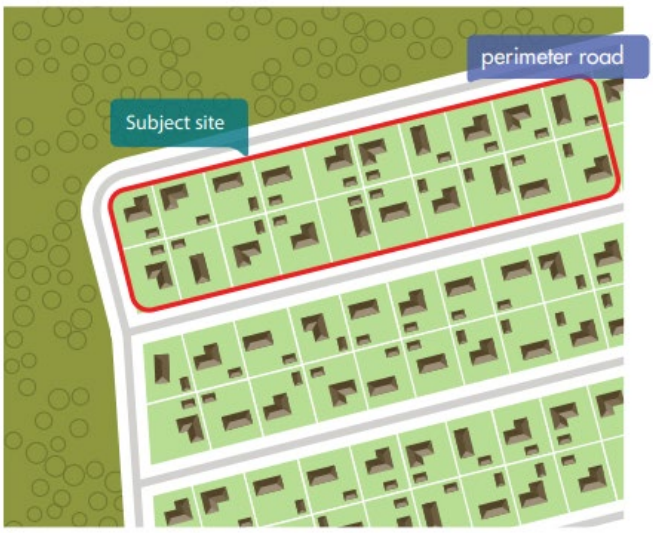


Figure 25: Example of a perimeter road

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

E3.2b Emergency access way

An emergency access way is not a preferred alternative to through public road access and should only be considered acceptable where it has been demonstrated that it will provide the safety and performance needs of emergency services and the community, including consideration for future needs, and that public road access to satisfy A3.2a cannot be achieved due to site constraints, such as an established road network with no opportunity to provide a public road for secondary access. Acceptance of an emergency access way should also consider the ability to accommodate reasonable worst-case vehicle volumes.

The principle function of the emergency access way is to provide a contingency (second) community evacuation route and simultaneously provide access for emergency services, in the event of a bushfire emergency. Where an emergency access way traverses classified vegetation, which has the potential to create a bushfire hazard, an emergency access way performs the secondary function of providing access by emergency services to this vegetation.

Emergency access ways should connect to a public road to allow alternative two-way through access. An emergency access way should not exceed 500 metres in length as they may not be as safe for road-use due to not being designed or constructed to the full requirements of a public road and may present uncertainties to emergency service personnel and the public as they are not part of the daily road network and not identified on Maps.

Permanent public emergency access way

An emergency access way can be provided as either a public easement in gross or a right-of-way. In both approaches, the management of the emergency access way is by the local government as the grantee of the easement or management body of the right-of-way. The proponent must obtain written consent from the local government that the local government will accept care, control and management of the easement or right-of-way; this must be provided to the decision-maker prior to granting planning approval. The approach taken is at the discretion of the decision-maker and/or the local government and is also dependent on whether the land is to remain in private ownership or be ceded to the Crown. Consultation with Land Use Management at the Department of Planning, Lands and Heritage should also be considered if the land is to be ceded to the Crown or if the local government is uncertain of which approach to take.

If the emergency access way is provided as an easement, it should be provided as a public easement in gross under sections 195 and 196 of the *Land Administration Act 1997* in favour of the local government and/or public authority, to ensure accessibility for emergency services and the public at all times. To be provided as a right-of-way the emergency access way should be vested in the Crown under section 152 of the *Planning and Development Act 2005* as a right-of-way and such land to be ceded free of cost and without any payment or compensation by the Crown. If gates are used to control traffic flow during non-emergency periods, these will be managed by the local government and must not be locked. Gates should be double gates wide enough to access the full pavement width and accommodate Type 3.4 fire appliances with the design and construction to be approved by the relevant local government.

Temporary public emergency access way

A temporary emergency access way may be proposed to facilitate the staging arrangements of a subdivision. The provision of two public roads may not be possible in the first stage of the subdivision and an emergency access way can be provided as an interim access route until the second public road is developed and gazetted in a subsequent stage of the subdivision (see figure 22). The emergency access way should be provided in the same manner as a permanent emergency access way, but it should be removed from the certificate of title once the public road is developed and gazetted. Where an emergency access way is proposed as an alternative to a public road, the Bushfire Management Plan should provide thorough justification for its use.

Restricted public emergency access way

There may be some instances where a restricted emergency access way is proposed as a performance principle-based solution where access is only available to the public in the event of a bushfire emergency. This option can only be considered where the local government or Main Roads WA have advised that vehicular access on the emergency access way is not allowed during non-emergency periods, as it provides an additional thoroughfare and entry point on a local or State road. In this scenario, the emergency access way can be provided as an easement under section 195 of the *Land Administration Act 1997*, as public access in the event of a bushfire emergency or vested in the Crown as a reserve under section 152 of the *Planning and Development Act 2005*. Such land is to be ceded free of cost without any payment or compensation by the Crown. The proponent must obtain written consent from the local government that

EXPLANATORY NOTES

the local government will accept care, control and management of the proposed reserve and agree to the terms of the Management Order Conditions (if applicable); this must be provided to the decision-maker prior to granting planning approval.

The purpose of the reserve should be for a public purpose specified in the condition related to the subdivision, for example for emergency access only, or for emergency access and recreation. A reserve for emergency access and recreation can optimise the land-use as a dual purpose where it provides vehicular access in the event of a bushfire emergency, but can be accessed by the public (on foot) on a day-to-day basis as a recreation link. Appropriate signage can ensure the general public is aware of the purpose of the reserve. The approach taken is at the discretion of the decision-maker and/or local government.

Right-of-carriageway emergency access way

There may be some instances where a right-of-carriageway easement is proposed as a performance principle-based solution. This may be where particular landowner(s) and emergency services, but not the public, require access over a neighbouring lot(s). A right-of-carriageway easement should be provided under section 195 of the *Land Administration Act 1997*. The easement is to provide alternative access for the particular landowner(s) in the event of a bushfire emergency and not for use by the public. In this scenario, support will be necessary from the adjoining lot owner(s). The easement is to be granted to the local government and it is to agree with the landowner on the arrangements of the management of the easement area by deed. These management arrangements will be at the discretion of the local government. If gated, the easement area can be locked to restrict day-to-day vehicular access.

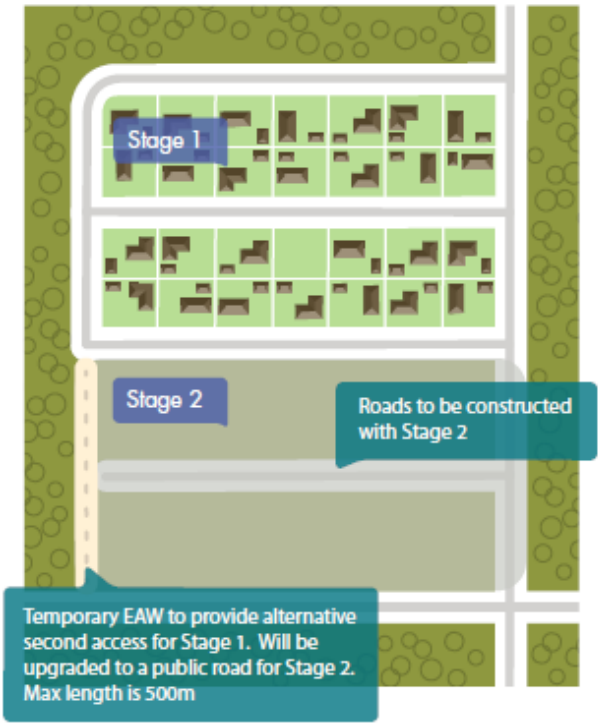


Figure 22: Example of an emergency access way

E3.3 Through-roads

In bushfire prone areas, a proposed structure plan or subdivision that incorporates no-through roads should be avoided because they do not provide a connected and legible design that allows for easy access and egress by the community, residents and emergency services in the event of a bushfire. No-through roads also reduce the options available for access and egress in the event of a bushfire emergency.

There will however be situations where a subject site is accessed via an existing or proposed no-through road and alternative access cannot be provided. In these situations, the proponent should demonstrate to the decision-maker, that all efforts have been made with the local government and/or adjoining landowners to secure alternative public road access or an emergency access way and that a redesign has been explored. The bushfire planning practitioner may need to develop a performance principle-based solution or address the non-compliance and demonstrate to the decision-maker why discretion should be exercised in accordance with section 2.6 of these Guidelines.

No-through roads will only be considered an acceptable solution where it is demonstrated by the proponent, to the satisfaction of the decision maker, that a no through-road cannot be avoided due to site constraints. For example, the internal road design of a structure plan or subdivision where site constraints, such as a water body or Bush Forever, prevent the ability to create a through-road and a no-through road may be a more appropriate road layout.

No-through roads should be a maximum of 200 metres from the lot(s) boundary to an intersection where two-way access is provided and may only exceed 200 metres if it meets the provisions which allow for no-through roads greater than 200 metres in A3.2a.

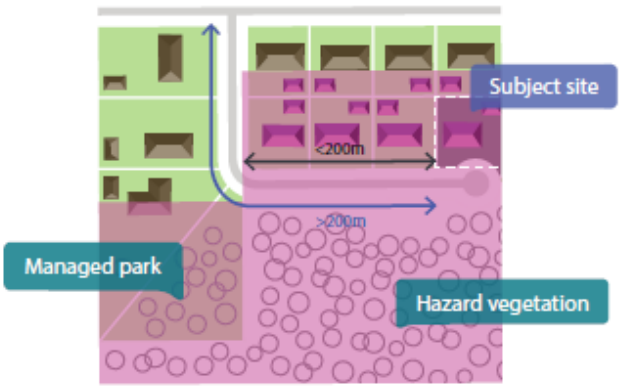


Figure 23: Example of a site on a no-through road greater than 200 metres from the intersection, but within 200 metres of BAL-LOW

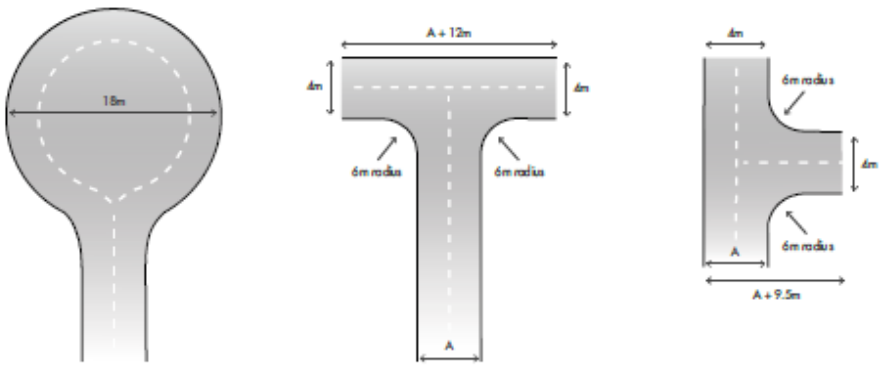


Figure 24: Turn-around area dimensions for a no-through road

Technical requirement	1	2	3	4
	Public road	Emergency access way[1]	Fire service access route[1]	Battle-axe and private driveways[2]
Minimum trafficable surface (m)	In accordance with A3.1	6	6	4
Minimum horizontal clearance (m)	N/A	6	6	6
Minimum vertical clearance (m)	4.5	4.5	4.5	4.5
Minimum weight capacity (t)	15	15	15	15
Maximum grade unsealed road[3]	As outlined in the IPWEA Subdivision Guidelines	1:10 (10%, 6°)	1:10 (10%, 6°)	1:10 (10%, 6°)
Maximum grade sealed road[3]		1:7 (14.3%, 8°)	1:7 (14.3%, 8°)	1:7 (14.3%, 8°)
Maximum average grade sealed road		1:10 (10%, 6°)	1:10 (10%, 6°)	1:10 (10%, 6°)
Minimum inner radius of road curves (m)		8.5	8.5	8.5

[1] To have crossfalls between 3 and 6%

[2] Where driveways and battle-axe legs are not required to comply with the widths in A3.5 or A3.6, they are to comply with the Residential Design Codes and Development Control Policy 2.2 Residential Subdivision

[3] Dips must have no more than a 1 in 8 (12.5% -7.1 degree) entry and exit angle.

Attachment C City of Cockburn Fire Control Notice

City of Cockburn

✖ Aboriginal and Torres Strait Islander people are warned that this website may contain images and voices of deceased persons.

Fire Control Order

Find on this page

» City of Cockburn Fire Control Order (May 2018)

» All property (vacant or developed) –less than 4,047m2

» All property (vacant or developed) – 4,047m2 or greater

» Firebreak specifications

» Additional works

» Fire Control Order variations

» Burning

» Penalties

» Terms and definitions

» More information and contact

City of Cockburn Fire Control Order - Effective from 10 May 2018

First and Final Notice

Pursuant to *Section 33* of the *Bush Fires Act 1954* owners or occupiers of land situated within the City of Cockburn are required by law to comply with the prescribed Fire Control Order here within.

1. All Property (vacant or developed) - less than 4,047m2

To reduce the fire hazard on your land and to comply with the requirements of this Fire Control Order you are required to:

1.1 Have all flammable materials such as dry grass and weeds slashed, mown or trimmed down by other means to a maximum height of 50mm across the entire property for the duration of this firebreak time; and

1.2 Remove all dead vegetation.

2. All property (vacant or developed) - 4,047m2 or greater

To reduce the fire hazard on your land and to comply with the requirements of this Fire Control Order you are required to:

2.1 Construct a firebreak (as defined within section 3 of this order) immediately inside all external property boundaries, this includes those adjacent to roads, drains, rail reserves and any public open space reserves

2.2 Remove all dead vegetation surrounding and over all habitable structures to a radius of 3 metres except living trees, shrubs, maintained grass and gardens under cultivation.

3. Firebreak Specifications

A firebreak is an area of land cleared of flammable material, installed to minimise the spread or extension of a fire and to provide suitable access for fire fighting vehicles. The standards of a compliant firebreak are as follows:

3.1 A firebreak must be constructed of bare earth, stone, or sealed surfaces and be clear of all flammable materials to create a 3 metre wide trafficable surface

3.2 Maintained grass may occupy a firebreak

3.3 Overhanging branches must be pruned to provide a 4 metre vertical clearance above the full width of the 3 metre firebreak surface

3.4 A firebreak must be a continuous trafficable surface for a fire fighting vehicle, clear of any obstructions and must not terminate in a cul-de-sac (dead end).

4. Additional Works

Regardless of land size and location, the City of Cockburn or its Authorised Officer(s) may require you to undertake additional work(s) on your property to improve access and/or undertake further works where in the opinion of that Authorised Officer(s), these works would be conducive to preventing the outbreak and/or the spread or extension of a fire.

5. Fire Control Order Variations

A variation will be considered where the owner and/or occupiers believe it is impractical to meet the compliance requirements of this Fire Control Order.

Approved structure's occupying a firebreak will not require a variation approval. However, a firebreak will be required to be installed as close as practical around the approved structure.

If approved, variations will be valid in perpetuity, unless a new variation has been approved or the property changes ownership.

The City of Cockburn reserves the right to review, amend or revoke an existing variation in writing at any time. Should a request to vary the Fire Control Order requirements on your property not be approved in writing, this Fire Control Order must be complied with as applicable in its entirety.

If you cannot comply with the above requirements you can complete the online firebreak variation application form.

Firebreak Variation Application Form

Approved: You must comply with the conditions of the approved variation.
Not approved: You must comply with the requirements of the Fire Control Order.

6. Burning

During the declared prohibited burning time, owners and/or occupiers must not undertake any bush or garden refuse burning activities.

During the declared restricted burning time only, owners and/or occupiers may:

6.1 Apply for a permit to burn the bush for bush fire risk mitigation purposes, by following the conditions imposed on a permit to burn as issued by an Authorised Officer.

6.2 In areas zoned rural by the Metropolitan Region Scheme you may undertake burning of leaves, tree branches, and other dry vegetation in piles no larger than $1m^3$ in size, without a permit to burn, subject to the following conditions:

6.2.1 No flammable material (other than that being burned) is to be within 5 metres of the fire at any time while the fire is burning

6.2.2 The fire is lit between 6pm and 11pm and is completely extinguished before midnight on the same day

6.2.3 At least one person is present at the site of the fire at all times until it is completely extinguished

6.2.4 When the fire is no longer required, the person ensures that the fire is completely extinguished by the application of water or earth.

During the unrestricted burning time, owners and/or occupiers in areas zoned rural under the Metropolitan Region Scheme may burn garden refuse and set fire to bush on their land without a permit 'To Set Fire To The Bush'. Burning of the bush must be in accordance with all relevant State legislative requirements.

Burning of garden refuse in areas not zoned rural should not be undertaken within the City of Cockburn, unless approved by an Authorised Officer. Burning of household waste is prohibited in all areas of the City of Cockburn.

Burning of household waste is prohibited in all areas of the City of Cockburn.

7. Penalties

Failing to comply with this Fire Control Order will result in a penalty of up to $5,000. A person in default is also liable whether prosecuted or not to pay the costs of performing the work directed by a City's Authorised Officer.

Any owner and/or occupier who engages a contractor to undertake works on their behalf is responsible to ensure that the works completed meet the requirements of this Fire Control Order.

Term	Definition
Authorised Officer	A person appointed by the City of Cockburn Chief Executive Officer as an authorised person/officer to exercise the powers and duties set out in the Local Government Act 1995, Bush Fires Act 1954 and Local Law(s).
Flammable Material	Any dead or dry grass, vegetation, substance, object, thing or material (except living flora including live and/ or habitat standing trees) that may or is likely to catch fire and burn or any other thing deemed by an Authorised Officer to be capable of combustion.
Maintained Grass	Soil covered land, planted with grasses or other durable plants, maintained green and less than 50mm in height.

Term	Definition
Prohibited Burning Time	The time of each year where it is unlawful to set fire to the bush at any time. This time is normally from 1 December of each year until and including 31 March of the following year. This time may be amended, subject to prevailing seasonal conditions.
Restricted Burning Time	The time of each year where it is unlawful to set fire to the bush without a valid Permit to Set Fire To The Bush issued by an Authorised Officer. This period is normally from 1 April until and including 31 May and from 1 October until and including 30 November of any year. This time may be amended, subject to the prevailing seasonal conditions.
Unrestricted Burning Time	The time of each year where it is lawful to set fire to the bush at any time, in areas zoned rural under the Metropolitan Region Scheme. This time is normally from 1 June until and including 30 September. This time may be amended, subject to the prevailing seasonal conditions.
Firebreak Time	The time of each year where fire hazard reduction works must be maintained as specified in this Fire Control Order. This time is 1 November of each year until and including 15 April of the following year.
Structure	A building, as defined in the Building Codes of Australia (BCA) may be made up of a number of classes if it has a mixed use.

Any Fire Control Order previously published by the City of Cockburn in the Government Gazette or in any Western Australian newsprint is hereby revoked.

By Order of Council

More information and contact

Please contact the City's Fire and Emergency Services for more information on firebreaks and burning permits on 08 9411 3444 or at rangercustomerservice@cockburn.wa.gov.au

Related Pages

- Fire and Emergency Management
- Fire Pits

- Prepare your home for Fire Season
- Proposed Prescribed Burning Areas
- Water Suppliers for Fire Fighters
- Cockburn Emergency Management Plans
- Home Emergency Plan

Appendix 2 - Local Water Management

emerge ASSOCIATES
Integrated Science & Design

LOCAL WATER MANAGEMENT STRATEGY

BARFIELD ROAD LOCAL STRUCTURE PLAN

Project Number EP11-046

Prepared for Gold Estate Holdings and Department of Housing
April 2013

Document Control

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DOC NO.	EP11-046(01)—002C RLE				
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	For issue to project team				
A	August 2012	Rachel Evans	RLE	Dave Coremans	DPC
	For issue to project team				
B	August 2012	Rachel Evans	RLE	Dave Coremans	DPC
	For inclusion with LSP and issue to DoW				
C	April 2013	Rachel Evans	RLE	Dave Coremans	DPC
	For issue to DoW and CoC				

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Executive Summary

Gold Estates Holdings (the 'proponent') proposes to develop Lots 13, 14, and 18 Barfield Road and Lots 48-51 Frankland Avenue, Hammond Park, WA (referred to herein as 'the site') for residential purposes. The site incorporates landholdings owned by Gold Estates Holdings and the Department of Housing (DoH). The site is located approximately 30 km south of Perth Central Business District, within the City of Cockburn (CoC). The site is currently zoned 'Urban' under the Metropolitan Region Scheme (MRS) (DoP 2011) and zoned 'Development' under the City of Cockburn Town Planning Scheme (TPS) No. 3 (CoC 2003).

The Local Water Management Strategy (LWMS) for the Barfield Road Local Structure Plan (LSP) area has been developed in accordance with *Better Urban Water Management* (WAPC 2008a), *State Planning Policy 2.9 Water Resources* (WAPC 2006) and *Planning Bulletin 92 Urban Water Management* (WAPC 2008b). Water will be managed using an integrated water cycle management approach, which has been developed using the philosophies and design approaches described in the *Stormwater Management Manual for Western Australia* (DoW 2007).

The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving waters and their ecosystems. Characteristics of both the existing and past environment within the site have been investigated. In summary, the environmental investigations conducted to date indicate that:

- The site receives 770 mm on average, predominantly between June and August.
- Topography of the site is undulating with levels ranging from 40.62 m Australian Height Datum (AHD) and 23.77 m AHD.
- The site is underlain by Bassendean sands with high permeability rates.
- There is a moderate to low risk of encountering Acid Sulfate Soils within 3 m of the surface across the site.
- Vegetation across the site is largely Banksia low woodland in excellent condition. Some areas of completely degraded vegetation consistent with residences and clearing for sand mining.
- There are no Geomorphic Wetlands present within the site.
- There are no existing surface drainage channels within the site.
- Depth to groundwater across the site varies between 5.4 m Below Ground Surface (BGS) and 17.65 m BGS. Measured Maximum Groundwater Levels (MGL) range between 19.6 m AHD and 21.1 m AHD across the site.
- Groundwater beneath the site is slightly acidic with generally low Total Nitrogen and Total Phosphorous levels across the LSP.
- The site is largely undeveloped except for a small number of residential properties and some areas of clearing through grazing of livestock and soil extraction.

The Barfield Road LSP consists of approximately 35 hectares and will incorporate medium and high density residential housing, incorporating local community areas. The Barfield Road LSP includes approximately 2.26 ha of Public Open Space (POS) designed to achieve a balance between useable passive and active open space, as well as recognising significant vegetation retention and drainage requirements within POS reserves.

The overall objective for integrated water cycle management for residential developments is to minimise pollution and maintain an appropriate water balance. The Barfield Road LWMS design objectives seek to deliver best practice outcomes using a Water Sensitive Urban Design (WSUD) approach, including detailed management approaches for:

- Potable water consumption
- Flood mitigation
- Stormwater quality management
- Groundwater management.

The criteria proposed within this LWMS are based on the characteristics of the existing environment and a contemporary best-practice approach to integrated water cycle management.

The overall approach to water conservation is to reduce the amount of scheme water required within the development at both a lot and at an estate scale. Water conservation measures proposed include fit-for-purpose water sources, including groundwater for POS and road verge irrigation, scheme water for potable uses within lots and harvested rainwater for irrigation of private lot gardens and to supplement potable water use within dwellings. Within the lot, in addition to the potential use of rainwater tanks, scheme water will also be reduced by provision of smaller lot sizes (with less garden area), water efficient fittings and appliances and waterwise gardens/landscaping. On an estate scale water will be reduced by use of waterwise landscaping practices including use of native vegetation within POS areas.

Stormwater management focuses on stormwater runoff quantity and quality. The principle behind the stormwater management strategy for the Barfield Road LSP area is to maintain the existing hydrology by retaining surface flows and to infiltrate the stormwater runoff as close to source as possible. The Barfield Road LSP will retain all runoff up to the 100 year ARI event within the site. The 1 year 1 hour ARI event will be retained as close to source as possible using a combination of soakwells and bio-retention areas within POS. Runoff from events greater than the 1 year 1 hour ARI event will be conveyed downstream via surface flow and the road network to flood storage areas within POS where it will infiltrate to groundwater. Stormwater quality will be addressed using a treatment train approach, utilising the storage provisions discussed above.

Depth to groundwater across the site is significant and groundwater level management measures are therefore somewhat passive and the focus of groundwater management is on water quality. Groundwater quality will be managed by managing nutrient inputs within surface runoff, and will aim to ensure that groundwater leaving the site is ideally better than existing conditions. Measures to address groundwater quality are consistent with those proposed for stormwater quality.

The proposed criteria and the manner in which they are proposed to be achieved are presented in **Table E 1**. This table provides a readily auditable summary of the required outcomes which can be used in the future detailed design stage to demonstrate that the agreed objectives for water management at the site have actually been achieved.

Table E 1 Water management criteria and compliance summary

Management Aspect	Criteria Number	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Water Conservation	WC1	Use fit for purpose water sources throughout the development	Use of groundwater for irrigation of POS and road verges	Proponent	Landscape Implementation
			Promotion of rainwater tanks within lots	Proponent	Point of sale
			Rainwater harvesting within lots for irrigation of private gardens	Lot owner	Post-house construction
			Use scheme water within lots	Lot owner	Post-house construction
	WC2	Minimise use of water at an estate scale	Contemporary lot sizes used across the development	Proponent	Subdivision design
			Provision of front of lot landscape packages utilising waterwise gardening principles	Proponent	Landscape implementation
			Promotion of waterwise gardening principles to lot owners	Proponent	Point of sale
			Use of waterwise gardening principles in lot	Lot owner	Post-house construction
			Mandated use of water efficient fittings within lots	Proponent/City of Cockburn	Building approvals
			Promotion of water efficient appliances within lots	Proponent	Point of sale
			Use of water efficient appliances within lots	Lot owner	Post-house construction
			Promotion of rainwater tanks for use within lots and for lot garden irrigation	Proponent	Point of sale
			Adoption of rainwater tanks within lot for non-potable uses	Lot owner	Post-house construction
			Use of waterwise principles in all POS and road verge areas	Proponent	Landscape implementation

Management Aspect	Criteria Number	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
			Use of groundwater for irrigation of POS and road verges	Proponent	Landscape implementation
	WC3	Consumption target of 100 kL/person/year for residential areas with no more than 40 – 60 kL/person/year of scheme water	Provision of front of lot landscape packages utilising WWG principles	Proponent	Landscape implementation
			Promotion of waterwise gardening principles to lot owners	Proponent	Point of sale
			Use of waterwise gardening principles within lot	Lot owner	Post-house construction
			Mandated use of water efficient fittings within lots	Proponent/City of Cockburn	Building approvals
			Promotion of water efficient appliances within lots	Proponent	Point of sale
			Use of water efficient appliances within lots	Lot owner	Post-house construction
			Promotion of rainwater tanks for use within lots and for lot garden irrigation	Proponent	Point of sale
			Use of rainwater tanks within lots	Lot owner	Post-house construction
Groundwater	GW1	Treat stormwater runoff before infiltration to groundwater	Bio-retention areas to treat surface water runoff prior to infiltration to groundwater	Proponent	During detailed drainage design
			Bio-retention areas to be underlain by soils with PRI>10	Proponent	Landscape implementation
	GW2	Use water sensitive design approaches to recharge the superficial aquifer	Soakwells within lots sized to infiltrate up to the 1 year 1 hour ARI event	Proponent	During detailed drainage design
			Infiltration basins sized to retain and infiltrate flows up to the 100 year ARI event	Proponent	During detailed drainage design
			Bio-retention areas sized to retain and infiltrate the 1 year 1 hour ARI event from road reserves	Proponent	During detailed drainage design

Management Aspect	Criteria Number	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
	GW3	Maintain or improve groundwater quality beneath the site	All surface runoff from the road network in a 1 year 1 hour ARI event will be directed to bio-retention areas within POS	Proponent	During detailed drainage design
			Soils underlying bio-retention areas will have a band of material that is a minimum of 150 mm deep with a PRI>10	Proponent	During detailed design
			Minimise fertiliser use in POS and road verges	Proponent	Landscape implementation
			Use roll-on, drought tolerant turf species	Proponent	Landscape implementation
			Garden beds will not be located adjacent to flood storage areas	Proponent	Landscape implementation
Stormwater Quantity	SW1	Retain the 100 year ARI rainfall event onsite	Soakwells within lots sized to hold the 1 year ARI 1 hour duration event runoff from lots	Lot owner	Construction
			Soakage pits within road pipe network to retain portion of runoff from road reserves	Proponent	During detailed drainage design
			Bio-retention areas within POS sized to hold residual 1 year 1 hour ARI event from road reserves	Proponent	During detailed drainage design
			Infiltration basins within downstream POS sized to hold up to the 100 year ARI event runoff	Proponent	During detailed drainage design
	SW2	Provide stormwater flowpath for runoff from the 100 year ARI event	The earthworks plans provided in **Appendix E** show that the road network is graded to allow runoff to flow towards retention areas within POS	Proponent	During detailed design
	SW3	Finished floor levels of lots must have a minimum of 300 mm clearance from the 100 year ARI event flows being conveyed within road reserves	This will be demonstrated within the earthworks strategy at detailed design stage	Proponent	During detailed design
	SW4	The finished floor levels must have a	This will be demonstrated within the earthworks strategy at	Proponent	During detailed design

Management Aspect	Criteria Number	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
		minimum of 500 mm clearance above the 100 year ARI flood levels in the onsite infiltration basins	detailed design stage		
	SW5	Roads are to remain passable in the 5 year ARI event	The pipe network will be designed to convey the 5 year ARI event which will ensure roads remain passable	Proponent	During detailed drainage design
	SW6	Design infiltration areas to avoid creating mosquito habitat	The high infiltration rates of the underlying sands ensure that the maximum inundation time within the infiltration basins will be no more than 16 hours	Proponent	During detailed drainage design
	SW7	Base of infiltration basins must be at least 500 mm above MGL	The earthworks plan provided in Appendix E provides indicative inverts of infiltration basins with a minimum clearance to MGL of 2 m assumed within the modelling. Levels will be confirmed at detailed design	Proponent	During detailed drainage design
Stormwater Quality	SWQ1	Retain the 1 year 1 hour duration ARI rainfall event at source or as close as practicable	Soakwells within lots sized to hold the 1 year ARI 1 hour duration event runoff from lots	Lot owner	Construction
			Soakage pits within road pipe network to retain portion of runoff from road reserves	Proponent	During detailed drainage design
			Bio-retention areas within POS sized to hold residual 1 year ARI event from road reserves	Proponent	During detailed drainage design
	SWQ2	The surface area of bio-retention areas is to be at least 2% of the connected impervious area	The surface area of bio-retention areas is 2.2% of the connected impervious area	Proponent	During detailed drainage design
	SWQ3	Apply appropriate structural and non-structural measures to reduce nutrient loads	Soakwells used within lots	Lot owner	Construction
			Soakage pits within pipe network	Proponent	During detailed drainage design
			Bio-retention areas used within POS	Proponent	During detailed drainage design
			Minimise use of fertilisers within POS and road verges	Proponent	Landscape

Management Aspect	Criteria Number	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
					implementation
			Maintenance of POS and drainage areas	Landscape Contractor	Ongoing
			Education of residents regarding fertiliser use	Proponent	Point of sale

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1 Introduction

1.1 Background

The Barfield Road Local Structure Plan (LSP) area (referred to herein as 'the site') is located approximately 30 km south of Perth's Central Business District within the City of Cockburn (CoC) in the locality of Hammond Park. The Kwinana Freeway lies directly east of the site. The site incorporates landholdings owned by Gold Estates Holdings and the Department of Housing (DoH) and includes Lots 13, 14, and 18 Barfield Road and Lots 48-51 Frankland Avenue. The site location is shown in **Figure 1** with the cadastral boundaries shown in **Figure 2**.

The site consists of approximately 36 ha of largely intact remnant bushland with some existing residences and sheds, grazing land for horses and areas of clearing related to soil extraction.

The site is currently zoned 'Urban' under the Metropolitan Region Scheme (MRS) (DoP 2011) and zoned 'Development' under the City of Cockburn Town Planning Scheme (TPS) No. 3 (CoC 2003).

It is important that the manner in which stormwater runoff from urban zoned areas is to be managed to avoid flooding and protect the environment are clearly documented early in the planning process. This approach provides the framework for actions and measures to achieve the desired outcomes at subdivision stage. This Local Water Management Strategy (LWMS) details the water management approach to support the Local Structure Plan (LSP).

1.2 Policy framework

There are a number of State Government policies of relevance to the site. These policies include:

- *State Water Strategy* (Government of WA 2003b)
- *State Planning Policy 2.9 Water Resources* (WAPC 2006)
- *Environmental Protection (Swan Coastal Plain Lakes) Policy* (Government of WA 1992)
- *Guidance Statement No. 33: Environmental Guidance for Planning and Development* (EPA 2008)
- *Liveable Neighbourhoods Edition 4* (WAPC 2007)
- *Planning Bulletin No. 64: Acid Sulfate Soils* (WAPC 2009).

In addition to the above policies, there are a number of published guidelines and standards available that provide direction regarding the water discharge characteristics that urban developments should aim to achieve. These are key inputs that relate either directly or indirectly to the site and include:

- *Better Urban Water Management* (WAPC 2008a)
- *Decision Process for Stormwater Management in Western Australia* (DoW 2009)
- *Stormwater Management Manual for Western Australia* (DoW 2007)
- *Australian Runoff Quality* (Wong 2006)
- *Australian Rainfall and Runoff* (Engineers Australia 1987)
- *National Water Quality Management Strategy* (ANZECC 2000)
- *Southern Suburbs District Structure Plan – Stage 3 Hammond Park/Wattleup (Draft)* (CoC 2005)
- *Southern Suburbs District Planning Area: Russell Road Arterial Drain Scheme (RRADS)* (David Wills and Associates 2003).

The guidance documents listed indicate a need for accurate water quality baseline data prior to urban development.

This will ensure that any future development is able to fulfil the stormwater management requirements of DoW and engineering standards specified by the CoC, but will also ensure that realistic water quality criteria that are practically achievable are adopted.

1.3 Previous Studies

1.3.1 Southern Suburbs District Structure Plan

The Southern Suburbs District Structure Plan – Stage 3 (SSDSP3) was prepared by the CoC (CoC 2005) and provides a broad land use framework for the area including major road network, neighbourhood structure, commercial, education, community and significant open space areas (CoC 2005). A District Water Management Strategy (DWMS) was not prepared as part of the SSDSP.

1.3.2 Southern Suburbs District Planning Area: Russell Road Arterial Drain Scheme

The Russell Road Arterial Drain Scheme (RRADS) was prepared to assist the CoC in providing a stormwater drainage system to service the SSDSP3 area. The report aimed to facilitate the installation of an integrated stormwater drainage system that controlled the rise of groundwater levels within the catchment area through the use of 'groundwater collection points' (David Wills and Associates 2003).

A considerable amount of development has been carried out within the RRADS catchment area since this document was produced. The drainage strategies within these developments have not adopted the strategy proposed within RRADS, with basins located at alternative locations and 'Groundwater collection point' detention basins not being constructed.

Considering the level of new development within the RRADS catchment area and the more current guidelines provided in *Better Urban Water Management* (WAPC 2008a) and the *Stormwater Management Manual for Western Australia* (DoW 2007), this LWMS does not propose to implement the strategy proposed within RRADS.

1.3.3 Barfield Road Various Lots District Water Management Strategy

The Barfield Road DWMS was prepared by Cardno (Cardno 2010). The key principles proposed in the DWMS are consistent with overall water cycle management principles outlined in the reference documents described previously, and include:

- Maximise water use efficiency
- Protect life and property from flooding
- Protect groundwater quality.

The proposed management approach used to achieve the broad objectives, are detailed in the following sections. These also form the basis for the design criteria that are further discussed in **Section 4**.

1.3.3.1 Maximise water use efficiency

The management approach that was proposed to maximise water use efficiency includes:

- Efficient use of scheme water across the development.

- Consumption target at a lot scale of 100 kL/person/year, with an aspirational target of 40-60 kL/person/year.

1.3.3.2 Protect life and property from flooding

The management approach that was proposed to protect life and property from flooding includes:

- Retain the 1 year 1 hour Annual Recurrence Interval (ARI) event on site, as close to source as possible.
- Detain the 5 year and 100 year ARI storm events to maintain pre-development peak flows and volumes.
- Defined major arterial roads are to remain passable in the 100 year ARI event.
- Minor roads are to remain passable in the 5 year ARI event by:
  - Providing conveyance of a 5 year ARI event within the piped stormwater network.
  - Providing conveyance of larger events within the road pavement network.
- Encourage localised infiltration where possible.
- Ensure development outside a floodway maintains finished floor levels at a minimum of 300 mm above the 100 year flood level.
- Stormwater treatment areas to be sized to reach a total surface area equivalent to 2% of the total connected impervious area of the site.
- Apply appropriate structural and non-structural measures to reduce applied nutrient loads.

1.3.3.3 Protect groundwater quality

The management approach that was proposed to protect groundwater quality includes:

- Minimise changes to the underlying groundwater levels as a result of development.
- Lots should have a separation distance from the MGL of at least 1.5 m to ensure protection of infrastructure and assets from flooding and inundation by high seasonal groundwater levels.
- Minimise the risk of nutrient enrichment of downstream receiving surface water bodies from groundwater sources.
- The groundwater leaving the site should at least be the same, or better, than the water entering the site.

1.4 LWMS Objectives

This LWMS has been developed in consideration of the objectives and principles detailed in guidance documents discussed in **Section 1.3**. It is intended to support the LSP, and is further based on the following major objectives:

- Provide a broad level stormwater management framework to support future urban development.
- Incorporate appropriate best management practices (BMPs) into the drainage systems that address the environmental and stormwater management issues identified.
- Minimise development construction costs, which will result in reduced land costs for future home owners.
- Minimise ongoing operation and maintenance costs for the land owners and CoC.
- Develop a water conservation strategy for the site that will accommodate existing groundwater allocation constraints for the area.
- Gain support from the DoW and CoC for the proposed method to manage stormwater within the site and potential impacts on downstream areas.

Detailed objectives for water management within the site are further discussed in **Section 4**.

2 Proposed Development

The LSP provides for a range of residential densities and a diversity of housing types, consistent with the requirements of the SSDSP3. The Barfield Road LSP consists of approximately 35 hectares and will incorporate areas of Public Open Space (POS) designed to achieve a balance between useable passive and active open space, as well as recognising significant vegetation retention and drainage requirements within POS reserves.

The Barfield Road LSP will incorporate:

- 366 single residential lots
- 24 grouped/multiple dwelling residential lots
- 2.26 ha of Public Open Space
- Local community facilities and businesses
- Approximately 12 ha of road reserve.

The Barfield Road LSP is shown in **Appendix A**.

3 Pre-development Environment

3.1 Sources of Information

The following sources of information were used to provide a broad regional environmental context for the site:

- *National Water Quality Management Strategy* (ANZECC 2000)
- *Regional 1:50 000 Geology Map Sheet* (Gozzard 1983)
- *WA Atlas* (Landgate 2012)
- *Weather and Climate Statistics (*Bureau of Meteorology 2012*)*
- *Perth Groundwater Atlas* (DoW 2012a)
- *Water Register* (DoW 2012b).

In addition to the above information, site-specific investigations have been conducted. These have aimed at providing more detail to the existing regional information. These site-specific investigations include:

- *Level 2 Flora and Vegetation Survey* (*Ecoscape 2009*)
- *Groundwater Monitoring report* (*Cardno 2011*)
- *Hammond Park Local Structure Plan Servicing Report* (GHD 2012).

The above studies have been reviewed to determine infiltration potential within the site and existing groundwater levels. This is important, as both can have implications for the stormwater management measures and the extent of earthworks that may be required to facilitate subdivision.

3.2 Climate

The site experiences a dry Mediterranean climate of hot dry summers and cool wet winters. Long term climatic averages indicate that the site is located in an area of moderate to high rainfall, receiving 770 mm on average annually (Bureau of Meteorology 2012) with the majority of rainfall received between June and August. The region experiences rainfall an average of 90 days per annum.

3.3 Geotechnical Conditions

3.3.1 Topography

The site has an undulating topography ranging from 41 m Australian Height Datum (AHD) to 24 m AHD. The highest areas within the site run along the west and south boundaries, along Frankland Road and Rowley Road respectively. There are high points towards the middle of the site (31 m AHD) and the north east corner (29 m AHD). There are steep slopes along the west of the site leading down from Frankland Road, specifically within the south west corner at the junction with Rowley Road.

Topographic contours across the site are shown in **Figure 3**.

3.3.2 Soils and Geology

The site is largely underlain by Spearwood sands, with the south-west portion of the site underlain by Bassendean Sands (Gozzard 1983). Soil and landform descriptions of the dominant phases include (Landgate 2012):

- Spearwood S1b Phase - Dune ridges with deep siliceous yellow brown sands or pale sands with yellow-brown subsoil and slopes up to 15%.
- Bassendean B1 Phase - Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than 2 m; Banksia dominant.

Bore logs recorded at the time that groundwater bores were installed across the site (discussed in **Section 3.5**) confirmed the classification of Gozzard (Gozzard 1983). The soil bore logs are given in **Appendix B** and soil mapping of the site is shown in **Figure 4**.

3.3.3 Acid Sulfate Soils

The WA Atlas Acid Sulfate Soil (ASS) risk mapping (DEC 2012) classifies the whole site as having a moderate to low risk of ASS being present within 3.0 m of the natural surface.

ASS risk mapping is shown in **Figure 5**.

3.4 Flora

A *Level 2 Flora and Vegetation Survey* (Ecoscape 2009) was carried across the site out in March 2009. The survey determined that the site contains Banksia low woodland which is mostly in excellent condition across the site. Some areas of completely degraded condition vegetation were identified, associated with housing and areas of sand mining and livestock grazing. No 'Declared Rare' or 'Priority' listed flora was identified on site (Ecoscape 2009).

The vegetation survey mapping is included within **Appendix C**.

3.5 Wetlands

The *Geomorphic Wetlands of the Swan Coastal Plain dataset* (DEC 1992) indicates that there are no Wetlands within the site. There are however, a number of wetlands within close vicinity of the site:

- Mandogalup Swamp South (UFI 6530) – a multiple use dampland, located approximately 250 m south of the site.
- Mandogalup Swamp North (UFI 6719) – a Resource Enhancement management category sumpland, located approximately 300 m south east of the site

There are no *Environmental Protection (Swan Coastal Plain Lakes) Policy* wetlands on site (Government of WA 1992).

The location of the surrounding wetlands is shown in **Figure 6**.

3.6 Hydrology

The permeability of the underlying sand is high, allowing surface water to infiltrate freely across the site. There are no defined streamlines or floodways within the site. Surface runoff from extreme rainfall events is likely to be seen as sheet flow, directed toward key low points across the site by the undulating nature of the topography.

3.6.1 Surface Water Quantity

The site is largely undeveloped and there are no existing drainage channels present. The high permeability of the underlying sands and the vegetation coverage has resulted in no natural channels forming over the site.

Pre-development modelling of the site was carried out within the DWMS (Cardno 2010) which identified the pre-development catchments within the site and surrounding SSDSP3 area. The pre-development catchments within the site are shown in **Figure 6** with the modelling results provided in **Appendix F**.

Pre-development modelling indicates that the majority of surface runoff is retained in low-lying areas located within the site and therefore discharge from the site is minimal. Some minor discharge occurs from the south of the site towards Rowley Road and from the north-west corner northwards. There is an existing low point to the north of the site which crosses across the site boundary.

The modelling results provided in **Appendix F** give peak flow rates for each catchment. These are total flow rates across broad sandy catchments, not flow rates leaving the site within defined flow channels. Surface runoff following extreme rainfall events will result in saturated soils with shallow sheet flow seen across the site.

Considering the minor discharge volumes leaving the site in the pre-development environment, the proposed stormwater strategy is to retain surface runoff from events up to the 100 year ARI event on site (discussed further in **Section 7**). This approach reduces the burden on existing infrastructure (i.e. Rowley Road drainage network) and ensures that flood risk to lots north of the site that are proposed to be developed is minimised.

3.6.2 Surface Water Quality

Given that there are no defined water bodies or channels, there is no surface water quality data available for the site.

3.6.3 Groundwater Levels

Information on groundwater from the DoW ‘Online Water Register’ indicates that groundwater beneath the site is a multi-layered system comprised of the following (DoW 2012b):

- Perth - Superficial Swan
- Perth - Leederville
- Perth - Yarragadee North.

The Superficial aquifer is considered to be the primary aquifer of interest in relation to this LWMS as this is the aquifer most likely impacted by water management practices within the site, and also most likely accessed for local use.

Groundwater monitoring was carried out to identify the baseline groundwater data for the site (Cardno 2011). Three monitoring bores were installed across the site, with an existing DoW bore also being located immediately adjacent to the site. Monitoring was carried out over a 14 month period, from October 2009. Groundwater levels were measured monthly and depth to groundwater ranged from 5.4 m Below Ground Surface (BGS) to 17.6 m BGS (in October 2009 and June 2010 respectively). Maximum Groundwater Levels (MGL) measured across the site ranged between 19.6 m AHD and 20.6 m AHD (Cardno 2011).

Measured MGL levels and sampling locations are shown in **Figure 7**.

3.6.4 Groundwater Quality

Groundwater quality was measured quarterly, with 5 sampling occasions in total. Physiochemical parameters were recorded in-situ with laboratory analysis conducted for nutrient analysis. Groundwater quality results are shown in **Table 1** (Cardno 2011).

Monitoring indicates a slightly acidic pH across the site (average 5.45). Total Nitrogen (TN) and Total Phosphorous (TP) levels are relatively consistent and generally low across the site.

Table 1 Groundwater quality results

Bore	Temp (°C)	Salinity (mS/cm)	DO (%)	pH	Redox	TN (µg/L)	TP (µg/L)	NH4 (µg/L)	NOx (µg/L)	TKN (µg/L)	Ortho-P (µg/L)
MW1	20 (0.9)	0.10 (0.01)	21.64 (9.9)	5.15 (0.8)	154.8 (33)	600 (418)	20 (10)	40 (34)	380 (388)	220 (44)	10 (0)
MW2	20.8 (1.15)	0.17 (0.03)	38.26 (10)	5.57 (0.9)	145.2 (18)	325 (125)	30 (17)	76 (56)	54 (27)	300 (141)	10 (0)
MW3	20.72 (2.9)	0.45 (0.02)	22.86 (3.2)	5.29 (0.3)	38.8 (54)	460 (260)	72.5 (99)	172 (50)	32 (22)	440 (250)	10 (0)
WIN3065	22 (3.7)	0.10 (0.04)	23.69 (11)	5.69 (0.5)	-5.25 (17.5)	300 (182)	26.67 (11.5)	55 (71)	35 (12.9)	275 (170)	10 (0)

Average and (Standard Deviation)

3.7 Current and Historical Land Uses

The site is largely undeveloped except for a small number of residential properties with areas historically used for grazing of livestock and small areas of clearing related to soil extraction. The cleared areas have been subjected to rubbish dumping.

3.8 Summary of Existing Environment

In summary, the environmental investigations conducted to date indicate that:

- The site receives 770 mm of rainfall on average, predominantly occurring between June and August.
- Topography of the site is undulating with levels ranging from 41 m AHD and 24 m AHD.
- The site is underlain by Bassendean sands with high permeability rates.
- There is a moderate to low risk of encountering ASS within 3 m of the surface across the site.

- Vegetation across the site is largely Banksia low woodland in excellent condition. Some areas of completely degraded vegetation consistent with residencies and clearing for sand mining.
- There are no Geomorphic Wetlands present within the site.
- There are no existing surface drainage channels within the site.
- Depth to groundwater across the site varies between 5.4 m BGS and 17.65 m BGS. MGL measured across the site ranges between 19.6 m AHD and 20.6 m AHD.
- Groundwater beneath the site is slightly acidic with generally low TN and TP levels across the LSP area.
- The site is largely undeveloped except for a small number of residential properties. Some areas of clearing for grazing of livestock and soil extraction.

4 Design Criteria and Objectives

This section outlines the objectives and design criteria that this LWMS and future UWMPs must achieve. The water management strategy covers stormwater management, groundwater management and water consumption.

4.1 Integrated Water Cycle Management

The *State Water Strategy* (Government of WA 2003a) and *Better Urban Water Management* (WAPC 2008a) endorses the promotion of total water cycle management and application of WSUD principles to provide improvements in the management of stormwater, and to increase the efficient use of other existing water supplies.

The key principles of integrated water cycle management include:

- Considering all water sources, including wastewater, stormwater and groundwater
- Integrating water and land use planning
- Allocating and using water sustainably and equitably
- Integrating water use with natural water processes
- Adopting a whole of catchment integration of natural resource use and management.

Integrated water cycle management addresses not only physical and environmental aspects of water resource use and planning, but also integrates other social and economic concerns. Stormwater management design objectives should therefore seek to deliver better outcomes in terms of:

- Potable water consumption
- Flood mitigation
- Stormwater quality management
- Groundwater management.

The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving environments. The existing environmental context of the site has been discussed in **Section 3** of this document. Guidance regarding environmental values and criteria is provided by a number of National and State policies and guidelines and site specific studies undertaken in and around the site. These were detailed in **Sections 1.2** and **3.1**.

The overall objective for preparing integrated water cycle management plans for proposed residential developments is to minimise pollution and maintain an appropriate water balance. This objective is central to the water management approach for the Barfield Road LSP.

4.2 Water Conservation

Water conservation design criteria have been determined in line with the guidelines presented in *Better Urban Water Management* and criteria detailed in the *Barfield Road Various Lots DWMS* (Cardno 2010). The Barfield Road LWMS proposes the following water conservation criteria:

Criteria WC 1 Use fit for purpose water sources throughout the development.

Criteria WC 2 Minimise use of water at an estate scale.

Criteria WC3 Consumption target for water of 100 kL/person/year, including not more than 40-60 kL/person/year scheme water.

The manner in which these objectives will be achieved is further detailed in **Section 5**.

4.3 Groundwater Management

The principle behind the groundwater management strategy is to maintain the existing groundwater hydrology. The groundwater management criteria for the Barfield Road LSP include:

Criteria GW1 Treat stormwater runoff before infiltration to groundwater.

Criteria GW2 Use water sensitive design approaches to recharge the superficial aquifer.

Criteria GW3 Maintain or improve groundwater quality onsite.

Groundwater management criteria proposed in the DWMS (Cardno 2010) included clearance to MGL requirements. Given that the depth to measured MGL has been shown to be greater than 5 m across the site, these criteria are no longer relevant and are not proposed within this LWMS.

The manner in which the groundwater management objectives will be achieved is further detailed in **Section 6**.

4.4 Stormwater Management

The principle behind stormwater management at the site is to mimic the pre-development hydrological conditions, as described in **Section 3.6**. This principle and the guidance documents discussed in **Section 1.2** have guided the stormwater management criteria.

4.4.1 Stormwater Quantity

Stormwater quantity design criteria include:

Criteria SW1 Retain the 100 year ARI rainfall event onsite.

Criteria SW2 Provide stormwater flow pathways for runoff from the 100 year ARI event.

Criteria SW3 Finished floor levels of lots must have a minimum of 300 mm clearance from the 100 year ARI event flows being conveyed within road reserves.

Criteria SW4 Finished floor levels of lots must have a minimum of 500 mm clearance above the 100 year ARI flood levels in the onsite retention areas.

Criteria SW5 Minor roads are to remain passable in a 5 year ARI event.

Criteria SW6 Design infiltration areas to avoid creating mosquito habitat.

Criteria SW7 Base of infiltration basins must be at least 500 mm above MGL.

The manner in which these objectives will be achieved is further detailed in **Section 7**.

4.4.2 Stormwater Quality

Stormwater quality design criteria include:

Criteria SWQ1 Retain the 1 year 1 hour duration ARI rainfall event at source or as close as practicable.

Criteria SWQ2 The surface area of bio-retention areas is to be at least 2% of the connected impervious area.

Criteria SWQ3 Apply appropriate structural and non-structural measures to reduce nutrient loads

The manner in which these objectives will be achieved is further detailed in **Section 7**.

5 Water Source Allocation, Infrastructure, Fit-for-Purpose and Water Use

5.1 Fit-for-Purpose water use

Conservation of water through fit-for-purpose use and best management practices is encouraged so that scheme water is not wasted. Fit-for-purpose describes the use of water that is of a quality suitable for the required use of the water. Fit-for-purpose principles have been utilised in the water conservation strategy for the Barfield Road LSP.

5.1.1 Scheme Water

Scheme water will be supplied by the existing DN250 network in Frankland Avenue which will be extended to the site and DN150/DN100 reticulation mains laid to service the subdivision. Easements may be required over the proposed water mains until road reserves are gazetted (GHD 2012).

5.1.2 Groundwater

The DoW 'Online Water Register' indicates that the site is located in the Jandakot groundwater area, within the Success sub-area and that there is allocation available within the Perth-Superficial aquifer (DoW 2012b).

Groundwater can be used for irrigation of POS areas and some road verges instead of utilising scheme water. Turf areas typically require 7,500 kL/ha/year, therefore at full rates, the 3.7 ha of POS and road verge that will require irrigation within the Barfield Road LSP would require a maximum of 27.7 ML a year. This provides a conservative estimate of the water required for the POS and road verge areas which will need to be revised at UWMP stage once the POS landscape design is complete and the proportion of the POS proposed to be turfed and native vegetation planted have been finalised.

Groundwater use for POS irrigation is further discussed in **Section 5.4**.

The use of the above water sources will help to achieve **Criteria WC1**.

5.2 Water Conservation Measures

The development will utilise groundwater for POS irrigation, active POS irrigation management, Contemporary Lot Sizes (CLS) (which provide less room for gardens), Rainwater Tanks (RWT), WaterWise (WC 2003) principles for lot scale gardens and within estate landscaping (WWG) and Water Efficient Fixtures and Appliances (WEFA) to ensure that the development minimises the use of water. These measures are further discussed in the following Sections.

5.2.1 Contemporary Lot Sizes

The Barfield Road LSP incorporates a range of lot sizes ranging from 300 m^2 to 550 m^2 for individual lots as well as grouped and multiple dwelling lots. These CLS reflect a trend towards smaller residential lots in new urban areas. Smaller lot sizes result in more compact garden areas than traditional residential lots, and therefore external house water requirements are reduced.

5.2.2 Rainwater Tanks

Collection of runoff from roof surfaces can be undertaken, with this water stored within rainwater tanks for later use. This water is of high quality however in urban environments this water is considered non-potable. Stored rainwater may be used for some irrigation requirements however this will need to be supplemented with scheme water during the lower rainfall months. During the higher rainfall months, the majority of the stored rainwater can be used to supplement internal building non-potable uses. This water efficiency strategy recommends that the rainwater is used in washing machines, toilets and hot water systems.

Rainwater tanks will not be mandated for the Barfield Road LSP however they will be promoted by the proponent at point of sale by providing educational literature regarding the benefits of using rainwater for in lot and irrigation purposes. It is assumed that 15% of future residents will utilise rainwater tanks, based on typical uptake rates taken from Australian Bureau of Statistics published data (ABS 2004; ABS 2010a; ABS 2010b).

The above measures will assist in achieving **Criteria WC1**, **WC2** and **WC3**.

5.2.3 Water Efficient Fixtures and Appliances

Significant reduction in in-house water uses can be achieved with the use of water efficient fixtures and appliances. **Table 2** provides an example of the water uses of typical appliances versus water efficient appliances (Melbourne Water 2003; Australian Government 2009). These water use rates have been used in the lot scale water balance analysis detailed in **Section 5.3**.

Table 2 Water efficient fixtures and appliances

Appliance	Water Use	
	Standard Device	Water Saving Device
Toilet	12 Litres/Flush	4 Litres/Flush
Washing Machine	130 Litres/Wash	40 Litres/Wash
Dishwashers	50 Litres/Wash	25 Litres/Wash
Shower Head	15-25 Litres/Minute	6-7 Litres/Minute
Taps	15-18 Litres/Minute	5-6 Litres/Minute

The Barfield Road LSP water conservation strategy proposes that all dwellings use water efficient fixtures and appliances. Water efficient fixtures will be mandated through the building licence, while uptake of water efficient appliances can be encouraged by state and local government rebates, as well as education from the proponent at point of sale. It is assumed that 35% of future residents will utilise water efficient appliances, based on typical uptake rates provided by ABS (ABS 2004; ABS 2010a; ABS 2010b).

The above measures will assist in achieving **Criteria WC1** and **WC2**.

5.2.4 Water Wise Gardens

Studies by the Water Corporation (WC 2003) have found that for a typical household, 56% of the water consumed by the lot is used on the gardens.

Therefore, reductions in water irrigation by employing water efficiency measures can significantly reduce the total water usage of the lot. The following water efficiency measures should be used on lot gardens:

- Improve soil with conditioner certified to Australian Standard AS4454 to a minimum depth of 150 mm where turf is to be planted and a minimum depth of 300 mm for garden beds.
- Design and install the irrigation system according to best water efficient practices.
    - Control systems must be able to irrigate different zones with different irrigation rates.
    - Emitters must disperse coarse droplets or be subterranean.
    - Utilise subsoil irrigation where appropriate.
- Garden beds will utilise 'waterwise' plants, which are (where possible) locally native species or plants from regions with similar climates. These plants require less water input than exotic species.
- Minimise the amount of turf areas.
- Select turf species of a genotype endorsed by the UWA Turf Industries Research Steering Committee (e.g. Couch grass – *Cynodon dactylon*).
- Mulch garden beds to 75 mm with a product certified to Australian Standard AS4454.
- Increase community awareness of water conservation by promoting waterwise practices at the point of sale.

Water conservation can also be reduced on a development scale within POS areas. As well as using the lot scale garden measures on POS gardens, the following additions measures will be utilised:

- Retain remnant native trees within POS areas where possible. This will provide shade, reduce water requirements during POS establishment and will assist in providing buffers for waterways.
- Minimise water requirements for POS maintenance. This will be achieved by implementing an appropriate management and maintenance program for POS areas – to be further detailed at the UWMP stage.

Front of lot landscape packages will be provided by the proponent for all lots which will utilise water wise gardening principles (WWG). The proponent will also promote WWG to lot owners at point of sale by providing educational literature regarding the benefits of WWG. It is therefore assumed that overall 75% of lot gardens (i.e. front and back yard landscaping) will utilise WWG, based on typical uptake rates taken from Australian Bureau of Statistics (ABS 2004; ABS 2010a; ABS 2010b).

The above measures will assist in achieving **Criteria WC2** and **WC3**.

5.3 Lot Water Balance

A water balance analysis has been undertaken for the Barfield Road LSP to demonstrate the effectiveness of the water conservation strategy proposed for lot-scale measures when compared to a development without a water conservation strategy. A comparison is given considering realistic uptakes of non-mandatory water conservation measures including water efficient appliances, rainwater tanks and waterwise gardens. Uptake rate assumptions are calculated using data taken from the Australian Bureau of Statistics (ABS 2004; ABS 2010a; ABS 2010b). A potential total reduction should 100% of all proposed measures be utilised is also provided.

1. Scenario 1 – No Water Conservation
2. Scenario 2 – % uptake of Water Conservation Strategy (WCS) (100% CLS, 75% WWG, 15% RWT, 100% WE Fixtures, 35% WE Appliances)

3. Scenario 3 – Full WCS (100% of all measures)

The Barfield Road LSP water balance analysis has been based on the rates and calculation methodology presented in the WC Spreadsheet *AltWaterSupply_Water_Use_Model.xls.* This spreadsheet has been adapted to model the effects of using the water conservation measures proposed within this LWMS. The water balance analysis assumes an average of 2.9 people per lot for single dwellings and 1.8 people per unit within grouped/multiple dwellings, a value calculated from data provided by the Australian Bureau of Statistics for new housing developments in Perth (ABS 2009). The lot scale water balance does not include irrigation requirements for POS or road verges as these are detailed within the estate scale requirements detailed in **Section 5.4**.

The lot scale water consumption comparison for the three water conservation scenarios is presented in **Table 3**.

Table 3 Barfield Road LSP lot water consumption

	Scenario 1 NWC	Scenario 2 % uptake of WCS	Scenario 3 Full WCS
Total Scheme Water Required (ML)	198	60	39
Scheme Water per Capita (kL/year/person)	112.7	41.3	29.1

The results of the water balance indicate that on average in the development, dwellings not using water conservation measures will exceed the consumption target of 100 kL/year/person. If households in the development adopt the proposed water conservation measures at typical uptake rates they will use on average 41.3 kL/year/person. There is a potential to reduce this to 29.1 kL/year/person should all households adopt all of the water conservation measures in the future.

This achieves the state water consumption target of no more than 100 kL/year/person and the *Better Urban Water Management* aspirational goal of 40-60 kL/year/person, and satisfies **Criteria WC2** and **WC3**.

5.4 Estate Scale Water Use

The water use at an estate scale is determined by the amount of POS provided, the amount of road verges and additional areas that will require irrigation and the rates at which these are irrigated.

2.26 ha of POS and 1.43 ha of road verge are proposed to be irrigated within the Barfield Road LSP. With traditionally recommended irrigation rates of 7500 kL/ha/year this leads to a total of 27.7 ML/year.

As previously discussed in **Section 5.1.2**, irrigation requirements can be supplied using groundwater from the underlying superficial aquifer, thereby reducing overall scheme water usage. A groundwater allocation for a total volume of 42,390 kL/year has been obtained for the irrigation of POS and road verge and for dust suppression during construction (licence #GWL174958(1)). This licence is valid until 3rd September 2022 and will be sufficient for all irrigation requirements across the site.

A breakdown of the irrigation requirements and concept POS landscape designs are included in **Appendix D**.

5.5 Wastewater Management

A 300 mm diameter and 225 mm diameter sewer will need to be extended southwards from the Hammond Rise development to the north through the privately owned land comprising of Lots 31 and 33. Should access across the privately owned land not be feasible, an alternative alignment for a 222 mm sewer along Barfield Road is possible as an interim measure, subject to WC approval (GHD 2012).

5.6 Water Conservation Criteria Compliance Summary

A summary of the proposed water conservation design criteria, and how these are addressed within the Barfield Road LSP is provided in **Table 4**.

Table 4 Water conservation criteria compliance

Criteria Number	Criteria Description	Manner in which compliance will be achieved
WC1	Use fit for purpose water sources throughout the development	Use of groundwater for irrigation of POS and road verges
		Rainwater harvesting promoted within lots for irrigation of private gardens
		Scheme water for use in lots
WC2	Minimise use of water at an estate scale	Contemporary lot sizes used across the development
		Provision of front of lot landscape packages utilising WWG principles
		Promotion of waterwise gardening principles to lot owners at point of sale
		Use of water efficient fittings within lots
		Promotion of water efficient appliances within lots
		Promotion of rainwater tanks for use within lots and for lot garden irrigation
		Use of waterwise principles in all POS and road verge areas
		Use of groundwater for irrigation of POS and road verges
WC2	Consumption target of 100 kL/person/year for residential areas with no more than 40 – 60 kL/person/year of scheme water	Provision of front of lot landscape packages utilising WWG principles
		Promotion of waterwise gardening principles to lot owners
		Use of water efficient fittings within lots
		Promotion of water efficient appliances within lots
		Promotion of rainwater tanks for use within lots and for lot garden irrigation

6 Groundwater Management Strategy

The development drainage system has been designed to achieve the objectives and criteria stated in **Section 4.3**.

6.1 Groundwater Level Management

As discussed in **Section 3.6.3**, depth to groundwater varies between 5.4 m and 17.7 m BGS. Groundwater level management measures are therefore somewhat passive and the focus of groundwater management is on water quality.

6.2 Groundwater Quality Management

The main objective for the management of the groundwater quality is to maintain or improve the existing groundwater quality. This can be achieved by reducing the total nutrient load into the groundwater that originates from the development. Groundwater that originates from the development consists of surface runoff that has infiltrated into the soil profile. Therefore, improving groundwater quality can be achieved by treatment of the surface runoff prior to infiltrating to groundwater.

The reduction of nutrient load to the groundwater will be achieved in the development by:

- Directing stormwater to vegetated bio-retention areas within POS (detailed in **Section 7.2.2**).
- Bio-retention areas will be underlain by a 150 mm band of material with a minimum Phosphorous Retention Index (PRI) of 10.
- Fertiliser use to establish and maintain vegetation within POS areas and road verges will be minimised.
- Drought tolerant turf species that require minimal water and nutrients will be used.
- Roll-on turf will be used within the POS areas and road verges, to prevent the high nutrient input requirement during establishment of the turf.
- Garden beds will not be placed immediately adjacent to infiltration basins or bio-retention areas to reduce nutrient transportation into these infiltration areas.

The above measures will improve the quality of the water prior to it infiltrating into the underlying groundwater, and will assist in achieving **Criteria GW3**.

6.3 Groundwater Criteria Compliance Summary

A summary of the proposed groundwater design criteria and how these are addressed within the Barfield Road LSP are given in **Table 5**.

Table 5 Groundwater management criteria compliance

Criteria Number	Criteria Description	Manner in which compliance will be achieved
GW1	Treat stormwater runoff before infiltration to groundwater	Bio-retention areas to treat surface water runoff prior to infiltration to groundwater
		Bio-retention areas to be underlain by soils with PRI>10

Criteria Number	Criteria Description	Manner in which compliance will be achieved
GW2	Use water sensitive design approaches to recharge the superficial aquifer	Soakwells within lots sized to infiltrate up to the 1 year 1 hour ARI event
		Infiltration basins sized to retain and infiltrate flows up to the 100 year ARI event
		Bio-retention areas sized to retain and infiltrate the 1 year 1 hour ARI event from road reserves
GW3	Maintain or improve groundwater quality beneath the site	All surface runoff from the road network in a 1 year 1 hour ARI event will be directed to bio-retention areas within POS
		Soils underlying bio-retention areas will have a band of material that is a minimum of 150 mm deep with a PRI>10
		Minimise fertiliser use in POS and road verges
		Use roll-on, drought tolerant turf species
		Garden beds will not be located adjacent to flood storage areas

7 Stormwater Management Strategy

The principles behind the stormwater management strategy for the Barfield Road LSP aim to maintain the existing hydrology by retaining surface flows and to infiltrate the stormwater runoff as close to source as possible. The development drainage system has been designed to achieve the objectives and criteria stated in **Section 4.4**.

7.1 Lot Drainage System

Rainfall on the front and backyards of lots (garden areas) will either infiltrate directly at-source or, in large rainfall events (i.e. approximately a 5 year ARI event), a portion of the runoff may discharge to the road network. The runoff from roof areas will be directed to soakwells where it will infiltrate into the sandy soil and ultimately to groundwater. Lot soakwells will be sized to hold runoff from the 1 year 1 hour ARI event.

The implementation of soakwells will assist in achieving **Criteria SW1** and **SWQ1**.

7.2 Development Drainage System

The storm water runoff from the 1 year 1 hour ARI event will be retained as close to source as practicably possible. There will be no runoff from the development for all events up to and including the 100 ARI rainfall event, consistent with the design criteria (see **Section 4.4**). The retention storage will be provided via a treatment train which includes soakage pits within the pipe network, vegetated bio-retention areas and infiltration basins within POS. Interaction with vegetation, and the infiltration process within the soil column, will remove a large portion of the contaminants (nutrients, gross pollutants, suspended sediments, etc.) within the stormwater runoff.

Rainfall events greater than the 1 year 1 hour ARI event will be conveyed by overland flow or the pipe network to infiltration basins with POS areas. The size of the infiltration storages will be minimised due to the retention storage provided higher up in the catchment and within lots. The stormwater drainage system for the development (including proposed locations for bio-retention areas and infiltration basins) is provided within **Figure 8**.

7.2.1 Soakage pits

Soakage pits within the pipe network will provide storage for a portion of the runoff from the 1 year 1 hour ARI event from road pavements. Runoff will be retained within soakage pits, located within road reserve, where it will infiltrate through the underlying sandy soils and ultimately to groundwater.

The pipe network across the development will include 164 soakage pits, each capable of storing 1 m^3 of surface runoff. The standard detail design for soakage pits within the pipe network is included within **Appendix E**.

Two small road catchments will not be routed to POS areas due to level requirements for connections to the existing road network (catchments R1 and R2 shown on **Figure 8**). These catchments will retain flows within soakage pits, sized to hold up to the 100 year ARI event, to ensure there is no discharge from the site during major rainfall events.

The use of soakage pits across the site will assist in achieving **Criteria SW1** and **SWQ1**.

7.2.2 Bio-retention areas

Residual surface water runoff from the 1 year 1 hour ARI event (i.e. that not retained in soakage pits) will be retained in vegetated bio-retention areas within POS. These will be located within dedicated bio-retention basins within POS. The bio-retention areas will have a maximum depth of 0.5 m, will have 1 in 3 side slopes and will be underlain with a layer of soil with a high PRI (>10). Vegetation within the bio-retention areas will be selected for their nutrient removal capability.

The use of bio-retention areas will achieve **Criteria SW1**, **SWQ1**, **SWQ3**, **GW3** and **GW4**.

7.2.3 Infiltration Basins

Infiltration basins will be utilised to retain major event flows for events up to the 100 year ARI event within site. Infiltration basins will be designed with a maximum depth of 1.2 m and 1 in 6 side slopes. The infiltration basins are not designed to be permanently wet and to achieve this inverts of basins will have a minimum clearance of 500 mm from MGL.

The use and design of infiltration basins will achieve **Criteria SW1** and **GW2**.

7.3 Post-development Surface Runoff Modelling

As described in **Section 7.1** and **7.2**, this LWMS proposes to utilise soakwells, soakage pits, bio-retention areas and infiltration basins to ensure all stormwater runoff from events up to a 100 year ARI event will be retained onsite. The calculation of these volumes is best achieved via a computational model. The post-development modelling uses the same methodology and parameters as the pre-development modelling carried out within the DWMS (Cardno 2010) and described in **Appendix F**. Post-development catchments are shown in **Figure 8**.

7.3.1 Minor Rainfall Event Modelling Results

The 1 year 1 hour ARI rainfall event will be retained onsite to satisfy **Criteria SW1** (**Section 4.4.1**). The location and size of the proposed retention storage required to achieve the design criteria is presented in **Figure 8** and the design volume and inundated areas of the bio-retention areas are shown in **Table 6**. The bio-retention areas have been assumed to have a maximum depth of 0.5 m and side slopes of 1 in 3. The total storage within soakage pits in the pipe network has been assumed to be split proportionately to the catchment area.

Table 6 1 year 1 hour ARI retention storage

Catchment	Soakage Pit Storage (m^3)	Bio-retention Area	Depth (m)	Volume (m^3)	Top water level surface area (m^2)
B1	7	Bio B	0.48	26.5	121
A1	9	Bio C	0.49	113	434
A2	5				
C1	13				
C2	20				
D1	18	Bio D	0.50	58	231
F1	11	Bio F	0.49	97	362

Catchment	Soakage Pit Storage (m^3)	Bio-retention Area	Depth (m)	Volume (m^3)	Top water level surface area (m^2)
F2	22	Bio F			
H1	19	Bio H	0.50	167	584
H2	23				
H3	10				
H4	7				
R1	2.6	N/A	N/A	N/A	N/A
R2	3.0	N/A	N/A	N/A	N/A
Total	*169.6*			*461.5*	*1732*

The total size of the bio-retention system, achieved through at-source retention storage provided by bio-retention areas in POS, is equal to 2.2% of the connected impervious area, which achieves **Criteria SWQ2**. Native vegetation known for nutrient uptake potential will be used for areas equal to at least 2% connected impervious area to ensure nutrient uptake is undertaken. The remainder of the bio-retention area will be utilised for the retention of the 1 year 1 hour ARI event, however will only require turf to ensure infiltration of the stormwater runoff occurs. This provides some flexibility at detailed design stage to accommodate other considerations (e.g. landscaping, parking and services).

The inundated areas for the 1 year 1 hour ARI event are shown in **Figure 9**. Note that the number of bio-retention areas can be modified at detailed design stage, provided the assumed storages detailed in **Table 6** are maintained. The Barfield Road LSP Landscape Masterplan, provided in **Appendix D**, shows how the stormwater management components within the development are intended to be landscaped.

7.3.2 Major Rainfall Event Modelling Results

The post-development drainage system is designed to retain runoff from major rainfall events (up to the 100 year ARI event) from lots and road reserves within site. This is achieved by the use of at-source retention (soakwells, soakage pits and bio-retention areas) and infiltration storage basins. The proposed locations of these are shown in **Figure 8** with the modelled inundated depths, volumes and top water surface levels of the infiltration areas provided within **Table 7**. Note that the infiltration basins have been assumed to have 1 in 6 side slopes.

Table 7 Infiltration basin storages in 5 year ARI, 10 year and 100 year ARI events

Catchment	Storage Area	5 year ARI			10 year ARI			100 year ARI		
		Depth (m)	Volume (m^3)	Top water level surface area (m^2)	Depth (m)	Volume (m^3)	Top water level surface area (m^2)	Depth (m)	Volume (m^3)	Top water level surface area (m^2)
B1	POS B	0.72	214	458	0.84	275	524	1.19	492	732
A1	POS C	0.52	1400	3038	0.68	1916	3259	1.20	3801	4009
A2										
C1										
C2										
D1	POS D	0.62	570	1161	0.76	749	1284	1.20	1394	1685
F1	POS F	0.56	1052	2179	0.71	1402	2355	1.20	2686	2953
F2										
H1	POS H	0.52	1864	3998	0.67	2518	4243	1.20	4977	5106
H2										
H3										
H4										
R1			8.1			9.7			14.1	
R2			9.3			11.2			15.9	
Total			*5743*	*12566*		*7506*	*13397*		*14006*	*16218*

The 5 year, 10 year and 100 year ARI event stormwater inundation areas are shown in **Figure 10**, **Figure 11** and **Figure 12** respectively.

In order to minimise the risk of creating mosquito habitat within the retention areas, inundation times within each retention area is required to be less than 96 hours. The maximum infiltration time within the proposed infiltration basins following an extreme rainfall event (100 year ARI) is 13.3 hours, achieving **Criteria SWQ3**. Infiltration calculations have been based on Darcy's law, considering the average surface area within each basin, with an assumed hydraulic conductivity of 2.5 $x10^{-5}$ m/s (consistent with the fine-medium grained sands seen across the site).

7.4 Non-structural water quality measures

The structural measures proposed within the Barfield Road LSP provide both a storage and treatment function to stormwater runoff, as detailed in **Sections 7.2** and **7.3**. A number of non-structural measures will also be implemented across the site to help reduce nutrient loads within stormwater runoff. These measures include:

- Minimising fertiliser use to establish and maintain vegetation within POS areas and road verges.
- Drought tolerant turf species that require minimal water and nutrients will be used.
- Garden beds will not be located immediately adjacent to the flood storage areas or bio-retention areas to reduce nutrient transportation into these areas.
- Education of residents regarding fertiliser use and nutrient absorbing vegetation species within lots.

The above measures will assist in achieving **Criteria SWQ3**.

7.5 Surface Water Criteria Compliance Summary

A summary of the proposed surface water design criteria and how these are addressed within the Barfield Road LSP is provided in **Table 8**.

Table 8 Surface water management criteria compliance

Criteria Number	Criteria Description	Manner in which compliance will be achieved
Surface water quantity		
SW1	Retain the 100 year ARI rainfall event onsite	Soakwells within lots sized to hold 1 year ARI 1 hour duration event runoff from lots
		Soakage pits within road pipe network to retain portion of runoff from road reserves
		Bio-retention areas within POS sized to hold residual 1 year 1 hour ARI event from road reserves
		Infiltration basins within downstream POS sized to hold up to the 100 year ARI event runoff
SW2	Provide stormwater flowpath for runoff from the 100 year ARI event	The earthworks plan provided in **Appendix E** shows that the road network is graded to allow runoff to flow towards retention areas within POS in a 100 year ARI event

Criteria Number	Criteria Description	Manner in which compliance will be achieved
SW3	Finished floor levels of lots must have a minimum of 300 mm clearance from the 100 year ARI event flows being conveyed within road reserves	This will be demonstrated within the earthworks strategy at detailed design stage
SW4	The finished floor levels must have a minimum of 500 mm clearance above the 100 year ARI flood levels in the onsite detention areas	This will be demonstrated within the earthworks strategy at detailed design stage
SW5	Roads are to remain passable in the 5 year ARI event	The pipe network will be designed to convey the 5 year ARI event which will ensure roads remain passable
SW6	Design infiltration areas to avoid creating mosquito habitat.	The high infiltration rates of the underlying sands ensure that the maximum inundation time within the infiltration basins is 13.3 hours.
SW7	Base of infiltration basins must be at least 500 mm above MGL	The earthworks plan provided in **Appendix E** provides indicative inverts of infiltration basins with a minimum clearance to MGL of 2 m assumed within the modelling. Levels will be confirmed at detailed design
Surface water quality		
SWQ1	Retain the 1 year 1 hour duration ARI rainfall event at source or as close as practicable	Soakwells within lots sized to hold 1 year ARI 1 hour duration event runoff from lots
		Soakage pits within road pipe network to retain portion of runoff from road reserves
		Bio-retention areas within POS sized to hold residual 1 year ARI event from road reserves
SWQ2	The surface area of bio-retention areas is to be at least 2% of the connected impervious area.	The surface area of bio-retention areas is 2.2% of the connected impervious area.
SWQ3	Apply appropriate structural and non-structural measures to reduce nutrient loads	Soakwells within lots, soakage pits in pipe network and bio-retention areas within POS
		Minimise use of fertilisers within POS and road verges
		Maintenance of POS and drainage areas
		Education of residents regarding use of fertilisers

8 Subdivision and Urban Water Management Plans

The requirement to undertake preparation of more detailed water management plans to support subdivision is generally imposed as a condition of subdivision. The development of any future UWMP should follow the guidance provided in *Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions* (DoW 2008).

While strategies have been provided within this LWMS that address planning for water management within the site, it is a logical progression that future subdivision designs and the supportive UWMP will clarify details not provided within the LWMS. The main areas that will require further clarification within future UWMPs include:

- Modelling of local road drainage network
- Infiltration basin area configurations
- ASS investigations
- Imported fill specifications and requirements
- Implementation of water conservation strategies
- Non-structural water quality improvement measures
- Management and maintenance requirements
- Construction period management strategy
- Monitoring and evaluation program
- Status of groundwater abstraction license.

These are further detailed in the following sections. As stated above, ongoing monitoring of groundwater will be detailed in the UWMP, however in this LWMS is outlined broadly in **Section 9**.

8.1 Modelling of Local Road Drainage Network

It is acknowledged that the drainage strategies documented in this LWMS are based upon broad-scale assumptions and regional data. These assumptions are considered adequate for development of the proposed infiltration basin sizes and are of an appropriate level of detail; however verification of proposed subdivision drainage designs within the LSP area will be undertaken by modelling the catchments serviced by the piped drainage network. Such modelling will allow verification that the development undertaken within the LSP area is consistent with this LWMS. The design of the drainage system to date has been undertaken at an appropriate level for local structure planning and runoff-routing computer modelling of the stormwater drainage system will be reviewed once detailed drainage design has commenced for the area. It is anticipated that this will occur during the subdivision design process and be detailed within the future UWMPs.

The exception to the requirement to revise the surface runoff modelling is if the catchment details and basin designs are consistent with the assumptions made in this LWMS. If this were the case it would be acceptable to provide design calculations for the pipe network and retention areas to demonstrate compliance with the LWMS.

8.2 Infiltration Basin Configurations and Outlet Structures

While the Barfield Road LSP area drainage catchments have been defined based on the earthworks model presented in **Appendix E**, it is possible that these could undergo some change to accommodate stakeholder feedback prior to final subdivision design. The exact location and shape of the infiltration basins will still need to be specified and presented within the future UWMP.

In order to review the final infiltration basin configurations, the hydrological model that has been developed to support this LWMS may need to be refined in light of stakeholder feedback. It is expected that the civil drainage designs will be progressed to a level that provides detailed cross-sections, sizes of storage areas, pipe sizes, inverts, etc. The ultimate aim of revising the hydrological model will be to confirm that the post-development runoff volumes and peak flows are able to meet the performance criteria proposed in **Section 4** of this LWMS.

8.3 ASS Investigation

The site is mapped as having a 'moderate to low risk' of ASS being found within 3 m of the natural surface. An investigation is required to determine the actual presence or otherwise of actual ASS or potential ASS. If ASS are found within the areas that are proposed to be developed or detailed designs indicate that ASS is likely to be disturbed due to excavation for installation of services, then an appropriate management plan will be a likely requirement of future development. These requirements will be clarified and/or summarised at UWMP stage once detailed earthworks designs and depths of trenching/excavation are known.

8.4 Imported Fill specifications

Soils beneath bio-retention areas will require a high PRI to ensure at-source nutrient retention leading to the protection of downstream water bodies. The specification for this would typically be that a 150 mm band of soil with a PRI >10 will be imported beneath any bio-retention or treatment areas.

8.5 Implementation of Water Conservation Strategies

A number of potential measures to conserve water have been presented within this LWMS. These water conservation strategies will be incorporated into the design and the ongoing maintenance of all POS areas. Landscape design measures that will be incorporated into the water conservation strategy will be further detailed within the future UWMPs produced for the development. The manner in which the developer intends to promote water conservation measures discussed in this LWMS to future lot owners will also be discussed within the future UWMP.

8.6 Non-Structural Water Quality Improvement Measures

Guidance for the development and implementation of non-structural water quality improvement measures is provided within the *Stormwater Management Manual for Western Australia* (DoW 2007). Some measures will be more appropriately implemented at a local government level, such as street sweeping, however many can be implemented relatively easily within the design and maintenance of the subdivision and the POS areas. It is expected that the future UWMP will provide reference to measures such as public education (through measures such as signage that may be implemented to raise awareness).

8.7 Management and Maintenance Requirements

The management measures to be implemented to address surface water quality, such as the use of vegetation within bio-retention areas, swales and infiltration basins will require ongoing maintenance. It is therefore expected that the future UWMP will provide detailed management and maintenance plans that will set out maintenance actions (e.g. gross pollutant removal), timing (e.g. how often it will occur), locations (e.g. exactly where it will occur) and responsibilities (e.g. who will be responsible for carrying out the actions). Given that approval from the CoC and DoW will be sought for the proposed measures, it is anticipated that consultation with these agencies will be undertaken and referral to guiding policies and documents will be made.

8.8 Construction Period Management Strategy

It is anticipated that the construction stage will require some management of various aspects (e.g. dust, surface runoff, noise, traffic etc.). The management measures undertaken for construction management will be addressed either in the future UWMP or a separate Construction Management Plan (CMP).

8.9 Monitoring and Evaluation Program

It will be necessary to confirm that the management measures that are implemented are able to fulfil their intended management purpose, and are in a satisfactory condition at a point of management hand-over to the CoC. A post-development monitoring program will be developed to provide this confirmation, and it will include details of objectives of monitoring, relevant issues and information, proposed methodology, monitoring frequency and reporting obligations. These monitoring programs are discussed in **Section 9** of this LWMS and will be further detailed at the UWMP stage.

8.10 Groundwater License Status

An allocation request application has been made to the DoW, as discussed in **Section 5.4**. This application is pending and it is expected that future UWMPs will demonstrate that adequate allocation of water has been obtained to irrigate POS and road verges within the Barfield Road LSP, or that an appropriate contingency plan has been established in the event that a reduced water allocation is obtained.

9 Monitoring

9.1 Condition monitoring

It is proposed that the overall condition of the development will be monitored on a bi-annual basis. This monitoring will be implemented after the completion of the civil and landscaping works and will continue for a period of two years.

A visual assessment will be undertaken to monitor the overall condition of the development, with the aim to ascertain that the maintenance activities are achieving the overall management objectives for the development. The parameters that will be monitored include:

- Gross Pollutants
- Terrestrial Weeds
- Irrigation
- Vegetation density
- Paths, benches, walkways and other infrastructure.

The management and maintenance objectives will be detailed within future UWMPs along with details of the corresponding groundwater monitoring program.

9.2 Groundwater monitoring

The aim of this section is to assess the effectiveness of the pre-development monitoring that has been undertaken and make recommendations regarding future post-development monitoring. It is anticipated that the post-development monitoring would be consistent with the pre-development monitoring of hydrological conditions (as documented in earlier sections), with the addition that the BMPs should also be monitored to ensure their continued effectiveness. It will be necessary to confirm that the structural management measures that are implemented are able to fulfil their intended management purpose and are in a satisfactory condition at a point of management hand-over to the CoC. These monitoring programs will be further detailed at the UWMP stage.

The pre-development groundwater monitoring was conducted at three locations within the Barfield Road LSP area. The collected data included groundwater levels, sampling of physio-chemical parameters in situ and laboratory analysis of nutrients. Monitoring was started in October 2009 and continued for 14 months with monthly groundwater levels and water quality sampling every 3 months (as detailed in **Section 3.6**). The monitoring results provide adequate baseline data that will assist in verification of future detailed designs at the subdivision stage.

9.2.1 Post-development trigger values

Groundwater quality targets have been derived from background levels measured during monitoring prior to development, provided in **Table 1**. Trigger values have been calculated using average readings across three monitoring bores within the site. The trigger criteria proposed are shown in **Table 9**.

Table 9 Post-development trigger values

Analyte	TN (µg/L)	TP (µg/L)	TKN (µg/L)	NH_4 (µg/L)	NO_X (µg/L)	pH	EC (mS/cm)
Value	380	37	309	86	125	5-7	0.21

9.2.2 Recommended program for UWMP

Given that there will be no surface water discharge from the site during a 1 year 1 hour ARI event it will be very difficult to collect a water quality sample for treated surface runoff. Rather, post-development monitoring will instead focus on groundwater quality.

The locations of existing groundwater bores need not necessarily be maintained post-development. It is proposed that post-development monitoring will reference both a derived water quality target, and an upstream/downstream comparison of water quality at key locations within the development site. The indicative proposed locations for groundwater monitoring are shown in **Figure 8** and have been selected to provide an indication of the results of POS management at one key representative POS area. Note that upstream/downstream locations are proposed, and given that the locations of bio-retention areas are nominally shown, these locations should be revised at UWMP to ensure that an upstream/downstream comparison is available.

There should be at least one key representative POS area per subdivision i.e. if the entire site is developed as one subdivision then an upstream/downstream comparison would be required for one POS area.

Groundwater quality monitoring will be conducted on a quarterly basis. A summary of the post-development monitoring program is shown in **Table 10**. The post-development monitoring should be conducted for two years and include at least one year of monitoring when 80% of the development is complete.

Table 10 Monitoring program summary

Monitoring Type	Locations	Frequency	Parameters
Groundwater	Bore upstream and downstream of key representative POS area	Quarterly (typically Jan, April, July, Oct).	*In situ* pH, EC, temperature. Sample TSS, TN, TKN, NH_4, NO_X, TP, FRP.

9.2.3 Contingency Action Plan

A Contingency Action Plan (CAP) will be detailed and implemented as a part of each UWMP. The CAP is effectively a plan of steps that will be undertaken should certain water quality criteria be reached.

9.2.3.1 Trigger criteria

As indicated, the groundwater trigger values proposed in **Section 9.2.1** have been derived from groundwater quality levels measured during pre-development monitoring within the site. These values should be reviewed for each UWMP to include additional data gained from any continued monitoring.

9.2.3.2 Contingency actions

If the results from the initial monitoring occasion indicate that nutrient concentrations exceed the nominated trigger values, a number of contingency measures will be employed.

The first action that will be undertaken if groundwater trigger criteria are exceeded is to repeat the monitoring to remove the potential for sampling error. If the repeat monitoring still shows results which breach the trigger value, the next action will be to compare the upstream (incoming) nutrient concentrations with the outgoing (downstream) nutrient concentrations.

If the downstream nutrient concentrations are >50% higher than the upstream nutrient concentrations, the following actions will be undertaken:

1. Review POS nutrient application practices to identify source if possible
2. Conduct surveillance of subdivision area to determine any other potential and obvious nutrient inputs
3. Remove source if possible (e.g. fertiliser input, etc.)
4. Remove sediment-bound nutrients by removing basin sediments
5. Manual removal of excess plant material from bio-retention areas to facilitate further nutrient uptake.

If the downstream nutrient concentrations are found to be generally consistent with the upstream concentrations the next action will be to conduct a site-specific comparison of background data collected within the site prior to development. There is some amount of variability (both spatially and temporally) in nutrient concentrations experienced across the Barfield Road LSP area and the trigger values may need to be modified following additional monitoring.

This information should then be used as a management tool in consultation with DoW to determine if the trigger values should be revised.

Following the implementation of the above contingency measures the groundwater quality will be re-sampled. If the results of the analysis still show water quality characteristics which breach the trigger values an additional set of upstream/downstream monitoring bores will be installed at another key representative POS area. The additional bores will be sampled as per the ongoing sampling regime already being undertaken for the first two bores. If the results from the second POS area demonstrate results consistent with the first POS area, DoW and CoC will be informed of the results, and the proponent will seek to work with DoW and CoC to determine if the results are representative of a broader catchment management issue, and whether any additional contingency actions need to be implemented onsite.

9.3 Reporting

A post-development monitoring report will be prepared on conclusion of the two year monitoring period, and will be provided to the CoC and the DoW. Interim results (spreadsheet) can be provided to either CoC or DoW on request during the monitoring program

10 Implementation

The LWMS is a key supportive document for the LSP. The development of the LWMS has been undertaken with the intention of providing a structure within which subsequent development can occur consistent with an integrated water cycle management approach. It is also intended to provide overall guidance to the general stormwater management principles for the area and to guide the development of the future UWMP.

10.1 Roles and Responsibility

The LWMS provides a framework that the proponent can utilise to assist in establishing stormwater management methods that have been based upon site-specific investigations, are consistent with relevant State and Local Government policies and have been endorsed by the CoC. The responsibility for working within the framework established within the LWMS rests with the subdivider, although it is anticipated that the future UWMP will be developed in consultation with the CoC and DoW and in consideration of other relevant policies and documents.

10.2 Funding

The site includes multiple landholdings owned by the proponent and DoH. As such, development costs are likely to be shared on a pro-rata basis. While there is no regional drainage system for the development to connect to, the proponent will need to work with the CoC to ensure provision of services is staged appropriately throughout the construction process.

10.3 Review

It is not anticipated that this LWMS will be reviewed, unless additional land parcels/lots are added to the LSP area prior to subdivision, or the LSP undergoes significant change post-lodgement of the LWMS. If additional areas are required to be covered by the LWMS it is most likely that an addendum to cover these areas could be prepared. If the LSP is substantially modified, surface runoff modelling undertaken for this LWMS will need to be reviewed and the criteria proposed revised to ensure that all are still appropriate.

The next stages of water management are anticipated to be lot planning through subdivision. Subdivision approvals will be supported by a UWMP. The UWMP is largely an extension of the LWMS, as it should provide detail to the designs proposed within this LWMS, and will demonstrate compliance with the criteria proposed in **Section 4**.

In addition to the issues detailed in **Section 8**, the UWMP will address:

- Compliance with design objectives within the LWMS
- Detailed stormwater management design
- Specific structural and non-structural methods to be implemented and their manner of implementation
- Details of proposed roles and responsibilities for the above measures.

The next stage of development following the UWMP is single lot or multiple dwelling developments. It is recognised that certain elements of the LWMS and the UWMP will not be implemented until this

stage, and that there is little or no statutory control that can be applied to ensure the implementation of any remaining measures. While the remaining measures are unlikely to be enforced at this stage, their implementation could be encouraged by the CoC through policy (or modification of these where necessary), building licence or awareness programs (such as the Water Corporation's Waterwise program).

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FIGURES

Figure 1: Locality diagram

Figure 2: Site boundary

Figure 3: Topographical contours

Figure 4: Soil types

Figure 5: ASS risk mapping

Figure 6: Existing wetland and hydrological features

Figure 7: Groundwater contours

Figure 8: Stormwater management features

Figure 9: 1 year 1 hour inundation areas

Figure 10: 5 year ARI stormwater inundation areas

Figure 11: 10 year ARI stormwater inundation areas

Figure 12: 100 year ARI stormwater inundation areas

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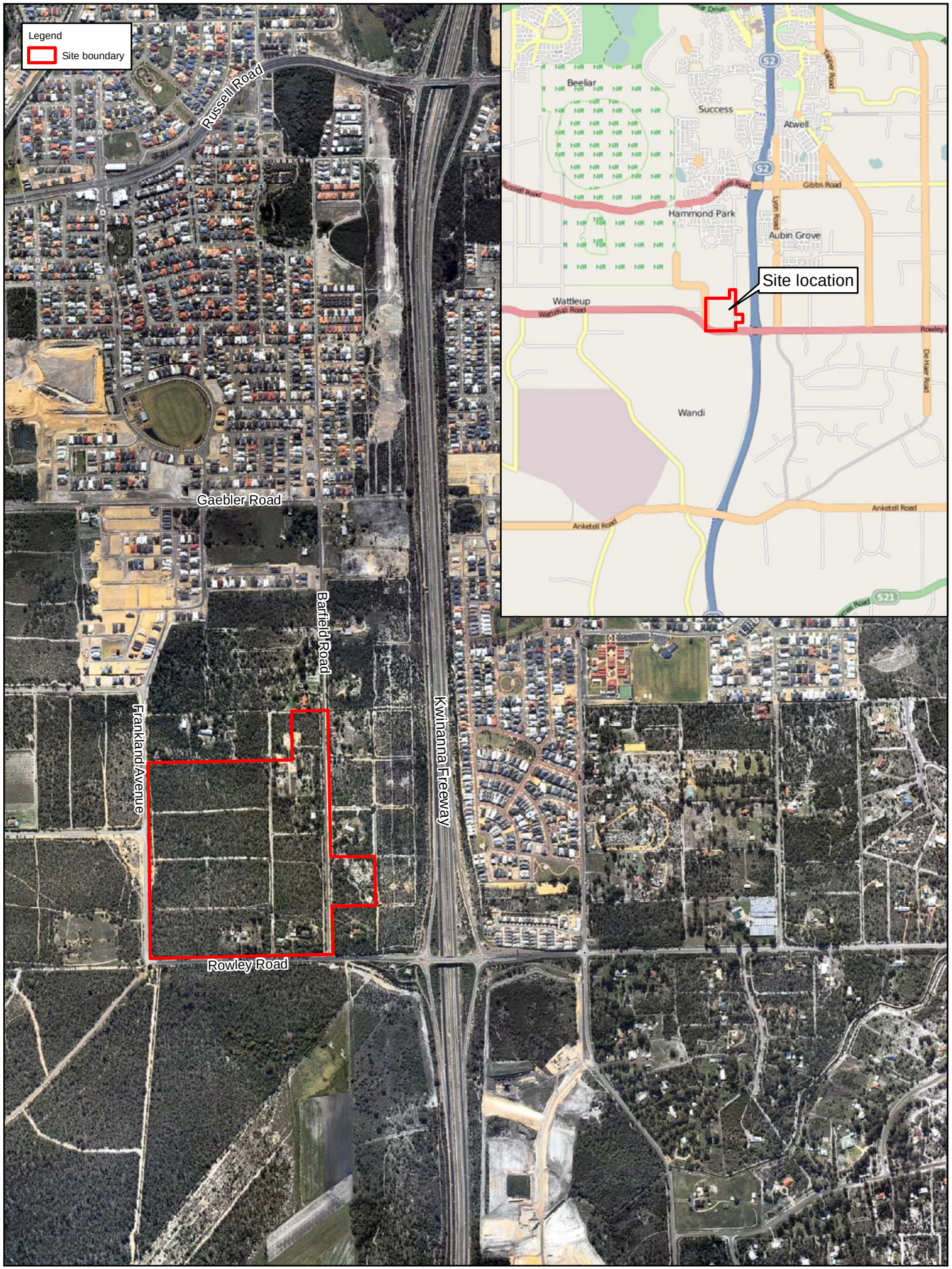


Figure 1:	**Locality Plan**	**Plan Number: EP11-046(01)--F04**	
Project:	Barfield Road Hammond Park LWMS	Drawn: GRO	Date: 19/07/12
Client:	Richard Noble	Approved: DPC	Date: 03/08/12
		Checked: RLE	Scale: 1:14,000@A4

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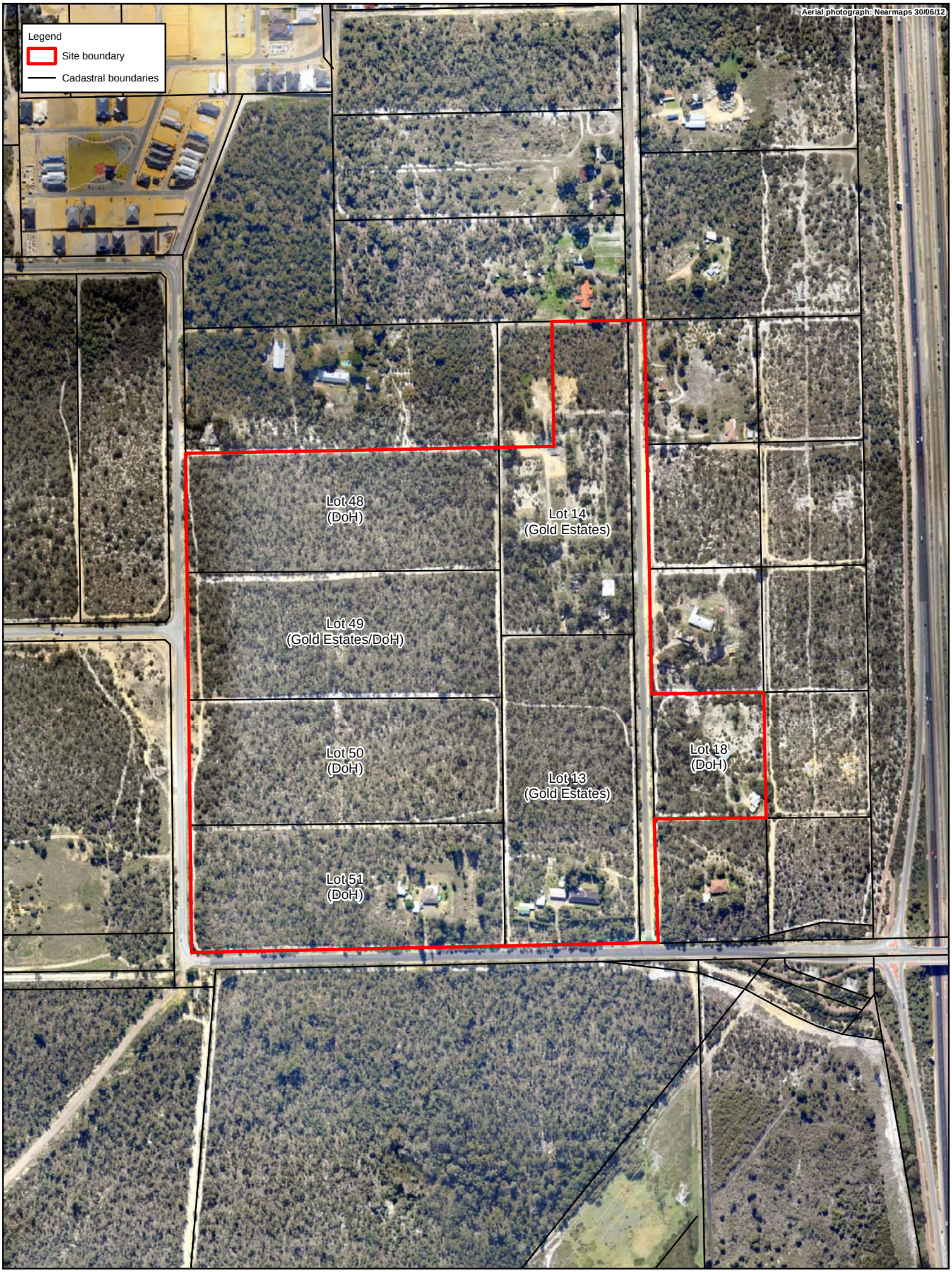


Figure 2:	**Site Boundary**	**Plan Number: EP11-046(01)--F05a**	
Project:	Barfield Road Hammond Park LWMS	Drawn: GRO	Date: 17/08/12
Client:	Richard Noble	Approved: DPC	Date: 17/08/12
		Checked: RLE	Scale: 1:5,500@A4

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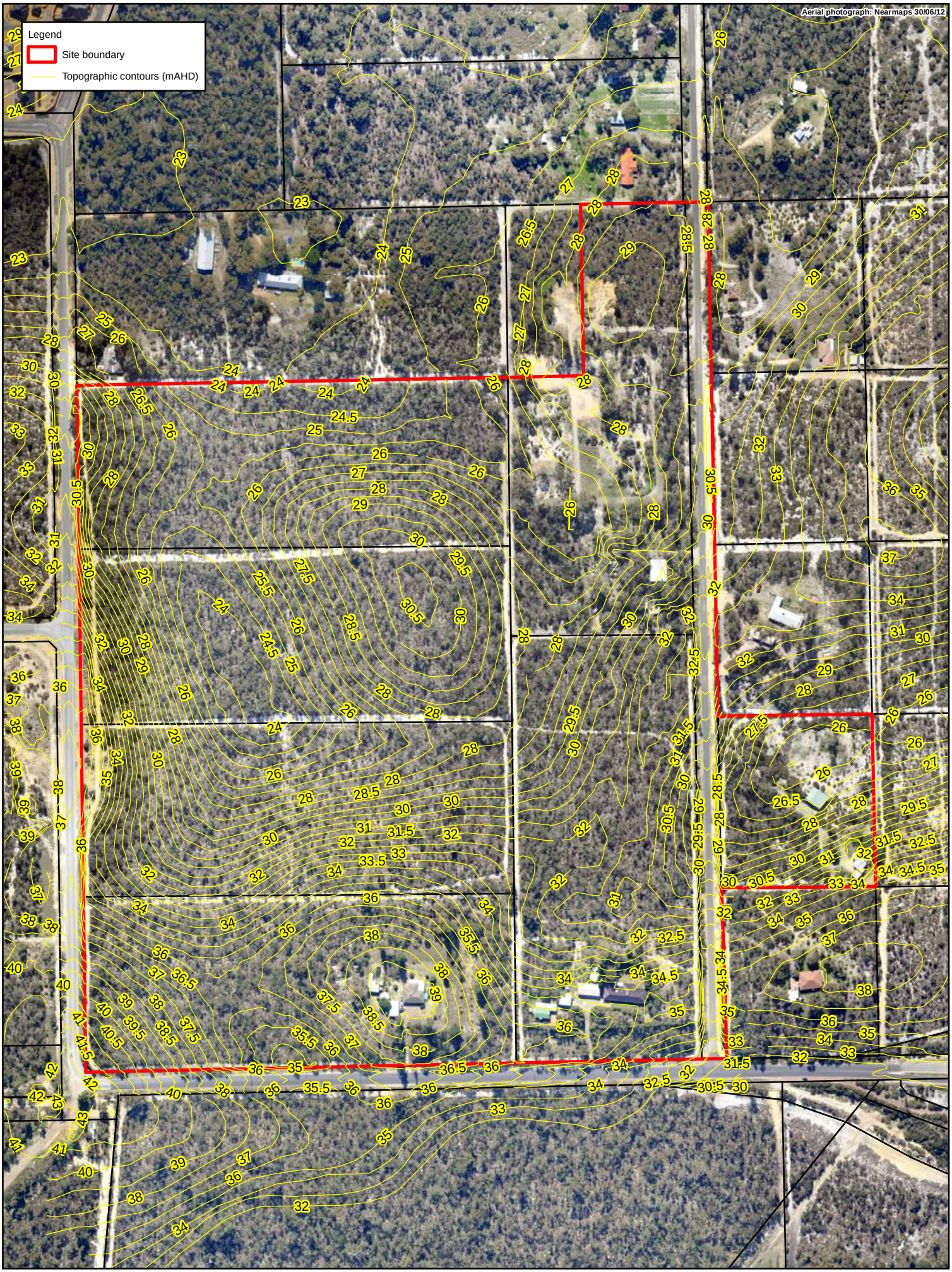


Figure 3: Topographic Contours

Project: Barfield Road Hammond Park LWMS

Client: Richard Noble

Plan Number: EP11-046(01)--F06

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Approved:	DPC	Date:	03/08/12
Checked:	RLE	Scale:	1:4,000@A4

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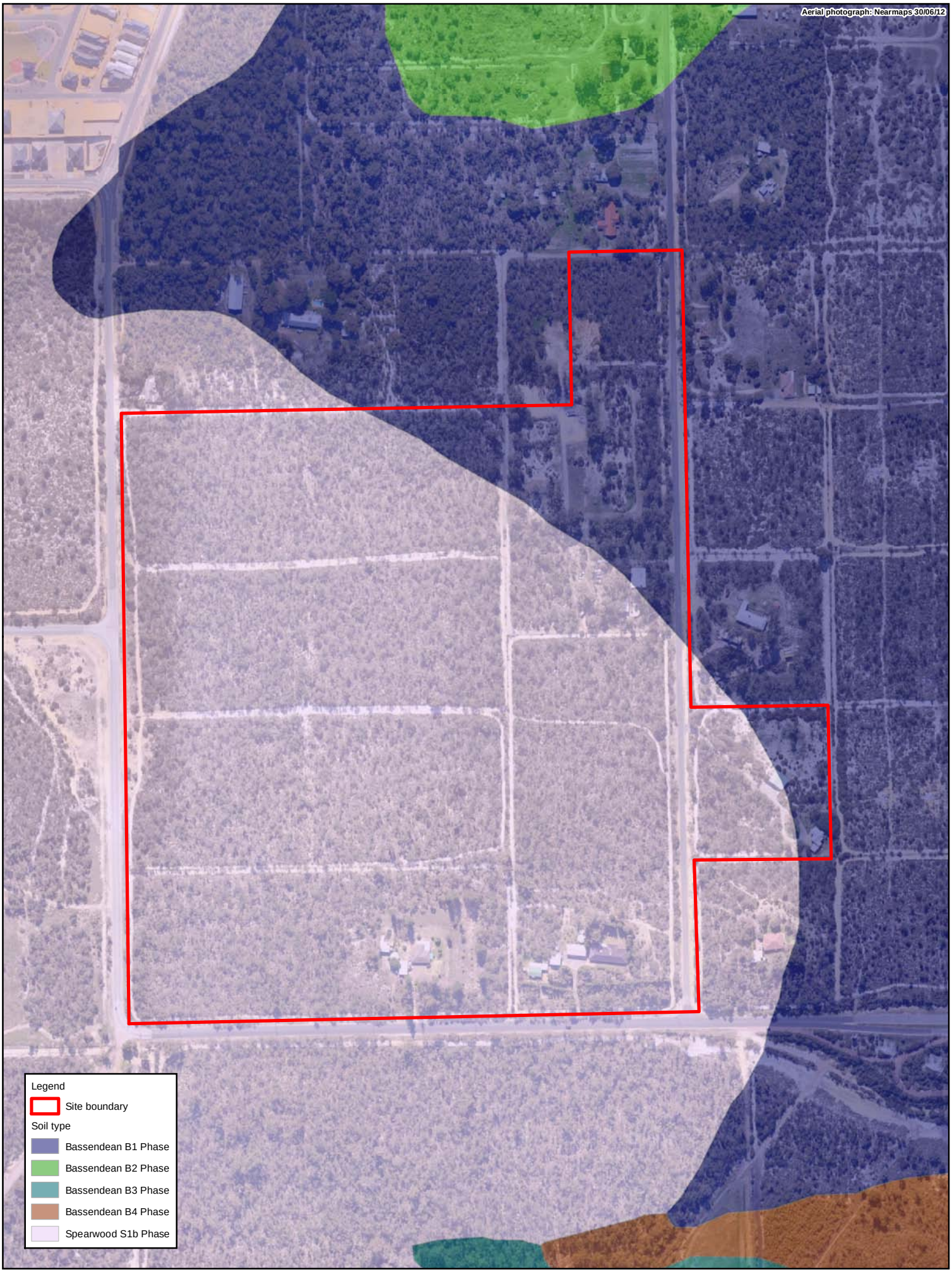


Figure 4: Soils and Landforms

Project: Barfield Road Hammond Park LWMS

Client: Richard Noble

Plan Number: EP11-046(01)--F07			
Drawn:	GRO	Date:	19/07/12
Approved:	DPC	Date:	03/08/12
Checked:	RLE	Scale:	1:4,500@A4

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Sources: The following datasets were used in the production of this map: Soil type - DoA (2007)



Figure 5: Acid Sulfate Soil Risk Mapping

Project: Barfield Road Hammond Park LWMS

Client: Richard Noble

Plan Number: EP11-046(01)--F08

Drawn:	GRO	Date:	19/07/12
Approved:	DPC	Date:	03/08/12
Checked:	RLE	Scale:	1:4,500@A4

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Sources: The following datasets were used in the production of this map: Acid Sulfate Soil Risk - DEC (2010)

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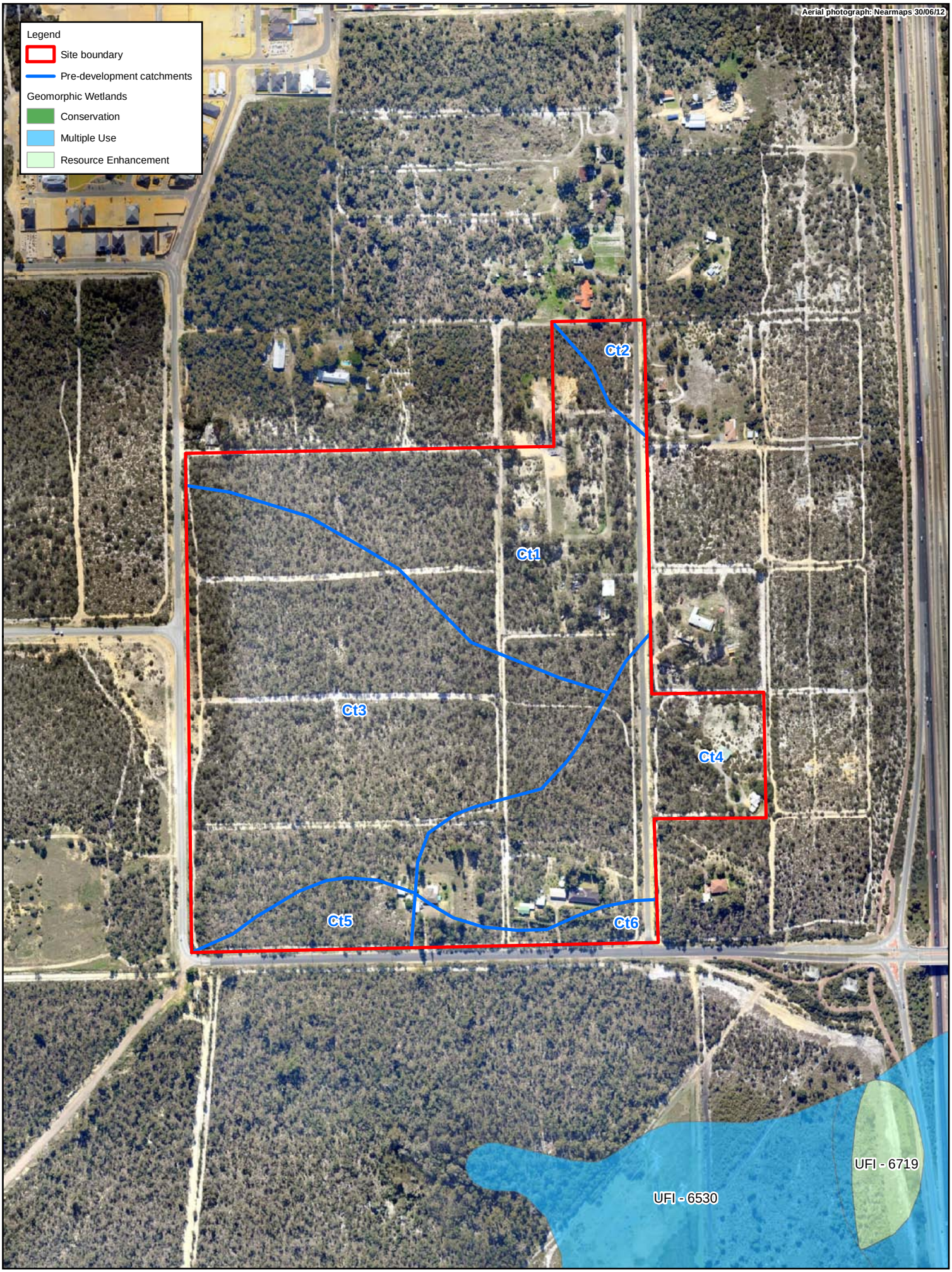


Figure 6:	**Hydrological Features**	**Plan Number: EP11-046(01)--F09a**	
Project:	Barfield Road Hammond Park LWMS	Drawn: GRO	Date: 19/07/12
Client:	Richard Noble	Approved: DPC	Date: 14/01/13
		Checked: RLE	Scale: 1:5,500@A4

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Sources: The following datasets were used in the production of this map: Geomorphic Wetlands - DEC (2012)



Figure 7: **Groundwater Levels**

Project: Barfield Road Hammond Park LWMS

Client: Richard Noble

Plan Number: EP11-046(01)--F11

Drawn:	GRO	Date:	19/07/12
Approved:	DPC	Date:	03/08/12
Checked:	RLE	Scale:	1:4,500@A4

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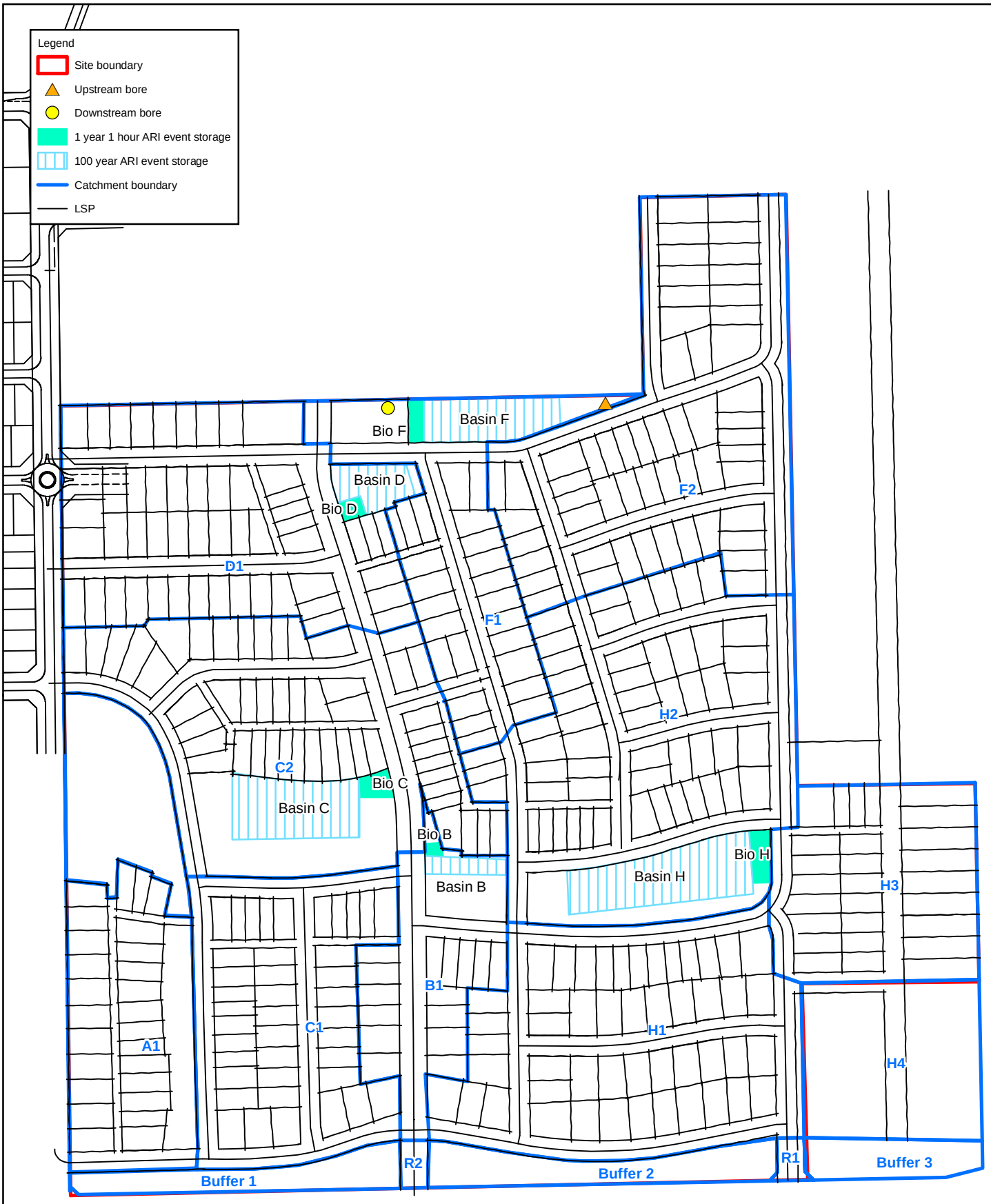


Figure 8:	**Stormwater Management Features**	**Plan Number: EP11-046(01)--F12b**	
Project:	Barfield Road Hammond Park LWMS	Drawn: GRO	Date: 20/03/13
		Approved: DPC	Date: 28/03/13
Client:	Richard Noble	Checked: RLE	Scale: 1:3,800@A4

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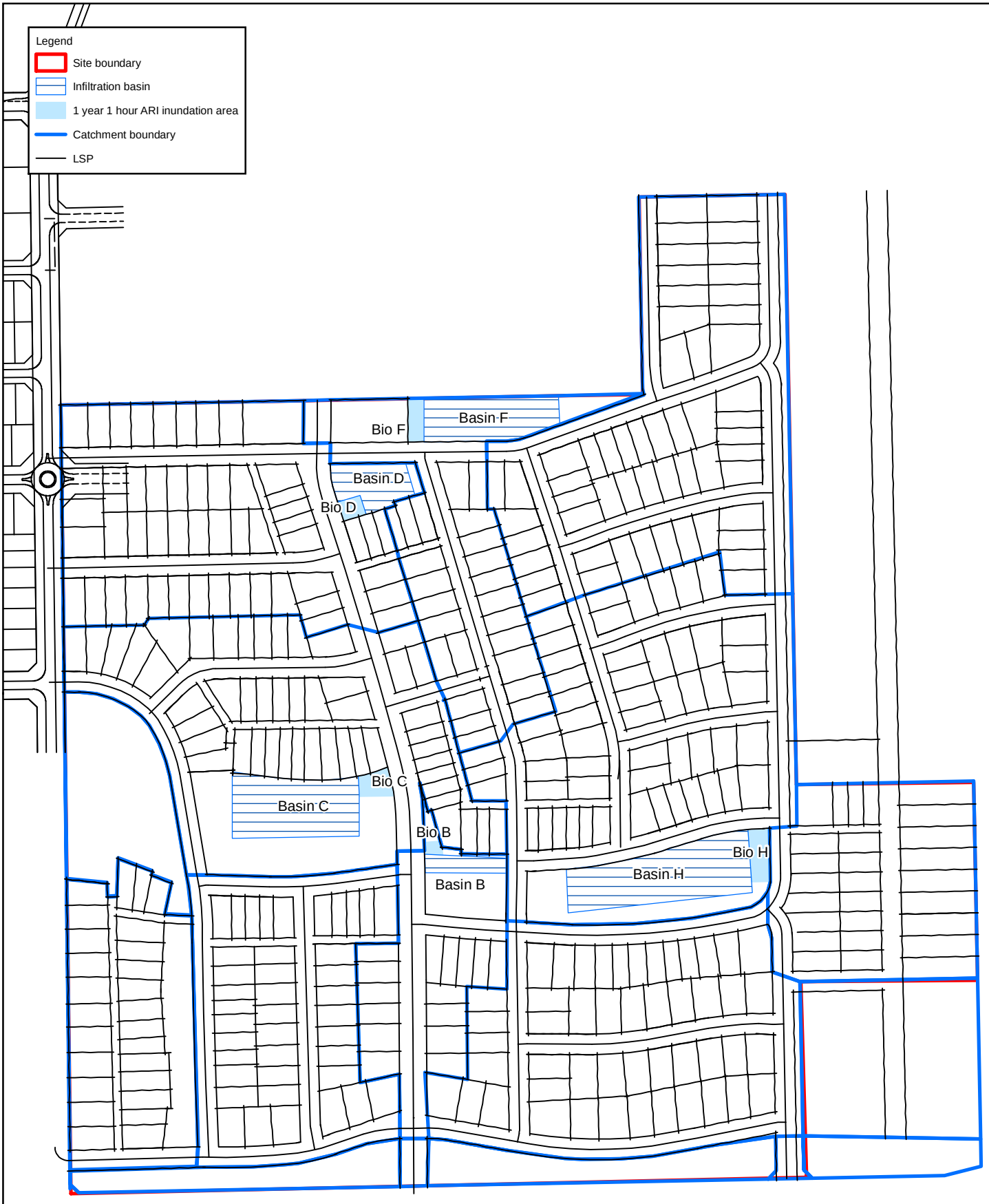


Figure 9: 1 Year ARI Inundation Areas

Project: Barfield Road Hammond Park LWMS

Client: Richart Noble

Plan Number: EP11-046(01)--F13a

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Approved:	DPC	Date:	28/03/13
Checked:	RLE	Scale:	1:3,800@A4

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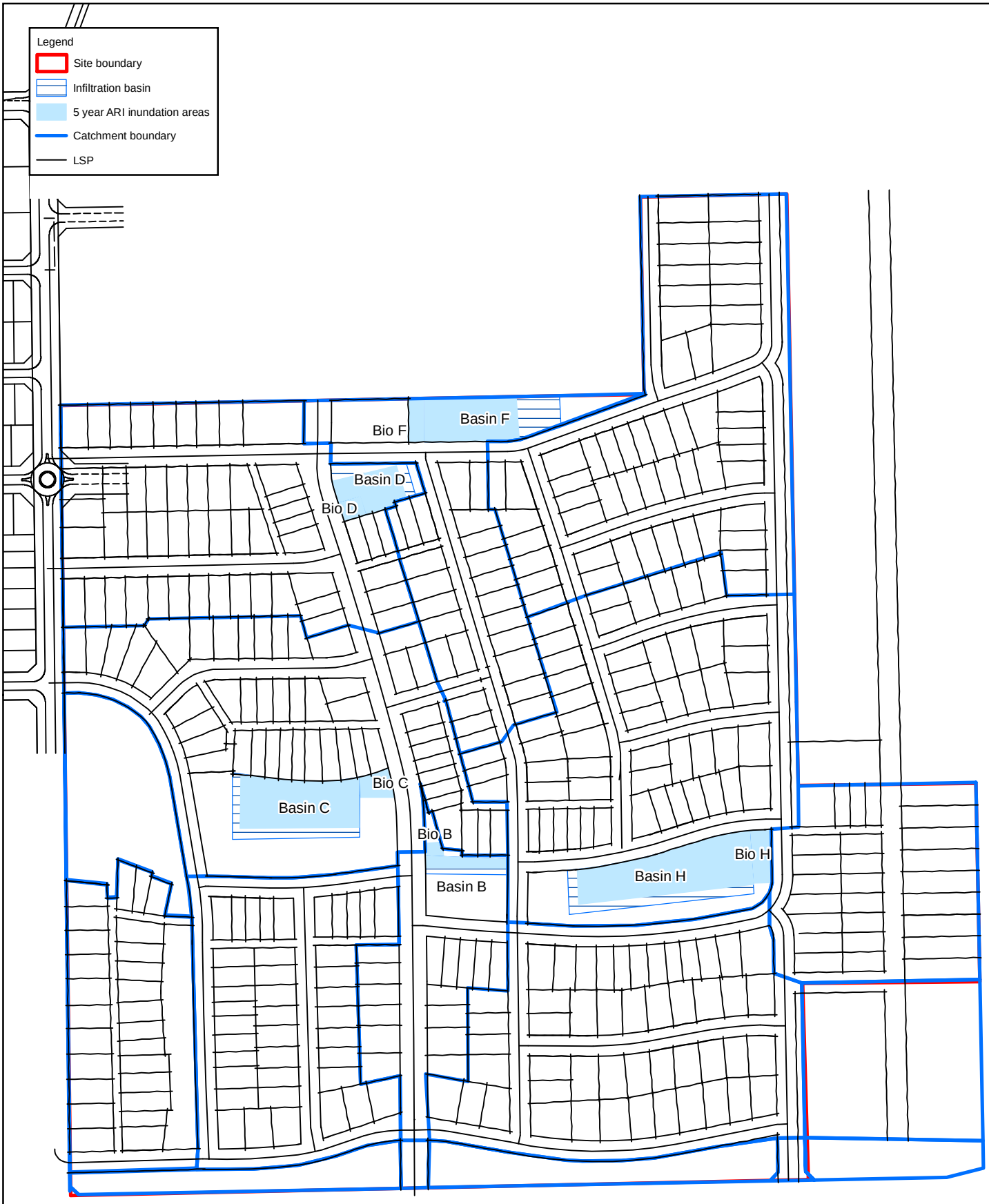


Figure 10: 5 Year ARI Inundation Areas

Project: Barfield Road Hammond Park LWMS

Client: Richart Noble

Plan Number: EP11-046(01)--F14a

Drawn:	GRO	Date:	20/03/13
Approved:	DPC	Date:	28/03/13
Checked:	RLE	Scale:	1:3,800@A4

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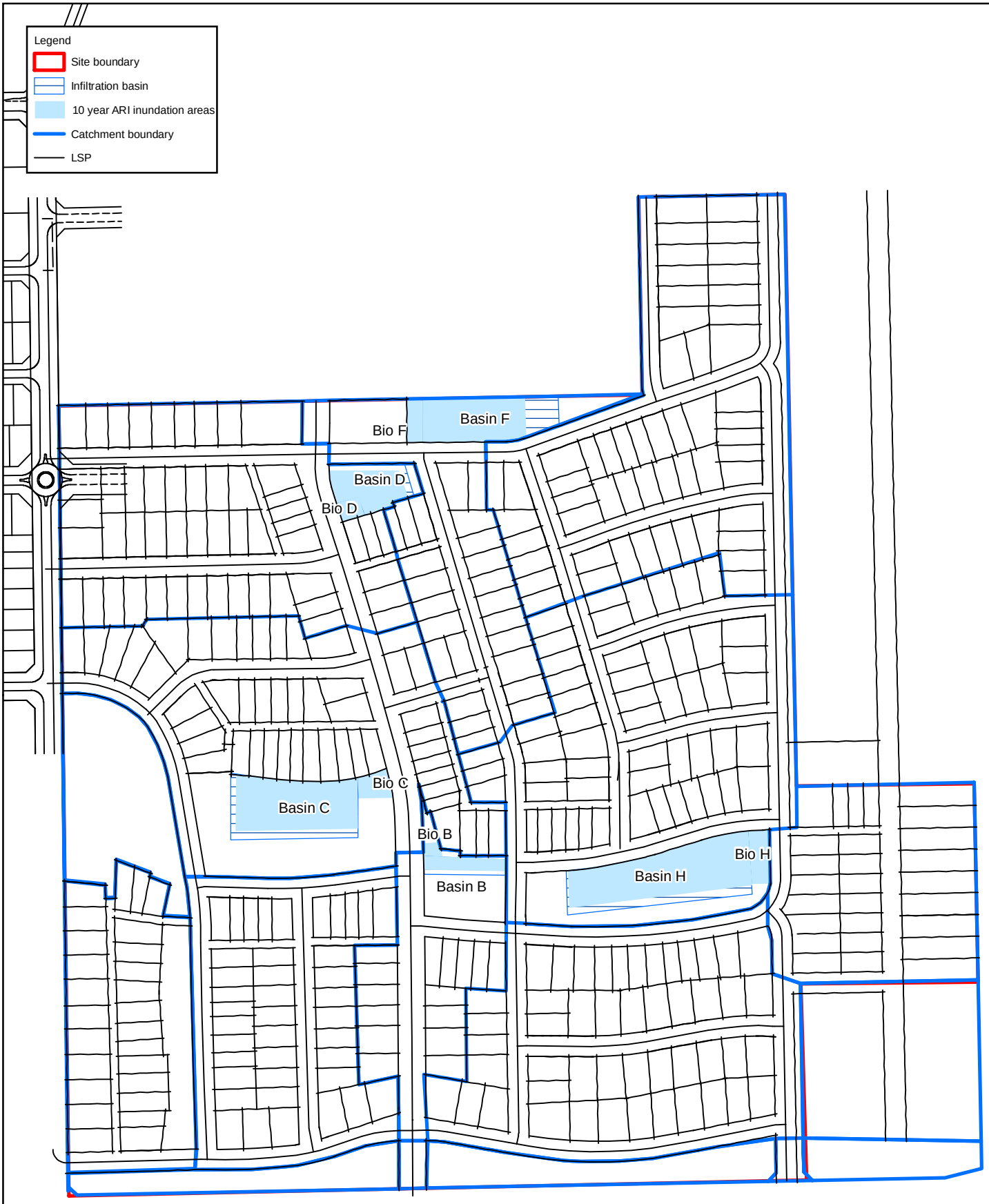


Figure 11: 10 Year ARI Inundation Areas

Project: Barfield Road Hammond Park LWMS

Client: Richart Noble

Plan Number: EP11-046(01)--F15a

Drawn:	GRO	Date:	20/03/13
Approved:	DPC	Date:	28/03/13
Checked:	RLE	Scale:	1:3,800@A4

0 35 70 140 Metres

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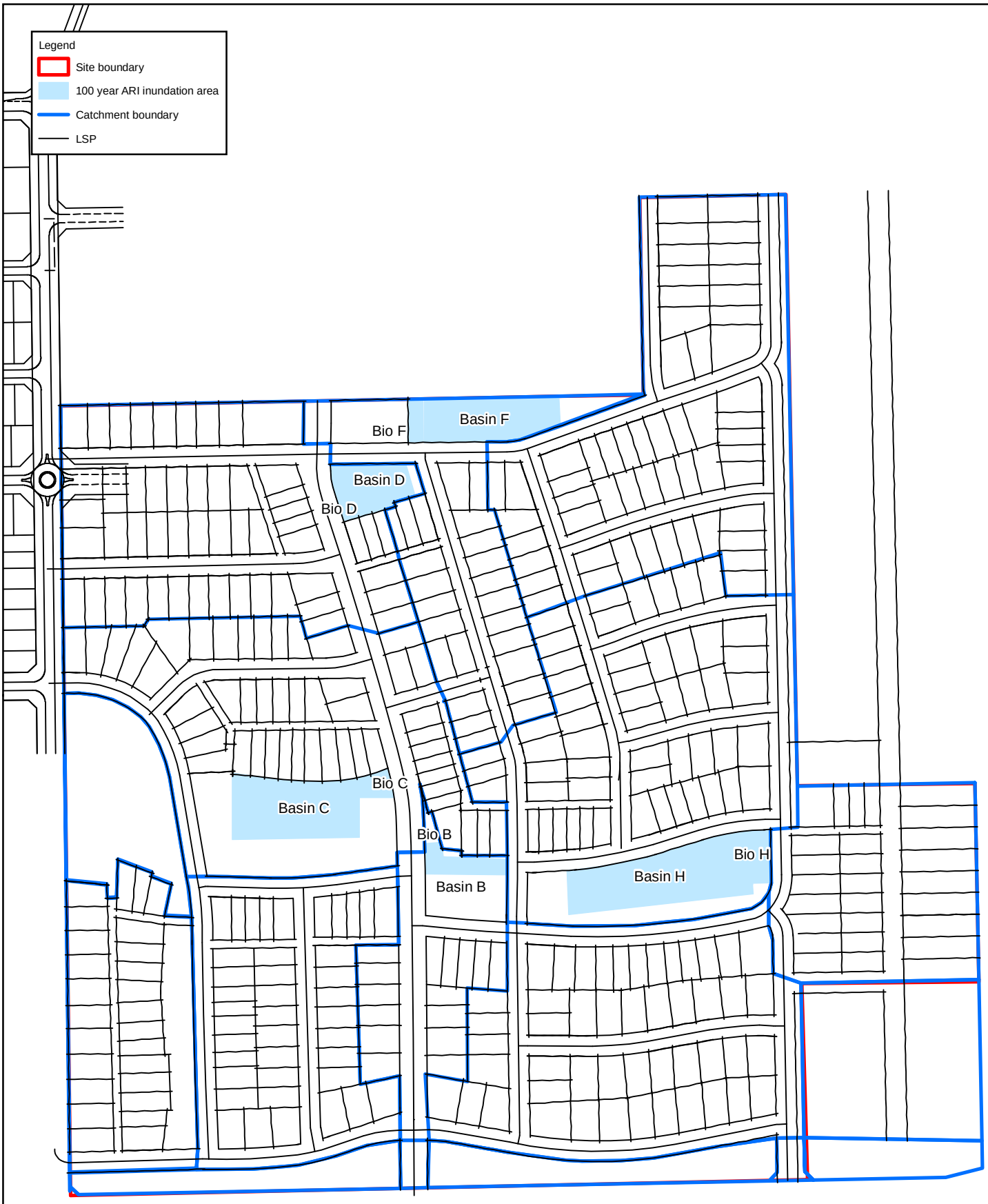


Figure 12: 100 Year ARI Inundation Areas

Project: Barfield Road Hammond Park LWMS

Client: Richart Noble

Plan Number: EP11-046(01)--F16a

Drawn:	GRO	Date:	20/03/13
Approved:	DPC	Date:	20/03/13
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0 35 70 140 Metres

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APPENDIX A

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LOCAL STRUCTURE PLAN

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LOCAL STRUCTURE PLAN



LEGEND

- RESIDENTIAL
- R25 RESIDENTIAL DENSITY CODE
- PUBLIC OPEN SPACE
- LOCAL CENTRE
- HIGH SCHOOL
- PROPOSED BUS ROUTE
- POLICY CONTROL AREA No. 95
- EXISTING CADASTRE
- INDICATIVE ROAD PAVEMENT
- STRUCTURE PLAN AREA

N

0 20 40 60 80 100m

SCALE 1:4000 @ A4

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APPENDIX B

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BORE LOGS

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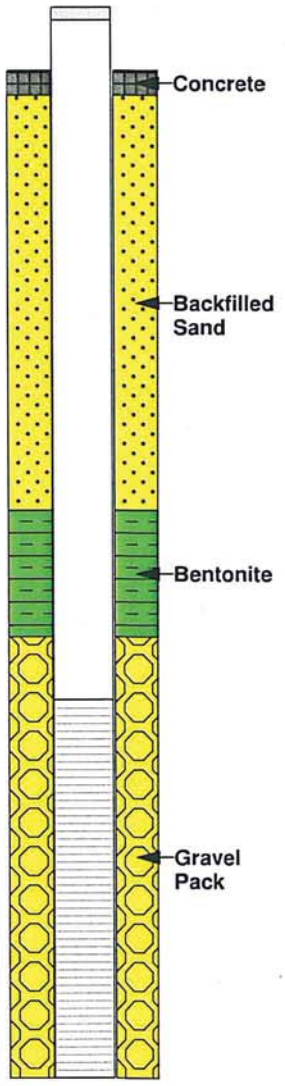
MONITORING WELL LOG & CONSTRUCTION DESCRIPTIONS

Cardno

PROJECT: DWMS
BORE NAME: MW1
BORE LOCATION: Hammond Park
DATUM: MGA 94
DRILLING METHOD: Sonic Drill Rig
CASING DIAMETER: 50 mm

JOB NUMBER: V9078
DATE: 27/10/09
TOTAL DEPTH: 10.5 m
RL TOP OF CASING: TBA
RL NATURAL SURFACE: TBA
LOGGED BY: IO

DEPTH mBGS	SOIL PROFILE	SOIL DESCRIPTION	MOISTURE CONTENT	DTW	WELL CONSTRUCTION	WELL DESCRIPTION
0.5		SP - SAND, medium to coarse grained, light grey/pale brown with minor silts.	Dry			
		SP - SAND, medium to coarse grained, pale yellow/pale brown.	Dry			
1.5		SP - SAND, medium to coarse grained, yellow/orange.	Moist			
3.0						
4.0						
5.0		colour change to pale yellow/white.	Moist	▼		
6.5						
7.5						
9.0		colour change to pale brown.	Wet			
10.0						



NOTES:

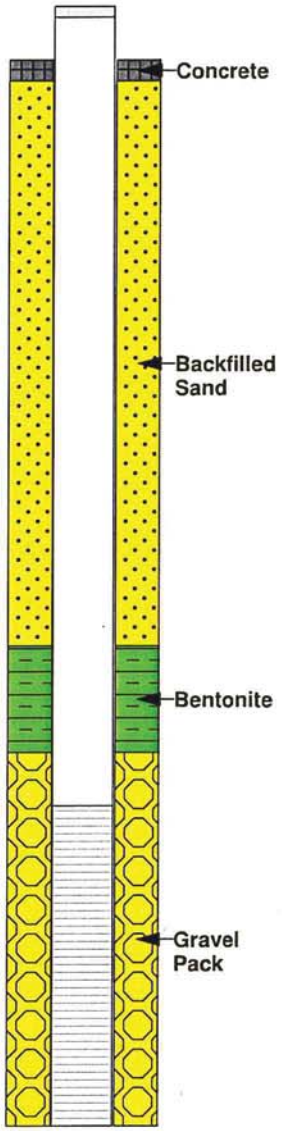
MONITORING WELL LOG & CONSTRUCTION DESCRIPTIONS

Cardno

PROJECT: DWMS
BORE NAME: MW2
BORE LOCATION: Hammond Park
DATUM: MGA 94
DRILLING METHOD: Sonic Drill Rig
CASING DIAMETER: 50 mm

JOB NUMBER: V9078
DATE: 27/10/09
TOTAL DEPTH: 12.5 m
RL TOP OF CASING: TBA
RL NATURAL SURFACE: TBA
LOGGED BY: IO

DEPTH mBGS	SOIL PROFILE	SOIL DESCRIPTION	MOISTURE CONTENT	DTW	WELL CONSTRUCTION	WELL DESCRIPTION
0.5						
0.0		SP - SAND, medium to coarse grained, light grey with minor silts.	Dry			
0.5		SP - SAND, medium to coarse grained, light grey/pale brown.	Dry			
1.0						
1.5		SP - SAND, medium to coarse grained, yellow/orange.	Moist			
2.0						
2.5						
3.0						
3.5						
4.0						
4.5						
5.0		colour change to pale yellow/white.	Moist			
5.5						
6.0						
6.5						
7.0		colour change to pale yellow/pale brown.	Moist			
7.5						
8.0				▼		
8.5		colour change to pale brown.	Wet			
9.0						
9.5						
10.0						
10.5						
11.0						
11.5						
12.0						
12.5						



NOTES:

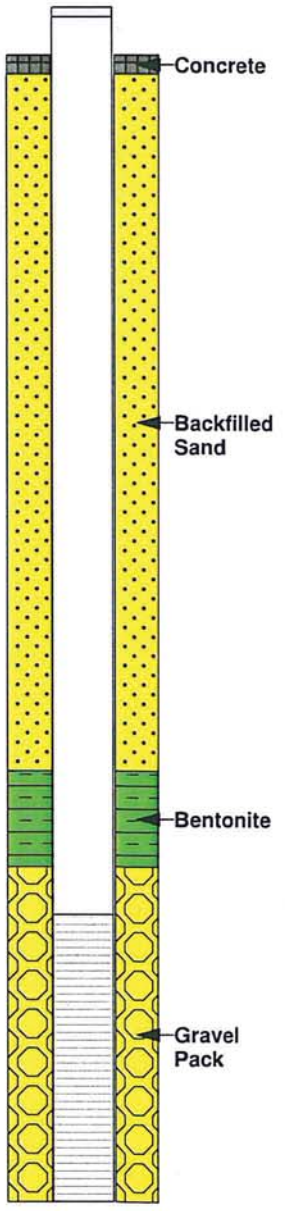
MONITORING WELL LOG & CONSTRUCTION DESCRIPTIONS

Cardno

PROJECT: DWMS
BORE NAME: MW3
BORE LOCATION: Hammond Park
DATUM: MGA 94
DRILLING METHOD: Sonic Drill Rig
CASING DIAMETER: 50 mm

JOB NUMBER: V9078
DATE: 27/10/09
TOTAL DEPTH: 14.0 m
RL TOP OF CASING: TBA
RL NATURAL SURFACE: TBA
LOGGED BY: IO

DEPTH mBGS	SOIL PROFILE	SOIL DESCRIPTION	MOISTURE CONTENT	DTW	WELL CONSTRUCTION	WELL DESCRIPTION
0.0		SP - SAND, medium to coarse grained, light grey/pale brown with minor silts.	Dry			
1.0		SP - SAND, medium to coarse grained, grey/pale brown.	Dry			
2.0		SP - SAND, medium to coarse grained, yellow/orange.	Moist			
9.0		colour change to pale yellow/white.	Moist			
10.0		colour change to white.	Wet	▼		



NOTES:

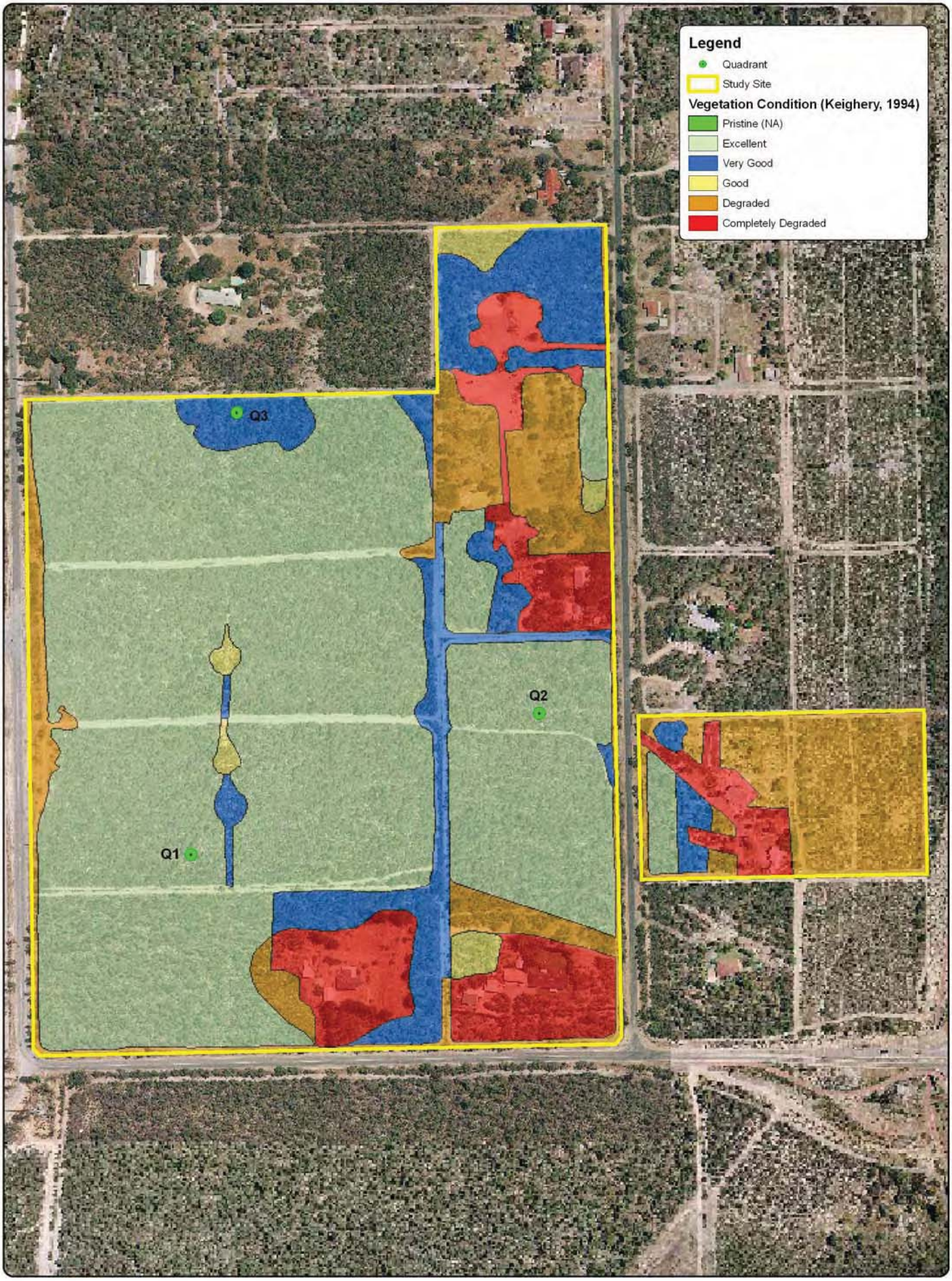
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APPENDIX C

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VEGETATION SURVEY

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Map 1

Dec 2008

Vegetation & Spring Flora Survey for Banfield Road &Rowley Road, Hammond Park

Vegetation Condition

prepared for Gold Estates Holdings Pty Ltd

0 50 100 150 Meters

1:4,500 @ A4

Project No. 2182-08

ecoscape

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APPENDIX D

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LANDSCAPE MASTERPLANS

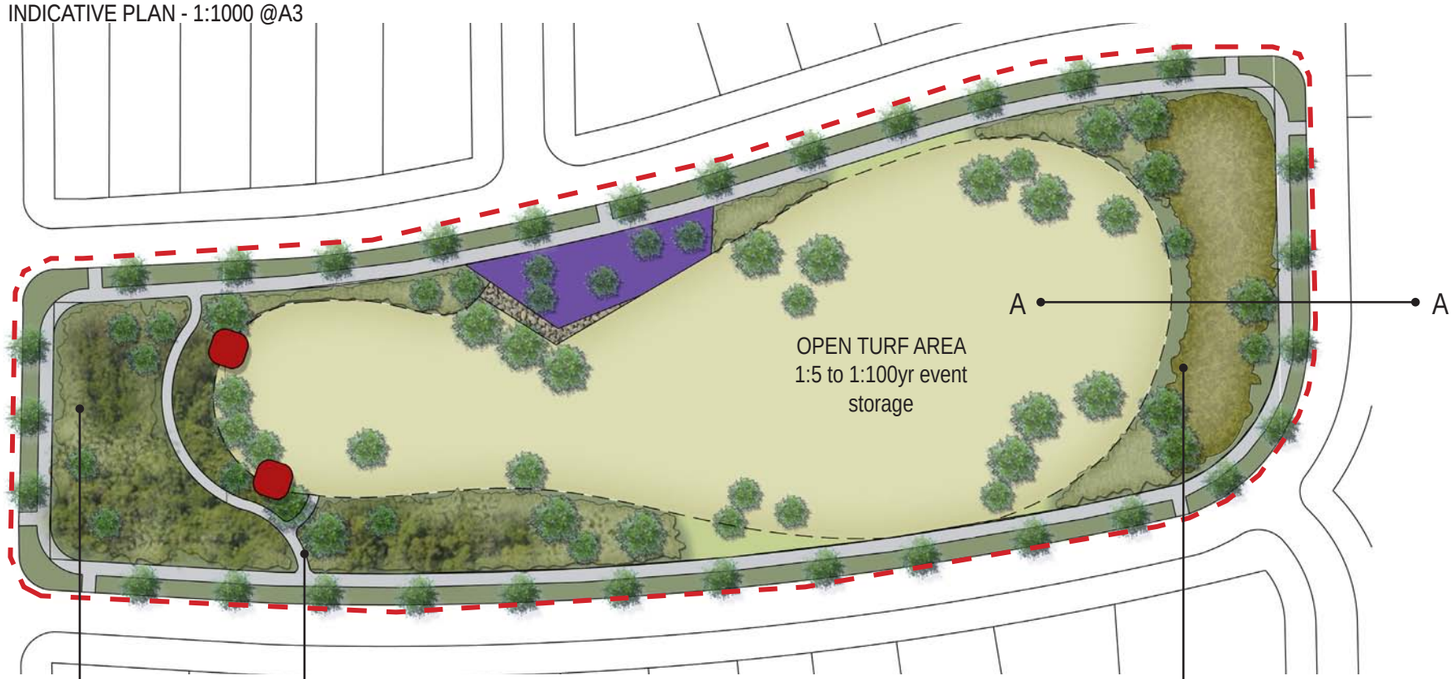
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INDICATIVE POS DRAINAGE SECTION

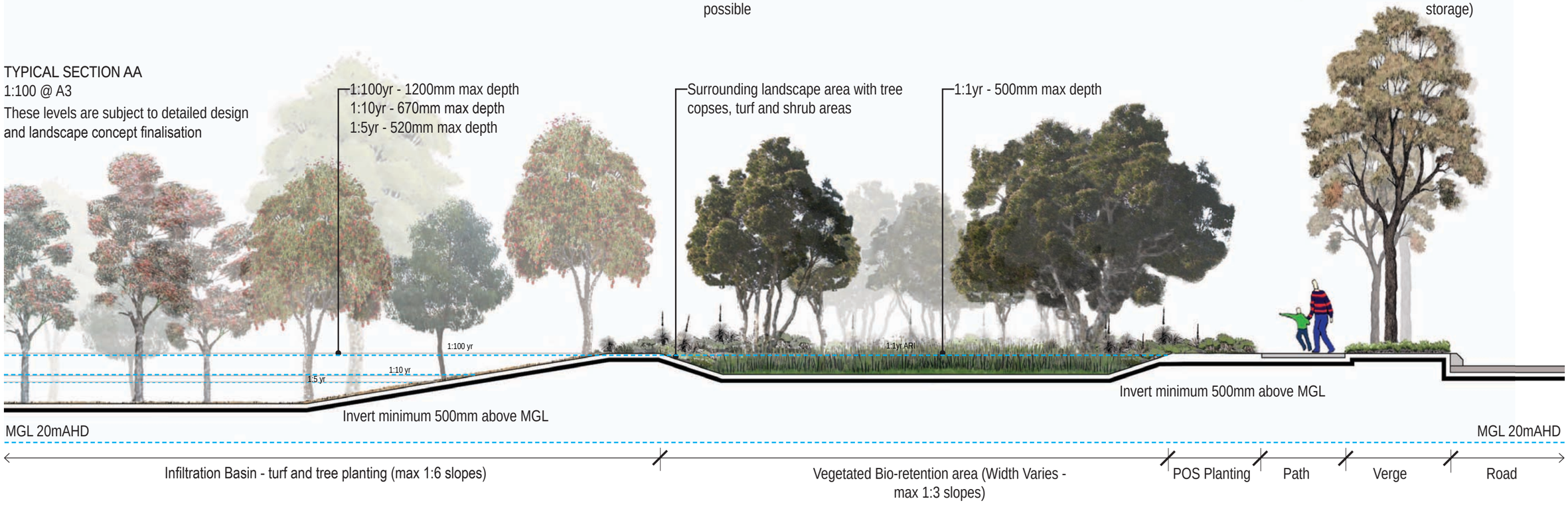
NOTE:
The below diagrams (plan and section) are provided as guidance only. Final design levels, concept design, open space amenity is subject to the future detailed design process and local government approvals process

- TURF
  (5yr to 100yr ARI event storage)
- PROPOSED SHRUB AND TREE PLANTING
- PROPOSED SHRUB AND TREE PLANTING
  (with 1yr ARI event storage)
- EXISTING VEGETATION
- HARDSCAPE AREA (POSSIBLE PLAYGROUND, PAVING, SHELTERS, FURNITURE)
  Not Irrigated
- HARDSCAPE AREA (POSSIBLE SHELTER AND PICINIC FACILITIES)
  Not irrigated
- PERIMETER AND INTERNAL PATH NETWORK
  Not Irrigated

POS H
INDICATIVE PLAN - 1:1000 @A3



TYPICAL SECTION AA
1:100 @ A3
These levels are subject to detailed design and landscape concept finalisation



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March 2013

Hammond Park

Local Structure Plan Rev D



emerge ASSOCIATES

Integrated Science & Design

LANDSCAPE MASTER PLAN



PUBLIC OPEN SPACE SUMMARY

POS	POS AREA + (VERGE AREA)	TYPOLOGY	DRAINAGE
A1	3,511m² (860m²)	Local Type 2	1:1 - n/a 1:100 - n/a
A2	10,091m² (964m²)	Local Type 2	1:1 - n/a 1:100 - n/a
B	3,160m² (1,196m²)	Neighbourhood Passive	1:1 - 121m² 1:100 - 732m²
C	10,272m² (1,513m²)	Neighbourhood Passive	1:1 - 434m² 1:100 - 4,009m²
D	2,101m² (736m²)	Neighbourhood Civic	1:1 - 231m² 1:100 - 1,685m²
F	4,114m² (829m²)	Local Type 1	1:1 - 362m² 1:100 - 2953m²
H	8,659m² (2,075m²)	Neighbourhood Passive	1:1 - 584m² 1:100 - 5,106m²





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LANDSCAPE STRATEGY



Overall Landscape Strategy is to provide a cohesive series of Public Open Spaces that is connected both physically and in character.

- Native vegetation and existing landform shall be retained where possible and have informed the design process.
- The POS areas shall cater for a variety of passive and active uses to suit a range of users and to cater to a broad demographic.
- An emphasis has been created on ease of access throughout the site and into surrounding areas for bikes and pedestrians.
- Materials, landform and planting shall reflect the natural environment of Hammond Park to create a unique sense of place.
- The site has 3 key POS typologies which have informed the development of character precincts. Neighbourhood Parks which cater for civic uses, Local Parks Type 1 which cater for active recreation and small gatherings and Local Parks Type 2 which focus on the retention of vegetation and passive recreation.

PUBLIC OPEN SPACE SUMMARY

NEIGHBOURHOOD CIVIC PARK
- Centrally located and easily accessible to the entire community.
- Multi use community gathering space for informal events
- Pedestrian/Cycle Path network linking to greater Hammond Park area.
- Primarily Civic space.
- All abilities play space.

NEIGHBOURHOOD PASSIVE
- Balance of native planted pockets and open turf areas.
- Large gathering nodes with BBQ/picnic facilities.
- All age play areas.
- Pedestrian/Cycle path network which links into the greater Hammond Park development.
- Primary focus informal active and pedestrian/cyclist connectivity.

LOCAL PARK TYPE 1
- Predominantly native planted areas with pockets of turf.
- Small gathering nodes and basic picnic facilities.
- Path network which links into the greater Hammond Park development.
- Primary focus on active recreation.

LOCAL PARK TYPE 2
- Predominantly retained vegetation.
- Path network which links into greater Hammond Park development.
- Primary focus on passive recreation.

BUFFER
- Predominantly native planting to provide screening.
- Shaded nooks with seating opportunities.
- Primary focus on passive recreation and pedestrian/cyclist connectivity.

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STREET TREE MASTER PLAN





Corymbia ficifolia - Red Flowering Gum



Agonis flexuosa - WA Peppermint



Jacaranda mimosifolia - Jacaranda



Eucalyptus torquata - Coral Gum



Eucalyptus sideroxylon - Red Ironbark



Melaluca quinquinervia - Paperbark

HAMMOND PARK LOCAL STRUCTURE PLAN
LANDSCAPE JOB NUMBER : HPK01 : MARCH 2013 : REV D

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POS TREE PLANTING PALETTE




Agonis flexuosa


Banksia attenuata


Banksia grandis


Banksia menziesii


Casuarina cunninghamiana


Corymbia calophylla


Corymbia ficifolia


Eucalyptus gomphocephala


Eucalyptus rudis


Eucalyptus wandoo


Macrozamia reidlei


Melaleuca lanceolata


Melaleuca preissiana


Melaleuca quinquernervia

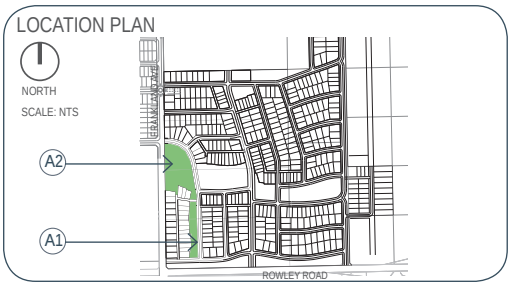

Xanthorrrhoea preissii

HAMMOND PARK LOCAL STRUCTURE PLAN
LANDSCAPE JOB NUMBER : HPK01 : MARCH 2013 : REV D

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POS A1 and A2 CONCEPT







POS TYPOLOGY

- Local Type 2 informal

SIZE

- **A1**: 3,511m^2 + 860m^2 verge
- **A2**: 10,091m^2 + 964m^2 verge

CONCEPT

- Maintain and protect existing healthy banksia's and other remant vegetation within POS.
- Meandering pathway to run length of the site and link to greater path networks.
- Planting pockets of native vegetation.

FUNCTIONS

- Native vegetation planting.
- Concrete Path.
- Provide linkages to pedestrian networks within and outside of the development area.

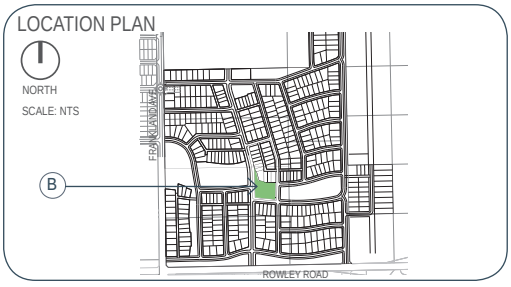
ENVIRONMENTAL CONSIDERATIONS

- Emphasis on retention of existing banksia's and associated vegetation where possible.
- Minimal/ temporary irrigation.
- Supplement native planting.
- Restricted access via fencing and path network.
- Removal of weed species.

DRAINAGE CONSIDERATIONS

- Not applicable.

POS B CONCEPT







POS TYPOLOGY

- Neighbourhood Passive

SIZE

- 3,160m^2 + 1,196m^2 verge

CONCEPT

- Provide local park catering for residents within a 200m-400m walkable catchment area.
- Create a safe local park with heavily planted in pockets with shade trees.
- Provide low key facilities for residents to play, nodes for exercise and a mixture of both active and passive spaces.
- Provide connection through the site via a cycle/pedestrian pathway which also links to the broader POS network.

FUNCTIONS

- Small pockets of turf.
- Native waterwise planting with areas of dry gardens.
- Maximise shade trees.
- Picnic facilities for family/friend and community gatherings.
- Path network connecting into broader path network.
- Drainage.

ENVIRONMENTAL CONSIDERATIONS

- Waterwise native planting.
- Planting design to be zoned according to the irrigation requirement, with full irrigation. requirements to the informal turf playing area.
- Dry garden with gravel mulch, clumping plants and limited irrigation.
- Source local materials where possible.
- Consider long term maintenance requirements for all materials.

DRAINAGE CONSIDERATIONS

- 1:1 33.5 m^3 storage required
- 1:5 214 m^3 storage required
- 1:10 275 m^3 storage required
- 1:100 492 m^3 storage required

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POS C CONCEPT







POS TYPOLOGY

- Neighbourhood Passive

SIZE

- 10,272m^2 + 1,513m^2 verge

CONCEPT

- Provide a Neighbourhood Park catering for broader community.
- Large accessible playspace with interest for all ages.
- Create a park with a balance of native planting and open turf areas for recreation.
- Provide shaded picnic facilities and BBQ.
- Nodes for exercise and a mixture of both active and passive spaces.

FUNCTIONS

- Turf – large pockets for informal kick about.
- Retained vegetation and native waterwise planting.
- Maximise shade trees.
- Picnic facilities for family/friends gatherings and play elements for all ages.
- Path network connecting into broader path network.
- Drainage.

ENVIRONMENTAL CONSIDERATIONS

- Waterwise native planting.
- Planting design to be zoned according to the irrigation requirement, with full irrigation. requirements to the informal turf playing area.
- Retention of existing vegetation.
- Source local materials where possible.
- Consider long term maintenance requirements for all materials.

DRAINAGE CONSIDERATIONS

- 1:1 160 m^3 storage required
- 1:5 1400 m^3 storage required
- 1:10 1916 m^3 storage required
- 1:100 3,801 m^3 storage required

POS D CONCEPT







POS TYPOLOGY

- Neigbourhood Civic

SIZE

- 2,101m^2 + 736m^2 verge

CONCEPT

- Provide a formal civic space catering for the broader community.
- Provide safe pedestrian and cycle linkages for all ages.
- Provide shared picnic facilities and play elements.
- Community focal area with space for small events/markets.

FUNCTIONS

- Turf – small pockets.
- Native waterwise planting with areas of dry gardens.
- Maximise shade trees.
- Picnic facilities for family/friends gatherings.
- Play elements.
- Path network connecting into broader path network.

ENVIRONMENTAL CONSIDERATIONS

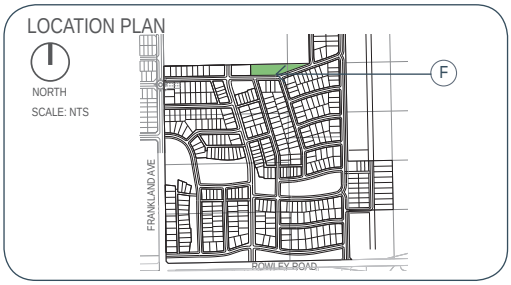
- Waterwise native planting.
- Planting design to be zoned according to the irrigation requirement, with full irrigation. requirements to the informal turf playing area.
- Dry garden with gravel mulch, clumping plants and limited irrigation.
- Source local materials where possible.
- Consider long term maintenance requirements for all materials.

DRAINAGE CONSIDERATIONS

- 1:1 76 m^3 storage required
- 1:5 570 m^3 storage required
- 1:10 749 m^3 storage required
- 1:100 1,394 m^3 storage required

THIS DRAWING IS INDICATIVE ONLY AND MAY NOT REPRESENT THE FINAL SCOPE OF LANDSCAPE WORKS

POS F CONCEPT







POS TYPOLOGY
- Local Type 1 informal

SIZE
- 4,114m^2 + 829m^2 verge

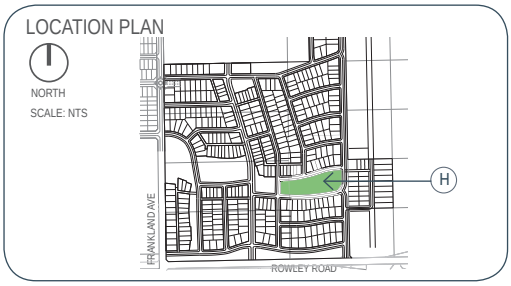
CONCEPT
- Provide local park catering for residents within a 200m-400m walkable catchment area.
- Provide a park with a balance of native planting and open turf areas for recreation.
- Provide a park to compliment the adjacent high school uses.

FUNCTIONS
- Turf – informal kick-a-bout areas.
- Native waterwise planting.
- Maximise shade trees around the perimeter of turf.
- Path network connecting into broader path network.
- Drainage.

ENVIRONMENTAL CONSIDERATIONS
- Waterwise native planting.
- Planting design to be zoned according to the irrigation requirement, with full irrigation requirements to the informal turf playing area.

DRAINAGE CONSIDERATIONS
- 1:1 130 m^3 storage required
- 1:5 1,052 m^3 storage required
- 1:10 1,402 m^3 storage required
- 1:100 2,686 m^3 storage required

POS H CONCEPT







POS TYPOLOGY
- Neighbourhood Passive

SIZE
- 8,025m^2 + 387m^2 verge

CONCEPT
- Provide local park catering for residents within a 200m-400m walkable catchment area.
- Create a safe local park with heavily planted in pockets with shade trees.
- Provide low key facilities for residents to play, nodes for exercise and a mixture of both active and passive spaces.
- Provide connection through the site via a cycle/pedestrian pathway which also links to the broader POS network.

FUNCTIONS
- Small turf pockets.
- Native waterwise planting with areas of dry gardens.
- Maximise shade trees.
- Picnic facilities for family/friend and community gatherings.
- Path network connecting into broader path network.
- Drainage.

ENVIRONMENTAL CONSIDERATIONS
- Waterwise native planting.
- Planting design to be zoned according to the irrigation requirement, with full irrigation. requirements to the informal turf playing area.
- Retention of existing native vegetation.
- Source local materials where possible.
- Consider long term maintenance requirements for all materials.

DRAINAGE CONSIDERATIONS
- 1:1 226 m^3 storage required
- 1:5 1,864 m^3 storage required
- 1:10 2,518 m^3 storage required
- 1:100 4,977 m^3 storage required

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BUFFER CONCEPT

LOCATION PLAN







POS TYPOLOGY

- Landscape Buffer

SIZE

- Buffer 1= 4786m^2 + 1368m^2 verge
- Buffer 2= 6023m^2 + 1597m^2 verge

CONCEPT

- Provide a landscape buffer adjacent to Rowley Drive
- Predominately native planted with shaded nooks for seating opportunities.
- Provide connection through the site via a pedestrian/cyclist pathway which also links to the broader POS network.
- Primary focus on screening along with passive recreation and pedestrian/cyclist connectivity.

FUNCTIONS

- Native waterwise planting with areas of dry gardens.
- Maximise shade trees.
- Path network connecting into broader path network.

ENVIRONMENTAL CONSIDERATIONS

- Waterwise native planting.
- No irrigation.
- Dry garden with gravel mulch, clumping plants and limited irrigation.
- Consider long term maintenance requirements for all materials.

DRAINAGE CONSIDERATIONS

- N/A.

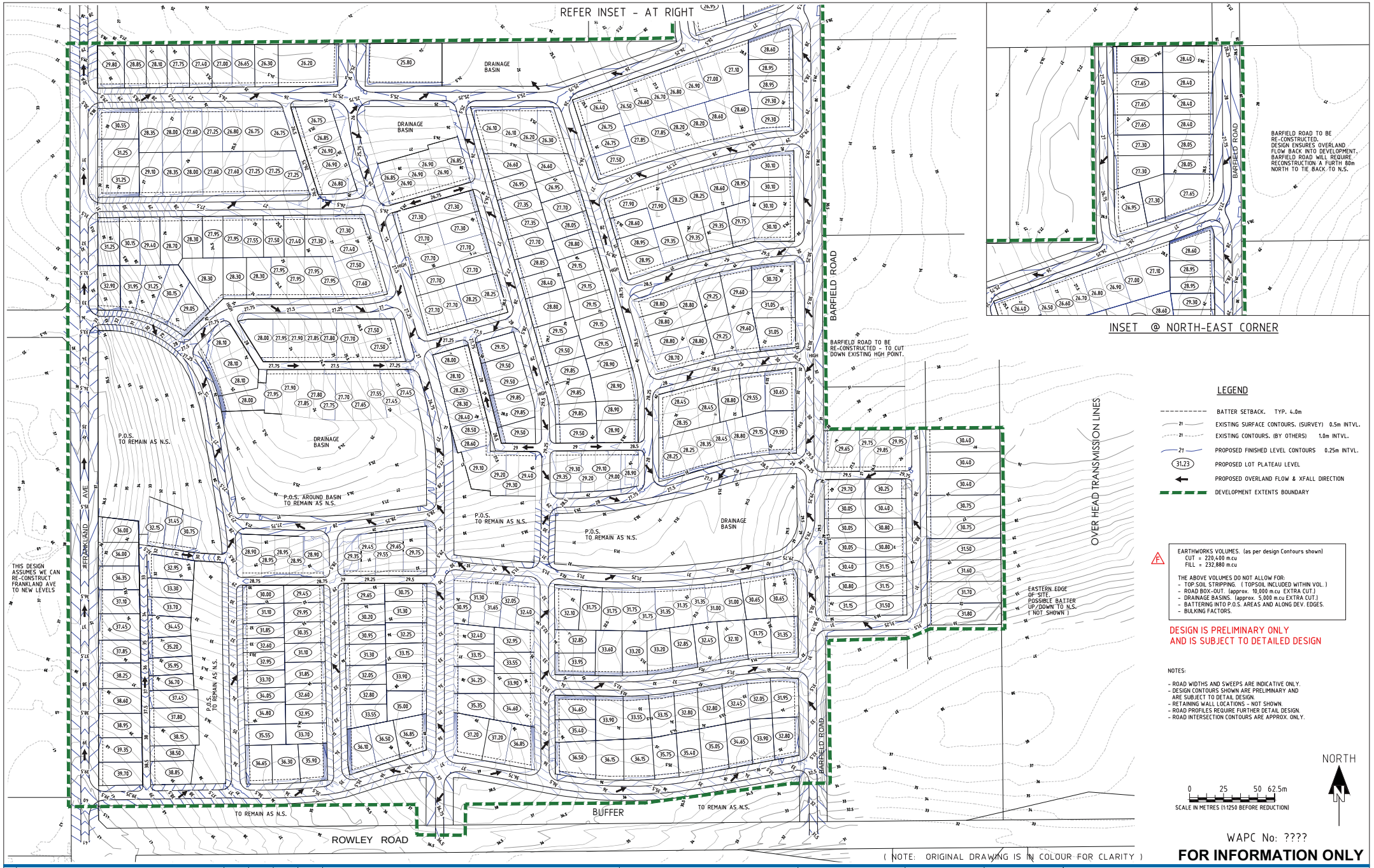
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APPENDIX E

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EARTHWORKS PLANS

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No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
E	COMPLETE NEW LAYOUT AND DESIGN		WSJ			7.03.13
D	DESIGN AMEND FOR DRNG-CATCHMENT. ROADs 17,18 & 19		WSJ			26.07.12
C	REVRS FLOW @END ROAD 1. FRANKLAND, BARFIELD, ROAD 7.		WSJ			28.06.12
B	OPTION 2 CONCEPT LAYOUT RE-MODELLED.		WSJ			20.06.12
F	ROAD & LOT LEVEL AMENDS FOR NEW DRNG CATCHMENT BDYs.		WSJ	JSG		17.03.13

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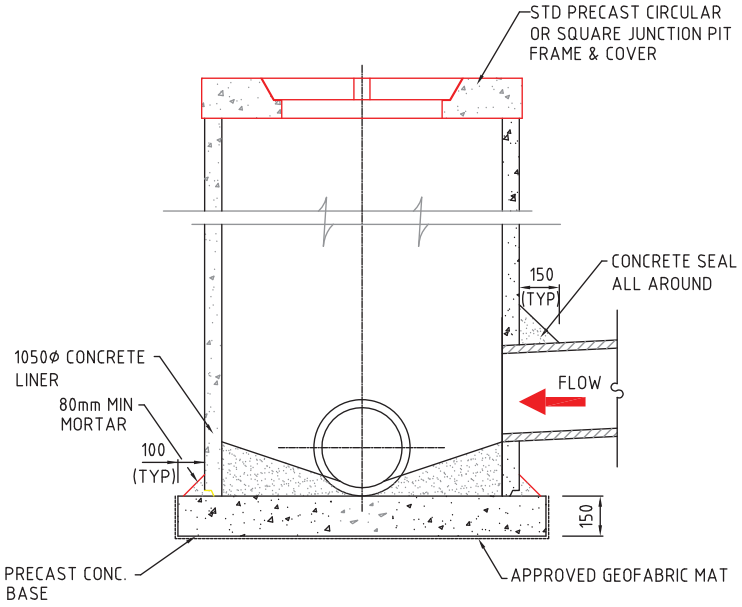
Drawn	WSJ 15-MAR-13	Designer	WSJ 15-MAR-13
Drafting Check	-	Design Check	
Approved (Project Director)			
Date			
Scale	1250	This Drawing must not be used for Construction unless signed as Approved	

Client	RICHARD NOBLE
Project	HAMMOND PARK - BARFIELD ROAD
Title	PRELIMINARY CIVIL BULK EARTHWORKS LAYOUT PLAN - (MARCH 2013)
Original Size	A1
Drawing No:	61-0911422-SK1
Rev:	F

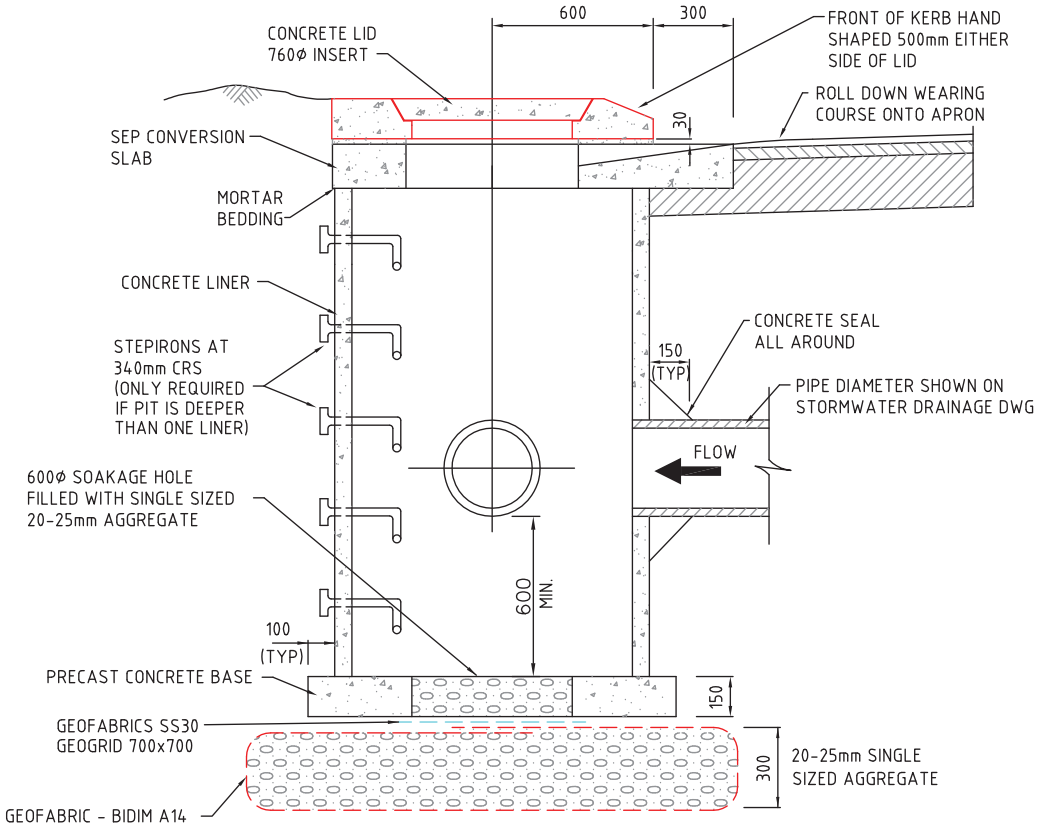
Plot Date: 17 March 2013 - 8:05 PM Plotted by: Wayne Joslin Cad File No: C:\b - Projects\AdvantageCivil\2011-12-23 GHD - Hammond Park - Feasability\61-0911422-SK1-Earthworks.dwg

NOTES
1. GEOFABRIC BIDIM A14 AND AGGREGATE SOAKAGE UDERPLAY IS REQUIRED FOR PITS WHEN BASE IS MORE THAN 500mm ABOVE AAMGL FOR THE SITE

2. LESS THAN 500mm ABOVE AAMGL PITS TO BE BENCHED



STD LINER JUNCTION PIT
BASE SHOWN FOR WET CONDITIONS



SINGLE SIDE ENTRY PIT WITH SOAKAGE
BASE SHOWN FOR WET CONDITIONS

400 200 0 400 800mm
1:20

No.	Revision-	Chk'd	App'd	Date

CITY OF COCKBURN WOULD LIKE TO ACKNOWLEDGE AND THANK GUTTERIDGEHASKINS & DAVEY PTY. LTD. FOR THEIR ASSISTANCE IN THE PRODUCTION OF THESE STANDARD DETAIL DRAWINGS

CITY OF COCKBURN
9 COLEVILLE CRESCENT, SPEARWOOD WA 6163
PHONE: (08) 9411 3444 FAX: (08) 9411 3416

STANDARD DETAILS

Title
DRAINAGE
SEP SOAKWELL & STD LINEAR JUNCTION PIT

DESIGNED	GHD	APPROVED	
DRAWN	KMF/SYC		
CHECKED	KR	DATE	

SCALE AS SHOWN | JOB No
DWG No 2423B03 | SHEET No 08 | REV

APPENDIX F

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HYDROLOGICAL AND HYDRAULIC MODELLING ASSUMPTIONS

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3.5 Hydrology

A DWMS requires a good understanding of the quantity and quality of the surface water across and the groundwater beneath the proposed development area. A sound understanding of these constraints and opportunities enables appropriate management strategies to be determined.

The groundwater levels across the site are required to determine the most appropriate post-development land use (e.g. areas of shallow water table are more suitable for POS than for dwellings or flood storage areas).

The quality of the groundwater leaving the site will affect the environmental health of the surface water body it drains into, as does the quality of the surface runoff. Understanding the quality of this water is the first step to managing it to acceptable water quality standards.

The quantity of the surface runoff is the most visually obvious constraint to management, yet it should be considered equally as important as the groundwater quantity and quality, and surface water quality. The management of surface runoff rates and volumes are important to protect areas from flooding and from potential erosion.

3.5.1 Surface Water Quantity

An understanding of the existing surface runoff throughout a proposed development site is required, so that an effective post-development stormwater management strategy can be designed. There are no defined streamlines or floodways within the study area, however the surface runoff is estimated using accurate data on topography, infiltration rates and vegetation. This information is used in the hydraulic and hydrologic XPSWMM model to calculate peak discharges and volumes of runoff.

3.5.1.1 Pre-Development Sub-Catchments

The study area is divided into a total of six pre-development sub-catchments as shown in **Figure 6**. The sub-catchment characteristics are shown in **Table 3.5.1.a**. A full description of the modelling methodology is provided in **Appendix C**.

Table 3.5.1.a Pre-Development Sub-Catchment Characteristics

Sub-Catchment	Area (ha)	Average Slope (%)
1	10.008	3.2
2	0.847	2.5
3	14.681	6.2
4	7.918	9.6
5	1.559	4.8
6	0.922	5.7

3.5.1.2 Pre-Development Modelling Results

A multi-storm analysis for the 5yr and 100yr ARI storm events was conducted in order to determine the critical duration event that produces the largest peak discharge from the study area. The analysis concluded that the critical storm duration for both the 5yr and 100yr events was the 36 hour storm duration. The peak discharge flow rates and volumes are shown in **Table 3.5.1.b**.

Table 3.5.1.b Pre-Development Peak Discharge Flow Rates and Volumes

Sub-Catchment	5yr		100yr	
	Flow Rate (m^3/s)	Volume (m^3)	Flow Rate (m^3/s)	Volume (m^3)
1	0.089	2,825	0.223	7,255
2	0.011	210	0.022	530
3	0.144	3,535	0.323	9,025
4	0.235	3,435	0.459	8,675
5	0.033	720	0.084	1,820
6	0.018	230	0.034	585
Total	-	10,955	-	27,890

Due to highly permeable sands and the location of multiple depression areas within the study area, the majority of the surface runoff is being retained on site. The larger Sub-catchments 1, 3 and 4 direct surface water runoff to low-lying areas from which they are infiltrated into the subsurface. Sub-catchment 2 directs a small portion of water to the north-east while Sub-catchments 5 and 6 direct runoff towards Rowley Road to the south of the study area.

3.5.2 Surface Water Quality

There are no defined streamlines or floodways within the study area, and therefore there is no existing surface water quality data specific to the site.

3.5.3 Groundwater Levels

The *Perth Groundwater Atlas* (DOE, 2004) indicates that the groundwater flow direction beneath the study area is in a west-to-south-west direction.

A search of the DOW *Registered Groundwater Bore Database* was requested and identified 19 registered bores within a 2km radius of the study area. Seven registered bores were identified on the southern boundary of the study area along Rowley Road; bores 3060, 3062, 3063, 3064 and 3065 are shallow groundwater bores, whilst bores 3423 and 3424 are deeper artesian aquifer bores. Measurements from the superficial bores indicate that the groundwater levels fluctuate between approximately 18.3mAHD and 20.9mAHD. The artesian groundwater level recorded from bore 3423 lies between -9mAHD and 17mAHD, whilst the groundwater levels from bore 3424 were recorded between approximately -5mAHD and 4mAHD.

Other DOW groundwater monitoring bores located within the vicinity of the study area include Bore 3049, 640m to the north-west, and Bore 3173, 740m to the north. Both bores are artesian aquifer bores. Groundwater levels at Bore 3049 were recorded between 18.0mAHD and 20.1mAHD over a 24 year period while Bore 3173 recorded groundwater levels between 20.9mAHD and 23.3mAHD over the same time period.

Monthly groundwater level monitoring is currently being conducted by the proponent at three bores installed by Cardno within the study area and will continue for a period of 18 months. The bores were installed with 3m of slotted screens to a depth greater than 2m below the groundwater level to ensure seasonal variation is captured. To date, monitoring has captured the 2009 winter peak, with measurements indicating that maximum groundwater levels within the study area occur in October.

Groundwater level measurements will be also be taken on a monthly basis from January 2010 from bore 3065, with data previously recorded from this bore by the DoW used to calculate the average

MODELLING ASSUMPTIONS

BARFIELD ROAD, HAMMOND PARK LWMS

Project Number EP11-046(01)

Prepared for Gold Estate Holdings
April 2013

Document Control

DOC NAME	BARFIELD ROAD, HAMMOND PARK LWMS MODELLING ASSUMPTIONS				
DOC NO.	EP11-046(01)—006A RLE				
REVISION	DATE	AUTHOR		REVIEWER	
1	August 2012	Rachel Evans	RLE	David Coremans	DPC
	Appendix to LWMS				
A	April 2013	Rachel Evans	RLE	David Coremans	DPC
	Appendix to LWMS rev C				

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1 Modelling Assumptions

In order to calculate the surface water runoff volumes within the Barfield Road, Hammond Park LSP area, XPStorm hydrologic and hydraulic modelling software was used.

The hydrologic component of the software uses the Laurenson non-linear runoff-routing method to simulate runoff from design storm events. Key assumptions regarding the hydrologic model include:

- Runoff is proportional to slope, area, infiltration and percentage of imperviousness of a catchment.
- Sub-catchment areas and slopes are determined from surveyed topographical data and earthworks plans.
- Infiltration rates and percentage imperviousness have been selected based on experience with model preparation for similar soil conditions.

Runoff from each sub-catchment is routed through the catchment using the hydraulic component of XPStorm. Assumptions associated with the hydraulic component of the model include:

- Virtual links (i.e. purely for model construction, not equivalent to flow path onsite) between nodes within a sub-catchment are given the length of 10 m and slope of 0.05 to minimise the lag time of conveying the water from a sub-catchment node to a ‘storage’ node, a ‘dummy intermediate’ node or a conduit/link.
- Links between sub-catchment storages act as conveyance channels (e.g. sheet flow within roads in a 100 year ARI event). These links are given lengths and slopes that are representative of the site conditions and actual pathway lengths between catchments.
- All channels are designed with a width of 4 m, roughness of 0.014 (Manning’s n) and are trapezoidal in shape. This allows for easy conveyance and represents concrete pipes and road surfaces within the model.
- Swales are modelled as trapezoidal channels with 6 m width, 0.5 m depth and 1 in 3 side slopes.
- Soakwells, bio-retention areas and flood storage areas are modelled as nodal-reservoirs with infiltration depth-rating curves to account for differential infiltration rates with changing depth.
- No ponding conditions have been allowed within 1 year 1 hour ARI storage nodes for events greater than the 1 year 1 hour ARI event.

2 Pre-development Model

Pre-development modelling of the site was carried out for the District Water Management Strategy (DWMS) (Cardno 2010) which identified the pre-development catchments within the site and surrounding Southern Suburbs District Structure Plan 3 (SSDSP3) area. The DWMS identified the 24 hour duration storm to be the critical event for the site. This critical duration event has been carried through in the LWMS post-development modelling.

There are some minor catchments that could potentially discharge from the site, however all runoff from these areas (for up to the 100 year ARI event) will be retained on site. Further pre-development modelling has therefore not been carried out for the LWMS, as matching of pre-development discharge flow rates is not required.

3 Post-development Model

An "initial loss - continual loss" infiltration model was adopted to represent the post-development environment, with loss values chosen based on project team experience on other projects in the area similar to Hammond Park. **Table 1** gives the parameters used within the post-development model.

Table 1 Post-development parameters

Land Type	Initial Loss (mm)	Continual Loss (mm)	Roughness
Road Pavement	1	0.1	0.014
Road Verge	12	2	0.05
Lot Roof	1	0.1	0.014
Lot Garden	20	2.5	0.05
Lot Paved	3	0.2	0.02
POS	20	2.5	0.05

The post-development catchment areas were taken from the earthworks strategy provided by the project team (dwg 61-0911422-SK1 provided in Appendix E of the Barfield Road LWMS). Land types within the catchments were guided by the Barfield Road Local Structure Plan. A summary of post-development catchment information is shown in **Table 2**. The post-development catchment boundaries are shown in Figure 8 of the Barfield Road LWMS.

The infiltration rates used were predominantly based upon the following assumptions:

- Lots on average will be consistent with other new developments in the Perth metropolitan area and have 60% roof areas with the remainder of the lots paved (15%) and pervious garden (25%).
- Road reserve contains 60% pervious verge and 40% impervious bitumen.
- There will be no infiltration on roads, pavements and driveways. There will however be some minor absorption storage loss, this is accounted for in the initial and continuing loss values.
- Lots will provide onsite storage within soakwells sized to cater for the 1 year 1 hour ARI event from lot roof areas.
- Garden areas will have high infiltration rates as it is likely that sand or mulch will be used. Residential lots will have little slope (i.e. will be flat) and pockets of storage are likely. This will effectively increase the initial loss (storage) and overall infiltration rate (continual loss).
- POS areas will likely contain dense vegetation or turf over a sand-based landscape mix. This turfed area will become compacted over time and reduce initial infiltration rates. It is anticipated that the infiltration losses allowed for in the initial loss and continual loss will be higher than the rate of runoff accumulation from the 1 year 1 hour ARI event.
- The road verge area is similar in characteristics to POS areas except that it will also have an impervious footpath and some driveway crossovers. It is anticipated that the averaged initial loss will be lower than POS initial loss rates.
- Garden areas in all lots will have high infiltration rates as it is likely that sand-based landscape mix or mulch will be used, and will infiltrate 1 year 1 hour ARI event within them.
- Infiltration is assumed to occur within the system of bio-retention areas/swales. A hydraulic conductivity of 5×10^{-5}m/s was assumed for the infiltration of soakwells and bio-retention systems, however a 50% clogging factor was then applied to the assumed infiltration rate.

- Bottom storage surface areas were considered when calculating the infiltration rating curve for Soakwells.
- The effect of infiltration through side slopes of bio-retention areas and infiltration basins was considered in the overall infiltration rating curve for these areas. This effectively accounts for infiltration across the entire wetted surface
- Volumes leaving the system through evapotranspiration were assumed to be negligible when compared to the total runoff volume, and since the duration of model run was comparatively short. XPStorm default evapotranspiration assumptions are therefore used.

Table 2 Post-development catchment areas

Catchment	Total area (ha)	Slope	Lot (ha)			Road (ha)		POS (ha)
			Roof	Garden	Lot Paved	Road Pavement	Road Verge	
A1	1.917	0.042	0.764	0.191	0.318	0.117	0.175	0.351
A2	1.017	0.053	0.000	0.000	0.000	0.000	0.000	1.017
B1	1.522	0.047	0.420	0.105	0.175	0.202	0.303	0.316
C1	2.806	0.043	1.043	0.261	0.435	0.427	0.641	0.000
C2	4.217	0.022	1.265	0.316	0.527	0.433	0.650	1.026
D1	3.721	0.038	1.404	0.351	0.585	0.468	0.702	0.210
F1	2.289	0.020	0.949	0.237	0.395	0.122	0.183	0.403
F2	4.602	0.012	1.723	0.431	0.718	0.692	1.038	0.000
H1	3.989	0.005	1.568	0.392	0.653	0.550	0.825	0.000
H2	4.898	0.005	1.505	0.376	0.627	0.611	0.916	0.862
H3	2.086	0.005	0.937	0.234	0.391	0.210	0.314	0.000
H4	1.487	0.005	0.762	0.190	0.317	0.087	0.131	0.000
R1	0.066	0.025	0.000	0.000	0.000	0.026	0.040	0.000
R2	0.071	0.038	0.000	0.000	0.000	0.029	0.043	0.000
Buffer 1	0.478	0.047	0.000	0.000	0.000	0.000	0.000	0.478
Buffer 2	0.599	0.021	0.000	0.000	0.000	0.000	0.000	0.599
Buffer 3	0.359	0.008	0.000	0.000	0.000	0.000	0.000	0.359
Total	*36.125*		*12.341*	*3.085*	*5.142*	*3.974*	*5.961*	*5.621*


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ASSOCIATES
Integrated Science & Design

Document Reference: EP14-023(04)--010 RLE

Emerge Associates contact: Rachel Evans

14 August 2015

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Attention: Graeme Morris
Richard Noble
Level 1, 189 Hay Street
Subiaco WA 6008

Delivered by email to: Graeme Morris <gmorris@rnoble.com.au>

Dear Graeme

BARFIELD ROAD LOCAL STRUCTURE PLAN - LOCAL WATER MANAGEMENT STRATEGY ADDENDUM

Emerge Associates have prepared this letter report as an addendum to the approved *Barfield Road Local Structure Plan (LSP) Local Water Management Strategy (LWMS)* (Emerge Associates 2013) to incorporate proposed amendments to the Barfield Road LSP.

Background

The Barfield Road LSP area is located in Hammond Park in the City of Cockburn (CoC), as illustrated in the attached **Figure 1**. The current, approved LSP incorporates Lots 13, 14 and 18 Barfield Road and 48 - 51 Frankland Avenue. The proposed amended Barfield Road LSP allows for inclusion of Lot 15 Barfield Road and minor changes to the lot layout within lots 50 and 51 Frankland Avenue, as illustrated in the attached **Figure 2**. The 'site' refers to the amended Barfield Road LSP area. A copy of the proposed LSP is provided in **Attachment A**.

Emerge Associates have prepared this letter report to provide a summary of the changes to water management across the site required to incorporate the proposed LSP amendments. This letter report should only be read in conjunction with the approved *Barfield Road LSP LWMS* (Emerge Associates 2013).

The water conservation and groundwater management criteria and measures for the amended LSP area are consistent with those detailed in the approved *Barfield Road LSP LWMS* (Emerge Associates 2013) and are therefore not detailed in this letter report.

The storm water management criteria for the site are detailed in the approved *Barfield Road LSP LWMS* (Emerge Associates 2013). The stormwater management measures proposed for the amended LSP are consistent with those presented in the LWMS however, the configuration of the drainage basins required to meet the key design criteria have changed. The changes to the drainage designs are discussed in the following sections of this letter.

Surface runoff modelling

As detailed in the *Barfield Road LSP LWMS* (Emerge Associates 2013), XPStorm (hydrological and hydraulic modelling software) has been used to determine the runoff volumes required to be retained on site in accordance with the stormwater management criteria. The key stormwater management parameters related to drainage design are to:

1. Retain runoff from the 100 year Average Recurrence Interval (ARI) event on site.
2. Retain and treat the 1 year 1 hour ARI event on site.

Since submission of the LWMS the modelling assumptions relating to lot retention have been revised to incorporate additional feedback from the CoC (S. Hussain [CoC] 2015, pers. comm. July 13). The assumptions used in the modelling of the amended LSP are detailed in the attached *Barfield Road LSP Modelling Report* (Emerge Associates 2015) with the key changes being:

- Retention of the 20 year ARI, 5 minute duration event (approximately 12 mm) on single lots within soakwells.
- Downstream retention areas are sized to allow for runoff from 20% of the total area of single lots. This is generally equivalent to assuming a runoff coefficient of 0.2 from lots (as requested by CoC (S. Hussain [CoC] 2015, pers. comm. July 13)).

Figure 1 within the modelling report provides a summary of the storage volumes and areas required within each catchment based on the revised lot assumptions. The 1 year 1 hour ARI event is retained within soakage pits in road reserves and bio-retention areas (BRAs) located in public open space (POS). Major event runoff (up to the 100 year ARI event) is retained in flood storage areas (FSAs) located in POS, consistent with the approach detailed in the LWMS.

As illustrated in Figure 1 of the modelling report, the amended Barfield Road LSP has sufficient public open space (POS) to incorporate surface runoff from the amended LSP area, consistent with the criteria presented in the approved *Barfield Road LSP LWMS* (Emerge Associates 2015).

Summary and closing

The proposed amended Barfield Road LSP is capable of managing water consistent with the approach detailed in the approved *Barfield Road LSP LWMS* (Emerge Associates 2015). This LWMS addendum demonstrates that by following the recommendations detailed in the report the site is capable of being developed.

Should you have any queries in relation to the content of this letter report please contact me on the details below.

Yours sincerely
Emerge Associates



Rachel Evans
SENIOR ENVIRONMENTAL CONSULTANT - HYDROLOGY

Figures: Figure 1 - Site location
Figure 2 - Proposed LSP amendments

Attachments: Amended Barfield Road LSP
Barfield Road LSP Modelling Report

References

Emerge Associates 2013, *Barfield Road Local Structure Plan Local Water Management Strategy*, unpublished report prepared by Emerge Associates, Subiaco.

Emerge Associates 2015, *Barfield Road Local Structure Plan Modelling Report*, unpublished report prepared by Emerge Associates, Subiaco.



Figure 1:	**Site location**	**Plan Number: EP14-023(04)--F15**	
Project:	Local Water Management Strategy addendum Barfield Road LSP	Drawn: SMF	Date: 05/08/15
		Approved: DPC	Date: 14/08/15
Client:	Gold Estates Holdings	Checked: RLE	Scale: 1:14,000@A4

0 125 250 500 Metres

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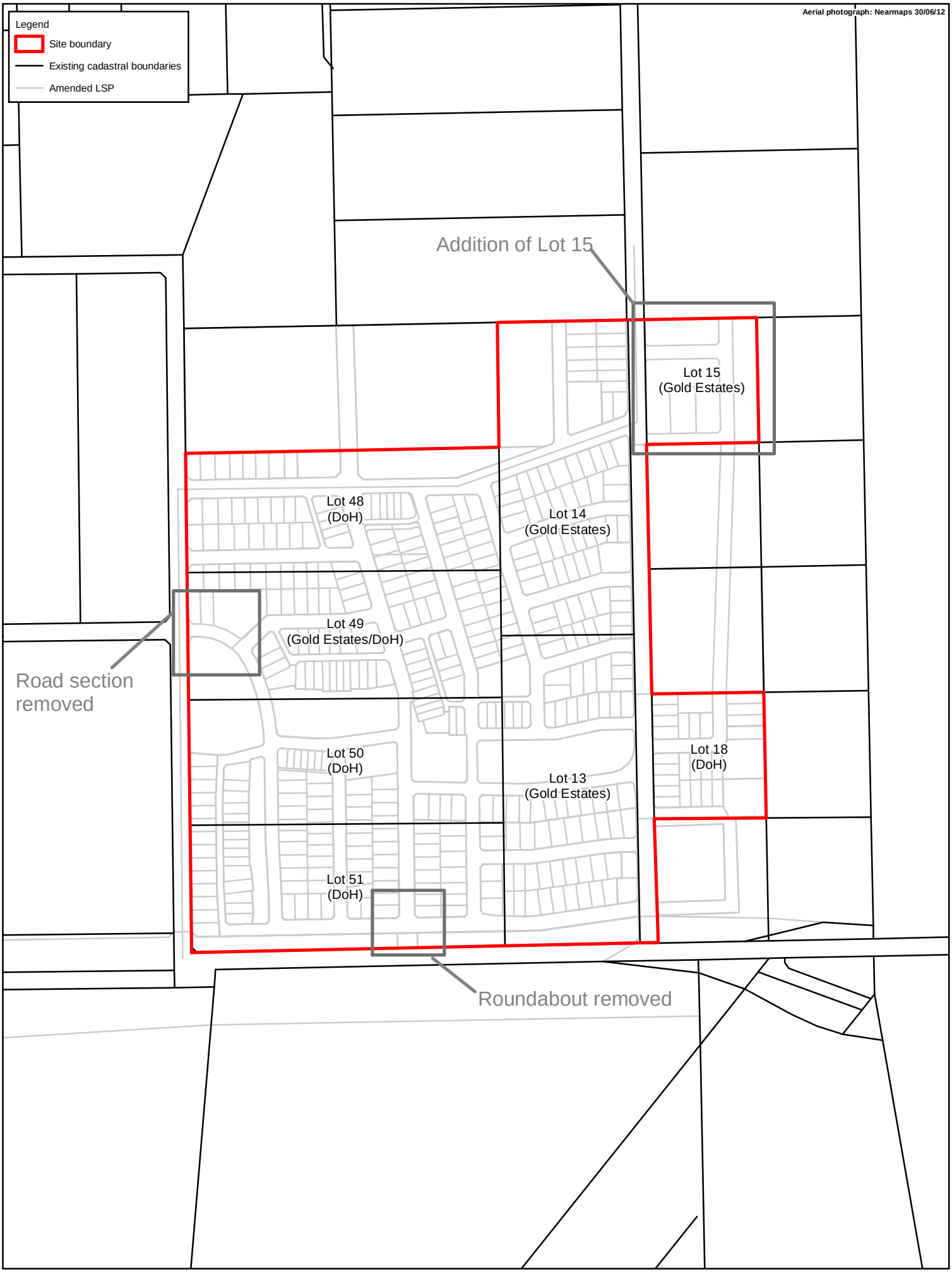


Figure 2: Site boundary and LSP amendments

Project:	Local Water Management Strategy addendum Barfield Road LSP
Client:	Gold Estates Holdings

Plan Number: EP14-023(04)--F16

Drawn:	SMF	Date:	5/08/15
Approved:	DPC	Date:	14/08/15
Checked:	RLE	Scale:	1:5,500@A4

0 50 100 200 Metres

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LEGEND

STRUCTURE PLAN BOUNDARY

ZONES
- RESIDENTIAL
- LOCAL CENTRE

RESERVES
- PARKS AND RECREATION
- PUBLIC PURPOSE

OTHER ELEMENTS THAT INFORM THE LSP
- R25 RESIDENTIAL DENSITY CODE
- PROPOSED BUS ROUTE
- PLANNING CONTROL AREA No. 95

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CADASTRAL INFORMATION
SOURCE: McMULLEN NOLAN
YYMMDD: 140501
DWG REF: 96236
PROJECTION: PCG 94

AERIAL PHOTOGRAPHY
SOURCE: NA
YYMMDD: NA

1:3000 SIZE A3

0 30 60 90 120 300 metres

REV	DESCRIPTION	YYMMDD	DRAWN	APPR'D
B	UPDATES	150520	RF	ER
A	BASE PLAN	141009	RF	ER

BARFIELD ROAD LOCAL STRUCTURE PLAN
Lots 13-14, 18 & 48-51 Hammond Park
City of Cockburn

REF NO. **RIC HAM** | DRAW NO. **RD1 034** | REV. **B**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY

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MODELLING REPORT

BARFIELD ROAD LOCAL STRUCTURE PLAN

Project Number EP14-023

Prepared for Gold Estate Holdings
August 2015

Document Control

DOC NAME	**BARFIELD ROAD LOCAL STRUCTURE PLAN MODELLING REPORT**				
DOC NO.	**EP14-023 (03)--002B SH**				
REVISION	**DATE**	**AUTHOR**		**REVIEWER**	
1	March 2015	Sujeewa Herath	SH	Dave Coremans	DPC
	Issued as an Appendix to UWMP				
A	May 2015	Amila Prasad	AP	Dave Coremans	DPC
	Issued as an Appendix to UWMP				
B	August 2015	Amila Prasad	AP	Dave Coremans	DPC
	Issued to client to incorporate revised LSP and lot assumptions				

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Table 2 Post-development catchment parameters 5
Table 3 1 year 1 hour ARI event storage 8
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1 Modelling Assumptions

In order to calculate the surface water runoff volumes within the Barfield Road Local Structure Planning (LSP) area (also referred to as the Vivente development), XPStorm hydrologic and hydraulic modelling software was used.

The hydrologic component of the software uses the Laurenson non-linear runoff-routing method to simulate runoff from design storm events. Key assumptions regarding the hydrologic model include:

- Runoff is proportional to slope, area, infiltration and percentage of imperviousness of a catchment.
- Sub-catchment areas and slopes are determined from surveyed topographical data and earthworks plans.
- Infiltration rates and percentage imperviousness is based on experience with model preparation for similar soil conditions.

Runoff from each sub-catchment is routed through the catchment using the hydraulic component of XPStorm. Assumptions associated with the hydraulic component of the model include:

- Virtual links (i.e. purely for model construction, not equivalent to flow paths onsite) between nodes within a sub-catchment are given the length of 10 m and slope of 0.05 to minimise the lag time of conveying the water from a sub-catchment node to a ‘storage’ node, a ‘dummy intermediate’ node or a conduit/link.
- Links between sub catchment storages act as conveyance channels (e.g. sheet flow within roads in 100 year ARI event). These links are given lengths and slopes that are representative of the site conditions and actual pathway lengths between catchments.
- All channels are designed with a width of 5 m, roughness of 0.014 (Manning’s n) and are trapezoidal in shape. This allows for easy conveyance and represents concrete pipes and road surfaces within the model.
- Soakwells are modelled as nodal-reservoirs with infiltration depth-rating curves.
- Minimum ponding conditions of less than the 5% from the total volume have been allowed within 1 year 1 hour average recurrence interval (ARI) storage nodes for events greater than the 1 year 1 hour ARI event.

2 Post-development Model

Post-development catchments within the site were informed by the earthworks plan and civil designs supplied by the project engineers (Civil Group). Post-development catchments are shown in **Figure 1** with a breakdown of the land types within each catchment provided in **Table 1**.

Table 1 Post-development catchment areas

Catchment	Road (m^2)	POS (m^2)	Lots > 300 (m^2)	Lots ≤ 300 (m^2)	Group housing (m^2)	SEP volume (m^3)
CtA1	0.389	0.353	1.034	0.180	0.000	2.86
CtA2	0.000	0.961	0.000	0.000	0.000	0.00
CtB1	0.523	0.391	0.707	0.000	0.000	3.84
CtC1	0.785	0.000	1.716	0.138	0.217	5.77
CtC2	1.189	0.774	1.540	0.308	0.282	8.74
CtF1	0.690	0.564	1.157	0.048	0.000	5.07
CtF2	2.647	0.000	3.970	0.000	0.590	19.46
CtF3	1.077	0.000	2.459	0.054	0.000	7.92
CtF4	0.461	0.000	1.231	0.161	0.000	3.39
Ct H1	1.483	0.000	2.545	0.125	0.000	10.91
Ct H2	0.606	0.864	0.311	0.178	0.000	4.46
Ct H3	0.564	0.000	1.010	0.000	0.525	4.15
BUF1	0.000	0.411	0.000	0.000	0.000	0.00
BUF2	0.000	0.507	0.000	0.000	0.000	0.00
Rd 2	0.066	0.000	0.000	0.000	0.000	0.49
Total	10.478	4.826	17.681	1.192	1.612	77.05

An “initial loss - continual loss” infiltration model was adopted to represent the post-development environment, with loss values chosen based on project team experience with similar land types to those found within the site. Post-development catchment parameters are provided in **Table 2**.

Table 2 Post-development catchment parameters

Land Type	Initial Loss (mm)	Continual Loss (mm/h)	Manning's Number (N)
Road Surface	1	0.1	0.14
Road Verge	12	2.0	0.05
Roof	1	0.1	0.14
Lot IMP	1	0.2	0.02

Land Type	Initial Loss (mm)	Continual Loss (mm/h)	Manning's Number (N)
Gardens	25	3.5	0.05
POS	20	3	0.05

The infiltration rates used in the post-development model were predominantly based upon the following assumptions:

- Typical residential lots (lots > 300 m^2) will be consistent with other new developments in the area and have 50% roof areas with the remainder of the front yard (20%) and back yard (30%). The front yard has been assumed to be 100% impervious with all flows from this area being directed to downstream drainage areas. This assumption is in response to the City of Cockburn (CoC) requirement for a 0.2 runoff co-efficient from lots of this size (S. Hussain [CoC] 2015, pers. comm. 22nd July).
- Group housing and high density lots (lots ≤ 300 m^2) on average will be consistent with other new developments in the area and have 50% roof areas with the remainder of the lots paved (45%) and pervious garden (5%).
- Road reserve contains 60% pervious verge and 40% impervious bitumen areas.
- The road verge area is similar in characteristics to POS areas except that it will also have an impervious footpath and some driveway crossovers. Therefore the average initial loss will be lower than POS initial loss rates.
- There will be no infiltration on roads, pavements and driveways. There will however be some minor absorption storage loss and this is accounted for in the initial and continuing loss values.
- Typical residential lots (> 300 m^2) will provide onsite retention for roof and back garden runoff from the 100 year 1 day ARI event, with soakwells sized to retain the 20 year ARI 5 minute duration storm event consistent with CoC building design guidelines. Runoff from the front garden will be conveyed to downstream retention areas within the road drainage network and POS areas.
- High density lots (≤ 300 m^2) will retain the 100 year ARI event from the rear pervious garden areas (5%) only. All additional runoff will be conveyed to downstream retention areas via the road network.
- Group housing lots will provide retention for the 1 year 1 hour ARI event onsite. Pervious areas of group housing lots will retain the 100 year ARI event runoff within the lot.
- The school lot will retain runoff up to the 100 year ARI event onsite.
- Garden areas will have high infiltration rates as it is likely that sand or mulch will be used.
- Public Open Space (POS) areas will likely contain dense vegetation or turf over a sand-based landscape mix. This turfed area will become compacted over time and reduce initial infiltration rates. It is anticipated that the infiltration losses allowed for in the initial loss and continual loss will be higher than the rate of runoff accumulation from the 1 year 1 hour ARI event.
- Bio-retention areas (BRAs) and side entry soakage pits will retain runoff from the 1 year 1 hour ARI event from road reserves, residential lot drive ways and high density lots.
- BRAs have been assumed to be 500 mm in depth with 1:6 side slopes.
- Flood storage areas (FSAs) will retain major event runoff (up to the 100 year ARI event) and have been designed with a maximum 1.2 m depth with 1:6 side slopes.
- An infiltration rate of 5 x 10^{-5} m/s in FSAs and soakwells has been assumed. An additional 50% clogging is assumed for BRAs to allow for sedimentation.

- Volumes leaving the system through evapotranspiration were assumed to be negligible when compared to the total runoff volume and since the duration of model run was comparatively short. XPStorm default evapotranspiration assumptions are therefore used.

3 Results

The results of the modelling for the Barfield Road LSP are presented in **Table 3, Table 4** and **Table 5,** and illustrated in **Figure 1**. **Table 3** includes the total assumed volumes of soakage pit storage within the road network upstream of each BRA.

Table 3 1 year 1 hour ARI event storage

BRA	Soakage pit storage volume (m^3)	BRA design detail		
		Depth (m)	Volume (m^3)	Surface area (m^2)
BRA C	15	0.5	350	864
BRA F	36	0.5	505	1206
BRA H	20	0.5	250	640

Table 4 100 year ARI event storage

FSA	Depth (m)	Volume (m^3)	Surface area (m^2)
FSA C	1.2	1845	2134
FSA F	1.2	1985	2271
FSA H	1.2	1250	1537

Table 5 5 year and 10 year ARI event storage

FSA	5 year ARI event			10 year ARI event		
	Depth (m)	Volume (m^3)	Surface area (m^2)	Depth (m)	Volume (m^3)	Surface area (m^2)
FSA C	0.63	795	1545	0.80	1070	1709
FSA F	0.66	917	1695	0.82	1197	1855
FSA H	0.66	553	1074	0.83	737	1205

FIGURES

Figure 1: Surface runoff modelling results

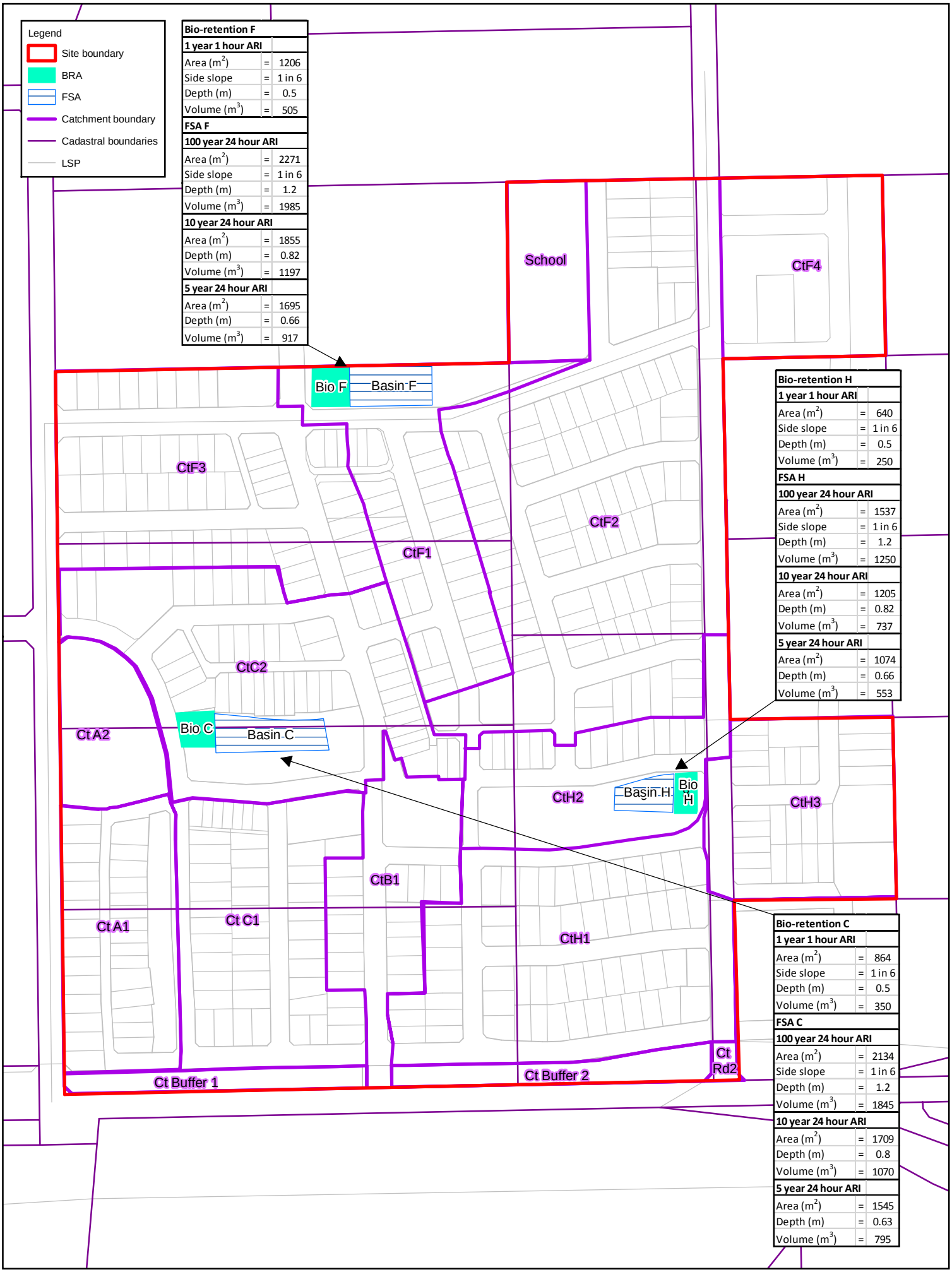


Figure 1: Surface runoff modelling results

Project: Barfield Road Local Structure Plan
Modelling Report

Client: Gold Estate Holdings

Plan Number: EP14-023(03)--F14

Drawn:	ADB	Date:	24/07/15
Approved:	DPC	Date:	24/07/15
Checked:	RLE	Scale:	1:3,800@A4

0 37.5 75 150 Metres

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Document Reference: EP14-023(04)—034B AJI

Emerge contact: David Coremans

7 February 2025

Attention: Peter Dockett
Richard Noble
Level 1, 189 Hay Street
Subiaco WA 6008

Delivered by email to: pdockett@rnoble.com.au

Dear Peter

VIVENTE LOCAL STRUCTURE PLAN – LOCAL WATER MANAGEMENT STRATEGY ADDENDUM

Emerge Associates have prepared this letter report as an addendum to the approved *Barfield Road Local Structure Plan (LSP) Local Water Management Strategy (LWMS)* (Emerge Associates 2013) and previous *LWMS addendum* (Emerge Associates 2015a) to incorporate the proposed amendments to the Barfield Road LSP. Since further subdivision approval, the LSP area has been renamed to '*Vivente'*, therefore from herein, the LWMS addendum will be referring to the Vivente LSP area.

1 BACKGROUND

Vivente is located in Hammond Park in the City of Cockburn (CoC), as illustrated in the attached **Figure 1**. The current, approved LSP incorporates Lots 13, 14, 15, and 18 Barfield Road and 48 - 51 Frankland Avenue. The proposed amendment of the Vivente LSP facilitates the inclusion of Lot 16 Barfield Road, as illustrated in the attached **Figure 2**. The 'site' refers to the amended Vivente LSP area, inclusive of Lot 16. A copy of the proposed amendment to the LSP and the Lot 16 subdivision concept is provided in **Attachment A**.

Emerge Associates have prepared this letter report to provide a summary of the changes to water management across the site required to incorporate the proposed LSP amendments. This letter report should only be read in conjunction with the approved *Barfield Road LSP LWMS* (Emerge Associates 2013) and the previous *LWMS addendum* (Emerge Associates 2015a).

The water conservation and groundwater management criteria and measures for the amended LSP area are consistent with those detailed in the approved *Barfield Road LSP LWMS* (Emerge Associates 2013) and are therefore not detailed in this letter report.

The storm water management criteria for the site are detailed in the approved *Barfield Road LSP LWMS* (Emerge Associates 2013). The stormwater management measures proposed for the amended LSP are consistent with those presented in the LWMS.

The key stormwater management parameters related to drainage design are to:

Criteria SW1 Retain runoff from the 1% Annual Exceedance Probability (AEP) event on site.

Criteria SQ1 Retain and treat the 1 event per year (EY) rainfall event on site.

2 SURFACE RUNOFF MODELLING

As detailed in the *Barfield Road LSP LWMS* (Emerge Associates 2013), XPSWMM (hydrological and hydraulic modelling software) was used to determine the runoff volumes required to be retained on site in accordance with the stormwater management criteria.

The inclusion of Lot 16 will result in additional runoff being directed to the two basins located within Ct-F (see **Figure 3**). The configuration of these two basins were designed and constructed based on modelling assumptions provided in the *Barfield Road LSP Modelling Report* (Emerge Associates 2015b). The modelling was conceptual and not based on the final landscape design (which at that stage had not been completed). The final landscaped construction of these basins within Ct-F, resulted in two co-located bio-retention areas (BRA) and flood storage areas (FSA) within the Ct-F1 public open space (POS) area. The inclusion of Ct-F5 (Lot 16) increases the total catchment area of Ct-F to 17 ha (approximately 2 ha larger), and therefore the purpose of this addendum is to confirm that the already constructed BRAs and FSAs have capacity to provide the required treatment and flood storage for the existing and amended sub-catchments within Ct-F.

Given the original sizing of BRAs and FSAs were modelled using the 1987 Australian Rainfall and Runoff (ARR) guidelines (Engineers Australia 1987) and respective rainfall patterns, and adopted the conceptual approach which models a square basin, it is appropriate to update the XPSWMM model to be consistent with the most recent 2019 ARR guidelines (Ball J *et al.* 2019) and updated rainfall patterns, as well as to include the design contours of the already constructed BRAs/FSAs. Updating the model and resizing the FSAs with the actual design contours will better reflect the flood storage likely to occur and determine if additional capacity is required to accommodate the addition of sub-catchments Ct-F.

The lot assumptions for all single residential lots within Ct-F5 will retain the 20% AEP event within soakwells, as required by the CoC. All additional runoff from lots will either be infiltrated on lot in pervious garden areas or discharged to downstream retention areas. The runoff from lots assumed in the hydrological modelling (detailed in the modelling report, provided in **Attachment B**) equates to a runoff co-efficient of 0.2, required by CoC (S Hussain [CoC] 2015, pers. comm., July 13).

Since the *Barfield Road LSP Modelling Report* (Emerge Associates 2015b), a geotechnical investigation within Stage 3 (including the basin locations) was undertaken and found that the existing soils are capable of achieving very high infiltration rates, with results ranging between 63 m/day and 200 m/day. Therefore, the updated modelling report adopted the following infiltration rates for POS-F basin, as outlined within the *Modelling Assumptions Report* (Emerge Associates 2017) prepared to support the *Vivente Stage 3 UWMP addendum* (Emerge Associates 2018), which include:

- An infiltration rate of 25 m/day has been assumed in the FSA areas of the basin based on infiltration testing carried out in POS C post-landscape completion (detailed in the *Vivente Stage 3 UWMP addendum* (Emerge Associates 2017)).
- An infiltration rate of 3.5 m/day has been assumed in the BRA based on infiltration testing carried out in POS C post-landscape completion.

Based on the updated XPSWMM model results, the FSAs provide sufficient storage to accommodate the additional roads and <300 m^2 lots within catchment Ct-F5 (Lot 16) and still meet the relevant design criteria. This outcome was to be expected as the original modelled volume and area of FSAs were designed using conservative assumptions, and the additional contributing area within Ct-F5 is relatively minor (0.3 ha).

As shown in **Table 1**, the addition of Ct-F5 (Lot 16) increases the depth of the BRA (1 EY event) in Basin 1 to 20 mm higher than the depth without the inclusion of Ct-F5. This additional volume will spill over into the BRA of Basin 2 and due to the shallow depth, large surface area and high infiltration rates (25 m/day) of Basin 2, the additional volume will readily be infiltrated.

The flood storage requirements can be achieved within the existing FSAs, as shown in **Figure 3** and **Table 1**. The required flood storage is 3 m^3 more than the 1,750 m^3 of storage achieved by the POS-F

basin design which is very minor, therefore the FSAs have sufficient storage to accommodate the additional runoff.

Table 1: Updated bio-retention and flood storage requirements for management of small, minor and major rainfall event

Basin location	Basin type	Small – First 15 mm/1EY			Minor – 20% AEP			Major – 1% AEP		
		Depth (m)	Surface area (m^2)	Volume (m^3)	Depth (m)	Surface area (m^2)	Volume (m^3)	Depth (m)	Surface area (m^2)	Volume (m^3)
POS F	Basin 1	0.52	1291	472	0.67	1830	700	0.99	2603	1417
	Basin 2	0.00	270.60	0.02	0.47	465	171	0.79	561	336
	Total	0.52*	1561	472	1.14	2295	871	1.780	3164	1753

**Maximum water depth*

Summary and closing

Based on the updated XPSWMM modelling, the already constructed FSAs within POS-F have sufficient storage to accommodate the additional runoff resulting from the minor amendment to the Vivente LSP Lot 16. The summary of updated flood storage requirements, as shown in **Table 1** and **Figure 3**, demonstrates that the criteria presented in the approved *Barfield Road LSP LWMS* (Emerge Associates 2013) and previous *LWMS addendum* (Emerge Associates 2015a) can be achieved, and that the amendment of Lot 16 can be accommodated within the Vivente LSP area and specifically within POS-F.

Yours sincerely
Emerge Associates



David Coremans
DIRECTOR AND PRINCIPAL ENVIRONMENTAL CONSULTANT - HYDROLOGY

Figure: Figure 1 - Site location
Figure 2 - Proposed LSP amendments
Figure 3 – Stormwater Management Plan

Attachments:
Lot 16 Subdivision Concept Plan
Vivente Updated LSP Modelling Report

General References

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M and Testoni I (Editors) 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia (Geoscience Australia).

Emerge Associates 2013, *Barfield Road Local Structure Plan Local Water Management Strategy*.

Emerge Associates 2015a, *Barfield Road Local Structure Plan Local Water Managment Strategy Addendum*.

Emerge Associates 2015b, *Barfield Road Local Structure Plan Modelling Report*.

Emerge Associates 2017, *Modelling Assumptions Report - Vivente, Hammond Park*, EP14-023(03).

Emerge Associates 2018, *Vivente Stage 3 Urban Water Management Plan* EP14-023(08)--028, A.

Emerge Associates 2023, *Vivente Local Structure Plan - Local Water Management Strategy Addendum* EP14-023(04)--034 AJI, Version 1.

Engineers Australia 1987, *Australian Rainfall and Runoff*, National Committee for Water Engineering, Canberra.

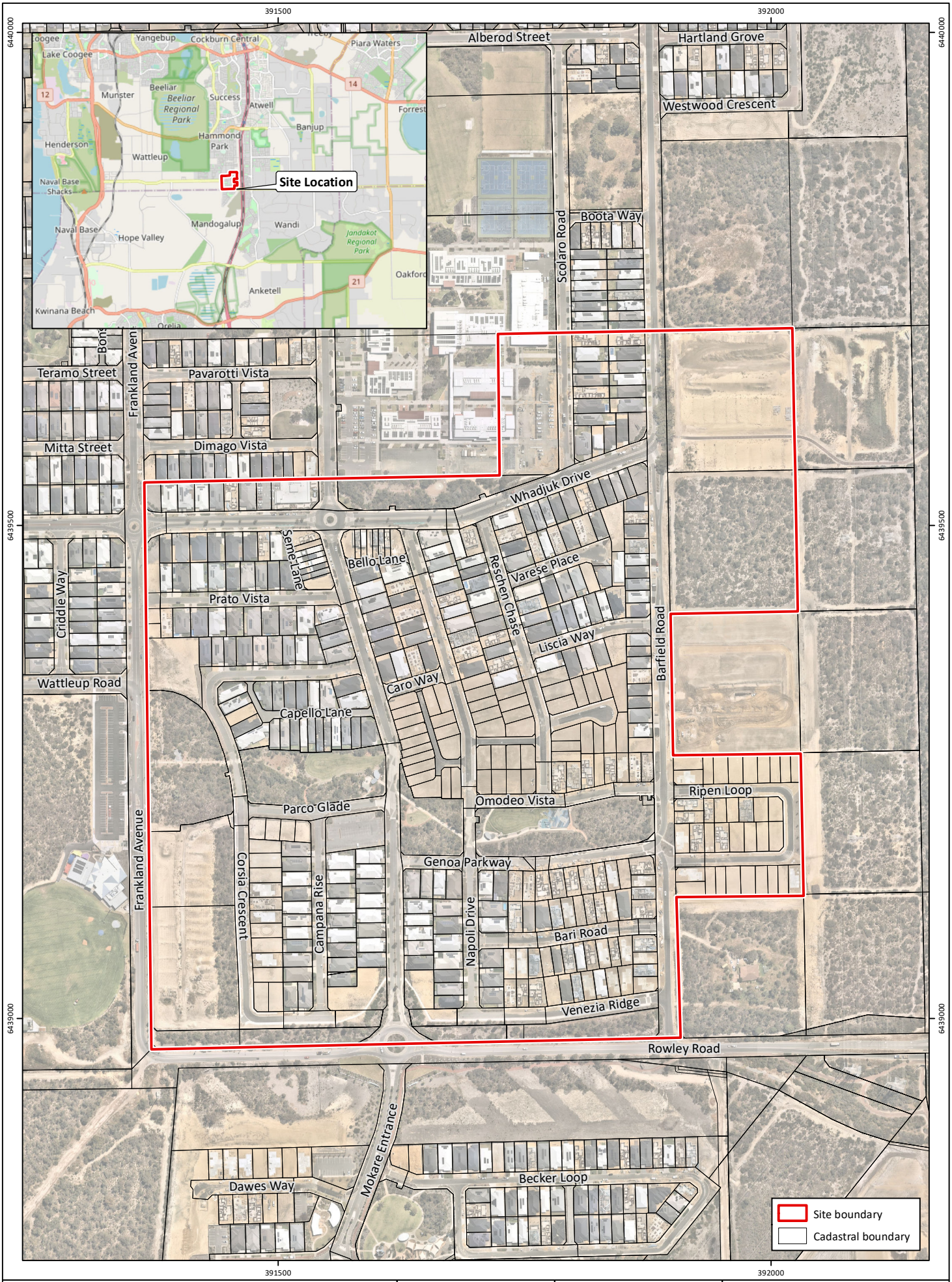


Figure 1: Site Location

Project:	Local Water Management Strategy Addendum Vivente Structure Plan Support
Client:	Richard Noble

Plan Number:
EP14-023(04)--F40

Drawn:	GAR
Date:	02/02/2023
Checked:	AJI
Approved:	DPC
Date:	08/02/2023

N

0 50 100
Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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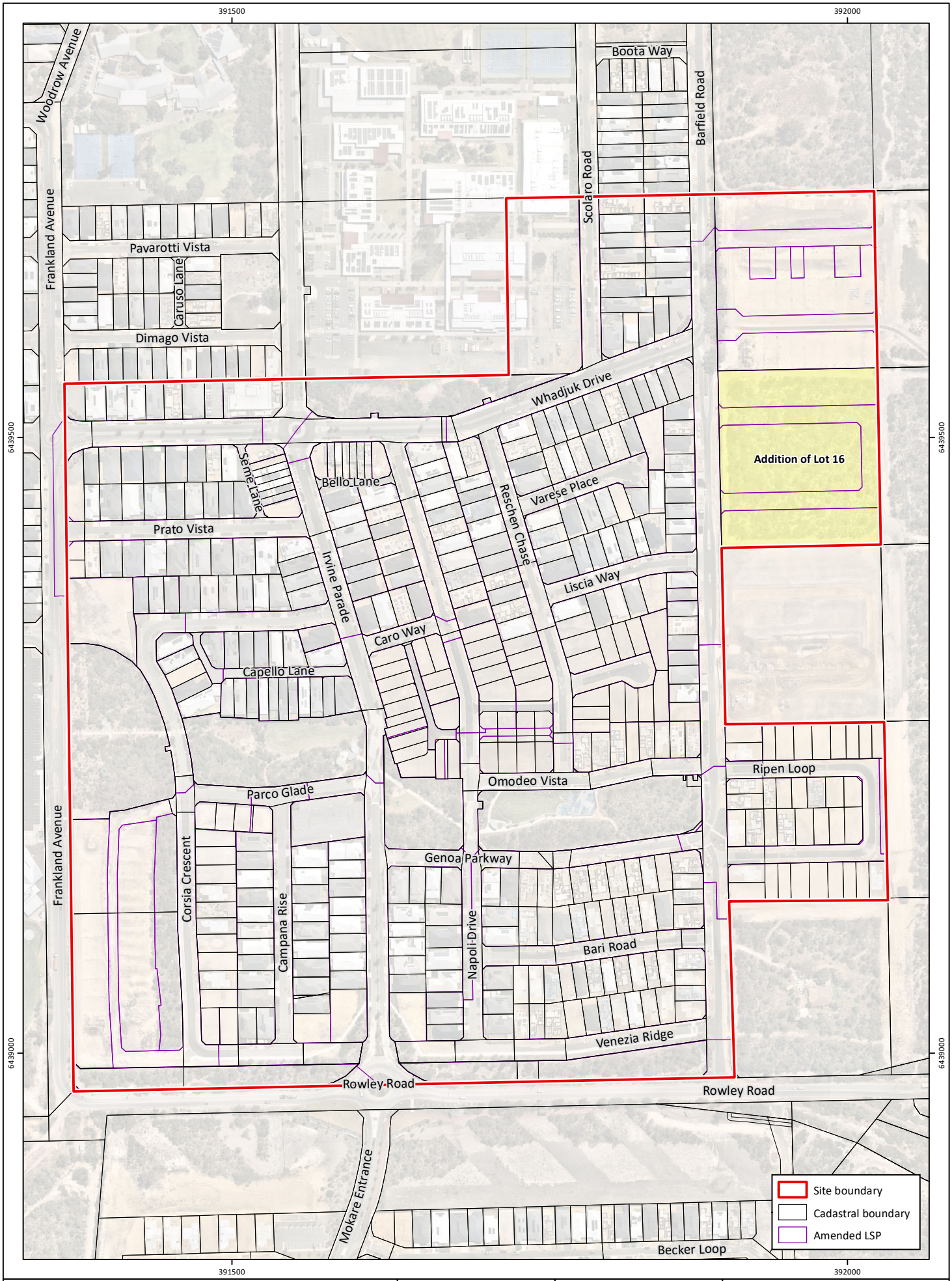


Figure 2: **Site Boundary with LSP Amendments**

Project: Local Water Management Strategy Addendum
Vivente Structure Plan Support

Client: Richard Noble

Plan Number: EP14-023(04)--F41

Drawn:	GAR
Date:	02/02/2023
Checked:	AJI
Approved:	DPC
Date:	08/02/2023

N

0 40 80
Metres

Scale: 1:4,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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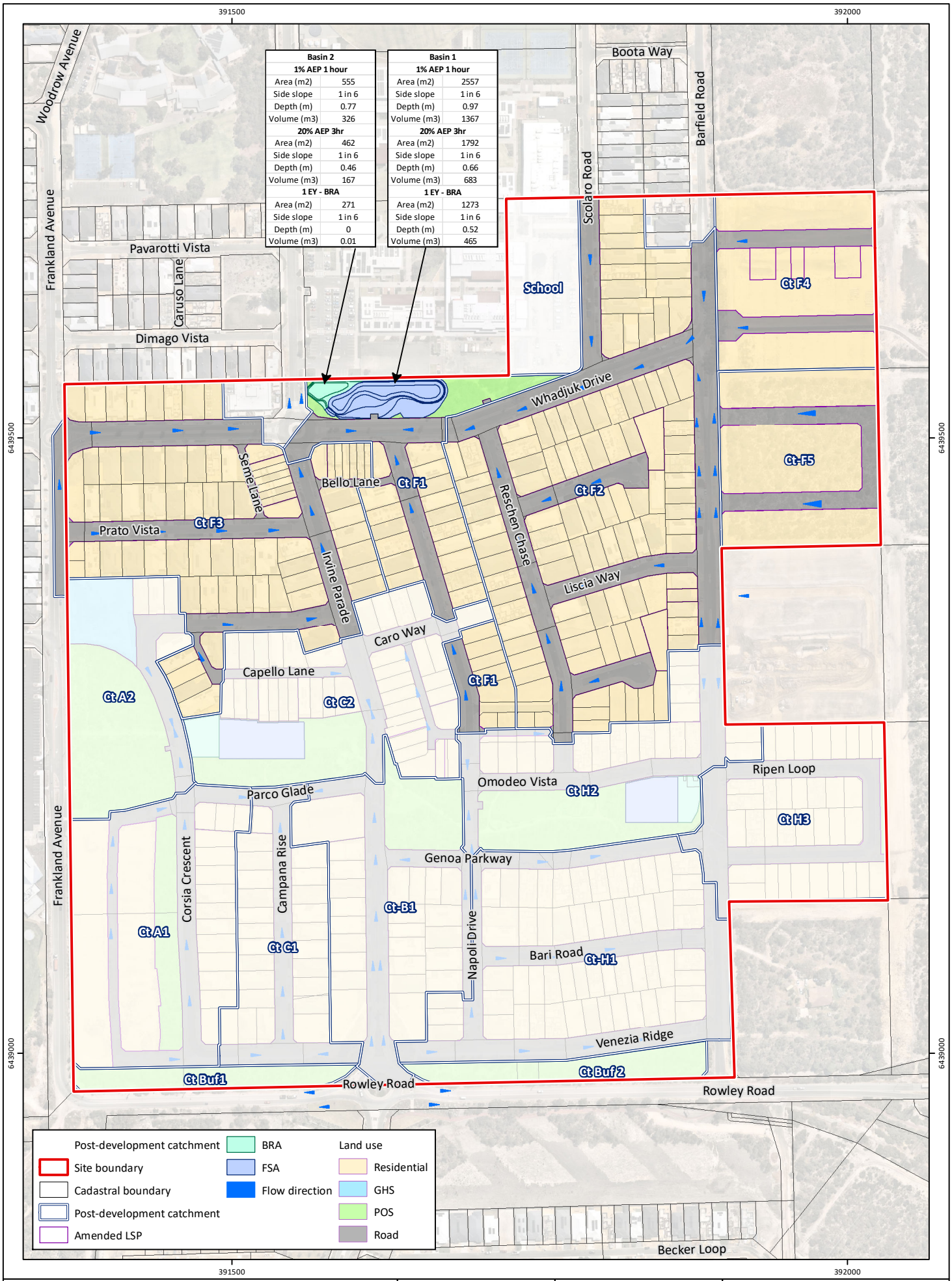


Figure 3: Stormwater Management Plan

Project: Local Water Management Strategy Addendum
Vivente Structure Plan Support
Client: Richard Noble

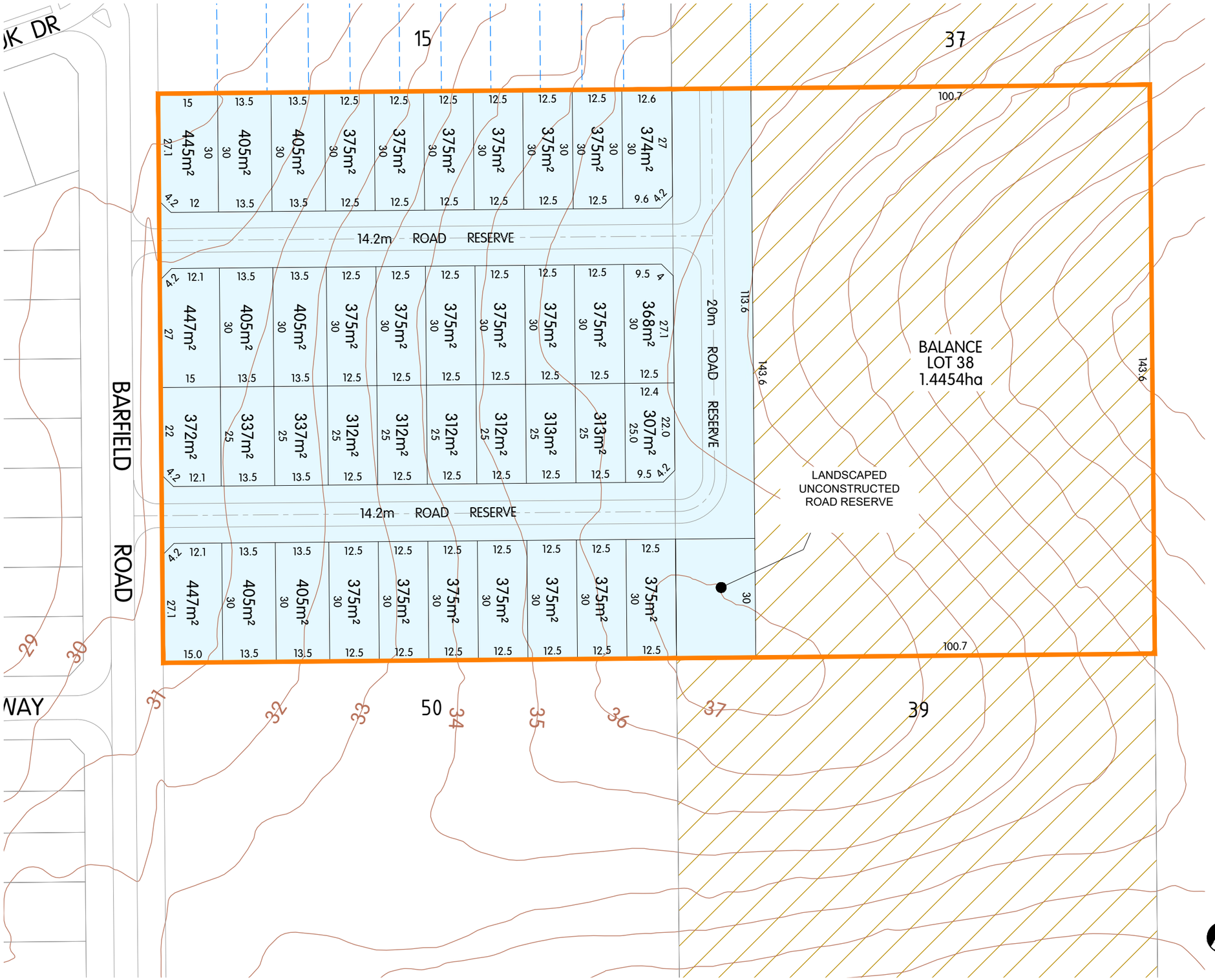
Plan Number: EP14-023(04)--F42
Drawn: GAR
Date: 02/02/2023
Checked: AJI
Approved: DPC
Date: 08/02/2023

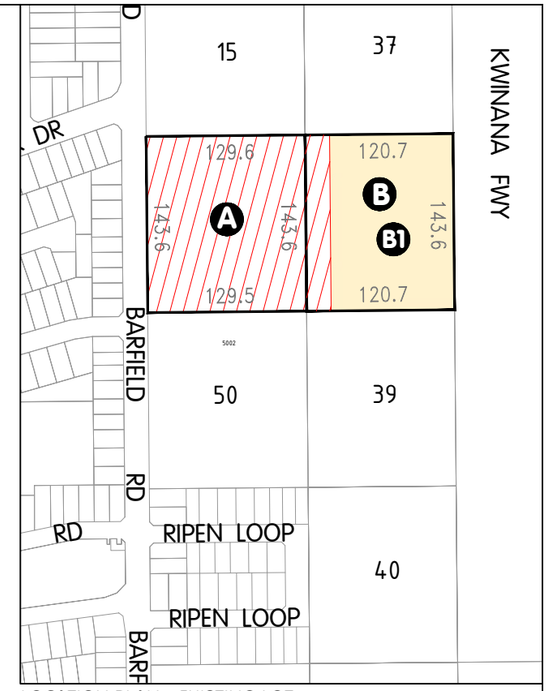
N

0 40 80
Metres
Scale: 1:4,000@A4
GDA 1994 MGA Zone 50

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LOCATION PLAN - EXISTING LOT

- EXISTING LOT 16 — A 1.8606ha
- EXISTING LOT 38 — B 1.7326ha
- PROPOSED SUBDIVISION
- BALANCE LOT 38 — B1 1.4454ha

LEGEND

- SUBJECT LOTS
- EXISTING LOT BOUNDARY
- 50 EXISTING LOT NUMBERS
- PROPOSED SUBDIVISION
- 52 EXISTING CONTOURS
- EXISTING EASEMENTS

YIELD TABLE

Existing Lots	2
Proposed Lots	
Residential (Single)	40
Balance of Title	1
TOTAL	**41**

PROPOSED LAND USE/DEVELOPMENT

Zone	Lot Size	No. of Lots
Residential	235m² - 319m²	7
Residential	320m² - 449m²	33
Other	1ha - 2ha	1
	TOTAL	**41**

RICHARDNOBLE
PROPERTY INTEGRITY COMMUNITY

CADASTRAL INFORMATION
SOURCE: MNG
YYMMDD: 220408
DWG REF: 96326lots-9999bn-PCG94
PROJECTION: PCG94

AERIAL PHOTOGRAPHY
SOURCE: NA
YYMMDD: NA

HATCH | RobertsDay

SIZE A3_ 1:1000
0 metres 10 20 30 40 50

SUBDIVISION PLAN
Lot 16 Barfield Road
City of Cockburn

REF NO. **RIC HAM**
DRAW NO. **RD1 412**
REV. **G**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY.

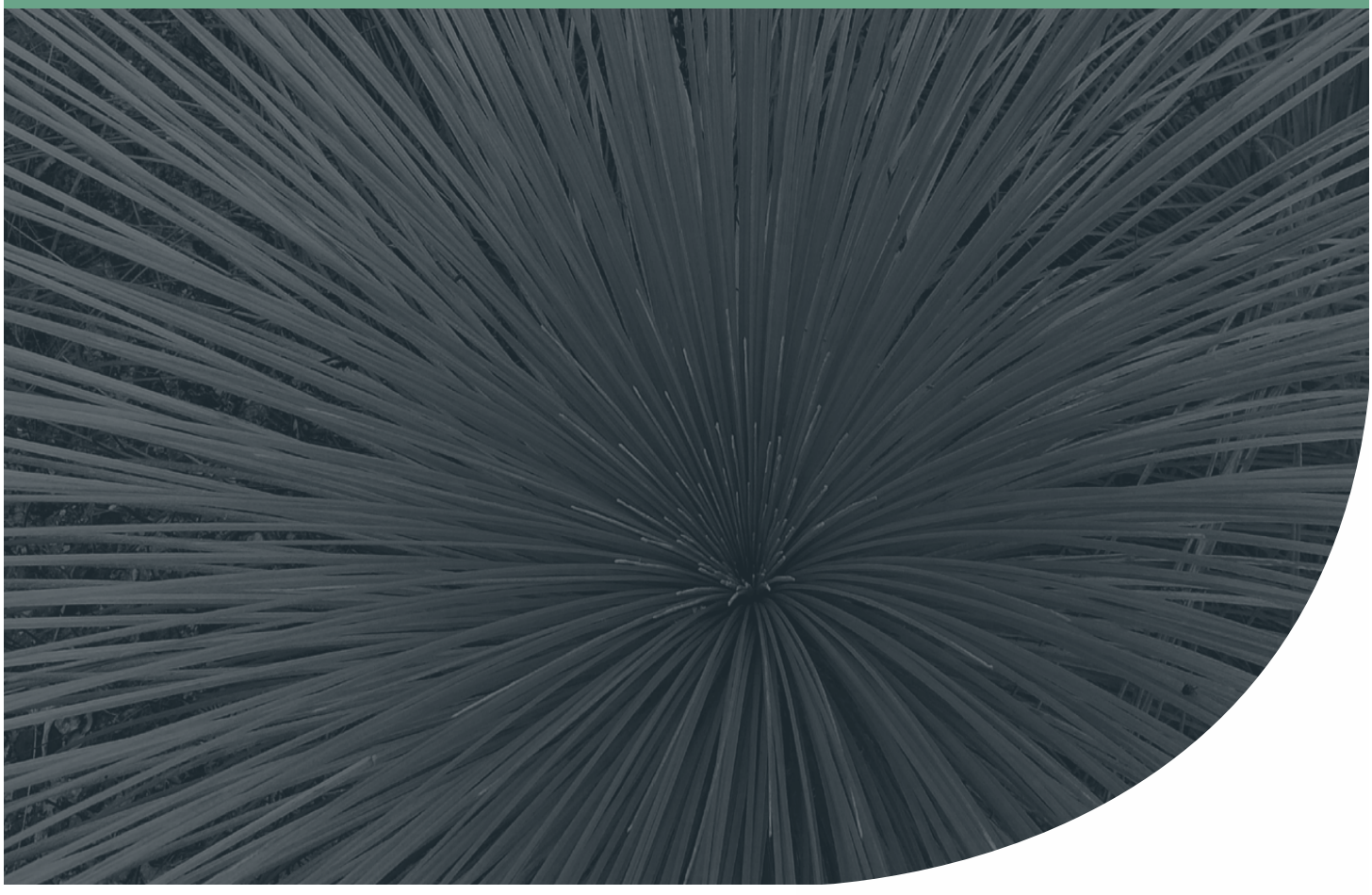
emerge ASSOCIATES
Integrated Science & Design

Modelling Assumptions Report

Vivente, Hammond Park

Project No: EP14-023(03)

Prepared for Richard Noble
February 2023



Document Control

Doc name:	Modelling Assumptions Report Vivente, Hammond Park				
Doc no.:	**EP14-023(03)--035**				
Version	**Date**	**Author**		**Reviewer**	
1	February 2023	April Irwin	AJI	Dave Coremans	DPC
	For inclusion as appendix to LWMS addendum				

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1 Background

This report provides a summary of the detailed hydrological and hydraulic modelling that was undertaken to inform the Vivente Local Structure Plan Area (LSP) Local Water Management Strategy (LWMS) addendum. The current, approved LSP incorporates Lots 13, 14, 15, and 18 Barfield Road and 48 - 51 Frankland Avenue. The proposed amendment of the Vivente LSP facilitates the inclusion of Lot 16 Barfield Road, and the inclusion of Lot 16 will increase the LSP area to 38.24 ha.

2 Methodology

XPSWMM hydrological and hydraulic modelling software was used to calculate the surface water runoff volumes. The hydrological component of the software uses the Laurenson non-linear runoff-routing method to simulate runoff from design storm events. Key assumptions regarding the hydrological model include:

- Runoff is proportional to slope, area, infiltration and percentage of imperviousness of a catchment.
- Sub-catchment areas and slopes are determined from surveyed topographical data and earthworks plans.
- Infiltration rates and percentage imperviousness have been selected based on experience with model preparation for similar soil conditions.

Runoff from each sub-catchment is routed through the catchment using the hydraulic component of XPSWMM. Assumptions associated with the hydraulic component of the model include:

- Virtual links (i.e. purely for model construction, not equivalent to flow path onsite) between nodes within a sub-catchment are given the length of 10 m and slope of 0.05 to minimise the lag time of conveying the water from a sub-catchment node to a 'storage' node, a 'dummy intermediate' node or a conduit/link.
- Links between sub-catchment storages act as conveyance channels (e.g. sheet flow within roads in a 1% annual exceedance probability (AEP)). These links are given lengths and slopes that are representative of the site conditions and actual pathway lengths between catchments.
- All channels are designed with a width of 5 m, roughness of 0.014 (Manning's n) and are trapezoidal in shape. This allows for easy conveyance and represents concrete pipes and road surfaces within the model.
- Soakwells are modelled as nodal-reservoirs with infiltration depth-rating curves.
- Minimum ponding conditions of less than the 5% from the total volume have been allowed within 1 event per year (EY) event storage nodes for events greater than the 1 EY event.
- Where relevant roadside swales, bio-retention areas (BRAs), and flood storage areas (FSAs) are modelled as nodal-reservoirs with infiltration depth-rating curves to account for differential infiltration rates with changing depth.

2.1 Rainfall

The superceded 1987 Australian Rainfall and Runoff (AR&R) (Engineers Australia 1987) rainfall patterns used in previous model revisions were updated to include the 2019 ensemble temporal patterns obtained from the AR&R Data Hub (AR&R 2019) to perform the rainfall analysis.

Up to eight durations ranging between 1 hour and 72 hours were tested, with the peak flood elevation being assessed as the determining result.

Following the process suggested by AR&R (Ball J et al. 2019), the highest mean duration was selected as the critical duration. AR&R also recommends that when it is not practical to run the entire ensemble array, the ensemble that produces the result closest to the mean (for the critical duration) should be adopted. The 1 hour duration ensemble 7 and the 3 hour duration ensemble 1 was adopted for the 1% AEP and 20% AEP events respectively.

3 Post-development Model

A breakdown of the existing post-development catchments within the site are shown within **Table 1**, including the additional land types due to the inclusion of Ct-F5.

Table 1: Post-development catchment areas

Catchment	Road (ha)	POS (ha)	Lots > 300 (ha)	Lots ≤ 300 (ha)	Group housing (ha)
CtA1	0.720	0.352	1.756	0.062	0.000
CtA2	0.278	0.965	0.217	0.000	0.258
CtB1	0.694	0.398	1.224	0.000	0.217
CtC1	0.586	0.000	1.075	0.015	0.000
CtC2	0.481	0.774	1.336	0.262	0.000
CtF1	0.684	0.564	0.911	0.048	0.000
CtF2	2.629	0.000	4.056	0.000	0.604
CtF3	1.306	0.000	2.780	0.048	0.000
CtF4	0.406	0.000	1.230	0.000	0.161
CtF5	**0.49**	**0.000**	**1.411**	**0.000**	**0.000**
Ct H1	1.267	0.000	2.254	0.125	0.066
Ct H2	0.542	0.864	0.371	0.108	0.000
Ct H3	0.522	0.000	1.010	0.000	0.525
BUF1	0.000	0.393	0.000	0.000	0.000
BUF2	0.000	0.490	0.000	0.000	0.000
Rd 2	0.066	0.000	0.000	0.000	0.000
Total	10.671	4.800	19.631	0.668	1.830

**Highlight indicates the additional catchment and land types from the inclusion of CTF5 (Lot 16)*

An “initial loss - continual loss” infiltration model was adopted to represent the post-development environment, with loss values chosen based on project team experience with similar land types to those found within the site. Post-development catchment parameters are provided in **Table 2**.

Table 2: Post-development catchment parameters

Land type	Initial loss (mm)	Continual loss (mm/h)	Manning's number (n)
Road surface	1	0.1	0.14
Road verge	12	2.0	0.05
Roof	1	0.1	0.14
Lot impervious	1	0.1	0.02
Gardens	25	3.5	0.05
POS	20	3	0.05

The infiltration rates used in the post-development model were predominantly based upon the following assumptions:

- Land use assumptions
  - Residential lots > 300 m^2 will have 50% roof areas, 20% front yard and 30% back yard. The front yard has been assumed to be 100% impervious with all flows from this area being directed to downstream drainage areas. This assumption is in response to the City of Cockburn (CoC) requirement for a 0.2 runoff co-efficient from lots of this size (S. Hussain [CoC] 2015, pers. comm. 22nd July).
  - Group housing and high density lots (lots ≤ 300 m^2) will have 50% roof areas with the remainder of the lots paved (45%) and pervious garden (5%).
  - Road reserve contains 60% pervious verge and 40% impervious bitumen areas with road verges having an initial loss of 12 mm (i.e. overall road reserve has an equivalent runoff coefficient of approximately 0.9).
  - The road verge area is similar in characteristics to POS areas except that it will also have an impervious footpath and some driveway crossovers. Therefore the average initial loss will be lower than POS initial loss rates.
- Lot retention assumptions
  - Residential lots > 300 m^2 will provide onsite retention for roof and back garden runoff from the 1% AEP event, with soakwells sized to retain the 20% AEP event consistent with CoC building design guidelines. Runoff from the front garden will be conveyed to downstream retention areas within the road drainage network and public open space (POS) areas.
  - High density lots (≤ 300 m^2) will retain the 1% AEP event from the rear pervious garden areas (5%) with soakwells sized to retain the 20% AEP storm event consistent with CoC building design guidelines. All additional runoff will be conveyed to downstream retention areas via the road network.
  - Group housing lots will provide retention for the 1 EY event onsite. Pervious areas of group housing lots will retain the 1% AEP event runoff within the lot.
- Catchment infiltration assumptions
  - There will be no infiltration on roads, pavements and driveways. There will however be some minor absorption storage loss and this is accounted for in the initial and continuing loss values.
  - Garden areas will have high infiltration rates as it is likely that sand or mulch will be used.

  - POS areas will likely contain dense vegetation or turf over a sand-based landscape mix. It is anticipated that the infiltration losses allowed for in the initial loss and continual loss will be higher than the rate of runoff accumulation from the 1 EY event.
- Storage assumptions
  - Side entry soakage pits (SEP), bio-retention areas (BRAs) and the first two rows of subsurface storage cells (within catchment H) will retain runoff from the 1 EY event from road reserves, residential lot drive ways and high density lots.
  - Major event runoff (up to the 1% AEP event) will be retained within flood storage areas (FSAs).
  - The existing basin designs have been accounted for within the model and has indicated a maximum depth of 1.2 m.
- Storage infiltration assumptions
  - POS F
    - An infiltration rate of 25 m/day has been assumed in the FSA areas of the basin based on infiltration testing carried out in POS C post-landscape completion (detailed in the *Vivente Stage 3 UWMP addendum* (Emerge Associates 2017a)).
    - An infiltration rate of 3.5 m/day has been assumed in the BRA based on infiltration testing carried out in POS C post-landscape completion.
- Volumes leaving the system through evapotranspiration are assumed to be negligible when compared to the total runoff volume and since the duration of model run is comparatively short. XPSWMM default evapotranspiration assumptions are therefore used.

4 References

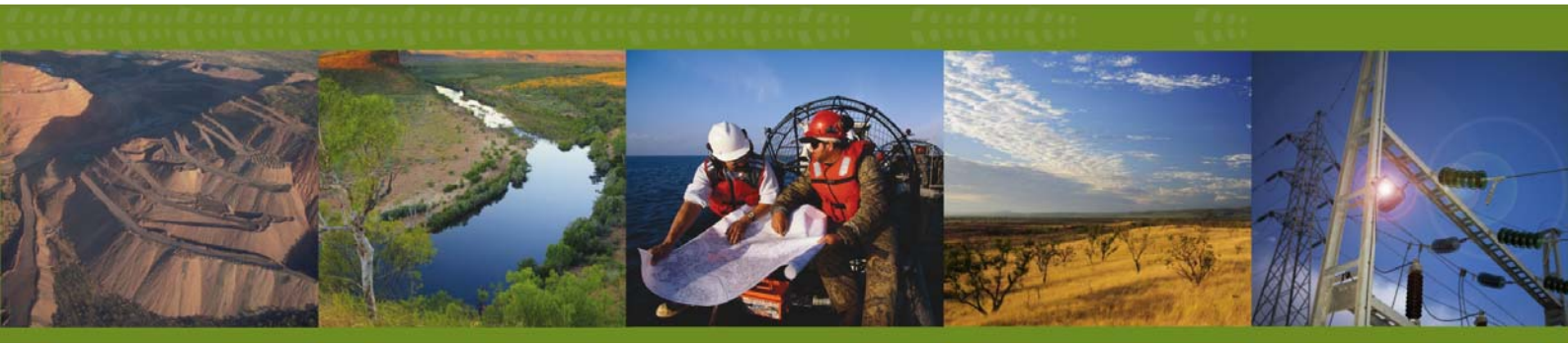
Emerge Associates 2015, *Vivente Stage 1 Urban Water Management Plan*, August 2015.

Emerge Associates 2017a, *Vivente Stage 3 Urban Water Management Plan Addendum*, November 2017.

Emerge Associates 2017b, *Vivente Stage 8 Urban Water Management Plan Addendum*, November 2017.

Engineers Australia 1987, *Australian Rainfall and Runoff*, National Committee for Water Engineering, Canberra.

Appendix 3A - Bushfire Management Plan



Fire Management Plan

Barfield Road Local Structure Plan

Prepared for
Richard Noble
by Strategen

August 2015

STRATEGEN
environmental consultants

Fire Management Plan

Barfield Road Local Structure Plan

Strategen is a trading name of
Strategen Environmental Consultants Pty Ltd
Level 2, 322 Hay Street Subiaco WA
ACN: 056 190 419

August 2015

Limitations

Scope of services

This report ("the report") has been prepared by Strategen Environmental Consulting Pty Ltd (Strategen) in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen has also not attempted to determine whether any material matter has been omitted from the data. Strategen will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen. The making of any assumption does not imply that Strategen has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

Client: Richard Noble

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Draft Report	Rev A	For review by client	Z Cockerill / R Banks	Electronic (email)	10/05/2013
Final Draft Report	Rev 0	For review by City of Cockburn and DFES	Z Cockerill	Electronic (email)	21/05/2013
Final Report	Rev 1	Issued for use: submission to City of Cockburn and DFES	Z Cockerill	Electronic (email)	6/08/2013
Final Report	Rev 2	Issued for use: for submission to WAPC to address LSP Schedule of Modifications	Z Cockerill	Electronic (email)	3/11/2014
Final Report	Rev 3	Issued for use: to support revised LSP for submission to City of Cockburn	P Molinari / Z Cockerill	Electronic (email)	17/07/2015
Final Report	**Rev 4**	**Issued for use: to address City of Cockburn comments**	**Z Cockerill**	**Electronic (email)**	**14/08/2015**

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1. Introduction

1.1 Background

Gold Estates Holdings Pty Ltd, in association with Department of Housing (DoH), is proposing to implement the Barfield Road Local Structure Plan (LSP). The LSP applies to eight properties across a 35 ha vegetated site, including Lots 13, 14, 15 and 18 Barfield Road and Lots 48–51 Rowley Road, located at Hammond Park in the City of Cockburn (the Project Area).

The LSP outlines proposed development of the Project Area and provides for a mix of residential, public purpose, and community land uses, with additional areas of Public Open Space (POS) (Figure 1).

There is an inherent bush fire risk to future assets of the development from surrounding permanent and temporary bush fire hazard areas. As such, Strategen has been commissioned to prepare this Fire Management Plan (FMP) to support the Barfield Road LSP and address the requirements for bush fire preparedness and bush fire damage mitigation. City of Cockburn (CoC) has confirmed that an FMP will be required to support the proposed LSP development prior to approval.

This FMP has been prepared in accordance with *Planning for Bush Fire Protection Guidelines (Edition 2)* (the Guidelines; WAPC et al. 2010) to support the Barfield Road LSP. The FMP is for submission to CoC, Department of Fire and Emergency Services (DFES) and Western Australian Planning Commission (WAPC). A completed FMP compliance checklist is contained in Appendix 1.

1.2 Purpose and application of the document

The purpose of the FMP is to provide guidance on how to plan for and manage the potential bush fire risk to future assets of the Project Area through recommendation of a range of bush fire management measures. The FMP outlines how on-site assets can be protected during the summer months when the threat from bush fire is at its peak. This is particularly relevant when existing fire appliances in the area may be unable to offer an adequate emergency suppression response. Therefore, the developer should aim to ensure site assets are self-protecting from bush fire.

Implementation of the FMP is a shared responsibility between the developer, CoC and prospective landowners to ensure bush fire management measures are adopted and implemented on an ongoing basis to achieve bush fire management objectives.

1.3 Stakeholder consultation

Strategen has facilitated consultation between the developer, CoC, DFES and WAPC to ensure aims and objectives of the FMP are in accordance with stakeholder expectations and the FMP maintains compliance with the Guidelines.

1.4 Document review

This plan will be updated on an annual basis, as required, following the date of approval. The plan will be revised every five years following the date of approval to ensure:

1. Implementation of the FMP is assessed and corrective actions are applied in cases of non-compliance.
2. The effectiveness and impact of fire prevention work is evaluated.

The developer will be responsible for updating the FMP annually as required until the development has been fully implemented. Five yearly review of the FMP will be the responsibility of the developer until the development has been fully implemented, after which time CoC will be the authority responsible for the five yearly review.

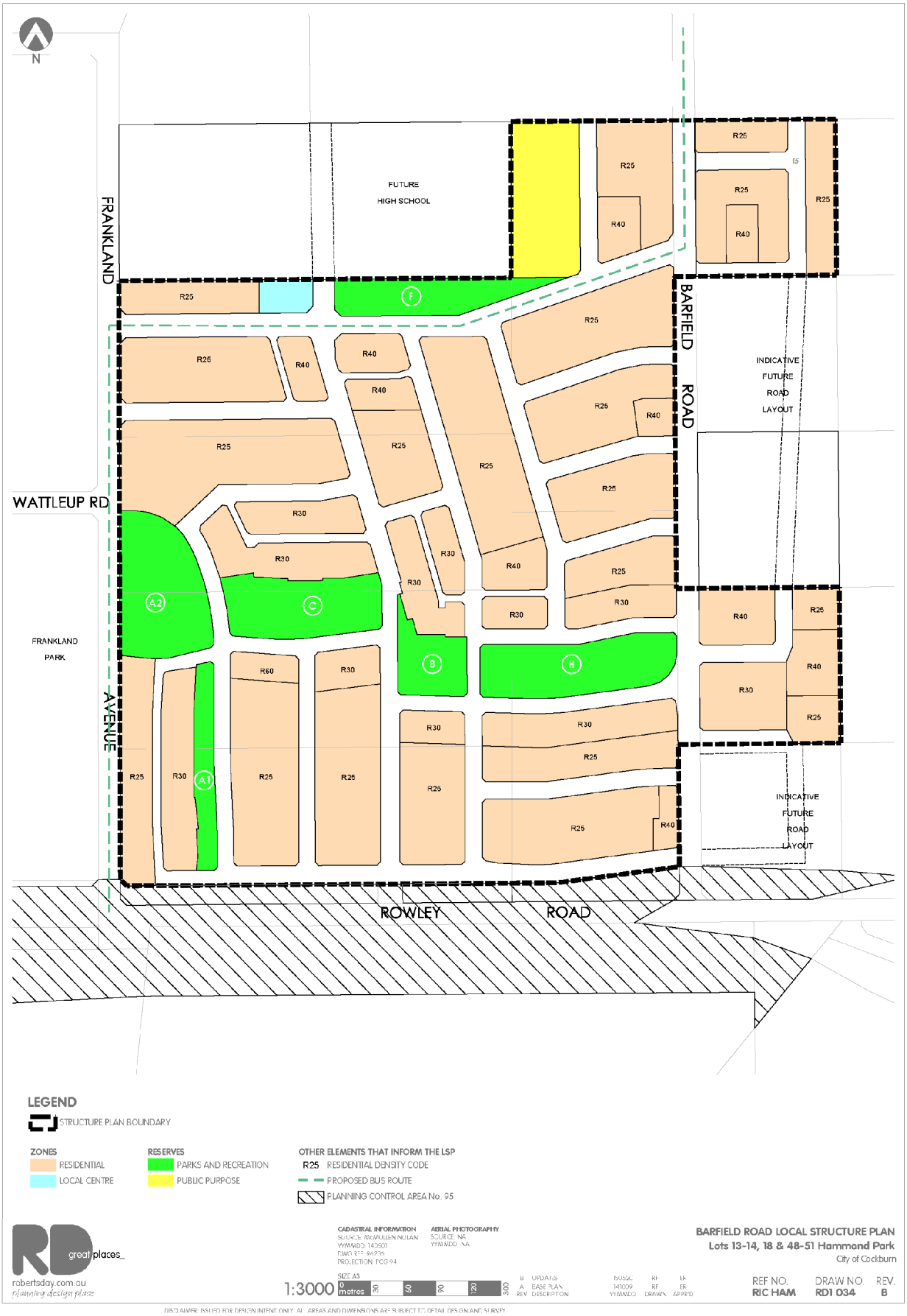


Figure 1 Barfield Road Local Structure Plan

Date: 25/06/2015
Author: JCrute
Source: Client 2015.

Path: Q:\Consult\2014\RDP\RDP14301\ArcMap_documents\R001\RevA\RDP14301_01_R001_RevA_F001.mxd

2. Aim and objectives

2.1 Aim

The FMP aims to achieve a reduction in the occurrence of uncontrolled bush fires and minimise potential impacts on life, property and environmental assets of the proposed LSP development through the following:

- quantifying the bush fire hazard and assessing the bush fire risk to the Project Area
- documenting bush fire prevention requirements of the Project Area to provide ongoing protection to future residents, visitors and built assets of the subject land
- identifying bush fire protection issues, appropriate strategies and those persons and/or organisations who have a responsibility to implement the FMP
- complying with the Guidelines and maintaining compatibility with bush fire management on neighbouring subdivisions
- providing guidance for the developer, CoC and prospective landowners to protect the subject land and on-site assets in the event that fire appliances may not be available to offer an adequate bush fire suppression response.

2.2 Objectives

Key objectives of the FMP and the relevant section/s of this document in which they are addressed are outlined in Table 1.

Table 1: Key objectives of the FMP

Objective	Section
Define areas where values are located	Section 3.7
Define and rank fire hazard areas	Section 4.2.1
Nominate individuals and organisations responsible for fire management and associated works within the Project Area	Section 5.13
Propose fire management measures for the Project Area, with due regard for life, property and the environment	Section 5
Define an assessment procedure that will evaluate the effectiveness and impact of proposed, as well as existing fire prevention work and strategies	Section 6.3
Provide performance criteria and acceptable solutions for all fire management works (e.g. firebreaks, low fuel areas and building construction standards)	Section 4.2.2

3. Description of the area

3.1 General overview

3.1.1 Project Area

The Project Area is located approximately 25 km south of the Perth Central Business District within the southern municipal boundary of the City of Cockburn (Figure 2). The Project Area consists of approximately 35 ha of vegetated land across eight properties situated at Lots 13, 14, 15 and 18 Barfield Road and Lots 48–51 Rowley Road, Hammond Park (Figure 3). The Project Area is bound by:

- Frankland Avenue, Frankland Reserve and private properties zoned for future urban development to the west
- Rowley Road (City of Cockburn/City of Kwinana boundary) and private properties zoned for future urban development to the south
- Barfield Road, private properties zoned for future urban development and a power-line corridor to the east
- private properties zoned for future urban development to the north.

Kwinana Freeway is located approximately 200 m east of the Project Area.

The Project Area comprises several existing dwellings, outbuildings and cleared areas, but is otherwise vegetated with banksia-Sheoak low woodland in predominantly excellent condition (Ecoscape 2009).

The majority of the Project Area is proposed for residential development in accordance with the LSP, with other areas assigned for public purpose, local centre and POS (Figure 1).

POS will be provided throughout the development to meet standard POS requirements. All POS areas will be subject to varying degrees of landscaping, vegetation modification and fuel hazard reduction.

3.1.2 Adjacent land

The majority of land adjacent to the Project Area is currently vegetated with banksia-Sheoak low woodland (Figure 3). Frankland Reserve (No. 27057), located adjacent west of the Project Area, is considered the only vegetated area situated adjacent to proposed lots that will be retained in the long term and will subsequently pose a permanent bush fire risk to future assets of the Project Area.

An existing District Structure Plan and numerous Local Structure Plans are in place over the Hammond Park locality, which outline the direction for future urban development proposed to be implemented to the north, west, east and south of the Project Area. Implementation of these developments is expected to remove much of the surrounding vegetation extent and associated bush fire risk. However, the vegetation currently on these sites will pose a temporary bush fire risk to future assets of the Project Area until such time that it is cleared. A temporary bush fire risk is therefore contained within the following vegetated properties and subsequently requires a bushfire management response for the adjacent 100 m of proposed development:

- Lots 2 and 682 located adjacent south of the Project Area
- Lots 28, 16, 50, 39–41 and 301 located adjacent east of the Project Area
- Lots 47 and 31 located adjacent north of the Project Area
- Lot 126 located adjacent west of the Project Area.



Figure 2 Regional location

Scale 1:200,000 at A4

0 1 2 3 4 5 km

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 25/06/2015
Author: JCrute
Source: Topography: Geoscience Australia 2011.



Legend

- Town
- Major road
- Minor road
- Major river
- Lakes
- Project area boundary
- Native vegetation
- Local government boundary

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Figure 3 Project Area overview

Scale 1:7,000 at A4

0 50 100 150 m

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 25/06/2015

Author: JCrute

Source: Aerial image: Nearmap 2012. Concept plan: Client 2015.

Legend

- Railway
- Existing cadastre
- Project area boundary

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3.2 Local climate

The Project Area is located approximately 7 km from the nearest Bureau of Meteorology (BoM) weather station at Medina Research Centre (Station No. 9194) and experiences a temperate climate characterised by mild, wet winters and warm to hot, dry summers. Rainfall may occur at any time of year; however, most occurs in winter in association with cold fronts from the southwest. The mean annual rainfall since 1983 for Medina Research Centre is 765.6 mm (BoM 2012).

Table 2: Mean monthly climate statistics for Medina Research Centre

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)	30.6	31.4	29.4	25.6	22.1	19.3	18.3	18.8	20.2	22.5	25.9	28.0	24.3
Mean minimum temperature (°C)	17.0	17.5	15.9	13.3	10.5	9.1	8.2	8.0	9.1	10.3	13.4	15.0	12.3
Mean rainfall (mm)	12.2	20.1	18.3	40.3	97.5	148.3	147.9	114.2	76.3	40.2	32.1	10.6	765.6

Source: BoM 2012

3.2.1 Fire weather

Southwest Western Australia generally experiences a cool to mild growing season in the months of August through to November of each year, followed by four months of summer drought conditions, which is when the potential for bush fire occurrence is at its peak. The worst fire weather conditions occur during this dry period when a low pressure trough forms off the west coast and strong winds develop from the north or northeast. These conditions are sometimes associated with 'Extreme' or 'Catastrophic' fire danger indices, which are consistent with very high temperatures, low relative humidity and strong winds. These high fire risk conditions are considered to occur less than 5% of the time during the designated bush fire season.

Average 9:00 am and 3:00 pm January wind profiles for Medina Research Centre are contained in Appendix 2, which illustrate that the predominant winds during this high risk period are from the east and southeast in the morning averaging around 13 km/h; and from the southwest in the afternoon averaging around 20 km/h (BoM 2012). These dominant wind patterns are considered to occur 95% of the time during the designated bush fire season.

3.3 Landform and topography

The Project Area is located on the Swan Coastal Plain at the transition of the Spearwood and Bassendean Dune Systems (Churchward & McArthur 1980). Both systems are of Aeolian origin, with the Spearwood System to the west overlying the older Bassendean System to the east (McArthur & Bettenay 1960).

Topographic elevation at the site ranges from approximately 40 mAHD (Australian Height Datum) at the southwest corner to approximately 25 mAHD along the northern boundary (Figure 4). Site elevation generally decreases from south to north, but the decline is intercepted by small rises and depressions associated with numerous east-west and north-south orientated ridge lines.

The steepest slope of the site is parallel to the western boundary, where elevation decreases from west to east at slopes of up to 15 degrees. Adjacent vegetation to the east, north and west is located either on flat land or up-slope from the Project Area. Vegetation contained to the south of the Project Area (opposite Rowley Road) is located down-slope from the site at up to 5 degrees. These slope characteristics have been used to determine specified Bushfire Attack Levels (BALs) throughout the development (refer to Section 4.2.3).



Figure 4 Site topography

Scale 1:7,000 at A4

0 50 100 150 m

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 25/06/2015

Author: JCrute

Source: Aerial image: Nearmap 2012. Concept plan: Client 2015.

Legend

- Railway
- Surface elevation (mAHD)
- 100m wide assessment area
- Project area boundary

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3.4 Geology and soils

Soil landscape mapping undertaken by Department of Agriculture Western Australia (2005) indicates that the Project Area is contained within the Spearwood (211Sp) and Bassendean (212Bs) soil landscape systems. The Spearwood system comprises a core of Tamala Limestone with a hard capping of calcite (cap-rock) overlain by a variable depth of yellow to brown sands. The Bassendean system comprises low hills and intervening swampy areas, with iron or humus podzols (McArthur 1991). Soil landscape systems and their component subsystems are described in Table 3.

Table 3: Soils of the Project Area

Soil landscape system	Soil landscape subsystem	Description
Spearwood (211Sp)	Spearwood S1b phase	Dune ridges with deep siliceous yellow brown sands or pale sands with yellow-brown subsoil and slopes up to 15%
Bassendean (212Bs)	Bassendean B1 phase	Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than 2 m; banksia dominant

Source: AgWA 2005

3.5 Vegetation

3.5.1 Bioregional context

Interim Biogeographic Regionalisation for Australia (IBRA) divides Western Australia into 26 biogeographic regions and 53 subregions based on dominant landscape characteristics of climate, lithology, geology, landform and vegetation (McKenzie et al. 2003). The Project Area is situated within the Perth subregion of the Swan Coastal Plain bioregion, which is characterised by a low-lying coastal plain, mainly covered with woodlands. Banksia and Jarrah-banksia woodlands are the usual vegetation contained within the dune systems (McKenzie et al. 2003).

3.5.2 Vegetation and flora

The Project Area is situated within the Bassendean (Central and South) vegetation complex, which is described as ranging from woodland of *Eucalyptus marginata–Allocasuarina fraseriana–Banksia* spp., to low woodland of *Melaleuca* spp. and sedgelands on moister sites (Heddle et al. 1980).

Ecoscape undertook a Level 2 vegetation survey of the Project Area and verified the presence of one vegetation community, described as *Banksia* spp.*–Allocasuarina fraseriana* (Sheoak) low woodland (Ecoscape 2009). Vegetation was mostly in ‘excellent’ condition, but ranged to ‘completely degraded’ in areas associated with houses, sand mining and livestock grazing (Ecoscape 2009).

A list of key flora species recorded from three floristic quadrats sampled during the survey is provided in Table 4, along with vegetation conditions for each quadrat.

A total of 149 vascular plant species were identified during the survey, including 31 weed species (Ecoscape 2009). No Threatened or Priority listed flora species were recorded during the survey (Ecoscape 2009). In addition, the Project Area does not contain any Threatened or Priority Ecological Communities (Ecoscape 2009).

Table 4: Key species and vegetation condition

Floristic quadrat	Overstorey species	Midstorey species	Understorey species	Vegetation condition
1	*Banksia attenuata* and *Allocasuarina fraseriana* low woodland	*Xanthorrhoea preissii*, *A. humilis* and *Stirlingia latifolia* open dwarf scrub	*Hibbertia hypericoides*, *Petrophile linearis* and *Calytrix fraseri* dwarf scrub	Excellent
2	*Banksia menziesii*, *B. attenuata*, *B. ilicifolia* and *Allocasuarina fraseriana* low woodland	*Eremaea pauciflora*, *Stirlingia latifolia* and *Xanthorrhoea preissii* dwarf scrub	*Hibbertia hypericoides*, *Leucopogon conostephioides*, *Eremaea asterocarpa* subsp. *asterocarpa* and *Conostephium pendulum* dwarf scrub	Excellent
3	*Banksia attenuata*, *B. ilicifolia*, *Allocasuarina fraseriana* and *B. menziesii* low woodland	*Kunzea glabrescens* scrub over *Xanthorrhoea preissii* and *A. humilis* open low scrub	*Stirlingia latifolia* and *Hemiandra pungens* open dwarf scrub	Very good

3.5.3 Adjacent vegetation

The majority of land adjacent to the Project Area is partly or fully vegetated with banksia-Sheoak low woodland, similar to that contained within the Project Area.

3.6 Land use

3.6.1 Current zoning and land use

The Project Area is currently zoned 'Urban' under the Metropolitan Region Scheme (Figure 5) and 'Development' under provisions of the *City of Cockburn Town Planning Scheme No.3* (the Scheme, DPI 2012). The 'Development' zone provides for future residential, industrial or commercial development in accordance with a comprehensive Structure Plan prepared under the Scheme.

Lots 48–50 are fully vegetated and contain no infrastructure apart from boundary fencing and firebreaks. Lots 13, 14, 15, 18 and 51 contain various degrees of vegetation plus dwellings, outbuildings and areas of cleared land. Lot 18 is also currently being used for low intensity horse agistment (Roberts Day 2015).

3.6.2 Proposed land use

The LSP provides for a range of residential densities, a POS network, a local centre and a portion of land set aside to facilitate development of a high school to the north. Implementation of the proposed development will result in significant vegetation clearance across the site.

POS will be provided to meet standard POS requirements. The POS concept provides both passive and active recreation areas, which will be subject to varying degrees of landscaping, vegetation modification and fuel hazard reduction (Figure 6).

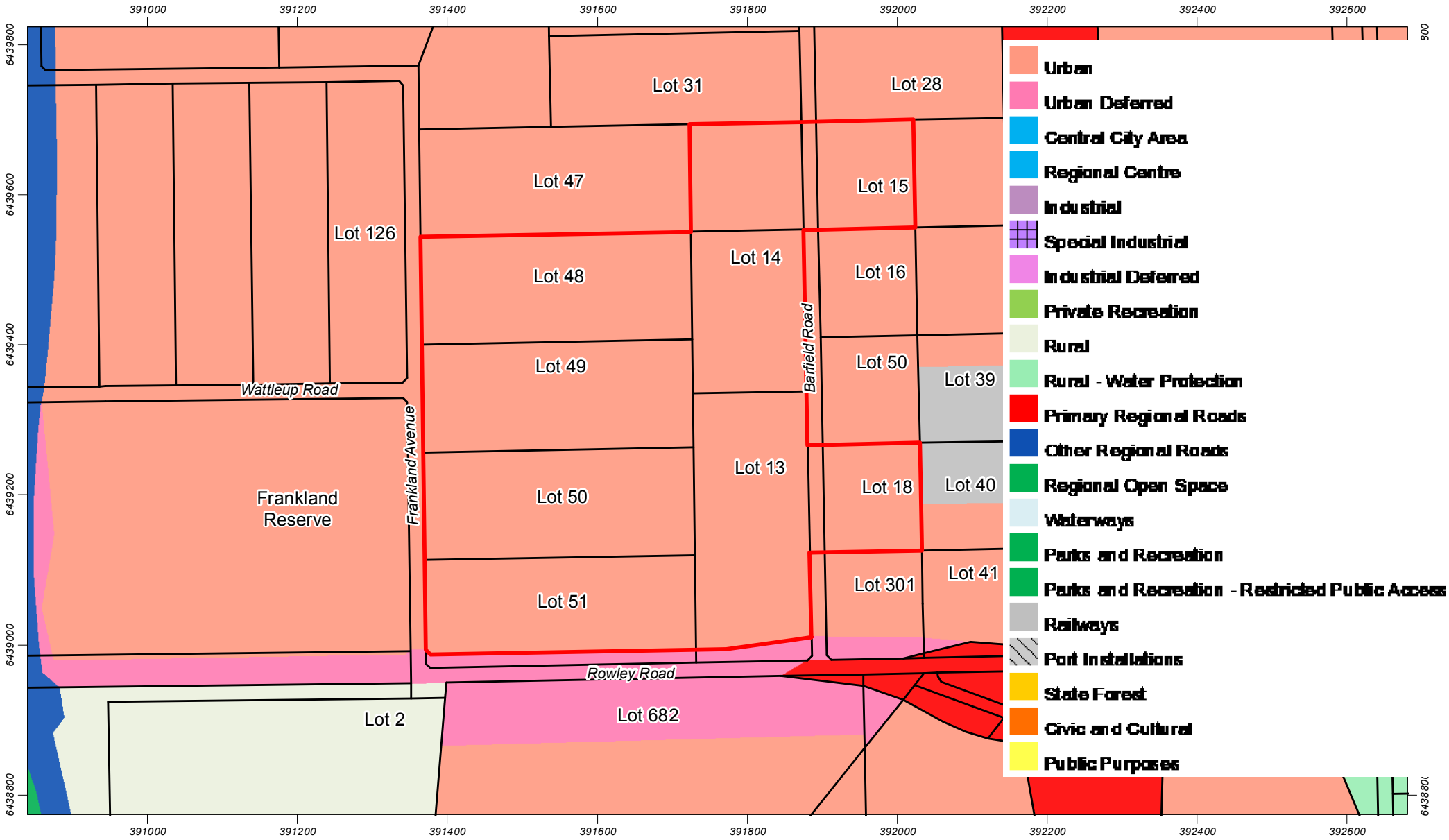


Figure 5 Project Area Zoning

Scale 1:7,000 at A4

0 50 100 150 m

N

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 25/06/2015

Author: JCrute

Source: Aerial image: Nearmap 2012. Concept plan: Client 2015.

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Legend

Existing cadastre

Project area boundary

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LANDSCAPE MASTER PLAN



PUBLIC OPEN SPACE SUMMARY

POS	POS AREA (incl. VERGE)	TYPOLOGY	DRAINAGE
A1	3,518 sq.m	Local Type 2	1:1 - n/a 1:100 - n/a
A2	9,635 sq.m	Local Type 2	1:1 - n/a 1:100 - n/a
B	3,910 sq.m	Neighbourhood Civic	1:1 - n/a 1:100 - n/a
C	7,743 sq.m	Neighbourhood Passive	1:1 - 809m^2 1:100 - 2,360m^2
F	5,639 sq.m	Local Type 1	1:1 - 909m^2 1:100 - 2,064m^2
H	8,689 sq.m	Neighbourhood Passive	1:1 - 571m^2 1:100 - 1,445m^2





Source: Emerge 2015

3.6.3 Adjacent land use

The Project Area is situated adjacent to undeveloped private properties to the north, south, east and west. Like the Project Area, these properties are currently vegetated with banksia-Sheoak low woodland but are expected to be subject to future urban development in accordance with existing District and Local Structure Plans. These properties include the following, which will pose a temporary bush fire risk to future assets of the Project Area until such time that the vegetation is removed:

- Lots 2 and 682 located adjacent south of the Project Area (within the municipal boundary of City of Kwinana)
- Lots 28, 16, 50, 39–41 and 301 located adjacent east of the Project Area, some of which is located within a Western Power easement containing high voltage electrical transmission lines
- Lots 47 and 31 located adjacent north of the Project Area
- Lot 126 located adjacent west of the Project Area.

Frankland Reserve (No. 27057) is located west of the Project Area and is partially vegetated with banksia-Sheoak low woodland. This vegetation presents a permanent bush fire risk to future assets of the Project Area.

Policy Control Area No. 95 abuts the southern boundary of the Project Area to allow for future widening of Rowley Road. A sand quarry and the Alcoa Mandogalup Residue Disposal Area are located a further 540 m and 2 km respectively to the southwest of the Project Area.

3.7 Site assets

The Project Area currently contains life and property assets in the form of residential dwellings and associated outbuildings located on Lots 13, 14, 15, 18 and 51. These built assets will be removed on implementation of the proposed development.

Private properties located north, east and west of the Project Area also contain residences and associated outbuildings. The scale of life and property assets within these lots is expected to increase subject to future subdivision and development of these areas.

The Project Area and much of the surrounding land contains environmental assets in the form of native vegetation (banksia-Sheoak low woodland), a large proportion of which is in ‘excellent’ condition. Banksia-Sheoak woodland is a preferred foraging habitat for conservation significant black cockatoo species and a Level 1 fauna survey of the site provided evidence of foraging by these species (Ecoscape 2009). The site also contains numerous Jarrah trees, some of which have been identified as potential breeding and nesting habitat for black cockatoos (Ecoscape 2009).

3.7.1 Proposed assets

Proposed development of the Project Area will significantly increase the density of life and property assets of the site through creation of a range of residential densities, a POS network and a local centre (Roberts Day 2015).

The environmental value of the Project Area and adjacent land will decrease as a result of proposed urban development throughout the area and associated clearing of native vegetation.

On-site environmental assets post-development will be restricted mainly to native vegetation retained and/or planted within on-site POS and along road reserves.

3.8 Water supply

The existing water supply network located along Frankland Avenue will be extended to provide reticulated mains water supply to the proposed development (Roberts Day 2015).

3.9 Power supply

The existing 22 kV overhead power supply network located along Rowley Road, Barfield Road and Frankland Avenue will be re-routed underground as stages along these roads are developed. The upstream power supply network may require upgrading as the project develops (Roberts Day 2015).

3.10 Site access

Public access throughout the site is currently restricted to private driveways and internal lot boundary firebreaks. These access ways will be removed as a result of the proposed development, which aims to implement an internal road network providing numerous links to the surrounding public road network in Rowley Road, Frankland Avenue, Barfield Road and Wattleup Road (Figure 1).

4. Fire problem

4.1 Bush fire history

Uncontrolled bush fire in the Hammond Park locality is uncommon. The last known occurrence of uncontrolled bush fire or prescribed burning in the locality is unconfirmed, but is expected to be more than 20 years ago (Woodcock L [City of Cockburn Fire Control Officer] 2013, pers. comm. 9 April). This means that woodland fuels within the Project Area and adjacent vegetated land have gone long unburnt for possibly greater than 20 years.

City of Cockburn manages Frankland Reserve (adjacent west of the Project Area) in accordance with an FMP, of which the main fire management control is through the provision of firebreaks.

In general, City of Cockburn receives a range of ignition sources, most notably suspected arson and accidental causes, such as vehicle accidents (Woodcock L [City of Cockburn Fire Control Officer] 2013, pers. comm. 9 April).

There are numerous emergency service resources in City of Cockburn that could provide a suppression response to the Project Area within 30 minutes, including local bush fire brigades stationed at Jandakot and South Coogee, along with career brigades at Hope Valley and Success.

4.2 Bush fire hazards

A bush fire hazard assessment aims to classify the bush fire hazard at both the strategic and local level, which enables the assessor to classify the BAL. A bush fire hazard assessment has been undertaken across the Project Area and adjacent land in accordance with procedures outlined in the Guidelines.

4.2.1 Classifying the bush fire hazard

Fuel hazard assessment

A comprehensive fuel hazard assessment of the Project Area and adjacent land was undertaken by Strategen during a site visit on 8 November 2012.

On-site fuel hazards

On-site fuel hazards comprise banksia-Sheoak low woodland with scattered Jarrah, which is consistent with the vegetation community identified during the Level 2 flora and vegetation assessment (refer to Table 4 for a list of key flora species located on site).

Pre-development fuel loads were estimated to be in the range of 5–10 tonnes per hectare (t/ha) (Plate 1 to Plate 3). This estimation was made on the basis of a visual inspection of the following factors and was cross-referenced with the Swan Coastal Plain Visual Fuel Load Guide (FESA 2012):

- vegetation type and structure
- vegetation condition and density
- fuel age
- scrub extent
- litter and trash accumulation.

Areas containing fuel loads at the higher end of the range (i.e. at 10 t/ha) were associated with denser mid and understoreys, along with areas of high trash and litter accumulation, particularly under Sheoak canopies (Plate 4).

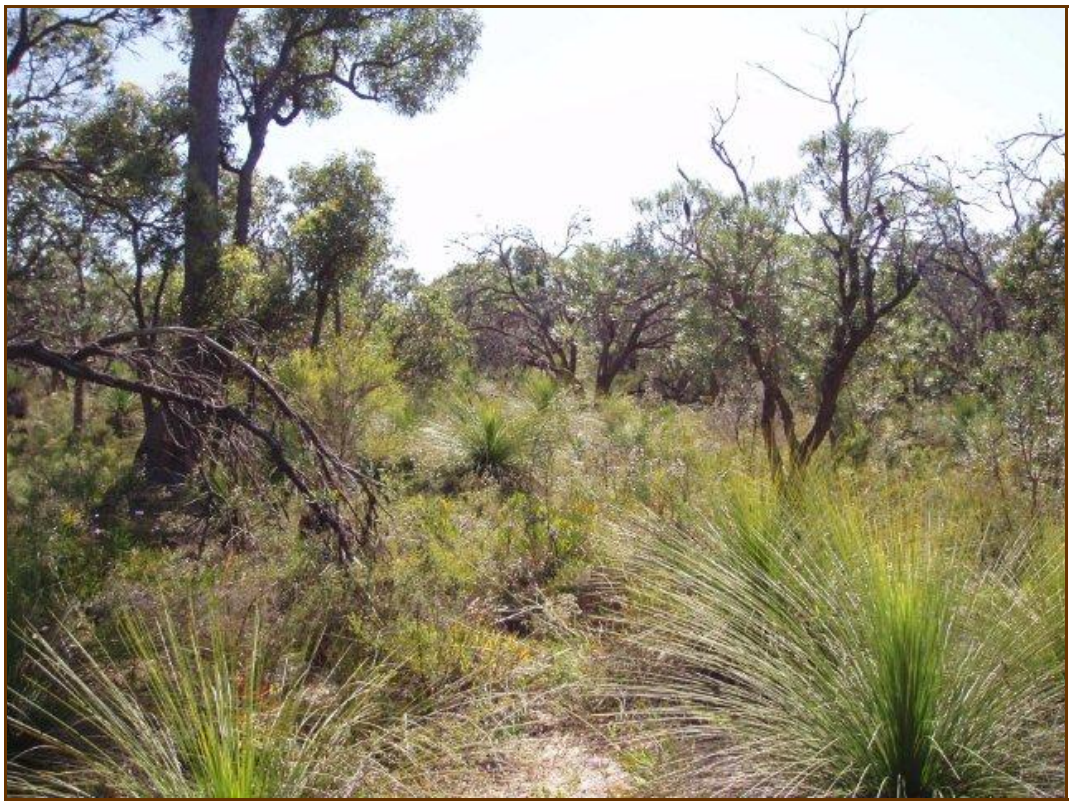


Plate 1: On-site banksia-Sheoak low woodland (Jarrah present) at Lot 51



Plate 2: On-site banksia-Sheoak low woodland at Lot 50



Plate 3: On-site banksia-Sheoak low woodland at Lot 48



Plate 4: Example of high trash and litter accumulation underneath a Sheoak canopy at Lot 48

The majority of the abovementioned on-site fuels will be removed through vegetation clearing associated with the proposed development. POS areas throughout the site will be subject to varying degrees of landscaping, vegetation modification and fuel hazard reduction to ensure fuel loads are maintained annually at less than 5 t/ha, or less than 2 t/ha in areas where the POS occurs within a designated Building Protection Zone (BPZ).

Adjacent fuel hazards

Fuel hazards adjacent to the Project Area generally consist of banksia-Sheoak low woodland with scattered areas of Jarrah (similar to the fuel hazards identified on-site). Numerous properties surrounding the Project Area, particularly to the north and east, have been subject to various levels of disturbance associated with clearing and historical land use practices. Consequently, fuel loads surrounding the Project Area vary from 0–10 t/ha depending on the level of disturbance imposed.

Vegetated areas with higher levels of disturbance were assessed to contain lower fuel loads ranging from 0–5 t/ha (Plate 5 to Plate 7). Vegetated areas with little to no evidence of past disturbance were assessed to contain higher fuel loads ranging from 5–10 t/ha (Plate 8 to Plate 10).

As previously discussed, vegetated private properties adjacent to the northern, southern, eastern and western boundaries of the Project Area are expected to be subject to future vegetation clearance and urban development in accordance with existing District and Local Structure Plans. These properties include the following, which will contain temporary fuel hazards until such time that the vegetation is removed:

- Lots 2 and 682 located adjacent south of the Project Area
- Lots 28, 16, 50, 39–41 and 301 located adjacent east of the Project Area
- Lots 47 and 31 located adjacent north of the Project Area
- Lot 126 located adjacent west of the Project Area.

Fuel hazards contained within Frankland Reserve to the west are permanent and will pose an ongoing bush fire risk to future assets of the Project Area.

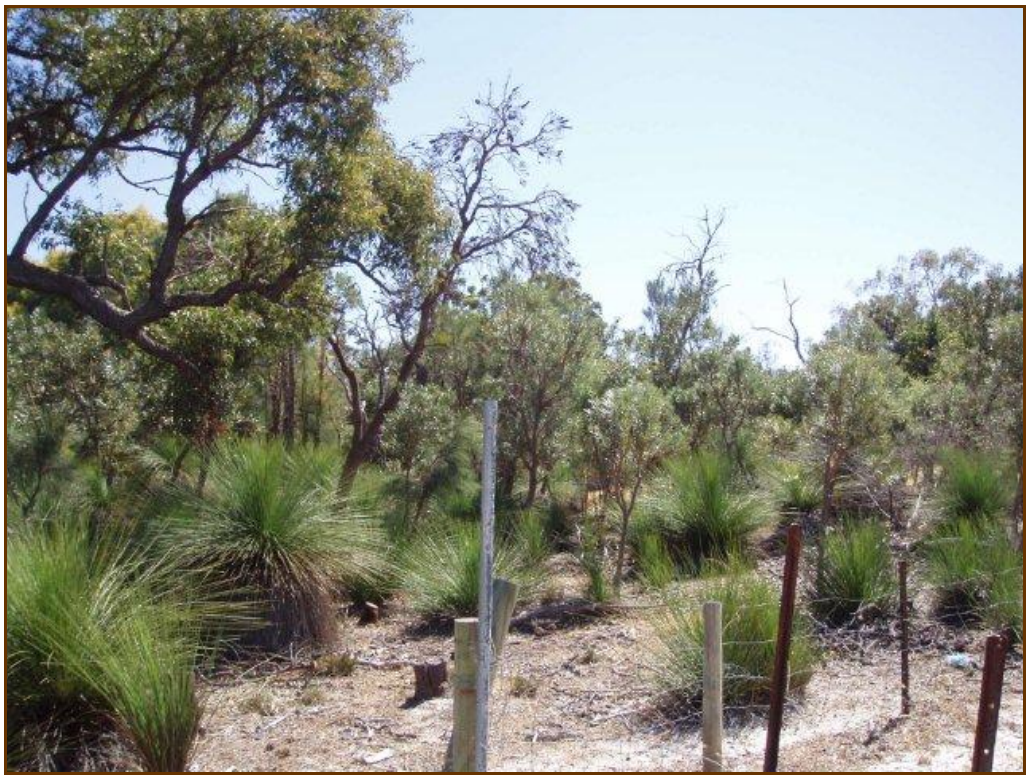


Plate 5: Temporary fuels to the north (low woodland): high level disturbance to vegetation at Lot 31



Plate 6: Temporary fuels to the east: recovering banksia-Sheoak low woodland at Lot 301



Plate 7: Temporary fuels to the west: recovering banksia-Sheoak low woodland at Lot 126



Plate 8: Temporary fuels to the north: dense banksia-Sheoak low woodland at Lot 47



Plate 9: Permanent fuels to the west: dense banksia-Sheoak low woodland within Frankland Reserve

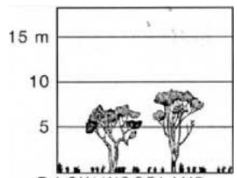


Plate 10: Temporary fuels to the south: dense banksia-Sheoak low woodland at Lot 682

Vegetation class and type

An assessment of vegetation class and type within and adjacent to the Project Area has been undertaken in accordance with procedures outlined in the Guidelines (Table 5).

Table 5: Predominant vegetation class and type

Vegetation location and fuel load	Vegetation class	Vegetation type	Figure (taken from the Guidelines)	Description
On-site and surrounding areas of banksia-Sheoak low woodland	(B) Woodland	Low woodland	 B LOW WOODLAND FIGURE 2.2-07	Low trees and shrubs 2–10 m high; foliage cover less than 10%; dominated by eucalypts and acacias; often have a grassy understorey or low shrubs.

Location of bush fire hazards

The location of existing bush fire hazard areas located within 100 m of the Project Area is outlined in the vegetation class map (Figure 7). This map has been created using the abovementioned woodland vegetation class description.

Bush fire hazard levels

Bush fire hazard levels located within 100 m of the Project Area are displayed in the bush fire hazard assessment map (Figure 8). Classifying the bush fire hazard by assessing the predominant vegetation is a key to the initial determination of site suitability for development. This also leads to determination of the potential level of building construction standard by the application of AS 3959–2009 *Construction of buildings in bushfire prone areas* (SA 2009) for any proposed development that cannot achieve the full 100 m separation distance to bush fire prone areas, regardless of whether the bush fire hazard is a permanent or temporary hazard.

The pre-development, on-site bush fire hazard level is 'Extreme'; however, the on-site vegetation is proposed to be cleared or landscaped with ongoing management to enable development of residential lots, roads and low fuel on-site POS. Therefore, the on-site bush fire hazard is expected to be removed on completion of the development.

The pre-development bush fire hazard level on adjacent land varies from 'Low' to 'Extreme', based on the following:

- 'Low' bush fire hazard level: areas where the vegetation is significantly degraded
- 'Moderate' bush fire hazard level: areas of banksia-Sheoak low woodland subject to varying levels of disturbance
- 'Extreme' bush fire hazard level: areas of dense, banksia-Sheoak low woodland that is predominantly undisturbed.

According to the Guidelines, land with an assessed 'Moderate' or 'Extreme' bush fire hazard level is classified as bush fire prone land and any proposed development located within 100 m requires the application of AS 3959–2009, as depicted in Figure 8 by the 100 m wide BAL assessment area and distances measured between proposed lots and surrounding hazards. Application of AS 3959–2009 will be considered regardless of whether the affecting hazard and vegetation is of a permanent or temporary nature.

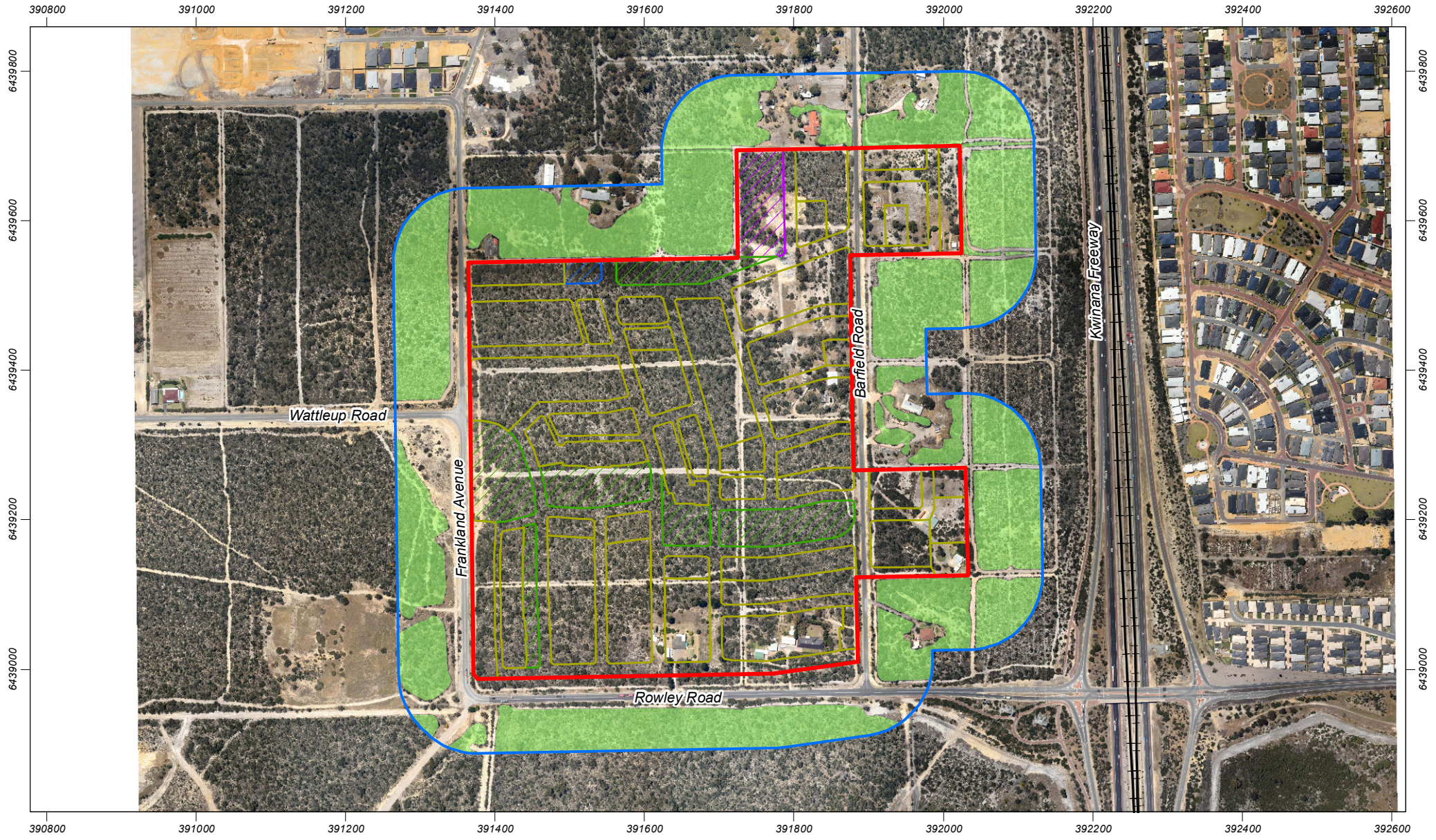


Figure 7: Vegetation class map

Scale 1:7,000 at A4

0 50 100 150 m

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 25/06/2015

Author: JCrute

Source: Aerial image: Nearmap 2012. Concept plan: Client 2015.

Legend

- Railway
- Project area boundary
- 100m wide assessment area
- Residential
- POS
- High school
- Child care

Vegetation class

- Woodland

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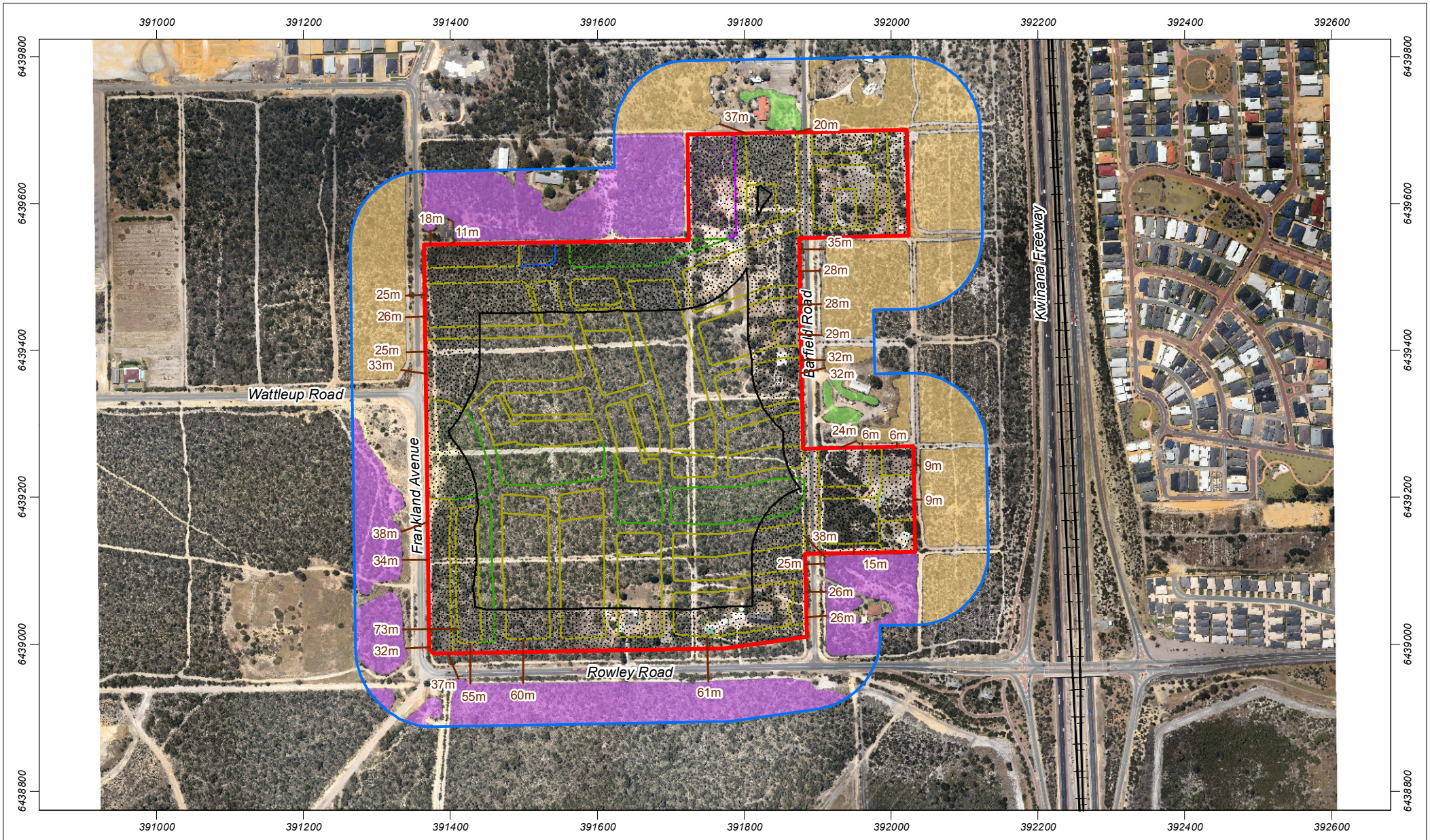


Figure 8: Bush fire hazard assessment map

Scale 1:7,000 at A4

0 50 100 150 m

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 25/06/2015

Author: JCrute

Source: Aerial image: Nearmap 2012. Concept plan: Client 2015.

Legend

- Railway
- Project area boundary
- 100m wide assessment area
- Residential
- POS
- High school
- Child care
- 100m wide BAL assessment area

Bush fire hazard level

- Low
- Moderate
- Extreme

32m Distance between Extreme and Moderate fire hazard level and lot boundary

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4.2.2 Bush fire hazard performance criteria

The relationship between various bush fire hazard levels and development performance criteria is set out in Table 6. A proportion of the proposed development cannot achieve the full 100 m hazard separation distance to surrounding bush fire prone areas (as outlined in Figure 8). Consequently, a comprehensive suite of bush fire risk treatment and mitigation measures, including implementation of AS 3959–2009, will need to be implemented to mitigate the risk from permanent and temporary hazards.

Compliance with performance criteria for a 'Moderate' bush fire hazard level will be achieved, focussing on the key areas of development location, vehicular access, water supply, siting of development and design of development. Performance criteria will be achieved through adoption of recommended acceptable solutions outlined in the Guidelines.

Table 6: Bush fire hazard levels and performance criteria

Bush fire hazard level	Bush fire protection performance criteria required
Low hazard	Development does not require special bush fire planning controls. Despite this, DFES strongly recommends that ember protection features be incorporated in design where practicable.
Moderate hazard	Performance criteria for: • location (Element 1) • vehicular access (Element 2) • water (Element 3) • siting of development (Element 4) • design of development (Element 5).
Extreme hazard	Development is to be avoided in areas with these hazard levels.

Source: WAPC et al. 2010

Compliance of the Barfield Road LSP development with bush fire protection performance criteria and associated acceptable solutions is documented in the compliance checklist (Appendix 1).

4.2.3 Classifying the Bushfire Attack Level (BAL)

This procedure, as outlined in the Guidelines and AS 3959–2009, uses a combination of the state-adopted Fire Danger Index rating of FDI 80, assessed vegetation class, slope under classified vegetation, and the distance maintained between proposed development areas and predominant vegetation to specify the Bushfire Attack Level (BAL). Based on the specified BAL, construction requirements for proposed buildings can then be assigned.

Application of BALs to address permanent bush fire risk

The permanent bush fire risk to future assets of the Project Area is from bush fire prone land contained within Frankland Reserve to the west. The BALs and associated building construction standards required to address the permanent bush fire risk are outlined in Table 7 and depicted in Figure 9. BAL 12.5 has been assessed on the basis of a minimum 32 m hazard separation distance (refer to Figure 8) to woodland vegetation (refer to Figure 7) located up-slope from the Project Area (refer to Figure 4).

Table 7: Determination of BALs to mitigate permanent bush fire risk

Vegetation class	Bushfire Attack Level (BAL)				
	BAL FZ	BAL 40	BAL 29	BAL 19	BAL 12.5
	Distance (m) of the site from the predominant vegetation class				
	All up-slopes and flat land (0 degrees)				
(B) Woodland	<10 (not supported in WA)	10–<14 (not supported in WA)	14–<20	20–<29	29–<100

Application of BALs to address the temporary bush fire risk

The temporary bush fire risk to future assets of the Project Area is from bush fire prone land contained within the following private properties surrounding the project area to the north, south, east and west:

- Lots 2 and 682 located adjacent south of the Project Area
- Lots 28, 16, 50, 39–41 and 301 located adjacent east of the Project Area
- Lots 47 and 31 located adjacent north of the Project Area
- Lot 126 located adjacent west of the Project Area.

The BALs and associated building construction standards required to address the temporary bush fire risk are outlined in Table 8 and depicted in Figure 9. A range of BALs have been determined, mainly due to variations in the hazard separation distance between proposed lots and the adjacent woodland extent. Some proposed lots directly abut the adjoining temporary bush fire hazard extent, and these have been assessed as requiring BAL FZ or BAL 40 building construction standards, which are not supported in WA. These lots cannot achieve BAL 29 or lower, or the required 20 m wide Building Protection Zone (BPZ), until such time that the adjoining temporary bush fire hazard has been removed through development of adjacent properties.

Where proposed lots have been assigned BAL FZ or BAL 40, or are located in the 20 m wide BPZ, these lots are to be cleared and left undeveloped until such time that the temporary bush fire hazard on adjoining land is removed, after which time the BALs for these unconstructed lots are to be reassessed and new BALs assigned where applicable. This is particularly relevant along the northern and eastern boundaries where proposed lots directly abut the adjacent vegetation extent. Leaving these lots cleared and undeveloped will enable the adjacent internal lots to be developed at either BAL 19 or BAL 12.5.

The application of BALs to address temporary bush fire risk, as outlined in this FMP, will need to be revised (and may not apply) should the temporary bush fire hazards be removed prior to development of affected areas of the LSP.

Table 8: Determination of BALs to mitigate temporary bush fire risk

Vegetation class	Bushfire Attack Level (BAL)				
	BAL FZ	BAL 40	BAL 29	BAL 19	BAL 12.5
	Distance (m) of the site from the predominant vegetation class				
	All up-slopes and flat land (0 degrees)				
(B) Woodland (to the north, east and west)	<10 (not supported in WA)	10–<14 (not supported in WA)	14–<20	20–<29	29–<100
Vegetation class	Down-slope >0 to 5 degrees				
(B) Woodland (to the south)	<13 (not supported in WA)	13–<17 (not supported in WA)	17–<25	25–<35	35–<100

Additional measures to reduce the bush fire risk

The following additional components of development design are considered to provide further protection to future life and property assets of the development:

- on-site vegetation clearance to enable development of a significant built footprint across the site
- landscaping, vegetation modification and fuel hazard reduction within on-site POS
- construction of a 2 m average height masonry (retaining) wall along the lot interface with POS A1/A2
- construction of a 3 m average height masonry (noise attenuation) wall along the southern development boundary adjacent to Policy Control Area No. 95
- utilisation of existing perimeter road reserves as BPZs where possible
- implementation of cleared undeveloped buffers throughout BAL FZ, BAL 40 and BPZ areas to address temporary bushfire risk and enable internal lots to be developed at BAL 19/12.5.

Construction standards

The relevant sections of AS 3959–2009 which outline construction standards for buildings in areas specified as BAL 12.5 and BAL 19 are provided in Table 9. Construction standards for BAL 12.5 and BAL 19 are fully explained in Appendix 3.

Table 9: Construction standards

BAL	Classified vegetation within 100 m of the site and heat flux exposure thresholds	Description of predicted bush fire attack and levels of exposure	AS 3959–2009 section
BAL 12.5	≤12.5 kW/m^2	Ember attack	3 and 5
BAL 19	>12.5 kW/m^2 ≤19 kW/m^2	Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux	3 and 6

Source: WAPC et al. 2010

4.3 Inherent bush fire risk

An inherent bush fire risk assessment has been undertaken across the Project Area, which quantifies the level of risk of loss or damage to current site assets from uncontrolled bush fire, prior to the implementation of the Barfield Road LSP and associated bush fire management measures. The risk assessment is derived from the FESA *Rural Urban Bush Fire Threat Analysis* (Smith 2003).

Results of the risk assessment are outlined in Table 10. The assessment indicates that the inherent risk of loss or damage to current site assets from uncontrolled bush fire is high on the basis of the following:

1. The Project Area maintains an 'Extreme' bush fire hazard level, derived from the extent of banksia-Sheoak low woodland located on site.
2. Land adjacent to the Project Area maintains up to an 'Extreme' bush fire hazard level, derived from the extent of banksia-Sheoak low woodland located on adjacent land.
3. The Project Area currently maintains critical life and property assets, as well as high environmental value.
4. The current extent of on-site vegetation has not been subject to fuel hazard reduction for some time, so maintains high available fuel loads and presents an increased likelihood of ignition and bush fire occurrence.

Table 10: Inherent bush fire risk assessment for the Project Area

Parameter	Risk to site assets
On-site fuel hazard rating (low, moderate, extreme)	Extreme
Asset located up-slope from vegetation	Yes
Asset located in the flame zone	Yes
Resident/visitor presence (low, moderate, high)	Moderate
Values or assets (low, moderate, high)	High
Fire unit access risk (low, moderate, high)	Moderate
Fire suppression response time (minutes)	<30
Probability of bush fire occurrence (low, moderate, high)	Moderate
Level of bush fire management (low, moderate, high)	Low
Overall inherent risk	**High**

4.4 Summary of key bush fire issues

The following is a summary of key bush fire issues for the Project Area that have been used to inform the bush fire management concept to protect future assets of the development:

- the Project Area has not been subject to fire for possibly more than 20 years
- common sources of ignition within City of Cockburn include suspected arson and accidental causes such as vehicle accidents
- response times in the event that the Project Area is threatened by bush fire is expected to be within 30 minutes from local bush fire brigades
- the Project Area contains bush fire hazards in the form of banksia-Sheoak low woodland ('Extreme' bush fire hazard level) with slopes of up to 15 degrees in some areas
- the on-site vegetation extent is proposed to be cleared or landscaped with ongoing management to accommodate the proposed development and any vegetation retained within on site POS is not considered to pose a significant bush fire risk
- land adjacent to the Project Area contains bush fire hazards in the form of banksia-Sheoak low woodland, grading from 'Low' to 'Extreme' bush fire hazard level
- permanent bush fire hazards contained on adjacent land include Frankland Reserve to the west ('Extreme' bush fire hazard level, up-slope of development)
- temporary bush fire hazards contained within adjacent private properties subject to future urban development include the following, which grade from 'Low' to 'Extreme' bush fire hazard level:
    - Lots 2 and 682 located adjacent south of the Project Area (down-slope of development at >0–5 degrees)
    - Lots 28, 16, 50, 39–41 and 301 located adjacent east of the Project Area (up-slope of development)
    - Lots 47 and 31 located adjacent north of the Project Area (up-slope or flat land)
    - Lot 126 located adjacent west of the Project Area (up-slope of development)
- a proportion of the proposed development cannot achieve the full 100 m hazard separation distance to surrounding bush fire prone areas and a comprehensive suite of bush fire risk treatment and mitigation measures, including implementation of AS 3959–2009, will need to be implemented to mitigate the risk from permanent and temporary hazards described above
- proposed lots depicted on Figure 9 as being BAL Flame Zone or BAL 40; as well as proposed lots located in the 20 m wide BPZ, are to be cleared and left undeveloped until such time that the temporary bush fire hazard on adjoining land is removed, after which time the BALs for these unconstructed lots are to be reassessed and new BALs assigned where applicable
- remaining lots within the 100 m wide BAL assessment area are to apply building construction standards for BAL 12.5 and BAL 19, as depicted on Figure 9
- the application of BALs to address temporary bush fire risk, as outlined in this FMP, will need to be revised (and may not apply) should the temporary bush fire hazards be removed prior to development of affected areas of the LSP
- performance criteria and associated acceptable solutions will be achieved for a moderate bush fire hazard level, focussing on the key areas of development location, vehicular access, water, siting of development and design of development
- the pre-development, inherent bush fire risk to the Project Area is high.

5. Bush fire management measures

The following bush fire management measures will be considered in order to manage the potential threat from bush fires and guide future protection of the Project Area:

- low fuel buffers
- on-site fuel hazard reduction and vegetation management
- building location and materiality
- development staging
- public access
- firebreaks and emergency access
- water supply
- provision of fire appliances
- suggested muster points
- landowner education and awareness
- notifications on Title
- Detailed Area Plans.

Key measures are illustrated on an aerial image of the Project Area in Figure 9 to assist with implementation of the FMP.

5.1 Low fuel buffers

When considering the overall bush fire management of the Project Area, protection should be provided to critical life and property assets (residents, visitors and built assets) as a minimum requirement. Low fuel buffers between fire hazard areas and critical assets can be implemented to achieve this.

A 20 m wide BPZ will be implemented for the proposed development as depicted in Figure 9. The BPZ will be accommodated within the Frankland, Rowley and Barfield road reserves (all greater than 20 m wide) and POS areas where possible. However, in areas where proposed lots directly abut an adjoining temporary bush fire prone area (i.e. to the east and north), the lots are to be cleared and left undeveloped as BPZs until such time that the temporary bush fire hazard on adjoining land is removed. This will ensure the BPZ does not extend onto adjacent private property. The BPZ is to be constructed in accordance with acceptable solution A4.3 of the Guidelines and maintained annually at less than 2 t/ha.

5.2 On-site fuel hazard reduction and vegetation management

The majority of on-site fuels will be removed through vegetation clearing as part of the development. However, on-site POS and vacant areas of private property or undeveloped land will contribute an ongoing and increasing bush fire threat if not managed annually. The following fuel hazard reduction measures will be implemented to ensure that fuel hazards are managed appropriately throughout on-site POS areas, vacant areas of private property, undeveloped land and the BPZ:

- on-site POS areas are to have available fuel loads maintained annually at less than 5 t/ha, or less than 2 t/ha in areas where the POS occurs within a designated BPZ
- vacant areas of private property and undeveloped land are to maintained annually at less than 2 t/ha
- fuel hazard reduction should target understorey trash, litter, scrub, grass and weeds and be undertaken by the relevant land manager in accordance with the current City of Cockburn annual fire control order
- fuel hazard reduction may be undertaken via chemical spraying, mechanical slashing/mowing and/or manual fuel removal by hand

- annual fuel inspections may be undertaken by CoC and failure to comply with this FMP and the specified requirements of the current City of Cockburn annual fire control order will result in the issuing of fines of up to $5000 (refer to Appendix 4).

5.3 Building location and materiality

Strategic location, layout and management of future development at the planning stage can reduce future fire threat and risk to critical life and property assets of the development. The following areas are considered to be the predominant bush fire risks to the site:

- Frankland Reserve to the west (permanent bush fire risk)
- Lots 2 and 682 to the south of the Project Area (temporary bush fire risk)
- Lots 28, 16, 50, 39–41 and 301 to the east of the Project Area (temporary bush fire risk)
- Lots 47 and 31 to the north of the Project Area (temporary bush fire risk)
- Lot 126 to the west of the Project Area (temporary bush fire risk).

All proposed lots located within 100 m of the abovementioned hazards will need to apply AS 3959–2009 to assign relevant BALs and achieve compliant development through increasing the building construction standard in accordance with acceptable solution A4.1. This is discussed in Section 4.2.3, which recommends the following, as depicted in Figure 9:

- to address the permanent bush fire risk, building construction standards for BAL 12.5 and a 20 m wide BPZ will be implemented for all proposed lots located within 100 m of Frankland Reserve bush fire hazards
- to address the temporary bush fire risk, proposed lots depicted on Figure 9 as being BAL Flame Zone or BAL 40 (for which building construction standards are not supported in WA), as well as proposed lots located in the 20 m wide BPZ, are to be cleared and left undeveloped until such time that the temporary bush fire hazard on adjoining land is removed, after which time the BALs and BPZs for these unconstructed lots are to be reassessed and new BALs assigned where applicable
- to address the temporary bush fire risk, building construction standards for BAL 12.5 and BAL 19 will be implemented for all remaining lots located within 100 m from temporary bush fire hazard areas, as depicted in Figure 9
- the application of BALs and BPZs to address temporary bush fire risk, as outlined in this FMP, will need to be revised (and may not apply) should the temporary bush fire hazards be removed prior to development of affected areas of the LSP

The above measures are considered to achieve development compliance with the Guidelines and AS 3959–2009; however, the following components of development design are proposed as a means of enhancing the fire management concept to provide additional protection to future life and property assets:

- on-site vegetation clearance to enable development of a significant built footprint across the site
- landscaping, vegetation modification and fuel hazard reduction within on-site POS
- construction of a 2 m average height masonry (retaining) wall along the lot interface with POS A1/A2 with permitted open style fencing at the top of the wall (Figure 9)
- incorporation of hazard separation services, for example a car park, paved or lawn area along the northern lot interface with POS A2 (Figure 9, exact services to be determined at subdivision)
- construction of a 3 m average height masonry (noise attenuation) wall along the southern development boundary adjacent to Policy Control Area No. 95 (Figure 9)
- utilisation of existing perimeter road reserves as BPZs where possible
- implementation of cleared undeveloped buffers throughout BAL FZ, BAL 40 and BPZ areas to address temporary bushfire risk and enable internal lots to be developed at BAL 19/12.5.

Proposed lots located outside the 100 m wide BAL assessment area will not require heightened levels of building construction standard.

Installation of evaporative air-conditioners in the rooves of houses built in this environment, along with mesh screens/shutters, is not supported as a result of the recent fire evidence in similar developments. This message will be communicated through guidance material issued to prospective landowners.

5.4 Development staging

Each stage of the Barfield Road LSP subject to development and construction is to be bound by a 100 m wide on-site fuel reduced buffer to address the temporary bush fire risk posed by future undeveloped stages of the site. The available fuel load within the fuel reduced buffer is to be maintained annually at less than 5 t/ha through targeted management of the understorey (overstorey trees can be retained). Each stage of the LSP development is also to be provided with a minimum of two vehicular access points that connect to the surrounding public road network (refer to Section 5.5 for further information).

Further to the above staging requirement, any POS areas located within 100 m of a stage being developed will need to be landscaped/fuel reduced as per the approved landscape plan/FMP prior to lot development to ensure there are no unmanaged POS hazards located within 100 m of developed areas.

Bush fire management measures to address the temporary bush fire risk posed by adjoining land is discussed in Section 5.1 and 5.3 in the event that clearing of temporary vegetation surrounding the LSP does not precede staging of the LSP.

5.5 Public access

The proposed development will result in an extensive internal road network that provides vehicular access routes to the north, south, east and west. This will ensure that all residents and visitors will be provided with at least two public vehicular access routes for all stages of development that connect to the surrounding public road network at all times in accordance with acceptable solution A2.1. All public roads will be constructed to the relevant Main Roads WA, CoC and DFES standards, including those specified under acceptable solution A2.2 of the Guidelines.

5.6 Firebreaks and emergency access

The Guidelines state that lots greater than 0.5 ha must have an internal perimeter firebreak of a minimum 3 m width. POS Areas A2, C and H each exceed this threshold; however, internal perimeter firebreaks are not considered necessary based on the following:

- the level of access provided around each POS area by the extensive public road network is expected to achieve suitable alternatives to acceptable solutions for firebreaks and emergency access
- each POS area will be subject to fuel hazard reduction to ensure available fuel loads are maintained at less than 5 t/ha (or less than 2 t/ha within BPZs) to manage fuel loads and reduce the likelihood of uncontrolled bush fires occurring in these areas.

5.7 Water supply

The existing water supply network located along Frankland Avenue will be extended to provide reticulated mains water supply to the proposed development in accordance with acceptable solution A3.1.

5.8 Provision of fire appliances

A network of hydrants will be provided along the internal road network at locations which meet relevant water supply authority and DFES requirements in accordance with acceptable solution A3.1. Additional fire appliances will be provided by local and career bush fire brigades (within an expected 30 minute response time) in the event that uncontrolled bush fire threatens life and property assets.

5.9 Suggested muster points

POS Area H is a suggested muster point to be used by residents and visitors in the event that bush fire threatens life and property of the proposed development. This is a large, easily accessible area of cleared POS located away from potential bush fire hazard areas.

5.10 Landowner education and awareness

Landowners should obtain a copy of local government and DFES bush fire information booklets that are currently available. In addition, attendance by landowners at annual DFES bush fire awareness briefings would be advantageous.

All landowners will be required to comply with the current City of Cockburn annual fire control order, which is contained in Appendix 4.

5.11 Notifications on Title

Section 70 notifications will be placed on all Certificates of Title for those lots located within the 100 m wide BAL assessment area (i.e. all proposed lots deemed to be affected by a bush fire hazard and consequently have a designated BAL classification). The notification will ensure that prospective landowners are aware that an FMP exists over the site and that specified building construction requirements and/or building setbacks may apply in accordance with AS 3959–2009.

5.12 Detailed Area Plans

Detailed Area Plans (DAPs) may be required at subdivision as a mechanism to enforce detailed planning requirements, such as additional building setbacks for specific lots in order to achieve development compliance with the hazard separation and building construction requirements of AS 3959–2009. This may be required particularly for those perimeter lots to the north and east of the development that currently cannot achieve BAL 29 or lower or are located within the 20 m wide BPZ to temporary bush fire hazards.

5.13 Summary of bush fire management measures and works program

A summary of the bush fire management measures described in Section 5, as well as a works program, is provided in Table 11. These measures will be implemented to ensure the ongoing protection of on-site assets is achieved. Additional optional techniques are also provided and can be adopted by residents to further mitigate their risk to life and property from uncontrolled bush fires. Responsibilities are also defined to assist with implementation of each management measure.

Table 11: Summary of bush fire management measures and works program

Bush fire management measure	Recommended works	Mandatory	Optional	Timing	Responsibility
Low fuel buffers	Implement the 20 m wide BPZ as depicted on Figure 9. Refer to FMP Section 5.1.	Yes	No	During implementation of the development	Developer
On-site fuel hazard reduction and vegetation management	Maintain on-site POS at less than 5 t/ha, or less than 2 t/ha in areas where the POS occurs within a designated BPZ. Refer to FMP Section 5.2.	Yes	No	Annually prior to the onset of the designated bush fire season	Developer during development, CoC thereafter
	Maintain vacant areas of private property and undeveloped land at less than 2 t/ha. Refer to FMP Section 5.2.	Yes	No	Annually prior to the onset of the designated bush fire season	Developer during development, prospective landowners thereafter
	Comply with the current City of Cockburn annual fire control order. Refer to Appendix 4. Refer to FMP Section 5.2.	Yes	No	Annually	Developer, prospective landowners
	Undertake fuel inspections and issue notices or fines where compliance with this FMP or the current City of Cockburn annual fire control order has been compromised. Refer to FMP Section 5.2.	No	Yes	Annually prior to the onset of the designated bush fire season	CoC staff
Building location and materiality	Apply BAL 19 and BAL 12.5 building construction standards to proposed lots as depicted in Figure 9. Refer to FMP Section 5.3.	Yes	No	During building construction	Builder, prospective landowners
	Clear and leave undeveloped those lots depicted in Figure 9 as BAL Flame Zone or BAL 40, as well as those lots located in the 20 m wide BPZ. Refer to FMP Section 5.3.	Yes	No	Until such time that the temporary bush fire hazard on adjoining land is removed, after which time the BALs for these unconstructed lots are to be reassessed and new BALs assigned where applicable	Developer
	Revise the BALs currently depicted on Figure 9 that address temporary bush fire risk. Refer to FMP Section 5.3.	Yes	No	If the temporary bush fire hazards are removed prior to development of affected areas of the LSP	Developer
	Construct the masonry walls currently depicted on Figure 9. Refer to FMP Section 5.3.	Yes	No	During implementation of the development	Developer
	Incorporate additional hazard separation services along the northern lot interface with POS A2. Refer to FMP Section 5.3.	Yes	No	To be determined at subdivision and implemented during construction of the relevant stage	Developer
Development staging	Implement a 100 m wide on-site fuel reduced buffer (maintained annually at less than 5 t/ha) around each stage subject to construction to address the temporary bush fire risk posed by future undeveloped stages of the site. Refer to FMP Section 5.4.	Yes	No	Prior to lot development of the relevant stage	Developer
	Undertake landscaping/fuel reduction work in accordance with the approved landscape plan/FMP throughout any POS areas located within 100 m of a stage being developed. Refer to FMP Section 5.4.	Yes	No	Prior to lot development of the relevant stage	Developer

Bush fire management measure	Recommended works	Mandatory	Optional	Timing	Responsibility
Public access	Ensure that all residents and visitors are provided with at least two public vehicular access routes for all stages of development that connect to the surrounding public road network at all times in accordance with acceptable solution A2.1. Refer to FMP Section 5.5.	Yes	No	During implementation of the development	Developer
Water supply	Provide a reticulated water supply throughout the development in accordance with acceptable solution A3.1. Refer to FMP Section 5.7.	Yes	No	During implementation of the development	Developer
Provision of fire appliances	Provide a network of hydrants along the internal road network at locations which meet relevant water supply authority and DFES requirements in accordance with acceptable solution A3.1. Refer to FMP Section 5.8.	Yes	No	During implementation of the development	Developer
Suggested muster points	Utilise the suggested muster point location at POS Area H. Refer to FMP Section 5.9.	No	Yes	In the event that life and property of the development are threatened by bush fire	Residents and visitors
Landowner education and awareness	Obtain a copy of local government and DFES bush fire information booklets that are currently available and attend annual DFES bush fire awareness briefings. Refer to FMP Section 5.10.	No	Yes	Following purchase of lots	Prospective landowners
Notifications on Title	Include Section 70 Notification on Title for all proposed lots located within the 100 m wide BAL assessment area to ensure prospective landowners are aware that an FMP exists over the site and that specified building construction requirements and/or building setbacks may apply in accordance with AS 3959–2009. Refer to FMP Section 5.11.	Yes	No	On creation of Certificates of Title	Developer
Detailed Area Plans	Prepare DAPs for relevant lots as required. Refer to FMP Section 5.12.	Yes	No	As required following subdivision	Developer
Optional building requirements	Advise against the installation of rooftop evaporative air-conditioners. Installation of residential building sprinkler systems.	No	Yes	During building construction	Builder, prospective landowners
Restricted and prohibited burning times	Comply with the current DFES/CoC-determined burning periods. Refer to Appendix 4.	Yes	No	As specified by DFES/CoC	Developer, prospective landowners
FMP update	Update the FMP as required, particularly with regards to the removal of temporary bush fire hazards and modified BAL requirements. Refer to FMP Section 1.4.	Yes	No	Annually until the development has been fully implemented	Developer
FMP review	Review the social, financial and environmental benefits of the FMP and level of compliance, and update accordingly. Refer to FMP Section 1.4.	Yes	No	Five yearly	Developer during development, CoC thereafter

6. Implementation of the Fire Management Plan

6.1 Implementation of bush fire management measures

Key bush fire management measures and location of implementation as specified in this FMP, overlain on an aerial image of the Project Area, is provided in Figure 9.

6.2 Residual bush fire risk

The residual bush fire risk is the level of risk remaining after the Barfield Road LSP and associated FMP and bush fire management measures have been implemented. A residual bush fire risk assessment for the Project Area is provided in Table 12.

The residual bush fire risk to life and property assets was assessed as low, due to the increased level of bush fire management proposed across the site and the subsequent expected reduction in on-site fuel loads, access risk, building risk and probability of bush fire occurrence.

Table 12: Residual bush fire risk assessment for the Project Area

Parameter	Risk to site assets
On-site fuel hazard rating (low, moderate, extreme)	Low
Asset located up-slope from vegetation	Yes
Asset located in the flame zone	No
Resident/visitor presence (low, moderate, high)	High
Values or assets (low, moderate, high)	High
Fire unit access risk (low, moderate, high)	Low
Fire suppression response time (minutes)	<15
Probability of bush fire occurrence (low, moderate, high)	Low
Level of bush fire management (low, moderate, high)	High
Overall residual risk	**Low**

6.3 Assessment of bush fire management measures

Implementation of the bush fire management measures outlined in this FMP will ensure that should a bush fire occur within or adjacent to the Project Area, fire intensity on-site will be minimised and life, property and environmental assets are expected to be protected. In addition, a fire occurring on the site is highly likely to be readily contained within 30 minutes, which is the expected normal emergency response time provided by local bush fire brigades.

The cost of undertaking the various tasks and initiatives outlined in the FMP will provide significant cost benefit to the developer and landowners when compared with the possible loss of life, infrastructure and conservation values of the site. Implementation of the management measures will ensure that there will be no net long term environmental detriment to the site.

Five yearly review of the FMP will assess the social, financial and environmental effectiveness of the management measures described in Section 5.

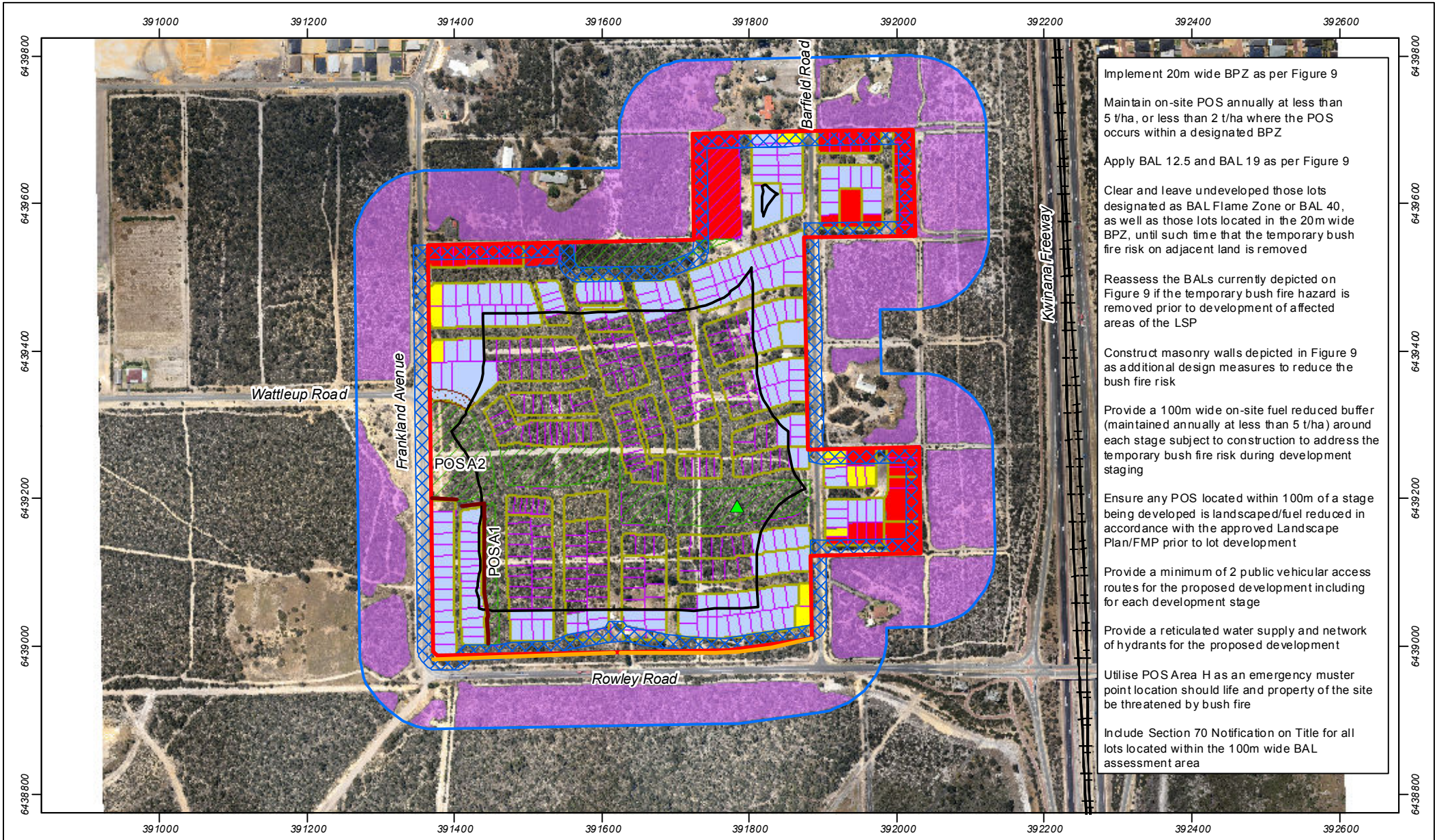


Figure 9 Fire Management Plan: Barfield Road Local Structure Plan

Scale 1:7,000 at A4

0 50 100 150 m

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 14/08/2015

Author: JCrute

Source: Aerial image: Nearmap 2012. Concept plan: Client 2014.

Legend

- Suggested muster point
- Lot boundaries
- Railway
- 2m high masonry wall
- 3m high masonry wall
- Project area boundary
- 20m wide BPZ
- 100m wide assessment area
- 100m wide BAL assessment area
- Location of additional hazard separation services to be determined at subdivision
- Residential
- POS
- High school
- Child care
- Bush fire prone areas
- BAL 12.5
- BAL 19
- BAL Flame Zone/BAL 40 cannot achieve 20m wide BPZ (clear and leave as undeveloped land until such time that the adjoining temporary bush fire hazard has been removed)

STRATEGEN

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6.4 Legislative requirements, specifications and standards

The legislative requirements, specifications and standards applicable to implementation of this FMP are referenced in Section 7 and Appendix 5 and pertain to the following:

- *Bush Fires Act 1954*
- *Planning and Development Act 2005*
- *Environment Protection and Biodiversity Conservation Act 1999*
- *Environmental Protection Act 1986*
- *Wildlife Conservation Act 1950*
- Building Code of Australia
- Planning for Bush Fire Protection Guidelines (Edition 2)
- Australian Standard AS 3959–2009 Construction of Buildings in Bushfire Prone Areas
- City of Cockburn annual fire control order.

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Appendix 1
Fire Management Plan compliance checklist

Compliance checklist for performance criteria and acceptable solutions

Element	Acceptable solution	Compliance	Yes/No	Explanation (if no)
1. Location	A1.1 Development location	Does the proposal comply with performance criteria P1 by applying acceptable solution A1.1?	Yes	
2. Vehicular access	A2.1 Two access routes	Does the proposal comply with performance criteria P2 by applying acceptable solution A2.1?	Yes	
	A2.2 Public roads	Does the proposal comply with performance criteria P2 by applying acceptable solution A2.2?	Yes	
	A2.3 Cul-de-sacs	Does the proposal comply with performance criteria P2 by applying acceptable solution A2.3?	N/A	
	A2.4 Battle axes	Does the proposal comply with performance criteria P2 by applying acceptable solution A2.4?	N/A	
	A2.5 Private driveways	Does the proposal comply with performance criteria P2 by applying acceptable solution A2.5?	N/A	
	A2.6 Emergency access ways	Does the proposal comply with performance criteria P2 by applying acceptable solution A2.6?	N/A	
	A2.7 Fire service access routes	Does the proposal comply with performance criteria P2 by applying acceptable solution A2.7?	N/A	
	A2.8 Gates	Does the proposal comply with performance criteria P2 by applying acceptable solution A2.8?	N/A	
	A2.9 Firebreak widths	Does the proposal comply with performance criteria P2 by applying acceptable solution A2.9?	No	Alternative solution proposed in Section 5.6
	A2.10 Signs	Does the proposal comply with performance criteria P2 by applying acceptable solution A2.10?	N/A	
3. Water	A3.1 Reticulated areas	Does the proposal comply with performance criteria P3 by applying acceptable solution A3.1?	Yes	
	A3.2 Non-reticulated areas (a)	Does the proposal comply with performance criteria P3 by applying acceptable solution A3.2?	N/A	
	A3.3 Non-reticulated areas (b)	Does the proposal comply with performance criteria P3 by applying acceptable solution A3.3?	N/A	
4. Siting of development	A4.1 Hazard separation – moderate to extreme bush fire hazard level	Does the proposal comply with performance criteria P4 by applying acceptable solution A4.1?	Yes	
	A4.2 Hazard separation – low bush fire hazard level	Does the proposal comply with performance criteria P4 by applying acceptable solution A4.2?	Yes	
	A4.3 Building protection zone	Does the proposal comply with performance criteria P4 by applying acceptable solution A4.3?	Yes	
	A4.4 Hazard separation zone	Does the proposal comply with performance criteria P4 by applying acceptable solution A4.4?	N/A	AS 3959–2009 has been implemented accordingly to reduce the level of hazard separation required

Element	Acceptable solution	Compliance	Yes/No	Explanation (if no)
	A4.5 Reduction in bush fire attack level due to shielding	Does the proposal comply with performance criteria P4 by applying acceptable solution A4.5?	N/A	
5. Design of development	A5.1 Compliant development	Does the proposal comply with performance criteria P5 by applying acceptable solution A5.1?	Yes	
	A5.2 Non-compliant development	Does the proposal comply with performance criteria P5 by applying acceptable solution A5.2?	N/A	

Note: Performance criteria and acceptable solutions are in accordance with *Planning for Bush Fire Protection Guidelines (Edition 2)* (WAPC et al. 2010).

Applicant Declaration

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

Full name: Roger Banks

Applicant signature:



Date: 14/08/2015

Appendix 2

January wind profiles for Medina Research Centre

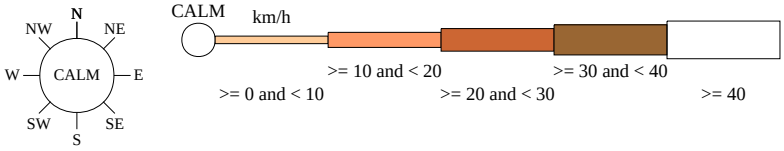
Rose of Wind direction versus Wind speed in km/h (01 Apr 1983 to 30 Sep 2010)

Custom times selected, refer to attached note for details

MEDINA RESEARCH CENTRE

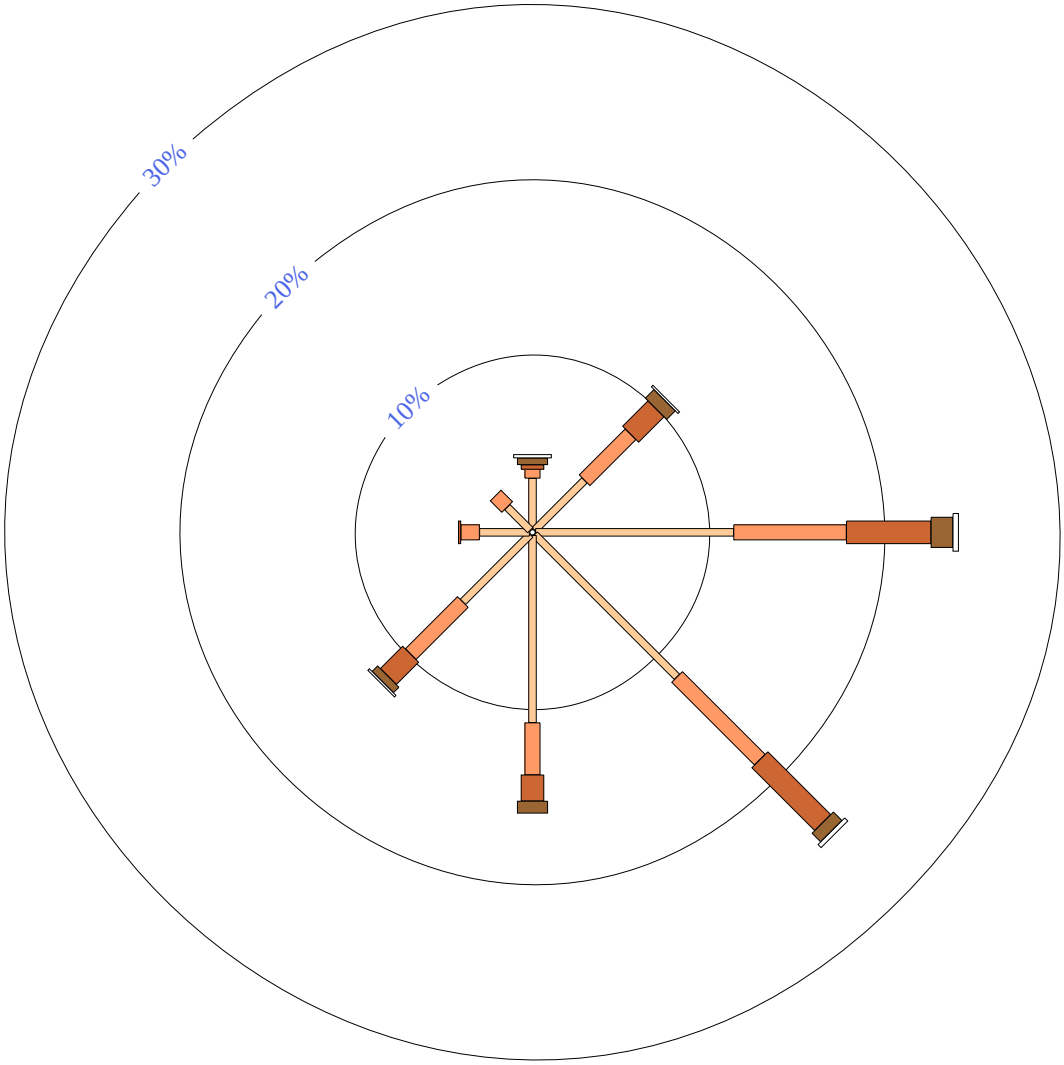
Site No: 009194 • Opened Apr 1983 • Still Open • Latitude: -32.2208° • Longitude: 115.8075° • Elevation 14m

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



9 am Jan
796 Total Observations

Calm 1%



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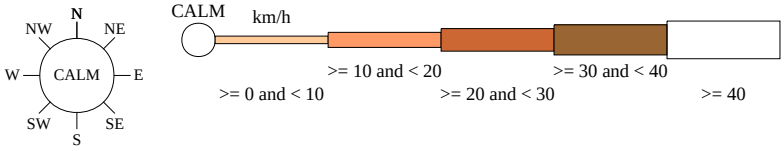
Rose of Wind direction versus Wind speed in km/h (01 Apr 1983 to 30 Sep 2010)

Custom times selected, refer to attached note for details

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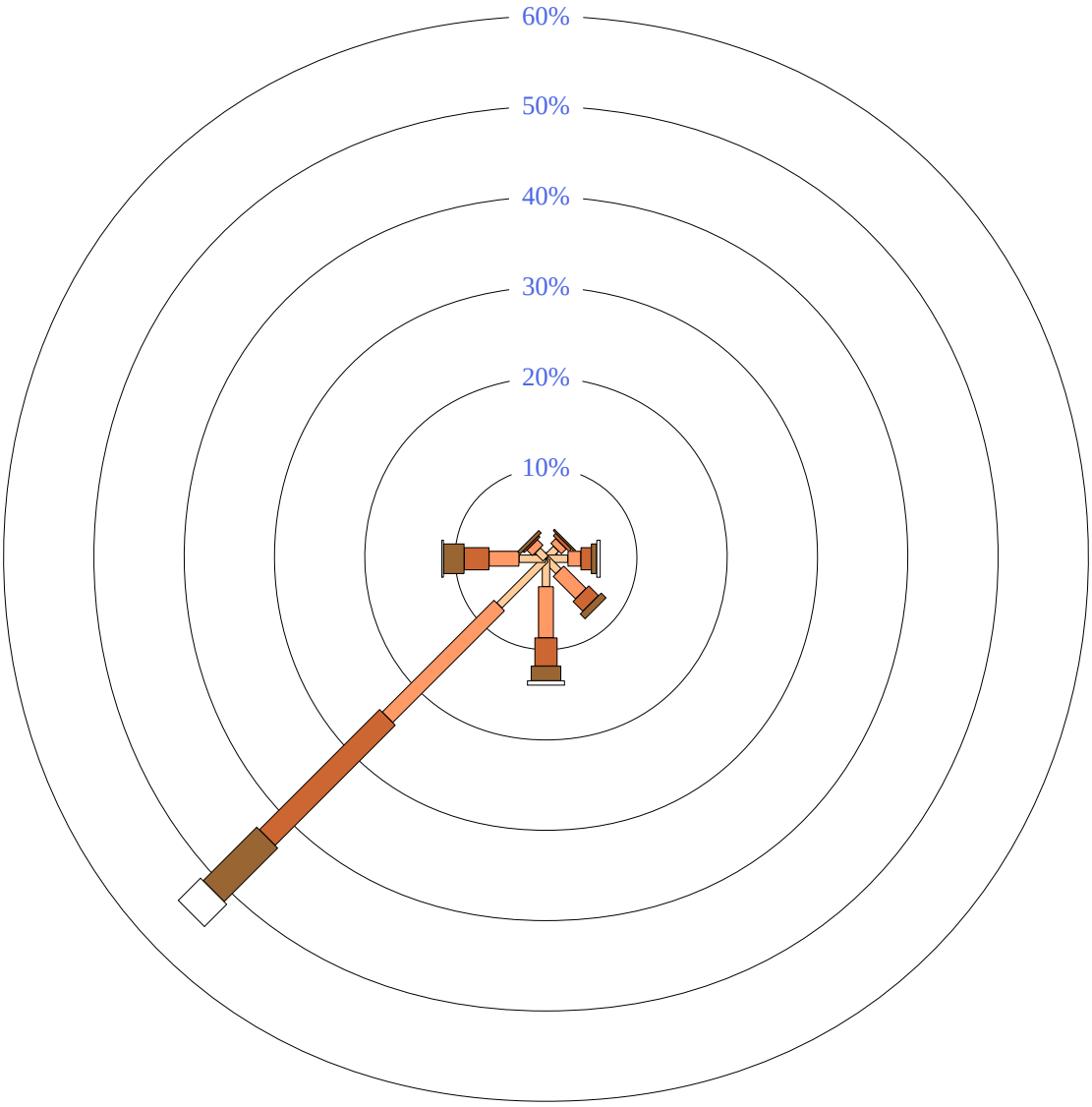
Site No: 009194 • Opened Apr 1983 • Still Open • Latitude: -32.2208° • Longitude: 115.8075° • Elevation 14m

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



3 pm Jan
532 Total Observations

Calm *



Australian Government
Bureau of Meteorology

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Appendix 3
Construction standards for BAL 12.5 and BAL 19 as per AS 3959–2009

SECTION 5 CONSTRUCTION FOR BUSHFIRE ATTACK LEVEL 12.5 (BAL — 12.5)

5.1 GENERAL

A building assessed in Section 2 as being BAL—12.5 shall comply with Section 3 and Clauses 5.2 to 5.8.

NOTE: There are a number of Standards that specify requirements for construction; however, where this Standard does not provide construction requirements for a particular element, the other Standards apply.

Any element of construction or system that satisfies the test criteria of AS 1530.8.1 may be used in lieu of the applicable requirements contained in Clauses 5.2 to 5.8 (see Clause 3.8).

NOTE: BAL—12.5 is primarily concerned with protection from ember attack and radiant heat up to and including 12.5 kW/m^2 where the site is less than 100 m from the source of bushfire attack.

5.2 SUBFLOOR SUPPORTS

This Standard does not provide construction requirements for subfloor support posts, columns, stumps, piers and poles.

NOTE: The exclusion of requirements for subfloor supports applies to the principal building only and not to verandas, decks, steps, ramps and landings (see Clause 5.7).

C5.2 *Ideally, storage of combustible materials beneath a floor at this BAL would not occur and on this assumption, there is no requirement to enclose the subfloor space or to protect flooring materials from bushfire attack. However, should combustible materials be stored, it is recommended the area be protected as materials stored in the subfloor space may be ignited by embers and cause an impact to the building.*

5.3 FLOORS

5.3.1 Concrete slabs on ground

This Standard does not provide construction requirements for concrete slabs on the ground.

5.3.2 Elevated floors

This Standard does not provide construction requirements for elevated floors, including bearers, joists and flooring.

5.4 EXTERNAL WALLS

5.4.1 Walls

That part of an external wall surface that is less than 400 mm from the ground or less than 400 mm above decks, carport roofs, awnings and similar elements or fittings having an angle less

than 18 degrees to the horizontal and extending more than 110 mm in width from the wall (see Figure D3, Appendix D) shall be of—

(a) non-combustible material; or

(b) fibre-cement external cladding, a minimum of 6 mm in thickness; or

(c) bushfire-resisting timber (see Appendix F); or

(d) a timber species as specified in Paragraph E1 and listed in Table E1, Appendix E; or

(e) a combination of any of Items (a), (b), (c) or (d) above.

There are no requirements for external wall surfaces 400 mm or more from the ground or for external wall surfaces 400 mm or more above decks, carport roofs, awnings and similar elements or fittings having an angle less than 18 degrees to the horizontal and extending more than 110 mm in width from the wall (see Figure D3, Appendix D).

5.4.2 Joints

All joints in the external surface material of walls shall be covered, sealed, overlapped, backed or butt-jointed to prevent gaps greater than 3 mm.

Alternatively, sarking-type material may be applied over the outer face of the frame prior to fixing any external cladding.

5.4.3 Vents and weepholes

Vents and weepholes in external walls shall be screened with a mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium, except where the vents and weepholes are less than 3 mm (see Clause 3.6), or are located in an external wall of a subfloor space.

5.5 EXTERNAL GLAZED ELEMENTS AND ASSEMBLIES AND EXTERNAL DOORS

5.5.1 Bushfire shutters

Where fitted, bushfire shutters shall comply with Clause 3.7 and be made from—

(a) non-combustible material; or

(b) a timber species as specified in Paragraph E1 and listed in Table E1, Appendix E; or

(c) bushfire-resisting timber (see Appendix F); or

(d) a combination of any of Items (a), (b) or (c) above.

5.5.2 Windows

Window assemblies shall comply with one of the following:

(a) They shall be completely protected by a bushfire shutter that complies with Clause 5.5.1.

or

(b) They shall be completely protected externally by screens with a mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

or

(c) They shall comply with the following:

(i) For window assemblies less than 400 mm from the ground or less than 400 mm above decks, carport roofs, awnings and similar elements or fittings having an angle less than 18 degrees to the horizontal and extending more than 110 mm in width from the window frame (see Figure D3, Appendix D), window frames and window joinery shall be made from one of the following:

(A) Bushfire-resisting timber (see Appendix F).

or

(B) A timber species specified in Paragraph E2 and listed in Table E2, Appendix E.

or

(C) Metal.

Or

(D) Metal-reinforced PVC-U. The reinforcing members shall be made from aluminium, stainless steel, or corrosion-resistant steel and the frame and sash shall satisfy the design load, performance and structural strength of the member.

(ii) Externally fitted hardware that supports the sash in its functions of opening and closing shall be metal.

(iii) Where glazing is less than 400 mm from the ground or less than 400 mm above decks, carport roofs, awnings and similar elements or fittings having an angle less than 18 degrees to the horizontal and extending more than 110 mm in width from the window frame (see Figure D3, Appendix D), the glazing shall be Grade A safety glass minimum 4 mm, or glass blocks with no restriction on glazing methods.

NOTE: Where double glazed units are used the above requirements apply to the external face of the window assembly only.

(iv) Where glazing is other than that specified in Item (iii) above, annealed glass may be used.

(v) The openable portions of windows shall be screened with mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

5.5.3 Doors—Side-hung external doors (including French doors, panel fold and bi-fold doors)

Side-hung external doors, including French doors, panel fold and bi-fold doors, shall comply with one of the following:

(a) They shall be protected by a bushfire shutter that complies with Clause 5.5.1.

or

(b) They shall be completely protected externally by screens with a mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

or

(c) They shall comply with the following:

(i) Doors shall be—

(A) non-combustible; or

(B) a solid timber door, having a minimum thickness of 35 mm for the first 400 mm above the threshold; or

(C) a door, including a hollow core door, with a non-combustible kickplate on the outside for the first 400 mm above the threshold; or

(D) a fully framed glazed door, where the framing is made from materials required for bushfire shutters (see Clause 5.5.1), or from a timber species specified in Paragraph E2 and listed in Table E2, Appendix E.

(ii) Where doors incorporate glazing, the glazing shall comply with the glazing requirements for windows.

(iii) Doors shall be tight-fitting to the doorframe and to an abutting door, if applicable.

(iv) Where any part of the door assembly is less than 400 mm from the ground or less than 400 mm above decks, carport roofs, awnings and similar elements or fittings having an angle less than 18 degrees to the horizontal and extending more than 110 mm in width from the door (see Figure D3, Appendix D), that part of the door assembly shall be made from one of the following:

(A) Bushfire-resisting timber (see Appendix F).

or

(B) A timber species specified in Paragraph E2 and listed in Table E2, Appendix E.

or

(C) Metal.

or

(D) Metal-reinforced PVC-U. The reinforcing members shall be made from aluminium, stainless steel, or corrosion-resistant steel and the door assembly shall satisfy the design load, performance and structural strength of the member.

(v) Weather strips, draught excluders or draught seals shall be installed at the base of side-hung external doors.

5.5.4 Doors—Sliding doors

Sliding doors shall comply with one of the following:

(a) They shall be protected by a bushfire shutter that complies with Clause 5.5.1.

or

(b) They shall be completely protected externally by screens with a mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

or

(c) They shall comply with the following:

(i) Any glazing incorporated in sliding doors shall be Grade A safety glass complying with AS 1288.

(ii) There is no requirement to screen the openable part of the sliding door. However, if screened, the screens shall be a mesh or perforated sheet made of corrosion-resistant steel, bronze or aluminium.

NOTE: The construction of manufactured sliding doors should prevent the entry of embers when the door is closed. There is no requirement to provide screens to the openable part of these doors as it is assumed that a sliding door will be closed if occupants are not present or during a bushfire event. Screens of materials other than those specified may not resist ember attack.

(iii) Sliding doors shall be tight-fitting in the frames.

5.5.5 Doors—Vehicle access doors (garage doors)

The following apply to vehicle access doors:

(a) The lower portion of a vehicle access door that is within 400 mm of the ground when the door is closed (see Figure D4, Appendix D) shall be made from—

(i) non-combustible material; or

(ii) bushfire-resisting timber (see Appendix F); or

(iii) fibre-cement sheet, a minimum of 6 mm in thickness; or

(iv) a timber species specified in Paragraph E1 and listed in Table E1, Appendix E; or

(v) a combination of any of Items (i), (ii), (iii) or (iv) above.

(b) Panel lift, tilt doors or side-hung doors shall be fitted with suitable weather strips, draught excluders, draught seals or guide tracks, as appropriate to the door type, with a maximum gap no greater than 3 mm.

(c) Roller doors shall have guide tracks with a maximum gap no greater than 3 mm and shall be fitted with a nylon brush that is in contact with the door (see Figure D4, Appendix D).

(d) Vehicle access doors shall not include ventilation slots.

5.6 ROOFS (INCLUDING VERANDA AND ATTACHED CARPORT ROOFS, PENETRATIONS, EAVES, FASCIAS, GABLES, GUTTERS AND DOWNPIPES)

5.6.1 General

The following apply to all types of roofs and roofing systems:

(a) Roof tiles, roof sheets and roof-covering accessories shall be non-combustible.

(b) The roof/wall junction shall be sealed, to prevent openings greater than 3 mm, either by the use of fascia and eaves linings or by sealing between the top of the wall and the underside of the roof and between the rafters at the line of the wall.

(c) Roof ventilation openings, such as gable and roof vents, shall be fitted with ember guards made of non-combustible material or a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

5.6.2 Tiled roofs

Tiled roofs shall be fully sarked. The sarking shall—

(a) have a flammability index of not more than 5;

(b) be located directly below the roof battens;

(c) cover the entire roof area including the ridge; and

(d) be installed so that there are no gaps that would allow the entry of embers where the sarking meets fascias, gutters, valleys and the like.

5.6.3 Sheet roofs

Sheet roofs shall—

(a) be fully sarked in accordance with Clause 5.6.2, except that foil-backed insulation blankets may be installed over the battens;

or

(b) have any gaps greater than 3 mm, under corrugations or ribs of sheet roofing and between roof components, sealed at the fascia or wall line and at valleys, hips and ridges by—

(i) a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium; or

(ii) mineral wool; or

(iii) other non-combustible material; or

(iv) a combination of any of Items (i), (ii) or (iii) above.

5.6.4 Veranda, carport and awning roofs

The following apply to veranda, carport and awning roofs:

(a) A veranda, carport or awning roof forming part of the main roof space [see Figure D1(a), Appendix D] shall meet all the requirements for the main roof, as specified in Clauses 5.6.1, 5.6.2, 5.6.3, 5.6.5 and 5.6.6.

(b) A veranda, carport or awning roof separated from the main roof space by an external wall [see Figures D1(b) and D1(c), Appendix D] complying with Clause 5.4 shall have a non-combustible roof covering.

NOTE: There is no requirement to line the underside of a veranda, carport or awning roof that is separated from the main roof space.

5.6.5 Roof penetrations

The following apply to roof penetrations:

(a) Roof penetrations, including roof lights, roof ventilators, roof-mounted evaporative cooling units, aerials, vent pipes and supports for solar collectors, shall be adequately sealed at the roof to prevent gaps greater than 3 mm. The material used to seal the penetration shall be non-combustible.

(b) Openings in vented roof lights, roof ventilators or vent pipes shall be fitted with ember guards made from a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

(c) All overhead glazing shall be Grade A laminated safety glass complying with AS 1288.

(d) Glazed elements in roof lights and skylights may be of polymer provided a Grade A safety glass diffuser, complying with AS 1288, is installed under the glazing. Where glazing is an insulating glazing unit (IGU), Grade A toughened safety glass, minimum 4 mm, shall be used in the outer pane of the IGU.

(e) Flashing elements of tubular skylights may be of a fire-retardant material, provided the roof integrity is maintained by an under-flashing of a material having a flammability index no greater than 5.

(f) Evaporative cooling units shall be fitted with butterfly closers at or near the ceiling level or, the unit shall be fitted with non-combustible covers with a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

(g) Vent pipes made from PVC are permitted.

5.6.6 Eaves linings, fascias and gables

The following apply to eaves linings, fascias and gables:

(a) Gables shall comply with Clause 5.4.

(b) Eaves penetrations shall be protected the same as for roof penetrations, as specified in Clause 5.6.5.

(c) Eaves ventilation openings greater than 3 mm shall be fitted with ember guards made of non-combustible material or a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

Joints in eaves linings, fascias and gables may be sealed with plastic joining strips or timber storm moulds.

This Standard does not provide construction requirements for fascias, bargeboards and eaves linings.

5.6.7 Gutters and downpipes

This Standard does not provide material requirements for—

(a) gutters, with the exception of box gutters; and

(b) downpipes.

If installed, gutter and valley leaf guards shall be non-combustible.

Box gutters shall be non-combustible and flashed at the junction with the roof with non-combustible material.

5.7 VERANDAS, DECKS, STEPS, RAMPS AND LANDINGS

5.7.1 General

Decking shall be either spaced or continuous (i.e., without spacing).

There is no requirement to enclose the subfloor spaces of verandas, decks, steps, ramps or landings.

C5.7.1 *Spaced decking is nominally spaced at 3 mm (in accordance with standard industry practice); however, due to the nature of timber decking with seasonal changes in moisture content, that spacing may range from 0–5 mm during service. The preferred dimension for gaps is 3 mm (which is in line with other 'permissible gaps') in other parts of this Standard. It should be noted that recent research studies have shown that gaps at 5 mm spacing afford opportunity for embers to become lodged in between timbers, which may contribute to a fire. Larger gap spacings of 10 mm may preclude this from happening but such a spacing regime may not be practical for a timber deck.*

5.7.2 Enclosed subfloor spaces of verandas, decks, steps, ramps and landings

5.7.2.1 *Materials to enclose a subfloor space*

This Standard does not provide construction requirements for the materials used to enclose a subfloor space except where those materials are less than 400 mm from the ground.

Where the materials used to enclose a subfloor space are less than 400 mm from the ground, they shall comply with Clause 5.4.

5.7.2.2 *Supports*

This Standard does not provide construction requirements for support posts, columns, stumps, stringers, piers and poles.

5.7.2.3 *Framing*

This Standard does not provide construction requirements for the framing of verandas, decks, ramps or landings (i.e., bearers and joists).

5.7.2.4 *Decking*

This Standard does not provide construction requirements for decking that is more than 300 mm from a glazed element.

Decking less than 300 mm (measured horizontally at deck level) from glazed elements that are less than 400 mm (measured vertically) from the surface of the deck (see Figure D2, Appendix D) shall be made from—

(a) non-combustible material; or

(b) bushfire-resisting timber (see Appendix F); or

(c) a timber species, as specified in Paragraph E1 and listed in Table E1 of Appendix E;

(d) PVC-U; or

(e) a combination of any of Items (a), (b), (c) or (d) above.

5.7.3 Unenclosed subfloor spaces of verandas, decks, steps, ramps and landings

5.7.3.1 *Supports*

This Standard does not provide construction requirements for support posts, columns, stumps, stringers, piers and poles.

5.7.3.2 *Framing*

This Standard does not provide construction requirements for the framing of verandas, decks, ramps or landings (i.e., bearers and joists).

5.7.3.3 *Decking*

This Standard does not provide construction requirements for decking unless it is less than 300 mm from a glazed element.

Decking less than 300 mm (measured horizontally at deck level) from glazed elements that are less than 400 mm (measured vertically) from the surface of the deck (see Figure D2, Appendix D) shall be made from—

(a) non-combustible material; or

(b) bushfire-resisting timber (see Appendix F); or

(c) a timber species, as specified in Paragraph E1 and listed in Table E1, Appendix E; or

(d) a combination of any of Items (a), (b) or (c) above.

5.7.4 Balustrades, handrails or other barriers

This Standard does not provide construction requirements for balustrades, handrails and other barriers.

5.8 WATER AND GAS SUPPLY PIPES

Above-ground, exposed water and gas supply pipes shall be metal.

SECTION 6 CONSTRUCTION FOR BUSHFIRE ATTACK LEVEL 19 (BAL — 19)

6.1 GENERAL

A building assessed in Section 2 as being BAL—19 shall comply with Section 3 and Clauses 6.2 to 6.8.

NOTE: There are a number of Standards that specify requirements for construction; however, where this Standard does not provide construction requirements for a particular element, the other Standards apply.

Any element of construction or system that satisfies the test criteria of AS 1530.8.1 may be used in lieu of the applicable requirements contained in Clauses 6.2 to 6.8 (see Clause 3.8).

NOTE: BAL—19 is primarily concerned with protection from ember attack and radiant heat greater than 12.5 kW/m2 up to and including 19 kW/m2.

6.2 SUBFLOOR SUPPORTS

This Standard does not provide construction requirements for subfloor support posts, columns, stumps, piers and poles.

NOTE: The exclusion of requirements for subfloor supports applies to the principal building only and not to verandas, decks, steps, ramps and landings (see Clause 6.7).

C6.2 Ideally, storage of combustible materials beneath a floor at this BAL would not occur and on this assumption, there is no requirement to enclose the subfloor space or to protect flooring materials from bushfire attack. However, should combustible materials be stored, it is recommended the area be protected as materials stored in the subfloor space may be ignited by embers and cause an impact to the building.

6.3 FLOORS

6.3.1 Concrete slabs on the ground

This Standard does not provide construction requirements for concrete slabs on ground.

6.3.2 Elevated floors

This Standard does not provide construction requirements for elevated floors, including bearers, joists and flooring.

6.4 EXTERNAL WALLS

6.4.1 Walls

That part of an external wall surface that is less than 400 mm from the ground or less than 400 mm above decks, carport roofs, awnings and similar elements or fittings having an angle less than 18

degrees to the horizontal and extending more than 110 mm in width from the wall (see Figure D3, Appendix D) shall be made from—

(a) non-combustible material; or

(b) fibre-cement external cladding, a minimum of 6 mm in thickness; or

(c) bushfire-resisting timber (see Appendix F); or

(d) a timber species, as specified in Paragraph E1 and listed in Table E1, Appendix E; or

(e) a combination of any of Items (a), (b), (c) or (d) above.

This Standard does not provide construction requirements for external wall surfaces 400 mm or more from the ground or for external wall surfaces 400 mm or more above decks, carport roofs, awnings and similar elements or fittings having an angle less than 18 degrees to the horizontal and extending more than 110 mm in width from the wall (see Figure D3, Appendix D).

6.4.2 Joints

All joints in the external surface material of walls shall be covered, sealed, overlapped, backed or butt-jointed to prevent gaps greater than 3 mm.

Alternatively, sarking-type material may be applied over the outer face of the frame prior to fixing any external cladding.

6.4.3 Vents and weepholes

Vents and weepholes in external walls shall be screened with mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium, except where they are less than 3 mm (see Clause 3.6), or are located in an external wall of a subfloor space.

6.5 EXTERNAL GLAZED ELEMENTS AND ASSEMBLIES AND EXTERNAL DOORS

6.5.1 Bushfire shutters

Where fitted, bushfire shutters shall comply with Clause 3.7 and be made from—

(a) non-combustible material; or

(b) a timber species, as specified in Paragraph E1 and listed in Table E1, Appendix E; or

(c) bushfire-resisting timber (see Appendix F); or

(d) a combination of any of Items (a), (b), or (c) above.

6.5.2 Windows

Window assemblies shall comply with one of the following:

(a) They shall be completely protected by a bushfire shutter that complies with Clause 6.5.1.

or

(b) They shall be completely protected externally by screens with a mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

or

(c) They shall comply with the following:

(i) For window assemblies less than 400 mm from the ground or less than 400 mm above decks, carport roofs, awnings and similar elements or fittings, having an angle less than 18 degrees to the horizontal and extending more than 110 mm in width from the window frame (see Figure D3, Appendix D), window frames and window joinery, shall be made from one of the following:

(A) Bushfire-resisting timber (see Appendix F).

or

(B) A timber species, as specified in Paragraph E2 and listed in Table E2, Appendix E.

or

(C) Metal.

or

(D) Metal-reinforced PVC-U. The reinforcing members shall be made from aluminium, stainless steel, or corrosion-resistant steel and the frame and the sash shall satisfy the design load, performance and structural strength of the member.

(ii) Externally fitted hardware that supports the sash in its functions of opening and closing, shall be metal.

(iii) Where glazing is less than 400 mm from the ground or less than 400 mm above decks, carport roofs, awnings and similar elements or fittings, having an angle less than 18 degrees to the horizontal and extending more than 110 mm in width from the window frame (see Figure D3, Appendix D), the glazing shall be toughened glass, minimum 5 mm, or glass blocks with no restriction on glazing methods.

NOTE: Where double-glazed units are used, the above requirements apply to the external face of the window assembly only.

(iv) Where glazing is other than that specified in Item (iii) above, annealed glass may be used. Where annealed glass is used, the fixed and openable portions of windows shall be screened externally with a mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

(v) Where toughened glass is used, the openable portions of windows shall be screened internally or externally with a mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

(vi) Glazed elements that are designed to take internal screens shall use toughened glass and the openable portion shall be screened in such a way to have no gaps greater than 3 mm in diameter. Screening material shall be a mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

6.5.3 Doors—Side-hung external doors (including French doors, panel fold and bi-fold doors)

Side-hung external doors, including French doors, panel fold and bi-fold doors, shall comply with one of the following:

(a) They shall be protected by a bushfire shutter that complies with Clause 6.5.1.

or

(b) They shall be completely protected externally by screens with a mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

or

(c) They shall comply with the following:

(i) Doors shall be—

(A) non-combustible; or

(B) a solid timber door, having a minimum thickness of 35 mm for the first 400 mm above the threshold; or

(C) a door, including a hollow core door, with a non-combustible kickplate on the outside for the first 400 mm above the threshold; or

(D) a fully-framed glazed door, where the framing is made from materials specified for bushfire shutters (see Clause 6.5.1).

(ii) Where doors incorporate glazing, the glazing shall be toughened glass minimum 5 mm.

(iii) Doors shall be tight-fitting to the doorframe and to an abutting door, if applicable.

(iv) Where the doorframe is less than 400 mm from the ground or less than 400 mm above decks, carport roofs, awnings and similar elements or fittings having an angle less than 18 degrees to the horizontal and extending more than 110 mm in width from the door (see Figure D3, Appendix D) the doorframe shall be made from one of the following:

(A) Bushfire-resisting timber (see Appendix F).

or

(B) A timber species, as specified in Paragraph E2 and listed in Table E2, Appendix E.

or

(C) Metal.

or

(D) Metal-reinforced PVC-U. The reinforcing members shall be made from aluminium, stainless steel, or corrosion-resistant steel and the door assembly shall satisfy the design load, performance and structural strength of the member.

(v) Weather strips, draught excluders or draught seals shall be installed at the base of side-hung external doors.

6.5.4 Doors—Sliding doors

Sliding doors shall comply with one of the following:

(a) They shall be completely protected by a bushfire shutter that complies with Clause 6.5.1.

or

(b) They shall be completely protected externally by screens with a mesh with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

or

(c) They shall comply with the following:

(i) Any glazing incorporated in sliding doors shall be toughened glass, minimum 5 mm.

(ii) There is no requirement to screen the openable part of the sliding door. However, if screened, the screens shall be mesh or perforated sheet made of corrosion-resistant steel, bronze or aluminium.

NOTE: The construction of manufactured sliding doors should prevent the entry of embers when the door is closed. There is no requirement to provide screens to the openable part of these doors as it is assumed that a sliding door will be closed if occupants are not present or during a bushfire event. Screens of materials other than those specified may not resist ember attack.

(iii) Sliding doors shall be tight-fitting in the frames.

6.5.5 Doors—Vehicle access doors (garage doors)

The following apply to vehicle access doors:

(a) The lower portion of a vehicle access door that is within 400 mm of the ground when the door is closed (see Figure D4, Appendix D) shall be made from—

(i) non-combustible material; or

(ii) bushfire-resisting timber (see Appendix F); or

(iii) fibre-cement sheet, a minimum of 6 mm in thickness; or

(iv) a timber species, as specified in Paragraph E1 and listed in Table E1, Appendix E; or

(v) a combination of any of Items (i), (ii), (iii) or (iv) above.

(b) Panel lift, tilt doors or side-hung doors shall be fitted with suitable weather strips, draught excluders, draught seals or guide tracks, as appropriate to the door type, with a maximum gap no greater than 3 mm.

(c) Roller doors shall have guide tracks with a maximum gap no greater than 3 mm and shall be fitted with a nylon brush that is in contact with the door (see Figure D4, Appendix D).

(d) Vehicle access doors shall not include ventilation slots.

6.6 ROOFS (INCLUDING VERANDA AND ATTACHED CARPORT ROOFS, PENETRATIONS, EAVES, FASCIAS, GABLES, GUTTERS AND DOWNPIPES)

6.6.1 General

The following apply to all types of roofs and roofing systems:

(a) Roof tiles, roof sheets and roof-covering accessories shall be non-combustible.

(b) The roof/wall junction shall be sealed, to prevent openings greater than 3 mm, either by the use of fascia and eaves linings or by sealing between the top of the wall and the underside of the roof and between the rafters at the line of the wall.

(c) Roof ventilation openings, such as gable and roof vents, shall be fitted with ember guards made of non-combustible material or a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

6.6.2 Tiled roofs

Tiled roofs shall be fully sarked. The sarking shall—

(a) have a flammability index of not more than 5, when tested to AS 1530.2;

(b) be located directly below the roof battens;

(c) cover the entire roof area including the ridge; and

(d) be installed so that there are no gaps that would allow the entry of embers where the sarking meets fascias, gutters, valleys and the like.

6.6.3 Sheet roofs

Sheet roofs shall—

(a) be fully sarked in accordance with Clause 6.6.2, except that foil-backed insulation blankets may be installed over the battens;

or

(b) have any gaps greater than 3 mm under corrugations or ribs of sheet roofing and between roof components sealed at the fascia or wall line and at valleys, hips and ridges by—

(i) a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium; or

(ii) mineral wool; or

(iii) other non-combustible material; or

(iv) a combination of any of Items (i), (ii), or (iii) above.

6.6.4 Veranda, carport and awning roofs

The following apply to veranda, carport and awning roofs:

(a) A veranda, carport or awning roof forming part of the main roof space [see Figure D1(a), Appendix D] shall meet all the requirements for the main roof, as specified in Clauses 6.6.1, 6.6.2, 6.6.3, 6.6.5 and 6.6.6.

(b) A veranda, carport or awning roof separated from the main roof space by an external wall [see Figures D1(b) and D1(c), Appendix D] complying with Clause 6.4 shall have a non-combustible roof covering.

NOTE: There is no requirement to line the underside of a veranda, carport or awning roof that is separate from the main roof space.

6.6.5 Roof penetrations

The following apply to roof penetrations:

(a) Roof penetrations, including roof lights, roof ventilators, roof-mounted evaporative cooling units, aerials, vent pipes and supports for solar collectors shall be adequately sealed at the roof to prevent gaps greater than 3 mm. The material used to seal the penetration shall be non-combustible.

(b) Openings in vented roof lights, roof ventilators or vent pipes shall be fitted with ember guards made from a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

(c) All overhead glazing shall be Grade A laminated safety glass complying with AS 1288.

(d) Glazed elements in roof lights and skylights may be of polymer provided a Grade A safety glass diffuser, complying with AS 1288, is installed under the glazing. Where glazing is an insulating glazing unit (IGU), Grade A toughened safety glass of minimum 4 mm shall be used in the outer pane of the IGU.

(e) Flashing elements of tubular skylights may be of a fire-retardant material, provided the roof integrity is maintained by an under-flashing of a material having a flammability index no greater than 5.

(f) Evaporative cooling units shall be fitted with butterfly closers at or near the ceiling level, or the unit shall be fitted with non-combustible covers with a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

6.6.6 Eaves linings, fascias and gables

The following apply to eaves linings, fascias and gables:

(a) Gables shall comply with Clause 6.4.

(b) Eaves penetrations shall be protected the same as for roof penetrations, as specified in Clause 6.6.5.

(c) Eaves ventilation openings greater than 3 mm shall be fitted with ember guards made of non-combustible material or a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.

Joints in eaves linings, fascias and gables may be sealed with plastic joining strips or timber storm moulds.

This Standard does not provide construction requirements for fascias, bargeboards and eaves linings.

6.6.7 Gutters and downpipes

This Standard does not provide material requirements for—

(a) gutters, with the exception of box gutters; and

(b) downpipes.

If installed, gutter and valley leaf guards shall be non-combustible.

Box gutters shall be non-combustible and flashed at the junction with the roof with non-combustible material.

6.7 VERANDAS, DECKS, STEPS, RAMPS AND LANDINGS

6.7.1 General

Decking shall be either spaced or continuous (i.e., without spacings).

There is no requirement to enclose the subfloor spaces of verandas, decks, steps, ramps or landings.

C6.7.1 Spaced decking is nominally spaced at 3 mm (in accordance with standard industry practice); however, due to the nature of timber decking with seasonal changes in moisture content, that spacing may range from 0–5 mm during service. The preferred dimension for gaps is 3 mm (which is in line with other ‘permissible gaps’) in other parts of this Standard. It should be noted that recent research studies have shown that gaps at 5 mm spacing afford opportunity for embers to become lodged in between timbers, which may contribute to a fire. Larger gap spacings of 10 mm may preclude this from happening but such a spacing regime may not be practical for a timber deck.

6.7.2 Enclosed subfloor spaces of verandas, decks, steps, ramps and landings

6.7.2.1 *Materials to enclose a subfloor space*

This Standard does not provide construction requirements for the materials used to enclose a subfloor space except where those materials are less than 400 mm from the ground.

Where the materials used to enclose a subfloor space are less than 400 mm from the ground, they shall comply with Clause 6.4.

6.7.2.2 *Subfloor supports*

This Standard does not provide construction requirements for subfloor support posts, columns, stumps, stringers, piers and poles.

6.7.2.3 *Framing*

This Standard does not provide construction requirements for the framing of verandas, decks, ramps or landings (i.e., bearers and joists).

6.7.2.4 *Decking*

This Standard does not provide construction requirements for decking that is more than 300 mm from a glazed element.

Decking less than 300 mm (measured horizontally at deck level) from glazed elements that are less than 400 mm (measured vertically) from the surface of the deck (see Figure D2, Appendix D) shall be made from—

(a) non-combustible material; or

(b) bushfire-resisting timber (see Appendix F); or

(c) a timber species, as specified in Paragraph E1 and listed in Table E1, Appendix E; or

(d) a combination of any of Items (a), (b), or (c) above.

6.7.3 Unenclosed subfloor spaces of verandas, decks, steps, ramps and landings

6.7.3.1 *Supports*

This Standard does not provide construction requirements for support posts, columns, stumps, stringers, piers and poles.

6.7.3.2 *Framing*

This Standard does not provide construction requirements for the framing of verandas, decks, ramps or landings (i.e., bearers and joists).

6.7.3.3 *Decking*

This Standard does not provide construction requirements for decking that is more than 300 mm from a glazed element.

Decking less than 300 mm (measured horizontally at deck level) from glazed elements that are less than 400 mm (measured vertically) from the surface of the deck (see Figure D2, Appendix D) shall be made from—

(a) non-combustible material; or

(b) bushfire-resisting timber (see Appendix F); or

(c) a timber species, as specified in Paragraph E1 and listed in Table E1, Appendix E; or

(d) a combination of any of Items (a), (b), or (c) above.

6.7.4 Balustrades, handrails or other barriers

This Standard does not provide construction requirements for balustrades, handrails and other barriers.

6.8 WATER AND GAS SUPPLY PIPES

Above-ground, exposed water and gas supply pipes shall be metal.

Appendix 4
City of Cockburn annual fire control order

City of Cockburn

Fire Control Order 2014 - 2015

To all Owners and Occupiers of Land within the District of the City of Cockburn

FIRST AND FINAL NOTICE
Pursuant to the powers contained in Section 33 of the Bush Fires Act 1954 (as amended) you are hereby required without exception to comply with the requirements set out in this notice.

DEFINITIONS

Act	means *Bush Fires Act 1954* (as amended).
Authorised **Officer**	means an officer appointed as a City of Cockburn Fire Control Officer.
Building Protection Zone	means the area within a distance of 20 metres from a dwelling that has a reduced bush fire fuel load, measured from the external walls within the boundaries of the lot on which the dwelling is situated.
Bush Fire Prone Areas	means an area of the Local Government where there is a declaration made in the Town Planning Scheme to recognise the area as Bush Fire Prone or an area where there is a high chance of Bush Fire due to the local environment.
Firebreak	means a strip or area of trafficable ground, of 3.0 metres clear in width that is kept and maintained totally clear of all flammable material which includes the pruning or removal of any living or dead trees, scrub or any other material encroaching within the minimum height of the firebreak.
Fire Management Plan	means a plan that has been developed and approved by the City of Cockburn to reduce and mitigate fire hazards within a particular subdivision, lot or other area of land anywhere in the district.
Flammable Material	means any dead or dry grass, vegetable, substance, object, thing or material (except living flora including live and/ or habitat standing trees) that may or is likely to catch fire and burn or any other thing deemed by an authorised officer to be capable of combustion.
Minimum Height	means a continuous vertical uninterrupted line at a right angle to the horizontal line of the firebreak to a minimum height of 4 metres from the ground.
Permit	means a "Permit to Burn the Bush" as issued by an authorised City of Cockburn Fire Control Officer under s18 of the *Bush Fires Act 1954.*
Prohibited Burning Times	means the time period of each year where it is unlawful to set fire to the bush at any time. This season is normally from 1 December of each year until and including 31 March of the following year. This period may be amended from time to time, subject to the prevailing seasonal conditions.
Restricted Burning Times	means the time period of each year where it is unlawful to set fire to the bush without a valid Permit to Burn the bush issued by an authorised Fire Control Officer. This period normally is from 1 April until and including 30 November of any year. This period may be amended from time to time, subject to the prevailing seasonal conditions.
Trafficable	means to be able to travel from one point to another non-stop in a 4x4 vehicle on a clear surface, without any obstruction that may endanger fire fighters and their resources. A firebreak is not to terminate (dead end).
Zone	means the land zoning description as recorded by the City of Cockburn in its property rates register.

The works outlined in the following (as applicable) must be completed on or before the 1 November of each year and then maintained up to and including 31 May of the following year.

1. LAND AREA 2032m² or greater

You are required to:

1.1. Ensure that a trafficable firebreak 3.0 metres in width is established and maintained inside immediately along all boundaries in a continuous path without obstruction, including boundaries adjacent to roads, drains, rail reserves and any public open space reserves.

1.2. Trim back all overhanging branches, trees, limbs, etc. from over the top of the firebreak area to a minimum height of 4 metres.

1.3. Remove all flammable material surrounding all habitable buildings situated on the land except living trees, shrubs, lawns (maintained to a height of no more than 50mm) and maintained gardens under cultivation to a minimum width of 5 metres and a minimum height of 4 metres;

1.4. Remove all flammable material except living trees, shrubs, lawns (maintained to a height of no more than 50mm) and maintained gardens under cultivation to a minimum width of 5 metres and a minimum height of 4 metres immediately surrounding any place where wood, timber, mulch piles, hay stacks, tyres, vehicles, flammable liquids, chemicals and gas products are stored on the land.

Maintained and living lawns are an acceptable alternative in conjunction with or in lieu of firebreaks provided that the same minimum width and height requirements for a firebreak are maintained.

2. LAND AREA less than 2032m²

To reduce the fire hazard on your land you are required to:

2.1. Have all flammable materials such as long dry grass, weeds, etc. slashed, mown or trimmed down by other means to a maximum height of 50mm across the entire property for the firebreak period.

Where living gardens and lawns are established these areas are to be maintained at a height of no more than 50mm.

3. Additional Requirements

In addition to the requirements noted above, regardless of land size and location, Council or its duly authorised officer may require you to undertake additional works on your property to improve access and/or undertake further hazard removal and/or reduction works, where in the opinion of that authorised officer, the works would be conducive to preventing the outbreak and/or the spread or extension of a bush fire.

It is the landowner/occupiers responsibility to ensure all dangerous goods where stored on their land, are stored in compliance with relevant legislative requirements.

4. Fire Management Plans and Building Protection Zones

All subdivisions and/or developments within the City of Cockburn must comply with the Fire Management Plans for their subdivision/estates in entirety to the satisfaction of Council or its duly authorised officer.

5. Firebreak Variations

Please note that all firebreak variations approved prior to the 1 July 2014 will remain in place for 3 years, with an expiry date of the 30 June 2017 unless a new variation has been approved. An authorised officer of the City of Cockburn will make contact with individual property owners who have existing variations to reassess them against their individual circumstances during this period.

If it is considered to be impractical by the owner/occupier of land to clear firebreaks or establish other arrangements as required by this notice, the owner or occupier of land in the district may apply in writing for a variation to the City of Cockburn for its consideration prior to the 1 October of each year.

New firebreak variations may be approved by the City of Cockburn for up to a 3 year period, subject to the owner of the property not changing and the property remaining compliant with the approved variation conditions. Failure to comply may result in the approved variation being revoked.

Should a request to vary the firebreak requirements on your property not be approved, this notice must be complied with as outlined and as applicable in its entirety.

6. Hazard Reduction Burning

During the prohibited burning times you cannot undertake any bush or garden refuse burning activities at any time within the City of Cockburn.

During the restricted burning times, owner/occupiers of land not zoned residential, commercial or industrial within the City of Cockburn may burn the bush for fire mitigation purposes by following the conditions of a valid permit to burn issued by a City of Cockburn Fire Control Officer.

During the restricted fire season only, it is permissible for owners/occupiers of land in areas not zoned residential, commercial or industrial within the City of Cockburn to undertake the burning of garden refuse (dry leaves, small branches, off cuts, etc.) on the ground in a pile no larger than 1.0m³ during this period by complying with all the outlined requirements of s24D and s24F (3) in the *Bush Fires Act 1954*.

Any other methods of burning of garden refuse such as incineration in areas not zoned residential, commercial or industrial shall not be undertaken within the City of Cockburn.

7. Penalties

The penalty for failing to comply with this Order can be up to $5,000. A person in default is also liable whether prosecuted or not to pay the costs of performing the work directed by its duly authorised officer if it is not carried out by the owner and/ or occupier by the date required by this notice, or by the date as shown on any written additional works notice as issued by the duly authorised officer of Council.

Owner/occupier who engages a contractor to undertake works on their behalf are responsible to ensure that the works comply with the requirements of this Order.

Any notice previously published by City of Cockburn in the *Government Gazette* or in any Western Australian newsprint is hereby revoked.

By Order of Council

PERMITS

All areas zoned either Residential, Commercial or Industrial

No burning allowed at anytime in accordance with section 24G(2) of the Act.

Areas zoned Rural and Other Areas

» Prohibited burning period
1 December – 31 March (No burning permitted)

» Restricted burning period
1 April – 30 November (permit required)
Permits to burn must be obtained prior to any burning

Note: these periods can be varied at the discretion of council because of weather conditions. Permit holders are responsible to verify the current dates with the council.

Without any exception, no fire may be lit on a day when the fire danger is declared as very high, extreme, severe or catastrophic.

To determine what the fire danger level is, a person should ring 1196 for information. If there is any doubt of your responsibility in lighting a fire, of any type, the City of Cockburn should be contacted before lighting.

For more information on City of Cockburn's Fire Control Order or a permit, contact Rangers on 9411 3444.

IN THE EVENT OF FIRE TELEPHONE 000

Appendix 5
AFAC bush fire glossary

afac
Australasian Fire and Emergency Service Authorities Council

BUSHFIRE GLOSSARY

Prepared by Rural and Land Management Group for AFAC Agencies

January 2012



Disclaimer
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Preface

The AFAC Bushfire Glossary has been developed to promote an exchange of information between member agencies on terminology used specifically in bushfires.

The Glossary has been developed based on a set of agreed business rules. It includes the bushfire technical terms, their definition or description as adopted and applied by the AFAC member agencies. It does include some fire terms that are of a general industry wide nature for completeness. It excludes terms for which an agreed definition could not be reached by the member agencies.

This document is not designed to be a text book or to provide a discussion of a term beyond the definition/description of that term. Nor is it an attempt to modify or redefine terms defined in codes, standards or legislation. Terms that have been adopted for use by the fire management industry from another discipline will maintain the meaning ascribed to them in their originating discipline.

It is proposed that this Glossary will be reviewed regularly to ensure that it continues to be relevant and meets the needs of AFAC member agencies. This is the fifth review. It is the current 2012 version.

AFAC acknowledges the significant contribution of the Rural and Land Management Glossary Working Group lead by Greg Esnouf and Country Fire Authority staff, Matthew Fraser and Jo Richards, who contributed generously of their time and expertise in the establishment of this document and the work of the Genesis Institute to provide a framework for refining the glossary.

Previous versions of the Glossary were titled Wildfire Glossary. The term wildfire has been replaced with the term bushfire in line with a trend towards using language more accepted by the general public.

The terms appear in alphabetical order excluding spaces. In this way it is possible to find a compound word without knowing if it is one or two words.

Aim

The purpose of this Glossary is to seek to facilitate a greater understanding by using common language between bushfire and land management agencies and support organisations during the prevention of, preparedness for, response to and recovery from bushfires.

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Term	Definition
Accelerant	Any substance (such as oil, gasoline, etc) that is applied to a fuel-bed to expedite the burning process.
Adaptor	A fitting used to couple different sized hoses, hoses of the same size with different threads, or different types of couplings, or to connect the male to male, or female to female parts of the same type of coupling.
Adsorption	The taking in of water vapour from the air by dead plant material.
Advance burn	A prescribed fire that reduces fuel through a forest area before felling operations. It is intended to improve the safety of timber harvesting operations and as a silvicultural tool to protect lignotubers and standing trees.
Advancing fire	That portion of the fire with rapid fire spread and higher intensity which is normally burning with the wind and/or up slope.
Aerial detection	The discovering, locating and reporting of fires from aircraft.
Aerial fuel	See: Elevated fuel
Aerial ignition	Ignition of fuels by dropping incendiary devices or materials from aircraft.
Aerial ignition device (AID)	Inclusive term applied to equipment designed to ignite wildland fuels from an aircraft.
Aerial Observer	See: Air Observer
Aerial reconnaissance	Use of aircraft for detection of fires and observing fire behaviour, values-at-risk, suppression activity, and other critical factors to facilitate command decisions on strategy and tactics needed for fire suppression.
Aerosol	Airborne solid or liquid particles dispersed or suspended in a gas stream.
After action review (AAR)	A discussion, focused on performance standards, of an event that enables those involved to discover what happened, why it happened, and how to sustain strengths and improve on weaknesses. An After action review is a tool incident command personnel and units can use to get maximum benefit from every incident. It provides a review of the incident upon its completion to identify and discuss effective and non-effective performance and lessons learned and how to apply them in the future. (adapted from NWCG)
AIIMS structure	The combination of facilities, equipment, personnel, procedures, and communications operating within a common organisational structure with responsibility for the management of allocated resources to effectively accomplish stated objectives relating to an incident (AIIMS).
Air attack	The direct use of aircraft in the suppression of bushfires.
Air attack Supervisor	Primarily responsible for the safety and efficient tactical coordination of aircraft operations when fixed and/or rotary firebombing aircraft are operating at a fire (Air Attack Supervisor Training Manual).
Air base Manager	An experienced, trained person who is appointed to manage all the functions and personnel on an air base or helicopter base.
Air mass	A meteorological term referring to an extensive body of air within which the conditions of temperature and moisture in a horizontal plane are essentially uniform.
Air Observer	The primary role of the air observer is to aerially obtain intelligence to assist the planning of fire suppression operations (NSWRFS).
Air operations	The use of aircraft in support of an incident for the purposes of suppression, transportation of personnel, equipment or supplies, or for aerial reconnaissance.

Term	Definition
Air operations Manager	The air operations manager position is responsible for overall coordination of air operations and air support activities in support of an incident.
Aircraft Officer	The aircraft officer is responsible for ground operations and overall provision of support, enabling a safe and efficient air operation to be conducted.
Airside	The parts of an airport not normally open to unauthorised people. It comprises the apron, taxiways, runways and the areas containing them.
Allocated resources	Resources working at an incident (AIIMS).
Anchor point	An advantageous location, usually a barrier to fire spread, from which to start constructing a fireline. The anchor point is used to minimize the chance of being flanked by the fire while the line is being constructed (NWCG).
Aqueous film forming-foam (AFFF)	A synthetic amber coloured liquid concentrate mixed with water to form an agent that is capable of forming water-solution films on the surface of flammable liquids that prevent the escape of fuel vapours, excludes oxygen and maintain the surface when disturbed (self healing).
Area ignition	Ignition of several individual fires throughout an area, either simultaneously or in rapid succession, and so spaced that they add to and influence the main body of the fire to produce a hot, fast-spreading fire condition. Also called simultaneous ignition.
Area of origin	General location where the fire started.
Arson	The deliberate setting of a fire where the intent of the person responsible was to cause harm or destruction to life or property.
Aspect	The direction towards which a slope faces.
Asphyxiants	Substances which interfere with the respiratory process.
Assembly area	See Staging area.
Assessment	The process of determining if an individual has the prescribed skills, knowledge and experience needed to acquire a specific capability.
Assets	Anything valued by people which includes houses, crops, forests and, in many cases, the environment.
Assisting agency	An agency directly contributing suppression, support or service resources to another agency.
Atmospheric stability	The degree to which the atmosphere resists turbulence and vertical motion.
Attack time	See Elapsed time
Australasian Inter-service Incident Management System (AIIMS)	A nationally adopted structure to formalise a coordinated approach to emergency incident management.
Automatic dispatch	See Pre-planned dispatch.
Automatic weather station (AWS)	The Bureau's standard AWSs use sensors to monitor temperature, humidity, wind speed and direction, pressure and rainfall. Various advanced sensors are available for specialised applications. These sensors can monitor cloud height (ceilometer), visibility, present weather, thunderstorms, soil temperature (at a range of depths) and terrestrial temperature. (Developed from the BOM)
Available fuel	The portion of the total fuel that would actually burn under various environmental conditions.
Available resources	The resources at an incident and available for allocation at short notice. (AIIMS)

Term	Definition
Backburn	1. A fire started intentionally along the inner edge of a fireline during indirect attack operations to consume fuel in the path of a bushfire (Australia). 2. A counterfire commenced from within continuous fuel for the purpose of fighting a fire (New Zealand).
Back fire	See: Backburn (Preferred term).
Backing fire	The part of a fire which is burning back against the wind or down slope, where the flame height and rate of spread are reduced.
Bark fuel	The flammable bark on tree trunks and upper branches.
Bark heaps	Accumulations of bark and branch material resulting from timber harvesting operations. Soil may be mixed with bark heaps, but generally the heap is formed by a machine dropping fresh bark on the top of the heap.
Basal accumulation	Bark fallen from a tree and forming a relatively high and localized accumulation of fine fuel.
Base camp	A location where personnel are accommodated and fed for a period of time. A base camp usually contains catering, ablution and accommodation facilities, a water supply and a lighting system, and may include other facilities such as car parking maintenance and servicing. (AIIMS)
Bay(s)	A marked indentation (s) in the fire perimeter usually located between two fingers.
Beaufort wind scale	A system for estimating wind speeds based on observation of visible wind effects. A series of descriptions of visible wind effects upon land objects or sea surfaces is matched with a corresponding series of wind speed ranges, each being allocated a *Beaufort number.*
Blacking out	The process of extinguishing or removing burning material along or near the fire control line, felling stags, trenching logs to prevent rolling and the like, in order to make the fire safe.
Blackspot	An area where two-way radio coverage does not exist.
Blank cap	The metal cap used on delivery outlets and on the suction inlet of the pump to prevent discharge of water.
Blow down	See: Wind throw.
Blow up	Sudden increase in fireline intensity or rate of spread of a fire sufficient to preclude direct control or to upset existing suppression plans. Often accompanied by violent convection and may have other characteristics of a fire storm. (NWCG)
Bole	The trunk of a tree.
Bole damage	The damage to the trunk of a living tree by fire, mechanical equipment or disease.
Bracken	Bracken fern varies significantly in height and density. If Bracken is generally upright (either alive or dead) with the majority of its biomass in the top half of the plant and only the stems in touch with the ground, then it is considered to be part of the elevated fuel. If however, it has collapsed and most of its biomass is in touch with the ground, then it is considered to be Near-surface fuel.
Branch	A tapered pipe, fitted to the end of a hose line, which increases the velocity (converting pressure energy to kinetic energy) of the water or foam solution travelling through the hose, and forms an effective firefighting jet or spray.
Breakaway	The points at which a fire, after it has been contained, escapes into unburnt areas across a fireline or fire edge.

Term	Definition
Breeching	A device to divide one hose line into two or collect two hose lines into one.
Briefing	A general overview of an operation.
Broad area hazard reduction	Large scale removal of selected fuel before the onset of a bushfire danger period.
Broadcast burning	See: Prescribed burning (Preferred term)
Buffer	A strip or block of land on which the fuels are reduced to provide protection to surrounding lands.
Bulk water carrier	A large tanker used for replenishing water to firefighting tankers.
Burn back	See: Reburn (Preferred term).
Burning brands	Lofted burning material such as bark, usually flaming.
Burning conditions	The state of the combined components of the fire environment that influence fire behaviour and fire impact in a given fuel type. Usually specified in terms of such factors as fire weather elements, fire danger indices, fuel load and slope.
Burning off	Generally setting fire - with more or less regard to areas carrying unwanted vegetation such as rough grass, slash and other fuels.
Burning out	To intentionally light fires to consume islands of unburned fuel inside the fire perimeter.
Burning program	A program of prescribed burns scheduled these for a designated area over a nominated time, normally looking ahead over one fire season (for the coming spring to the following autumn), but can also look ahead five years or more.
Burning rotation	The period between burning of a prescribed area for management purposes.
Burning unit	A specified land area for which prescribed burning is planned.
Burn out	1. A fire set to consume islands of unburnt fuel inside the fire perimeter and between the fire edge and fireline (Australia). 2. A counterfire commenced from a natural or previously constructed firebreak for the purpose of fighting a fire (New Zealand).
Burn over	A section of fire that overruns personnel and/or equipment.
Burn plan	The plan which is approved for the conduct of prescribed burning. It contains a map identifying the area to be burnt and incorporates the specifications and conditions under which the operation is to be conducted.
Bushfire	Un planned vegetation fire. A generic term which includes grass fires, forest fires and scrub fires both with and without a suppression objective.
Bushfire danger period	A period of the year either established by legislation or declared by the relevant agency, when restrictions are placed on the use of fire due to dry vegetation and the existence of conditions conducive to the spread of fire.
Bushfire management	All those activities directed to prevention, detection, damage mitigation, and suppression of bushfires. Includes bushfire legislation, policy, administration, law enforcement, community education, training of fire fighters, planning, communications systems, equipment, research, and the multitude of field operations undertaken by land managers and emergency services personnel relating to bushfire control.
Byram-Keetch Drought index (BKDI)	See: Keetch-Byram Drought Index
Cache	A predetermined complement of supplies stored in a designated location. (CIMS).
Campaign fire	A fire normally of a size and/or complexity that requires substantial firefighting resources, and possibly several days or weeks to suppress.

Term	Definition
Candle (Candling)	A tree (or small clump of trees) is said to candle when its foliage ignites and flares up, usually from the bottom to top.
Candlebark	Long streamers of bark that have peeled from some eucalypt species that form fire brands conducive to very long distance spotting.
Canopy	The crowns of the tallest plants in a forest – the overstorey cover.
Canopy cover	Canopy cover refers to 2 dimensions (ie plan view, area coverage)
Canopy density	Canopy density refers to 3 dimensions (ie mass/volume)
Catastrophic fire danger	The highest fire danger rating as determined by fire agencies and generally with a Forest fire danger index greater than 100 or a Grassland fire danger index greater than 150.
Central ignition	A method of prescribed burning in which fires are set in the centre of an area to create a strong convective column. Additional fires are then set progressively closer to the outer control lines causing indraft winds to build up. This has the effect of drawing the fires towards the centre.
Chaining	The process of flattening vegetation (usually mallee or scrub) by dragging a heavy chain or cable between two large tractors or bulldozers.
Charged line	A line of fire hose filled with water under pressure and ready to use.
CIMS	Coordinated Incident Management System used in New Zealand.
Class A foam	See: Foam
Class labels	Class labels identify the type of hazardous material being stored or transported. These are grouped under broad classifications according to the predominant type of risk involved.
Climate	The atmospheric conditions of a place over an extended period of time.
Clinometer	An instrument used to measure the angle of a slope.
Cloud cover	The amount of sky covered or obscured by cloud, expressed in eighths. Eight eighths is complete cloud cover.
Coarse fuels	Dead woody material, greater than 25mm in diameter, in contact with the soil surface (fallen trees and branches). Some researchers categorise forest fuels as: fine <6 mm diameter; twigs 6-25 mm diameter; coarse >25 mm diameter.
Code of Practice	Document giving methods developed to assist compliance with acts and regulations in the performance of work.
Cold front	A cold front is the delineation between cold polar air moving towards the equator and undercutting warm tropical air moving poleward. The temperature differences across a cold front can be extreme and associated with strong winds. The warm tropical air is forced to rise and become unstable with the development of large cumuliform clouds. Severe weather such as thunderstorms, squall lines and severe turbulence may accompany these cold fronts. (BOM)
Cold trailing	A method of determining whether or not a fire is still burning, involving careful inspection and feeling with the hand, or by use of a hand-held infrared scanner, to detect any heat source.
Collecting head	A collecting head is used to collect (usually from two to four) lines into the suction inlet of a pump.
Combat agency/authority	See: Control authority
Combustion	Rapid oxidation of fuels producing heat, and often light.

Term	Definition
Command	The direction of members and resources of an agency in the performance of the agency's role and tasks. Authority to command is established in legislation or by agreement within an agency. Command relates to agencies and operates vertically within an agency.
Communications plan	Details the methods and systems for people to communicate with each other, the incident management structure, including the actual radio channels/mobile phone numbers. (AIIMS)
Compartment	(1) Forestry Definition – A basic administrative unit of a managed forest. (2) Building Definition - An enclosed space with floor, walls and ceiling.
Competency	Skills and knowledge and their application within an occupation to the standard of performance required in the workplace. (Vic report)
Conduction	The transfer of thermal energy between regions of matter due to temperature gradient.
Contained	The status of a wildfire suppression action signifying that a control line has been completed around the fire, and any associated spot fires, which can reasonably be expected to stop the fire's spread. (NWCG)
Contour lines	Contour lines connect points of equal elevation on a topographical map.
Control	The overall direction of response activities in an emergency situation. Authority for control is established in legislation or in an emergency response plan, and carries with it the responsibility for tasking and coordinating other agencies in accordance with the needs of the situation. Control relates to situations and operates horizontally across agencies.
Control authority	The agency, service, organization or authority with legislative responsibility for control of the incident. (Also referred to as the responsible authority or agency.) (AFAC)
Controlled	The stage during fire suppression activities at which the complete perimeter of a fire is secured and no breakaway is expected.
Controlled burning	See: Prescribed burning.
Control line	See: Fireline
Convection	1. As applied in meteorology, atmospheric motions that are predominantly vertical, resulting in vertical transport and mixing of atmospheric properties; distinguished from advection. 2. As applied in thermodynamics is a mechanism of heat transfer occurring because of the bulk movement of fluids.
Convection burn	See: Central ignition
Convection column	The rising column of smoke, ash, burning embers and other particle matter generated by a fire.
Convective activity	General term for manifestations of convection in the atmosphere, alluding particularly to the development of convective clouds and resulting weather phenomena, such as showers, thunderstorms, squalls, hail, and tornadoes. (NWCG)
Convergence zone	1. See: Junction zone. 2. In fire weather, that area where two winds come together from opposite directions and are forced upwards often creating clouds and precipitation. (NWCG)
Convoy	Two or more vehicles driving together under the control of a single Convoy Leader.

Term	Definition
Coordination	The bringing together of agencies and elements to ensure effective response to an incident or emergency. It is primarily concerned with the systematic acquisition and application of resources in accordance with the requirements imposed by the emergency or emergencies. Coordination relates primarily to resources and operates: • vertically, within an agency, as a function of the authority to command; • horizontally, across agencies, as a function of the authority to control.
Cordon	A cordon is the means to maintain an area and is used to restrict movement into and out of an area.
Coupe	A defined forest area in which timber harvesting takes place.
Crew	See: Fire crew.
Crew leader	Person responsible for the supervision and management of crews
Critical burnout time	Total time a fuel can burn and continue to feed energy to the base of a forward-travelling convection column.
Critical incident stress	Unusually strong emotional reactions which have the potential to interfere with the ability of personnel to function, either at the incident scene or later, arising from any situation faced during operations.
Critical incident stress debriefing	The process in which teams of professional and peer counsellors provide emotional and psychological support to incident personnel who are or have been involved in a critical (highly stressful) incident.
Cross bearings	Intersecting lines of sight from two or more points on the same object; used to determine the location of bushfire from lookouts.
Crown fire	A fire that advances from top to top of trees or shrubs.
Crown scorch	Browning of the needles or leaves in the crown of a tree or shrub caused by heat from a fire.
Crowning	A fire ascending into the crowns of trees and spreading from crown to crown.
Crowning potential	A probability that a crown fire may start, calculated from inputs of foliage moisture content and height of the lowest part of the tree crowns above the surface. (NWCG)
Curing	Drying and browning of herbaceous vegetation due to mortality or senescence.
Dead fuel	Fuels with no living tissue in which moisture content is governed almost entirely by absorption or evaporation of atmospheric moisture (relative humidity and precipitation). (NWCG)
Debrief	To gather information from the participants in an action so as to gauge the success or otherwise of the action at the end of the task, shift, tour or incident.
Deep-seated fire	A fire burning far below the surface in duff, mulch, peat, or other combustibles as contrasted with a surface fire.
Defensive strategy	A firefighting strategy used where the protection of life and assets is a priority when a fire is: (i) located in inaccessible or remote location OR (ii) too intense to be safely or effectively attacked directly.
Dehydration	Excessive loss of water from the body's tissues. Dehydration may follow any condition in which there is a rapid depletion of body fluids.
Delayed aerial ignition devices (DAID)	An incendiary device that will ignite after a predetermined time.

Term	Definition
Deliberate fire	A fire resulting from a person placing burning material to cause ignition. The intent of the person may have been to cause harm or destruction to life or property (arson-criminal offence) or to modify fuels and/or vegetation for land management purposes (summary offence). See also Arson.
Delivery hose	Hose used to transport water under pressure.
Delivery valve	On a pump, the valved outlet through which water is discharged.
Demobilisation	The orderly release of resources no longer required at an incident.
Depth of burn	The reduction in forest floor litter thickness (cm) due to consumption by fire. Most commonly used in connection with prescribed burning.
Desiccant	A chemical that, when applied to a living plant causes or accelerates the drying out of its aerial parts.
Desorption	The loss of moisture to the atmosphere from dead plant material.
Detection	The discovery of a fire. Individuals, fire towers, reconnaissance aircraft and automatic devices may be used, either alone or in combination.
Dew	The moisture which collects in small droplets on the surface of substances and vegetation by atmospheric condensation, chiefly at night.
Dew point temperature	This is a measure of the moisture content of the air and is the temperature to which air must be cooled in order for dew to form. The dew-point is generally derived theoretically from dry and wet-bulb temperatures, with a correction for the site's elevation. (BOM)
Dieback	The progressive dying, from the top downward, of twigs, branches or tree crowns.
Diffused pattern	A spray pattern (as opposed to straight stream) of water or foam.
Direct attack	A method of fire attack where wet or dry firefighting techniques are used. It involves suppression action right on the fire edge which then becomes the fireline.
Dispatch	The act of ordering attack crews and/or support units to respond to a fire, or from one place to another.
Division	A portion of the incident comprising of two or more sectors. The number of sectors grouped in a Division should be such as to ensure effective direction and control of operations. Divisions are generally identified by a local geographic name.
Dominant height	Mean height of the largest trees in a stand. A specified number per unit area are generally selected.
Downwind	Away from the wind direction. In the direction opposite to the direction from which the wind is blowing. The direction that smoke will travel.
Dozer	A crawler tractor fitted with a blade which can be transported to a fire on a tray truck or trailer. Dozer is a shortened form of "Bulldozer"
Dozer line	Fireline constructed by the front blade of a dozer.
Drain time	The time (minutes) it takes for foam solution to drop out from the foam mass; for a specified percent of the total solution contained in the foam to revert to liquid and drain out of the bubble structure.
Drift	The effect of wind on smoke or on a water drop.
Drip torch	A canister of flammable fuel fitted with a wand, a burner head and a fuel flow control device. It is used for lighting fires for prescribed burning, backburning and burning out.

Term	Definition
Drop pass	Indicates that the firefighting aircraft has the target in sight and will make a drop of fire control agent on this run over the target.
Drop pattern	The distribution of an aerially delivered fire control agent drop on the target area in terms of its length, width, and momentum (velocity x mass) as it approaches the ground. The latter determines the relative coverage level of the fire control agent on fuels within the pattern.
Drop zone (DZ)	Target area for firefighting aircraft, or cargo dropping.
Drought	Prolonged absence or marked deficiency of precipitation (rain). (BOM)
Drought index	A numerical value reflecting the dryness of soils, deep forest litter, logs and living vegetation.
Dry bulb temperature	Technically, the temperature registered by the dry-bulb thermometer of a psychrometer. However, it is identical to the temperature of the air. (Degrees Celsius). (NZ)
Dry firefighting	The suppression of a fire without the use of water. This is normally achieved by removing the fuel by the use of hand tools, burning or machinery.
Duff	The layer of decomposing vegetative matter on the forest floor below the litter layer, the original structure still being recognisable.
Ecological burning	A form of prescribed burning. Treatment with fire of vegetation in nominated areas to achieve specified ecological objectives.
Edge burning	A term used to describe perimeter burning of an area in mild conditions prior to large scale prescribed burning. This practice is used to strengthen buffers and to reduce mop-up operations.
Elevated fuel	The standing and supported combustibles not in direct contact with the ground and consisting mainly of foliage, twigs, branches, stems, bark and creepers.
Embers	Glowing particles cast from the fire (as ‘showers’ or ‘storms’). (Vic report)
Emergency centre	A facility where the coordination of the response and support to the incident is provided.
En route resources	Resources despatched to an incident that have not yet checked in. (AIIMS)
Entrapment	A situation in which individuals are exposed to life threatening or potentially life threatening conditions from which they cannot safely remove themselves.
Equilibrium moisture content (EMC)	The moisture content that a fuel element would attain if exposed for an infinite period in an environment of specified constant dry-bulb temperature and relative humidity. When a fuel element has reached its EMC, it neither gains nor loses moisture as long as conditions remain constant.
Equipment	All material supplied to an incident excluding personnel and vehicles.
Escape route	A planned route away from danger areas at a fire.
Evacuation	The temporary relocation of persons from dangerous or potentially dangerous areas to safe areas.

Term	Definition
Exposures	Parts of the same structure or other structures or property not directly involved in the fire but at risk of being burnt or damaged if the fire is not controlled. In the bushfire context: 1. Property that may be endangered by a fire burning in another structure or by a bushfire. In general, property within 12 metres of a fire may be considered to involve an exposure hazard, although in very large fires the danger may exist at much greater distances. 2. Direction in which a slope faces, usually with respect to cardinal directions (N, S, E, W). 3. The general surroundings of a site, with special reference to its openness to winds and sunshine.
Extinguishing agent	A substance used to put out a fire by cooling the burning material or blocking the supply of oxygen, or chemically inhibiting combustion or combinations of these mechanisms.
Extreme fire behaviour	A level of bushfire behaviour characteristics that ordinarily precludes methods of direct suppression action. One or more of the following is usually involved: • high rates of spread • prolific crowning and/or spotting • presence of fire whirls • a strong convective column. Predictability is difficult because such fires often exercise some degree of influence on their environment and behave erratically, sometimes dangerously.
Extreme fire danger	The second highest fire danger rating as determined by fire agencies and generally with a Forest fire danger index between 75 and 99 or a Grassland fire danger index greater between 100 and 149.
Facilities	Permanent and temporary facilities where personnel sleep, cook, maintain and repair equipment. (AIIMS)
Fall back fire control line	Any fire control line which is at a distance from the fire perimeter, and is the second control line at which the fire perimeter may be stopped should it cross the first fire control line. Also known as 'fallback line'.
Fine fuel	Fuel such as grass, leaves, bark and twigs less than 6mm in diameter that ignite readily and are burnt rapidly when dry.
Fingers	Long and narrow slivers of fire which extend beyond the head or flanks. (AFAC)
Fire	The chemical reaction between fuel, oxygen and heat. Heat is necessary to start the reaction and once ignited, fire produces its own heat and becomes self-supporting.
Fire access track	A track constructed and/or maintained expressly for fire management purposes.
Fire behaviour	The manner in which a fire reacts to the variables of fuel, weather and topography.
Fire Behaviour Analyst	Person responsible for developing fire behaviour predictions based on fire history, fuel, weather, and topography. (NWCG)amended
Fire behaviour model	A set of mathematical equations that can be used to predict certain aspects of fire behaviour.
Fire behaviour prediction	Prediction of probable fire behaviour usually prepared by a fire behaviour analyst in support of fire suppression or prescribed burning operations. (NWCG)
Fire behaviour prediction system	A system that uses a set of mathematical equations to predict certain aspects of fire behaviour in wildland fuels when provided with data on fuel and environmental conditions.

Term	Definition
Fire bombing	A technique of suppressing a bushfire by dropping water, foam or retardants on it from an aircraft.
Fire brand	A piece of flaming or smouldering material capable of acting as an ignition source. eg eucalypt bark.
Fire climate	The composite pattern or integration over time of the fire weather elements that affect fire occurrence and fire behaviour in a given area.
Fire control	See Fire suppression.
Fire control agent	A substance that acts as an Extinguishing agent, and or a Fire retardant and or a Fire suppressant.
Fire control line	See: Fireline.
Fire crew	A general term for two or more firefighters organised to work as a unit. (NWCG)
Fire danger	Sum of constant danger and variable danger factors affecting the inception, spread, and resistance to control, and subsequent fire damage; often expressed as an index. (NWCG)
Fire danger class	A segment of a fire danger index scale identified by a descriptive term and or a colour code. The classification system may be based on more than one fire danger index and an assessment of risk exposure.
Fire danger index (FDI)	A relative number denoting the potential rates of spread, or suppression difficulty for specific combinations of temperature, relative humidity, drought effects and wind speed.
Fire danger rating	A relative class denoting the potential rates of spread, or suppression difficulty for specific combinations of temperature, relative humidity, drought effects and wind speed, indicating the relative evaluation of fire danger.
Fire ecology	The study of the relationships between fire, the physical environment and living organisms.
Fire edge	Any part of the boundary of a going fire at a given time. *NOTE*: The entire boundary is termed the 'fire perimeter'.
Fire effects	The physical, biological and ecological impact of fire on the environment. (NWCG)
Fire environment	The surrounding conditions, influences, and modifying forces of topography, fuel, and weather that determine fire behaviour. (NWCG)
Firefighter	Any employee, volunteer or agent of any fire agency who occupies, or is designated, to undertake a role for the purpose of fire suppression.
Firefighting operations	Any work or activity directly associated with control of fire.
Fire frequency	A general term referring to the recurrence of fire in a given area over time (NWCG). Also see: Fire regime
Fire front	The part of a fire within which continuous flaming combustion is taking place. Unless otherwise specified, the fire front is assumed to be the leading edge of the fire perimeter. In ground fires, the fire front may be mainly smouldering combustion. (NWCG)
Fireground	The area in the vicinity of a fire suppression operations, and the area immediately threatened by the fire. It includes burning and burnt areas; constructed and proposed fire lines; the area where firefighters, vehicles, machinery and equipment are located when deployed; roads and access points under traffic management control; tracks and facilities in the area surrounding the actual fire; and may extend to adjoining area directly threatened by the fire.

Term	Definition
Fire hazard	A fuel complex, defined by volume, type condition, arrangement, and location, that determines the degree of ease of ignition and of resistance to control.
Fire intensity	See: Fireline intensity.
Fireline	A natural or constructed barrier, or treated fire edge, used in fire suppression and prescribed burning to limit the spread of fire.
Fireline intensity	The rate of energy release per unit length of fire front usually expressed in kilowatts per metre (Kw/m). The rate of energy release per unit length of fire front, defined by the equation I=Hwr, where I = fireline intensity (kW/m) H = heat yield of fuel (kJ/kg)-16,000 kJ/kg w = dry weight of fuel consumed (kg/m2) (mean total less mean unburnt) r = forward rate of spread (m/s) The equation can be simplified to I = w r/2 where I = fireline intensity (kW/m) w = dry weight of fuel consumed (tonnes/ha) r = forward rate of spread (m/hr)
Fire lookout	A structure strategically located and manned to detect the occurrence and the location of fires. It may be a tower or a structure on a high point
Fire management	All activities associated with the management of fire prone land, including the use of fire to meet land management goals and objectives.
Fire potential	The chance of a fire or number of fires occurring of such size, complexity or impact that requires resources (both a pre-emptive management and suppression capability) from beyond the area of the fire origin. (BCRC)
Fire preparedness	All activities undertaken in advance of bushfire occurrence to decrease its extent and severity and to ensure more effective fire suppression.
Fire prevention	All activities concerned with minimising the incidence of bushfire particularly those of human origin.
Fire regime	The history of fire in a particular vegetation type or area including the frequency, intensity and season of burning. It may also include proposals for the use of fire in a given area. (AFAC)
Fire report	An official record of a fire, generally including information on cause, location, action taken, damage, costs, etc., from start of the fire until completion of suppression action. These reports vary in form and detail from agency to agency (NWCG). Also see Report of Fire
Fire retardant	A chemical generally mixed with water, designed to retard combustion by a chemical reaction. It is applied as slurry from the ground or air to fuels ahead of the fire.
Fire risk	Processes, occurrences or actions that increase the likelihood of fires occurring.
Fire run	A rapid advance of a fire front. It is characterised by a marked transition in intensity and rate of spread.
Fire scar	1) A healing or healed-over injury caused or aggravated by fire on a woody plant. 2) A mark left on a landscape by fire.
Fire season	The period during which bushfires are likely to occur, spread and do sufficient damage to warrant organised fire control.
Fire simulator	A device that imposes simulated fire and smoke on a projected landscape scene, for the purpose of informing fire suppression personnel of potential fire situations either for an actual fire or hypothetical fire(s).
Fire spread	Development and travel of fire across surfaces.

Term	Definition
Fire storm	Violent convection caused by a large continuous area of intense bushfire often characterised by destructively violent surface indrafts, a towering convection column, long distance spotting, and sometimes by tornado-like whirlwinds. (AFAC)
Fire suppressant	An additive designed to reduce the surface tension of water and/or to hold water in suspension thus increasing water's efficiency as a fire extinguishing agent. Suppressants are applied directly to the burning fuels.
Fire suppression	The activities connected with restricting the spread of a fire following its detection and before making it safe.
Fire suppression organisation	1. The personnel and equipment collectively assigned to the suppression of a specific fire or group of fires. 2. The personnel responsible for fire suppression within a specified area. 3. The management structure, usually shown in the form of an organization chart of the persons and groups having specific responsibilities in fire suppression. (NWCG)
Fire suppression plan	See Incident action plan (IAP).
Fire tetrahedron	An instructional aid in which the sides of the tetrahedron (comprising 4 triangular shaped figures) are used to represent the 4 components of combustion and flame production process-fuel, heat, oxygen and the chemical chain reaction.
Fire threat	The impact a fire will have on a community.
Fire tower	Tower strategically located and manned to detect and report the occurrence and location of fires. A type of Fire lookout
Fire training simulator	A training device that imposes simulated fire and smoke on a projected landscape scene, for the purpose of instructing fire suppression personnel in fire situations and fire suppression techniques.
Fire triangle	Diagrammatic expression of the three elements that are necessary for a fire to occur. FUEL – HEAT – OXYGEN. The removal of any one of these will extinguish a fire.
Fire weather	Weather conditions which influence fire ignition, behaviour, and suppression. (NWCG)
Fire weather forecast	A weather prediction specially prepared for use in wildland fire operations and prescribed fire. (NWCG)
Fire whirl	Spinning vortex column of ascending hot air and gases rising from a fire and carrying aloft smoke, debris, and flame. Fire whirls range in size from less than one foot to over 500 feet in diameter. Large fire whirls have the intensity of a small tornado. (NWCG)
Fire wind	The inflow of air close to a fire caused by the action of convection. It is not to be confused with a prevailing wind.
First attack	See: Initial attack
Fixed wing aircraft	A heavier than air aircraft which obtains lift for flight by forward motion of wings through the air.
Flame angle	The angle of the flame in relation to the ground, caused by wind direction or the effect of a slope.
Flame depth	The depth of the zone within which continuous flaming occurs behind the fire edge.

Term	Definition
Flame height	The average maximum vertical extension of flames at the leading edge of the fire front. Occasional flashes that rise above the general level of flames are not considered. This distance is less than the flame length if flames are tilted due to wind or slope. (NWCG)
Flame length	The distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface), an indicator of fire intensity. (NWCG)
Flame Zone	The highest level of bushfire attack as a consequence of direct exposure to flames from the fire front in addition to heat flux and ember attack. (AS 3959 - 2009)
Flame zone	The area around fuels where the combustion of gases occurs to form flames.
Flaming zone	See: Flame zone.
Flammability	The ease with which a substance is set on fire.
Flammable	Capable of being ignited and of burning with a flame.
Flank attack	Obtaining control of a fire by attacking its side/s (flank).
Flanks of a fire	Those parts of a fire's perimeter that are roughly parallel to the main direction of spread. (NWCG)
Flare up	Any sudden acceleration of fire spread, or intensification of fire, or a part of the fire. A flare up is of relatively short duration and does not radically change existing control plans. (NWCG)
Flash fire	A fast moving fire consuming most of the fine fuels available.
Foam	Foam is a mass of bubbles formed by mixing air with water and a foam concentrate in specific proportions. It is used as a firefighting agent to form a smothering, cooling and/or ignition preventing layer of the surface over a fuel.
Foam blanket	A layer of foam which forms an insulating and reflective barrier to heat and is used for fuel protection, suppression, and mop-up. (NWCG)
Foam Class A	A mixture of foam concentrate & water specifically formulated for extinguishing bushfires. The foam is biodegradable, non toxic and is used at very low concentrates. It may be delivered aspirated or non-aspirated. (See also Foam solution).
Foam Class B	A foam formulated for application on Class B fires
Foam concentrate	The concentrated foaming agent as received from the manufacturer which, when added to water, creates a foam solution.
Foam inductor	Equipment consisting of an inlet connection, ejector pump and a discharge assembly, for the induction of foam concentrate.
Foam solution	The mixture of water and foam concentrate.
Forest	An area, incorporating all living and non-living components, that is dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding 2 metres and with existing or potential crown cover of overstorey strata about equal to or greater than 20 per cent. This definition includes Australia's diverse native forests, woodlands and plantations, regardless of age.
Forest fire	A fire burning mainly in forest and/or woodland.
Forest type	A category for describing a forest commonly based on the predominant tree species, tree form and structure.

Term	Definition
Forward looking infrared (FLIR)	Hand held or aircraft mounted device designed to detect heat differentials and display them. FLIRs have thermal resolution similar to IR line scanners, but their spatial resolution is substantially less; commonly used to detect hot spots and flare ups obscured by smoke, evaluate the effectiveness of firing operations, or detect areas needing mop-up. (NWCG)
Forward rate of spread (FROS)	The speed with which a head fire moves in a horizontal direction across the landscape.
Frontal fire intensity	See: Fireline Intensity
Front end loader	Earthmoving equipment designed to move loose earth and/or loads into vehicles. A multi-purpose bucket is fitted to articulated arms at the front of the vehicle. May be either wheeled or tracked.
Fuel	Any material such as grass, leaf litter and live vegetation which can be ignited and sustains a fire. Fuel is usually measured in tonnes per hectare. Related Terms: Available fuel, Coarse fuel, Dead fuel, Elevated dead fuel, Fine fuel Ladder fuels, Surface fuels, and Total fine fuel.
Fuel age	The period of time lapsed since the fuel was last burnt.
Fuel arrangement	A general term referring to the spatial distribution and orientation of fuel particles or pieces. (NWCG)
Fuel array	The totality of fuels displayed in a location: fine and coarse, live and dead. (Vic report)
Fuel assessment	The estimation or calculation of total and available fuel present in a given area.
Fuel bed depth	Average height of surface fuels contained in the combustion zone of a spreading fire front. (NWCG)
Fuelbreak	A natural or manmade change in fuel characteristics which affects fire behaviour so that fires burning into them can be more readily controlled.
Fuelbreak system	A series of modified strips or blocks tied together to form continuous strategically located fuel breaks around land units.
Fuel continuity	The degree or extent of continuous or uninterrupted distribution of fuel particles in a fuel bed thus affecting a fire's ability to sustain combustion and spread. This applies to aerial fuels as well as surface fuels.
Fuel depth	The average distance from the bottom of the litter layer to the top of the layer of fuel, usually the surface fuel.
Fuel load	The oven dry weight of fuel per unit area. Commonly expressed as tonnes per hectare. (AFAC). (Also known as fuel loading)
Fuel management	Modification of fuels by prescribed burning, or other means. (AFAC)
Fuel map	A map showing areas of varying fuel quantities and types and usually indicates past fire history.
Fuel model	Simulated fuel complex for which all fuel descriptors required for the solution of a mathematical rate of spread model have been specified. (NWCG)
Fuel modification	Manipulation or removal of fuels to reduce the likelihood of ignition and/or to lessen potential damage and resistance to control (e.g., lopping, chipping, crushing, piling and burning).(NWCG)
Fuel moisture content	The water content of a fuel expressed as a percent of the oven dry weight of the fuel particle. (%ODW)

Term	Definition
Fuel moisture differential	A term used to describe the situation where the difference in the moisture content between fuels on adjacent areas results in noticeably different fire behaviour on each area.
Fuel profile	The vertical cross section of a fuel bed down to mineral earth.
Fuel quantity	See: Fuel load.
Fuel reduction	Manipulation, including combustion, or removal of fuels to reduce the likelihood of ignition and/or to lessen potential damage and resistance to control.
Fuel reduction burning	The planned application of fire to reduce hazardous fuel quantities; undertaken in prescribed environmental conditions within defined boundaries.
Fuel separation	The action of separating fuel for the purpose of providing a mineral earth firebreak. Also means the actual gap between fuel layers or particles eg gap between individual hummock grasses or gap between surface and canopy fuels
Fuel type	An identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause predictable rate of spread or difficulty of control under specified weather conditions. (AFAC)
Fuel weight	See Fuel load.
General origin area	The larger area where the fire started that is readily identifiable based on macro scale indicators and witness statements. (NWCG)
Going fire	Any bushfire which is expanding and suppression actions have not yet contained the fire.
Grass fire	Any fire in which the predominant fuel is grass or grass like. (NWCG)
Grassland curing	The proportion of dead material in grasslands – usually increases over summer as tillers die off and dry out, increasing the risk of grassland fire.
Grid ignition	A method of lighting prescribed fires where ignition points are set individually at a predetermined spacing through an area.
Ground crew	See: Hand crew.
Ground fire	Fire that consumes the organic material beneath the surface litter ground, such as a peat fire. (NWCG)
Ground fuel	All combustible materials below the surface litter, including duff, roots, peat and saw dust dumps that normally support a glowing or smouldering combustion without flame.
Habitat	The local environment of conditions in which an animal or plant lives.
Hand crew	A fire suppression crew trained and equipped to fight fire with hand tools.
Hand line	A fireline constructed with hand tools. (NWCG) (Wildfire context)
Hand trail	See Hand line.
Hang up	A situation in which a tree is lodged in another and prevents it from falling to the ground.
Hazard	A source of potential harm or a situation with potential to cause loss.
Hazard reduction	See: Fuel Management
Head	See: Head Fire
Head attack	Directly knocking down the head of a fire. Recommended only for low intensity fires where firefighters can be sure that the fire will not flare up unexpectedly.
Head fire	The part of a fire where the rate of spread, flame height and intensity are greatest, usually when burning downwind or upslope.

Term	Definition
Heat exhaustion	A form of shock, due to depletion of body fluids resulting from overexposure to a hot environment.
Heat stress	Illness caused by the body overheating.
Heat stroke	A life-threatening condition that develops when the body's temperature-regulating and cooling mechanisms are overwhelmed and body systems begin to fail.
Heat transfer	The transfer of thermal energy from one physical system to another by conduction, convection or thermal radiation.
Heavy fuels	See: Coarse fuels.
Heel	See: Rear (Preferred term).
Heel fire	See: Backing Fire.
Helibase (HB)	A location for parking, refuelling and maintenance of helicopters operating in support of an incident.
Helicopter	A form of heavier-than-air, rotor-wing aircraft whose lift is produced by engine-driven rotors which behave as if they were both propellers and wings.
Helipad (HP)	A designated location which meets specific requirements for a helicopter to take off and land.
Helitack crew	An initial attack crew specially trained in the tactical and logistical use of helicopters for fire suppression.
Heli-torch	An aerial ignition device hung from or mounted on a helicopter to disperse ignited lumps of gelled gasoline. Used for backburns, burnouts, or prescribed burns. (NWCG)
High fire danger	The second lowest fire danger rating as determined by fire agencies and generally with a Forest fire danger index between 25 and 49 or a Grassland fire danger index between 25 and 49.
High intensity fire	Fires with an average intensity greater than 3000 $kW.m^{-1}$ and flame heights greater than 3 m, causing complete crown scorch or possibly crown fires in forests. Uncontrollable by direct attack. The term is also applied to stationary fires burning in very high fuel loads (such as logging slash).
Hold over fire	See: Sleeper
Hop over	See: Breakaway.
Hose bandage	A means of affecting a temporary repair to a canvas or synthetic hose.
Hose strangler	A crimping device for stopping the flow of water in a hose.
Hot Refueller	A trained person responsible for the operation of the equipment for the 'hot' refuelling of helicopters.
Hot spot	1. A particularly active part of a fire. 2. An area of smouldering fuels requiring to be extinguished during patrol operations.
Humus	Layer of decomposed organic matter on the forest floor beneath the fermentation layer and directly above the soil. It is that part of the duff in which decomposition has rendered vegetation unrecognizable and mixing of soil and organic matter is underway. See Also: Duff & Litter
Hygrometer	An Instrument which measures the humidity in the air.
Ignition	The beginning of flame production or smouldering combustion; the starting of a fire.

Term	Definition
Ignition pattern	The manner in which a prescribed burn, backburn, or burnout is set, determined by weather, fuel, ignition system, topographic and other factors having an influence on fire behaviour and the objective of the burn.
Ignition source	A source of energy sufficient to initiate combustion.
Incendiary	A burning compound or metal used to produce intense heat or flame, like a bomb.
Incendiary device	Device designed and used to start a fire.
Incident	Any unplanned event requiring emergency intervention. (AIIMS)
Incident Action Plan (IAP)	The plan used to describe the incident objectives, strategies, resources and other information relevant to the control of an incident. (AIIMS)
Incident control	See: Incident management
Incident Control Centre (ICC)	The location where the Incident Controller and various members of the Incident Management Team provide overall direction of response activities. (See also Incident Control Point)
Incident Controller	The individual responsible for the management of all incident control activities across a whole incident (AIIMS)
Incident Control Point (ICP)	The location where the Incident Controller and, where established, members of the Incident Management Team provide overall direction of response activities in an emergency situation. (See also Incident Control Centre)
Incident control system (ICS)	A command structure to systematically and logically manage suppression of emergency incidents including bushfires, from small, simple incidents to large, difficult or multiple situations. It is designed to develop in modular fashion from the top (Incident Controller) downwards. Refer NIMS, AIIMS, CIMS
Incident management	The process of controlling the incident and coordinating resources. (EMA)
Incident Management Team (IMT)	The group of incident management personnel comprising the Incident Controller, and the personnel he or she appoints to be responsible for the functions of Operations, Planning and Logistics. (AIIMS)
Incident objective	An incident objective is a goal statement indicating the desired outcome of the incident. Incident objectives guide the development of the Incident Action Plan and must reflect the policies and needs of the control authority and supporting agencies. All factors affecting the incident and its potential impact must be considered before determining the objective. (AIIMS)
Incident strategies	The incident strategies will be developed from the incident objectives and will describe how the Incident Management Team plans to resolve the incident. There is a requirement for strategies to be developed throughout the incident and they should be reviewed for each operational period. (AIIMS)
Indirect attack	A method of suppression in which the control line is located some considerable distance away from the fire's active edge. Generally done in the case of a fast-spreading or high-intensity fire and to utilize natural or constructed firebreaks or fuelbreaks and favourable breaks in the topography. The intervening fuel is usually backburnt; but occasionally the main fire is allowed to burn to the line, depending on conditions.(NWCG)
Induced wind	See: Fire wind.
Infrared scanning	Use of an optical-electronic system for identifying or obtaining imagery of thermal infrared radiation to detect non-smoking fires or fire perimeters through smoke.
Initial attack	The first suppression work on a fire.

Term	Definition
Instability	The tendency for air parcels to accelerate when they are displaced from their original position; especially, the tendency to accelerate upward after being lifted. Instability is a prerequisite for severe weather - the greater the instability, the greater the potential for severe thunderstorms. (Weather Zone)
Interface	See: Urban Rural interface.
Inversion	A layer of the atmosphere in which temperature increases with increasing elevation. A condition of strong atmospheric stability.
Island	An unburnt area within a fire perimeter.
Isobar	Lines on weather maps joining places which have the same air pressure.(BOM)
I zone	See: Urban Rural interface.
Jump fire	See: Spot fire
Jump over	See: Breakaway
Junction zone	An area of greatly increased fire intensity caused by two fire fronts (or flanks) burning towards one another.
Keetch-Byram Drought Index (KBDI)	A numerical value reflecting the dryness of soils, deep forest litter, logs and living vegetation, and expressed as a scale from 0 - 200 where the number represents the amounts of rainfall (mm) to return the soil to saturation.
Knock down	To reduce the flame or heat on the more vigorously burning parts of a fire edge. (NWCG)
Ladder fuels	Fuels that provide vertical continuity between strata. Fire is able to carry surface fuels into the crowns of trees with relative ease.
Lag time	The time delay in fuel moisture content responding to changing environmental conditions (for example, relative humidity). Technically, it is the time necessary for a fuel particle to lose approximately 63% of the difference between its initial moisture content and its equilibrium moisture content.
Lead agency	The organisation with the legislative or agreed authority for control of an incident.
Lee (leeward)	Away from the wind, on the sheltered side of something that the wind is blowing on.
Legislation	A set of rules made by a State, Territory or Federal Government; includes acts and regulation.
Light fuel	An assessment of fuel quantity indicating a low weight.
Lighting pattern	See: Ignition pattern.
Lightning	The flash of light accompanying a sudden electrical discharge which takes place from or inside a cloud, or less often from high structures or the ground or from mountains. A large electrical spark. Caused when the negative charge in the lower part of the cloud and the positive charge in the upper part of the cloud become so great that they can overcome the natural resistance of the air and discharge between negative and positive takes place. (BOM)
Lightning fire	A fire caused by lightning.
Lightning formation	See: Lightning.
Light patrol unit	See: Tanker.
Line ignition	See: Strip burning.

Term	Definition
Litter	The top layer of the forest floor composed of loose debris of dead sticks, branches, twigs, and recently fallen leaves and needles, little altered in structure by decomposition. (The litter layer of the forest floor). (NWCG)
Litter bed fuel	Dead fine fuel, including surface fuel and fuel lower in the fuel profile.
Litter fall	The addition of litter that falls from vegetation to the forest floor.
Living fuels	Fuels made up of living vegetation.
Living shrub fuel	Living understorey fine fuel less than 2 metres above ground level.
Local winds	Winds which are generated over a comparatively small area by local terrain and weather. They differ from those which would be appropriate to the general pressure pattern. (NWCG)
Log	Documentation of information and actions arising during an incident
Logistics	The provision of facilities, services and materials in support of an incident.
Lookout	1. A person designated to detect and report fires from a fixed vantage point. 2. A member of a fire crew designated to observe the fire and warn the crew when there is danger. 3. For structure see: Fire lookout
Lookout tower	See: Fire tower.
Low intensity fire	A fire which travels slowly and only burns lower storey vegetation, like grass and lower tree branches, with an average intensity of less than 500 $kW.m^{-1}$ and flame height less than 1.5m. Usually causes little or no crown scorch and is easily controlled.
Low-moderate fire danger	The lowest fire danger rating as determined by fire agencies and generally with a Forest fire danger index less than 12 or a Grassland fire danger index less than 12.
Medium fuels	See Course fuels.
Mineral earth	When used in the context of fire control refers to a non-flammable surface (either natural or prepared) which provides a break in understorey, litter and humus fuels and hence a barrier (of varied effectiveness depending, amongst other things, on its width and the intensity of the approaching fire) to fire travelling on or near the ground surface.
Mobilisation	The processes and procedures for organisations to activate, assemble, and transport the requested resources to an incident.
Moisture content	See Fuel moisture content.
Mopping up	See Blacking out
Mosaic	Used in reference to the spatial arrangement of burnt and unburnt fuels at either a local or a landscape scale.
Move up method	See: Step-up method
Multi-agency response	The response to an incident where one or more agencies assist the jurisdictional control agency or agencies.
Multiple fire situation	A circumstance of high fire incidence over short periods of time in any administrative unit, usually overtaxing the normal initial attack capability of the unit.
Natural barrier	Any area where lack of flammable material obstructs the spread of vegetation fires.

Term	Definition
Near surface fuel	Live and dead fuel, including suspended leaves, bark or twigs, effectively in touch with the ground but not lying on it, with a mixture of vertical and horizontal orientation.
Needle bed	A fuel bed consisting mainly of pine needles.
Nozzle	A fitting that is used with a branch to control the size, pattern and/or velocity of water or extinguishing medium being discharged.
One lick method	A progressive system of building a fireline on a wildfire without changing relative positions in the line. Each worker does one to several "licks", or strokes removing a set proportion of the fuel on the line, with a given tool and then moves forward a specified distance to make room for the worker behind. (NWCG)
Operations	The direction, supervision and implementation of tactics in accordance with the Incident Action Plan.
Operations point	The location from which the overall field operations are commanded by the Operations Officer. (AIIMS)
Parallel attack	Method of fire suppression in which fireline is constructed approximately parallel to, and just far enough from the fire edge to enable workers and equipment to work effectively, though the fireline may be shortened by cutting across unburned bays. The intervening strip of unburned fuel is normally burned out as the control line proceeds but may be allowed to burn out unassisted where this occurs without undue delay or threat to the fireline. (NWCG)
Parallel fire suppression	See: Parallel attack.
Parallel method	See: Parallel attack.
Parts of a Fire	See: Bay(s), Fingers, Flanks of a fire, Head.
Patch burning	Burning in patches to prepare sites for group planting or sowing or to form a barrier to subsequent fires. (NWCG)
Patrol	1. To travel over a given route to prevent, detect, and suppress fires. Includes interaction with the public for wildland fire prevention and educational purposes. 2. To go back and forth vigilantly over a length of control line during and/or after construction to prevent breakaways, suppress spot fires, and extinguish overlooked hot spots. 3. A person or group of persons who carry out patrol actions. (NWCG)
Peat	An amorphous organic material formed by anaerobic decomposition which usually means that the area is seasonally or permanently inundated with water. Peat fires burn by smouldering combustion and generate very high amounts of energy per unit area.
Perimeter	See: Fire perimeter.
Peri urban interface	See: Urban rural interface.
Permit burn	A burn carried out under permit from a Fire Authority.
Personal protection equipment (PPE)	The equipment and clothing designed to mitigate the risk of injury from the chemical, physical and thermal hazards that may be encountered at an incident.
Personal protective clothing (PPC)	The clothing designed to mitigate the risk of injury from the chemical, physical and thermal hazards that may be encountered at an incident.
Plan of attack	See: Incident Action Plan (Preferred term)
Planned burning	See: Prescribed burning.
Pocket	See: Island.

Term	Definition
Point of attack	The part of the fire on which work is started when suppression forces arrive.
Point of origin	The specific location where the fire started.
Portable dam	A temporary water storage used in conjunction with power pumps and hose lines.
Predicted rate of spread	The rate of spread predicted by the application of fire spread models utilising appropriate inputs of fuel conditions, topography and weather. Also see Rate of Spread.
Pre-incident plan	Advanced planning and preparation for an emergency situation.
Pre-suppression plan	See Pre-Incident Plan
Prepared community	A community that has developed effective emergency management arrangements at the local level, resulting in: • An alert, informed and active community that supports its voluntary organizations • An active and involved local government • Agreed and coordinated arrangements from prevention, preparedness, response and recovery.
Preparedness	All activities undertaken in advance of the occurrence of an incident to decrease the impact, extent and severity of the incident and to ensure more effective response activities.
Pre-planned dispatch	The pre-planned dispatch of designated suppression forces to fires in predetermined zones. It is usually dependent on the location of the fire, and the forecast fire danger.
Prescribed burn	A fire utilised for Prescribed burning.
Prescribed burn plan	See: Burn plan.
Prescribed burning	The controlled application of fire under specified environmental conditions to a predetermined area and at the time, intensity, and rate of spread required to attain planned resource management objectives.
Prescribed fire	Any fire ignited by management actions to meet specific objectives. A written, approved burn plan must exist, and approving agency requirements (where applicable) must be met, prior to ignition.
Prescription	A written statement defining the objectives to be attained during prescribed burning.
Prevention	All activities concerned with minimising the occurrence of incidents, particularly those of human origin.
Profile litter moisture content	The moisture content, expressed as a percentage of oven-dry weight, of the entire leaf litter bed above the mineral soil surface.
Profile moisture content	See Fuel moisture content.
Psychrometer	The general name for instruments designed for determining the relative humidity of the air. A psychrometer consists of wet and dry bulb thermometers, generally with the aid of psychrometric tables or a psychrometric slide rule. (BOM)
Pulaski tool	A combination chopping and trenching tool widely used in fireline construction, which combines a single-bitted axe blade with a narrow adze-like trenching blade fitted to a straight handle. (NWCG)
Pumper	A firefighting vehicle equipped with a large capacity pump, water tank and hose. Generally intended to be operated when stationary, from reticulated or static water supplies.

Term	Definition
Quick-fill pump	A high volume water pump used for filling tankers.
Rain gauge	The general name for instruments designed to measure the amount of rain that has fallen.
Rakehoe (McLeod tool)	A hand tool used for bushfire fighting, consisting of a combination of a heavy rake and hoe.
Rate of spread (ROS)	The speed with which a fire moves in a horizontal direction across the landscape at a specified part of the fire perimeter. See also Forward rate of spread.
Reaction time	The time taken between the report of a fire or incident, and the departure of the crew. See also Response time.
Rear	1. That portion of a fire spreading directly into the wind or down slope. 2. That portion of a fire edge opposite the head. 3. Slowest spreading portion of a fire edge. Also called heel of a fire. (NWCG)
Reburn	Repeat burning of an area over which a fire has previously passed, but left fuel that later ignites when burning conditions are more favourable. (NWCG)
Reconnaissance	To examine a fire area to obtain information about current and probable fire behaviour and other related fire suppression information. (NWCG)
Recovery	The coordinated process of supporting emergency affected communities in reconstruction of the physical infrastructure and restoration of emotional, social, economic and physical wellbeing.
Red Flag Warning	A process for passing critical safety information to incident suppression resources and support resources on which they can base decisions regarding strategy, tactics and deployment.
Regeneration burn	A burn lit under prescribed conditions for the purpose of achieving regeneration of a particular vegetation type.
Re-ignition	The action of a material that ignites again after it has been extinguished.
Relative humidity (RH)	The amount of water vapour in a given volume of air, expressed as a percentage of the maximum amount of water vapour the air can hold at that temperature.
Relay pumping	Using a series of pumps positioned at intervals along a line or lines of hose to share the workload of pumping water over a long distance.
Relief	The replacement of personnel whose period of time at the incident has concluded.
Report of fire	The notification of the detection of a fire to the fire service. (AFAC)
Residence time	The time required for the flaming zone of a fire to pass a stationary point; the width of the flaming zone divided by the rate of spread of the fire.
Resources	All personnel and equipment available, or potentially available, for incident tasks.
Response	Actions taken in anticipation of, during, and immediately after an incident to ensure that its effects are minimised, and that people affected are given immediate relief and support.
Response time	The time taken between the report of a fire or incident, and arrival at the scene. It includes both reaction time and travel time.
Responsible authority	See: Control authority.
Retardant	See: Fire retardant.

Term	Definition
Risk	The exposure to the possibility of such things as economic or financial loss or gain, physical damage, injury or delay, as a consequence of pursuing a particular course of action. The concept of risk has two elements, i.e. the likelihood of something happening and the consequences if it happens. (AS4360)
Risk analysis	A systematic use of available information to determine how often specific events may occur and the magnitude of their likely consequences.
Road Management Point	A strategic position from which traffic can be observed and controlled. (See also Traffic Management Point and Vehicle Control Point)
Rural	Any area wherein residences and other developments are scattered and intermingled with forest, range, or farm land and native vegetation or cultivated crops.
Rural urban interface (RUI)	See Urban rural interface
Safe	The stage of bushfire suppression or prescribed burning when it is considered that no further suppression action or patrols are necessary.
Safety zone	An area cleared of flammable materials used for escape if the line is outflanked or in case a spot fire outside the control line renders the line unsafe. In fire operations, crews progress so as to maintain a safety zone close at hand, allowing the fuels inside the control line to be consumed before going ahead. Safety zones may also be constructed as integral parts of fuelbreaks. They are greatly enlarged areas which can be used with relative safety by fire fighters and their equipment in the event of a blow up in the vicinity. (Vic report)
Scorch height	1. The height above ground level up to which foliage has been browned by a fire. 2. A measurement for determining the acceptable height of flame during prescribed burning.
Scout	A person who checks and reports on conditions in the fire area.
Scrub	Refers to vegetation such as heath, wiregrass and shrubs, which grows either as an understorey or by itself in the absence of a tree canopy.
Scrub fire	Fires burning in scrub.
Secondary fire control line	See: Fall back fire control line.
Sector	A specific area of an incident which is under the control of a Sector Commander who is supervising a number of crews.
Seen area	The ground, or vegetation, that is directly visible from an established or proposed lookout point, or aerial detection flight route.
Severe fire danger	The third highest fire danger rating as determined by fire agencies and generally with a Forest fire danger index between 50 and 74 or a Grassland fire danger index between 50 and 74.
Shift	The period resources are allocated during an operation at the incident or on the fireground.
Shift change	Replacement of allocated crews and or equipment during operations.
Situation report **(Sitrep)**	A report on the progress of the fire and the efforts to control it. It confirms the location of the fire, its status and potential and the number, nature and effectiveness of resources deployed. Situation reports are normally provided at regular times until the fire is declared safe.
Size up	The evaluation of a fire to determine a course of action for suppression.
Slash	Accumulated fuel resulting from such natural events as wind, fire, snow breakage, or from such human activities as logging, cutting or road construction.

Term	Definition
Slash burn	A prescribed burn conducted to consume slash for fire hazard reduction or silvicultural purposes.
Sleeper	1. A fire that starts up again after appearing to have been extinguished. 2. A fire that is detected some time after an ignition opportunity (usually from lightning or hop over events).
Slip-on unit	A tank, a live hose reel or tray, a small capacity pump, and an engine combined into a single one-piece assembly that can be slipped onto a truck bed or trailer and used for spraying water and/or foam on bushfires.
Slop over	See: Breakaway
Smoke management	Used by land managers and meteorologists planning a prescribed burn, to ensure that smoke does not cause problems downwind of the burn.
Smoke Plume	The column of smoke that rises from a fire. (See also Convection Column)
Smoker	An isolated small burning item such as a log, stump or tree, in an area of fire otherwise mopped up.
Softwood	A conventional term used to describe a tree, and the timber of trees, belonging to the group of plants with cones, such as pine and cypress.
Soil Dryness Index (SDI)	A form of Drought Index, usually with slightly more detailed inputs than the Keetch-Byram Drought Index. May be on a scale of 0-200 like the KBDI, but some versions have different scales (for example, Western Australia: 0-2000).
Southern Oscillation Index (SOI)	The comparison of surface air pressure differences between Tahiti and Darwin that shows a strong correlation with rainfall.
Spark arrestor	A device fitted to the exhaust system of machinery for trapping carbon sparks.
Spot fire	1. Isolated fire started ahead of the main fire by sparks, embers or other ignited material, sometimes to a distance of several kilometres. 2. A very small fire that requires little time or effort to extinguish.
Spot ignition	An ignition pattern using a series of spaced points of ignition.
Spot over	See: Breakaway
Spotting	Behaviour of a fire producing sparks or embers that are carried by the wind and start new fires beyond the zone of direct ignition by the main fire. (NWCG)
Staging area	An area where resources are mustered and prepared for allocation to an incident. It may include the provision of welfare and equipment maintenance facilities. (AIIMS)
Stand by	The period during which personnel are to be immediately available at home or other location for fire suppression purposes.
Static water supply	A supply of water in a reservoir or pond, of limited capacity.
Step-up method	A method used by a team of firefighters to construct a firebreak in which each firefighter completely constructs a section of the firebreak after which the entire team ‘steps up’ to the next section.
Strike teams	A set number of resources of the same type that have an established minimum number of personnel. Strike Teams always have a leader (usually in a separate vehicle), and have a common communications system. Strike Teams are usually made up of five resources of the same type such as: vehicles, crews, earth moving machinery, etc (AIIMS).

Term	Definition
Strip burning	1. An ignition pattern using lines of continuous fire. 2. In hazard reduction, burning narrow strips of fuel and leaving the rest of the area untreated by fire. (NWCG)
Strip ignition	See: Strip burning.
Stripping	See: Strip burning.
Structure	A constructed object, usually a free-standing building above ground.
Sub surface fire	See: Ground fire
Sub surface fuel	See: Ground fuel
Suction hose	Hose used to draught from static/open water. It has a hard, usually reinforced, exterior to prevent it collapsing when a partial vacuum exists within the hose.
Supply hose	Hose feeding from a water supply to a pump.
Support agency	An organisation contributing services or resources directly to a lead agency.
Surface fire	Fire that burns loose debris on the surface, which includes dead branches, leaves, and low vegetation. (NWCG)
Surface fuel	Litter fuels made up of leaves, twigs, bark and other fine fuel lying on the ground, predominately horizontal in orientation.
Surface moisture content	The moisture content expressed as a percentage of oven dry weight of the top 5-10 mm of leaf litter.
Tactics	These are the tasking of personnel and resources to implement the incident strategies. Incident control tactics are accomplished in accordance with appropriate agency procedures and safety directives. (AIIMS)
Tail fire	See: Backing fire.
Tanker	A mobile firefighting vehicle equipped with a water tank, pump, and the necessary equipment for spraying water and/or foam on bushfires.
Task force	A combination of resources assembled for a specific purpose. Task Force always have a leader (usually in a separate vehicle), and have a common communications system. Task Forces are established to meet tactical needs and may incorporate a mixture of different resources types. (AIIMS)
Task group	A large or complex combination of resources assembled for a specific purpose including intrastate, interstate and international deployments made up of multiple strike teams or task forces and or other response or support resources in any combination.
Technical advisors	Are advisors with special skills needed to support incident activities/functions.(AIIMS)
Temperature (dry bulb)	The ambient air temperature recorded by an exposed thermometer.
Temperature (wet bulb)	Wet bulb temperature is measured by placing a moist, single-layer, muslin sleeve over the bulb of a dry bulb thermometer. The difference between dry and wet bulb readings is used to determine relative humidity and dewpoint values.
Test fire	A controlled fire ignited to evaluate fire behaviour.
Thermal imagery	A display or print out from an infra-red scanning device.
Thermal radiation	The process by which the surface of an object radiates its thermal energy in the form of electromagnetic radiation.

Term	Definition
Thermohygrograph	An instrument that simultaneously and continuously measures and records temperature and relative humidity, normally by tracing each onto a revolving chart. Charts can be either for one day or one week of continuous recording.
Time lag	See: Lag time
Tongues	See: Fingers
Topography	The surface features of a particular area or region. It may include mountains, rivers, populated areas, roads and railways and fuel types.
Torch	See: Candle
Torching	See: Candle
Traffic Management Point	Point along movement routes that are staffed by emergency personnel to direct and control traffic flow. (See also Road Management Point and Vehicle Control Point)
Travel time	The time taken between the departure of a crew, and arrival at the incident. See also Response time.
Under storey	The lowest stratum of a multi-storeyed forest.
Upwind	Towards the wind direction. In the same direction as the direction from which the wind is blowing. The opposite direction to that smoke will travel.
Urban	Area in which residences and other human developments form an essentially contiguous covering of the landscape, includes most area within cities & towns, subdivisions, commercial and industrial parks, and similar development whether inside city limits or not.
Urban interface	See Urban rural interface
Urban rural interface (URI)	The line, area, or zone where structures and other human development adjoin or overlap with undeveloped bushland.
Values at risk	The natural resources or improvements that may be jeopardised if a fire occurs.
Vehicle Control Point	A point on a vehicle access route controlled by a barrier, or similar means, at which a vehicle is required to stop. (See also Road Management Point and Traffic Management Point)
Very high fire danger	The forth highest fire danger rating as determined by fire agencies and generally with a Forest fire danger index between 25 and 49 or a Grassland fire danger index between 25 and 49.
Warning device	Audible devise fitted to fire bombing aircraft to alert ground crews of pending drop.
Water bombing	See: Fire bombing.
Water point	Any natural or constructed supply of water that is readily available for fire control operations.
Water tank	A container capable of storing a large volume of water.
Wetting agent	A chemical added in low concentration to water. It is used in firefighting to break down the surface tension of the water and to improve its penetration into fuels.
Widow maker	See: Hang up
Wilderness Area	Places where wilderness quality defined using thresholds of remoteness, naturalness and total area is recognised and valued by society.
Wildfire	See: Bushfire.
Wildfire control plan	See: Incident Action Plan

Term	Definition
Wildland urban interface (WUI)	See: Urban rural interface
Wind direction	The direction from which the wind blows.
Windfall	See: Wind throw
Wind throw	An area of previously standing timber which has been blown over by strong winds or storms.
Wind speed	The rate of horizontal motion of the air past a given point expressed in terms of distance per unit of time. In the NZ Fire Danger Rating System, wind speed is measured at the standard height of 10 metres in the open, averaged over a 10-minute interval and in kilometres per hour.
Wind strength	Generally measured as wind speed. May be measured by the Beaufort wind scale.
Windrow	A long line of piled slash or debris resulting from forest or scrub clearing.
Windrow burning	The burning of windrows.
Windward	Towards the wind. You are windward if the wind is blowing on your face.
Woodland	A subset of forest plant communities in which the trees form only an open canopy (between 20% and 50% crown cover), the intervening area being occupied by lower vegetation, usually grass or scrub.

Appendix 3B - Stage 9 and 10 Bushfire

FPA AUSTRALIA | Fire Protection Association Australia
Life. Property. Environment.

BPAD Bushfire Planning & Design

Bushfire Management Plan Coversheet

This Coversheet and accompanying Bushfire Management Plan has been prepared and issued by a person accredited by Fire Protection Association Australia under the Bushfire Planning and Design (BPAD) Accreditation Scheme.

Bushfire Management Plan and Site Details

Site Address / Plan Reference: Vivente Estate Structure Plan Amendment, including Stages 9 & 10

Suburb: Hammond Park **State:** WA **P/code:** 6164

Local government area: City of Cockburn

Description of the planning proposal: Structure Plan Amendment

BMP Plan / Reference Number: RDP19149.01/JBSG56821 **Version:** R001 Rev 1 **Date of Issue:** 28/05/2020

Client / Business Name: Gold Estates Holdings Pty Ltd

Reason for referral to DFES	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?	☐	☒
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the BPC elements)?	☐	☒
Is the proposal any of the following special development types (see SPP 3.7 for definitions)?		
Unavoidable development (in BAL-40 or BAL-FZ)	☐	☒
Strategic planning proposal (including rezoning applications)	☒	☐
Minor development (in BAL-40 or BAL-FZ)	☐	☒
High risk land-use	☐	☒
Vulnerable land-use	☐	☒

If the development is a special development type as listed above, explain why the proposal is considered to be one of the above listed classifications (E.g. considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

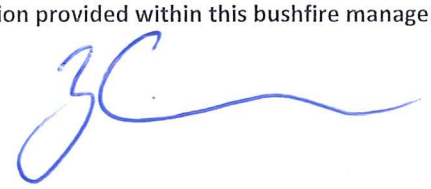
Structure Plan Amendment

Note: The decision maker (e.g. local government or the WAPC) should only refer the proposal to DFES for comment if one (or more) of the above answers are ticked "Yes".

BPAD Accredited Practitioner Details and Declaration

Name	Accreditation Level	Accreditation No.	Accreditation Expiry
Zac Cockerill	Level 2	BPAD 37803	31/08/2020
Company		**Contact No.**	
Strategen-JBS&G		(08) 9792 4797	

I declare that the information provided within this bushfire management plan is to the best of my knowledge true and correct

Signature of Practitioner  **Date** 28/05/2020

Bushfire Management Plan

Vivente Estate Structure Plan Amendment, including Stages 9 and 10

Prepared for
Gold Estates Holdings Pty Ltd
by Strategen-JBS&G

May 2020

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

www.jbsg.com.au

Bushfire Management Plan

Vivente Estate Structure Plan Amendment, including Stages 9 and 10

Strategen-JBS&G is a trading name of
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May 2020

Limitations

Scope of services

This report ("the report") has been prepared by Strategen-JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen-JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

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In preparing the report, Strategen-JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen-JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen-JBS&G has also not attempted to determine whether any material matter has been omitted from the data. Strategen-JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen-JBS&G. The making of any assumption does not imply that Strategen-JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen-JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made. The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose. Strategen-JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by Strategen-JBS&G, and should not be relied upon by other parties, who should make their own enquiries.

Document control

Client: Gold Estates Holdings Pty Ltd

Report Version	Revision No.	Purpose	Strategen-JBS&G author	Strategen-JBS&G reviewer	Submitted to Client	
					Form	Date
Draft Report	Rev A	For client review	Louisa Robertson (BPAD 36748, Level 1)	Zac Cockerill (BPAD 37803, Level 2)	Electronic (email)	12/06/2019
Final Report	Rev 0	For client use	Louisa Robertson (BPAD 36748, Level 1)	Zac Cockerill (BPAD 37803, Level 2)	Electronic (email)	20/06/2019
Final Report	**Rev 1**	**Issued for use: updated to address WAPC Schedule of Modifications**	**Louisa Robertson (BPAD 36748, Level 1)**	**Zac Cockerill (BPAD 37803, Level 2)**	**Electronic (email)**	**28/05/2020**

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1. Proposal details

1.1 Background

Roberts Day, on behalf of Gold Estates Holdings Pty Ltd, is seeking to lodge a Structure Plan amendment (Amendment No. 4) to the endorsed Structure Plan over the Barfield Road area in Hammond Park, known as Vivente Estate. The Structure Plan amendment is primarily associated with Stages 9 and 10 of the development situated east of Barfield Road; however, administrative changes are also proposed for three additional development cells located west of Barfield Road. The administrative changes to these cells do not involve modification of development boundaries or an increase in bushfire risk in comparison to the endorsed Structure Plan.

Designs for the endorsed Structure Plan and proposed amendment are compared in Figure 1 and identify five cells that are the subject of the proposed amendment (the project area). The proposed amendments are explained as follows:

- the proposed layout of development within Lot 18/Stage 9 has been revised
- Stage 10 has been added to the Structure Plan area which includes proposed development of Lot 15 and proposed road reserve within adjacent Lot 37
- the existing carpark central to the site is proposed to be changed from R30 to R60
- the BAL-FZ ratings applicable to two development cells in the northwest of the Structure Plan area have now been removed through clearing carried out to facilitate residential development to the north of the project area and for the development of the school site (lots within these cells have already been created under approved subdivision WAPC Ref No. 1429269 dated 17 December 2014).

The project area is located within the municipality of the City of Cockburn.

1.2 Site description

The overall Vivente Estate site is bound to the south by Rowley Road; to the west by Frankland Avenue; to the north by future residential development and a school site; and to the west by fully-vegetated lots situated east of Barfield Road.

The five cells which make up the project area, and the surrounding environment are depicted in Figure 2.

The three cells located within the existing Vivente Estate area to the west of Barfield Road are predominantly surrounded by existing residential development, land cleared and managed in a low threat state for future residential development and a school site, low threat landscaping, and Public Open Space (POS) managed in accordance with the adopted Bushfire Management Plan prepared to support the original Structure Plan (Strategen 2015).

The Stage 9 and 10 cells, situated east of Barfield Road, are currently bordered to the north, east and south by banksia—sheoak low woodland vegetation. A Western Power high voltage powerline corridor runs parallel to the eastern boundaries of Lots 15 and 18, being partially incorporated into Stage 10 to accommodate the proposed road.

The project area is designated as bushfire prone on the *Map of Bush Fire Prone Areas* (DFES 2020; see Plate 1).

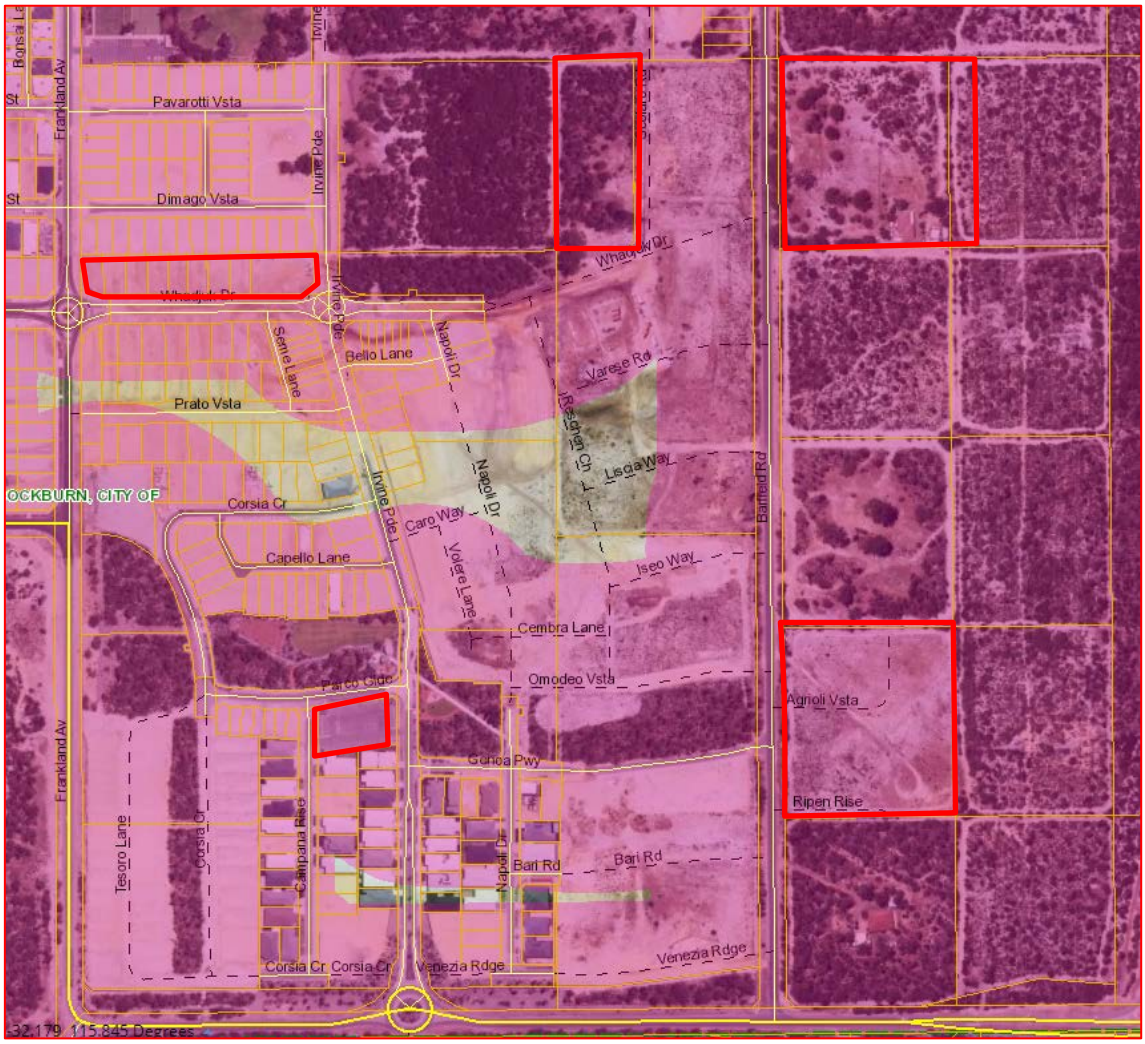


Plate 1: Map of Bush Fire Prone Areas (DFES 2020)

1.3 Purpose

This Bushfire Management Plan (BMP) has been prepared to address requirements under Policy Measure 6.3 of *State Planning Policy 3.7 Planning in Bushfire-Prone Areas* (SPP 3.7; WAPC 2015) and *Guidelines for Planning in Bushfire-Prone Areas* (the Guidelines; WAPC 2017).

1.4 Other plans/reports

Fire Management Plan, Barfield Road Local Structure Plan (Strategen, 2015)

The 2015 Fire Management Plan (FMP) was prepared to support the original Local Structure Plan (LSP) over Vivente Estate and has been subsequently used to support various subdivision applications within the LSP area.

In consultation and agreement with City of Cockburn and DFES officers, the FMP excluded all vegetation within the central east-west POS corridor as low threat vegetation in acknowledgement of the fragmented, small pockets of low fuel carrying banksia that would not warrant full BAL application in accordance with AS 3959 Method 1. This approach was further supported by commitments outlined in the FMP regarding ongoing management of the vegetation in a low fuel state and application of precautionary BAL-12.5 ratings on a number of lots with direct frontage to the POS cells. This strategy was deemed adequate in terms of addressing bushfire risk to future dwellings and was supported by the relevant decision makers at the time the Structure Plan was endorsed. To achieve consistency with this approach, and in acknowledgement that the amendments to the previously endorsed Structure Plan in these areas are largely administrative, this current BMP aims to align with the previously endorsed bushfire management strategies applicable to the approved Structure Plan area.

Clearing Permit Decision Report (DWER, 2018)

A clearing permit has been obtained from the Department of Water and Environmental Regulation (DWER) to clear up to 1.5 ha of native vegetation within Lot 37 for the purpose of bulk earthworks. This area encapsulates the majority of Lot 37 (including the proposed road within Stage 10), aside from a 10 m wide strip around the southern and eastern boundaries which are largely already cleared for firebreaks.

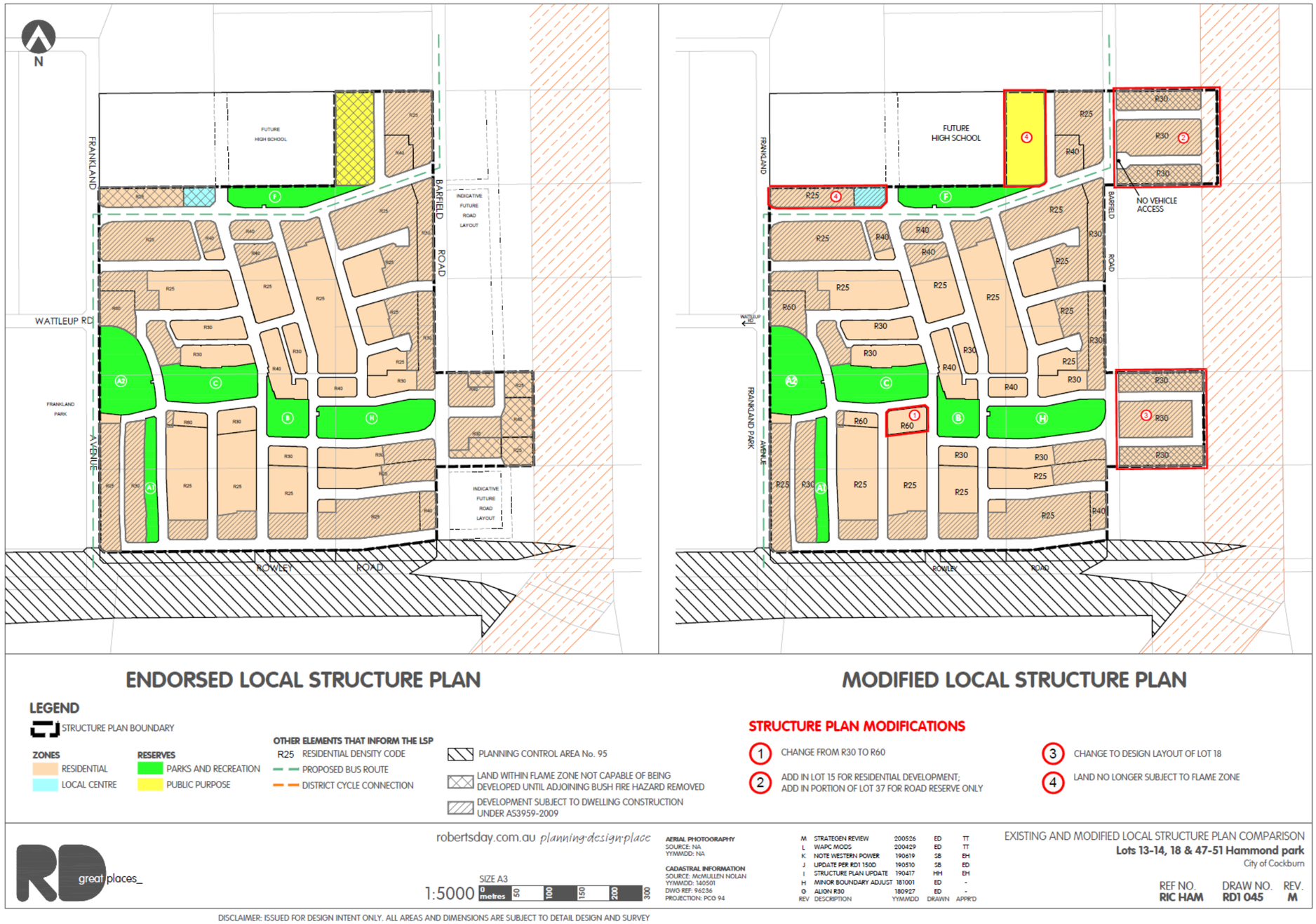
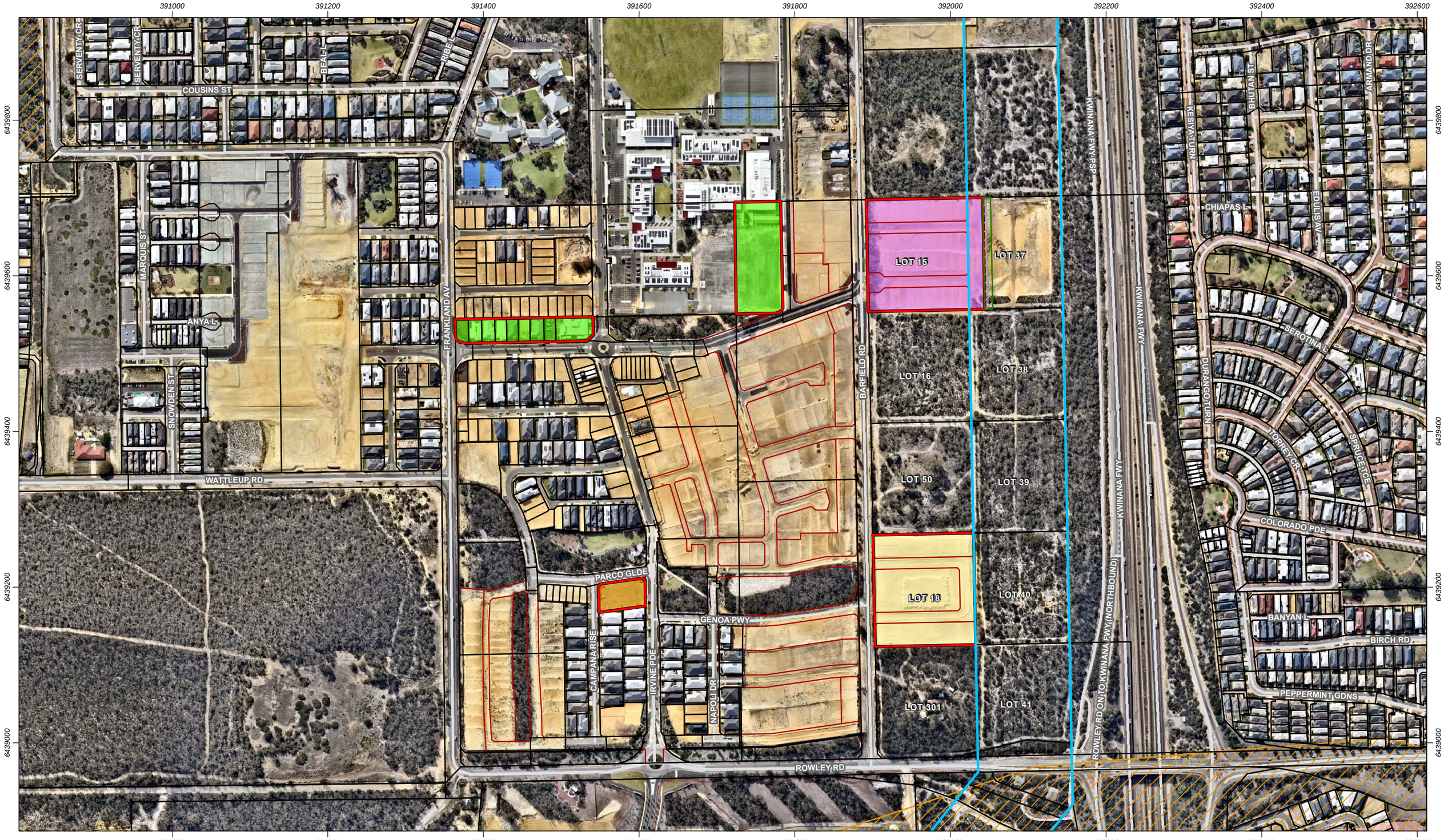


Figure 1: Existing and modified Local Structure Plan comparison

Figure 2: Site overview





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2. Environmental considerations

2.1 Native vegetation – modification and clearing

Aside from Lot 18 (east of Barfield Road), all land within the previously approved Structure Plan area (refer to Figure 1) has been previously cleared/modified to facilitate urban development of the site. Strategen-JBS&G (formerly Strategen) understands that all necessary environmental approvals have been obtained in regard to clearing/modification of this land.

Lot 15 (Stage 10) and Lot 18 (Stage 9) situated east of Barfield Road have not been previously cleared as part of the endorsed Structure Plan development. These lots currently contain a combination of remnant banksia woodland and scrub amongst substantial areas of grassland, indicating that the lots have been subject to previous clearing/disturbances. Environmental impacts resulting from proposed clearing within Stages 9 and 10 will need to be addressed under standard State and Federal environmental assessment and referral requirements under the *Environmental Protection Act 1986* and *Environment Protection and Biodiversity Conservation Act 1999* where appropriate.

Table 1 provides a summary of a search of publicly available environmental information relevant to the project area cells.

Table 1: Summary of environmental values

Environmental value	Present within or adjacent to project area	Description
Environmentally Sensitive Area	Adjacent	The nearest ESA is located to the south of Rowley Road (refer to Figure 2).
Swan Bioplan Regionally Significant Natural Area	No	N/A
Wetlands	Adjacent	The nearest wetlands include Resource Enhancement and Multiple Use wetlands to the south of Rowley Road (refer to Figure 2).
Waterways	No	N/A
Ecological Linkages	Within and adjacent	The western portion of the overall Structure Plan area is mapped as being within the Perth Regional Ecological Linkage
Threatened Ecological Communities listed under the EPBC Act	Possibly	The endangered banksia woodlands of the Swan Coastal Plain TEC is mapped as having potential to occur within the project area. The clearing permit obtained from DWER acknowledges that proposed clearing within Lot 37 will impact on a small, degraded area of this TEC but that the impacts to the TEC in the local area are negligible (DWER 2018).
Threatened and priority flora	No	There are no previous records of threatened and priority flora within the project area cells or within 1.5 km.
Fauna habitat listed under the EPBC Act	Yes	A portion of Lot 18 is mapped as being a potential feeding area for endangered Carnaby's Black Cockatoo (CBC). Adjacent land to the east of Barfield Road and a large portion of the overall structure plan area are also mapped as potential feeding areas for CBC. The project area and a large proportion of surrounding land is also mapped as a confirmed roosting area (buffered) for CBC. A portion of Lots 15 and 18 and a large portion of the overall Structure Plan area is mapped as being potential Quenda habitat.
Threatened and priority fauna	Yes	Observations of Priority fauna have been recorded within the south of the overall Structure Plan, however, this land has now been predominantly cleared. Observations of threatened and priority fauna have been recorded to the north of the Structure Plan area.
Bush Forever Site	No	N/A

Environmental value	Present within or adjacent to project area	Description
DBCA managed lands and lands and waters (includes legislated lands and waters and lands of interest)	No	N/A
Conservation covenants	No	N/A

2.2 Revegetation / Landscape Plans

The three project area cells to the west of Barfield Road are already cleared to facilitate development of urban lots and the school site. Any landscaping works within these cells will constitute low threat vegetation in accordance with AS 3959 Clause 2.2.3.2 (f) (e.g. cultivated gardens and maintained lawns).

The full extent of Lot 15/Part Lot 37 (Stage 10) and Lot 18 (Stage 9) has been cleared to facilitate urban residential development and the future road. Any vegetation retained for streetscaping/visual amenity will comprise low threat vegetation in accordance with AS 3959 Clause 2.2.3.2 (f).

To the east of Stage 10, a portion of Lot 37 has been cleared for bulk earthworks in accordance with the DWER clearing permit and City of Cockburn development approval (Reg No: 6000663 – DA18/0393). A 10 m wide strip of POS abutting the proposed road will be established within Lot 37 and the remainder of the lot will be revegetated in accordance with the previous vegetation assemblage (banksia—sheoak low woodland). Proposed revegetation within Lot 37 is depicted in Appendix 1. The POS strip is expected to comprise path connections, play space and other open space functions and is subject to detailed design that will ultimately deliver a low threat vegetation outcome, excluded from classification in accordance with Clauses 2.2.3.2 (e) and (f).

3. Bushfire assessment results

3.1 Assessment inputs

3.1.1 Vegetation classification

Strategen-JBS&G assessed classified vegetation and exclusions within 150 m of the project area cells through on-ground verification on 15 May 2019 in accordance with *AS 3959—2018 Construction of Buildings in Bushfire-Prone Areas* ([AS 3959]; SA 2018) and the *Visual Guide for Bushfire Risk Assessment in Western Australia* (DoP 2016). Georeferenced site photos and a description of the vegetation classifications and exclusions are contained in Appendix 2. The vegetation/exclusion plots identified are summarised in Table 2 and depicted in Figure 3.

3.1.2 Effective slope

Strategen-JBS&G assessed effective slope under classified vegetation through on-ground verification on 15 May 2019 in accordance with AS 3959. Results were cross-referenced with DPIRD 2 m contour data and are depicted in Table 2 and Figure 3.

Site observations indicate that the surrounding land is predominantly flat or upslope in relation to the five development cells.

3.1.3 Summary of inputs

Figure 3 illustrates the anticipated post-development vegetation classifications and exclusions following completion of subdivision works and implementation of low threat landscaping throughout the project area. The post-development vegetation classifications/exclusions and effective slope are summarised in Table 2

Table 2: Summary of post-development vegetation classifications/exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope	Comments
1	Class D Scrub	Flat/upslope (0°)	Low banksia scrub (2–6 m)
2	Class B Woodland	Flat/upslope (0°)	Tall banksia-sheoak woodland (>6 m)
3	Class G Grassland	Flat/upslope (0°)	Unmanaged grassland within vacant lots
4	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	All existing low threat and non-vegetated land within 150 m of the project area cells (includes existing POS within Vivente Estate)
5	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	Land to be modified to low threat state within the existing development portion of Vivente Estate in accordance with previous Structure Plan/subdivision approvals
6	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	Land to be modified to low threat state within Stage 10 (including POS within Lot 37)
7	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	Land to be modified to low threat state within Stage 9

391000 391200 391400 391600 391800 392000 392200 392400

6439800 6439600 6439400 6439200 6439000

COUSINS ST
WOODROW AV
MARQUIS ST
AGATA L
ANYA L
CHELINA L
SNOWDEN ST
WATTLEUP RD
FRANKLAND AV
PARCO GLDE
CAMPANA RISE
IRVINE PDE
NAPOLI DR
GENOA PWY
BARFIELD RD
ROWLEY RD
KWINANA FWY
KWINANA FWY PSP
KWINANA FWY (SOUTHBOUND) OFF TO ROWLEY RD
KESIYA TURN
BHUTAN ST
EDDIUS AV
DURANGO TURN
SEROTINA L
GLABRA L
TORREY CR
LATTERI TURN
UMAN L
BIRCH RD
PEPPERMINT GDNS

STAGE 10
STAGE 9

PLOT 1 F/US
PLOT 2 F/US
PLOT 3 F/US
PLOT 4
PLOT 5
PLOT 6
PLOT 7
PLOT 8

1A 1B 1C 1D 1E
2A 2B 2C
3A 3B
4A 4B 4C 4D
5A 5B
6A
7A 7B

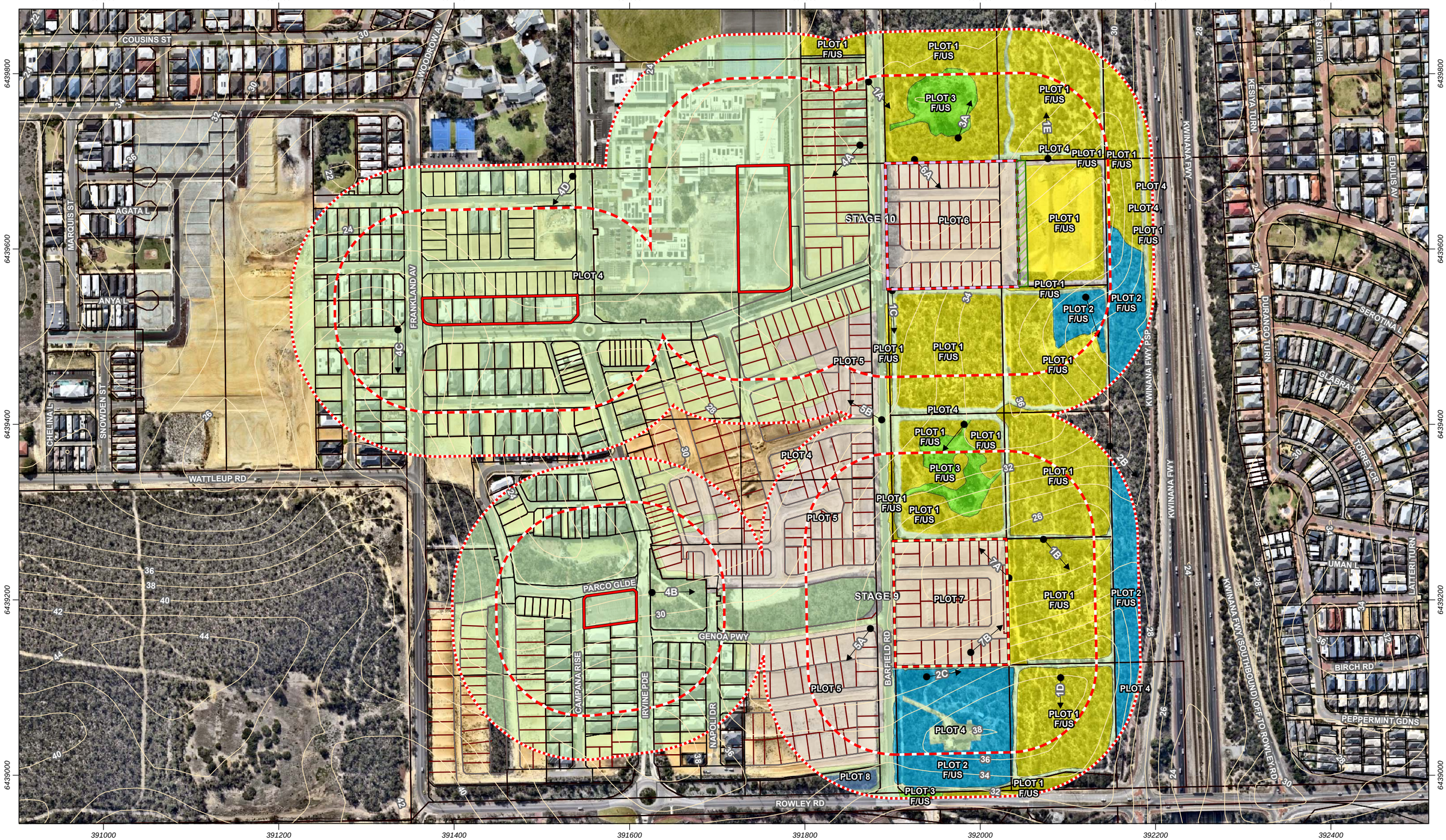


Figure 3: Post-development vegetation classification and effective slope

N

Scale 1:4,000 at A3

0 50 100 m

Coordinate System: GDA 1994 MGA Zone 50

Date: 28/05/2020

Legend

- Project area
- 100m assessment area
- 150m assessment area
- Existing cadastre
- Stage 9 boundary
- Stage 10 boundary
- POS
- Photo point and direction
- Surface elevation (mAHD)
- Modified LSP layout
- Proposed development

Vegetation classification

- Class B Woodland
- Class D Scrub
- Class G Grassland
- Excluded under Clause 2.2.3.2 (d)
- Excluded under Clause 2.2.3.2 (e) & (f)
- Area to be modified to a non-vegetated or low threat state

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3.2 Assessment outputs

3.2.1 Bushfire Attack Level (BAL) contour assessment

Indicative subdivision concepts show a proposed lot layout for Stages 9 and 10; therefore, Strategen-JBS&G has undertaken a BAL contour assessment in accordance with Method 1 of AS 3959 for the project area cells (Figure 4). The Method 1 procedure incorporates the following factors:

- state-adopted FDI 80 rating
- post-development vegetation classification
- effective slope
- distance maintained between proposed development areas and the classified vegetation.

The BAL rating gives an indication of the level of bushfire attack (i.e. the radiant heat flux) that may be received by proposed future development and subsequently informs the standard of building construction and/or setbacks required for proposed habitable development to potentially withstand such impacts.

Results of the BAL contour assessment for each project area cell are detailed in Table 3 (three cells to west of Barfield Road), Table 4 (Stage 9) and Table 5 (Stage 10) and illustrated in Figure 4.

The highest BAL applicable to the external boundary of the proposed lots for each cell are as follows:

- three cells to the west of Barfield Road: BAL-LOW
- Stage 9: BAL-FZ
- Stage 10: BAL-FZ.

In order to ensure that all habitable development will occur within areas subject to a maximum of BAL-29, all lots subject to BAL-40/FZ will be temporarily quarantined from development until the classified vegetation within adjacent landholdings is permanently removed and managed in a non-vegetated or low threat state as part of future development. Eighteen lots are to be temporarily excluded from development within Stage 9 and 22 lots are to be temporarily excluded from development within Stage 10. These temporarily quarantined lots are identified in Figure 4.

Table 3: BAL contour assessment results – three cells to west of Barfield Road

Method 1 BAL determination					
Plot	Vegetation classification	Effective slope	Separation distance	Highest BAL (to lot boundary)	Modified BAL (with building setbacks)
1	Class D Scrub	Flat/upslope (0°)	>100 m	BAL–Low	N/A
2	Class B Woodland	Flat/upslope (0°)	>100 m	BAL–Low	N/A
3	Class G Grassland	Flat/upslope (0°)	>100 m	BAL–Low	N/A
4	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low	N/A
5	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low	N/A
6	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low	N/A
7	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low	N/A
8	Excluded – Clause 2.2.3.2 [d]	N/A	N/A	BAL–Low	N/A
				Highest BAL	BAL-LOW

Table 4: BAL contour assessment results - Stage 9

Plot	Vegetation classification	Effective slope	Separation distance	Highest BAL (to lot boundary)
1	Class D Scrub	Flat/upslope (0°)	0 m	BAL-FZ*
2	Class B Woodland	Flat/upslope (0°)	3 m	BAL-FZ*
3	Class G Grassland	Flat/upslope (0°)	27 m	BAL–12.5
4	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low
5	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low
6	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low
7	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low
8	Excluded – Clause 2.2.3.2 [d]	N/A	N/A	BAL–Low
			Highest BAL	BAL-FZ
			Highest BAL with BAL-FZ lots excluded via temporary quarantining	BAL-29

*BAL-FZ applies to lots bordering the northern and southern boundaries of the Stage 9 cell only. All BAL-FZ lots are to be excluded from development until adjacent temporary bushfire hazards are removed as part of future development. All remaining lots will achieve BAL-29 or lower (which may be further reduced through the future occurrence of adjacent development).

Table 5: BAL contour assessment results - Stage 10

Plot	Vegetation classification	Effective slope	Separation distance	Highest BAL (to lot boundary)
1	Class D Scrub	Flat/upslope (0°)	0 m	BAL-FZ*
2	Class B Woodland	Flat/upslope (0°)	58 m	BAL–12.5
3	Class G Grassland	Flat/upslope (0°)	29 m	BAL–12.5
4	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low
5	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low
6	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low
7	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])	N/A	N/A	BAL–Low
8	Excluded – Clause 2.2.3.2 [d]	N/A	N/A	BAL–Low
			Highest BAL	BAL-FZ
			Highest BAL with BAL-FZ lots excluded via temporary quarantining	BAL-12.5

*BAL-FZ applies to lots bordering the northern and southern boundaries of the Stage 10 cell only. All BAL-FZ lots are to be excluded from development until adjacent temporary bushfire hazards are removed as part of future development. All remaining lots will achieve BAL-12.5 (which may be further reduced through the future occurrence of adjacent development).

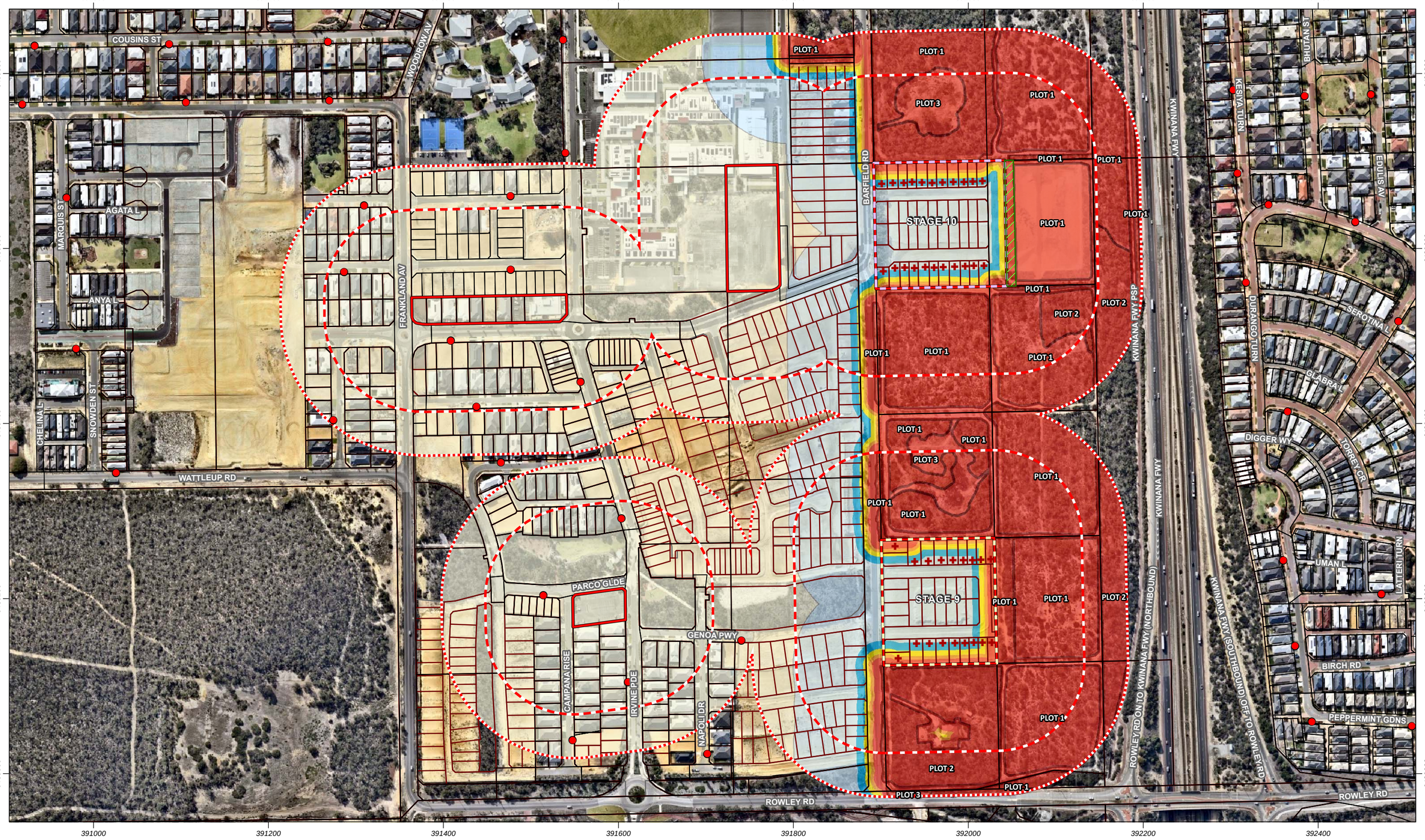


Figure 4: BAL contour map and bushfire management measures

N

Scale 1:4,000 at A3

0 50 100 m

Coordinate System: GDA 1994 MGA Zone 50

Date: 28/05/2020

Legend

- Project area
- 100m assessment area
- 150m assessment area
- Existing cadastre
- Stage 9 boundary
- Stage 10 boundary
- POS
- Classifiied vegetation
- BAL contours
- BAL FZ
- BAL 40
- BAL 29
- BAL 19
- BAL 12.5
- BAL LOW
- Modified LSP layout
- Proposed development
- Existing fire hydrants
- Lots subject to BAL-40/FZ to be quarantined until adjacent temporary bushfire hazards permanently removed/managed in a low threat state

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4. Identification of bushfire hazard issues

4.1 Bushfire context

The three development cells within the existing Vivente Estate subdivision area, west of Barfield Road, are cleared (some partially constructed) and surrounded by land that has already been cleared/modified as part of approved subdivision areas of Vivente Estate and adjacent development areas of Hammond Park. Banksia woodland vegetation within Frankland Park, west of Frankland Avenue, poses the greatest threat to the development cells; however, there is substantial separation (greater than 150 m) provided by Frankland Avenue and existing developed areas within Vivente Estate, meaning these cells would not be subject to significant bushfire impacts. Vegetated land to the south of Rowley Road is currently in the process of being cleared as part of a separate, staged development (Apsley Estate), and will therefore not pose a bushfire threat to the development cells in the long term.

The Vivente Estate approved Structure Plan and subdivision design includes a vegetated corridor extending through the centre of the site in an east-west direction. As part of a management measure written into the BMP prepared to support these previous planning applications (Strategen 2015), the vegetation will be managed in a low fuel state and is unlikely to pose a significant bushfire threat to adjacent development. The Strategen (2015) BMP does however cater for precautionary BAL-12.5 application on a number of lots located adjacent to the POS cells to provide for an additional level of safety for these dwellings in terms of ember protection.

The Stage 9 and 10 development cells are bordered to the west by Barfield Road and the existing Vivente Estate development area, which, as discussed above, comprises land cleared and partially developed along with the managed POS corridor. The bushfire threat from the west is therefore considered to be extremely limited. The development cells, however, are subject to potential bushfire impacts from surrounding banksia vegetation, which has been predominantly classified as Class D Scrub based on a fairly continuous horizontal and vertical fuel structure less than 6 m in height. This vegetation forms a narrow band of approximately 300 m width between Kwinana Freeway and Barfield Road and extends a length of approximately 900 m north from Rowley Road. This vegetation has a direct interface with the Stage 9 and 10 development cells, resulting in BAL-40/FZ impacts on lots proposed at the perimeter of these cells. However, as the surrounding land is expected to be cleared and developed in the future, these lots will be temporarily quarantined, excluding them from development until such a time as the temporary vegetation hazards adjacent to the cells are permanently removed and developed/managed in a low threat state. In addition, clearing within Lot 27 to facilitate bulk earthworks will reduce impacts on Stage 10 from the east. Strategen-JBS&G considers that the bushfire risk to Stages 9 and 10 posed by these hazards can be managed via standard staging mechanisms and application of acceptable solutions under the Guidelines, as well as through a direct bushfire suppression response if required. Bushfire mitigation strategies applicable to the proposed development are addressed in Section 5 of this BMP.

4.2 Bushfire hazard issues

Strategen-JBS&G does not consider there to be any bushfire hazard issues for the three development cells situated west of Barfield Road, since these are subject to BAL-Low and already meet all compliance requirements of the Guidelines. As such, these cells are not considered further within this section.

The key bushfire hazard issues for the remaining development cells (i.e. Stages 9 and 10, east of Barfield Road) that are likely to require management and/or consideration at future planning stages from a bushfire management perspective include:

1. Temporary quarantining of lots within the Stage 9 and 10 development cells currently subject to BAL-40/FZ until such a time that adjacent temporary bushfire hazards are permanently removed and/or managed in a low threat state.
2. Provision of two access/egress routes on completion of development as well as during staging.
3. Provision of a compliant cul-de-sac and turnaround area within the Stage 10 development cell on completion of development and the planned future road connection to the south.

4. Provisions for temporary emergency access from the Stage 10 cul-de-sac onto Barfield Road or staging of development until a compliant cul-de-sac can be provided through the planned construction of a future road linkage south to Rowley Road.
5. Provision of a suitable bushfire fighting water supply and associated infrastructure to support the scale of the proposed development.

The above potential bushfire hazard issues are considered further in Section 5.

Based on the above, Strategen-JBS&G considers the bushfire hazards within and adjacent to the project area and the associated bushfire risks are readily manageable through standard management responses outlined in the Guidelines and AS 3959. These responses will be factored into proposed development as early as possible at all stages of the planning process to ensure a suitable and effective bushfire management outcome is achieved for protection of future life, property and environmental assets.

5. Assessment against the bushfire protection criteria

5.1 Compliance table

An acceptable solutions assessment against the bushfire protection criteria is provided in Table 6.

Table 6: Compliance with the bushfire protection criteria of the Guidelines

Bushfire protection criteria	Method of compliance Acceptable solutions	Proposed bushfire management strategies
Element 1: Location	A1.1 Development location	The BAL contour assessment identifies that through compliance with the 2015 Strategen BMP (in terms of site earthworks/clearing, establishment and maintenance of staging buffers and management of the POS corridor), the three development cells located within the existing Vivente Estate development (west of Barfield Road) are subject to BAL-Low (refer to Table 3 and Figure 4). The BAL contour assessment identifies that the Stage 9 and 10 development cells contain proposed lots currently subject to BAL-40/FZ (refer to Table 4, Table 5 and Figure 4). The identified lots are to be temporarily quarantined until the adjacent temporary bushfire hazards are permanently removed and/or managed in a low threat state. This will ensure that all future habitable development has the ability to achieve BAL-29 or lower.
Element 2: Siting and design	A2.1 Asset Protection Zone	On completion of development, all developable lots will be cleared and developed with residential dwellings along with cultivated gardens and managed lawns. As all proposed lots will be subject to a maximum BAL of 29, no separate APZs are considered to be required on completion of development. Prior to being developed with residential dwellings, all vacant lots are to be established and maintained by the developer in a low threat state as temporary APZs in accordance with Schedule 1 of the Guidelines (Appendix 3) and the City of Cockburn Fire Control Order (Firebreak Notice; Appendix 4). As the proposed residential lots will be <4,047 m^2 in area, they will be subject to Firebreak Notice requirements, including slashing of grass and weeds to <50 mm until the lots are sold, when responsibilities will be handed over to the individual land owner. During staging of development, all balance land (including lots excluded from development through temporary quarantining) are to be cleared and managed in a low threat state by the developer as a temporary APZ. Balance lots <4,047 m^2 in area are to have grasses and weeds maintained at <50 mm in accordance with the Firebreak Notice. Balance lots >4,047 m^2 are to are to have grasses and weeds maintained at <100 mm in accordance with Schedule 1 of the Guidelines.

Bushfire protection criteria	Method of compliance Acceptable solutions	Proposed bushfire management strategies
Element 3: Vehicular access	A3.1 Two access routes.	The three cells within the existing Vivente Estate development (to the west of Barfield Road) are currently provided with more than two access routes, comprising three access routes to Frankland Avenue in the west, one access route to Rowley Road in the south and one access route to Barfield Road in the east. On completion of staged development, the cells will be provided five additional access points onto Barfield Road. Kwinana Freeway being located within 300 m east of Barfield Road and the surrounding public road network provides access to and egress from the site in all directions. The Stage 9 development cell will be provided with an internal loop road which will achieve two access points onto Barfield Road. Barfield Road provides access to the north (through Harmonie Estate), south to Rowley Road and west (through Vivente Estate); therefore, two access routes in two different directions are achieved/exceeded for this cell. Further to this, on extension of the proposed road within the Stage 10 development cell to the south to meet Rowley Road, access options would be further enhanced for the Stage 9 development cell. The Stage 10 development cell will be provided with a single access route (i.e. compliant cul-de-sac) onto Barfield Road until such time that the planned future road connection to the south is provided. As previously discussed, Barfield Road provides access to the north, south and west which meets compliance with A3.1. On provision of a future public road constructed to link Stage 10 with Rowley Road, this will provide additional access options for the Stage 10 development cell. Two access routes are to be provided during staging of development, which is considered to be achievable based on the above information.
	A3.2 Public road	All proposed public roads are to be constructed to relevant technical requirements under the Guidelines (see Appendix 5).
	A3.3 Cul-de-sac (including a dead-end-road)	Cul-de-sacs within the existing Vivente Estate development (to the west of Barfield Road) have either been constructed, or approved, under previous subdivision applications and are therefore not considered further within this assessment. The Stage 10 development cell includes a cul-de-sac which has been included in the development design at the request of the City. The justification for this cul-de-sac is that a through connection onto Barfield Road at this point would conflict with the connection already approved on the opposite (western) side of Barfield Road. In this regard, inclusion of the cul-de-sac is considered to be unavoidable and at the City's request. The cul-de-sac will be provided with a compliant turn around head (e.g. minimum 17.5 m diameter; refer to Appendix 5) however, the length of the road (as measured from the Barfield Road intersection) will exceed 200 m. The non-compliant length is, however, considered to be a temporary arrangement given an interim emergency access connection will be provided to Barfield Road at the cul-de-sac head until such time that a public road is planned to be constructed south to Rowley Road (and potentially north to service future adjacent development). In this regard, it is likely that the cul-de-sac will ultimately have a maximum length of 130 m on completion of development and will require interim staging mechanisms to ensure non-compliances are avoided. The cul-de-sac arrangement is discussed further in Section 5.2.2.
	A3.4 Battle-axe	N/A – no battle-axe lots are proposed as part of the development and the project area is not serviced by an existing battle-axe.
	A3.5 Private driveway longer than 50 m	N/A – the proposed lots are of size where all future habitable development will be located within 50 m of a public road.
	A3.6 Emergency access way	N/A – no emergency access ways (EAWs) are proposed as part of the development.

Bushfire protection criteria	Method of compliance Acceptable solutions	Proposed bushfire management strategies
	A3.7 Fire service access routes (perimeter roads)	N/A – no fire service access routes (FSARs) are proposed as part of the development.
	A3.8 Firebreak width	Each stage of development is required to comply with the requirements of Acceptable Solution A3.8 and the annual City Firebreak Notice as amended (refer to Appendix 4). On completion of development, firebreaks would not be required for the residential cells which will be less than <4,047 m^2 in area. Three metre wide, 4 m high internal perimeter firebreaks would be required for the Parks and Recreation Reserve within the Stage 10 development cell. During staged development, all balance land >4,047 m^2 in area will also require 3 m wide by 4 m high internal perimeter firebreaks.
Element 4: Water	A4.1 Reticulated areas	The proposed development will be connected to reticulated water supply via surrounding development in accordance with Water Corporations Design Standard 63 requirements (refer to Appendix 6). Existing firefighting hydrants are depicted in Figure 4.
	A4.2 Non-reticulated areas	N/A – the project area is located within an existing reticulated area.
	A4.3 Individual lots within non-reticulated areas	N/A – the project area is located within an existing reticulated area.

5.2 Additional management measures

5.2.1 Temporary quarantining of lots subject to BAL-40/FZ

The 18 lots within the Stage 9 development cells and 22 lots within the Stage 10 development cell impacted by BAL-FZ/40 will be subject to temporary quarantining (see Figure 4) until the temporary vegetation extents within adjacent lots to the north and south of these cells are permanently removed or managed to deliver a compliant rating of BAL-29 or lower for all proposed development. This exclusion area will be enforced via application of the following condition of subdivision:

> *The 18 lots within Stage 9 and 22 lots within Stage 10, highlighted on the attached subdivision plan, are not to be created until it can be adequately demonstrated, via a suitably qualified bushfire consultant, that the lots are not impacted by a Bushfire Attack Level of 40 or Flame Zone. (Local Government).*

5.2.2 Vehicular access during staging

As discussed in Table 6 (under Acceptable Solution A3.3), the proposed public road within the Stage 10 development cell will comprise an approximately 330 m long cul-de-sac. This non-compliant road arrangement is expected to be temporary in nature and would be resolved through the following strategies:

- A temporary emergency access connection will be provided from the cul-de-sac head onto Barfield Road which will resolve the dead-end road. The connection will be provided by way of landscaping treatments and an access gate, subject to approval from the City, with the design being confirmed at the subdivision stage.
- On completion of the planned north-south aligned public road, to be constructed to the east of the Stage 10 development cell and connected through to adjacent development to the north and/or south, the Stage 10 cul-de-sac length will be measured from this road, as opposed to Barfield Road, and will have a length of approximately 130 m. Therefore, the cul-de-sac will achieve compliance with Acceptable Solution A3.3 once future road connections have been constructed. The temporary emergency access connection onto Barfield Road (as mentioned above) would then be decommissioned.

It should be noted that the design of the Stage 10 development cell is very similar to the Stage 9 development cell, with the main difference being that, initially, the internal road network within Stage 10 is unable to be provided with a secondary public road connection due to the opposing intersection on the western side of Barfield Road. In this regard, Strategen-JBS&G considers that the temporary emergency access connection for the Stage 10 cul-de-sac will provide an access outcome comparable to that of Stage 9 until such time that a permanent secondary public access route can be provided.

5.2.3 Management of staging buffers

Ongoing management of POS cells will continue to be in accordance with the approved Strategen (2015) BMP. This is also the case with the provision of 100 m wide low threat staging buffers, which are to be established where possible and maintained around each stage of development to mitigate unnecessary bushfire risk during rollout of development stages.

The developer and City are to ensure that all fuel management commitments are being met in accordance with the 2015 FMP.

6. Responsibilities for implementation and management of the bushfire measures

This BMP has been prepared as a strategic guide to demonstrate how development compliance will be delivered at future planning stages in accordance with the Guidelines. Aside from the preparation of future BMPs to accompany future subdivision and development applications where appropriate, there are no further items to implement, enforce or review at this strategic stage of the planning process.

Future BMPs prepared for subsequent subdivision and development applications are to meet the relevant commitments outlined in this strategic level BMP, address the relevant requirements of SPP 3.7 (i.e. Policy Measures 6.4 and 6.5 respectively) and demonstrate in detail how the proposed development will incorporate the relevant acceptable solutions or meet the performance requirements of the Guidelines. Future BMPs are to include the following detailed information:

- confirmed lot layout, including any proposed public open space (POS)
- detailed landscaping design/plans in regard to proposed POS, consistent with the provisions of this BMP
- post development classified vegetation extent and effective slope
- BAL contour map demonstrating that proposed development areas will achieve BAL–29 or lower
- width and alignment of compliant APZs/setbacks where applicable
- confirmation of how bushfire management will be addressed during development staging, particularly with regards to temporary quarantining of lots, delayed/staged development, provision of low threat staging buffers/vegetation modification or clearing in advance, vehicular access staging requirements, etc
- proposed approach to fuel management or AS 3959 application in response to any on-site POS
- vehicular access provisions, including demonstration that a minimum of two access routes will be achieved for each stage of development in accordance with Acceptable Solution A3.1
- compliance with any specific vehicular access technical requirements (e.g. public roads, cul-de-sacs, EAWs, etc)
- water supply provisions with regards to reticulated water
- provisions for notification on Title for any future lots with a rating of BAL–12.5 or greater as a condition of subdivision
- compliance requirements with the current City annual firebreak notice
- construction of Class 1, 2, 3 or associated 10a buildings in accordance with AS 3959 to the assessed BAL rating
- requirements for BMP/BAL compliance reports as conditions of subdivision
- compliance with acceptable solutions of the bushfire protection criteria
- proposed implementation and audit program outlining all measures requiring implementation and the appropriate timing and responsibilities for implementation.

On the basis of the information contained in this BMP, Strategen-JBS&G considers the bushfire hazards within and adjacent to the project area and the associated bushfire risks are readily manageable through standard management responses outlined in the Guidelines and AS 3959.

7. References

Department of Fire and Emergency Services (DFES) 2019, *Map of Bush Fire Prone Areas*, [Online], Government of Western Australia, available from: *https://maps.slip.wa.gov.au/landgate/bushfireprone/*, [28/05/2019].

Department of Planning (DoP) 2016, *Visual guide for bushfire risk assessment in Western Australia*, Department of Planning, Perth.

Department of Water and Environmental Regulation (DWER), 2018, *Clearing Permit Decision Report*, Government of Western Australia, Perth.

Standards Australia (SA) 2018, *Australian Standard AS 3959–2018 Construction of Buildings in Bushfire-prone Areas*, Standards Australia, Sydney.

Strategen, 2015, *Fire Management Plan: Barfield Road Local Structure Plan*, Strategen, Perth.

Western Australian Planning Commission (WAPC) 2015, *State Planning Policy 3.7 Planning in Bushfire Prone Areas*, Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WAPC) 2017, *Guidelines for Planning in Bushfire Prone Areas*, Version 1.3 August 2017, Western Australian Planning Commission, Perth.

Appendix 1
Lot 37 Revegetation Plan

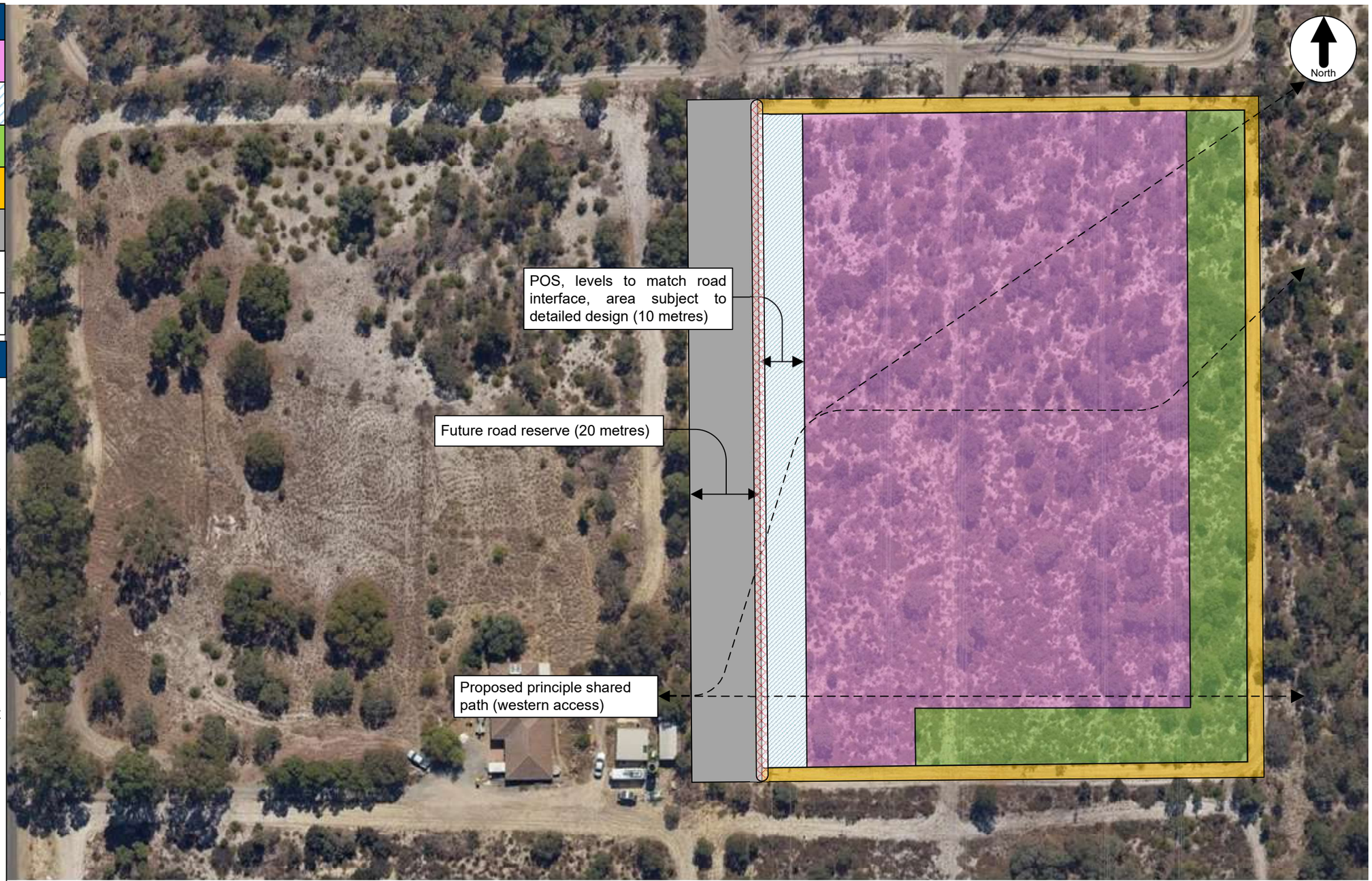
Lot 37 Barfield Road, Hammond Park – Revegetation Plan

RICHARDNOBLE
PROPERTY INTEGRITY COMMUNITY

vivente
HAMMOND PARK

This Revegetation Plan ("Plan") has been prepared to address Condition 3 of City of Cockburn development approval Ref No: 6000663 – DA18/0393 issued on 24 August 2018 for bulk earthworks on Lot 37 Barfield Road, Hammond Road ("site"). The Plan has been prepared as an indicative representation of the proposed revegetation and is subject to detailed design and co-ordination of future infrastructure, such as a potential extension of the principal shared path network to the Kwinana Freeway principal shared path.

LEGEND	
Revegetation area (9,100m^2)	
POS (1,320m^2)	
Retained vegetation (1,950m^2)	
Existing firebreak (1,750m^2)	
Future road reserve	
Location of temporary fencing	
Potential principal shared path routes	



NOTES

1) The provisions of the Revegetation Plan for Lot 37 Barfield Road, Hammond park are applicable to the revegetation and retained vegetation areas, including:

- Revegetation area;
- Retained vegetation area; and
- POS.

2) The provisions of the Fauna Management Plan for Vivente are applicable to clearing works.

3) The areas identified are subject to detailed design, quality of the vegetation, and final survey.

4) The site is subject of an Easement in Gross. The provisions of Electrical Networks Corporation Easement in Gross prevail and the following is not permitted:

- growth, cultivation or retention of any vegetation exceeding one (1) metre in height from the natural surface of the land within the Easement;
- stacking, placement or storage of any plant or material within the Easement.

5) The proposed POS includes potential path connections, playspace and other potential open space functions, subject to detailed design.

City of Cockburn Fire Control Order

Effective from 10 May 2018

First and Final Notice



Pursuant to *Section 33 of the Bush Fires Act 1954* owners or occupiers of land situated within the City of Cockburn are required by law to comply with the prescribed Fire Control Order here within.

Definitions	
Authorised Officer	A person appointed by the City of Cockburn Chief Executive Officer as an authorised person/officer to exercise the powers and duties set out in the Local Government Act 1995, Bush Fires Act 1954 and Local Law(s).
Flammable Material	Any dead or dry grass, vegetation, substance, object, thing or material (except living flora including live and/ or habitat standing trees) that may or is likely to catch fire and burn or any other thing deemed by an Authorised Officer to be capable of combustion.
Maintained Grass	Soil covered land, planted with grasses or other durable plants, maintained green and less than 50mm in height.
Prohibited Burning Time	The time of each year where it is unlawful to set fire to the bush at any time. This time is normally from 1 December of each year until and including 31 March of the following year. This time may be amended, subject to prevailing seasonal conditions.
Restricted Burning Time	The time of each year where it is unlawful to set fire to the bush without a valid Permit to Set Fire To The Bush issued by an Authorised Officer. This period normally is from 1 April until and including 31 May and from 1 October until and including 30 November of any year. This time may be amended, subject to the prevailing seasonal conditions.
Unrestricted Burning Time	The time of each year where it is lawful to set fire to the bush at any time, in areas zoned rural under the Metropolitan Region Scheme. This time normally is from 1 June until and including 30 September. This time may be amended, subject to the prevailing seasonal conditions.
Firebreak Time	The time of each year where fire hazard reduction works must be maintained as specified in this Fire Control Order. This time is 1 November of each year until and including 15 April of the following year.
Structure	A building, as defined in the Building Codes of Australia (BCA) may be made up of a number of classes if it has a mixed use.

1. All property (vacant or developed) – less than 4,047m^2

To reduce the fire hazard on your land and to comply with the requirements of this Fire Control Order you are required to;

1.1 Have all flammable materials such as dry grass and weeds slashed, mown or trimmed down by other means to a maximum height of 50mm across the entire property for the duration of this Firebreak Time; and

1.2 Remove all dead vegetation.

2. All property (vacant or developed) – 4,047m^2 or greater

To reduce the fire hazard on your land and to comply with the requirements of this Fire Control Order you are required to;

2.1 Construct a firebreak (as defined within section 3 of this order) immediately inside all external property boundaries, this includes those adjacent to roads, drains, rail reserves and any public open space reserves; and

2.2 Remove all dead vegetation surrounding and over all habitable structures to a radius of 3 metres except living trees, shrubs, maintained grass and gardens under cultivation.

3. Firebreak Specifications

A firebreak is an area of land cleared of flammable material, installed to minimise the spread or extension of a fire and to provide suitable access for fire fighting vehicles. The standards of a compliant firebreak are as follows;

3.1 A firebreak must be constructed of bare earth, stone, or sealed surfaces and be clear of all flammable materials to create a 3 metre wide trafficable surface;

3.2 Maintained grass may occupy a firebreak;

3.3 Overhanging branches must be pruned to provide a 4 metre vertical clearance above the full width of the 3 metre firebreak surface; and

3.4 A firebreak must be a continuous trafficable surface for a fire fighting vehicle, clear of any obstructions and must not terminate in a cul-de-sac (dead end).

4. Additional Works

Regardless of land size and location, the City of Cockburn or its Authorised Officer(s) may require you to undertake additional work(s) on your property to improve access and/or undertake further works where in the opinion of that Authorised Officer(s), these works would be conducive to preventing the outbreak and/or the spread or extension of a fire.

5. Fire Control Order Variations

A variation will be considered where the owner and/or occupiers believe it is impractical to meet the compliance requirements of this Fire Control Order.

Approved structure's occupying a firebreak will not require a variation approval. However, a firebreak will be required to be installed as close as practical around the approved structure.

If approved, variations will be valid in perpetuity, unless a new variation has been approved or the property changes ownership.

The City of Cockburn reserves the right to review, amend or revoke an existing variation in writing at any time. Should a request to vary the Fire Control Order requirements on your property not be approved in writing, this Fire Control Order must be complied with as applicable in its entirety.

6. Burning

During the declared Prohibited Burning Time owners and/or occupiers must not undertake any bush or garden refuse burning activities.

During the declared Restricted Burning Time only, owners and/or occupiers may:

6.1 Apply for a permit to burn the bush for bush fire risk mitigation purposes, by following the conditions imposed on a permit to burn as issued by an Authorised Officer.

6.2 In areas zoned rural by the Metropolitan Region Scheme you may undertake burning of leaves, tree branches, and other dry vegetation in piles no larger than 1m^3 in size, without a permit to burn, subject to the following conditions:

6.2.1 No flammable material (other than that being burned) is to be within 5m of the fire at any time while the fire is burning;

6.2.2 The fire is lit between 6pm and 11pm and is completely extinguished before midnight on the same day;

6.2.3 At least one person is present at the site of the fire at all times until it is completely extinguished; and

6.2.4 When the fire is no longer required, the person ensures that the fire is completely extinguished by the application of water or earth.

During the Unrestricted Burning Time, owners and/or occupiers in areas zoned rural under the Metropolitan Region Scheme may burn garden refuse and set fire to bush on their land without a permit 'To Set Fire To The Bush'. Burning of the bush must be in accordance with all relevant State legislative requirements.

Burning of garden refuse in areas not zoned rural shall not be undertaken within the City of Cockburn, unless approved by an Authorised Officer.

Burning of household waste is prohibited in all areas of the City of Cockburn.

7. Penalties

Failing to comply with this Fire Control Order will result in a penalty of up to $5,000. A person in default is also liable whether prosecuted or not to pay the costs of performing the work directed by a City's Authorised Officer.

Any owner and/or occupier who engages a contractor to undertake works on their behalf is responsible to ensure that the works completed meet the requirements of this Fire Control Order.

Any Fire Control Order previously published by the City of Cockburn in the Government Gazette or in any Western Australian newsprint is hereby revoked.

By Order of Council

The City of Cockburn Fire Control Order is available in Chinese, Portuguese, Italian and Croatian by contacting the City on 08 9411 3444.

Document Set ID: 7874932
Version: 1, Version Date: 12/10/2018

Appendix 2
Vegetation plot photos and description



Photo ID: 1a



Photo ID: 1b



Photo ID: 1c



Photo ID: 1d



Photo ID: 1e

Plot number		Plot 1
Vegetation classification	**Pre-development**	Class D Scrub
	Post-development	Class D Scrub
Description / justification		Shrubs greater than 2 m high at maturity (but generally less than 6 m), dominated by Banksia.



Photo ID: 2a

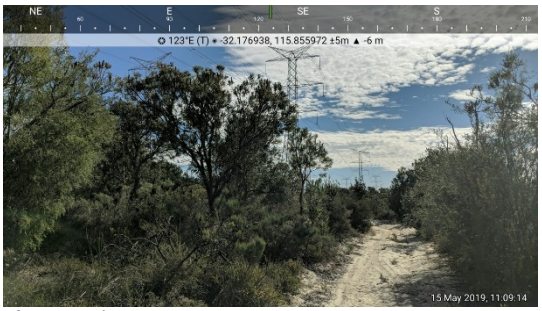


Photo ID: 2b



Photo ID: 2c

Plot number		Plot 2
Vegetation classification	**Pre-development**	Class B Woodland
	Post-development	Class B Woodland
Description / justification		Trees/shrubs generally greater than 6 m high at maturity, dominated by Banksia.



Photo ID: 3a



Photo ID: 3b

Plot number		Plot 3
Vegetation classification	**Pre-development**	Class G Grassland
	Post-development	Class G Grassland
Description / justification		Grassland greater than 100 mm in height within centre of Lots 50 and 28 (former house sites)



Photo ID: 4a



Photo ID: 4b



Photo ID: 4c



Photo ID: 4d

Plot number		Plot 4
Vegetation classification	**Pre-development**	Excluded – Non-vegetated & Low threat (Clauses 2.2.3.2 [e] and [f])
	Post-development	Modified to non-vegetated (exclusion 2.2.3.2 [e]) and/or low threat (exclusion 2.2.3.2 [f]) state
Description / justification		Portion of Vivente Estate to the west of Barfield Road, which has been cleared for urban development. Areas of POS excluded as low threat vegetation in accordance with 2015 FMP (refer to Section 5.2.3).



Photo ID: 5a



Photo ID: 5b

Plot number		Plot 5
Vegetation classification	**Pre-development**	Class G Grassland, Class D Scrub
	Post-development	Modified to non-vegetated (exclusion 2.2.3.2 [e]) and/or low threat (exclusion 2.2.3.2 [f]) state
Description / justification		Currently undeveloped portions of Vivente Estate to be modified to non-vegetated or low threat state as part of staging buffers in accordance with previously endorsed FMP (refer to Section 5.2.3). On completion of development, this land will be fully developed with residential lots and roads.

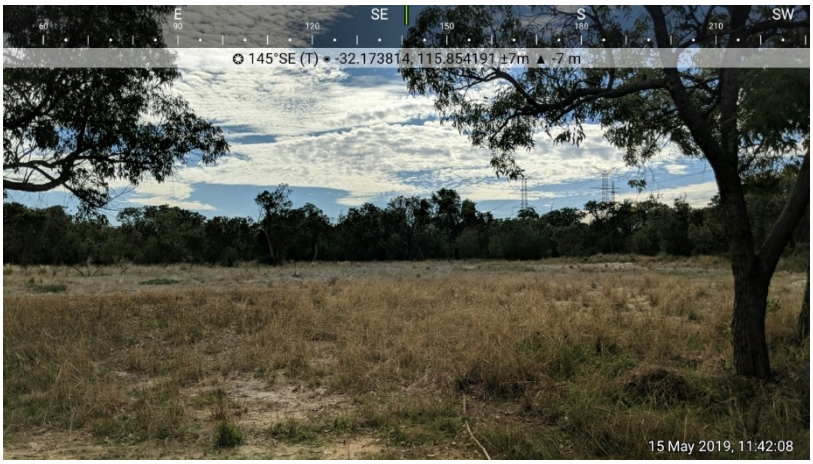


Photo ID: 6a

Plot number		Plot 6
Vegetation classification	**Pre-development**	Class G Grassland, Class D Scrub
	Post-development	Modified to non-vegetated (exclusion 2.2.3.2 [e]) and/or low threat (exclusion 2.2.3.2 [f]) state
Description / justification		Current vegetation comprises grassland >100 mm in height with regenerating banksias (Class D Scrub). Proposed Stage 10 development cell will comprise residential lots with cultivated gardens and reticulated lawns, roads and streetscaping.



Photo ID: 7a



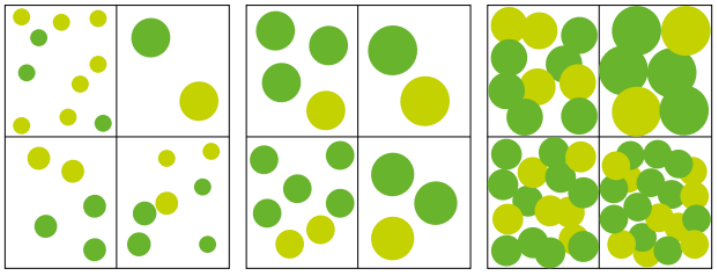
Photo ID: 7b

Plot number		Plot 7
Vegetation classification	**Pre-development**	Class G Grassland, Class D Scrub
	Post-development	Modified to non-vegetated (exclusion 2.2.3.2 [e]) and/or low threat (exclusion 2.2.3.2 [f]) state
Description / justification		Current vegetation comprises grassland >100 mm in height with regenerating banksias (Class D Scrub). Proposed Stage 9 development cell will comprise residential lots with cultivated gardens and reticulated lawns, roads and streetscaping and a limestone base FSAR or road.

Appendix 3
APZ standards (Schedule 1 of the Guidelines)

Schedule 1: Standards for Asset Protection Zones

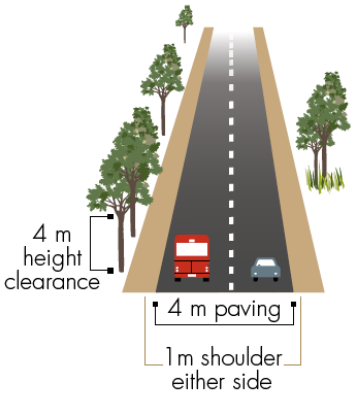
- **Fences:** within the APZ are constructed from non-combustible materials (e.g. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used.
- **Objects:** within 10 metres of a building, combustible objects must not be located close to the vulnerable parts of the building i.e. windows and doors.
- **Fine Fuel load:** combustible dead vegetation matter less than 6 millimetres in thickness reduced to and maintained at an average of two tonnes per hectare.
- **Trees (> 5 metres in height):** trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy.



- **Shrubs (0.5 metres to 5 metres in height):** should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m^2 in area, clumps of shrubs should be separated from each other and any exposed window or door by at least 10 metres. Shrubs greater than 5 metres in height are to be treated as trees.
- **Ground covers (<0.5 metres in height):** can be planted under trees but must be properly maintained to remove dead plant material and any parts within 2 metres of a structure, but 3 metres from windows or doors if greater than 100 millimetres in height. Ground covers greater than 0.5 metres in height are to be treated as shrubs.
- **Grass:** should be managed to maintain a height of 100 millimetres or less.

Appendix 4
City of Cockburn Fire Control Order
(2018-2019)

Appendix 5
Vehicular access technical standards of the Guidelines

Public roads	
Acceptable solution A3.2	A public road is to meet the requirements in Table 1, Column 1.
Explanatory note E3.2	Trafficable surface: Widths quoted for access routes refer to the width of the trafficable surface. A six metre trafficable surface does not necessarily mean paving width. It could, for example, include four metre wide paving one metre wide constructed road shoulders. In special circumstances, where eight lots or less are being serviced, a public road with a minimum trafficable surface of four metres for a maximum distance of 90 metres may be provided subject to the approval of both the local government and Department of Fire and Emergency Services. Public road design: All roads should allow for two-way traffic to allow conventional two-wheel drive vehicles and fire appliances to travel safely on them. 

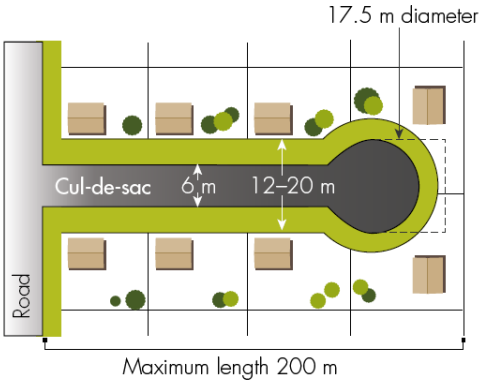
Cul-de-sac (including a dead-end road)	
Acceptable solution A3.3	A cul-de-sac and/ or a dead end road should be avoided in bushfire prone areas. Where no alternative exists (i.e. the lot layout already exists and/ or will need to be demonstrated by the proponent), the following requirements are to be achieved: • Requirements in Table 1, Column 2 • Maximum length: 200 metres (if public emergency access is provided between cul-de-sac heads maximum length can be increased to 600 metres provided no more than eight lots are serviced and the emergency access way is no more than 600 metres) • Turn-around area requirements, including a minimum 17.5 metre diameter head.
Explanatory note E3.3	In bushfire prone areas, a cul-de-sac subdivision layout is not favoured because they do not provide access in different directions for residents. In some instances it may be possible to provide an emergency access way between cul-de-sac heads to a maximum distance of 600 metres, so as to achieve two-way access. Such links must be provided as right of ways or public access easements in gross to ensure accessibility to the public and fire services during an emergency. A cul-de-sac in a bushfire prone area is to connect to a public road that allows for travel in two directions in order to address Acceptable Solution A3.1. 

Table 1: Vehicular access technical requirements

Technical requirement	1	2	3	4	5
	Public road	Cul-de-sac	Private driveway longer than 50 m	Emergency access way	Fire service access routes
Minimum trafficable surface (m)	6*	6	4	6*	6*
Horizontal distance (m)	6	6	6	6	6
Vertical clearance (m)	4.5	N/A	4.5	4.5	4.5
Maximum grade <50 m	1 in 10	1 in 10	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15	15	15
Maximum crossfall	1 in 33	1 in 33	1 in 33	1 in 33	1 in 33
Curves minimum inner radius	8.5	8.5	8.5	8.5	8.5

* Refer to E3.2 Public roads: Trafficable surface

Appendix 6
Water technical standards (the Guidelines, WAPC 2017)

Reticulated areas	
Acceptable solution A4.1	The subdivision, development or land use is provided with a reticulated water supply in accordance with the specifications of the relevant water supply authority and Department of Fire and Emergency Services.
Explanatory note E4.1	Water supply authorities in Western Australia include the Water Corporation, Aqwest and the Busselton Water Board. The Water Corporation's 'No. 63 Water Reticulation Standard' is deemed to be the baseline criterion for developments and should be applied unless local water supply authorities' conditions apply.

Appendix 3C - Bushfire Management Plan Lot

Bushfire Management Plan Coversheet

This Coversheet and accompanying Bushfire Management Plan has been prepared and issued by a person accredited by Fire Protection Association Australia under the Bushfire Planning and Design (BPAD) Accreditation Scheme.

Bushfire Management Plan and Site Details

Site Address / Plan Reference: Vivente Structure Plan Amendment (Lot 16 Barfield Road)

Suburb: Hammond Park **State:** WA **P/code:** 6164

Local government area: City of Cockburn

Description of the planning proposal: Structure Plan Amendment

BMP Plan / Reference Number: 64203/149,088 **Version:** M01 Rev 2 **Date of Issue:** 08/05/2024

Client / Business Name: Gold Estates Holdings Pty Ltd

Reason for referral to DFES	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?	☐	☒
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the BPC elements)?	☐	☒
Is the proposal any of the following special development types (see SPP 3.7 for definitions)?		
Unavoidable development (in BAL-40 or BAL-FZ)	☐	☒
Strategic planning proposal (including rezoning applications)	☒	☐
Minor development (in BAL-40 or BAL-FZ)	☐	☒
High risk land-use	☐	☒
Vulnerable land-use	☐	☒

If the development is a special development type as listed above, explain why the proposal is considered to be one of the above listed classifications (E.g. considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

The proposal is a Structure Plan Amendment, which is a strategic planning proposal.

Note: The decision maker (e.g. local government or the WAPC) should only refer the proposal to DFES for comment if one (or more) of the above answers are ticked "Yes".

BPAD Accredited Practitioner Details and Declaration

Name	Accreditation Level	Accreditation No.	Accreditation Expiry
Zac Cockerill	Level 2	BPAD 37803	31/08/2024
Company		**Contact No.**	
JBS&G Australia Pty Ltd		(08) 9792 4797	

I declare that the information provided within this bushfire management plan is to the best of my knowledge true and correct

Signature of Practitioner **Date** 08/05/2024

Name:	Ali Smyth	Date:	8 May 2024
Company:	Gold Estates Holdings Pty Ltd	Job/Doc. No.:	64203/149,088
Email:	asmyth@rnoble.com.au	Inquiries:	Zac Cockerill

Bushfire Management Plan Addendum: Vivente Structure Plan Amendment (Lot 16 Barfield Road)

1.1 Introduction

Hatch Roberts Day, on behalf of Gold Estates Holdings Pty Ltd, is lodging a Structure Plan Amendment over Vivente Estate to facilitate inclusion of Lot 16 Barfield Road, Hammond Park into the development area. Inclusion of Lot 16 and part of the adjacent east Lot 38 (hereon referred to as the project area) will provide for additional residential development (40 proposed residential lots) and an internal road network, as depicted in the indicative subdivision concept (Figure 1). A 20 m wide road reserve is proposed as part of the Structure Plan amendment within the adjoining Lot 38 to the east. This north-south road reserve is consistent with Stage 10 Structure Plan provisions adjacent north of the project area, as depicted in the updated Barfield Road Structure Plan (Attachment A).

Strategen-JBS&G (now JBS&G) prepared a comprehensive Bushfire Management Plan (BMP) in May 2020 to support the previous Structure Plan Amendment that incorporated Stages 9 and 10 into the development area of Vivente Estate. This report has been prepared as an addendum to the 2020 BMP to accompany the Structure Plan Amendment relating to Lot 16.

This BMP addendum provides an updated strategic level bushfire assessment specific to the project area (appropriate to the Structure Plan stage of development) and should be read in conjunction with the original BMP (Strategen-JBS&G 2020a). This BMP addendum includes the following information:

1. A revised bushfire assessment including:
    a. indicative subdivision concept for the project area (Figure 1)
    b. updated pre and post-development Vegetation Classification and Effective Slope maps specific to the project area and current/proposed vegetation conditions (Figure 2 and Figure 3)
    c. updated pre-development Bushfire Hazard Level Assessment map specific to the project area and current vegetation conditions, as mapped from Item 1b above (Figure 4)
    d. updated post-development Bushfire Attack Level (BAL) Assessment map specific to the project area and proposed vegetation conditions, as mapped from Item 1b above (Figure 5).
2. A revised assessment against the bushfire protection criteria of the *Guidelines for Planning in Bushfire-Prone Areas Version 1.4* (the Guidelines; WAPC 2021), demonstrating that compliance will be achieved at subsequent planning stages (Table 5).

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1.2 Purpose

The project area is designated bushfire prone on the Map of Bush Fire Prone Areas (refer to Plate 1; DFES 2021); therefore, bushfire risk considerations and assessment are required to inform the development proposal in accordance with Policy Measure 6.2 of *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP3.7; WAPC 2015).

This BMP addendum has been prepared to accompany the proposed Structure Plan Amendment and address strategic planning requirements under Policy Measure 6.3 of SPP3.7 in accordance with the Guidelines.

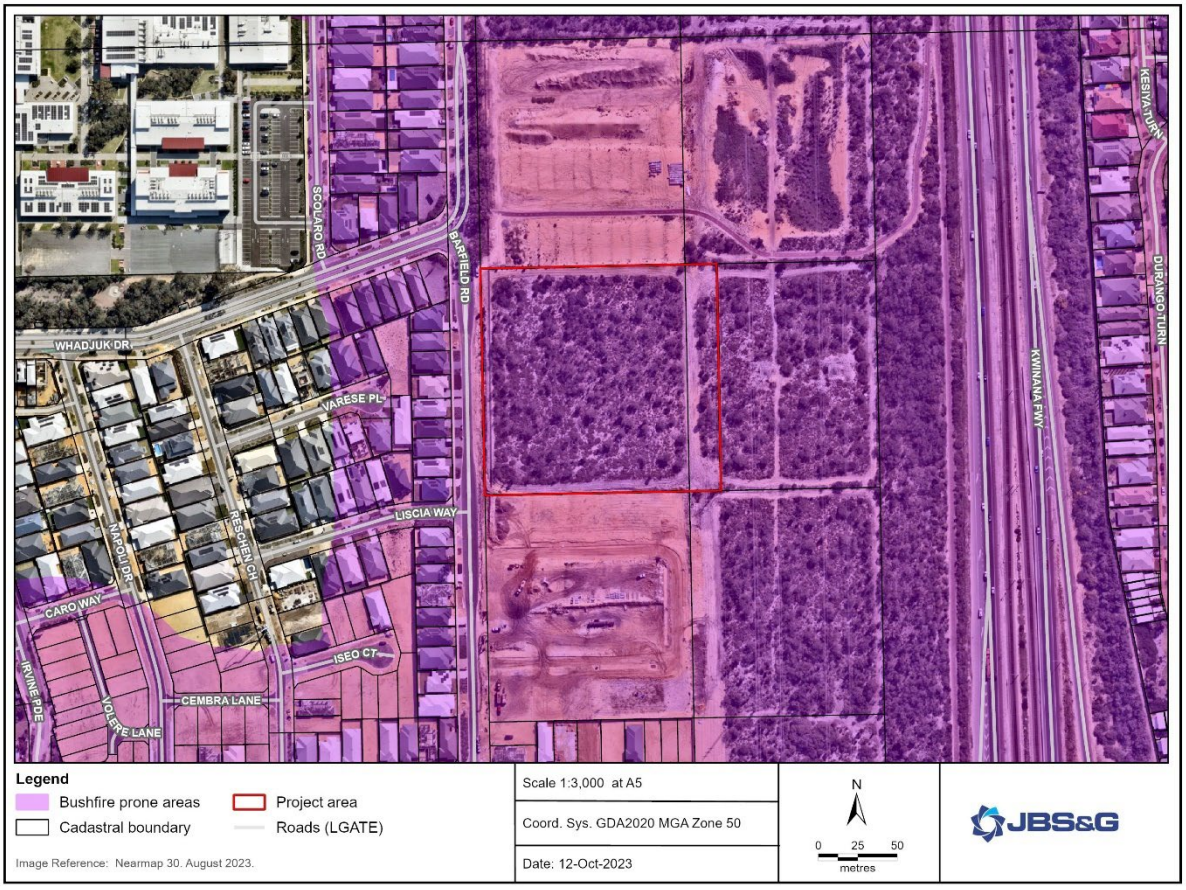
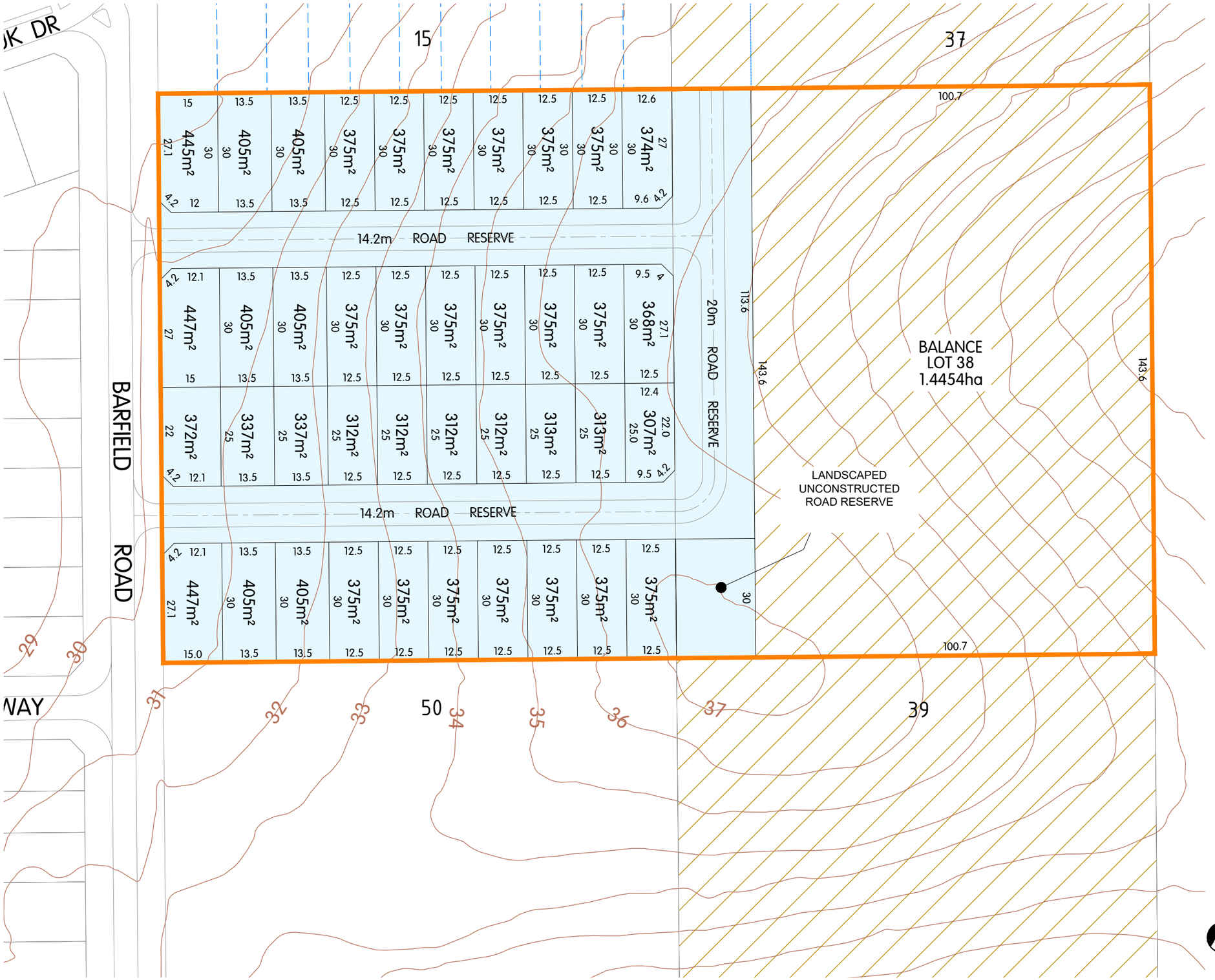
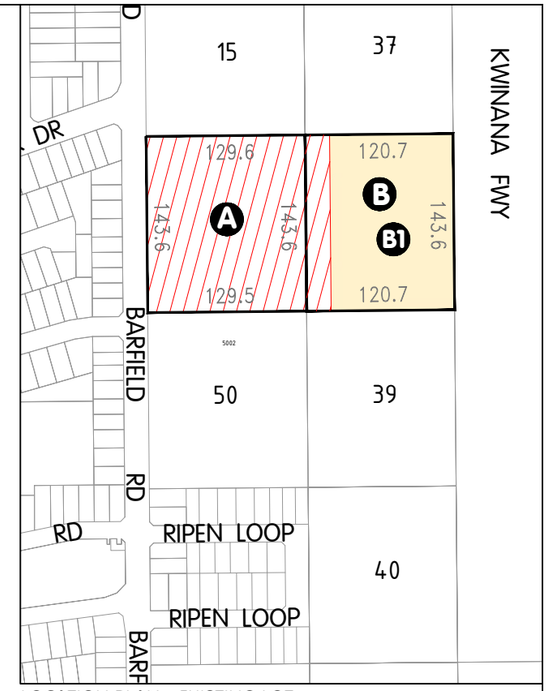


Plate 1: Designated bushfire prone status of the project area (DFES 2021)





LOCATION PLAN - EXISTING LOT

- EXISTING LOT 16 — A 1.8606ha
- EXISTING LOT 38 — B 1.7326ha
- PROPOSED SUBDIVISION
- BALANCE LOT 38 — B1 1.4454ha

LEGEND

- SUBJECT LOTS
- EXISTING LOT BOUNDARY
- 50 EXISTING LOT NUMBERS
- PROPOSED SUBDIVISION
- 52 EXISTING CONTOURS
- EXISTING EASEMENTS

YIELD TABLE

Existing Lots	2
Proposed Lots	
Residential (Single)	40
Balance of Title	1
TOTAL	**41**

PROPOSED LAND USE/DEVELOPMENT

Zone	Lot Size	No. of Lots
Residential	235m² - 319m²	7
Residential	320m² - 449m²	33
Other	1ha - 2ha	1
	TOTAL	**41**

RICHARDNOBLE
PROPERTY INTEGRITY COMMUNITY

CADASTRAL INFORMATION
SOURCE: MNG
YYMMDD: 220408
DWG REF: 96326lots-9999bn-PCG94
PROJECTION: PCG94

AERIAL PHOTOGRAPHY
SOURCE: NA
YYMMDD: NA

HATCH | RobertsDay

SIZE A3_ 1:1000
0 metres 10 20 30 40 50

SUBDIVISION PLAN
Lot 16 Barfield Road
City of Cockburn

REF NO. **RIC HAM**
DRAW NO. **RD1 412**
REV. **G**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY.

1.3 Bushfire assessment results (assessment inputs)

1.3.1 Vegetation classification

JBS&G assessed vegetation classifications and exclusions within the project area and adjacent 150 m (i.e. the assessment area) through on-ground verification on 12 June 2018, 15 May 2019, 23 July 2020, 12 October 2021, 17 May 2022 and 7 September 2022 to support previous BMPs and BAL certification processes.

Vegetation classifications have been assigned in accordance with *AS 3959—2018 Construction of Buildings in Bushfire-Prone Areas* (AS3959; SA 2018) and the *Visual Guide for Bushfire Risk Assessment in Western Australia* (DoP 2016). Georeferenced site photos and a description of the vegetation classifications and exclusions are contained in Figure 3 and Appendix 2 of the previous Structure Plan Amendment BMP for Vivente Estate (Strategen-JBS&G 2020a), as well as Figure 1 and Appendix B of the BAL Compliance Report for Stage 4 Vivente Estate (Strategen-JBS&G 2020b). Vegetation classification results are outlined in Table 1 and Figure 2 for existing pre-development conditions; and Table 2 and Figure 3 for anticipated post-development conditions.

Site and desktop observations indicate that where vegetated, the project area and adjacent 150 m comprises consistent coverage of Class D scrub containing a predominant banksia/sheoak fuel profile between 2–6 m in height over a low shrub understorey. Vegetation previously classified as Class B woodland under the Strategen-JBS&G (2020a) BMP has been updated to Class D scrub, which is a more accurate representation of the vegetation and potential bushfire behaviour in accordance with current AS3959–2018 methodology.

The area of non-vegetated and low threat managed land excluded under Clauses 2.2.3.2 (e) and (f) has also been updated throughout the assessment area to reflect current on-ground conditions and the latest clearing/earthworked extent adjacent to the project area, particularly to the north and south.

1.3.2 Effective slope

Effective slope under classified vegetation was assessed through on-ground verification on 12 June 2018, 15 May 2019, 23 July 2020, 12 October 2021, 17 May 2022 and 7 September 2022 in accordance with AS 3959. Results were cross referenced with DPIRD 2m contour data.

Effective slope under classified vegetation was assessed to be downslope (>0–5°) to the east and southeast of the project area, associated with a gradual incline from Kwinana Freeway to the site; and flat/upslope to the north and northeast.

Effective slope results are outlined in Table 1 and Figure 2 for existing pre-development conditions; and Table 2 and Figure 3 for anticipated post-development conditions.

1.3.3 Pre-development inputs

A summary of the assessed pre-development classified vegetation, exclusions and effective slope within the project area and adjacent 150 m are listed in Table 1 and illustrated in Figure 2.

Table 1: Summary of pre-development vegetation classifications/exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope	Comments
1	Class D Scrub	Downslope >0–5°	Continuous banksia/sheoak fuel profile 2–6 m high over low shrubs to the east and southeast of the project area.
2	Class D Scrub	Flat/Upslope (0°)	Continuous banksia/sheoak fuel profile 2–6 m high over low shrubs to the north and northeast of the project area.
3	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	Existing non-vegetated land (i.e. buildings, roads, footpaths, sealed areas, mineral earth, etc) and low threat managed vegetation (i.e. urban street verges, managed turf, managed gardens, managed POS, etc).

1.3.4 Post-development inputs

A summary of the expected post-development classified vegetation, exclusions and effective slope within the assessment area are listed in Table 2 and illustrated in Figure 3.

The entire project area and adjacent north Stage 10 area (currently being constructed) is expected to be modified to a non-vegetated/low threat managed state in accordance with Clauses 2.2.3.2 (e) and (f) to facilitate the proposed urban built footprint as per the indicative subdivision concept (Figure 1).

Vegetation classifications and exclusions for all land external to the project area are expected to remain as per pre-development conditions.

Table 2: Summary of post-development vegetation classifications, exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope	Comments
1	Class D Scrub	Downslope >0–5°	Continuous banksia/sheoak fuel profile 2–6 m high over low shrubs to the east and southeast of the project area.
2	Class D Scrub	Flat/upslope (0°)	Continuous banksia/sheoak fuel profile 2–6 m high over low shrubs to the north and northeast of the project area.
3	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	Existing non-vegetated land (i.e. buildings, roads, footpaths, sealed areas, mineral earth etc) and low threat managed vegetation (i.e. urban street verges, managed turf, managed gardens, managed POS, etc).
4	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	Areas within the project area and adjacent north Stage 10 area that are to be modified to a non-vegetated/low threat managed state as part of proposed development.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary

Vegetation classification

- Class D Scrub
- Clause 2.2.3.2 (e) & (f)

Topographic contours (mAHD)

- Highway
- Minor road

JBS&G

Job No: 64203

Client: Richard Noble

Version: A	Date: 12/10/2023
Drawn By: jcrute	Checked By: ZC

Scale 1:2,500 at A4

0 25 50
metres

Coord. Sys. GDA2020 MGA Zone 50

Vivente Lot 16 Barfield Road, Hammond Park, WA

PRE-DEVELOPMENT VEGETATION CLASSIFICATION AND EFFECTIVE SLOPE

FIGURE 2

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Image Reference: www.nearmap.com© - Imagery Date: 30. August 2023.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary

Vegetation classification

- Class D Scrub
- Clause 2.2.3.2 (e) & (f)
- Area to be modified to non-vegetated and low threat state
- Proposed roads
- Proposed layout
- Future subdivisions on adjacent stages
- Topographic contours (mAHD)
- Highway
- Minor road

JBS&G

Job No: 64203

Client: Richard Noble

Version: A	Date: 12/10/2023
Drawn By: jcrute	Checked By: ZC

Scale 1:2,500 at A4

0 25 50
metres

Coord. Sys. GDA2020 MGA Zone 50

Vivente Lot 16 Barfield Road, Hammond Park, WA

POST-DEVELOPMENT VEGETATION CLASSIFICATION AND EFFECTIVE SLOPE

FIGURE 3

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Image Reference: www.nearmap.com© - Imagery Date: 30. August 2023.

1.4 Bushfire assessment results (assessment outputs)

1.4.1 Bushfire Hazard Level (BHL) assessment

Pre-development vegetation extents have been assigned a bushfire hazard level in accordance with the methodology detailed in Appendix 2 of the Guidelines, as outlined in Table 3.

Table 3: BHL assessment results

Bushfire hazard level	Characteristics*
Extreme	• Class A Forest • Class B Woodland (05) • Class D Scrub • Any classified vegetation with a greater than 10° slope.
Moderate	• Class B Low Woodland (07) • Class C Shrubland • Class E Mallee/Mulga • Class G Grassland, including sown pasture and crops • Class G Grassland: Open woodland (06), Low open woodland (08), Open shrubland (09) • Vegetation that has a low hazard level but is within 100 metres of vegetation classified as a moderate or extreme hazard, is to adopt a moderate hazard level.
Low	• Low threat vegetation may include areas of maintained lawns, golf courses, public recreation reserves and parklands, vineyards, orchards, cultivated gardens, commercial nurseries, nature strips and windbreaks • Managed grassland in a minimal fuel condition (insufficient fuel is available to significantly increase the severity of the bushfire attack). For example, short-cropped grass to a nominal height of 100 millimetre • Non-vegetated areas including waterways, roads, footpaths, buildings and rock outcrops.
*Vegetation classifications from AS 3959-2018 Table 2.3.	

1.4.1.1 Pre-development BHL

JBS&G has mapped the pre-development BHLs within the project area and adjacent 150 m wide assessment area. The BHLs have been assessed on the basis of the vegetation discussed in Section 1.3.3 (i.e. the current pre-development extent of vegetation within and surrounding the project area).

The pre-development BHL assessment (refer to Figure 4) indicates that based on the existing vegetation extent, the project area contains land with Moderate and Extreme BHLs.

1.5 Post-development Bushfire Attack Level (BAL) Contour Assessment

Figure 1 depicts an indicative subdivision concept with a proposed lot layout and internal road network within the project area. Therefore, JBS&G has undertaken a BAL contour assessment for the project area in accordance with the expected post-development conditions discussed in Section 1.3.4 and Method 1 of AS 3959 (refer to Figure 5). The Method 1 procedure incorporates the following factors:

- state adopted FDI 80 rating
- vegetation classification
- effective slope
- distance maintained between proposed development areas and the classified vegetation.

The BAL rating gives an indication of the level of bushfire attack (i.e. the radiant heat flux) that may be received by proposed development and subsequently informs the standard of building construction and/or setbacks required for proposed habitable development to potentially withstand such impacts and deliver compliance with relevant bushfire protection criteria of the Guidelines.

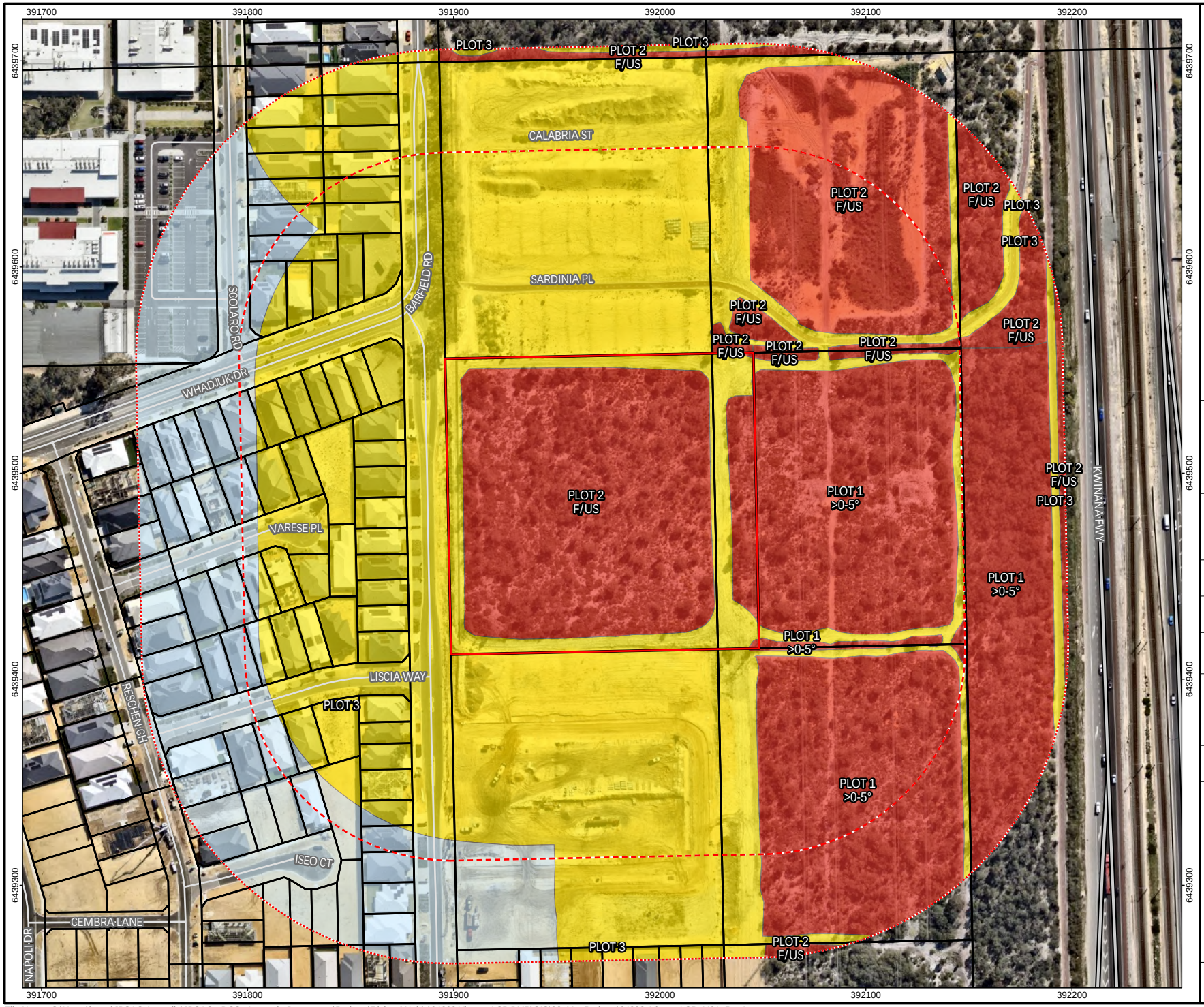
The BAL contours depicted in Figure 5 are based on:

- the vegetation classifications and effective slope observed during the various site inspections undertaken to capture current on-ground conditions
- the expected post-development vegetation extent in consideration of the areas to be modified to a non-vegetated/low threat managed state in accordance with the indicative subdivision concept in Figure 1.

Results of the BAL contour assessment are detailed in Table 4 and illustrated in Figure 5. The determined worst-case BAL impact to proposed habitable development within the project area is BAL-29, which is an acceptable rating in accordance with SPP3.7 and Guidelines requirements.

Table 4: Post-development BAL contour assessment results

Method 1 BAL determination				
Vegetation plot	**Vegetation classification**	**Effective slope**	**Separation distance**	**Highest BAL**
1	Class D Scrub	Downslope >0–5°	20 m	BAL-29
2	Class D Scrub	Flat/upslope (0°)	20 m	BAL-19
3	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	N/A	N/A
4	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	N/A	N/A



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary

Bushfire hazard level

- Extreme
- Moderate
- Low
- Highway
- Minor road

JBS&G

Job No: 64203

Client: Richard Noble

Version: A	Date: 12/10/2023
Drawn By: jcrute	Checked By: ZC

Scale 1:2,500 at A4

0 25 50
metres

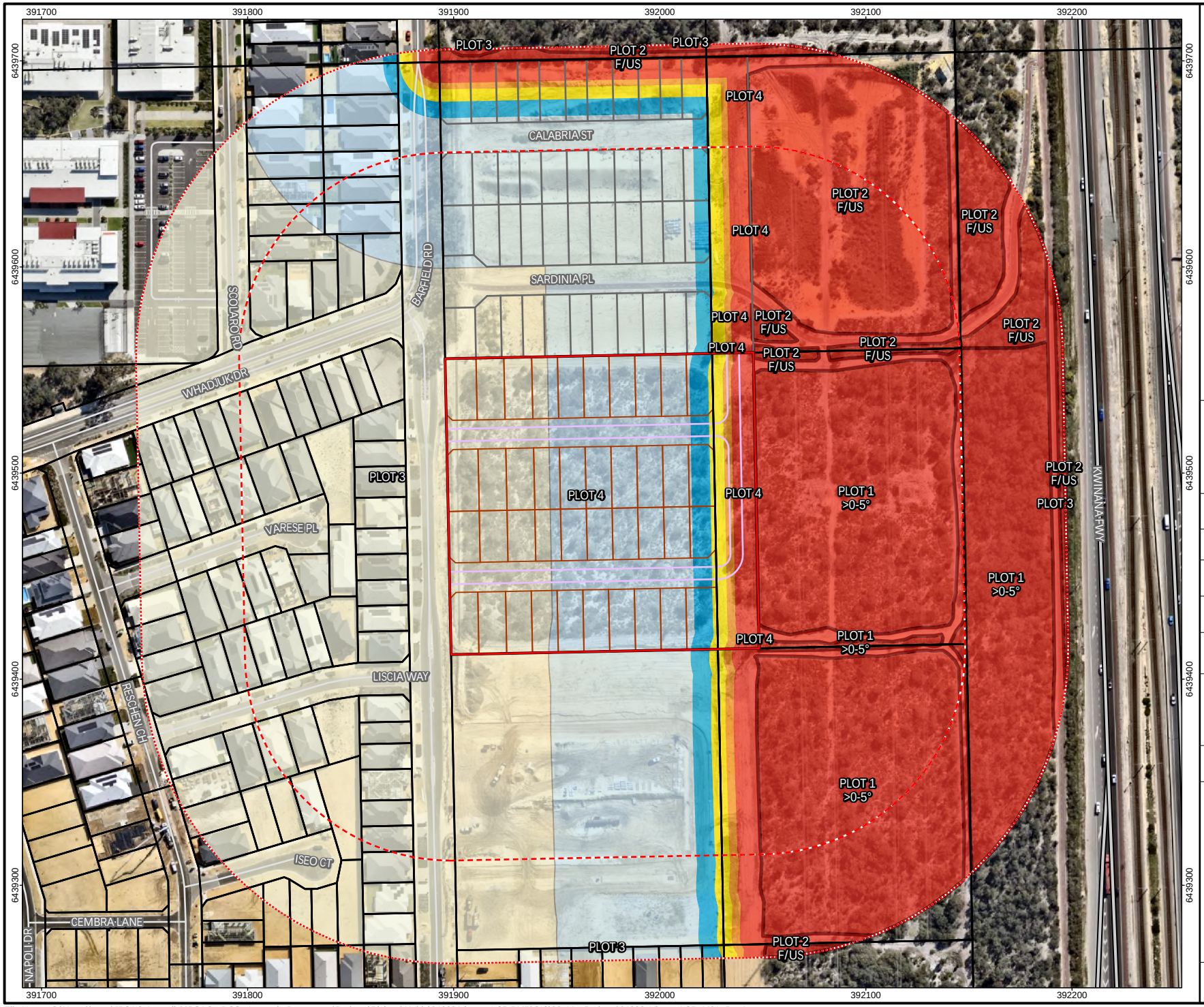
Coord. Sys. GDA2020 MGA Zone 50

Vivente Lot 16 Barfield Road, Hammond Park, WA

PRE-DEVELOPMENT BUSHFIRE HAZARD LEVELS

FIGURE 4

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Image Reference: www.nearmap.com© - Imagery Date: 30. August 2023.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- Classified vegetation

BAL contours

- BAL FZ
- BAL 40
- BAL 29
- BAL 19
- BAL 12.5
- BAL Low
- Proposed roads
- Proposed layout
- Future subdivisions on adjacent stages
- Highway
- Minor road

JBS&G

Job No: 64203

Client: Richard Noble

Version: A	Date: 12/10/2023
Drawn By: jcrute	Checked By: ZC

Scale 1:2,500 at A4

0 25 50
metres

Coord. Sys. GDA2020 MGA Zone 50

Vivente Lot 16 Barfield Road, Hammond Park, WA

POST-DEVELOPMENT BAL CONTOUR MAP

FIGURE 5

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Image Reference: www.nearmap.com© - Imagery Date: 30. August 2023.

1.6 Assessment against bushfire protection criteria

1.6.1 Compliance with Elements 1–4

Compliance with Elements 1–4 of the bushfire protection criteria of the Guidelines (Version 1.4) will be demonstrated by meeting the acceptable solutions, as detailed in Table 5.

Table 5: Compliance with the bushfire protection criteria of the Guidelines (Elements 1–4)

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Statement of development compliance	Compliance achieved
Element 1: Location	**Performance Principle P1** The strategic planning proposal, subdivision and development application is located in an area where the bushfire hazard assessment is or will, on completion, be moderate or low, or a BAL–29 or below, and the risk can be managed. For unavoidable development in areas where BAL–40 or BAL–FZ applies, demonstrating that the risk can be managed to the satisfaction of the decision-maker.	**A1.1 Development location** The strategic planning proposal, subdivision and development application is located in an area that is or will, on completion, be subject to either a moderate or low bushfire hazard level, or BAL–29 or below.	The post-development BAL contour map (see Figure 5) demonstrates that the project area will, on completion, be subject to BAL-29 or lower for all proposed lots.	✓
Element 2: Siting and design	**Performance Principle P2** The siting and design of the strategic planning proposal, subdivision or development application, including roads, paths and landscaping, is appropriate to the level of bushfire threat that applies to the site. The proposal incorporates a defendable space and significantly reduces the heat intensities at the building surface thereby minimising the bushfire risk to people, property and infrastructure, including compliance with AS 3959 if appropriate.	**A2.1 Asset Protection Zone** Every habitable building is surrounded by, and every proposed lot can achieve, an APZ depicted on submitted plans, which meets the requirements set out in Schedule 1.	None of the proposed lots are to be adjoined by classified vegetation so it is expected that no formal Asset Protection Zones (APZs) or APZ setbacks will be required and that all proposed lots will be able to achieve BAL-29 or lower through standard low threat separation provided in line with the proposed subdivision concept plan, including via provision of a 20 m wide road reserve to the east of proposed lots within the project area, consistent with Stage 10 Structure Plan provisions adjacent north of the project area. Any land to be modified to a low threat state as part of proposed development is to comply with Schedule 1 APZ standards of the Guidelines (refer to Attachment B).	✓
Element 3: Vehicular access	**Performance Principle P3i** The design and capacity of vehicular access and egress is to provide for the community to evacuate to a suitable destination before a bushfire arrives at the site, allowing emergency services personnel to attend the site and/or hazard vegetation.	**A3.1 Public roads** *The minimum requirements under this acceptable solution are applicable to all proposed and existing public roads.* Public roads are to meet the minimum technical requirements in Table 6, Column 1. The trafficable (carriageway/pavement) width is to be in accordance with the relevant class of road in the Local Government Guidelines for Subdivisional Development (IPWEA Subdivision Guidelines), Liveable Neighbourhoods, Austroad standards and/or any applicable standards for the local government area.	All proposed public roads will be constructed to the technical requirements of the Guidelines (see Attachment C) and in accordance with relevant federal, State and local government requirements.	✓
		A3.2a Multiple access routes Public road access is to be provided in two different directions to at least two different suitable destinations with an all-weather surface (two-way access). If the public road access to the subject site is via a no-through road which cannot be avoided due to demonstrated site constraints, the road access is to be a maximum of 200 metres from the subject lot(s) boundary to an intersection where two-way access is provided. The no-through road may exceed 200 metres if it is demonstrated that an alternative access, including an emergency access way, cannot be provided due to site constraints and the following requirements are met: • the no-through road travels towards a suitable destination; and • the balance of the no-through road, that is greater than 200 metres from the subject site, is wholly within BAL-LOW, or is within a residential built-out area – Figure 23.	The project area forms an extension to the existing Vivente Estate and based on indicative development design, two separate access connections will be provided to the surrounding public road network. These connections will enable two access and egress points to Barfield Road to the west, which provides broader access to Russell Road in the north and Rowley Road in the south. Additional access/egress north to Stage 10 is also proposed as via the eastern road reserve. Rowley Road provides broader access to multiple suitable destinations via Kwinana Freeway to the east of the development. The proposed internal access provisions will prevent any permanent no-through roads.	✓

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Statement of development compliance	Compliance achieved
		A3.2b Emergency access way *Where it is demonstrated that A3.2a cannot be achieved due to site constraints, or where an alternative design option does not exist, an emergency access way can be considered as an acceptable solution.* An emergency access way is to meet all the following requirements: • requirements in Table 6, Column 2; • provides a through connection to a public road; • be no more than 500 metres in length; and • must be signposted and if gated, gates must open the whole trafficable width and remain unlocked.	Based on indicative development design, no permanent Emergency Access Ways (EAWs) will be required as part of the proposed development, and no EAWs are proposed. Any temporary EAWs required to manage compliance during internal staging of development will be constructed to the technical requirements of the Guidelines (see Attachment C).	✓
		A3.3 Through-roads All public roads should be through-roads. No-through roads should be avoided and should only be considered as an acceptable solution where: • it is demonstrated that no alternative road layout exists due to site constraints; and • the no-through road is a maximum length of 200 metres to an intersection providing two-way access, unless it satisfies the exemption provisions in A3.2a of this table. A no-through road is to meet all the following requirements: • requirements of a public road (Table 6, Column 1); and • turn-around area as shown in Figure 24.	Based on indicative development design, all proposed public roads will be through roads. Any temporary no-through roads required to manage compliance during internal staging of development will be constructed to the technical requirements of the Guidelines (see Attachment C).	✓
	Performance Principle P3ii The design of vehicular access and egress provides: • access and egress for emergency service vehicles while allowing the community to evacuate; • a defendable space for emergency services personnel on the interface • between classified vegetation and development site; and • hazard separation between classified vegetation and the subject site to reduce the potential radiant heat that may impact a lot(s).	**A3.4a Perimeter roads** A perimeter road is a public road and should be provided for greenfield or infill development where 10 or more lots are being proposed (including as part of a staged subdivision) with the aim of: • separating areas of classified vegetation under AS3959, which adjoin the subject site, from the proposed lot(s); and • removing the need for battle-axe lots that back onto areas of classified vegetation. A perimeter road is to meet the requirements contained in Table 6, Column 1. A perimeter road may not be required where: • the adjoining classified vegetation is Class G Grassland; • lots are zoned for rural living or equivalent; • it is demonstrated that it cannot be provided due to site constraints; or • all lots have frontage to an existing public road.	A 20 m wide road reserve is proposed to be installed at the only interface with classified vegetation (i.e. the eastern interface), consistent with Stage 10 Structure Plan provisions adjacent north of the project area. This road reserve will be established to a non-vegetated and low threat managed state and provide adequate separation to deliver a BAL-29 or lower rating for proposed residential lots within the project area. No other development interfaces contain classified vegetation.	✓
	Performance Principle P3iii Vehicular access is provided which allows: • access and egress for emergency service vehicles; • defendable space for emergency services	**A3.4b Fire service access route** *Where proposed lots adjoin classified vegetation under AS3959, and a perimeter road is not required in accordance with A3.4a, a fire service access route can be considered as an acceptable solution to provide firefighter access, where access is not available, to the classified vegetation.*	N/A. As previously mentioned, perimeter roads have been provided where required in accordance with acceptable solution A3.4a.	N/A

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Statement of development compliance	Compliance achieved
	• personnel on the interface between classified vegetation and development; and • hazard separation between classified vegetation and the site to reduce the potential radiant heat that may impact a lot(s).	A fire service access route is to meet all the following requirements: • requirements in Table 6, Column 3; • be through-routes with no dead-ends; • linked to the internal road system at regular intervals, every 500 metres; • must be signposted; • no further than 500 metres from a public road; • if gated, gates must open the required horizontal clearance and can be locked by the local government and/or emergency services, if keys are provided for each gate; and • turn-around areas designed to accommodate type 3.4 fire appliances and to enable them to turn around safely every 500 metres.		
	Performance Principle P3iv Vehicular access is provided which allows emergency service vehicles to directly access all habitable buildings and water supplies and exit the lot without entrapment.	**A3.5 Battle-axe access legs** *Where it is demonstrated that a battle-axe cannot be avoided due to site constraints, it can be considered as an acceptable solution.* There are no battle-axe technical requirements where the point the battle-axe access leg joins the effective area of the lot, is less than 50 metres from a public road in a reticulated area. In circumstances where the above condition is not met, or the battle-axe is in a non-reticulated water area, the battle-axe is to meet all the following requirements: • requirements in Table 6, Column 4; and • passing bays every 200 metres with a minimum length of 20 metres and a minimum additional trafficable width of two metres (i.e. the combined trafficable width of the passing bay and constructed private driveway to be a minimum six metres).	N/A. Not applicable to the strategic planning stage. Notwithstanding, based on indicative development design, no battle-axe lots are proposed.	N/A
		A3.6 Private driveways There are no private driveway technical requirements where the private driveway is: • within a lot serviced by reticulated water; • no greater than 70 metres in length between the most distant external part of the development site and the public road measured as a hose lay; and • accessed by a public road where the road speed limit is not greater than 70 km/h. In circumstances where all of the above conditions are not met, or the private driveway is in a non-reticulated water area, the private driveway is to meet all the following requirements: • requirements in Table 6, Column 4; • passing bays every 200 metres with a minimum length of 20 metres and a minimum • additional trafficable width of two metres (i.e. the combined trafficable width of the passing bay and constructed private driveway to be a minimum six metres); and • turn-around area as shown in Figure 28 and within 30 metres of the habitable building.	N/A. Not applicable to the strategic planning stage. Notwithstanding, the proposed development will be located within a reticulated area where road speeds will be lower than 70 km/hr and proposed lots are of size where all future habitable development will be located within 70 m of a public road. In this regard, there will be no private driveway compliance requirements for the proposed development.	N/A

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Statement of development compliance	Compliance achieved
Element 4: Water	No performance principle applies	**A4.1 Identification of future water supply** Evidence that a reticulated or sufficient non-reticulated water supply for bushfire fighting can be provided at the subdivision and/or development application stage, in accordance with the specifications of the relevant water supply authority or the requirements of Schedule 2. Where the provision of a strategic water tank(s) is required a suitable area within a road reserve or a dedicated lot the location should be identified, should be identified on the structure plan, to the satisfaction of the local government.	Arrangements will be made to connect the proposed development to a reticulated water supply via extension of existing services from adjacent development areas.	✓
	Performance Principle P4 Provide a permanent water supply that is: • sufficient and available for firefighting purposes; • constructed from non-combustible materials (e.g. steel), or able to maintain its integrity throughout a bushfire; and • accessible, with legal access for maintenance and re-filling by tankers and emergency service vehicles.	**A4.2 Provision of water for firefighting purposes** Where a reticulated water supply is existing or proposed, hydrant connection(s) should be provided in accordance with the specifications of the relevant water supply authority. Where these specifications cannot be met, then the following applies: • The provision of a water tank(s), in accordance with the requirements of Schedule 2; and • Where the provision of a strategic water tank(s) is applicable, then the following requirements apply: – land to be ceded free of cost to the local government for the placement of the tank(s); – the lot or road reserve where the tank is to be located is identified on the plan of subdivision; – tank capacity, construction, and fittings, provided in accordance with the requirements of Schedule 2; and – a strategic water tank is to be located no more than 10 minutes from the subject site (at legal road speeds). Where a subdivision includes an existing habitable building(s) that is to be retained, a water supply should be provided to this existing habitable building(s), in accordance with the requirements listed above.	N/A. Not applicable to the strategic planning stage. Notwithstanding, the proposed development will be connected to a reticulated water supply via extension of services from adjacent development areas in accordance with Water Corporations Design Standard 63 requirements.	N/A

1.7 Responsibilities for implementation and management of the bushfire measures

This BMP addendum has been prepared as a strategic guide to demonstrate how development compliance will be delivered at future planning stages in accordance with the Guidelines. Aside from the preparation of future BMPs/addendums to accompany future subdivision applications where appropriate, there are no further items to implement, enforce or review at this strategic stage of the planning process.

Future BMPs/addendums prepared to accompany future subdivision applications are to meet the relevant commitments outlined in this strategic level BMP addendum, address the relevant requirements of SPP 3.7 (i.e. Policy Measure 6.4) and demonstrate in detail how the proposed development will comply with the relevant acceptable solutions of the Guidelines. Future BMPs/addendums prepared to accompany future subdivision applications are to include the following detailed information:

- confirmation of final lot layout in accordance with a plan of subdivision
- confirmation of the anticipated post-development classified vegetation extent, effective slope and separation distances
- confirmation of areas to be modified to a non-vegetated/low threat managed state as part of proposed development to achieve BAL-29 or lower
- confirmation of how BAL management will be addressed during development staging (if required), including management of temporary bushfire hazards resulting from staged clearing (i.e. provision of low threat staging buffers or temporary quarantining of lots where required)
- confirmation of how vehicular access provisions will be addressed during development staging, including demonstration that a minimum of two access routes will be achieved for each stage of development (i.e. provision of public roads in advance and/or temporary compliant access provisions such as no-through roads and EAWs)
- confirmation of reticulated water supply provisions
- provisions for notification on Title for any proposed lots situated within a designated bushfire prone area containing a rating of BAL-12.5 or greater
- compliance requirements with the annual City of Cockburn firebreak notice (see Attachment D)
- compliance assessment against the acceptable solutions of Elements 1–4 of the bushfire protection criteria of the Guidelines
- proposed audit and compliance program outlining all measures requiring implementation prior to lot title and the appropriate timing and responsibilities for implementation.

Should preparation of future BMPs/addendums not be required at the subdivision stage (i.e. in the event where this BMP addendum is considered sufficient to support future subdivision application), then Table 6 has been prepared to drive implementation of all bushfire management works associated with this BMP addendum.

Table 6: Responsibilities for implementation and management of the bushfire measures

Implementation/management table	
Developer – prior to issue of titles	
No.	Implementation action
1	Construct (or have works bonded) the public roads (including any temporary no-through-roads/emergency access ways required as part of internal staging) to the standards stated in this BMP addendum.
2	Construct (or have works bonded) the reticulated water supply to the standards stated in this BMP addendum.
3	Establish the project area and adjacent north Stage 10 to a non-vegetated/low threat managed state in accordance with the requirements of this BMP addendum.
4	Comply with the relevant requirements of the City of Cockburn annual firebreak notice (refer to Attachment D).
5	Prepare a BMP compliance report to demonstrate the relevant bushfire management measures have been implemented to deliver compliance in accordance with this BMP addendum.
Developer – until sale/transfer of lots	
No.	Implementation action
1	Maintain the project area and adjacent north Stage 10 to a non-vegetated/low threat managed state in accordance with the requirements of this BMP addendum.
2	Comply with the relevant requirements of the City of Cockburn annual firebreak notice (refer to Attachment D).
Landowner/occupier – prior to building construction and ongoing	
No.	Implementation action
1	Comply with the relevant requirements of the City of Cockburn annual firebreak notice (refer to Attachment D), including maintenance of cleared/vacant lots in a low threat state.
2	Construct dwellings to the assessed BAL, where required under As3959.
Local government – ongoing management following handover	
No.	Implementation action
1	Maintain urban street verges in a low threat minimal fuel condition as per Clause 2.2.3.2 (f) of AS3959.

Based on the information contained in this BMP, JBS&G considers the bushfire hazards within and adjacent to the project area and the associated bushfire risks to the proposed development are readily manageable through adoption of standard acceptable solution management responses in accordance with the Guidelines.

1.8 References

Department of Fire and Emergency Services (DFES) 2021, *Map of Bush Fire Prone Areas*, [Online], Government of Western Australia, available from: https://maps.slip.wa.gov.au/landgate/bushfireprone/, [21/12/2022].

Department of Planning (DoP) 2016, *Visual guide for bushfire risk assessment in Western Australia*, Department of Planning, Perth.

Standards Australia (SA) 2018, Australian Standard *AS 3959–2018 Construction of Buildings in Bushfire-prone Areas*, Standards Australia, Sydney.

Strategen-JBS&G 2020a, *Bushfire Management Plan Vivente Estate Structure Plan Amendment, including Stages 9 and 10*, report prepared for Gold Estate Holdings Pty Ltd, May 2020.

Strategen-JBS&G 2020b, *Bushfire Attack Level (BAL) Compliance Report Stage 4 Vivente, Hammond Park,* report prepared for Gold Estate Holdings Pty Ltd, August 2020.

Western Australian Planning Commission (WAPC) 2015, *State Planning Policy 3.7 Planning in Bushfire Prone Areas*, Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WAPC) 2021, *Guidelines for Planning in Bushfire Prone Areas*, Version 1.4 December 2021, Western Australian Planning Commission, Perth.

Attachment A Barfield Road Structure Plan

Plan 1: Barfield Road Structure Plan



LEGEND

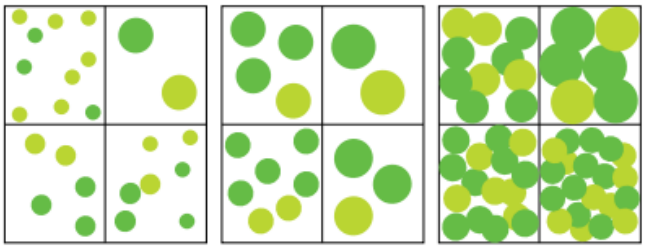
STRUCTURE PLAN AREA

ZONES
- RESIDENTIAL
- LOCAL CENTRE

RESERVES
- PARKS AND RECREATION
- PUBLIC PURPOSE - EDUCATION

OTHER ELEMENTS THAT INFORM THE LSP
- PROPOSED BUS ROUTE
- R25 RESIDENTIAL DENSITY CODE
- PLANNING CONTROL AREA No. 156
- WESTERN POWER EASEMENT

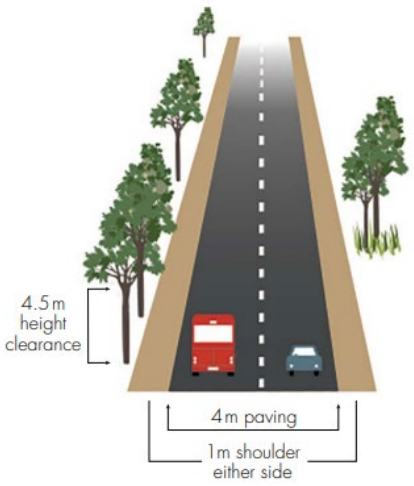
Attachment B APZ standards (Schedule 1 of the Guidelines)

Schedule 1: Standards for Asset Protection Zones	
Object	**Requirement**
Fences within the APZ	• Should be constructed from non-combustible materials (for example, iron, brick, limestone, metal post and wire, or bushfire-resisting timber referenced in Attachment F of AS 3959).
Fine fuel load (Combustible, dead vegetation matter <6 millimetres in thickness)	• Should be managed and removed on a regular basis to maintain a low threat state. • Should be maintained at <2 tonnes per hectare (on average). • Mulches should be non-combustible such as stone, gravel or crushed mineral earth or wood mulch >6 millimetres in thickness.
Trees* (>6 metres in height)	• Trunks at maturity should be a minimum distance of six metres from all elevations of the building. • Branches at maturity should not touch or overhang a building or powerline. • Lower branches and loose bark should be removed to a height of two metres above the ground and/or surface vegetation. • Canopy cover within the APZ should be <15 per cent of the total APZ area. • Tree canopies at maturity should be at least five metres apart to avoid forming a continuous canopy. Stands of existing mature trees with interlocking canopies may be treated as an individual canopy provided that the total canopy cover within the APZ will not exceed 15 per cent and are not connected to the tree canopy outside the APZ. **Figure 19:** Tree canopy cover – ranging from 15 to 70 per cent at maturity 
Shrub* and scrub* (0.5 metres to six metres in height). Shrub and scrub >6 metres in height are to be treated as trees.	• Should not be located under trees or within three metres of buildings. • Should not be planted in clumps >5 square metres in area. • Clumps should be separated from each other and any exposed window or door by at least 10 metres.
Ground covers* (<0.5 metres in height. Ground covers >0.5 metres in height are to be treated as shrubs)	• Can be planted under trees but must be maintained to remove dead plant material, as prescribed in 'Fine fuel load' above. • Can be located within two metres of a structure, but three metres from windows or doors if >100 millimetres in height.
Grass	• Grass should be maintained at a height of 100 millimetres or less, at all times. • Wherever possible, perennial grasses should be used and well-hydrated with regular application of wetting agents and efficient irrigation.

Schedule 1: Standards for Asset Protection Zones	
Defendable space	Within three metres of each wall or supporting post of a habitable building, the area is kept free from vegetation, but can include ground covers, grass and non-combustible mulches as prescribed above.
LP Gas Cylinders	• Should be located on the side of a building furthest from the likely direction of a bushfire or on the side of a building where surrounding classified vegetation is upslope, at least one metre from vulnerable parts of a building. • The pressure relief valve should point away from the house. • No flammable material within six metres from the front of the valve. • Must sit on a firm, level and non-combustible base and be secured to a solid structure.

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Attachment C Vehicular access technical standards of the Guidelines

Acceptable Solution A3.1 – Public Roads
Explanatory Note E3.1
These Guidelines do not prescribe values for the trafficable (carriageway/pavement) width of public roads as they should be in accordance with the class of road as specified in the IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards and/or any applicable standard in the local government area. The IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards do not prescribe a horizontal clearance. However, it is recommended that a traversable verge is provided to allow for emergency services vehicles to stop and operate on the side of the public road, specifically where the public road may traverse large areas of classified vegetation. Where local government roads are proposed to be widened by the proponent, they must obtain approval from the local government.    Figure 20: Example of a public road

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.2a – Multiple access routes
Explanatory Note E3.2a

Two-way public road access is public road access from a lot in at least two different directions to two suitable destinations, and provides residents and the community, as well as emergency services, with access and egress from both the subdivision and individual habitable buildings/development in the event of a bushfire emergency. A single road provides no alternative route if the access becomes congested or is unable to be traversed due to smoke and/or fallen trees during a bushfire.

Two-way public road access applies to access/egress routes leading into a subdivision, as well as those within a subdivision. A road that loops back onto itself does not constitute the option of two different directions.

Two-way public road access should always be the first option. Where the site is not able to achieve two-way access within 200 metres of the lot boundary, due to demonstrated site or environmental constraints, the proponent should identify options for an emergency access way from the subject site to a suitable destination. Where an emergency access way cannot be provided, the proponent should demonstrate compliance with the performance principle.

Subject sites or proposed lots greater than 200 metres from an intersection, which provides two-way access, do not satisfy the requirement for two-way access unless they meet the provisions which allow for no-through roads greater than 200 metres in A3.2a.

To demonstrate compliance with the performance principle for two-way access, the bushfire planning practitioner may have regard to:

a. the extent of the bushfire hazard, location and vegetation classification, the likelihood, potential severity and impact of bushfire to the subject site and the road network;
b. time between fire detection and the onset of conditions in comparison to travel time for the community to evacuate to a suitable destination;
c. available access route(s) travelling towards a suitable destination; and
d. turn-around area for a fire appliance for no-through roads.



Figure 21: Example of compliant and non-compliant two-way

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.4a – Perimeter roads
Explanatory Note E3.4a

Where a planning proposal includes the creation of 10 or more lots adjacent to each other, which adjoin classified vegetation under AS 3959 with the exception of Class G Grassland, as part of a greenfield development or large urban infill site, hazard separation and defendable space should be provided in the form of a perimeter road. Greenfield is 'undeveloped or minimally developed areas that have been identified for urban development'; and urban infill is 'the redevelopment of existing urban areas at a higher density than currently exists'. The creation of 10 or more lots includes cumulative subdivision applications where the subdivision application may be part of a staged subdivision.

A perimeter road should be in accordance with the class of road as specified in the IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards and/or any applicable standard in the local government area as per the requirements of a public road in Table 6, Column 1.

As the road is likely to function as a key neighbourhood distributor, or similar, consideration should be given to the provision of additional width to allow for emergency services vehicles to stop and operate on the side of the perimeter road, whilst simultaneously proving for the evacuation of the community (Figure 20).

When designing a strategic planning proposal and/or subdivision, creating a large setback between classified vegetation and proposed lots with a perimeter road, and orientating habitable buildings to front onto (rather than back onto) areas of vegetation has many benefits, including:

- passive surveillance;
- defendable space for firefighting and emergency management purposes;
- reducing the potential radiant heat that may impact a habitable building in a bushfire event;
- reducing the need for battle-axe lots; and
- unconstrained public access/egress for the community in the event of a bushfire.

In developments where no perimeter road exists, property defence in a bushfire event is difficult and can be impossible. Where proposed lots have frontage to an existing public road and abut the hazard at the rear or side, it may be an undesirable planning outcome to create lots which front the existing public road and back onto a perimeter road. In this instance, consideration should be given to a fire service access route. Refer to E3.4b.

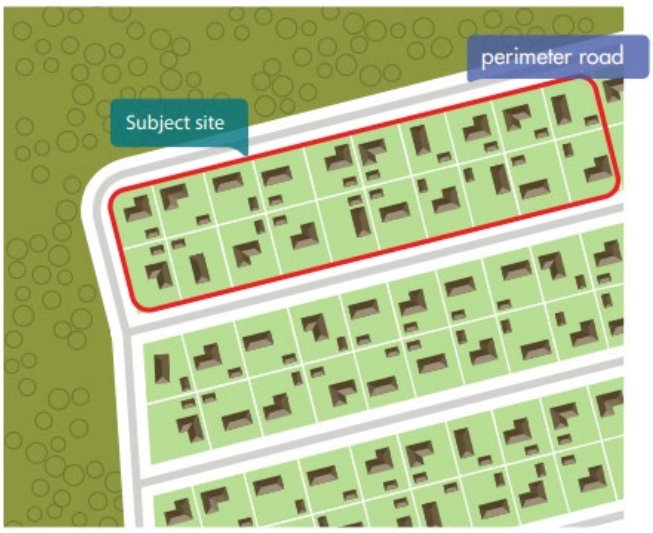


Figure 25: Example of a perimeter road

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.2b – Emergency access way
Explanatory Note E3.2b
An emergency access way is not a preferred alternative to through public road access and should only be considered acceptable where it has been demonstrated that it will provide the safety and performance needs of emergency services and the community, including consideration for future needs, and that public road access to satisfy A3.2a cannot be achieved due to site constraints, such as an established road network with no opportunity to provide a public road for secondary access. Acceptance of an emergency access way should also consider the ability to accommodate reasonable worst-case vehicle volumes. The principle function of the emergency access way is to provide a contingency (second) community evacuation route and simultaneously provide access for emergency services, in the event of a bushfire emergency. Where an emergency access way traverses classified vegetation, which has the potential to create a bushfire hazard, an emergency access way performs the secondary function of providing access by emergency services to this vegetation. Emergency access ways should connect to a public road to allow alternative two-way through access. An emergency access way should not exceed 500 metres in length as they may not be as safe for road-use due to not being designed or constructed to the full requirements of a public road and may present uncertainties to emergency service personnel and the public as they are not part of the daily road network and not identified on Maps. **Permanent public emergency access way** An emergency access way can be provided as either a public easement in gross or a right-of-way. In both approaches, the management of the emergency access way is by the local government as the grantee of the easement or management body of the right-of-way. The proponent must obtain written consent from the local government that the local government will accept care, control and management of the easement or right-of-way; this must be provided to the decision-maker prior to granting planning approval. The approach taken is at the discretion of the decision-maker and/ or the local government and is also dependent on whether the land is to remain in private ownership or be ceded to the Crown. Consultation with Land Use Management at the Department of Planning, Lands and Heritage should also be considered if the land is to be ceded to the Crown or if the local government is uncertain of which approach to take. If the emergency access way is provided as an easement, it should be provided as a public easement in gross under sections 195 and 196 of the Land Administration Act 1997 in favour of the local government and/or public authority, to ensure accessibility for emergency services and the public at all times. To be provided as a right-of-way the emergency access way should be vested in the Crown under section 152 of the Planning and Development Act 2005 as a right-of-way and such land to be ceded free of cost and without any payment or compensation by the Crown. If gates are used to control traffic flow during non-emergency periods, these will be managed by the local government and must not be locked. Gates should be double gates wide enough to access the full pavement width and accommodate Type 3.4 fire appliances with the design and construction to be approved by the relevant local government. **Temporary public emergency access way** A temporary emergency access way may be proposed to facilitate the staging arrangements of a subdivision. The provision of two public roads may not be possible in the first stage of the subdivision and an emergency access way can be provided as an interim access route until the second public road is developed and gazetted in a subsequent stage of the subdivision (see figure 22). The emergency access way should be provided in the same manner as a permanent emergency access way, but it should be removed from the certificate of title once the public road is developed and gazetted. Where an emergency access way is proposed as an alternative to a public road, the Bushfire Management Plan should provide thorough justification for its use. **Restricted public emergency access way** There may be some instances where a restricted emergency access way is proposed as a performance principle based solution where access is only available to the public in the event of a bushfire emergency. This option can only be considered where the local government or Main Roads WA have advised that vehicular access on the emergency access way is not allowed during non-emergency periods, as it provides an additional thoroughfare and entry point on a local or State road. In this scenario, the emergency access way can be provided as an easement under section 195 of the Land Administration Act 1997, as public access in the event of a bushfire emergency or vested in the Crown as a reserve under section 152 of the Planning and Development Act 2005. Such land is to be ceded free of cost without any payment or compensation by the Crown. The proponent must obtain written consent from the local government that the local government will accept care, control and management of the proposed reserve and agree to the terms of the Management Order Conditions (if applicable); this must be provided to the decision-maker prior to granting planning approval. The purpose of the reserve should be for a public purpose specified in the condition related to the subdivision, for example for emergency access only, or for emergency access and recreation. A reserve for emergency access and recreation can optimise the land-use as a dual purpose where it provides vehicular access in the event of a bushfire

Acceptable Solution A3.2b – Emergency access way
Explanatory Note E3.2b

emergency, but can be accessed by the public (on foot) on a day-to-day basis as a recreation link. Appropriate signage can ensure the general public is aware of the purpose of the reserve. The approach taken is at the discretion of the decision-maker and/or local government.

Right-of-carriageway emergency access way

There may be some instances where a right-of-carriageway easement is proposed as a performance principle-based solution. This may be where particular landowner(s) and emergency services, but not the public, require access over a neighbouring lot(s). A right-of-carriageway easement should be provided under section 195 of the Land Administration Act 1997. The easement is to provide alternative access for the particular landowner(s) in the event of a bushfire emergency and not for use by the public. In this scenario, support will be necessary from the adjoining lot owner(s). The easement is to be granted to the local government and it is to agree with the landowner on the arrangements of the management of the easement area by deed. These management arrangements will be at the discretion of the local government. If gated, the easement area can be locked to restrict day-to-day vehicular access.

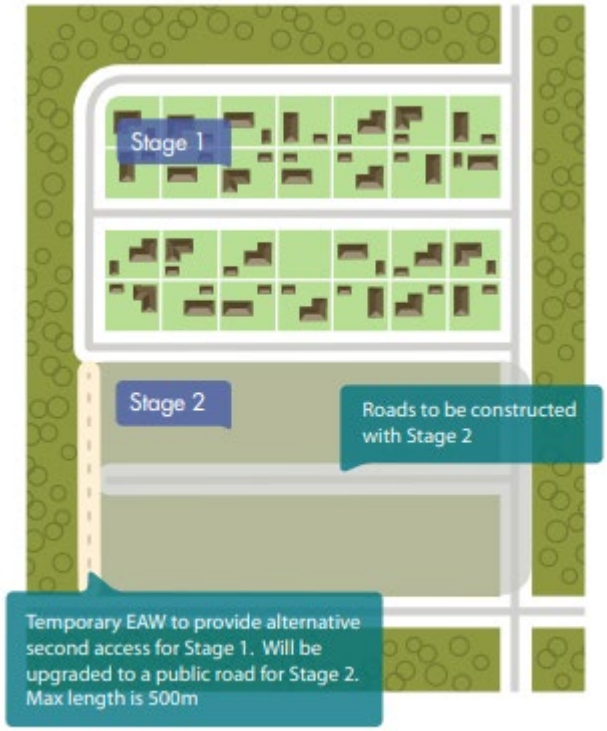


Figure 22: Example of an emergency access way

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.3 – Through roads

Explanatory Note E3.3

In bushfire prone areas, a proposed structure plan or subdivision that incorporates no-through roads should be avoided because they do not provide a connected and legible design that allows for easy access and egress by the community, residents and emergency services in the event of a bushfire. No-through roads also reduce the options available for access and egress in the event of a bushfire emergency.

There will however be situations where a subject site is accessed via an existing or proposed no-through road and alternative access cannot be provided. In these situations, the proponent should demonstrate to the decision-maker, that all efforts have been made with the local government and/or adjoining landowners to secure alternative public road access or an emergency access way and that a redesign has been explored. The bushfire planning practitioner may need to develop a performance principle-based solution or address the non-compliance and demonstrate to the decisionmaker why discretion should be exercised in accordance with section 2.6 of these Guidelines.

No-through roads will only be considered an acceptable solution where it is demonstrated by the proponent, to the satisfaction of the decision maker, that a no through-road cannot be avoided due to site constraints. For example, the internal road design of a structure plan or subdivision where site constraints, such as a water body or Bush Forever, prevent the ability to create a through-road and a no through road may be a more appropriate road layout.

No-through roads should be a maximum of 200 metres from the lot(s) boundary to an intersection where two-way access is provided and may only exceed 200 metres if it meets the provisions which allow for no-through roads greater than 200 metres in A3.2a.

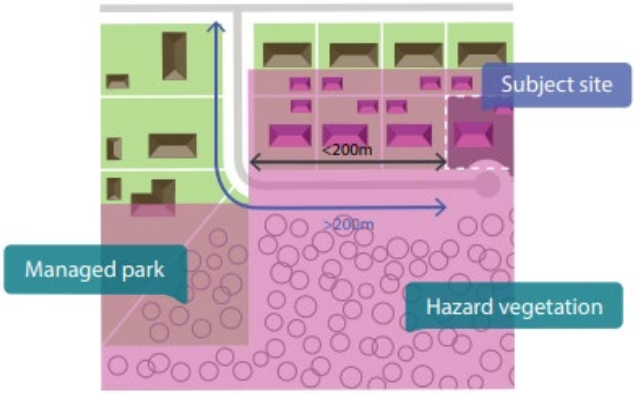


Figure 23: Example of a site on a no-through road greater than 200 metres from the intersection, but within 200 metres of BAL-LOW

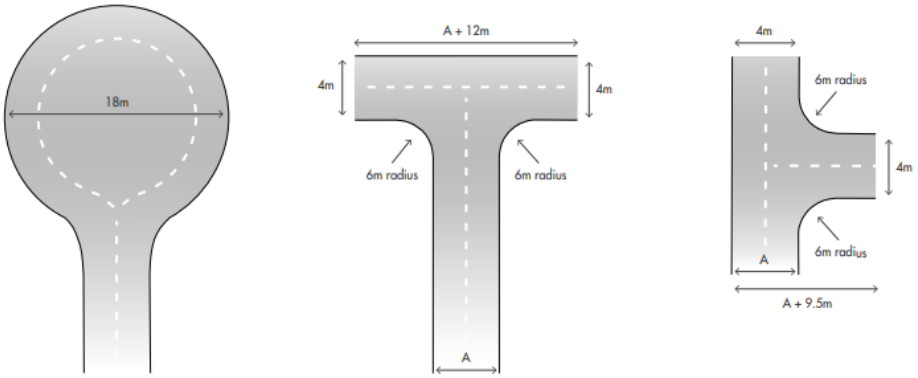


Figure 24: Turn-around area dimensions for a no-through road

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Technical requirement	1	2	3	4
	Public road	Emergency access way[1]	Fire service access route[1]	Battle-axe and private driveways[2]
Minimum trafficable surface (m)	In accordance with A3.1	6	6	4
Minimum horizontal clearance (m)	N/A	6	6	6
Minimum vertical clearance (m)	4.5	4.5	4.5	4.5
Minimum weight capacity (t)	15	15	15	15
Maximum grade unsealed road[3]	As outlined in the IPWEA Subdivision Guidelines	1:10 (10%, 6°)	1:10 (10%, 6°)	1:10 (10%, 6°)
Maximum grade sealed road[3]		1:7 (14.3%, 8°)	1:7 (14.3%, 8°)	1:7 (14.3%, 8°)
Maximum average grade sealed road		1:10 (10%, 6°)	1:10 (10%, 6°)	1:10 (10%, 6°)
Minimum inner radius of road curves (m)		8.5	8.5	8.5

[1] To have crossfalls between 3 and 6%

[2] Where driveways and battle-axe legs are not required to comply with the widths in A3.5 or A3.6, they are to comply with the Residential Design Codes and Development Control Policy 2.2 Residential Subdivision

[3] Dips must have no more than a 1 in 8 (12.5% -7.1 degree) entry and exit angle.

Attachment D City of Cockburn Fire Control Notice

City of Cockburn

✖ Aboriginal and Torres Strait Islander people are warned that this website may contain images and voices of deceased persons.

Fire Control Order

Find on this page

» City of Cockburn Fire Control Order (May 2018)

» All property (vacant or developed) –less than 4,047m2

» All property (vacant or developed) – 4,047m2 or greater

» Firebreak specifications

» Additional works

» Fire Control Order variations

» Burning

» Penalties

» Terms and definitions

» More information and contact

City of Cockburn Fire Control Order - Effective from 10 May 2018

First and Final Notice

Pursuant to *Section 33* of the *Bush Fires Act 1954* owners or occupiers of land situated within the City of Cockburn are required by law to comply with the prescribed Fire Control Order here within.

1. All Property (vacant or developed) - less than 4,047m2

To reduce the fire hazard on your land and to comply with the requirements of this Fire Control Order you are required to:

1.1 Have all flammable materials such as dry grass and weeds slashed, mown or trimmed down by other means to a maximum height of 50mm across the entire property for the duration of this firebreak time; and

1.2 Remove all dead vegetation.

2. All property (vacant or developed) - 4,047m2 or greater

To reduce the fire hazard on your land and to comply with the requirements of this Fire Control Order you are required to:

2.1 Construct a firebreak (as defined within section 3 of this order) immediately inside all external property boundaries, this includes those adjacent to roads, drains, rail reserves and any public open space reserves

2.2 Remove all dead vegetation surrounding and over all habitable structures to a radius of 3 metres except living trees, shrubs, maintained grass and gardens under cultivation.

3. Firebreak Specifications

A firebreak is an area of land cleared of flammable material, installed to minimise the spread or extension of a fire and to provide suitable access for fire fighting vehicles. The standards of a compliant firebreak are as follows:

3.1 A firebreak must be constructed of bare earth, stone, or sealed surfaces and be clear of all flammable materials to create a 3 metre wide trafficable surface

3.2 Maintained grass may occupy a firebreak

3.3 Overhanging branches must be pruned to provide a 4 metre vertical clearance above the full width of the 3 metre firebreak surface

3.4 A firebreak must be a continuous trafficable surface for a fire fighting vehicle, clear of any obstructions and must not terminate in a cul-de-sac (dead end).

4. Additional Works

Regardless of land size and location, the City of Cockburn or its Authorised Officer(s) may require you to undertake additional work(s) on your property to improve access and/or undertake further works where in the opinion of that Authorised Officer(s), these works would be conducive to preventing the outbreak and/or the spread or extension of a fire.

5. Fire Control Order Variations

A variation will be considered where the owner and/or occupiers believe it is impractical to meet the compliance requirements of this Fire Control Order.

Approved structure's occupying a firebreak will not require a variation approval. However, a firebreak will be required to be installed as close as practical around the approved structure.

If approved, variations will be valid in perpetuity, unless a new variation has been approved or the property changes ownership.

The City of Cockburn reserves the right to review, amend or revoke an existing variation in writing at any time. Should a request to vary the Fire Control Order requirements on your property not be approved in writing, this Fire Control Order must be complied with as applicable in its entirety.

If you cannot comply with the above requirements you can complete the online firebreak variation application form.

Firebreak Variation Application Form

Approved: You must comply with the conditions of the approved variation.
Not approved: You must comply with the requirements of the Fire Control Order.

6. Burning

During the declared prohibited burning time, owners and/or occupiers must not undertake any bush or garden refuse burning activities.

During the declared restricted burning time only, owners and/or occupiers may:

6.1 Apply for a permit to burn the bush for bush fire risk mitigation purposes, by following the conditions imposed on a permit to burn as issued by an Authorised Officer.

6.2 In areas zoned rural by the Metropolitan Region Scheme you may undertake burning of leaves, tree branches, and other dry vegetation in piles no larger than $1m^3$ in size, without a permit to burn, subject to the following conditions:

6.2.1 No flammable material (other than that being burned) is to be within 5 metres of the fire at any time while the fire is burning

6.2.2 The fire is lit between 6pm and 11pm and is completely extinguished before midnight on the same day

6.2.3 At least one person is present at the site of the fire at all times until it is completely extinguished

6.2.4 When the fire is no longer required, the person ensures that the fire is completely extinguished by the application of water or earth.

During the unrestricted burning time, owners and/or occupiers in areas zoned rural under the Metropolitan Region Scheme may burn garden refuse and set fire to bush on their land without a permit 'To Set Fire To The Bush'. Burning of the bush must be in accordance with all relevant State legislative requirements.

Burning of garden refuse in areas not zoned rural should not be undertaken within the City of Cockburn, unless approved by an Authorised Officer. Burning of household waste is prohibited in all areas of the City of Cockburn.

Burning of household waste is prohibited in all areas of the City of Cockburn.

7. Penalties

Failing to comply with this Fire Control Order will result in a penalty of up to $5,000. A person in default is also liable whether prosecuted or not to pay the costs of performing the work directed by a City's Authorised Officer.

Any owner and/or occupier who engages a contractor to undertake works on their behalf is responsible to ensure that the works completed meet the requirements of this Fire Control Order.

Term	Definition
Authorised Officer	A person appointed by the City of Cockburn Chief Executive Officer as an authorised person/officer to exercise the powers and duties set out in the Local Government Act 1995, Bush Fires Act 1954 and Local Law(s).
Flammable Material	Any dead or dry grass, vegetation, substance, object, thing or material (except living flora including live and/ or habitat standing trees) that may or is likely to catch fire and burn or any other thing deemed by an Authorised Officer to be capable of combustion.
Maintained Grass	Soil covered land, planted with grasses or other durable plants, maintained green and less than 50mm in height.

Term	Definition
Prohibited Burning Time	The time of each year where it is unlawful to set fire to the bush at any time. This time is normally from 1 December of each year until and including 31 March of the following year. This time may be amended, subject to prevailing seasonal conditions.
Restricted Burning Time	The time of each year where it is unlawful to set fire to the bush without a valid Permit to Set Fire To The Bush issued by an Authorised Officer. This period is normally from 1 April until and including 31 May and from 1 October until and including 30 November of any year. This time may be amended, subject to the prevailing seasonal conditions.
Unrestricted Burning Time	The time of each year where it is lawful to set fire to the bush at any time, in areas zoned rural under the Metropolitan Region Scheme. This time is normally from 1 June until and including 30 September. This time may be amended, subject to the prevailing seasonal conditions.
Firebreak Time	The time of each year where fire hazard reduction works must be maintained as specified in this Fire Control Order. This time is 1 November of each year until and including 15 April of the following year.
Structure	A building, as defined in the Building Codes of Australia (BCA) may be made up of a number of classes if it has a mixed use.

Any Fire Control Order previously published by the City of Cockburn in the Government Gazette or in any Western Australian newsprint is hereby revoked.

By Order of Council

More information and contact

Please contact the City's Fire and Emergency Services for more information on firebreaks and burning permits on 08 9411 3444 or at rangercustomerservice@cockburn.wa.gov.au

Related Pages

- Fire and Emergency Management
- Fire Pits

- Prepare your home for Fire Season
- Proposed Prescribed Burning Areas
- Water Suppliers for Fire Fighters
- Cockburn Emergency Management Plans
- Home Emergency Plan

Appendix 4 - Transport Impact Assessment

TRANSPORT IMPACT ASSESSMENT

Barfield Road Structure Plan

Hammond Park

October 2023

Rev B

kctt

HISTORY AND STATUS OF THE DOCUMENT

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
Rev A Draft	20.05.2019	M Kleyweg	M Kleyweg	20.05.2019	Issued for Review
Rev A	5.06.2019	M Kleyweg	M Kleyweg	5.06.2019	Report Finalised
Rev B	6.10.2023	M Kleyweg	M Kleyweg	9.10.2023	LSP amended

DISTRIBUTION OF COPIES

Revision	Date of issue	Quantity	Issued to
Rev A Draft	21.05.2019	1 (PDF)	Peter Dockett (Richard Noble)
Rev A	5.06.2019	1 (PDF)	Peter Dockett (Richard Noble)
Rev B	10.10.2023	1 (PDF)	Ali Smyth (Richard Noble)

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Appendices

Appendix 1 - The layout of the proposed development
Appendix 2 - Transport Planning and Traffic Plans

1. Executive Summary

Site Context

- Barfield Road Structure Plan is located within Hammond Park suburb, City of Cockburn.
- The Structure Plan area is fronting Frankland Avenue to the east, Barfield Road to the west and Rowley Road to the south. It should be noted that the majority of the structure plan area has already been developed.
- The previously approved Barfield Road Structure Plan is being amended/updated to include Lot 16. This report will outline the recommendations for the structure plan areas that are still being developed and provide input into the wider network analysis.

Technical Findings

- The entire Barfield Road Structure Plan area is expected to generate a total of 3,765 vehicular trips per day, 453 vehicular trips in the AM peak and 448 VP vehicular trips in the PM peak.
- Currently, a large part of the structure plan has already been developed, the remaining land uses are expected to generate 1,909 vehicular trips per day, 231 vehicular trips in the AM peak and 226 vehicular trips in the PM peak.
- The additional traffic generated by Lot 16 is up to 268 vehicular trips per day and up to 32 vehicular trips in the AM and PM peak.
- KCTT believe that the well-planned road network will successfully absorb the additional traffic. Six major routes will be available for accessing the Structure Plan area:
    - Via Rowley Road towards east (Kwinana Freeway)
    - Via Barfield Road towards north
    - Via Frankland Avenue and Hammond Road towards north
    - Via Wattleup Road towards west
    - Via Proposed Scolaro Road towards north (proposed High School)
    - Via Irvine Parade towards north (proposed Primary School)

Relationship with Policies

- The predominant use is residential and to comply with the R-Codes, all residences are expected to provide a garage for each dwelling. KCTT believe that by having a garage for the owner, visitors are likely to park in the driveway space in front of the garage.
- According to the City of Cockburn Town Planning Scheme No. 3, the childcare centre will require 21 bays. The approved and constructed Childcare Centre (Nido Early School Hammond Park) located at 36 Whadjuk Drive provides 21 parking spaces.
- It is expected that delivery and service vehicles (such as waste removal vehicles) servicing the area will not require designated parking spaces, given that they can operate safely within the road reserve.

Other

- The following intersection controls are proposed:
    - Frankland Avenue / Whadjuk Drive - Roundabout – constructed
    - Irvine Parade / Whadjuk Drive - Roundabout – constructed
    - Rowley Road / Irvine Parade - Roundabout - constructed as an interim solution. When Rowley Road is upgraded and under MRWA jurisdiction, it is expected that this roundabout and

intersection with Barfield Road will be terminated. The exact timeframes for these changes are unknown currently.

- Road 02 - Barfield Road - No vehicle access, only cycling. There is potential for a Left-in only, however this will be assessed at a more detailed stage of planning.
- All other intersections - Give-way/Yield

2. Transport Impact Assessment

2.1. Proposal

Richard Noble engaged KCTT to prepare a Transport Impact Assessment (TIA) for thBarfield Road Structure Plan Area amendments.

The proposed subdivision/ structure plan comprises 520 single residential dwelling lots and a childcare centre.

This report will primarily address the requirements for integration of the proposed development with the surroundings, namely the existing and planned road network and mitigation strategies to accommodate generated traffic.

2.2. Location

Structure Plan	Barfield Road Structure Plan
Lot Numbers	Lots 13-16,18, 37-38 and 47-51 Hammond Park
Road Name(s)	Barfield Road, Rowley Road, Frankland Avenue
Suburb	Hammond Park
Description of Site	The previously approved Barfield Road Structure Plan is being amended/updated to include Lot 16 to the LSP with the following changes included in the previous revision of the report: • Addition of Lots 15 and 37 to the LSP • Redesign of Lot 18 • The Local Centre land use is changed to a Childcare Centre • Minor changes in R-Code densities.

2.3. Technical Literature Used

Local Government Authority	City of Cockburn
Type of Development	Residential
Are the R-Codes referenced?	YES
If YES, nominate which:	State Planning Policy 3.1 Residential Design Codes 2018 R-Codes (incorporating amendments gazetted on 2/8/2013, 23/10/15 and 2/3/2018)
Are other State Planning Policies referenced?	NO
Is the NSW RTA Guide to Traffic Generating Developments Version 2.2 October 2002 (referenced to determine trip generation / attraction rates for various land uses) referenced?	YES
Which WAPC Transport Impact Assessment Guideline should be referenced?	Volume 2 - Planning Schemes, Structure Plans & Activity Centre Plans Volume 5 - Technical Guidance
Are there applicable LGA schemes for this type of development?	YES

Name Number of Scheme	City of Cockburn Town Planning Scheme No. 3
Are Austroads documents referenced?	YES
Is the Perth Transport Plan for 3.5 million and Beyond referenced?	YES

2.4. Land Uses

Are there any existing Land Uses within the Structure Plan Area?	YES
If YES, nominate:	Approximately 277 dwellings have already been constructed as part of Barfield Road Structure Plan

Proposed Land Uses

How many types of land uses are proposed?	Two
Nominate land use type and yield	Residential (480 lots + 40 additional lots on Lot 16 = a total of 520 single residential lots) – partially constructed Childcare Centre (77 children and 13 staff members) - constructed
Are the proposed land uses complimentary with the surrounding land-uses?	YES

2.5. Local Road Network Information

How many existing roads are there within the Structure Plan Area?	Most of the planned roads within the LSP have already been constructed to previously determined standards and classification.

Name of Roads within the Structure Plan Area / Road Classification and Description:

Road 1

Road Name	Barfield Road
Number of Lanes	two way, one lane each direction, undivided
Road Reservation Width	20m
Road Pavement Width	6.2m
Classification	Local Distributor
Speed Limit	50kph
Bus Route	YES (North of Gaebler Road)
If YES Nominate Bus Routes	536
On-street parking	NO

Road 2

Road Name	Frankland Avenue
Number of Lanes	two way, one lane each direction, undivided
Road Reservation Width	20m
Road Pavement Width	7.3m
Classification	Access Road / Regional Distributor
Speed Limit	50kph; 70kph
Bus Route	NO

On-street parking	NO

Road 3

Road Name	Irvine Parade
Number of Lanes	two way, one lane (no linemarking), undivided
Road Reservation Width	20m
Road Pavement Width	7.2m
Classification	Local Distributor
Speed Limit	50kph or State Limit
Bus Route	YES
If YES Nominate Bus Routes	536
On-street parking	NO

Name of Other Roads within 2km radius of site, or roads likely to take increased traffic due to the development:

Road 1

Road Name	Wattleup Road
Number of Lanes	two way, one lane each direction, undivided
Road Reservation Width	20m
Road Pavement Width	6.5m
Classification	Regional Distributor
Speed Limit	70kph
Bus Route	NO
On-street parking	NO

Road 2

Road Name	Rowley Road
Number of Lanes	two way, one lane each direction, undivided
Road Reservation Width	20m
Road Pavement Width	7.5
Classification	Regional Distributor
Speed Limit	70kph
Bus Route	NO
On-street parking	NO

Road 3

Road Name	Kwinana Freeway
Number of Lanes	two way, two lanes per direction, divided
Road Reservation Width	130m
Road Pavement Width	14.4m (7.2m each direction)
Classification	Primary Distributor
Speed Limit	100kph
Bus Route	NO
On-street parking	NO

2.6. Traffic Volumes

Road Name	Location of Traffic Count	Vehicles Per Day (VPD)	Vehicles per Peak Hour (VPH)		Heavy Vehicle %	Year	
			AM Peak Time - AM Peak VPH	PM Peak Time - PM Peak VPH	*If HV count is Not Available, are HV likely to be in higher volumes than generally expected?*	Date of Traffic Count	*If older than 3 years multiply with a growth rate to the current year*
Barfield Road	650m north of Rowley Road	2,562	08:00 – 236	17:00 – 284	3.4 %	Jun 2019	2,884
	150m South of Gaebler Road	2,506	07:00 – 234	17:00 – 293	4.5 %	Jun 2019	2,820
	200m north of Gaebler Road	1,292	08:00 – 127	17:00 – 131	9.2 %	Feb 2022	-
	90m south of Jackadder Avenue	1,448	08:00 – 119	17:00 – 156	5.6 %	Feb 2020	1,582
Frankland Avenue	45m south of Woodrow Avenue*	1,502	08:00 - 218	15:00 - 215	3,8%	May 2020	1,641
	160m south of Wattleup Road*	5,329	07:00 – 430	16:00 – 430	14.2%	May 2020	5,823
Irvine Parade	97m north of Teramo Street*	1,170	08:00 – 184	15:00 – 180	9.9 %	Sep 2020	1,278
Wattleup Road	300m west of Frankland Avenue*	5,227	07:00 – 499	16:00 – 487	15.2%	Jun 2019	5,883
Rowley Road	West of Kwinana Freeway	9,450	07:45 – 855	14:45 – 910	17.4%	2020/ 2021	-

Note - These traffic counts have been obtained from the City of Cockburn's Intramaps*

2.7. Vehicular Crash Information

Is Crash Data Available on Main Roads WA website?	YES
If YES, nominate important survey locations:	
Location 1	Rowley Road [SLK 0.00 - 0.80]
Location 2	Frankland Avenue [SLK 1.94 - 2.74] – no crashes
Location 3	Barfield Road [SLK 1.51-2.37]
Location 4	Barfield Road & Rowley Road
Location 5	Frankland Avenue & Rowley Road
Period of crash data collection	01/01/2018 - 31/12/2023

Road / Intersection Name	SLK	Road Hierarchy	Speed Limit	Crash Statistics			
				No of KSI Crashes	No of Medical Attention Crashes	No of PDO Major Crashes	No of PDO Minor Crashes
Rowley Road	0.00 - 0.80	Regional Distributor	70kph	0	0	1	0
No of MVKT Travelled at Location			≈ 9,500 VPD * 365 * 5 years * 0.8 km = 13.87 MVKT				
KSI Crash Rate			0 KSI crashes / 13.87 MVKT = 0 KSI crashes/MVKT				
All Crash Rate			1 crashes / 13.87 MVKT = 0.07 crashes/MVKT				
Comparison with Crash Density and Crash Rate Statistics			The average of 0.07 crashes/MVKT is lower than the network average of 0.95 crashes/MVKT.				
Barfield Road	1.51-2.37	Local Distributor	50kph	0	0	2	0
No of MVKT Travelled at Location			≈ 2,500 VPD * 365 * 5 years * 1.35 km = 3.92 MVKT				
KSI Crash Rate			0 KSI crashes / 3.92 MVKT = 0 KSI crashes/MVKT				
All Crash Rate			2 crashes / 3.92 MVKT = 0.51 crashes/MVKT				
Comparison with Crash Density and Crash Rate Statistics			The average of 0.51 crashes/MVKT is lower than the network average of 0.95 crashes/MVKT.				
Barfield Road & Rowley Road	2.37	Local Distributor/ Regional Distributor	50kph / 70kph	0	0	2	0
No of MVKT Travelled at Location			≈ 12,000 VPD * 365 * 5 years * 0.3 km = 6.57 MVKT				
KSI Crash Rate			0 KSI crashes / 6.57 MVKT = 0 KSI crashes/MVKT				
All Crash Rate			2 crashes / 6.57 MVKT = 0.30 crashes/MVKT				
Comparison with Crash Density and Crash Rate Statistics			The average of 0.30 crashes/MVKT is lower than the network average of 1.98 crashes/MVKT.				
Frankland Avenue & Rowley Road	0.00	Regional Distributor / Regional Distributor	70kph / 70kph	0	0	1	0
No of MVKT Travelled at Location			≈ 15,000 VPD * 365 * 5 years * 0.3 km = 8.12 MVKT				
KSI Crash Rate			0 KSI crashes / 8.12 MVKT = 0 KSI crashes/MVKT				
All Crash Rate			1 crashes / 8.12 MVKT = 0.12 crashes/MVKT				
Comparison with Crash Density and Crash Rate Statistics			The average of 0.12 crashes/MVKT is lower than the network average of 1.98 crashes/MVKT.				

The following tables show crash rates and crash densities in the Perth Metropolitan area on local roads and state roads for the period from 2017 to 2022, as obtained from Main Roads WA on the 31st May 2022 by email request:

Crash Density and Crash Rate on Metropolitan Local Roads Network only

	All Crashes		Serious Injury Crashes (Fatal+Hospital)	
	Average Annual Crash Density (All Crashes/KM)	Average Annual Crash Rate (All Crashes/MVKT)	Average Annual Crash Density (Ser. Inj. Crashes/KM)	Average Annual Crash Rate (Ser. Inj. Crashes/MVKT)
Metro Local Roads - Midblock	2.51	0.95	0.12	0.05
Metro Local Roads - All	5.23	1.98	0.24	0.09

Note: Based on 5-years data for the period 2017 to 2021.

2.8. Public Transport Accessibility

How many bus routes are within 400 metres of the subject site?			One (Route 536)
How many bus routes are within 800 metres of the subject site?			Three
Bus / Rail Route	Description	Peak Frequency	Off-Peak Frequency
535	Aubin Grove Station - Hammond Park West via Macquarie Boulevard	20 minutes	60 minutes
536	Aubin Grove Station - Hammond Park East via Barfield Road	20 minutes	60 minutes
537	Aubin Grove Station - Wandi via Lyon Road	10 minutes	60 minutes

Walk Score Rating for Accessibility to Public Transport.

25-49 | Some Transit. A few nearby public transportation options.

Is the development in a Greenfields area? NO

2.9. Pedestrian Infrastructure

Describe existing local pedestrian infrastructure within a 400m radius of the site:

Classification	Road Name
"Principal Shared Path"	Kwinana Freeway
"Other Shared Path (Shared by Pedestrians and Cyclists)"	Along Inverson Boulevard
Does the site have existing pedestrian facilities	YES
Does the site propose to improve pedestrian facilities?	YES

If YES, describe the measures proposed.

Refer to Section 2.19 Proposed Internal Road Network for roads with the proposed pedestrian paths.

What is the Walk Score Rating?

0-24 | Car-Dependent. Almost all errands require a car.

2.10. Cyclist Infrastructure

Are there any PBN Routes within an 800m radius of the subject site? YES

If YES, describe:

Classification	Road Name
"Principal Shared Path"	Kwinana Freeway
"Other Shared Path (Shared by Pedestrians and Cyclists)"	Along Inverson Boulevard, Kesiya Turn, Macquarie Boulevard, Botany Parade, Durango Turn
"Good Road Riding Environment"	Irvine Parade, Gaebler Road, Lyon Road, Kesiya Turn, Macquarie Boulevard, Botany Parade, Ironbark Terrace, Durango Turn
"Perth Bicycle Network - Continuous Signed Routes"	SW18 - Wattleup Road, Rowley Road; SE41 - Barfield Road

Are there any PBN Routes within a 400m radius of the subject site? YES

If YES, describe:

Classification	Road Name
"Principal Shared Path"	Kwinana Freeway
"Other Shared Path (Shared by Pedestrians and Cyclists)"	Along Inverson Boulevard, Kesiya Turn
"Good Road Riding Environment"	Irvine Parade, Kesiya Turn
"Perth Bicycle Network - Continuous Signed Routes"	SW18 - Wattleup Road, Rowley Road; SE41 - Barfield Road

Does the site have existing cyclist facilities? YES

Does the site propose to improve cyclist facilities? YES

If YES, describe the measures proposed.

Refer to Section 2.19 Proposed Internal Road Network for roads with the proposed pedestrian paths.

2.11. Vehicular Parking

Local Government: City of Cockburn

Local Government Document Utilised: Town Planning Scheme No. 3
State Planning Policy 3.1 - R-Codes

Description of Parking Requirements in accordance with Scheme:

City of Cockburn - Town Planning Scheme No. 3

"Dwelling - As prescribed in the Residential Design Codes

Child Care Premises:

- *1:1 employee Plus*
- *1:10 children"*

R-Codes:

"The following minimum number of on-site car parking spaces is to be provided for each single house, grouped dwelling and special purpose dwelling comprising the following number of bedrooms:

- *1-bedroom dwellings – Location B – 1 bay per dwelling*
- *2+ bedroom dwellings – Location B – 2 bays per dwelling"*

Justification

Predominant use is residential and to comply with the R-Codes, all residences are expected to provide a garage for each dwelling. The visitors are likely to park in the driveway space in front of the garage. Access Street "C" can accommodate on-street parking to provide additional bays but also to visually narrow the street and improve

safety in the pedestrian environment. Neighbourhood Connector B roads are expected to have parking on both sides of the road.

The approved and constructed Childcare Centre (Nido Early School Hammond Park) located at 36 Whadjuk Drive provides 21 parking spaces.

Have Vehicle Swept Paths been checked for Parking? NO

2.12. Bicycle Parking

Local Government	City of Cockburn
Reference Document Utilised	Town Planning Scheme No. 3 State Planning Policy 3.1 - R-Codes

Description of Parking Requirements in accordance with Scheme:

City of Cockburn - Town Planning Scheme No. 3

"Dwelling - For Grouped and Multiple Dwellings.

- *1:4 units for residents*
- *1:16 units for visitors"*

R-Codes:

"Single houses - No minimum requirement"

Justification

It is expected that any grouped and multiple dwellings would provide bicycle parking as outlined by the City of Cockburn Town Planning Scheme No. 3.

The approved and constructed Childcare Centre (Nido Early School Hammond Park) located at 36 Whadjuk Drive provides 1 bicycle rack.

2.13. ACROD Parking

Class of Building	Class 1a - a single dwelling Class 2 - a building containing 2 or more sole-occupancy units each being a separate dwelling
Does this building class require specific provision of ACROD Parking?	NO
Reference Document Utilised	Building Code of Australia

Justification

The approved and constructed Childcare Centre (Nido Early School Hammond Park) located at 36 Whadjuk Drive provides 1 accessible car parking bay.

2.14. Delivery and Service Vehicles

Guideline Document used as reference NSW RTA Guide to Traffic Generating Developments

Requirements

Residential flat buildings (> 200 flats or home Units) - 4 + 1 per 100 units over 200 plus 1 space per 1,000 m2 of public area set aside for bar, tavern, lounge and restaurant

Justification

It is expected that delivery and service vehicles (such as waste removal vehicles) servicing the area will not require designated parking spaces given that they can operate safely within the road reserve.

2.15. Calculation of Development Generated / Attracted Trips

What are the likely hours of operation?	For residential land uses, the hours of operation are not applicable. Child Care Centre 06:30 - 18:30
What are the likely peak hours of operation?	AM 08:00 - 09:00 PM 17:00 - 18:00
Do the development generated peaks coincide with existing road network peaks?	YES
If YES, Which:	Partially, AM peak only
Guideline Document Used	**WAPC Transport Assessment Guidelines for Developments**
Rates from above document:	**Residential** – 0.8 vehicle trips per dwelling for the AM and PM peak hours. A 25% IN / 75% OUT split has been adopted for the AM peak and a 67% IN / 33% OUT split for the PM peak hour; **Schools** - The rates are based on data from the PARTS surveys that indicate that around 65% - 70% of children are driven to primary school, with an average occupancy of around 1.4 - 1.5 children per car. This equates to 0.5 trips per child to school and 0.5 trips per child from school in each of the AM and PM peak hours. For secondary schools the PARTS data indicate that the proportion driven to school is generally a little lower but, to simplify the process of determining the level of assessment required and for the broad assessment of structure plans, it is suggested that the above primary school rates be used for all schools.
Guideline Document Used	**NSW RTA Guide to Traffic Generating Developments**
Rates from above document:	The NSW RTA Guide to Traffic Generating Developments suggest residential developments of this type in Sydney tend to generate between 4 and 5 vehicular trips per dwelling. In Perth, the Department of Planning and Infrastructure conducted a series of studies in the late 1990's / early 2000's which showed that higher density dwellings tended to average closer to 6.7 vehicle movements per day. KCTT propose using an average VPD of 6.7 vehicular trips per day per residence for R30 and below and an average VPD of 5.5 vehicular trips per day per residence for R40 and above (these rates were used in the previously approved TIA for the Barfield Road Structure Plan).
Guideline Document Used	**ITE Trip Generation Report (9th Edition)**
Rates from above document:	**Elementary School** *Students: 1.29 vehicular trips per day per student*

Child care centres vehicular daily trips can be assumed to be a maximum of 4 VPD per child and 2 VPD per employee. Each parent generates 2 vehicular trips when dropping off the child to the day care centre and 2 vehicular trips when picking the child up. Employees generate 1 vehicular trip arriving at work, and another vehicular trip when leaving work. It is a conservative assumption based on the idea that every child in the centre is driven to the premises and that there are no siblings in the centre.

	Land Use Type	Rate above	Yield	Daily Traffic Generation	AM Peak	PM Peak
Previously approved Barfield Road Local Structure Plan	*Residential (R25-R30)*	*6.7 vehicle trips per day* *0.8 vehicle trips per peak hour*	392 dwellings	2,626	314	314
	Residential (R40-R60)	*5.5 vehicle trips per day* *0.8 vehicle trips per peak hour*	44 dwellings	242	35	35
	Residential (R30)	*6.7 vehicle trips per day* *0.8 vehicle trips per peak hour*	44 dwellings	295	35	35
	Constructed Child Care Centre	*4 vehicle trips per child* *2 vehicle trips per staff member* **Peak hour traffic generation was adopted from the TIS report for the proposed child care centre prepared by Cirqa - November 2018*	77 children 13 staff members	334	37*	32*
Amendments to Barfield Road Local Structure Plan Rev B	Lot 16 Single Residential Lots	*6.7 vehicle trips per day* *0.8 vehicle trips per peak hour*	40 dwellings	268	32	32
			Total LSP Traffic - (A):	**3,765**	**453**	**448**
Land Uses Outside of the LSP Area	*Constructed Primary School*	**Assume up to 60% of all children are driven to school* *1.2 vehicle trips per child per day* *0.5 vehicle trips per child per peak hour*	*Assume up to 300 children and up to 30 staff members*	360	150	150
	Constructed High School	**Assume up to 30% of all children are driven to school* *0.6 vehicle trips per child per day* *0.3 vehicle trips per child per peak hour*	*Assume up to 1,000 children and up to 50 staff members*	600	300	300
			Total (B):	**4,725**	**903**	**898**

Does the site have existing trip generation / attraction?	YES
No of Daily Trips	Approximately 277 dwellings (according to the latest aerial imagery) 277 * 6.7 VPD = 1,856 VPD (C)
No of AM Peak Hour Trips	277 * 0.8 = 222 VPH
No of PM Peak Hour Trips	277 * 0.8 = 222 VPH
What is the total impact of the proposed structure plan area?	A - C = 1,909 VPD; AM 231 VPH; PM 226 VPH Currently a large part of the structure plan has already been developed, the remaining land uses are expected to generate 1,909 vehicular trips per day, 231 vehicular trips in the AM peak and 226 vehicular trips in the PM peak. The impact of the proposed development on the surrounding road network is high according to WAPC guidelines.

2.16. Trip Purposes

Land Use	Employment	Shopping	Education	Social / Recreational
Residential	40%	17.5%	25%	17.5%

2.17. Expected Origin / Destination

Name the closest existing major residential generators and non-residential attractors of traffic and the distance from the boundaries of the Structure Plan Area.

Residential — Employment (profile.id)

The majority of employment trips is expected to be external to the proposed Structure Plan Area. The ID website on the City of Cockburn's webpage suggests the following breakdown for employment destinations for residents of the City of Cockburn:

- Cockburn (C) – 27.3%
- Melville (C) – 12.2%
- Perth (C) - 10.0%
- Fremantle (C) – 8.5%
- Canning (C) - 5.9%
- No Fixed Address (WA) - 4.4%
- Kwinana (C) - 2.8%
- Belmont (C) - 2.8%
- Rockingham (C) - 2.7%
- Stirling (C) - 2.4%
- Victoria Park (T) - 2.0%
- Gosnells (C) - 1.9%
- Armadale (C) - 1.8%
- Swan (C) - 1.4%
- Vincent (C) - 1.1%
- South Perth (C) - 1.1%
- Subiaco (C) - 1.1%
- Others – less than 1.0% each

	The City Cockburn i.d. site shows that up to 69.2% of all work trips are undertaken using a vehicle (i.e. vehicle as driver plus vehicle as passenger). Given the predominant transport mode and distribution of destinations, which excluding working from home, shows that there is no source of employment within the structure plan area, the following roads in KCTT's opinion will be predominantly used for access/egress to the site: - • Rowley Road • Frankland Avenue • Barfield Road
Shopping	Shopping centre is not proposed within the structure plan area. The nearest shopping centres are: • Aubin Grove Local Centre located 1km to the north-east • The Park Hive located 1.6km to the north • Harvest Lakes Shopping centre 2km to the north-east
Education	There are no schools proposed within the structure plan area, however an approved and constructed Childcare Centre (Nido Early School Hammond Park) is located at 36 Whadjuk Drive. Several schools are located in close vicinity: • Hammond Park Catholic Primary School is adjacent to the structure plan area to the north • Hammond Park Secondary Collegeadjacent to the structure plan area to the north • Hammond Park Primary School is located 800m to the north-west • Aubin Grove Primary School is located 800m to the east
Social / Recreational	It is deemed that a minimum of 80% of the trips for social and recreational purpose will be external.

2.18. Traffic Flow Distribution onto External Road Networks

How many routes are available for access / egress to the site?	6 routes 4,725 VPD / 903 AM VPH / 898 PM VPH (LSP + Primary and Secondary School Trips)
Route 1	
Provide details for Route No 1	**Via Rowley Road towards east (Kwinana Freeway)**
Percentage of Vehicular Movements via Route No 1	24% = 1,134 VPD / AM 217 VPH / PM 216 VPH
Route 2	
Provide details for Route No 2	**Via Barfield Road towards north**
Percentage of Vehicular Movements via Route No 2	17% = 803 VPD / AM 154 VPH / PM 153 VPH
Route 3	
Provide details for Route No 3	**Via Frankland Avenue and Hammond Road towards north**
Percentage of Vehicular Movements via Route No 3	34% = 1,607 VPD / AM 307 VPH / PM 305 VPH
Route 4	
Provide details for Route No 4	**Via Wattleup Road towards west**
Percentage of Vehicular Movements via Route No 4	13% = 614 VPD / AM 117 VPH / PM 117 VPH
Route 5	

Provide details for Route No 5	**Via Proposed Scolaro Road towards north (proposed High School)**
Percentage of Vehicular Movements via Route No 5	7% = 331 VPD / AM 63 VPH / PM 63 VPH
Route 6	
Provide details for Route No 6	**Via Irvine Parade towards north (proposed Primary School)**
Percentage of Vehicular Movements via Route No 6	5% = 236 VPD / AM 45 VPH / PM 45 VPH

**Note - To and from Rowley Road will only be permitted until construction of the land identified in the WAPC application 149269 has been completed and all Lots developed contained therein being sold to prospective purchasers. Once the construction and sale of these lots has been completed, access to and from Rowley Road for Irvine Parade will be removed at the full cost of the developer / applicant / original landowner and reconfigured to a T-intersection. No access will be permitted to or from Rowley Road for Irvine Parade once the above criteria have been met.*

***Note - Access to and from Rowley Road for Barfield Road will be either a cul-de-sac or an underpass as communicated in Main Roads response to the WAPC application 149269. In the short-term only a cul-de-sac will be permitted.*

2.19. Road Safety

Are sight distances adequate at proposed intersections? YES

Justification

Liveable Neighbourhoods guidelines state that junction spacing for access streets or laneway junctions are not to be located closer than 20m. The proposed road network complies with this requirement.

2.20. Proposed Internal Road Network

Guideline Document used as reference	Liveable Neighbourhoods
How many proposed roads are there within the Structure Plan Area?	Total of 28 roads, as some of the roads have already been constructed, the cross sections will be provided for unconstructed roads only

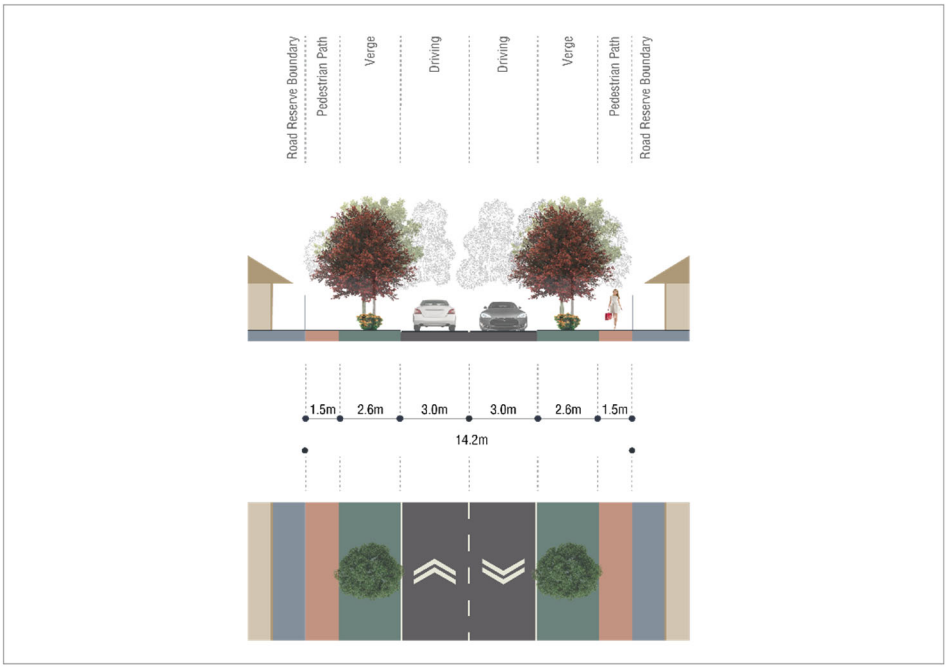
The classification below is reflective of minimal traffic requirements. The road reservation widths can be expanded and re-organised to satisfy different types of requirements (e.g. civil engineering, environmental, conservational, urban design etc.), therefore roads that have lower order hierarchy according to traffic engineering requirements might have wider road reservations if required.

Name of Roads within the Structure Plan Area / Road Classification and Description:

Road 1-3

Name	Road 03, Road 04, Road 05
Projected Traffic Volumes	<1,000 VPD
Proposed Number of Lanes	one lane per direction
Proposed Road Reservation Width	14.2m (20.0m Road 04 adjacent to power line easement to the east)
Proposed Road Pavement Width	6.0m
Proposed Median Width	-
Proposed Pedestrian / Cyclist / Shared Path Width	1.5m pedestrian path on at least one side of the road reservation
Proposed Classification	Access Street "D"
Proposed Speed Limit	40 km/h
Proposed Bus Route Extension / Introduction	NO
Proposed On-street parking	NO

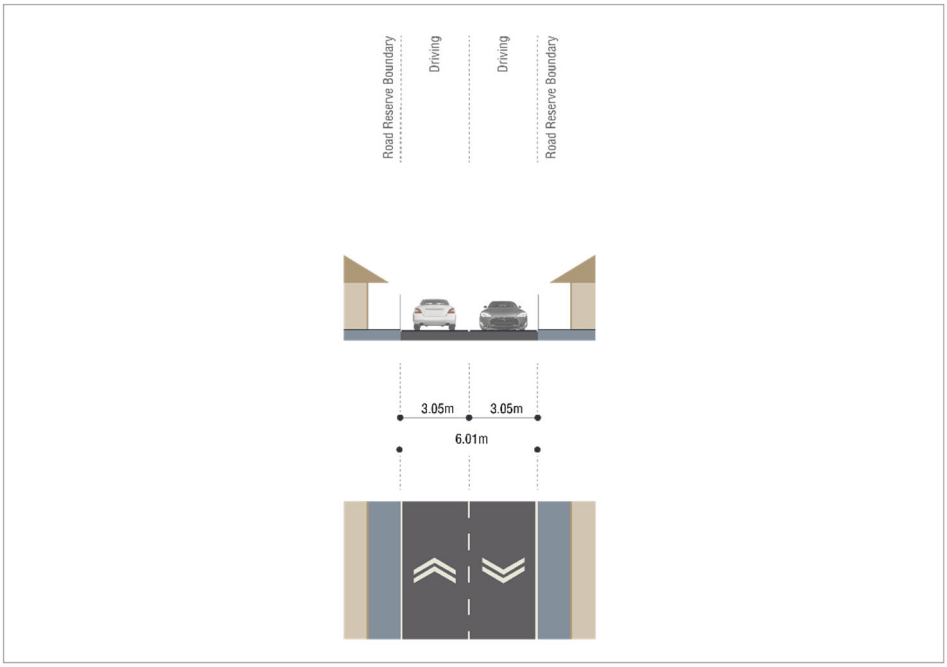
Provide graphics of the proposed internal road cross section within the Structure Plan Area



Road 4

Name	Tesoro Lane
Projected Traffic Volumes	<100 VPD
Proposed Number of Lanes	one lane per direction
Proposed Road Reservation Width	6.01m
Proposed Road Pavement Width	6.01m
Proposed Median Width	-
Proposed Pedestrian / Cyclist / Shared Path Width	-
Proposed Classification	Laneway
Proposed Speed Limit	15 km/h
Proposed Bus Route Extension / Introduction	NO
Proposed On-street parking	NO

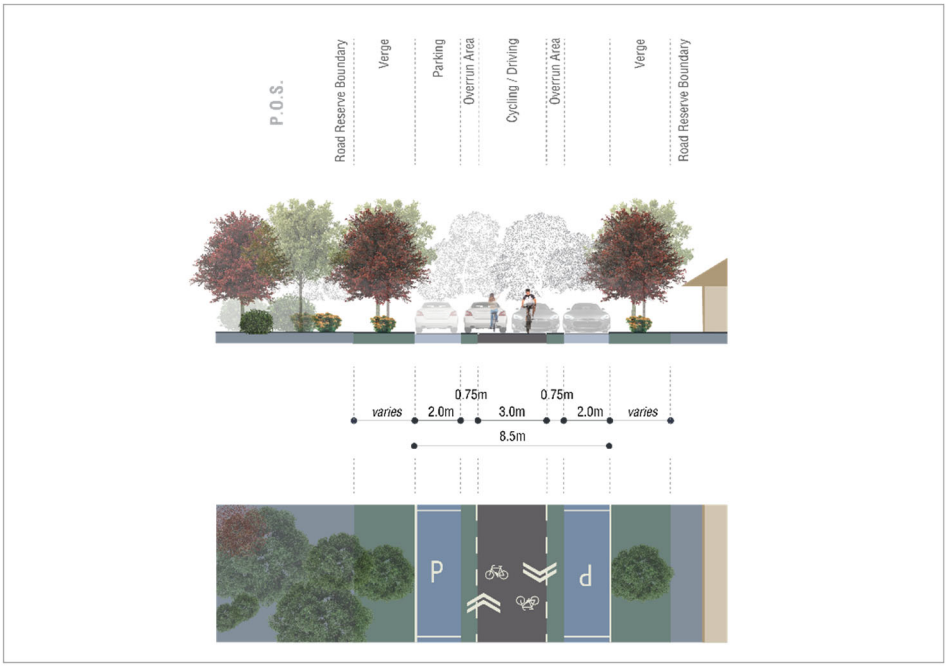
Provide graphics of the proposed internal road cross section within the Structure Plan Area



Road 5

Name	Road 02
Projected Traffic Volumes	<100 VPD
Proposed Number of Lanes	one lane per direction
Proposed Road Reservation Width	varies
Proposed Road Pavement Width	3.0
Proposed Median Width	-
Proposed Pedestrian / Cyclist / Shared Path Width	3.0m shared space
Proposed Classification	Safe Active Street *It should be noted that SAS can take up many forms, the one presented below is one of the examples.*
Proposed Speed Limit	15 km/h
Proposed Bus Route Extension / Introduction	NO
Proposed On-street parking	YES - 2.0m parallel parking

Provide graphics of the proposed internal road cross section within the Structure Plan Area



2.21. Proposed Intersection Controls

How many proposed intersections have been analysed?

Name of Intersections within the Structure Plan Area / Road Classification and Description:

Intersection 1	
Name	Frankland Avenue / Whadjuk Drive
Proposed Intersection Control	Roundabout – constructed
Intersection 2	
Name	Irvine Parade / Whadjuk Drive
Proposed Intersection Control	Roundabout – constructed
Intersection 3	
Name	Irvine Parade / Rowley Road
Proposed Intersection Control	Roundabout – constructed as an interim solution; When Rowley Road is upgraded, most likely the roundabout will be terminated. Timeframe is unknown currently.
Intersection 4	
Name	Road 02 - Barfield Road
Proposed Intersection Control	No vehicle access, only cycling. There is potential for a Left-in only, however this will be assessed at a more detailed stage of planning.
All other intersections	
Name	All other intersections
Proposed Intersection Control	Give-way/Yield *

*Note - Intersection with Irvine Parade north of Rowley Road might have Left-in/Left-out only configuration until the roundabout is closed. After roundabout closure, this intersection might be configured to a full movement T-intersection.

Name additional recommendations

Liveable Neighbourhoods suggest 6.0 metres kerb radii for access street intersections in order to discourage reckless driving therefore it would be prudent to allow for 6.0 metres curb radii for Access Street D intersections and laneways internal to the LSP area.

2.22. Proposed Internal Transport Networks

Are there any changes / additions to the existing road network?

- 28 proposed roads, some of them are already constructed or under construction as part of the approved structure plan area.
- The existing Rowley Road / Irvine Parade roundabout will serve as an interim solution. It is expected that this roundabout will be closed when Rowley Road is upgraded. However, the exact timeframe for this is unknown. Similarly, the intersection of Barfield Road and Rowley Road is expected to be terminated in the future.

Were there any discussions / agreements with MRWA regarding intersections with, or direct access onto roads under their jurisdiction?	YES
If YES, nominate:	The proposed access/egress arrangements to Rowley Road are short to medium term only and are subject to rationalisation in the future when MRWA constructs new Rowley Road geometry.
Are there any pedestrian / cycle networks and crossing facilities proposed for the roads within the Structure Plan Area?	YES • Proposed pedestrian path on one side of all proposed streets within the subject area • Proposed high quality shared path on one side of Road 02 connecting to the existing PSP path along Kwinana Freeway
Were there any discussions / agreements with the local authority over local road networks and pedestrian and cycle facilities?	NO
Were there any discussions / agreements with PTA / Transperth on new bus services or extensions / alterations to existing bus services to serve the Structure Plan Area?	YES • Bus route 535 is planned to service the Structure Plan Area with a network to be confirmed along Barfield Road to a location near Rowley Road. • Bus route 536 is planned to service the western portion of the Structure Plan Area with a network to be confirmed along the future Hammond Road and / or Frankland Road.

2.23. Changes to External Transport Networks

Are there any proposed changes of the road network?	YES: • Rowley Road has been identified as a primary freight route to the Naval Base / Kwinana Beach industrial areas. It will be constructed to four lanes and divided in accordance with Main Roads WA standards. However, timing for these upgrades are unknown at this stage (Perth and Peel @3.5 million - Road Network Plan). • Hammond Road extension south to Rowley Road, with the connection ultimately extending to Anketell Road.
Are there any proposed changes of the intersection controls?	YES • There are plans for grade separation on the intersection of Hammond Park and Rowley Road Extension, however this is yet to be confirmed at a more detailed planning stage.
Are there any proposed changes of the pedestrian / cycle networks and crossing facilities?	YES • Several new pedestrian and cycling facilities are planned as part of the adjoining structure plans areas in Hammond Park, Wattelup and Mandogalup.
Are there any proposed changes of the public transport services?	YES: • Bus route 535 is planned to service the Structure Plan Area with a network to be confirmed along Barfield Road to a location near Rowley Road. • Bus route 536 is planned to service the western portion of the Structure Plan Area with a network to be confirmed along the future Hammond Road and / or Frankland Road.

These changes could be those committed or proposed by others, MRWA or local authority, or by the proponent as part of the structure plan.

2.24. Integration with Surrounding Area

Are there any existing major residential generators of traffic within a minimum of 800 metres from the boundaries of the Structure Plan Area?	YES:
If YES, nominate:	• Hammond Park residential area north of the subject site • Aubin Grove residential area west of the subject site
Are there any existing major non-residential attractors of traffic within a minimum of 800 metres from the boundaries of the Structure Plan Area?	YES
If YES, nominate:	• Aubin Grove Local Centre located 1km to the north-east • The Park Hive located 1.6km to the north • Harvest Lakes Shopping centre 2km to the north-east • Hammond Park Catholic Primary School is adjacent to the structure plan area to the north • Hammond Park Secondary College adjacent to the structure plan area to the north • Hammond Park Primary School is located 800m to the north-west • Aubin Grove Primary School is located 800m to the east
Identify any proposals for major changes to the land uses within 800 metres of the boundaries of the Structure Plan Area.	• A large residential area is in construction south of the subject site as part of the Mandogalup East LSP and Mandogalup West LSP with R-codes ranging from 30 to 80. Additionally, the plans outline a primary school and local centre site. • Southern Suburbs District Structure Plan for the area north and west of the subject site outline medium to high residential densities with mixed business, schools and local centres. Parts of this area are already constructed or under construction.
What are the main desire lines between the structure plan land uses and these external attractors / generators?	• Barfield Road • Hammond Road/Frankland Avenue • Rowley Road • Kwinana Freeway • Lyon Road
Will the existing transport networks, plus any proposed changes, adequately match these desire lines, particularly for pedestrians, cyclist and public transport users?	• Structure Plan Area is well connected to the metropolitan road network with connectivity to Rowley Road and Kwinana Freeway for major external trips, Frankland Avenue / Future Hammond Road alignment for external trips to the west and Barfield Road for localised travel between the existing Hammond Park area and the Structure Plan Area.
Propose remedial measures to address these deficiencies.	The area is well planned, when all infrastructure is completed, it is expected that the network will function without any major issues.

2.25. Analysis of Transport Networks

Determine the year(s) for assessment and the time period(s) for the traffic flow analysis.	2031

Determine structure plan generated traffic. Refer Sections 2.14. and 2.17.

Road Name and Location		Existing Traffic Volumes with 3% growth rate to 2023	Forecasted Traffic Volumes in 2031
Barfield Road	Northern Boundary of Structure Plan Area	2,884	3,209
Frankland Avenue	North of Wattleup Road	1,641	2,290
	North of Rowley Road	5,823	5,512
Wattleup Road	West of Frankland Avenue	5,883	6,131
Rowley Road	East of Barfield Rd	10,326	10,555
Irvine Parade	North of Whadjuk Drive	N/A	300
	South of Whadjuk Drive	N/A	1,070
	North of Rowley Road	N/A	310
Whadjuk Drive	East of Frankland Avenue	N/A	3,000
	West of Barfield Road	N/A	1,950
Prato Vista	East of Frankland Avenue	N/A	730
Parko Glade	West of Irvine Parade	N/A	260
Napoli Drive	South of Whadjuk Drive	N/A	350
	North of Venezia Ridge	N/A	50
Rechen Chase	South of Whadjuk Drive	N/A	300
Corsia Crescent	West of Irvine Parade	N/A	490
Liscia Way	West of Barfield Road	N/A	300
Genoa Parkway	West of Barfield Road	N/A	110
Venezia Ridge	West of Barfield Road	N/A	110
Rippen Loop	East of Barfield Road	N/A	100
Road 02	East of Barfield Road	N/A	100
Road 03	East of Barfield Road	N/A	300
Road 04	East of Barfield Road	N/A	334
Road 05	East of Barfield Road	N/A	134

Identify all schools within the structure plan area and those within 800 metres of the structure plan area.	There are no schools proposed within the structure plan area, however an approved and constructed Childcare Centre (Nido Early School Hammond Park) is located at 36 Whadjuk Drive provides Several schools are located in vicinity: • Hammond Park Catholic Primary School is adjacent to the structure plan area to the north • Future high school is currently being constructed adjacent to the structure plan area to the north • Hammond Park Primary School is located 800m to the north-west • Aubin Grove Primary School is located 800m to the east
Identify the most likely walk and cycle routes to each school from the catchment areas.	It is expected that all proposed roads will have pedestrian paths in their road reserves. The main collector roads will be Irvine Parade, Napoli Drive and Rechen Chase and further via or across Whadjuk Drive to Irvine Parade (Primary School) or Scolaro Road (High School).

2.26. Site-Specific Issues and Proposed Remedial Measures

How many site-specific issues need to be discussed?	One (1)
Site Specific Issue No 1	**Traffic Impact of the proposed changes to the Local Structure Plan**
Remedial Measure / Response	The proposed changes will generate approximately 268 vehicular trips per day and 32 vehicular trips in the AM and PM peak.) in addition to the original Structure Plan. Since this additional traffic will be spread throughout the internal and external network with traffic distribution as described in Section 2.17, these amendments will not have a significant impact on the road network and its performance. KCTT believe that the proposed road network will successfully absorb the traffic generated by the proposed LSP area.

Appendix 1

The Layout of the Proposed Development



LEGEND

STRUCTURE PLAN AREA

ZONES
- RESIDENTIAL
- LOCAL CENTRE

RESERVES
- PARKS AND RECREATION
- PUBLIC PURPOSE - EDUCATION

OTHER ELEMENTS THAT INFORM THE LSP
- PROPOSED BUS ROUTE
- R25 RESIDENTIAL DENSITY CODE
- PLANNING CONTROL AREA No. 156
- LAND WITH AN INDICATIVE BAL RATING OF BAL-19 AND/OR BAL-29 AND/OR BAL-40 NOT CAPABLE OF BEING DEVELOPED UNTIL THE ADJOINING BUSHFIRE HAZARD IS REMOVED
- DEVELOPMENT SUBJECT TO DWELLING CONSTRUCTION UNDER AS3959-2009
- WESTERN POWER EASEMENT

SIZE A4_1:5000 0 metres 50 100 150 200

REV	DESCRIPTION	YYMMDD	DRAWN	APPR'D
S	UPDATE LOT DESIGN	231102	CC	TT
R	UPDATE LOT DESIGN	230731	LI	TT
Q	UPDATE LOT 16 + 30	221219	SB	TT
P	UPDATE R-CODES	221214	TG	NT
O	UPDATE PCA + LEGEND	220304	SB	EH

BARFIELD ROAD STRUCTURE PLAN

Lots 13-16, 18 & 47-51 Hammond park

City of Cockburn

REF NO. **RIC HAM** DRAW NO. **RD1 045** REV. **S**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY

Appendix 2

Transport Planning and Traffic Plans



PARKS AND RECREATION
WATERWAYS
PUBLIC PURPOSE
SHOPPING AREA
ROAD
Hay Street STREET NAME
RAILWAY
ROAD BRIDGE, FOOT BRIDGE UNDERPASS
APPROVED STRUCTURE PLAN BOUNDARY
STRUCTURE PLAN AREA
DISTANCE FROM LOCATION
CITY OF COCKBURN LOCAL GOVERNMENT NAME
LOCAL AUTHORITY BOUNDARY
HAMMOND PARK SUBURB

LEGEND

No	DATE	AMENDMENT
D	07-11-2023	PROPOSED LAYOUT AMENDED
C	09-10-2023	PROPOSED LAYOUT AMENDED
B	29-11-2022	PROPOSED LAYOUT AMENDED
A	10-05-2019	ISSUED FOR REVIEW

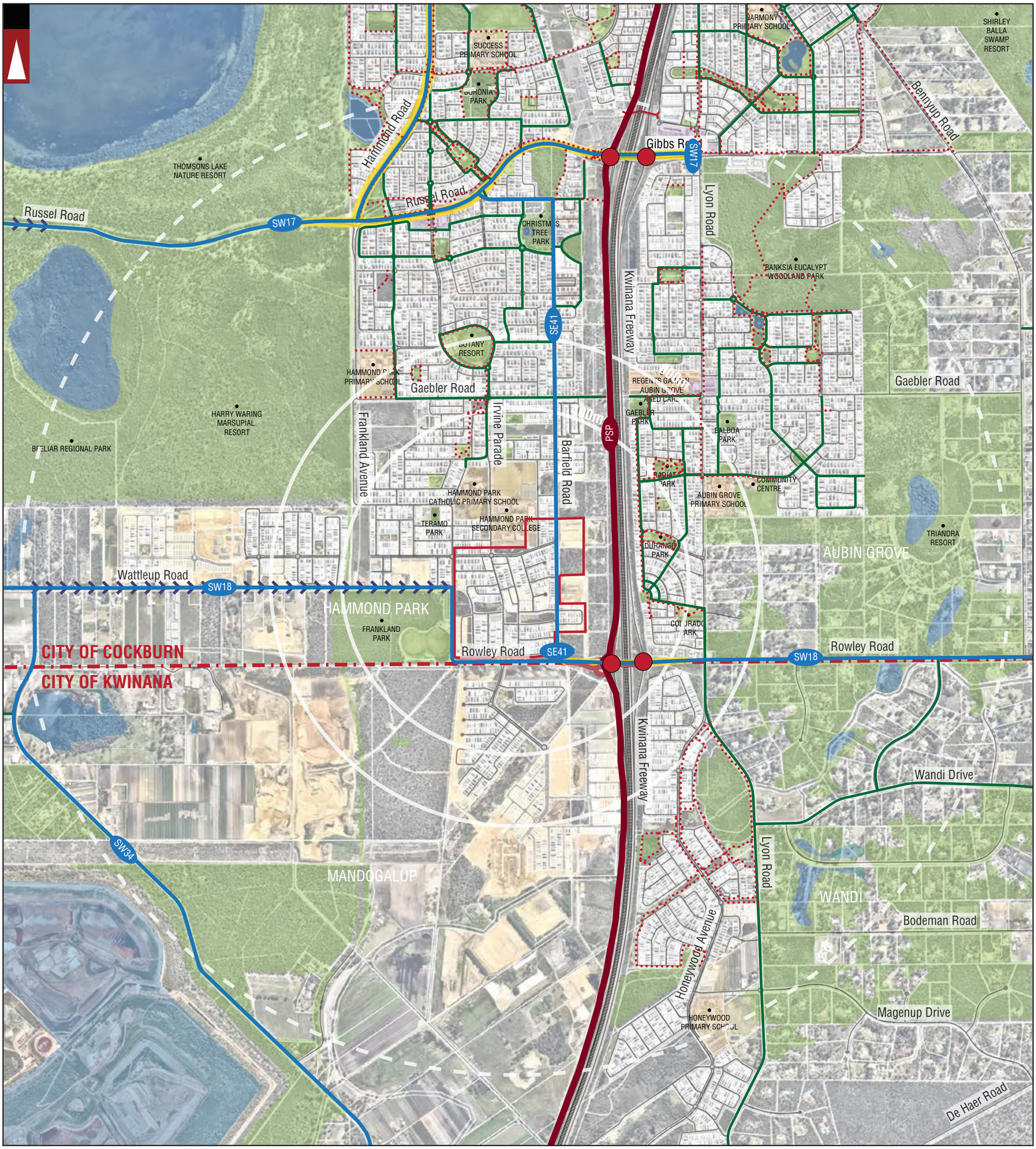
PROJECT: BARFIELD ROAD, HAMMOND PARK

TITLE: LOCALITY PLAN - 2KM RADIUS

DRAWING NUMBER: KC00050.000_ S01

DRAWN BY: A.M.

Civil & Traffic Engineering Consultants
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kctt



PARKS AND RECREATION
WATERWAYS
PUBLIC PURPOSE
SHOPPING AREA

ROAD
Hay Street STREET NAME
RAILWAY
ROAD BRIDGE, FOOT BRIDGE UNDERPASS
APPROVED STRUCTURE PLAN BOUNDARY

STRUCTURE PLAN AREA
DISTANCE FROM LOCATION
CITY OF COCKBURN LOCAL GOVERNMENT NAME
LOCAL AUTHORITY BOUNDARY
HAMMOND PARK SUBURB

PSP PRINCIPAL SHARED PATH (PSP)
HIGH QUALITY SHARED PATH
OTHER SHARED PATH (SHARED BY PEDESTRIANS & CYCLISTS)
GOOD ROAD RIDING ENVIRONMENT
NW12 PERTH BICYCLE NETWORK (PBN) - CONTINUOUS SIGNED ROUTES

BICYCLE LANES OR SEALED SHOULDER EITHER SIDE
GRADIENT ARROW
TRAFFIC LIGHT

LEGEND

No	DATE	AMENDMENT
D	07-11-2023	PROPOSED LAYOUT AMENDED
C	09-10-2023	PROPOSED LAYOUT AMENDED
B	29-11-2022	PROPOSED LAYOUT AMENDED
A	10-05-2019	ISSUED FOR REVIEW

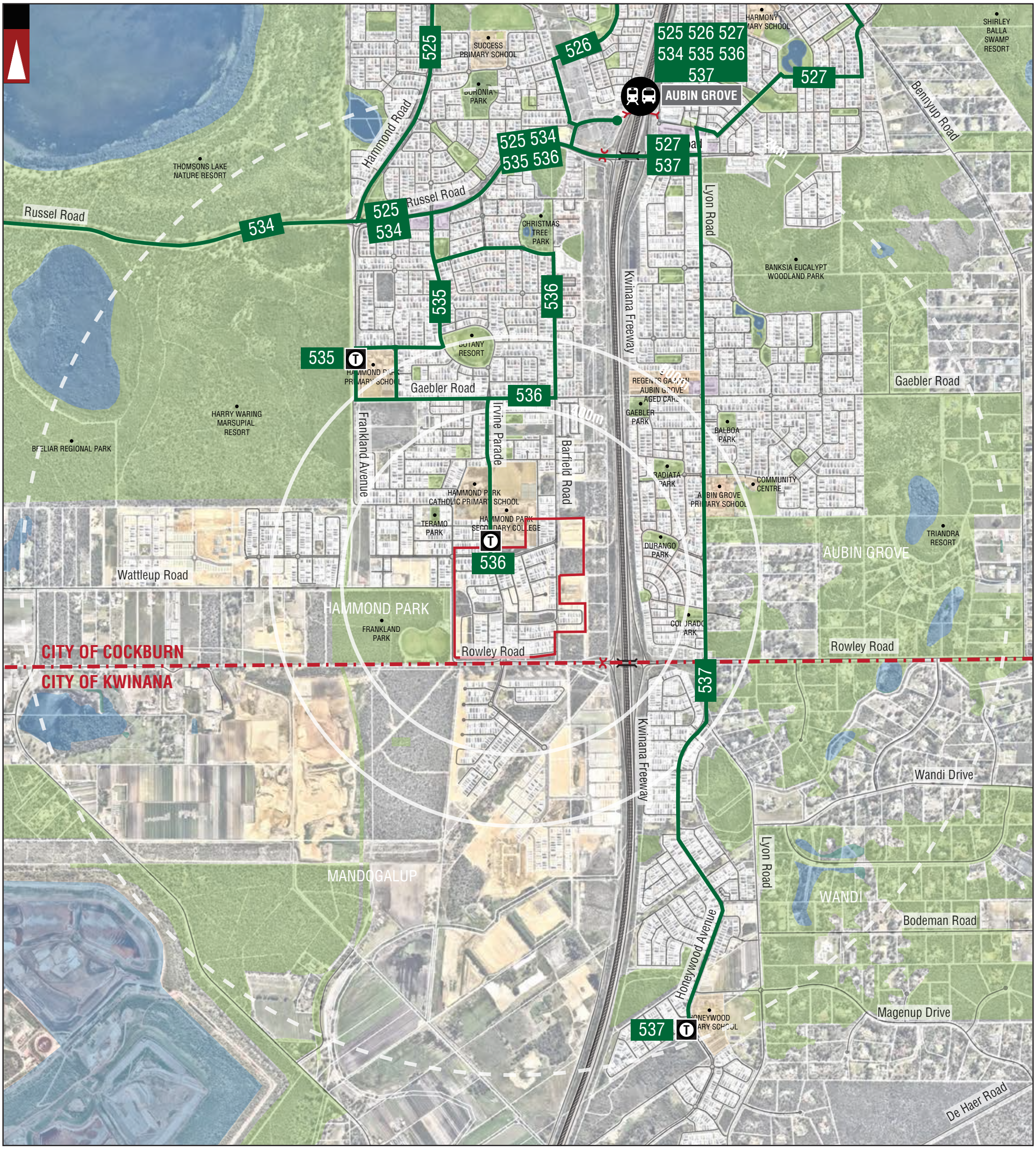
PROJECT: BARFIELD ROAD, HAMMOND PARK

TITLE: BICYCLE NETWORK PLAN - 2KM RADIUS

DRAWING NUMBER: KC00050.000_ S02

DRAWN BY: A.M.

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PARKS AND RECREATION
WATERWAYS
PUBLIC PURPOSE
SHOPPING AREA
ROAD
Hay Street STREET NAME
RAILWAY
ROAD BRIDGE, FOOT BRIDGE UNDERPASS
APPROVED STRUCTURE PLAN BOUNDARY
STRUCTURE PLAN AREA
DISTANCE FROM LOCATION
CITY OF COCKBURN LOCAL GOVERNMENT NAME
LOCAL AUTHORITY BOUNDARY
HAMMOND PARK SUBURB
BUS ROUTES
103 BUS ROUTE NUMBER
TRAIN AND BUS TRANSFER
BUS TERMINUS

NOTE : FOR MORE INFORMATION REGARDING THE DESCRIPTION OF BUS ROUTES AND THEIR INDICATIVE PEAK AND OFF-PEAK FREQUENCIES REFER TO TIA REPORT

LEGEND

No	DATE	AMENDMENT
D	07-11-2023	PROPOSED LAYOUT AMENDED
C	09-10-2023	PROPOSED LAYOUT AMENDED
B	29-11-2022	PROPOSED LAYOUT AMENDED
A	10-05-2019	ISSUED FOR REVIEW

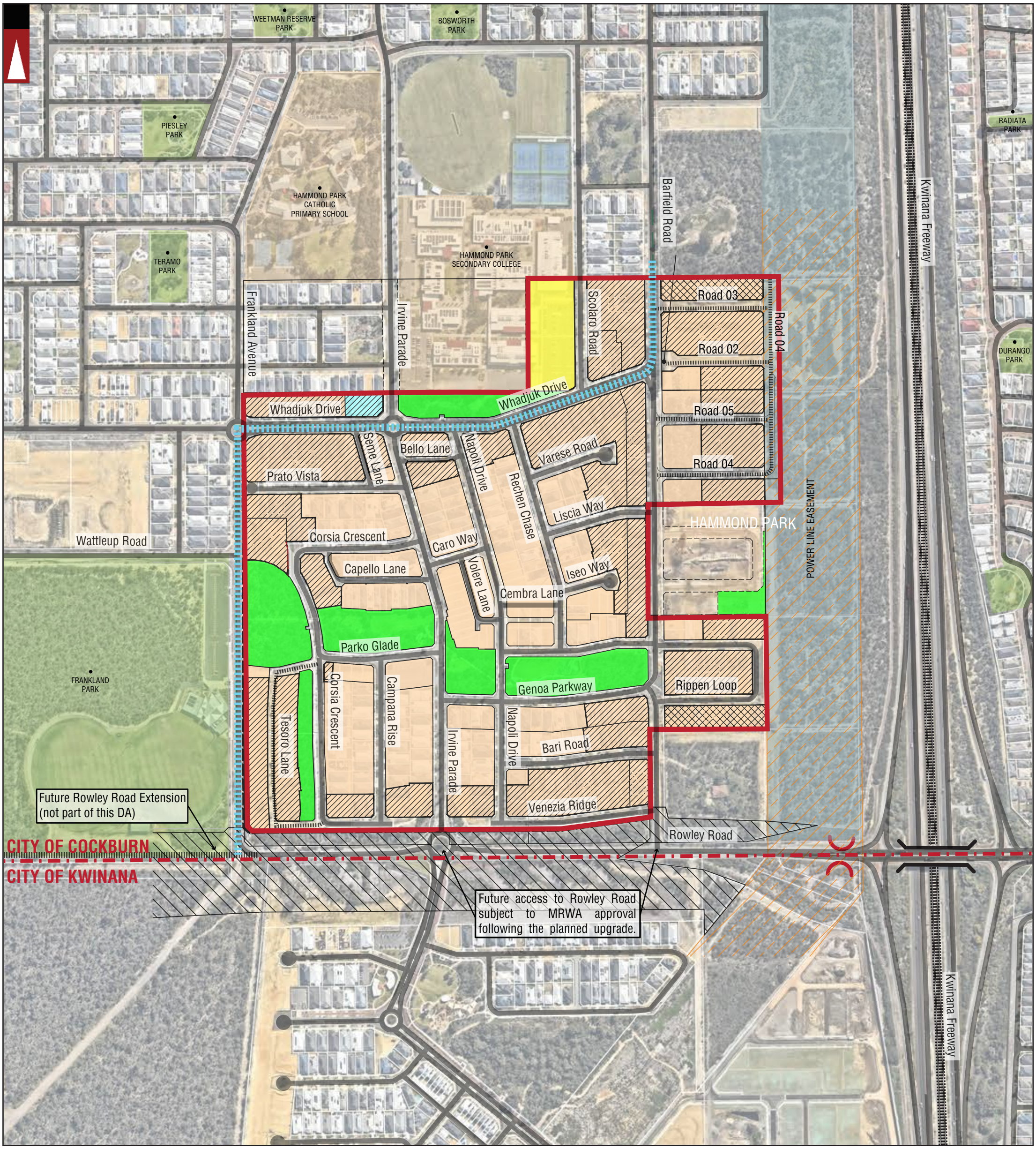
PROJECT: BARFIELD ROAD, HAMMOND PARK

TITLE: PUBLIC TRANSPORT PLAN - 2KM RADIUS

DRAWING NUMBER: KC00050.000_ S03

DRAWN BY: A.M.

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PARKS AND RECREATION
PUBLIC PURPOSE
EXISTING ROAD
PROPOSED ROAD
Hay Street — STREET NAME
RAILWAY
ROAD BRIDGE, UNDERPASS
STRUCTURE PLAN BOUNDARY
CITY OF COCKBURN — LOCAL GOVERNMENT NAME
LOCAL AUTHORITY BOUNDARY
HAMMOND PARK — SUBURB
POTENTIAL BUS ROUTE

LEGEND

No	DATE	AMENDMENT
D	07-11-2023	PROPOSED LAYOUT AMENDED
C	09-10-2023	PROPOSED LAYOUT AMENDED
B	29-11-2022	ISSUED FOR REVIEW
A	16-05-2019	ISSUED FOR REVIEW

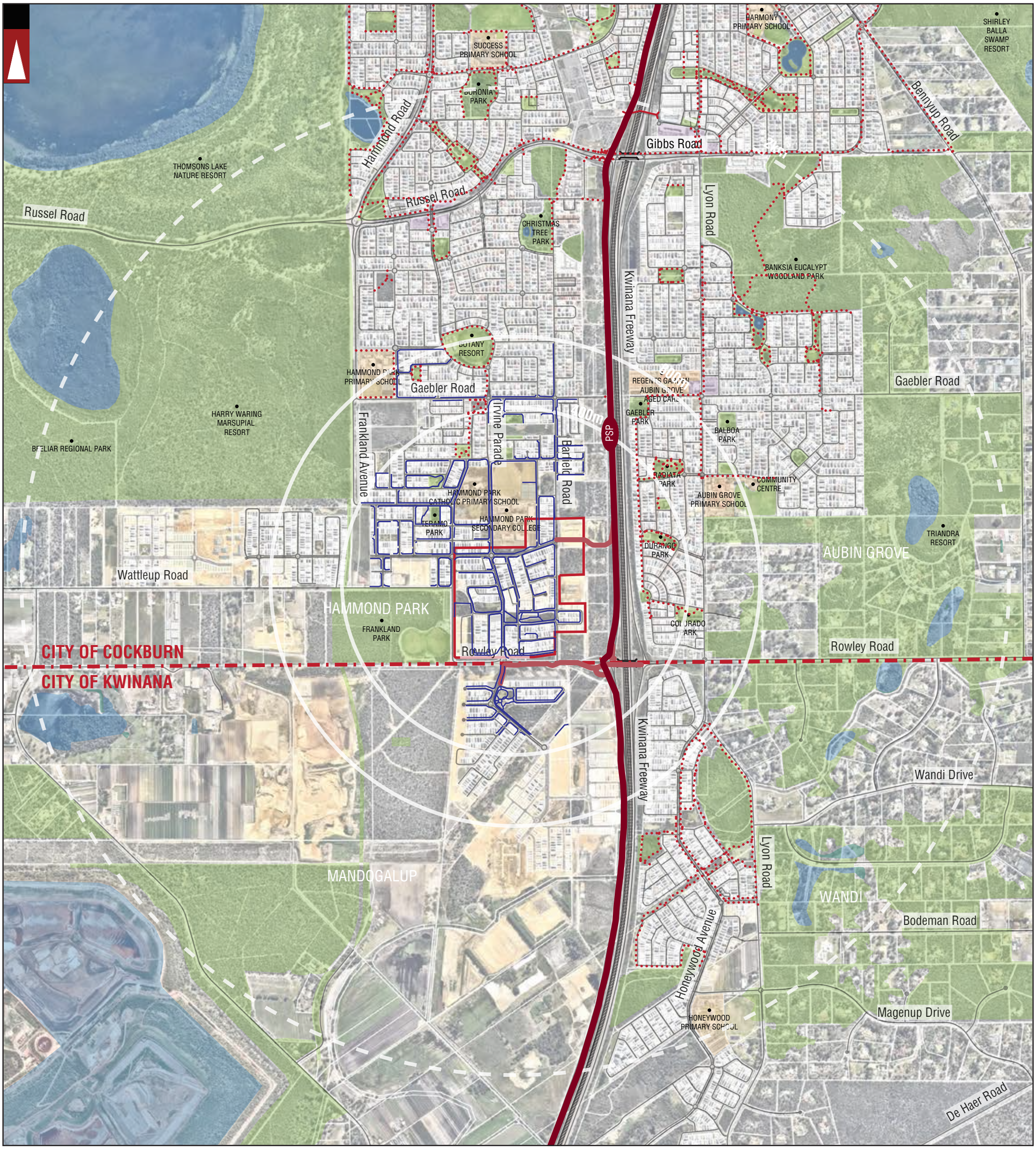
PROJECT: BARFIELD ROAD, HAMMOND PARK

TITLE: PROPOSED BUS ROUTES

DRAWING NUMBER: KC00050.000_ S03a

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PARKS AND RECREATION
WATERWAYS
PUBLIC PURPOSE
SHOPPING AREA

ROAD
Hay Street STREET NAME
RAILWAY
ROAD BRIDGE, FOOT BRIDGE UNDERPASS
APPROVED STRUCTURE PLAN BOUNDARY

STRUCTURE PLAN AREA
DISTANCE FROM LOCATION
CITY OF COCKBURN LOCAL GOVERNMENT NAME
LOCAL AUTHORITY BOUNDARY
HAMMOND PARK SUBURB

PSP PRINCIPAL SHARED PATH
HIGH QUALITY SHARED PATH
OTHER SHARED PATH (SHARED BY PEDESTRIANS & CYCLISTS)
PEDESTRIAN PATH

LEGEND

No	DATE	AMENDMENT
D	07-11-2023	PROPOSED LAYOUT AMENDED
C	09-10-2023	PROPOSED LAYOUT AMENDED
B	29-11-2022	PROPOSED LAYOUT AMENDED
A	10-05-2019	ISSUED FOR REVIEW

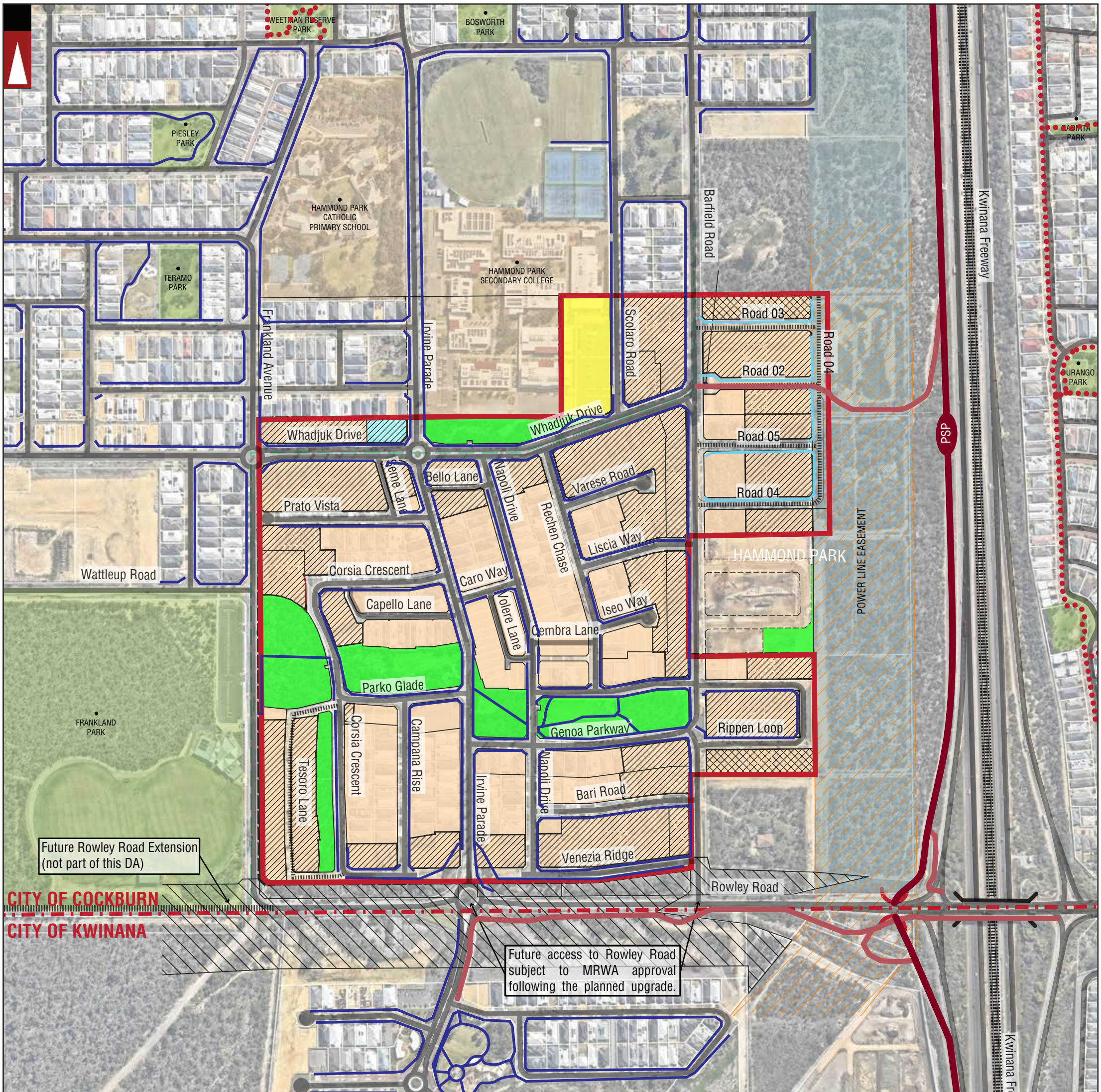
PROJECT: BARFIELD ROAD, HAMMOND PARK

TITLE: PEDESTRIAN PATHS PLAN - 2KM RADIUS

DRAWING NUMBER: KC00050.000_ S04

DRAWN BY: A.M.

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PARKS AND RECREATION
PUBLIC PURPOSE
EXISTING ROAD
PROPOSED ROAD
Hay Street — STREET NAME
RAILWAY

ROAD BRIDGE, UNDERPASS
STRUCTURE PLAN BOUNDARY
CITY OF COCKBURN — LOCAL GOVERNMENT NAME
LOCAL AUTHORITY BOUNDARY
HAMMOND PARK — SUBURB

PSP — PRINCIPAL SHARED PATH
HIGH QUALITY SHARED PATH
OTHER SHARED PATH (SHARED BY PEDESTRIANS & CYCLISTS)
PEDESTRIAN PATH
PROPOSED PEDESTRIAN PATH

LEGEND

No	DATE	AMENDMENT
D	07-11-2023	PROPOSED LAYOUT AMENDED
C	09-10-2023	PROPOSED LAYOUT AMENDED
B	29-11-2022	ISSUED FOR REVIEW
A	16-05-2019	ISSUED FOR REVIEW

PROJECT: BARFIELD ROAD, HAMMOND PARK

TITLE: PROPOSED PEDESTRIAN AND SHARED PATHS PLAN

DRAWING NUMBER: KC00050.000_ S04a

DRAWN BY: A.M.

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PARKS AND RECREATION
WATERWAYS
PUBLIC PURPOSE
SHOPPING AREA
ROAD
Hay Street — STREET NAME
RAILWAY
ROAD BRIDGE, FOOT BRIDGE UNDERPASS
APPROVED STRUCTURE PLAN BOUNDARY
STRUCTURE PLAN AREA
DISTANCE FROM LOCATION
CITY OF COCKBURN — LOCAL GOVERNMENT NAME
LOCAL AUTHORITY BOUNDARY
HAMMOND PARK — SUBURB
5,512 — NUMBER OF VEHICLES PER DAY
AM 1145 – 381 / PM 1630 – 480 — NUMBER OF VEHICLES PER AM PEAK HOUR / NUMBER OF VEHICLES PER PM PEAK HOUR
2014 — YEAR
EAST OF HARLOW ROAD — LOCATION

LEGEND

No	DATE	AMENDMENT
D	07-11-2023	PROPOSED LAYOUT AMENDED
C	09-10-2023	PROPOSED LAYOUT AMENDED
B	29-11-2022	PROPOSED LAYOUT AMENDED
A	10-05-2019	ISSUED FOR REVIEW

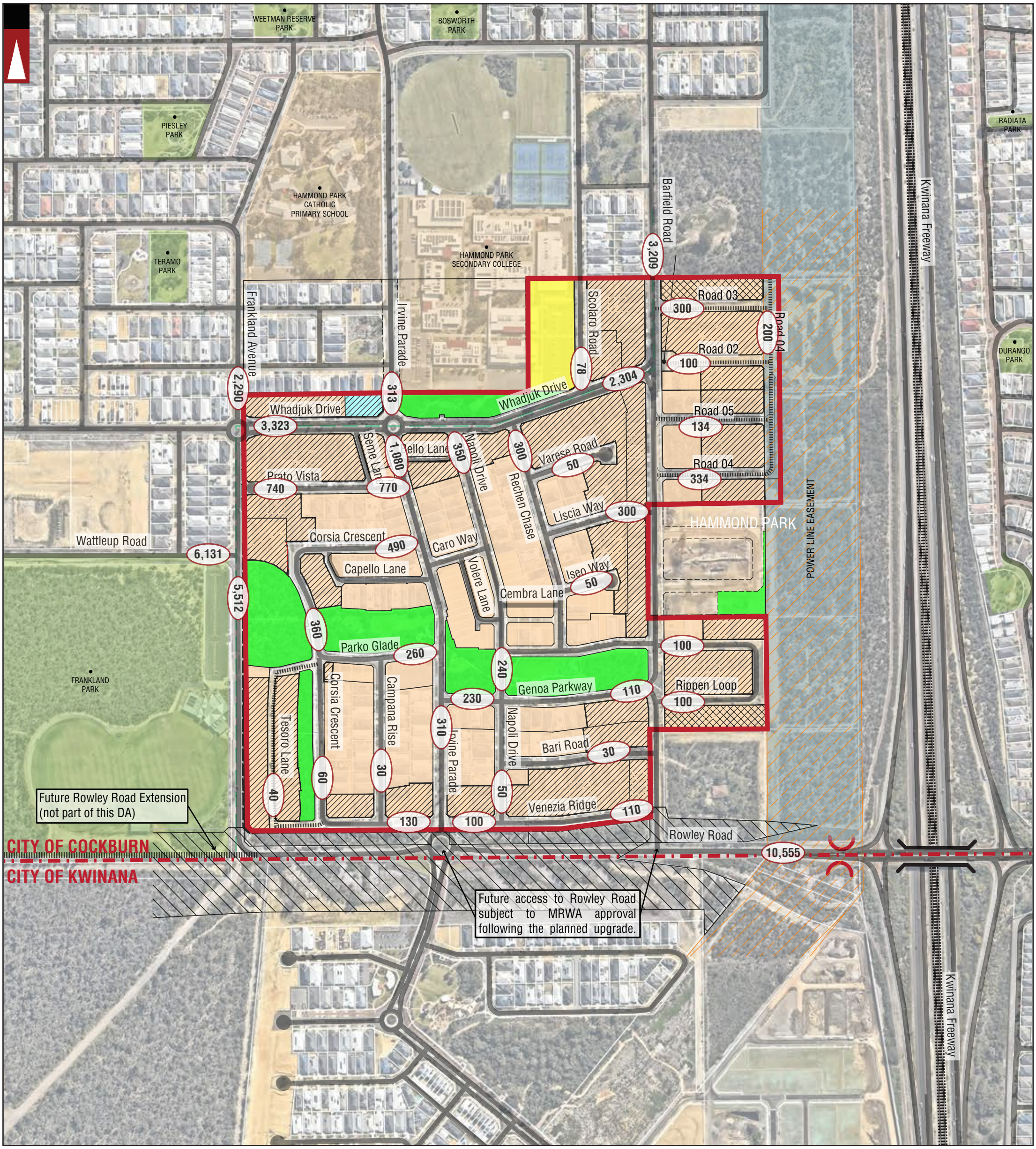
PROJECT: BARFIELD ROAD, HAMMOND PARK

TITLE: EXISTING TRAFFIC COUNTS

DRAWING NUMBER: KC00050.000_ S05

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PARKS AND RECREATION

PUBLIC PURPOSE

EXISTING ROAD

PROPOSED ROAD

Hay Street — STREET NAME

RAILWAY

ROAD BRIDGE, UNDERPASS

STRUCTURE PLAN BOUNDARY

CITY OF COCKBURN — LOCAL GOVERNMENT NAME

LOCAL AUTHORITY BOUNDARY

HAMMOND PARK SUBURB

7,418 — FORECASTED TRAFFIC VOLUMES

LEGEND

No	DATE	AMENDMENT
D	07-11-2023	PROPOSED LAYOUT AMENDED
C	09-10-2023	PROPOSED LAYOUT AMENDED
B	29-11-2022	ISSUED FOR REVIEW
A	16-05-2019	ISSUED FOR REVIEW

PROJECT: BARFIELD ROAD, HAMMOND PARK

TITLE: DAILY TRAFFIC VOLUMES - YEAR 2031

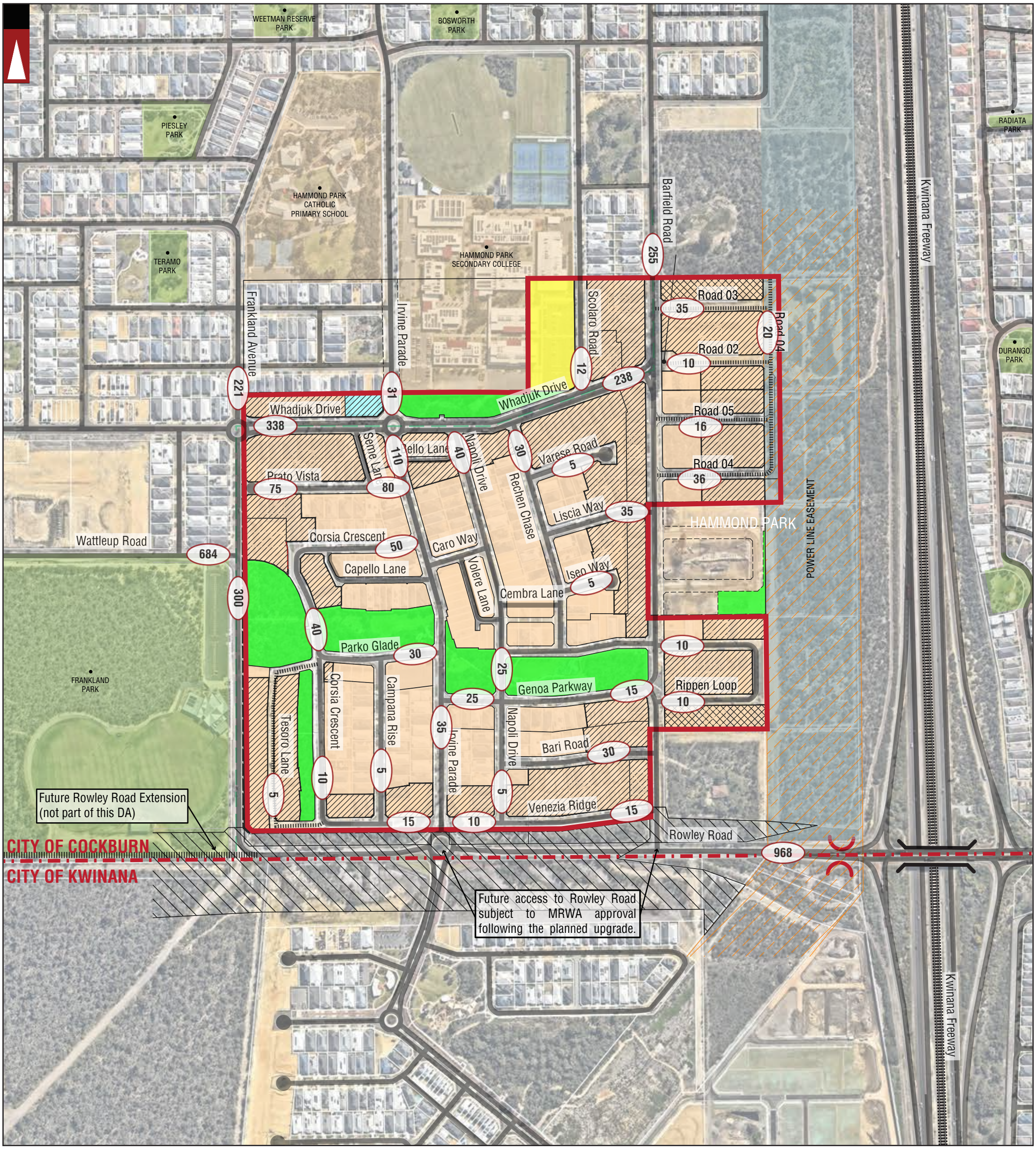
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PARKS AND RECREATION
PUBLIC PURPOSE
EXISTING ROAD
PROPOSED ROAD
Hay Street — STREET NAME
RAILWAY

ROAD BRIDGE, UNDERPASS
STRUCTURE PLAN BOUNDARY
CITY OF COCKBURN — LOCAL GOVERNMENT NAME
LOCAL AUTHORITY BOUNDARY
HAMMOND PARK SUBURB

7,418 — FORECASTED TRAFFIC VOLUMES - PEAK

LEGEND

No	DATE	AMENDMENT
D	07-11-2023	PROPOSED LAYOUT AMENDED
C	09-10-2023	PROPOSED LAYOUT AMENDED
B	29-11-2022	ISSUED FOR REVIEW
A	16-05-2019	ISSUED FOR REVIEW

PROJECT: BARFIELD ROAD, HAMMOND PARK

TITLE: PEAK TRAFFIC VOLUMES - YEAR 2031

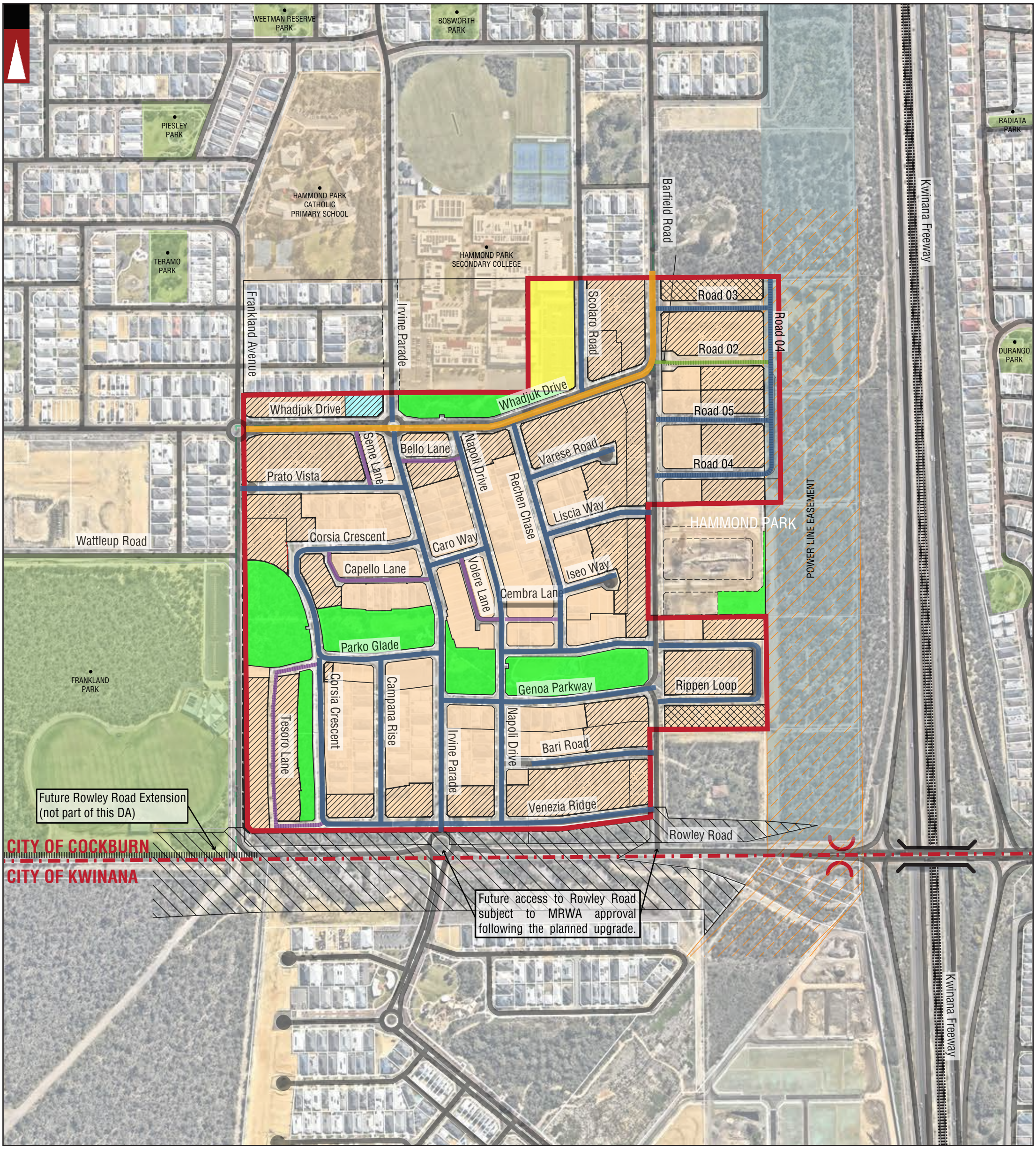
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PARKS AND RECREATION
PUBLIC PURPOSE
EXISTING ROAD
PROPOSED ROAD
Hay Street — STREET NAME
RAILWAY

ROAD BRIDGE, UNDERPASS
STRUCTURE PLAN BOUNDARY
CITY OF COCKBURN — LOCAL GOVERNMENT NAME
LOCAL AUTHORITY BOUNDARY
HAMMOND PARK — SUBURB

NEIGHBOURHOOD CONNECTOR "B"
AACCESS STREET "D"
LANEWAY
SAFE ACTIVE STREET

LEGEND

No	DATE	AMENDMENT
D	07-11-2023	PROPOSED LAYOUT AMENDED
C	09-10-2023	PROPOSED LAYOUT AMENDED
B	29-11-2022	ISSUED FOR REVIEW
A	16-05-2019	ISSUED FOR REVIEW

PROJECT: BARFIELD ROAD, HAMMOND PARK

TITLE: ROAD HIERARCHIES PLAN

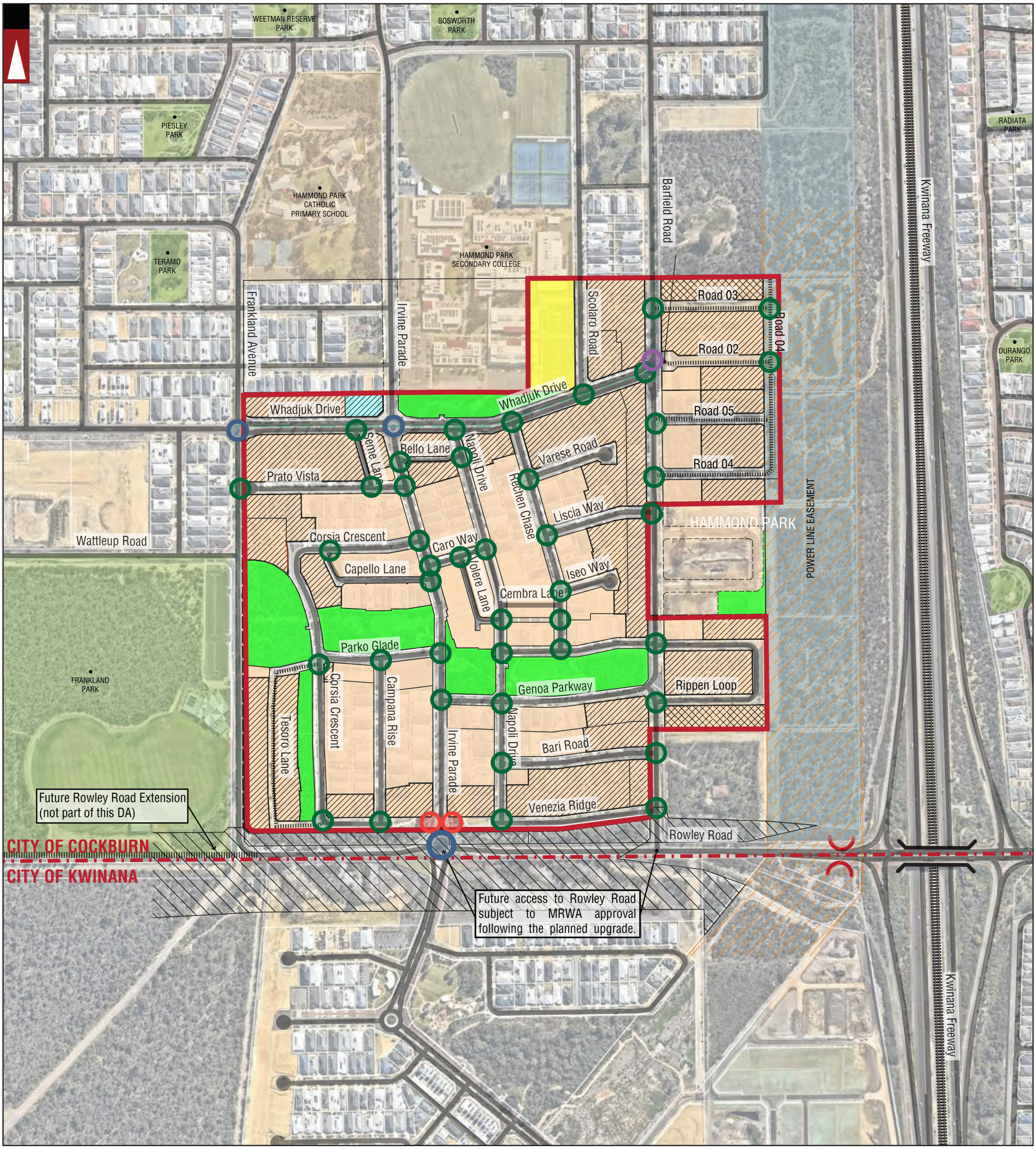
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DRAWN BY: A.M.

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PARKS AND RECREATION
PUBLIC PURPOSE
EXISTING ROAD
PROPOSED ROAD
Hay Street STREET NAME
RAILWAY

ROAD BRIDGE, UNDERPASS
STRUCTURE PLAN BOUNDARY
CITY OF COCKBURN LOCAL GOVERNMENT NAME
LOCAL AUTHORITY BOUNDARY
HAMMOND PARK SUBURB

ROUNDABOUT
SIGN CONTROLLED / YIELD
CYCLING ACCESS ONLY (POSSIBLE LEFT IN ONLY FOR VEHICULAR TRAFFIC)
LEFT-IN/LEFT-OUT (FULL MOVEMENT CAN BE CONSIDERED IF IRVINE PARADE LOSES ACCESS TO ROWLEY ROAD)

LEGEND

No	DATE	AMENDMENT
D	07-11-2023	PROPOSED LAYOUT AMENDED
C	09-10-2023	PROPOSED LAYOUT AMENDED
B	29-11-2022	ISSUED FOR REVIEW
A	16-05-2019	ISSUED FOR REVIEW

PROJECT: BARFIELD ROAD, HAMMOND PARK

TITLE: Proposed Intersection Configurations

DRAWING NUMBER: KC00050.000_ S10

DRAWN BY: A.M.

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Appendix 5 - Noise Management Report

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Transportation Noise Assessment

Lot 16 Barfield Road, Hammond Park

Reference: 22117711-01C

Prepared for:
Gold Estates C/- Richard Noble

Association of Australasian Acoustical Consultants

Reference: 22117711-01C

Lloyd George Acoustics Pty Ltd
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Date	Rev	Description	Author	Verified
15-Dec-22	0	Issued to Client	Terry George	Matt Moyle
18-Jan-23	A	Updated Layout	Terry George	-
1-Nov-23	B	Updated Layout	Terry George	-
23-Jan-24	C	Included text justifying noise mitigation approach.	Terry George	-

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1. INTRODUCTION

It is proposed to subdivide land at Lot 16 Barfield Road, Hammond Park (refer *Figure 1-1*) with the proposed subdivision plan shown in *Figure 1-2*. The site is in the vicinity of Kwinana Freeway, which is considered a 'Strategic Freight/Major Traffic Route in accordance with the PlanWA Maps, such that a noise assessment is required against *State Planning Policy No. 5.4 Road and Rail Noise*, being the subject of this report.

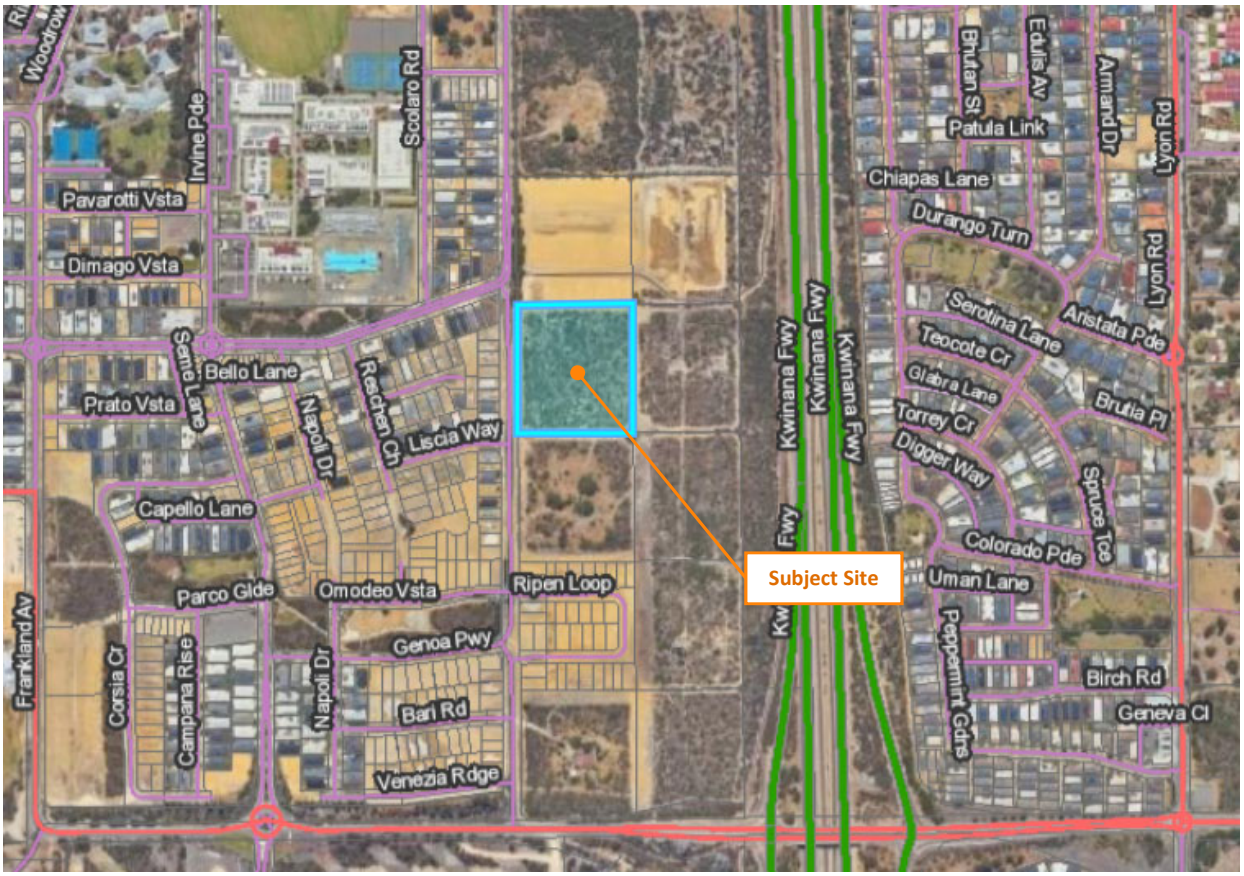


Figure 1-1: Subdivision Location (Source: DPLH PlanWA)

Appendix B contains a description of some of the terminology used throughout this report.

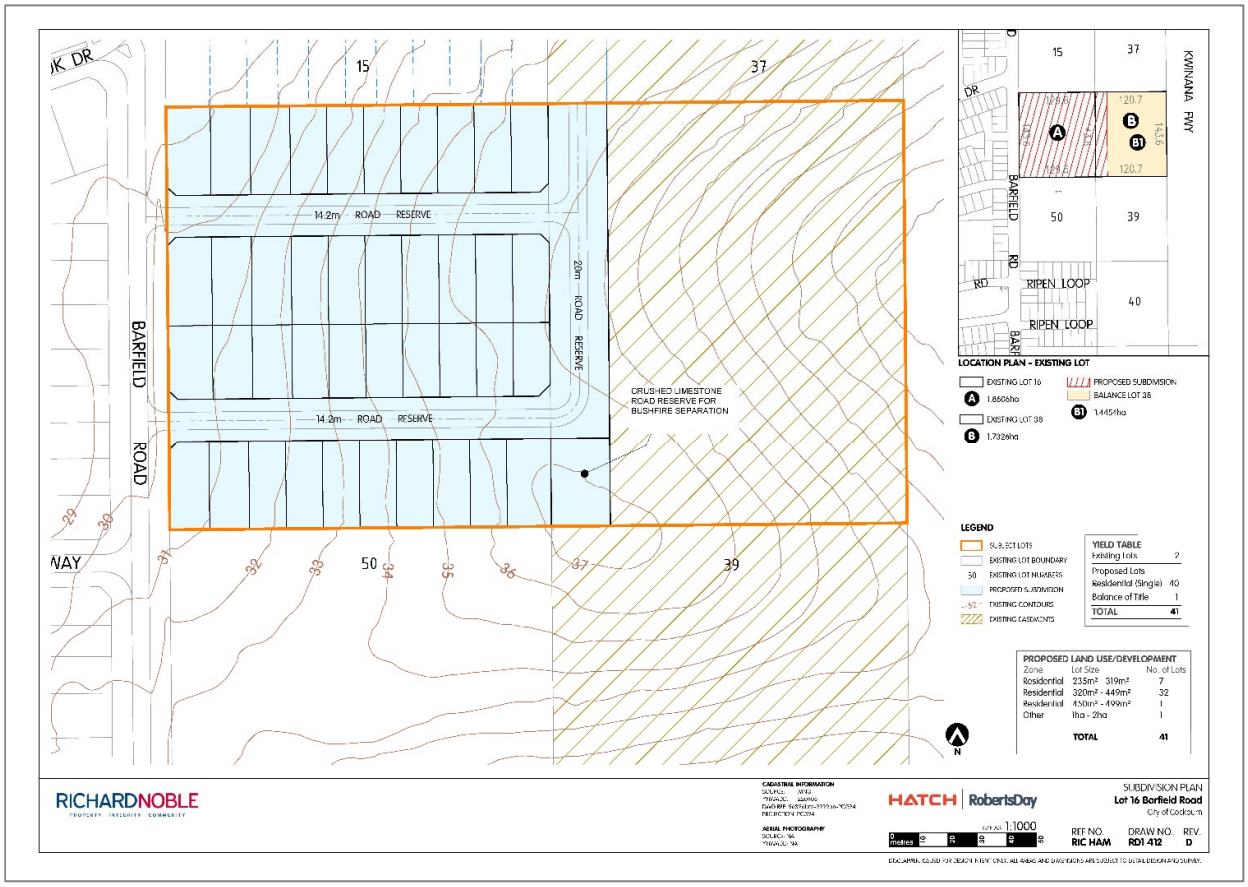


Figure 1-2: Subdivision Layout

2. CRITERIA

The criteria relevant to this project is provided in *State Planning Policy No. 5.4 Road and Rail Noise* (hereafter referred to as SPP 5.4) produced by the Western Australian Planning Commission (WAPC). SPP 5.4 is supported by the *Road and Rail Noise Guidelines* (the Guidelines) and the Department of Planning, Lands and Heritage mapping. The objectives of SPP 5.4 are to:

- Protect the community from unreasonable levels of transport noise;
- Protect strategic and other significant freight transport corridors from incompatible urban encroachment;
- Ensure transport infrastructure and land-use can mutually exist within urban corridors;
- Ensure that noise impacts are addressed as early as possible in the planning process; and
- Encourage best practice noise mitigation design and construction standards.

Table 2-1 sets out noise targets that are to be achieved by proposals under which SPP 5.4 applies. Where the targets are exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.

Table 2-1: Noise Targets for Noise Sensitive Land-Use

Scenario	Outdoor Noise Target		Indoor Noise Target	
Noise-sensitive land-use and/or development	55 dB $L_{Aeq(Day)}$	50 dB $L_{Aeq(Night)}$	40 dB $L_{Aeq(Day)}$ (Living and Work Areas)	35 dB $L_{Aeq(Night)}$ (Bedrooms)

Notes:

- Day period is from 6am to 10pm and night period from 10pm to 6am.
- The outdoor noise target is to be measured at 1-metre from the most exposed, habitable[1] facade of a noise sensitive building.
- For all noise-sensitive land-use and/or development, indoor noise targets for other room usages may be reasonably drawn from Table 1 of Australian Standard/New Zealand Standard AS/NZS 2107:2016 *Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors* (as amended) for each relevant time period.
- Outdoor targets are to be met at all outdoor areas as far as is reasonable and practicable to do so using the various noise mitigation measures outlined in the Guidelines.

The application of SPP 5.4 is to consider anticipated traffic volumes for the next 20 years from when the noise assessment has been undertaken.

[1] *A habitable room is defined in State Planning Policy 3.1 as a room used for normal domestic activities that includes a bedroom, living room, lounge room, music room, sitting room, television room, kitchen, dining room, sewing room, study, playroom, sunroom, gymnasium, fully enclosed swimming pool or patio.*

3. METHODOLOGY

Noise measurements and modelling have been undertaken in accordance with the requirements of SPP 5.4 and associated Guidelines, as described in *Section 3.1* and *Section 3.2*.

3.1. Site Measurements

Noise monitoring was undertaken alongside Kwinana Freeway using an Acoustic Research Laboratories (ARL) Noise Data Logger (S/N: 15-301-468) (refer *Figure 3-1*). The logger was programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. The logger complies with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The logger was field calibrated before and after the measurement session and found to be accurate to within ± 1 dB. Lloyd George Acoustics holds current laboratory calibration certificate for the logger.

The microphone was approximately 1.4 metres above existing ground level and approximately 30 metres from the edge of the northbound Kwinana Freeway main carriageway. The measurements were recorded between 12 October 2021 and 22 October 2021 and are still considered valid for model calibration.



Figure 3-1: Photograph of Noise Logger on Site

3.2. Noise Modelling

The computer program *SoundPLAN 7.3* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Class 1 and 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two source heights at 1.5 metres and 3.6 metres above road level;
- A -0.8 dB correction has been applied to the lower level heavy vehicle noise source and -8.0 dB to the higher level noise source based on the *Transportation Noise Reference Book*; Paul Nelson (1987), so as to provide consistent results with the CoRTN algorithms;
- Adjustments of -0.8 dB and -1.7 dB have been applied to the predicted levels for the 'free-field' and 'at façade' cases respectively, based on the findings of *An Evaluation of the U.K. DoE Traffic Noise Prediction*; Australian Road Research Board, Report 122 ARRB – NAASRA Planning Group (March 1983).

Predictions are made at heights of 1.4 metres above ground floor level, representing single storey houses. The noise is predicted at 1-metre from an assumed building façade, resulting in a + 2.5 dB correction due to reflected noise.

Various input data are included in the modelling and these are discussed in *Section 3.2.1* to *Section 3.2.5*.

3.2.1. Ground Topography and Buildings

Topographical and road design data was on file with regard to previous developments in the area and combined with the expected finished lot levels provided by Richard Noble and shown in *Figure 3-2*.

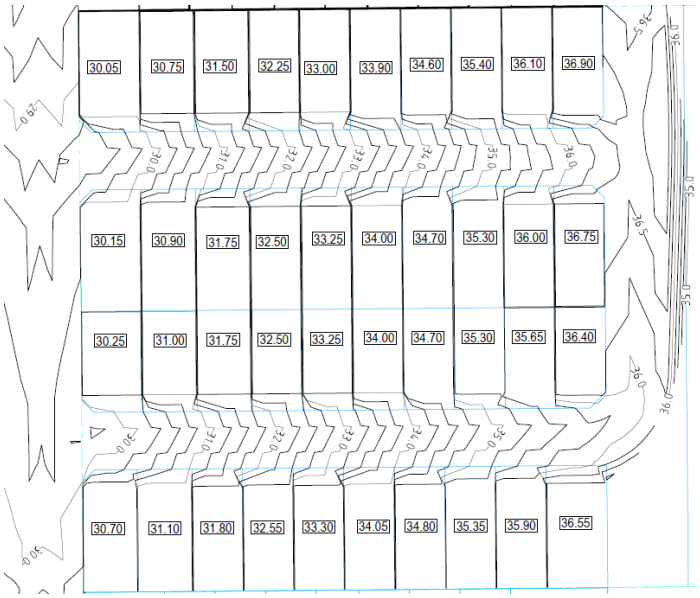


Figure 3-2: Expected Finished Lot Levels

Indicative building outlines have been included as these can provide barrier attenuation when located between a source and a receiver, in much the same way as a hill or wall. All buildings are assumed to be single storey with heights of 3.5 metres.

3.2.2. Road Surface

The corrections applied for different road surface finishes are provided in *Table 3-1*.

Table 3-1: Noise Relationship Between Different Road Surfaces

Chip Seal				Asphalt			
14mm	10mm	5mm	Slurry	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	+1.0 dB	0.0 dB	-0.2 dB	-1.5 dB	-2.5 dB

The existing road surface for Kwinana Freeway is open graded asphalt and assumed to remain unchanged into the future.

3.2.3. Vehicle Speed

The existing posted speed is 100 km/hr for Kwinana Freeway and assumed to remain unchanged into the future.

3.2.4. Traffic Volumes

Existing traffic volumes were obtained from Main Roads WA Traffic Map. A modelled Validation Plot and Forecast 2041 traffic volumes were obtained from Main Roads WA (Thomas Ng, Traffic Modelling Analyst, Reference: #42030). The validation plot allows the forecast volumes to be calibrated with *Table 3-2* providing the traffic volumes used in the noise modelling. Note that the percentage heavy vehicles are assumed to be the same in the future as existing.

Table 3-2: Traffic Information Used in Noise Modelling

Road	Scenario			
	Existing – 2020/21		Future – 2041	
	Northbound	Southbound	Northbound	Southbound
Kwinana Freeway – north of ramps	50,773 (16.0)	49,803 (12.5)	78,300 (11.0)	82,700 (10.0)
Kwinana Freeway – south of ramps	45,428 (13.6)	45,614 (13.1)	72,400 (9.0)	74,100 (9.0)
Ramps – north of Rowley Road	5,345 (36.4)	4,189 (6.0)	5,900 (25.0)	8,600 (20)

Numbers in brackets are percentage heavy vehicles.

3.2.5. Ground Absorption

The ground absorption has been assumed to be 0.0 (0%) for the roads, 0.5 (50%) outside of the roads and 1.0 (100%) for public open spaces, noting that 0.0 represents hard reflective surfaces such as water and 1.0 represents absorptive surfaces such as grass.

4. RESULTS

4.1. Noise Monitoring

The results of the noise monitoring are summarised in *Table 4-1* and shown graphically in *Figure 4-1*.

Table 4-1: Measured Average Noise Levels at Logger

Date	Parameter			
	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
Wednesday, 13 October 2021	72.0	70.5	70.9	69.7
Thursday, 14 October 2021	70.4	68.3	69.1	66.4
Friday, 15 October 2021	70.9	68.7	69.6	65.9
Saturday, 16 October 2021	69.7	66.7	67.8	63.0
Sunday, 17 October 2021	69.0	66.1	67.5	60.5
Monday, 18 October 2021	69.9	67.7	68.6	65.4
Tuesday, 19 October 2021	72.9	70.8	71.4	69.5
Wednesday, 20 October 2021	72.1	69.5	70.3	67.1
Thursday, 21 October 2021	70.6	68.6	69.2	67.3
Average	**70.4**	**68.3**	**69.1**	**66.2**

Shaded cells not used in average due to poor weather or not being a weekday.

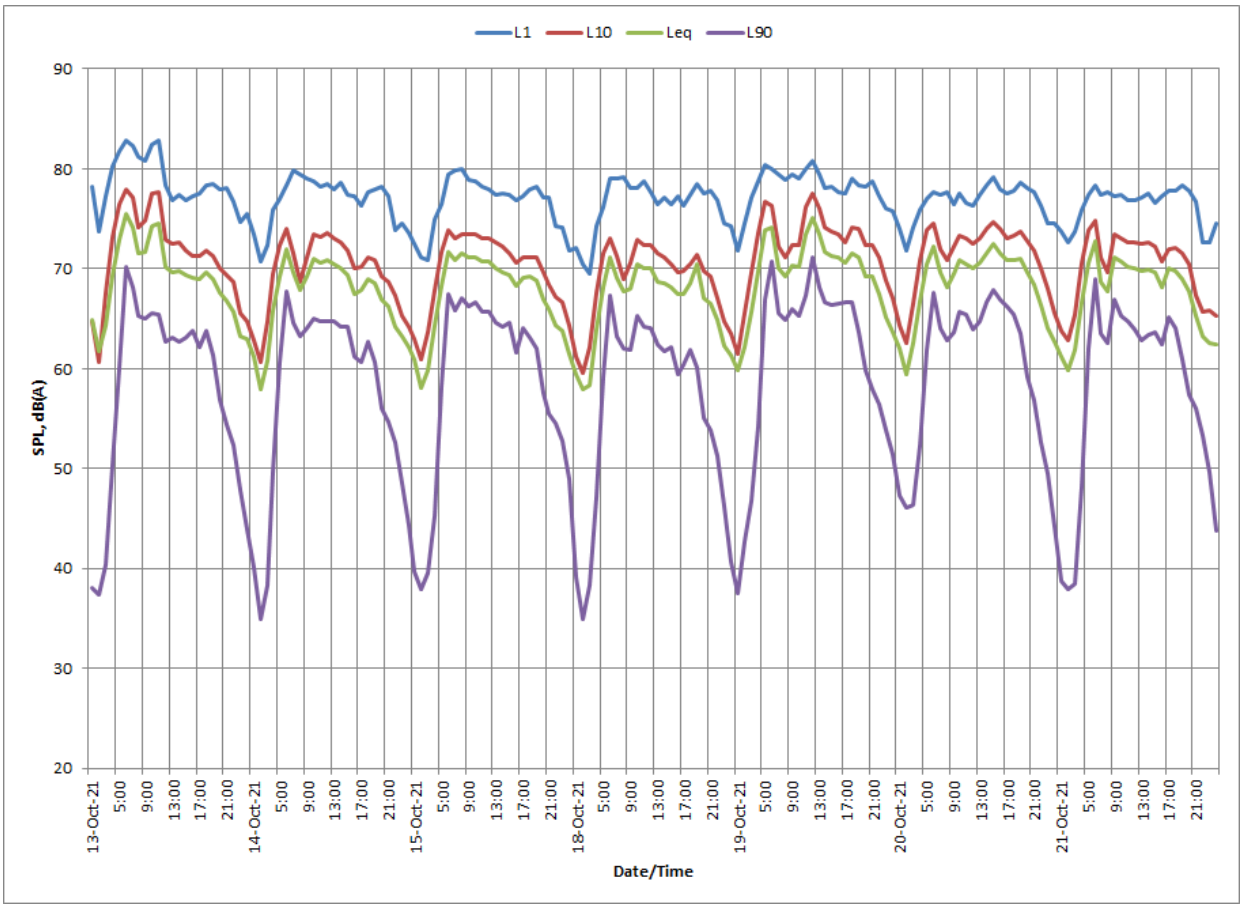


Figure 4-1: Hourly Noise Measurement Results at Noise Logger

The average difference between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 2.9 dB and this same difference has been assumed to exist in future years. As the difference between these two parameters is less than 5 dB, it is the night-time noise that will dictate compliance or otherwise (refer *Section 2*).

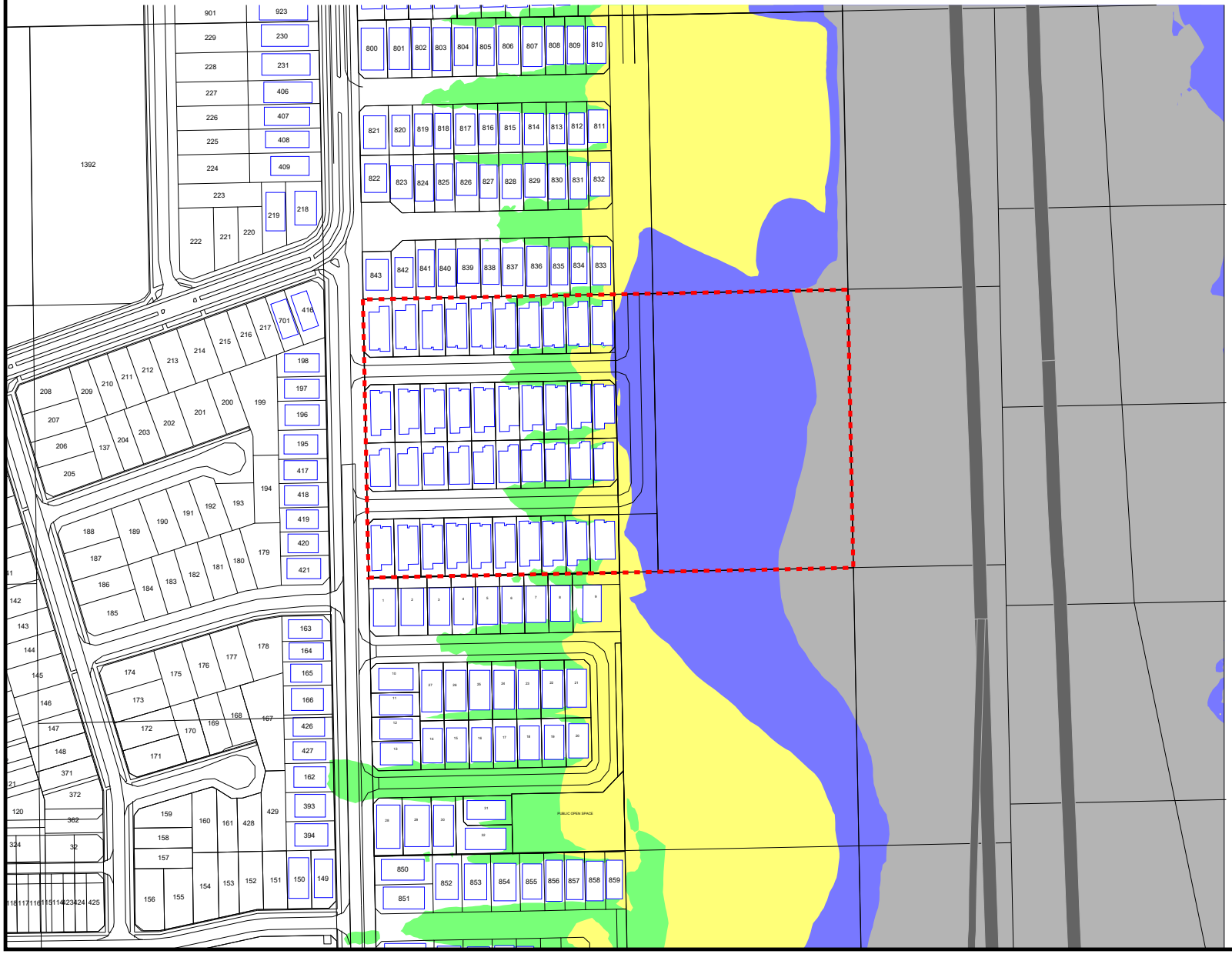
4.2. Noise Modelling

The noise model was initially set-up for existing conditions and calibrated to the noise measurement location. The model is then updated to include the proposed subdivision, indicative buildings and future traffic volumes, maintaining the same model calibration. The results of the noise modelling is provided as a noise contour plot in *Figure 4-2*.

Lot 16 Barfield Road, Hammond Park - Proposed Subdivision

$L_{Aeq(Night)}$ Noise Level Contours - Future

Figure 4-2



Noise levels

$L_{Aeq(Night)}$ dB

<=	50	
<=	51	Exposure A
<=	52	
<=	53	
<=	54	Exposure B
<=	55	
<=	56	
<=	57	
<=	58	Exposure C
<=	59	
<=	60	
<=	61	
>	61	Exposure D+

N

Signs and symbols

- Road Lanes
- Building
- Subject Site

1 November 2023

Length Scale 1:3000

0 15 30 60 90 120 m

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5. ASSESSMENT

The objectives of SPP 5.4 are to achieve:

- Indoor noise levels specified in *Table 2-1* in noise-sensitive areas (e.g. bedrooms and living rooms or houses); and
- A reasonable degree of acoustic amenity for outdoor living areas on each residential lot.

Where the outdoor noise targets of *Table 2-1* are achieved, no further noise controls are necessary. With reference to *Section 4.2*, it is evident the outdoor noise target will be exceeded at some lots.

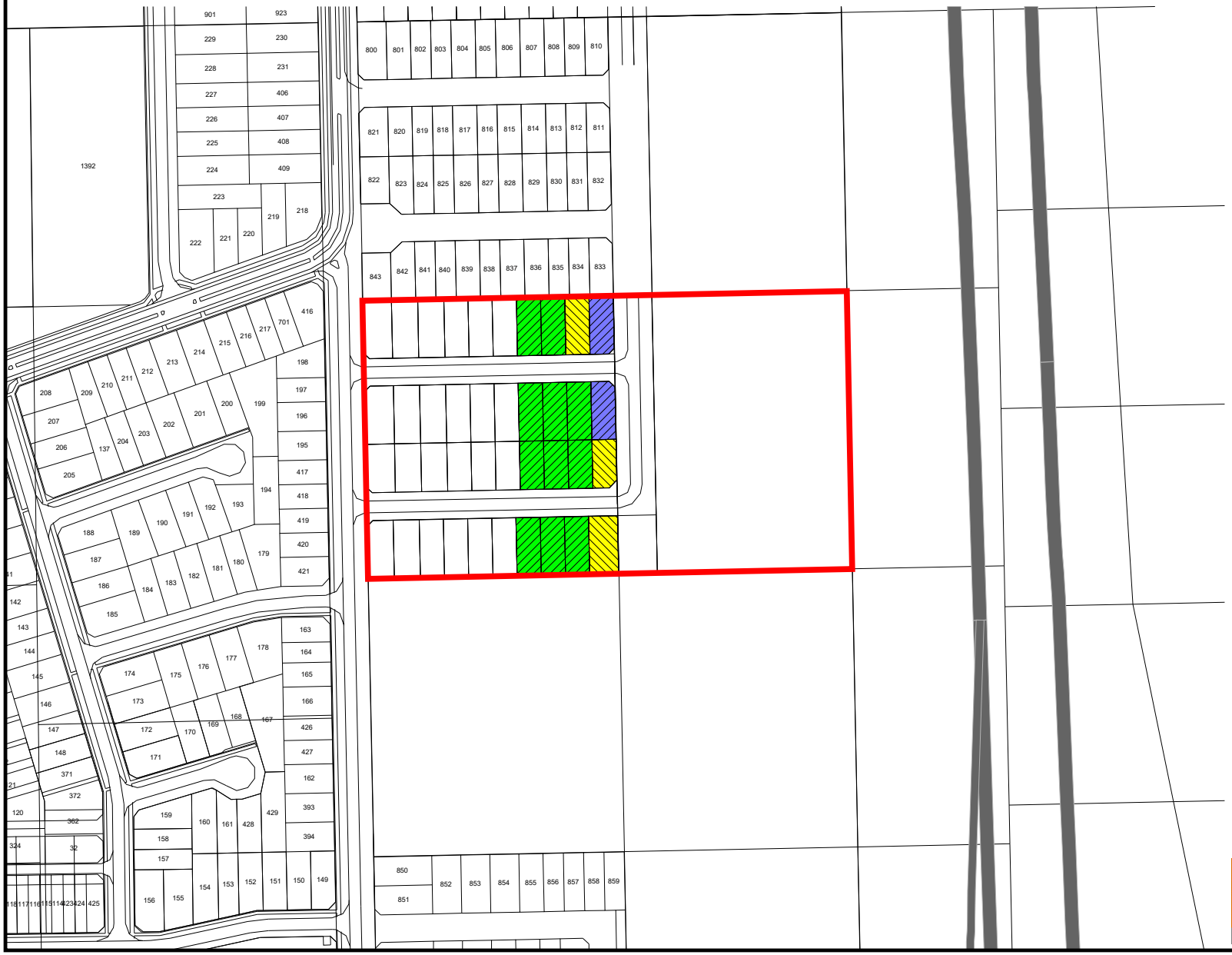
To mitigate noise, noise walls are often used. In this project, such a wall would be located on the east side of the local road. The wall would therefore be separated from the residential lots and become less effective. Furthermore, the lots are elevated compared to the east side of the development, meaning a noise wall 2.4m high on the eastern edge, would not be that high relative to finished lot levels.

As such, the noise control will be via architectural packages (refer *Appendix A*) as shown on *Figure 5-1* being for ground floor. This approach is consistent with subdivisions to the north and south. Alternatives to the provided Packages can be accepted if supported by a report from a suitably qualified acoustical consultant (member firm of the Association of Australasian Acoustical Consultants (AAAC)) once the specific house plans for the lot are available. In addition, each of these lots will require a notification on title in accordance with SPP 5.4. Any lot within the subdivision that is two storey dwelling shall be subject to an individual house assessment when plans are available.

Lot 16 Barfield Road, Hammond Park - Proposed Subdivision

Proposed Noise Mitigation

Figure 5-1



Signs and symbols

- Road Lanes
- Subject Site
- Package A (Kwinana Fwy)
- Package B (Kwinana Fwy)
- Package C (Kwinana Fwy)

1 November 2023

Length Scale 1:3000

0 15 30 60 90 120 m

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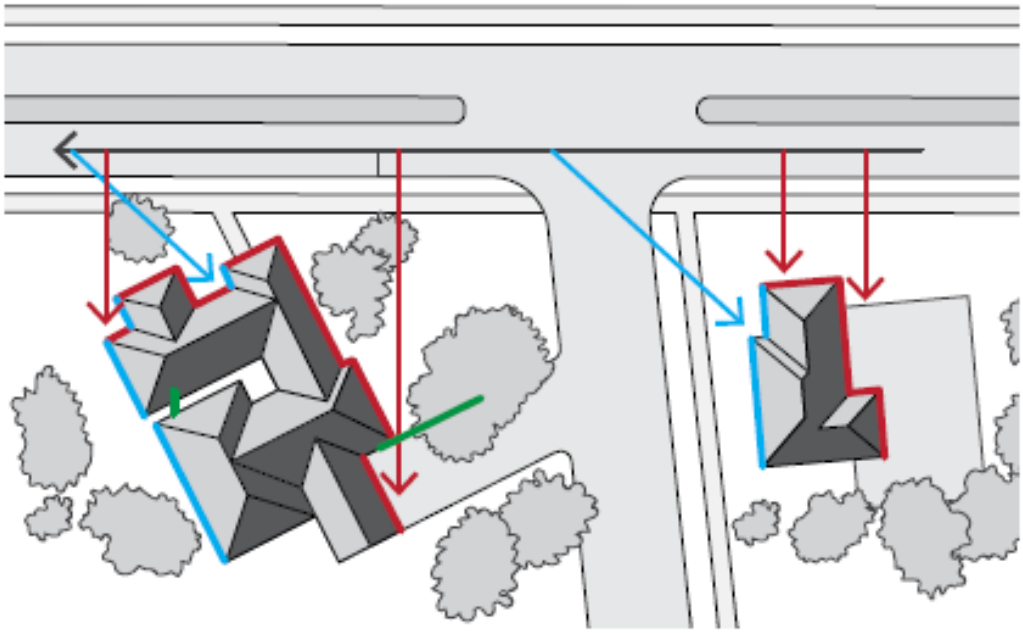
Appendix A – Quiet House Packages

The packages and information provided on the following pages are taken from *Road and Rail Noise Guidelines* (September 2019).

Where outdoor and indoor noise levels received by a noise-sensitive land-use and/or development exceed the policy's noise target, implementation of quiet house requirements is an acceptable solution.

With regards to the packages, the following definitions are provided:

- **Facing** the transport corridor (red): Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular (at a 90 degree angle) to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).
- **Side-on** to transport corridor (blue): Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line, at any angle, can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).
- **Opposite** to transport corridor (green): Neither 'side on' nor 'facing', as defined above.



Quiet House Package A

56-58 dB $L_{Aeq(Day)}$ & 51-53 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): – Sliding or double hung with minimum 10mm single or 6mm-12mm-10mm double insulated glazing; – Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$): – Sealed awning or casement windows with minimum 6mm glass.	• Up to 40% floor area ($R_w + C_{tr} \geq 25$): – Sliding or double hung with minimum 6mm single or 6mm-12mm-6mm double insulated glazing; • Up to 60% floor area ($R_w + C_{tr} \geq 28$); • Up to 80% floor area ($R_w + C_{tr} \geq 31$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	No specific requirements	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.	• Doors to achieve $R_w + C_{tr} \geq 25$: – 35mm Solid timber core hinged door and frame system certified to R_w 28 including seals; – Glazed sliding door with 10mm glass and weather seals.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less.	
	Opposite	No specific requirements	
External Walls	All	• $R_w + C_{tr} \geq 45$: – Two leaves of 90mm thick clay brick masonry with minimum 20mm cavity; or – Single leaf of 150mm brick masonry with 13mm cement render on each face; or – One row of 92mm studs at 600mm centres with: ▪ Resilient steel channels fixed to the outside of the studs; and ▪ 9.5mm hardboard or fibre cement sheeting or 11mm fibre cement weatherboards fixed to the outside; ▪ 75mm thick mineral wool insulation with a density of at least 11kg/m^3; and ▪ 2 x 16mm fire-rated plasterboard to inside.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: • Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2 metres height above ground level.	

Quiet House Package B

59-62 dB $L_{Aeq(Day)}$ & 54-57 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): – Sliding or double hung with 6mm-12mm-10mm double insulated glazing; – Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$); • Up to 80% floor area ($R_w + C_{tr} \geq 34$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass.	• Doors to achieve $R_w + C_{tr} \geq 28$: – 40mm Solid timber core hinged door and frame system certified to R_w 32 including seals; – Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: – Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester (24kg/m³). Resilient ties used where required to connect leaves. – Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). – Single leaf of 220mm brick masonry with 13mm cement render on each face. – 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. – Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m³) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: – Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling with R3.0+ fibrous insulation.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2.4 metres height above ground level.	

Quiet House Package C

63-66 dB $L_{Aeq(Day)}$ & 58-61 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 20% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 40% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Not recommended.	• Doors to achieve $R_w + C_{tr} \geq 30$: – Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass; – 40mm Solid timber core side hinged door, frame and seal system certified to R_w 32 including seals. Any glass inserts to be minimum 6mm.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: – Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). Resilient ties used where required to connect leaves. – Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). – Single leaf of 220mm brick masonry with 13mm cement render on each face. – 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. – Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m³) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 40$: – Concrete or terracotta tile roof with sarking, or metal sheet roof with foil backed R2.0+ fibrous insulation between steel sheeting and roof battens; – R3.0+ insulation batts above ceiling; – 2 x 10mm plasterboard ceiling or 1 x 13mm sound-rated plasterboard affixed using steel furring channel to ceiling rafters.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2.4 metres height above ground level.	

Mechanical Ventilation requirements

In implementing the acceptable treatment packages, the following mechanical ventilation / air-conditioning considerations are required:

- Acoustically rated openings and ductwork to provide a minimum sound reduction performance of R_w 40 dB into sensitive spaces;
- Evaporative systems require attenuated ceiling air vents to allow closed windows;
- Refrigerant based systems need to be designed to achieve National Construction Code fresh air ventilation requirements;
- Openings such as eaves, vents and air inlets must be acoustically treated, closed or relocated to building sides facing away from the corridor where practicable.

Notification

Notifications on title advise prospective purchasers of the potential for noise impacts from major transport corridors and help with managing expectations.

The Notification is to state as follows:

This lot is in the vicinity of a transport corridor and is affected, or may in the future be affected, by road and rail transport noise. Road and rail transport noise levels may rise or fall over time depending on the type and volume of traffic.

Appendix B – Terminology

The following is an explanation of the terminology used throughout this report:

- **Decibel (dB)**

The decibel is the unit that describes the sound pressure levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

- **A-Weighting**

An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A, dB.

- **L_{eq}**

The L_{eq} level represents the average noise energy during a measurement period.

- **L_1**

The L_1 level represents the noise level exceeded for 1 percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

- **L_{10}**

The L_{10} level represents the noise level exceeded for 10 percent of the measurement period and is considered to represent the "intrusive" noise level.

- **L_{90}**

The L_{90} level represents the noise level exceeded for 90 percent of the measurement period and is considered to represent the "background" noise level.

- **$L_{Aeq(Day)}$**

The $L_{Aeq(Day)}$ level is the logarithmic average of the L_{Aeq} levels from 6.00am to 10.00pm.

- **$L_{Aeq(Night)}$**

The $L_{Aeq(Night)}$ level is the logarithmic average of the L_{Aeq} levels from 10.00pm to 6.00am.

- **$L_{A10,18hour}$**

The $L_{A10,18hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00am and midnight.

- **$L_{Aeq,24hour}$**

The $L_{Aeq,24hour}$ level is the logarithmic average of the L_{Aeq} levels from over an entire day.

- **Noise-sensitive land use and/or development**

Land-uses or development occupied or designed for occupation or use for residential purposes (including dwellings, residential buildings or short-stay accommodation), caravan park, camping ground, educational establishment, child care premises, hospital, nursing home, corrective institution or place of worship.

- **R_w**

This is the weighted sound reduction index. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

- **C_{tr}**

This is a spectrum adaptation term for airborne noise and provides a correction to the R_w value to suit source sounds with significant low frequency content such as road traffic or home theatre systems. A wall that provides a relatively high level of low frequency attenuation (i.e. masonry) may have a value in the order of – 4 dB, whilst a wall with relatively poor attenuation at low frequencies (i.e. stud wall) may have a value in the order of -12 dB.

- **About the Term 'Reasonable'**

An assessment of reasonableness should demonstrate that efforts have been made to resolve conflicts without comprising on the need to protect noise-sensitive land-use activities. For example, have reasonable efforts been made to design, relocate or vegetate a proposed noise barrier to address community concerns about the noise barrier height? Whether a noise mitigation measure is reasonable might include consideration of:

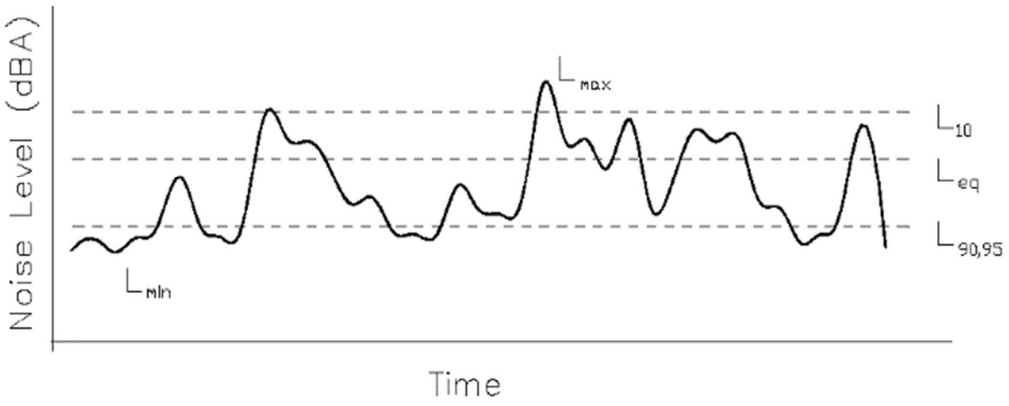
- The noise reduction benefit provided;
- The number of people protected;
- The relative cost vs benefit of mitigation;
- Road conditions (speed and road surface) significantly differ from noise forecast table assumptions;
- Existing and future noise levels, including changes in noise levels;
- Aesthetic amenity and visual impacts;
- Compatibility with other planning policies;
- Differences between metropolitan and regional situations and whether noise modelling requirements reflect the true nature of transport movements;
- Ability and cost for mobilisation and retrieval of noise monitoring equipment in regional areas;
- Differences between Greenfield and infill development;
- Differences between freight routes and public transport routes and urban corridors;
- The impact on the operational capacity of freight routes;
- The benefits arising from the proposed development;
- Existing or planned strategies to mitigate the noise at source.

- **About the Term 'Practicable'**

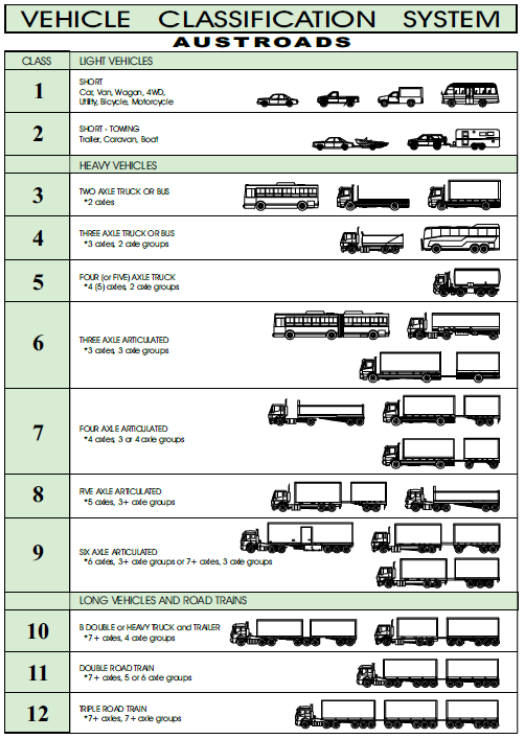
'Practicable' considerations for the purposes of the policy normally relate to the engineering aspects of the noise mitigation measures under evaluation. It is defined as "reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge" (*Environmental Protection Act 1986*). These may include:

- Limitations of the different mitigation measures to reduce transport noise;
- Competing planning policies and strategies;
- Safety issues (such as impact on crash zones or restrictions on road vision);
- Topography and site constraints (such as space limitations);
- Engineering and drainage requirements;
- Access requirements (for driveways, pedestrian access and the like);
- Maintenance requirements;
- Bushfire resistance or BAL ratings;
- Suitability of the building for acoustic treatments.

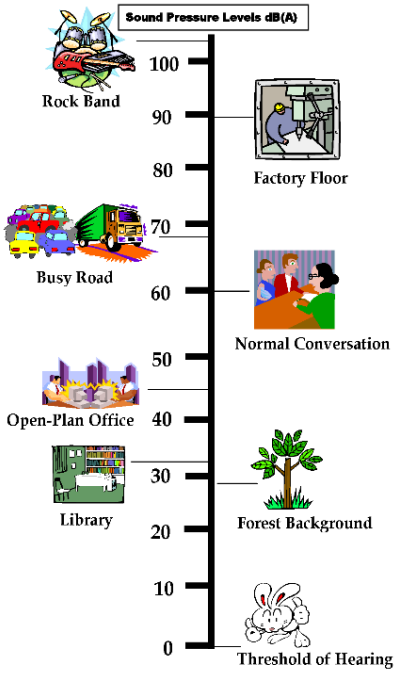
- **Chart of Noise Level Descriptors**



- **Austroads Vehicle Class**



- **Typical Noise Levels**



Appendix 6 - Engineering Servicing Plan

thecivilgroup

GOLD ESTATES HOLDINGS PTY LTD

Lot 16 Barfield Road, Hammond Park

Local Structure Plan - Engineering Report

October 2023

Project Ref Nº: 7893-14

Lot 16 Barfield Road, Hammond Park

Engineering Report

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Summary

Introduction

In this report the availability of existing services and servicing strategies have been considered to demonstrate that Lot 16 Barfield Road, Hammond Park can be subdivided to create residential lots. The Land is zoned urban under the MRS and local town planning schemes.

Land Capability

The previous geotechnical investigations for Vivente, Hammond Park and a review of the Regional Geology Map confirms that the site generally comprises well drained Bassendean sands.

The site is within an area of *"moderate to low risk of acid sulphate soils (ASS) occurring within 3m of natural soil surface"* with an area of *"no known risk of acid sulphate spoils occurring within 3m of natural surface"*.

Based on site geology, the land is capable of being developed into urban residential lots to an 'A' Class classification without importation of sand fill.

Earthworks

Lot 16 will be earthworked by cutting and filling to create level lots. Retaining walls will be constructed between lots.

Stormwater Drainage

Emerge has updated the XPSWMM modelling and concluded that the already constructed Flood Storage Area (FLS's) within the POS on Whadjuk Drive (POS-F) have sufficient storage to accommodate the additional runoff from Lot 16.

Roads

Lot 16 fronts Barfield Road which has been upgraded to urban standards. The internal roads will be connected to Barfield Road by constructing two T intersections.

Water Supply

The development of Lot 16 will be supplied by connecting 100mm water mains to the existing 150mm water main in Barfield Road.

Wastewater

The lots will be serviced by installing 150mm diameter sewers connected to the existing sewer in Barfield Road.

Underground Power

Initially it is anticipated that the development will connect into the existing LV underground cables which extend along the western side of Barfield Road. However, proposed future developments in the area will most likely require a Transformer & Switchgear to accommodate the overall demand depending on volt drop calculations within the existing LV cables.

Gas

ATCO Gas has a medium pressure gas pipe in Barfield Road. The lots will be serviced by extending the gas off the existing main.

Telecommunications

The lots will be serviced by extending the existing NBN network in Barfield Road into Lot 16.

1. General

Gold Estates Holdings Pty Ltd has prepared a Local Structure Plan (LSP) amendment for the inclusion of Lot 16 Barfield Road in the approved Barfield Road LSP.

The Civil Group has investigated the availability of services and has detailed a servicing strategy to support the Local Structure Plan amendment.

2. Concept Plan

The proposed Concept Plan by the Town Planner, Hatch / Roberts Day is shown in Appendix **A**.

Road access to Lot 16 is on Barfield Road, which has recently been upgraded to urban standards by Gold Estates as part of the Vivente development.

The land directly to the north of Lot 16 is owned by Gold Estates. The land to the east of Lot 16 is encumbered by a Western Power easement for overhead transmission lines. The land immediately south is in private ownership and is currently being developed into residential lots by the owner.

3. Site Description

Lot 16 is largely undeveloped and is located west of Barfield Road, immediately south of Lot 15, which is included in the Barfield Road LSP.

The site measures 129.5m x 143.6m and is approximately 1.86 Ha in area. There are no existing dwellings on the land.

The site slopes evenly from RL36m AHD on the eastern boundary to RL30m AHD on the Barfield Road boundary. Lot 16 fronts an existing urban road.

No geotechnical investigations have been reviewed or carried out as part of this preliminary investigation. A review of the Regional Geology Map and previous geotechnical investigations for the surrounding land indicates that Lot 16 is predominantly underlain by well drained Bassendean sands.

A review of the South Metropolitan Region Scheme Acid Sulfate Soils map indicates that the site is in an area of moderate to low risk of actual and potential acid sulfate soils occurring at depths generally greater than 3m from the surface.

It has been assumed that the site is free from any contamination as it is undeveloped.

Groundwater is located well below the natural contours at approximately RL21m AHD.

4. Earthworks Strategy

Site clearing and bulk earthworks will be required over the entire site to create level lots and the road reserves. A preliminary earthworks design has determined that a cut to fill balance can be achieved without importation of fill. The existing natural surface levels on the boundaries of Lot 16 and Lot 50 will be maintained.

Retaining walls will be required to create level lots. Based on the site geotechnical conditions, it is anticipated that A Class lots will be achieved.

5. Stormwater Management

The run-off from Lot 16 will be conveyed in pipes connecting into the existing stormwater network in Barfield Road.

Emerge has updated the XPSWMM modelling and concluded that the already constructed Flood Storage Area (FLS's) within the POS on Wadjuk Drive (POS-F) have sufficient storage to accommodate the additional runoff resulting from the minor amendment to the Vivente LSP. (Refer to the summary of updated flood storage requirements, as shown in Table 1 and Figure 3 of the Emerge report).

6. Roads

Road reserve widths and pavement thicknesses for the proposed subdivision of Lot 16 will be in accordance with the applicable planning and City of Cockburn standards. The internal roads will be connected to the existing Barfield Road by constructing T intersections.

7. Water Supply

A 150mm diameter water main has been installed in the western verge of Barfield Road fronting Lot 16. A 100mm diameter water main, connected to the existing 150mm diameter water main, will be installed for Lot 16 to service the lots.

Lot 16 is included in the Water Corporation's water planning for the area.

8. Wastewater

A 150mm diameter sewer has been installed in the western verge of Barfield Road. Lot 16 development will require the installation of 150mm diameter sewers connecting to the existing sewer in Barfield Road.

There is an existing pressure main (PM) in the eastern verge of Barfield Road. All services crossing the PM will need to be bored.

Lot 16 is included in the Water Corporation's wastewater planning for the area.

10. Electricity, Gas, and Communications

10.1 Electricity Supply

Based on the analysis of DFIS it was noted that the existing Western Power Infrastructure surrounding the site consists of existing underground LV and HV cables on the western side of Barfield Road. In addition to these assets there are also existing 330KV Overhead Transmission lines to the east of the lot.

Western Power's Underground Distribution Scheme (UDS) policy details that all new land developments are provided with an authority point of connection via an underground power service. New subdivisions in metropolitan areas provide single residential lots with a 63 amp single phase connection (ADMD of 4.7kVA per single residential lot & where group housing of more than 4 premises then 4kVA per premises).

The proposed development comprising a maximum of 40 lots will yield an estimated power load of 188 kVA.

Initially it is anticipated that the development will connect into the existing LV underground cables which extend along the western side of Barfield Road. However, current and proposed developments in the area will most likely require a Transformer & Switchgear to accommodate the overall demand depending on volt drop calculations within the existing LV cables.

Interconnection to the northern and southern developments will also occur at construction stage to maintain network reliability.

10.2 Gas Services

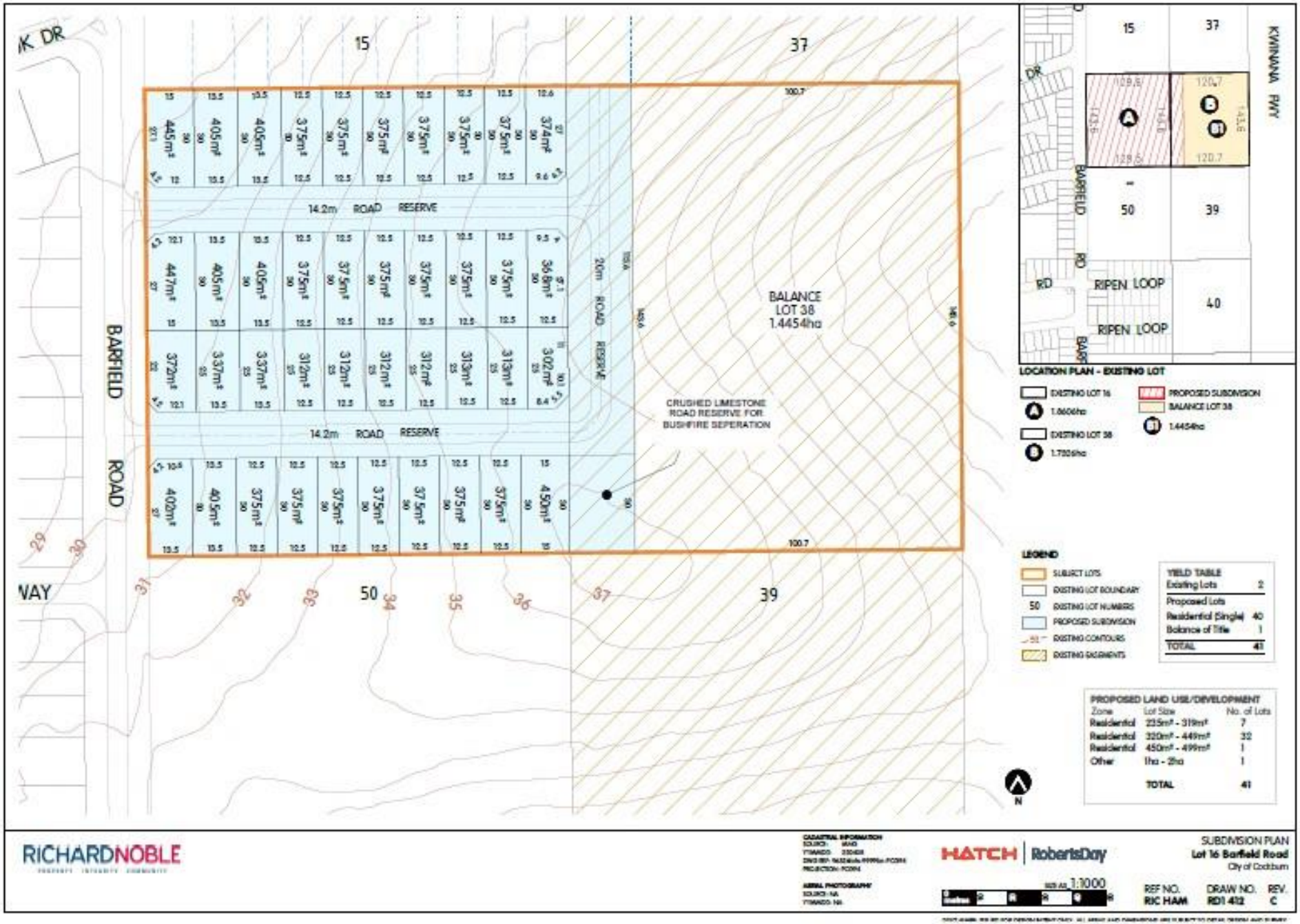
A medium pressure gas pipe has been installed in Barfield Road. This main should have sufficient capacity to provide gas for the development of Lot 16. Low pressure gas mains will be installed in Lot 16, connected to the existing medium pressure main.

10.3 Telecommunications

NBN communication pits and conduits will be provided for the lots and will be connected to the existing NBN infrastructure in Barfield Road.

APPENDIX A

LAYOUT PLAN



RICHARDNOBLE

CADASTRAL INFORMATION
AERIAL PHOTOGRAPHY

HATCH | RobertsDay

SUBDIVISION PLAN
Lot 16 Barfield Road
City of Cockburn

SIZE A3 1:1000

REF NO. RIC HAM
DRAW NO. RD1 402
REV. C

Appendix 7 - Landscape Plans

Trees Lot 16

Sym.	Key	Botanic Name	Common Name	Pot	Qty.
	Agfl	Agonis flexuosa	WA Peppermint	100 Litre	59
	List	Liquidambar styraciflua	Liquidambar 'Jennifer Carroll'	100 Litre	9

Plant Mix Lot 16

Key	Botanic Name	Common Name	Spacing	Pot	Qty.
Adcu	Adenanthos cuneatus	Coral Carpet	3 / m²	14 cm	1718
Ergl	Eremophila glabra	Tar Bush	3 / m²	14 cm	1718
Grob	Grevillea obtusifolia 'Gingin Gem'	Gin Gin Gem	3 / m²	14 cm	1718

LOT 16 EXTENT OF WORKS

LOT 16 EXTENT OF WORKS

LOT 16 EXTENT OF WORKS

3 List

4 List

2 List

Plant Mix Lot 16
69.3 m²@3/m3
Adcux69
Erglx69
Grobx69

Plant Mix Lot 16
237.3 m²@3/m3
Adcux237
Erglx237
Grobx237

Plant Mix Lot 16
149.1 m²@3/m3
Adcux149
Erglx149
Grobx149

Plant Mix Lot 16
112.0 m²@3/m3
Adcux112
Erglx112
Grobx112

2 Agfl

10 Agfl

10 Agfl

Plant Mix Lot 16
199.5 m²@3/m3
Adcux199
Erglx199
Grobx199

4 Agfl

10 Agfl

8 Agfl

Plant Mix Lot 16
953.3 m²@3/m3
Adcux952
Erglx952
Grobx952

10 Agfl

3 Agfl

COMPACTED LIMESTONE FOR BUSH FIRE SEPARATION

843 1847 841 840 839 838 837

416 198 197 196 195 417 418 419 420 421

FENCE LINE

LEGEND

- EXTENT OF WORKS
- PROPOSED PLANTING
- PROPOSED TREES TYPE 1: Agonis flexuosa
- PROPOSED TREES TYPE 2: Liquidambar 'Jennifer Carroll'
- COMPACTED LIMESTONE

STANDARD NOTES

1. **SET OUT & DIMENSIONS.** THE CONTRACTOR SHALL SET OUT ALL PATHS, WALLS, HARD SURFACES AND ELEMENTS EITHER ON OR OFF-SITE PRIOR TO CONSTRUCTION AND SHALL OBTAIN THE SUPERINTENDENTS SET OUT APPROVAL PRIOR TO WORKS COMMENCING. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALE. CHECK ALL DRAWING SCALES IN CONJUNCTION WITH DRAWING SIZE.
2. **SERVICES & SITE ASSETS.** THE CONTRACTOR SHALL INVESTIGATE THE NATURE AND LOCATION OF ALL EXISTING SERVICES AND RETAINED SITE ASSETS AFFECTED BY THEIR WORKS. FAILURE TO TAKE DUE CARE SHALL NOT LIMIT THE CONTRACTORS LIABILITIES
3. **REFERENCE.** THE CONTRACTOR SHALL REFER TO ALL CONTRACT DOCUMENTS, THE SPECIFICATION AND DRAWINGS PRIOR TO AND DURING THE WORKS.
4. **DISCREPANCIES.** NOTIFY SUPERINTENDENT OF ANY SUSPECTED OR KNOWN DISCREPANCIES OR ERRORS PRIOR TO THE ORDERING OF AFFECTED MATERIALS AND OR CONSTRUCTION OF AFFECTED WORKS.
5. **RELEVANT STANDARDS.** THE CONTRACTOR SHALL UNDERTAKE ALL PRICING AND WORKS IN ACCORDANCE WITH CURRENT INDUSTRY BEST PRACTICE AND ALL RELEVANT AUSTRALIAN STANDARDS.
6. **SERVICE LOCATOR.** THE CONTRACTOR SHALL UNDERTAKE A DIAL BEFORE YOU DIG PROCESS PRIOR TO COMMENCING WORKS ON SITE. THE CONTRACTOR SHALL ENGAGE A SERVICE LOCATOR TO MAP THE SPECIFIC LOCATIONS AND DEPTH OF ALL SERVICES AND ADVISE ALL RELEVANT STAFF AND SUBCONTRACTORS IN WRITING PRIOR TO COMMENCING WORKS ON SITE.

REV	DATE	BY	ISSUE OR AMENDMENT
A	05.02.2024	NW	ISSUE FOR COMMENT

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emerge ASSOCIATES
Integrated Science & Design
PERTH (08) 9380 4988 • MARGARET RIVER (08) 9758 8159

PROJECT
VIVENTE

STAGE OR PHASE
LOT 16

DRAWING TITLE
LANDSCAPE PLAN

CLIENT
GOLD ESTATES HOLDINGS

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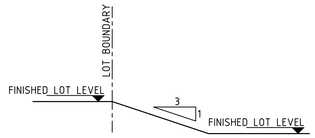
DESIGNED BY .	PRELIM DESIGN REVIEWED BY .
DRAWN BY .	PRELIM DWG REVIEWED BY .
DATE INITIALLY DRAWN .	

SCALE 1: 300 @ A1 METRES
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DRAWING NUMBER ----
REV .

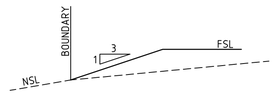
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Appendix 8 - Earthworks Plan



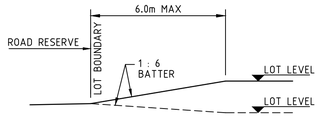
TYPICAL BATTER BETWEEN LOTS

N.T.S.



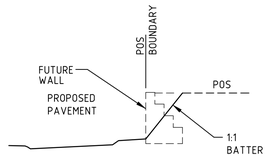
TYPICAL BATTER TO NSL

N.T.S.



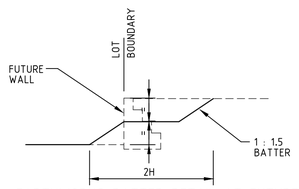
BATTER DETAIL FOR LOTS FRONTING ROAD

N.T.S.



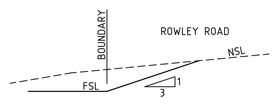
EARTHWORKS BATTER DETAIL
ADJACENT ROAD RESERVES
AT POS LOCATIONS

N.T.S.



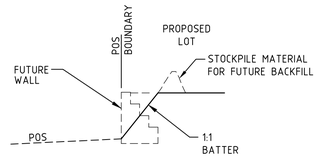
EARTHWORKS BATTER DETAIL AT FUTURE
RETAINING WALL LOCATIONS

N.T.S.



TYPICAL BATTER TO ROWLEY ROAD

N.T.S.

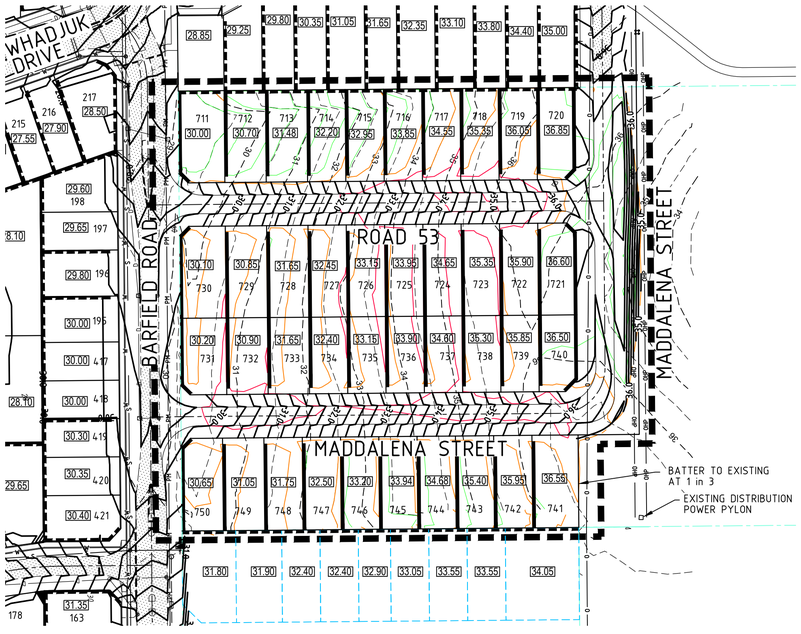


EARTHWORKS BATTER DETAIL
ADJACENT LOT BOUNDARIES
AT POS LOCATIONS

N.T.S.

NOTES:

1. THE CONTRACTOR SHALL LIAISE WITH ALL RELEVANT AUTHORITIES TO LOCATE ANY EXISTING SERVICES WITHIN THE CONTRACT AREA PRIOR TO THE COMMENCEMENT OF WORK.
2. THE CONTRACTOR SHALL DETERMINE ALL LEVELS FROM ESTABLISHED BENCHMARKS AS PROVIDED BY THE PROJECT SURVEYOR. ALL BENCHMARKS ARE TO BE PROTECTED.
3. THE CONTRACTOR SHALL BE BOUND TO THE "GUIDELINES FOR ASSESSMENT AND CONTROL OF DUST AND WINDBORNE MATERIAL FOR LAND DEVELOPED SITES" (INCLUDING APPENDICES 1 & 2) PUBLISHED BY THE D.E.P. – NOVEMBER 1996. SITE CLASSIFICATION AS SPECIFIED AND SHALL APPLY FOR THESE WORKS UNLESS OTHERWISE VARIED BY THE SUPERINTENDENT.
4. ALL EARTHWORKS TO BE RESTRICTED TO THE LIMIT OF CONTRACT BOUNDARY. NO MACHINERY MOVEMENTS TO OCCUR OUTSIDE LIMIT OF CONTRACT BOUNDARY WITHOUT APPROVAL OF THE SUPERINTENDENT
5. THE CONTRACTOR SHALL REFER TO THE SPECIAL REQUIREMENTS SECTION OF THE SPECIFICATION.
6. REFERENCE SHALL BE MADE TO THE RELEVANT CLAUSES OF THE EARTHWORKS SPECIFICATION
7. THE ENTIRE CONTRACT AREA (EXCEPT ROAD PAVEMENTS) SHALL BE STABILISED IN ACCORDANCE WITH THE SPECIFICATION
8. THE CONTRACTOR SHALL TAKE CARE WITH THE USE OF COMPACTION EQUIPMENT WITHIN THE VICINITY OF THE EXISTING RESIDENCES SO AS TO AVOID VIBRATION DAMAGE TO BUILDINGS. COST OF REPAIRS FOR ANY DAMAGE INCURRED WILL BE THE RESPONSIBILTY OF THE CONTRACTOR.
9. SOME EXISTING TREES WITHIN THE CONTRACT BOUNDARY WILL BE FLAGGED AND ARE NOT TO BE DISTURBED. CLEARING IS NOT TO COMMENCE UNTIL THE TREES ARE IDENTIFIED BY THE SUPERINTENDENT
10. CONTRACTOR TO STRIP TOPSOIL AND STOCKPILE ON SITE IN AREAS AGREED TO BY THE SUPERINTENDENT. RESPREAD TOPSOIL OVER NOMINATED EARTHWORKS AREA ON COMPLETION OF EARTHWORKS (EXCLUDING PAVEMENT AREAS).
11. CONTRACTOR TO LIAISE WITH RELEVANT SERVICE AUTHORITIES REGARDING COMPACTION REQUIREMENTS IN THE VICINITY OF EXISTING SERVICES.
12. CONTRACTOR TO ENSURE GRADES ADJACENT TO ROAD FRONTAGE TO BE 1:6 MAX.



LEGEND

- EXISTING SURFACE CONTOUR 0.5m INTERVAL)
- FINISHED SURFACE CONTOUR (1.0m INTERVAL)
- FINISHED SURFACE CONTOUR (0.25m INTERVAL)
- EARTHWORKS BOUNDARY
- FINISHED EARTHWORKED LOT LEVEL
- LOT NUMBER
- EXISTING ROAD PAVEMENT
- PROPOSED NATURE RESERVE AREA IS NOT TO BE ENCROACHED
- PROPOSED RETAINING WALL
- EXISTING RETAINING WALL
- EXISTING TREE TO REMAIN
- EXISTING OPTIC FIBRE
- EXISTING HIGH VOLTAGE POWER
- EXISTING PRESSURE MAIN
- EXISTING TELSTRA
- EXISTING SEWER
- EXISTING WATER
- EXISTING DRAINAGE
- CUT DEPTH CONTOURS TO FINISHED SURFACE (0.25m INTERVAL)
- ZERO DEPTH CONTOUR TO FINISHED SURAFCE
- FILL DEPTH CONTOURS TO FINISHED SURFACE (0.25m INTERVAL)

NO ACCESS OVER EXISTING ROADS IS PERMITTED EXCEPT WHERE AUTHORISED BY THE SUPERINTENDENT.

CONTRACTOR IS TO ALLOW FOR GEOTECHNICAL MONITORING AND CERTIFICATION OF EARTHWORKS TO ACHIEVE CLASS A LOTS.

CONTRACTOR IS TO PICKUP EXISTING SERVICES PRIOR TO COMMENCING CONSTRUCTION. THE SUPERINTENDENT IS TO BE NOTIFIED IF ANY DISCREPANCIES OCCUR.

WARNING! OPTIC FIBRE IN THE VICINITY

WARNING! MAJOR HIGH VOLTAGE POWER IN THE VACINITY

NOTE: ALL EARTHWORKS WITHIN PAVEMENT AREAS TO FINISH AT SUBGRADE LEVEL. REFER TO TYPICAL CROSS SECTIONS FOR PAVEMENT THICKNESS.

NOTE: TOPSOIL TO BE ASSESSED FOR RE-USE BY A GEOTECHNICAL ENGINEER PRIOR TO STRIPPING. FOR STOCKPILE OF TOPSOIL AND MULCH LOCATIONS AS DIRECTED BY THE SUPERINTENDENT.

BEFORE YOU DIG www.byda.com.au

NOTE:
ALL COORDINATES SHOWN ON THIS DRAWING SHALL BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF WORKS. ANY DISCREPANCIES TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

0 10 20 30 40 50m
SCALE 1:1000 AT ORIGINAL SIZE

W.A.P.C. No 200561

REV	REVISION	DATE	APPROVED
A	ISSUED FOR APPROVAL	28.11.24	JSG

CLIENT: GOLD ESTATES HOLDINGS PTY LTD — vivente HAMMOND PARK

DRAWN	J. Barram
DESIGNED	J. Barram
CHECKED	J. Grierson
APPROVED	
DATE	

TITLE: VIVENTE - STAGE 14
BULK EARTHWORKS PLAN

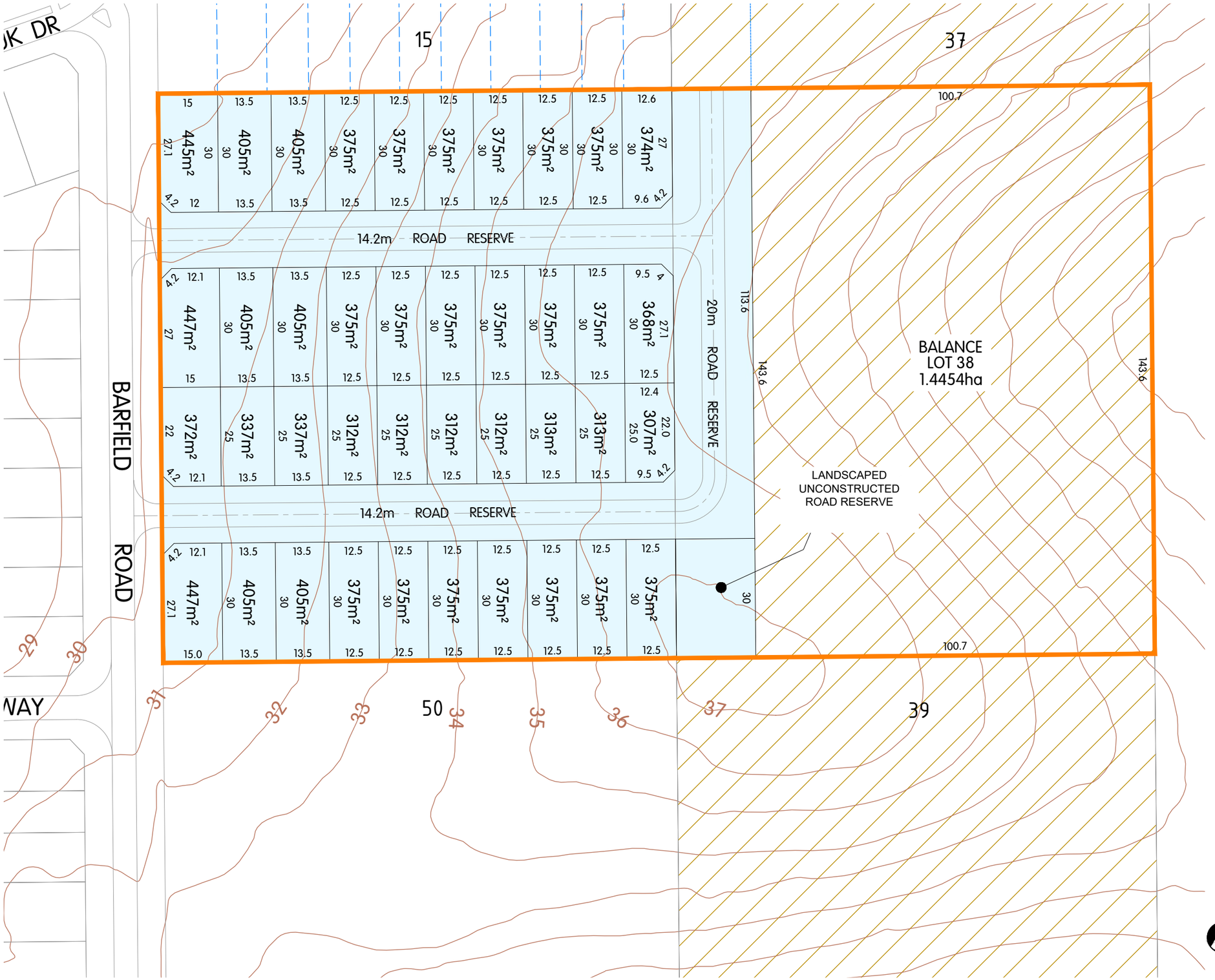
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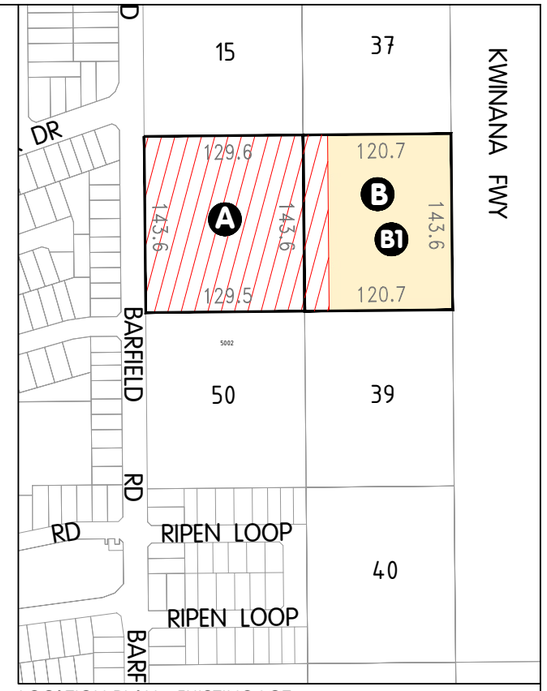
consulting civil engineers
3/224 Rokeby Road
Subiaco WA 6008
phone 9481 4255
fax 9481 3900
info@civilgroup.com.au
www.civilgroup.com.au
thecivilgroup

ORIGINAL SHEET SIZE	A1
SCALE	1:1000 UNO
LEVEL DATUM :	AHD
SHEET	1 OF 1
DRAWING No	7893-14-C101
REV	A
DO NOT SCALE	

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Level 2, 442 Murray Street,
Perth WA 6000, AUSTRALIA
T +61 8 9213 7300
W www.robertsday.com.au
ABN 53 667 373 703 | **ACN** 008 892 135

HATCH





LOCATION PLAN - EXISTING LOT

- EXISTING LOT 16
- A 1.8606ha
- EXISTING LOT 38
- B 1.7326ha
- PROPOSED SUBDIVISION
- BALANCE LOT 38
- B1 1.4454ha

LEGEND

- SUBJECT LOTS
- EXISTING LOT BOUNDARY
- 50 EXISTING LOT NUMBERS
- PROPOSED SUBDIVISION
- 52 EXISTING CONTOURS
- EXISTING EASEMENTS

YIELD TABLE

Existing Lots	2
Proposed Lots	
Residential (Single)	40
Balance of Title	1
TOTAL	**41**

PROPOSED LAND USE/DEVELOPMENT

Zone	Lot Size	No. of Lots
Residential	235m² - 319m²	7
Residential	320m² - 449m²	33
Other	1ha - 2ha	1
	TOTAL	**41**

RICHARDNOBLE
PROPERTY INTEGRITY COMMUNITY

CADASTRAL INFORMATION
SOURCE: MNG
YYMMDD: 220408
DWG REF: 96326lots-9999bn-PCG94
PROJECTION: PCG94

AERIAL PHOTOGRAPHY
SOURCE: NA
YYMMDD: NA

HATCH | RobertsDay

SIZE A3_ 1:1000
0 metres 10 20 30 40 50

SUBDIVISION PLAN
Lot 16 Barfield Road
City of Cockburn

REF NO. **RIC HAM**
DRAW NO. **RD1 412**
REV. **G**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY.