

AMENDMENT NO.2 TO KINGSFORD

BULLSBROOK CENTRAL LOCAL STRUCTURE PLAN

SEPTEMBER 2024



The Amendment to the Kingsford Central Local Structure Plan has been prepared under the provisions of the City of Swan Local Planning Scheme No. 17
The Amendment has been prepared by Hatch on behalf of the landowners Okeland Communities.

Title	Kingsford Local Structure Plan	
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	Aboriginal Heritage	Ethnoscience
	Retail Assessment	Taktiks4
	Bushfire	Strategen
	Hydrology	RPS
	Planning + Urban Design	Hatch RobertsDay

Revision	Comment	Author	Approved by	Date Issued
A	Draft for client review	TT	TT	August 2021
B	Final Version	TT	TT	September 2021
C	Final Version (A)	TT	TT	November 2021
D	WAPC Scheduled Modifications	TT	TT	August 2022
E	WAPC Scheduled Modifications	TT	TT	October 2022
F	WAPC Scheduled Modifications (Amendment No. 2)	TT	TT	September 2024

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Endorsement Page

This Structure Plan is prepared under the provision of the City of Swan Local Planning Scheme No. 17.

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

13 May 2019 Date

Signed for and on behalf of the Western Australian Planning Commission:



an officer of the Commission duly authorised by the Commission pursuant to section 16 of the Planning and Development Act 2005 for that purpose, in the presence of:


_____ Witness

14 May 2019 Date

13 May 2029 Date of Expiry

Table of Amendments

Amendment No.	Summary of the Amendment	Amendment Type	Date Approved by WAPC
1	<ul style="list-style-type: none"> • Extension of the Structure Plan area to include land to the east of the structure plan that had been identified for future indicative development but which now has been rezoned for urban development pursuant to the Metropolitan Region Scheme (MRS); • Contract the approved Bullsbrook Structure Plan area to exclude land that will comprise the Kingsford Town Centre Precinct Structure Plan; • Modify the existing Residential Density Codes indicated over various parts of the Structure Plan area by eliminating an area with an R40 coding and changing a 45ha area from R20-R50 to R20-R40; and • Reconfigure some areas of the proposed Public Open Space. 	Standard	01 November 2022
2	<ul style="list-style-type: none"> • Change the designation on the Cafe site from 'Recreation' to 'General Commercial' zone with restricted uses. Include notation stating the permissible uses within the General Commercial zone are Cafe and Sales office, with all other uses restricted; • Update POS schedule and POS plan 	Standard	08 August 2024

EXECUTIVE SUMMARY

The Kingsford Local Structure Plan (Structure Plan) has been prepared to guide the subdivision and development of Lots 1-6 & 1314 Great Northern Highway, Lots 2, 7-10, 900, 901 & 1396 Chittering Road, Lots 1165, 834, 433 and Part Lot 1343 Hurd Road, and Portion Lots 2792 & 1288 Taylor Road, Bullsbrook, within the City of Swan municipality. Implementation of a Structure Plan over this 207.32ha development site will assist in the delivery of strategic planning objectives set out by the State Government and the City of Swan in relation to housing supply, affordability and delivery of urban development.

The Structure Plan provides an overarching planning framework to guide and facilitate the development of the Structure Plan area for urban purposes, and has been prepared in accordance with the provisions of Part 5A.1 of the City of Swan Local Planning Scheme No.17, Planning and Development (Local Planning Schemes) Regulations 2015 and associated Structure Plan Framework.

The Structure Plan is aligned with the Bullsbrook Townsite District Structure Plan approved by the Western Australian Planning Commission (WAPC) in April 2018, which provides a high-level development framework for the broader locality through the allocation of land uses and service delivery.

The Structure plan provides for a range of residential densities and lot typologies, contributing to the availability of a diverse and affordable housing product within the North East Metropolitan Sub-Region. It also includes an integrated and legible movement network and generous provisions of public open space. It is anticipated that the LSP will accommodate approximately 2,355 lots and 2,355 dwellings, for a community of 6,947 residents.

The Structure Plan also provides the foundations for the development of the Kingsford Town Centre, which will provide a key employment and activity node within the City of Swan.

Development of the Structure Plan will be guided by Concept Plans prepared for each precinct Encourages a diversity of households to live within Kingsford, both in design and affordability.

Kingsford Estate is the first major extension of the Bullsbrook Townsite identified in the 'Bullsbrook Townsite Land Use Management Plan (BLUMP) endorsed in 2014 and associated MRS Amendments gazetted in late 2019.

The Kingsford project has commenced construction and will ultimately comprise over 2,355 homes, a Town Centre, District Open Space, Primary School and the re-alignment of Chittering Road. The project provides a number of critical community infrastructure elements necessary to support the long term growth of the expanded Bullsbrook

Executive Summary Table

ITEM	DATA	STRUCTURE PLAN REFERENCE
Total Kingsford Estate	207.32ha	
Area of each land use proposed (approx.):		
Residential:	108.41ha	
Private Clubs & Institutions (Church):	2.06 ha	
General Commercial	22.06 ha	
Public Open Space:	0.069 ha	
Core Creek Area:	13.20 ha	
1:1yr drainage:	1.9 ha	
Roads (inclusive of 'Primary Regional Roads' Reservation):	59.0 ha	
Total estimated lot yield	2,355 lots	
Estimated number of dwellings	2,355 dwellings	
Estimated residential site density	15 dwellings/gross urban zoned hectare 22 dwellings/site hectare	
Estimated population (based on 2.8 persons per dwelling)	6,947 people	
Number of high schools	0	
Number of primary schools	0	
Estimated number and % of public open space given over to:		
Regional Open Space	0 ha	
Neighbourhood Parks (>3,000m ²):	15 parks @ 22.06ha (12% of total Structure Plan area)	
Local Parks (<3,000m ²):	1 park @ 0.16 ha (~0.1% of total Structure Plan area)	

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Appendix 1	Bushfire Management Plan - Strategen JBS&G
Appendix 2	Acoustic Assessment - Herring Storer
Appendix 3	Local Water Management Strategy - RPS
Appendix 4	Environmental Summary Report - RPS
Appendix 5	Transport Impact Assessment - Transcore
Appendix 6	Landscape Strategy - Emerge
Appendix 7	Engineering Service Report - JDSI

ABBREVIATIONS

AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment Conservation Council
ASS	Acid Sulfate Soils
AS	Australian Standard
BGL	Below Ground Level
BMP	Bushfire Management Plan
BRA	Bio-Retention Areas
BRT	Ellenbrook Bus Rapid Transit
CBD	Central Business District
CCW	Conservation Category Wetland
CoS	City of Swan
DAA	Department of Aboriginal Affairs
DER	Department of Environment Regulation
DPaW	Department of Parks and Wildlife
DoP	Department of Planning
DoW	Department of Water
EPA	Environmental Protection Authority
FSA	Flood Storage Areas
Ha	Hectare
LDP	Local Development Plan
LILO	Left-in /Left-Out Road Intersection
LWMS	Local Water Management Strategy
MGL	Maximum Groundwater Level
MRS	Metropolitan Region Scheme
MRWA	Main Roads Western Australia
NESRF	Draft North-East Sub-Regional Planning Framework
OMSRS	Draft Outer Metropolitan Perth & Peel Sub Regional Structure Plan
POS	Public Open Space
PTA	Public Transport Authority
UWMP	Urban Water Management Plan
VPD	Vehicles per day
WAPC	Western Australian Planning Commission
WSUD	Water Sensitive Urban Design

PART 1

IMPLEMENTATION

1.0 Structure Plan Area

Kingsford Estate covers a total 207.32ha area, and is zoned 'Urban' under the Metropolitan Region Scheme (MRS).

This Local Structure Plan (LSP) applies to the land zoned 'Urban' under the MRS being Lots 1, 2, 3, 4, 5, 6 and 1314 Great Northern Highway, Lots 2, 7, 8, 9, 10, 900, 901 and 1396 Chittering Road, Lots 1165, 834, 433 and Part Lot 1343 Hurd Road, and Portion Lots 2792 & 1288 Taylor Road, Bullsbrook, being the land contained within the inner edge of the line denoting the Structure Plan boundary on the Structure Plan Map (refer Plan 1).

2.0 Operation

This Structure Plan comes into effect on the date on which it is approved by the Western Australian Planning Commission (WAPC) and is valid for a period of 10 years from that date, or another period determined by the WAPC in accordance with the Planning and Development (Local Planning Scheme) Regulations 2015 Schedule 2 – Deemed Provisions.

The Structure Plan is to be given due regard when making decisions on the development and subdivision of land within the Structure Plan area.

3.0 Staging

The development of the Structure Plan area will be implemented in multiple stages. The staging plan is indicative as timing, location and composition of the future stages will be dependent on market demand.

Stage 1, located within the north-western portion of the site, is currently under construction. The commencement of the project from this location has facilitated access to Chittering Road via upgraded roundabout intersecting with Maroubra Avenue and the development of the Display Village, Sales Office and 'first release' residential lots. The staging will now move eastwards to the north-south POS. Development will then progress and southwards with construction commencing for Stage 2 providing vehicle crossing of Ki-It Monger Brook. The staging will then continue south with a view to deliver the Kingsford Town Centre District Activity Centre, with potential to skip land parcels subject to individual landowner intentions.

The provision of engineering infrastructure and primary internal road network will also need to be staged to suit development demand and/or suitable access at an early stage. A detailed programme for this will be prepared as part of ongoing detailed planning and design of service infrastructure.

4.0 Subdivision and Development Requirements

Where land is zoned 'Urban' under the MRS and 'Residential Development' under the City of Swan Local Planning Scheme No. 17 (LPS17), the subdivision and development of land is to be generally in accordance with the Structure Plan (Plan 1).

4.1 Land Use Zones and Reserves

Land Use permissibility within the Structure Plan area shall be in accordance with the Structure Plan Map (Plan 1) and the corresponding Zones and Reserve under the City of Swan LSP17. Where there is a conflict with the Structure Plan and LSP17, the standards of LPS17 shall prevail to the extent of any inconsistency, in accordance with the Planning and Development (Local Planning Scheme) Regulations 2015 Schedule 2 – Deemed Provisions.

In the General Commercial zone (Restricted) a 'Cafe & Sales Office' are permissible land uses, with all other uses restricted.

4.2 Kingsford Town Centre

A Precinct Plan (PP) has been prepared for the Kingsford Town Centre, in accordance with State Planning Policy 4.2 for a 'District Centre' within the centre hierarchy, prior to the subdivision and development of land.

4.3 Hazards and Separation Areas

- a. Residential lots identified as a Bushfire Prone Area in the Bushfire Management Plan (Appendix 1) require a Bushfire Attack Level assessment and BAL Contour Plan to be prepared, in accordance with State Planning Policy 3.7, for an application of subdivision and/or development.
- b. Residential lots identified within the Transportation Noise Assessment (Appendix 2) require a Detailed Noise Assessment (customised noise mitigation measure to be implemented), in accordance with State Planning Policy 5.4, to be prepared and submitted with an application for subdivision and/or development where noise limit is likely to be exceeded.
- c. The landfill site, located in the southwestern portion of the Structure Plan area, is to be remediated prior to the subdivision and/or development of the land. All waste acceptance at the premises ceased in November 2018 and all waste processing was completed by the end of December 2020. Okeland Communities engaged Strategen JBSG / RPS to work with DWER on the licence surrender application /process. This process is ongoing with DWER. THE WAPC in their approval for the Lifting of Urban Deferment over the landfill land were advised applications for subdivision would not be lodged / considered until such time as the DWER Licence surrender process had been finalised.

4.4 Major Infrastructure

At the relevant time of subdivision, or as otherwise agreed, upon the advice of the City of Swan or Main Roads WA the following major infrastructure is to be constructed:

- a. Dual-lane roundabout at the intersection of the approved subdivisional road with Great Northern Highway;
- b. Upgrade of Maroubra Avenue, including intersection treatments, and the cul-de-sac of Chittering Road;
- c. Southern intersection with Great Northern Highway, the location and type of this intersection is subject to detailed design in consultation with affected landowners, Main Road and the City of Swan; and
- d. Suitable traffic management device(s) at the Alto Way/Hurd Road intersection.

4.5 Public Open Space

The provisions of a minimum 10% Public Open Space (POS) is to be provided in accordance with Liveable Neighbourhoods. POS is to be ceded free of cost to the Crown and vested for management to the City of Swan for the purpose of public open space. POS is to be provided generally in accordance with the Structure Plan (Plan 1) and Table 4 – Kingsford POS Schedule in Part Two of this report. An updated POS Schedule to be provided at the time of subdivision for determination by the WAPC, on the advice of the City of Swan.

Subdivision of Lot 2 will be subject to a separate contribute of Public Open Space, to the minimum 10% of the gross subdivisible area.

Ki-It Monger Brook core creek area is to be provided in addition to the 10% POS, and ceded free of cost to the Crown and vested for management to the City of Swan for the purpose of foreshore management and/or conservation.

4.6 Residential Development

4.6.1 Density Target

Residential densities application to the Structure Plan area shall be those densities shown on the Structure Plan Map (Plan 1).

Under Perth and Peel @ 3.5 million ‘Connected City’ scenario new urban areas are to use a minimum average residential target of 15 dwellings per gross hectare of Urban zoned land, and occupancy rate of 2.95 people per dwelling. The Structure Plan area complies, providing approximately 22 dwellings per ha.

Based on Liveable Neighbourhoods ‘Site Hectare’ definition, the Structure Plan ‘developable area’ equate to be developed for residential purposes and excludes non-residential land uses including streets, laneways and POS. Based on 2,355 dwellings, the Structure Plan estimates 22 dwellings per site hectare, this complies with LN target of 22 dwellings per site hectare.

4.6.2 Density Code Plans

The Structure Plan Map (Plan 1) defines the residential density ranges that apply to specific areas within the Structure Plan area.

A Residential Density Code Plan is to be submitted at the time of subdivision to the WAPC and will indicate the residential density code applicable to each lot within the subdivision consistent with the residential density code ranges identified on the Structure Plan (Plan 1) and location criteria contained in Clause 4.7.

Approval of the Density Code Plan is to be undertaken at the time of determination of the subdivision application by the WAPC. The approved Density Code Plan is to then form part of the Structure Plan and shall be used for the determination of future development applications.

Density Code Plans are not required if the WAPC considers that the subdivision is for one or more of the following:

- a. The amalgamation of lots;
- b. The purposes of facilitating the provision of access, services or infrastructure;
- c. Land which by virtue of its zoning or reservation under the Structure Plan cannot be developed for residential purposes; or
- d. Consolidation of land for ‘superlot’ purposes to facilitate land assembly for future development.

4.6.3 Locational Criteria

Residential densities applicable to the Structure Plan area are those residential densities shown on the Structure Plan (Plan 1).

The allocation of residential densities will generally be in accordance with the following location criteria:

DENSITY CODING	LOCATION CRITERIA
R5-R15 Precinct	
R5	The R5 density code applies to Residential zoned lots abutting/opposite land zoned Rural under the MRS and/or lots on the periphery of the LSP.
R10	The R10 density code applies as the base code to all Residential zoned lots, with the exception of those lots coded R5, R12.5 and R15 as set out below and above.
R12.5-R15	The R12.5 or R15 density code applies to Residential zoned lots abutting/opposite public open space.
R10-R30 Precinct	
R10	The R10 density code applies to Residential zoned lots abutting/opposite land zoned Rural under the MRS and/or lots on the periphery of the LSP.
R20	The R20 density code applies as the base code to all Residential zoned lots, with the exception of those lots coded R10 and R30 as set out above and below.
R25-R30	The R30 density code applies to Residential zoned lots where: <ul style="list-style-type: none"> the lot is directly opposite/abutting public open space; or the lot has a laneway abutting the rear boundary; or the lot is located on a street block end.
R20 Precinct	
R20	The R20 density code applies, however lower densities may be provided to achieve bushfire requirements and/or where lots are located on steeply sloping land.
R20-R30 Precinct	
R20	The R20 density code applies as the base code to all Residential zoned lots, with the exception of those lots coded R30 as set out below.
R25-R30	The R30 density code applies to Residential zoned lots where: <ul style="list-style-type: none"> the lot is within 100m of public open space; the lot has a laneway abutting the rear boundary; or the lot is located on a street block end.
R20-R40 Precinct	
R20	The R20 density code applies as the base code to all residential zoned lots, with the exception of those lots coded R30 and R40 as set out below.
R30-R40	The R30 density code applies to Residential zoned lots where: <ul style="list-style-type: none"> the lot is located within a 100m walkable catchment of public open space; or the lot is located within a 200m walkable catchment of a designated public transport route, or the lot has a laneway abutting the rear boundary, or the lot is located on a street block end. <p>The R40 density code applies to Residential zoned lots where the lot is created within a 400m walkable catchment of the town centre.</p>

Note: Lower densities may be acceptable to provide suitable interface/transition to existing development, to retain significant trees, to accommodate steep slopes or to address bushfire requirements

4.6.4 Future Residential Subdivision

Subdivision approval for residential lots will not be supported within 500m of the landfill facility until it has been remediated to the satisfaction of the Department of Water and Environmental Regulation.

5.0 Local Developments Plans

Local Development Plans (LDPs) are to be prepared in accordance with Part 6 of the Planning and Development (Local Planning Schemes) Regulations 2015 Schedule 2 – Deemed Provisions. LDPs may be required as a condition of subdivision approval for lots comprising one or more of the following site attributes:

- a. Lots with an area of 260m² or less;
- b. Irregular shaped lots;
- c. Lots with an interface with, or outlook to POS;
- d. Lots that obtain vehicular access from a laneway or right-of-way;
- e. Lots that propose grouped or multiple dwelling development;
- f. Lots affected by transport noise which exceeds the noise target as defined by the State Planning Policy 5.4 in relation to Great Northern Highway and Chittering Road; and
- g. Lots affected by Bushfire Hazard, as identified by the Bushfire Management Plan (refer Appendix 1).

LDPs will generally be prepared to address one or more of the following:

- a. Building orientation;
- b. Building design and setbacks;
- c. Overlooking and/or privacy;
- d. Vehicle access;
- e. Car parking;
- f. Private open space;
- g. Interface with POS (fencing, frontage, footpath location);
- h. Noise protection provisions (if any);
- i. Bushfire protection provisions (if any);
- j. Laneway treatments; and
- k. Any such information considered relevant by the proponent and/or determining authority to address the requirement of this Structure Plan.

6.0 Residential Design Code Variations

The City of Swan Local Planning Policy POL-LP-11 Variation to Deemed to Comply Requirements of the R-Codes – Medium Density Single House Development Standards (R-MD Codes) sets out acceptable variation to the deemed-to-comply provisions the R-Codes for lots coded R25-R60. Except where an approval Local Development Plan (LDP) varies the ‘Deemed-to-Comply’ provisions of the R-Codes, the standards set out in Local Planning Policy POL-LP-11 shall apply to this Structure Plan.

In the instance where R35 density code applies the lot will be subject to the R30 R-MD Code provisions, R50 code lots will be subject to the R40 R-MD Code provisions.

7.0 Other Requirements

7.1 Notifications on Title

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

- a. Construction standards to achieve higher noise standards in accordance with State Planning Policy 5.4 Road and Rail; Transportation Noise and Freight Considerations in Land Use Planning.
- b. Building setbacks and construction standards to achieve a Bushfire Attack Level -29 or lower in accordance with Australian Standards (AS3959-2009): Construction of buildings in bushfire prone areas.

7.2 Development Contributions

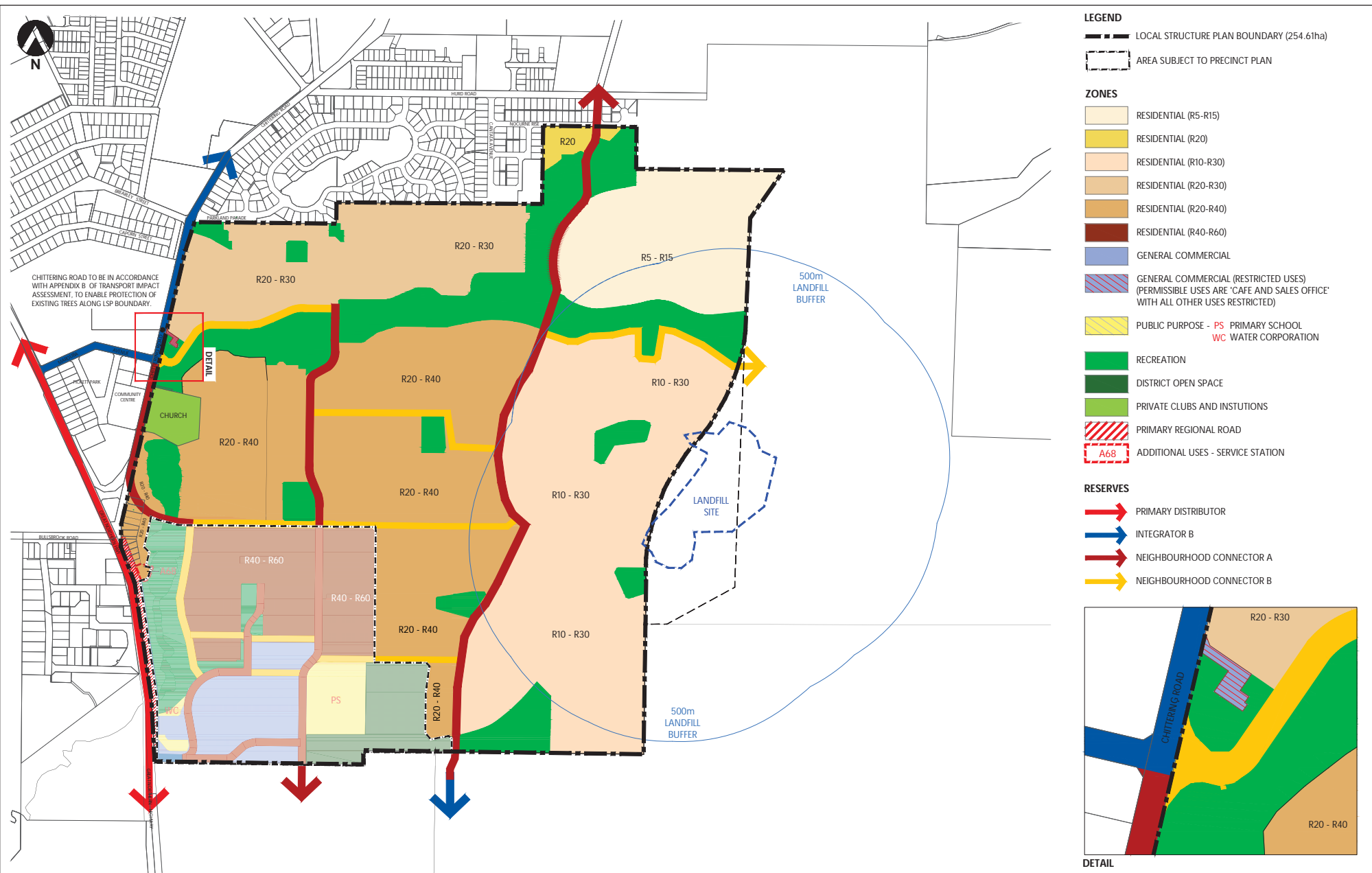
The Structure Plan area will be subject to a Development Contribution Plan (DCP) pursuant to LPS17 and guided by State Planning Policy 3.6 – Development Contributions for Infrastructure. The DCP will generally be guided by documents including, but not limited to, the following:

- a. Local Structure Plans and associated appendices;
- b. City of Swan Transport Strategy; and
- c. Bullsbrook Townsite Land Use Master Plan (BTLUMP).

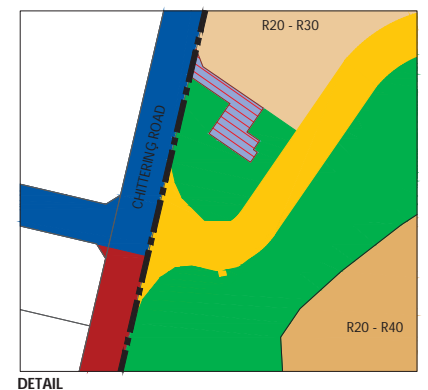
The landowner will be liable to make a contribution toward the costs of providing infrastructure in the DCP at the time and in the circumstances as established through subsequent amendment to the Scheme or other agreed legal arrangement in the interim.

8.0 Additional Information

ADDITIONAL INFORMATION	APPROVAL STAGE	CONSULTATION REQUIRED
Density Code Plan	Subdivision application	WAPC City of Swan
Public Open Space Schedule	Subdivision application	City of Swan
Detailed Noise Management Plan	<ul style="list-style-type: none"> Subdivision application/condition of subdivision for identified lots, or Development application for identified lots. 	City of Swan
Bushfire Attack Level Assessment	<ul style="list-style-type: none"> Subdivision application/condition of subdivision for identified lots, or Development application for identified lots 	City of Swan Department of Fire and Emergency Services
Urban Water Management Plan	<ul style="list-style-type: none"> Condition of subdivision 	City of Swan
Ki-It Monger Brook Foreshore Management Plan	Condition of subdivision for relevant landowner/stage adjacent foreshore	City of Swan
Wetland Management Plan	Condition of subdivision for relevant landowner/stage adjacent mapped wetland	City of Swan Department of Biodiversity, Conservation and Attractions



- LEGEND**
- LOCAL STRUCTURE PLAN BOUNDARY (254.61ha)
 - AREA SUBJECT TO PRECINCT PLAN
- ZONES**
- RESIDENTIAL (R5-R15)
 - RESIDENTIAL (R20)
 - RESIDENTIAL (R10-R30)
 - RESIDENTIAL (R20-R30)
 - RESIDENTIAL (R20-R40)
 - RESIDENTIAL (R40-R60)
 - GENERAL COMMERCIAL
 - GENERAL COMMERCIAL (RESTRICTED USES)
(PERMISSIBLE USES ARE 'CAFE AND SALES OFFICE'
WITH ALL OTHER USES RESTRICTED)
 - PUBLIC PURPOSE - PS PRIMARY SCHOOL
WC WATER CORPORATION
 - RECREATION
 - DISTRICT OPEN SPACE
 - PRIVATE CLUBS AND INSTUTIONS
 - PRIMARY REGIONAL ROAD
 - A68 ADDITIONAL USES - SERVICE STATION
- RESERVES**
- PRIMARY DISTRIBUTOR
 - INTEGRATOR B
 - NEIGHBOURHOOD CONNECTOR A
 - NEIGHBOURHOOD CONNECTOR B



CADASTRAL INFORMATION
 SOURCE: MING
 YMMDD: 220520
 DWG REF: 91797lots-9999bl-PCG94
 PROJECTION: PCG94

1:10,000



Z.3 TEXT MOD TO LEGEND
 Z.2 REVISE GENERAL COMMERCIAL ZONE [CAFE]
 Z.1 ADD GENERAL COMMERCIAL ZONE [CAFE]
 Z ADJUST LANDFILL BUFFER
 Y MODIFY DENSITIES
 X MODIFY DENSITIES
 REV DESCRIPTION

240911 SB TT
 231120 SB TT
 230919 SB KB
 221007 TG TT
 220803 SB TT
 210930 SB TT
 YMMDD DRAWN APPRD

KINGSFORD LOCAL STRUCTURE PLAN
Bullsbrook
 City of Swan

REF NO. **AMX BUL** DRAW NO. **RD1 107** REV. **Z.3**

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

PART 2

EXPLANATORY

1.0 Introduction

1.1 Purpose

The Kingsford Local Structure Plan (Structure Plan) has been prepared by RobertsDay and the project team on behalf of Okeland Communities (the developer). The purpose of the Structure Plan is to guide the orderly and proper subdivision and development of the Structure Plan area for 'urban' purposes, in line with the Bullsbrook Townsite District Structure Plan.

The Structure Plan is prepared in accordance with the requirements of Planning and Development (Local Planning Schemes) Regulations 2015 and the Western Australian Planning Commission (WAPC) Structure plan Framework, with regard to the City of Swan Local Planning Scheme No. 17 (LSP17) – Part 5A.

1.2 Project Vision & Objectives

The project vision and objectives for the Structure Plan will provide the overarching principles that guide the design, planning and place making development efforts. Located in the foothills of the Darling Scarp, views and green links to the Scarp are a key place identifier for the region providing bush backdrop.

Project Vision:

“Immersed in the captivating foothills, Kingsford celebrates the past and embraces the future to create an authentic urban village that is hallmarked by rich characters, a progressive outlook and engaged community”

– Okeland Communities

Project Objectives:

Creating Community Well-Being

- Authentic neighbourhoods and values;
- Healthy living, green walking and cycling links;
- New Town Centre as extension of existing town and community facilities;
- Highly connected green space and street network;
- Engaged community on-show through diverse activities, particularly on main street;

Inspired by Nature

- Ki-It Monger Brook celebrated as the lifeblood of Kingsford;
- Streets and houses oriented to capture breath taking views of the Darling Scarp;
- Natural landform retained for district sense of place and views as far as the City;
- Tree retention within public spaces and streets;

Character Rich

- Ki-It Monger Brook heritage discovery trails celebrating Indigenous and European site history;
- Contemporary, rural village-feel town centre;
- Adventure destination park, showcasing Bullsbrook's aviation history;
- Elevated larger lots and country lifestyle choices;
- Attention to detail and design quality throughout;

Progressive

- Advantages of contemporary urban living within a country setting;
- Environmentally sustainable and economical lifestyle choices;
- Education and health at the heart of the community;
- Design that prioritise walking and cycling;
- Urban places and space for knowledge exchange.

1.3 Land Description

1.3.1 Location

The Structure Plan area is located within the municipality of the City of Swan and in the locality of Bullsbrook, Perth which is approximately 40km north-east of the Perth CBD and 25km north of the Midland Town Centre (refer Figure 1.).

The Bullsbrook locality is well serviced by a number services and communities facilities which will provide immediate benefit to future residents including: Bullsbrook High School (Bullsbrook College), Pickett Park Oval, Bullsbrook Public Library, Ethel Warren Bullsbrook Community Centre, RSL Branch, Bullsbrook Community Kindergarten, Chequers Golf Club, as well as a number of sporting clubs, youth facilities, skate park, BMX track, tennis courts and bridle trail, all within close proximity to the Structure Plan area.

The improvement to the surrounding transport connections, including NorthLink (Perth to Darwin Highway), Great Northern Highway and Stock Road extensions have and will improve the traffic flow and accessibility of the Bullsbrook locality from central Perth.

Key employment areas within the sub-region include the well-established Strategic Metropolitan Centre at Midland (which is accessible by the Perth–Midland passenger rail line), the emerging Ellenbrook secondary centre, industrial centres at Malaga, Forrestfield and Hazelmere and attractors such as the Swan Valley and the Avon Valley. The area is also supported by Bullsbrook South industrial area and Muchea employment node, which provides service-based land uses such as transport, livestock, fabrication, warehousing, wholesaling and general commercial use. The viticulture and tourism related industries in the Swan Valley will continue to grow and contribute to employment provision and economic growth within the sub-region. In addition, the sub-region has established regional links to, employment nodes at Perth Airport, Kewdale and the Morley and Cannington strategic metropolitan centres.

The Royal Australian Air Force base (RAAF) which is west of the Structure Plan area, has played a key economic driver for Bullsbrook since the 1940s with strong community ties. The base is now supported by an industrial park which benefits from the passing trade of Great Eastern Highway. This industrial area is anchored by the Bullsbrook Townsite which provides daily needs such as IGA, bank, pharmacy and service station.

1.3.2 Area and Land Use

The Structure Plan area is generally bound by Chittering Road and Great Northern Highway to the west, private landholdings to the south and east, and existing residential development to the north.

The Structure Plan area encompasses 254.6hacomprising largely cleared land, historically used for agricultural purposes, namely cattle and sheep grazing with limited environmental value. An existing homestead and associated outbuildings are located centrally within the Structure Plan. Remnant vegetation is primarily located along Ki-It Monger Brook, an existing seasonal creek line which traverses east-west centrally through the Structure Plan area.

1.3.3 Legal Description and Ownership

The Structure Plan encompasses the following landholdings:

The Structure Plan area comprises:

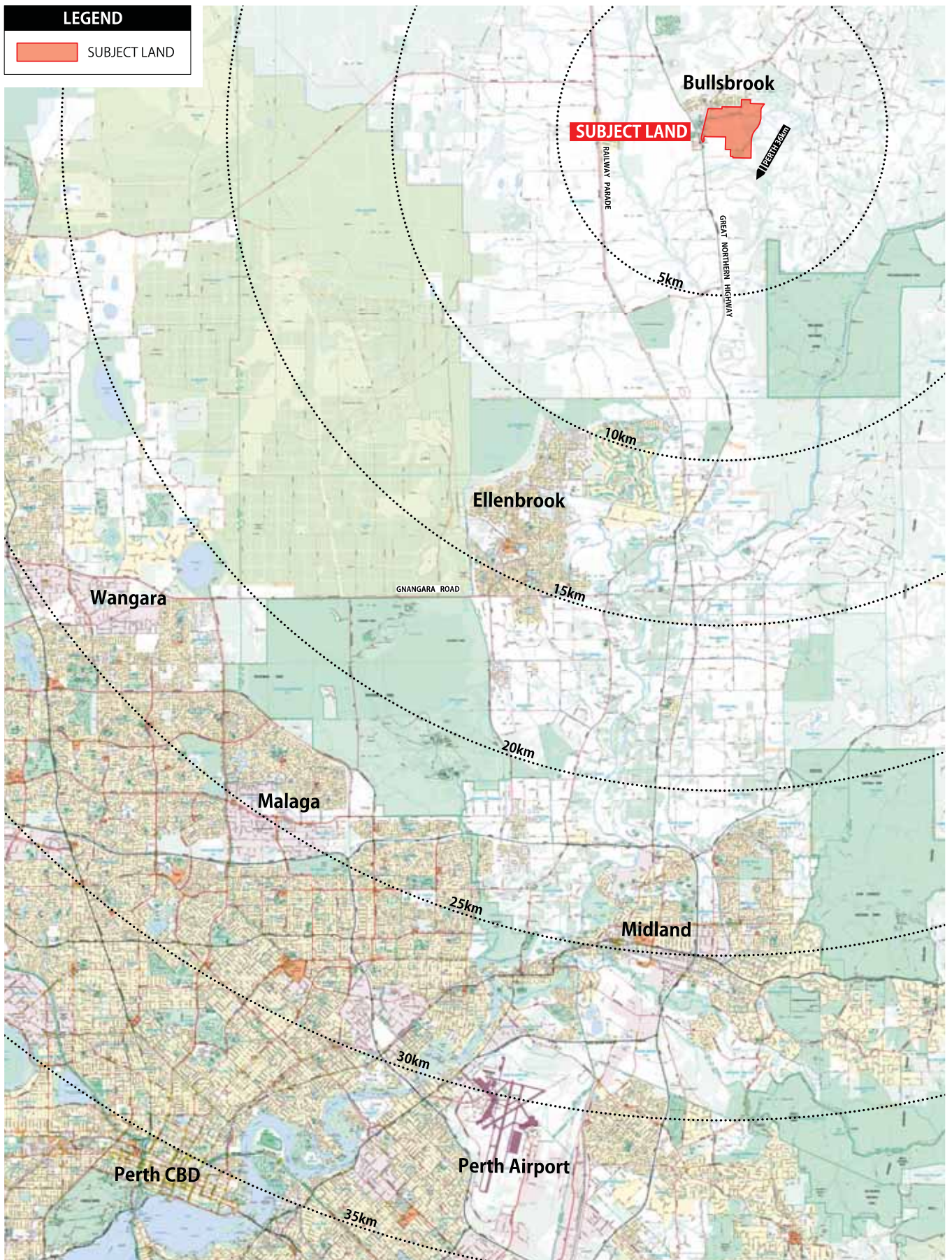
- Lots 1-6 Great Northern Highway
- Lots 2, 7, 8,9, 10, 900, 9007, 1396, 1314 Chittering Road
- Pt Lot 1343 and Lots 834, 433 Hurd Road.
- Pt Lot 2792 Taylor Road

1.4 Project Team

The following multi-disciplinary project team have been engaged to progress the preparation of the Structure Plan:

Discipline	Consultant
Acoustic	Herring Storer
Traffic and Transport	Transcore
Servicing and Infrastructure	JDSi
Surveyors	McMullen Nolan Group (MNG)
Landscape	Emerge Associates
Environmental	RPS
Aboriginal Heritage	Ethnoscience
Retail Assessment	Taktiks4
Bushfire	Strategen JBS&G
Hydrology	RPS
Planning + Urban Design	Hatch RobertsDay

FIGURE 1: Location Plan



2.0 Planning Framework

2.1 Zoning and Reservations

2.1.1 Metropolitan Region Scheme

The current Metropolitan Region Scheme (MRS) zoning and reservations are shown in Figure 2.

Kingsford Estate covers a total 254.6ha area, of which is zoned 'Urban' under the MRS. The Structure Plan area only encompasses land which is zoned 'Urban' under the MRS. The balance of the Kingsford Estate, is zoned a mix of 'Rural' zone (8.8ha) and Primary Regional Road reservation (1.21ha).

An application to amend the MRS to rezone the balance of Kingsford Estate from 'Rural' zone has been lodged and is currently with WAPC. Once the land is zoned 'Urban' under the MRS, an amendment/addendum to the Structure Plan will be required prior to subdivision and development of the land.

The land reserved as 'Primary Regional Roads' under the MRS will facilitate future widening required for Great Northern Highway, which abuts the south-western boundary of the Structure Plan area.

2.1.2 City of Swan Local Planning Scheme No. 17

The current Local Planning Scheme No. 17 (LPS 17) zoning and reservations are shown in Figure 3.

The Structure Plan area is zoned "Residential Development".

An MRS Amendment (1324/41) affecting the southern portion of the Structure Plan was gazetted on 10 December 2019, transferring the land from 'Rural' to 'Urban' zone. To reflect this change, Scheme Amendment No. 186 to LPS17 rezoned the land from "General Rural" to "Residential Development". This Scheme Amendment will ensure all land contained within the Structure Plan area is zoned "Residential Development" under LPS17.

The WA Planning Commission at their meeting on the 25 August 2021 resolved to:

1. transfer portions of Lots 1314, 1396 & 9003 Chittering Road, Lot 433 and portions of Lots 834 & 1343 Hurd Road, and a portion of Lot 2792 Taylor Road, Bul/sbrook as shown on Plan No. 4.1661 from the Urban Deferred zone to the Urban zone pursuant to Clause 27 of the Metropolitan Region Scheme; and
2. amend the City of Swan Local Planning Scheme No. 17, by transferring the Urban zoned land from the General Rural and Landscape zones to the Residential Development zone pursuant to section 126(3) of the Planning and Development Act 2005.

Under LPS17 the objectives 'Residential Development' zone include:

- c. Provide for the coordinated development of future residential areas through the application of a comprehensive plan to guide subdivision and development to be known as a "Structure Plan";
- d. Provide for predominantly residential development, but including also a range of compatible services, consistent with the needs of an integrated neighbourhood, and planned so as to minimise adverse impacts on amenity;
- e. Avoid the development of land for any purposes or at a time when it is likely to compromise development elsewhere in the district or prejudice the future development of land in the Residential Development zone for more appropriate purposes;
- f. Take account of the need to protect the amenity and on-going use of adjacent property owners as well as to provide for the needs of future residents.

This Structure Plan has been prepared in accordance with Part 4 of the Planning and Development (Local Planning Schemes) Regulations 2015 Schedule 2 – Deemed Provisions and Clause 5A.1 of LPS17 which requires a Structure Plan to be prepared for land zoned 'Residential Development' before any subdivision or development of the land is to be undertaken.

The balance of Kingsford Estate is zoned 'General Rural' and 'Landscape' under LPS17. This land is required to be zoned 'Urban' under the MRS and 'Residential Development' under LPS17 prior to inclusion within the Structure Plan area via a Structure Plan amendment/addendum.

FIGURE 2: Metropolitan Region Scheme

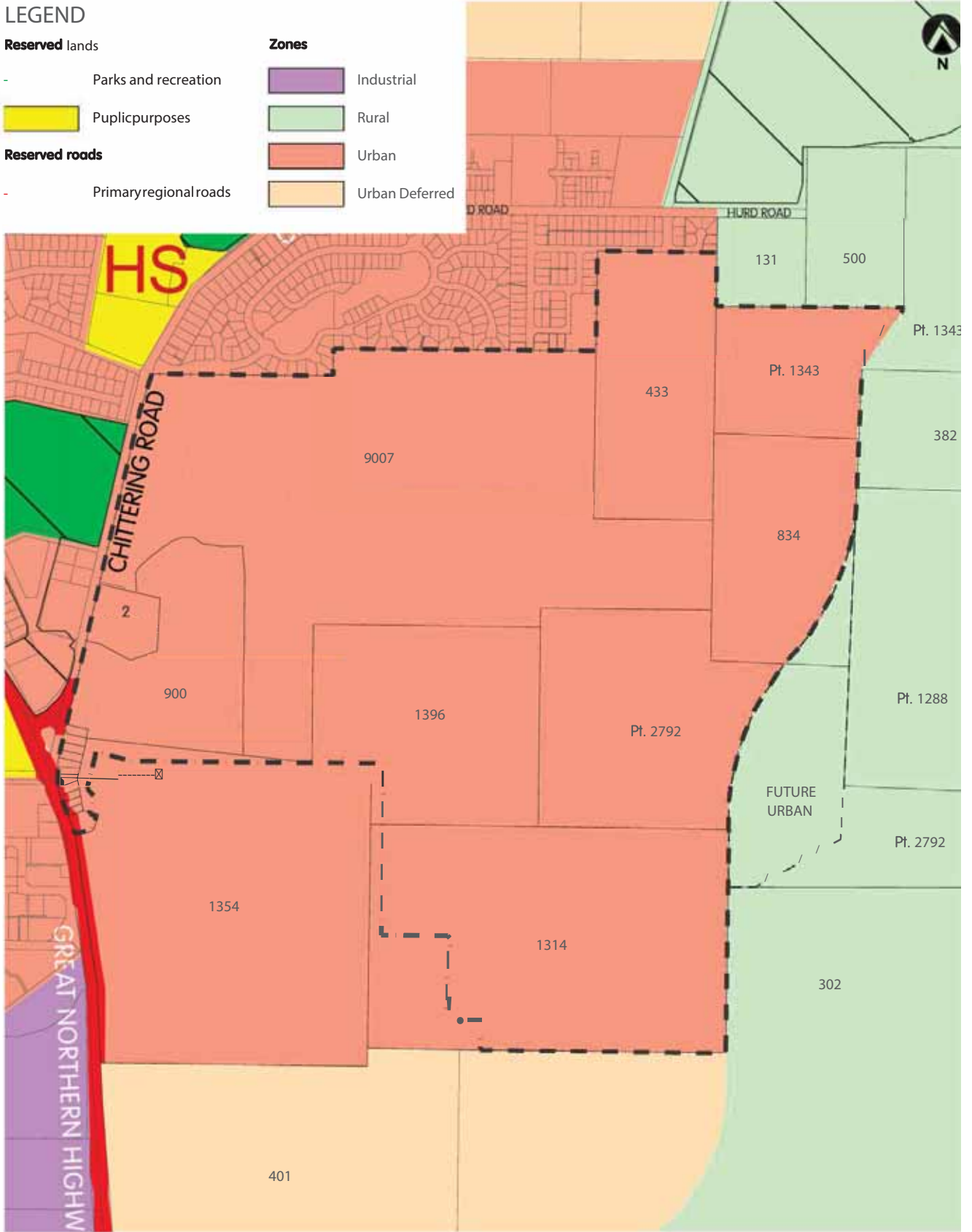
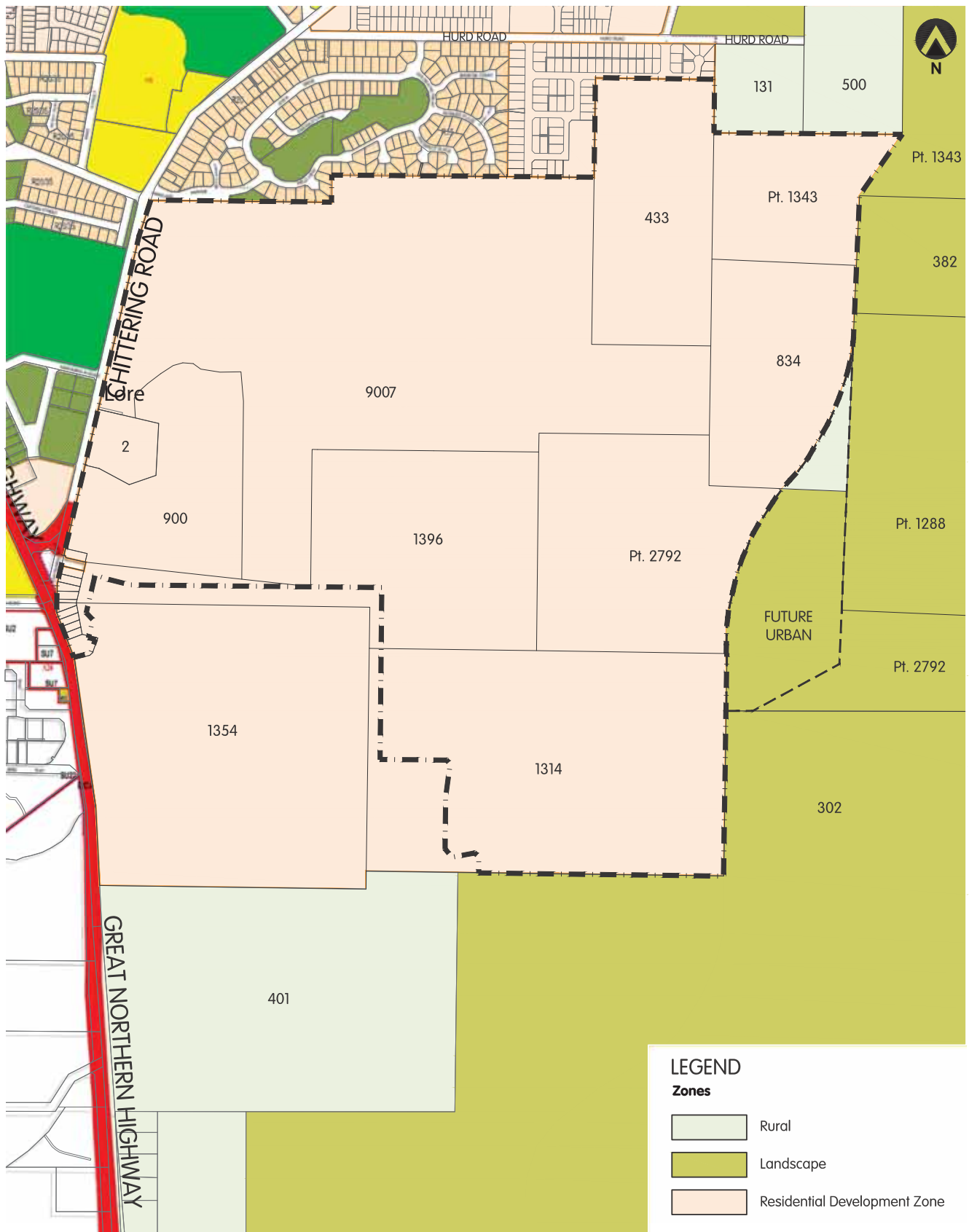


FIGURE 3: Local Planning Scheme No. 17



2.2 Strategic Planning Framework

2.2.1 Perth and Peel @ 3.5 million

Perth and Peel @ 3.5 million is the highest-level strategic planning document which establishes a vision for the future expansion of Perth Metropolitan and Peel Regions, which is project to grow to a population of 3.5 million, with a total 800,000 new dwellings to be provided by 2050. To achieve this expected growth without on our way of life, natural environment and physical infrastructure, the State sets housing targets for each sub-region. Of the new dwellings, 47% (380,000) dwellings are to be accommodated within existing infill areas, whilst the remaining 53% (420,000 dwellings) will be built in outer sub-regions. This 'Connected City' model ensures a wide range of choices to future home buyers across Perth and Peel. The suitability of development in the outer sub-regions is based on proximity to employment and services, protection of major environmental assets and capacity for efficient provisions of infrastructure and essential services.

The Structure Plan area is located within the North-East Sub-Region, which has a housing target of 102,560 to be provided by 2050. It is expected that this population growth will predominantly be focused within the City of Swan, which will contribute 73,450 additional dwellings (of which 25,690 infill) and approximately 60% of the sub-region's population by 2050.

The Structure Plan area is identified as 'Urban Zoned – Undeveloped' as land which is a State priority for increased density, being vacant, under-utilised urban land that can be serviced by the required infrastructure and located in proximity to activity centres, transit corridors and areas of high amenity (refer Figure X). The Sub-Regional Framework identifies 'Urban Zoned – Undeveloped' areas will contribute 57,440 new dwellings towards the housing target, and 'Urban Expansion' 35,330 new dwellings by 2050.

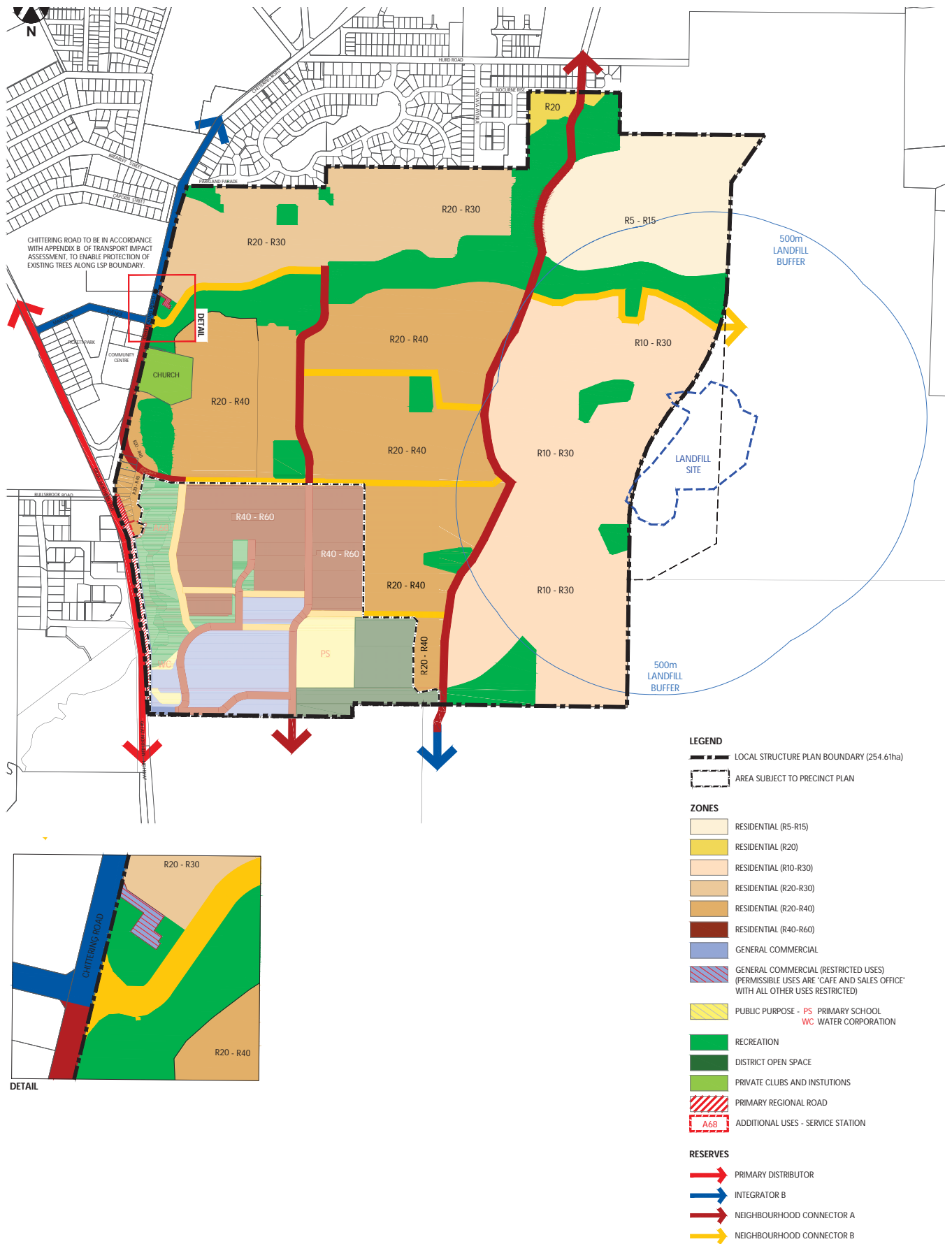
The Sub-Regional Framework also includes anticipated timeframes for the delivery of urban development sites, with the Structure Plan area identified as 'short term' to be developed by 2015-2031, with the balance of the Kingsford Estate identified as 'medium-long term' to be developed after 2022.

The planned residential growth within Bullsbrook will be supported by the Kingsford Town Centre which is identified within the Sub-Regional Framework as a "District Centre" within the activity centres hierarchy.

More broadly, the Structure Plan will be supported by the Bullsbrook South industrial area which is identified for future industry and commercial expansion to achieve an economic trade cluster focused on existing and proposed freight transport infrastructure. The Bullsbrook RAAF base will also continue to operate as a key military air training facility and flight training base.

An intermodal freight terminal is identified south-east from Bullsbrook, accessible to Stock Road, to connect Perth-Geraldton. The terminal will have an important role in the freight network having rail connections to Fremantle Port and proposed Kwinana Outer Harbour, as well as to the regions in the north of the State. It is anticipated this facility will not be required prior to 2031.

FIGURE 4: Local Structure Plan



2.2.2 City of Swan draft Local Planning Strategy

The Local Planning Strategy provides the local context to interpret State and regional policies for the City of Swan. It provides the planning rationale for zones, reservations and development controls contained in the City of Swan's Local Planning Scheme No. 17 (LPS17). The Strategy will be the principal land-use document used to assist the City in decisions making over the next 10-15 years.

The Strategy outlines the intended development outcome over a 10-15 year period, to achieve the State's housing target of 73,450 additional dwellings (of which 25,690 infill) and further 176,100 new residents.

The City will have regard to the strategies and actions which focus on the following themes/objectives:

1. Natural Resource Management and Environmental Protection – protect the City's natural resources, provide responsible environmental management and manage impacts of climate change;
2. Population and Housing – facilitate a wide range of housing and lifestyle choices for current and future residents;
3. Economy and Employment – Facilitate the creation of a sustainable economy and provide opportunities for growth in a wide range of employment areas;
4. Retail and Activity Centres – Develop a viable and sustainable network of activity centres to provide for the community's social and economic needs;
5. Tourism – to stimulate the tourism industry and showcase the Swan Valley and the City's main attractors;
6. Open Space and Community Facilities – Provide a diverse range of functional and quality open space and community facilities that can be managed in a sustainable way to meet the long terms needs of the community;
7. Rural Land Uses, Subdivision and Development - encourage sustainable development and land uses in rural areas whilst recognising the importance of protecting agricultural, natural and basic raw material resources;
8. Urban Design and Heritage – enhance the built form throughout the City to create interesting and attractive places and protect the City's heritage;
9. Transport, Traffic and Access - provide an integrated transport system that provides residents, workers and visitors with high quality, safe and efficient transport mode choices to meet the personal, employment and freight transport needs of the City into the future; and
10. Infrastructure Services - achieve a whole of government approach in the provision of and improvements to essential infrastructure (water, wastewater and power).

Bullsbrook is identified as a 'growth area' to accommodate the State's housing targets. A District level centre is also identified in Bullsbrook to cater for the future population growth.

The strategies and actions of the draft Local Planning Strategy will guide decision making with respect to future amendments to the MRS and LSP17, the adoption of Structure Plans and assessment of development proposals.

2.2.3 City of Swan Urban Housing Strategy

The Urban Housing Strategy reviews the City's current housing stock and identifies areas that are suitable for higher residential densities. It aims to ensure long term sustainable future residential development through the creation of an accessible, well connected and sustainable community where all demographics has access to varied housing. The Urban Housing Strategy is described as an informing document, and the draft Local Planning Strategy is the main document to guide consideration of development.

The principal objectives of the Urban Housing Strategy are to:

- Encourage the provision of a range of housing options through urban areas of the City to meet the changing needs of residents. This includes the provision of housing for Aged/Dependent persons and people with special needs.
- Facilitate the creation of walkable communities adjacent to activity centres and transport nodes that will reduce the demand for car based travel, encourage the use of alternative transport modes and provide opportunities for increased social interaction.
- Provide a strategy framework for increasing residential densities within existing established areas in selected locations. These location are to be identified in accordance with the principles of Liveable Neighbourhoods, Transit Oriented Development and heritage protection.
- Identify suitable mechanisms for controlling the built form outcomes in identified infill areas to protect existing residential amenity.

The Structure Plan will meet the objectives of the strategy through the provision of a range of housing densities and styles which will facilitate an accessible, amenable and walkable community. This will assist the City of Swan to fulfil its housing targets as its population grows.

The Urban Housing Strategy comprises an Infill Strategy and a Greenfields Strategy which respond to Perth and Peel @ 3.5 million and the City's draft Local Planning Strategy to achieve 73,450 additional dwellings by 2050. The Greenfields Strategy applies to greenfield areas which are subject to current and future structure planning. The Greenfields Strategy identifies the Structure Plan area as a mix of 'Urban Deferred Zoned Undeveloped' and 'Urban Expansion Area 2011 – 2015'.

2.2.4 City of Swan Bullsbrook Approved - Townsite District Structure Plan

The Bullsbrook Townsite District Structure Plan (DSP), provides a strategy for the future development of Bullsbrook Townsite and has been used as a base to guide the design of the Structure Plan and allocation of land uses.

The objectives of the DSP include:

- Allow for a diversity of land use, which:
 - Provides for metropolitan and local residential land needs for the growing population;
 - Create a vibrant activity centre with increased local employment and business opportunities, as well as improved services;
 - Assists in addressing the State's land shortage;
 - Generates local employment opportunities to contribute to self-sufficiency; and results in essential industrial growth within the existing 'Industrial' zone with an appropriate land use and built form interface along Great Northern Highway;
- Protect the natural environment;
- Provide the necessary basic infrastructure (including public open space and community facilities) to support urban development;
- Protect existing and identified long-term land uses, including the Pearce RAAF Base and resources; and
- Protect existing prime agricultural and horticultural land where applicable.

The DSP identifies the Structure Plan area to be developed for urban purposes, comprising largely of 'Future Residential'. A 'District Centre' co-located with a 'Primary School', 'Rapid Transit Terminus' and 'District Open Space' is to be provided to the south of the Structure Plan. An 'Activity Corridor' connects the existing Bullsbrook Townsite north of Chittering Road through the Structure Plan area to the 'District Centre'. This road will connect south, outside of the Structure Plan, to a smaller 'Neighbourhood Centre' at the intersection of Lage Road and Great Northern Highway. Ki-It Monger Brook is identified as 'Conservation' dissected by two north-south roads which provide key transport connections.

The DSP identifies a 'High School' nominated outside of Kingsford Estate, to the east. Based on pre-lodgement consultation with the Department of Education (DoE), it is our understanding the preferred approach is for expansion of the existing Bullsbrook College to be pursued in the first instance, with the site nominated in the DSP as a potential location in the event expansion of the existing Bullsbrook College cannot be facilitated.

The land use designations in the DSP have been generally reflected within the Structure Plan.

2.3 Planning Policies

The following State Government policies are considered relevant and applicable to the Structure Plan area:

- SPP 2.8 Bushland Policy for the Perth Metropolitan Region
- SPP 3.7 Planning in Bushfire Prone Areas
- SPP 5.4 Road and Road Noise
- SPP 7.0 Design of the Built Environment
- SPP 7.3 Residential Design Codes Volume 1
- Liveable Neighbourhoods

A number of Local Planning Policies and strategies have been taken into account of part of the Structure design, these include but are not limited to:

- Biodiversity Strategy
- Sustainable Environment Strategy
- Transport Strategy
- POL-E13.11 Inclusion of Pedestrian Accessways in Residential Subdivisions
- POL-C-104 Environmental Planning Policy
- POL-LP-11 Variation to deemed-to-comply requirements of the R-Codes Medium
- Density Single House Development Standards (R-MD Codes)

2.3.1 Liveable Neighbourhoods

Liveable Neighbourhoods (LN) is an operational policy used to guide the design and assessment of structure plans and subdivision applications in greenfield areas and larger infill sites.

The key initiatives of LN are covered under eight design elements: community design, movement network, lot layout, public parkland, urban water management, utilities, activity centres and employment and schools.

Objectives of particular relevance to this Structure Plan include:

- To ensure a site-responsive approach to urban development that supports and enhances the context in which it is located, strengthens local character and identity, integrates with its context and promotes a sense of community;
- To provide a safe, convenient and legible movement network, and to provide attractive streetscapes;
- To ensure that urban development lots have a suitable level of amenity, services and access;
- To provide a network of well-distributed parks and recreation areas that offer a variety of safe, appropriate and attractive public open spaces; and
- To integrate appropriate water management measures in an efficient urban structure and range of parkland types.

By providing for a diverse range of housing within a connected and walkable neighbourhood, structured around high-quality POS, the Structure Plan reflects the key aims of LN.

LN is a performance-based code where the requirements of LN may be satisfied in a number of ways. LN aims to balance the maintenance of acceptable standards and meeting strategic vision, with encouraging greater innovation in response to market needs.

2.3.2 State Planning Policy 7.3 – Residential Design Codes (Volume 1)

State Planning Policy 7.3 Residential Design Codes Volume 1 (R-Codes) provides a comprehensive basis for the control of residential development throughout the State. The key objectives of the policy are:

To encourage design which is responsive to the site, size and geometry of the development site;

- a. To allow variety and diversity as appropriate where it can be demonstrated this better reflects context or scheme objectives;
- b. To ensure clear scope of scheme objectives to influence the assessment of proposals; and
- c. To ensure certainty in timely assessment and determination of proposals applied consistently across the State and local governments.
- d. The R-Codes is a performance based document, where an application can either be assessed to satisfy the 'deemed-to-comply' provisions or by addressing the 'design principles' under the exercise of judgment by the City of Swan.

A Local Planning Policy (LPP) or Local Development Plan (LDP) may vary the provisions of the R-Codes where consistent with the 'element objectives' and 'design principles'.

2.3.3 State Planning Policy 5.4 – Road and Rail Noise

The purpose of this policy is to minimise the adverse impact of road and rail noise on noise sensitive land use and development within specified trigger distances of strategic freight and major traffic routes.

Great Northern Highway, which borders the south-western boundary of the Structure Plan is identified under the MRS as Primary Regional Road (red road), with a projected daily traffic count of 17,000 - 18,000. These roads have a "trigger distance" of 200m as measured from the road carriageway edge. The policy requires development within this trigger distance to require the preparation of a noise management plan to determine the actual noise levels and demonstrate the proposal can mitigate the impacts of noise through attenuation measures.

A Road Traffic Noise Impact Assessment has been prepared, in accordance with SPP 5.4 to support the design of the Structure Plan (refer Appendix I).

2.3.4 State Planning Policy 2.4 – Basic Raw Materials

This policy sets out the matters to be considered for development in the vicinity of identified Basic Raw Material Resource (BRM) areas. BRM are described as sand (including silica sand), clay, hard rock, limestone (including metallurgical limestone) and gravel and other construction and road building materials, which are generally important to land development. This policy seeks to ensure BRM can be extracted close to the market in the metropolitan region and sensitive development that could conflict with extraction.

The policy is applicable as the Structure Plan boundary incorporates the former Clay Quarry located within Kingsford Estate to the east. The operations ceased operation in December 2020.

2.3.5 City of Swan - Local Planning Policy (POL-LP-11)

Local Planning Policy POL-LP-11 Variation to Deemed to Comply Requirements of the R-Codes – Medium Density Single House Development Standards (R-MD Codes)

The City of Swan Local Planning Policy POL-LP-11 Variation to Deemed to Comply Requirements of the R-Codes – Medium Density Single House Development Standards (R-MD Codes) adopts the Medium-density single house development standards (R-MD Codes) via the WAPC Planning Bulletin 112/2016. The R-MD Codes reflects contemporary housing typologies and incorporates existing R-Code variations that have been applied to date.

The R-MD Codes replace the deemed-to-comply requirements of the following clauses of the R-Codes:

- Building and Garage setbacks;
- Open Space;
- Parking;
- Visual Privacy; and
- Solar Access.

All other relevant R-Code standards continue to apply. Where there is a conflict between the provisions of the R-MD Codes and an approved LDP, the LDP provisions prevail to the extent of any inconsistency.

2.3.6 Government Sewerage Policy

This policy establishes the State's position on the provision of sewerage through planning and development of land. The policy requires all subdivision and development to be connected to reticulated sewerage, unless it is exempted from this requirement under the Policy.

To address the requirements of the Policy a Local Water Management Strategy has been prepared (refer Appendix 3) in accordance with Better Urban Water Management including details relating to sewage disposal.

An Urban Water Management Plan will be required at the time of subdivision approval.

FIGURE 5: North East Sub-Regional Planning Framework

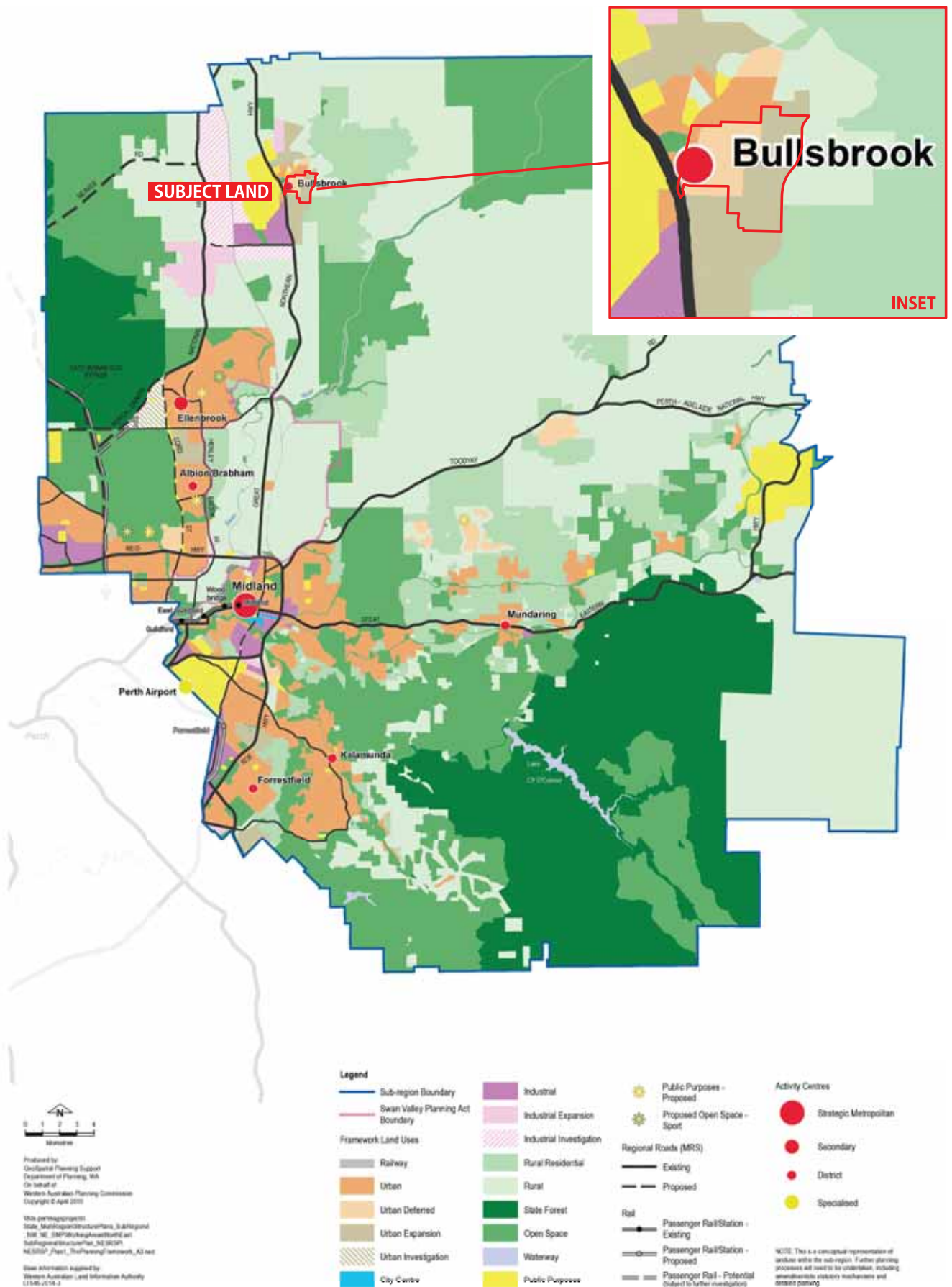
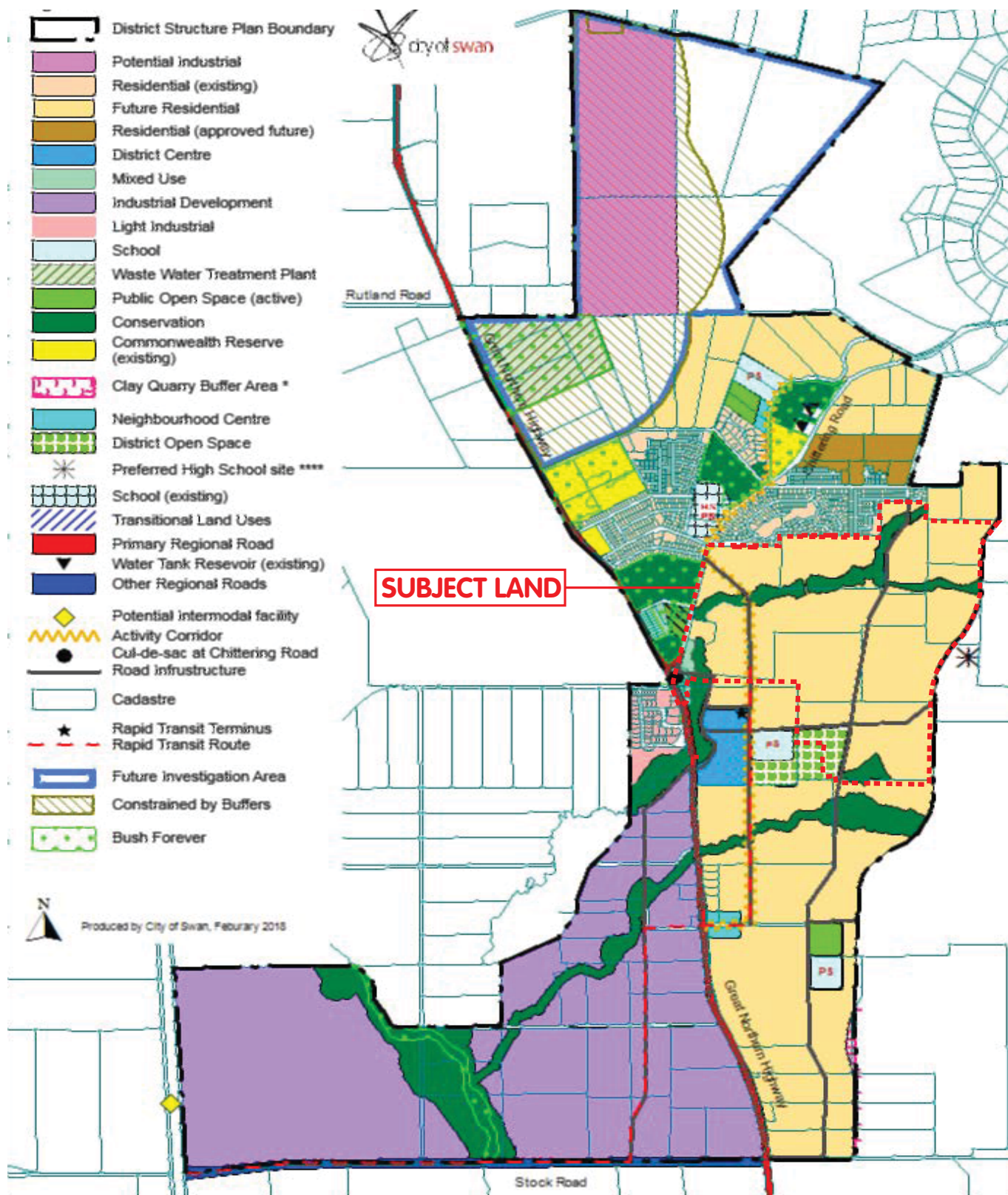


FIGURE 6: Bullsbrook District Structure Plan



3.0 Existing Site Conditions And Constraints

3.1 Biodiversity and Natural Area Assets

An Environmental Summary Report Strategy has been prepared by RPS (refer Appendix 4). To review the existing environmental factors that may be impacted as a result of the development and outline management measures to mitigate any potentially significant environmental impacts.

Historically, the site has been extensively cleared for agricultural purposes and consists largely of turfed paddocks used for cattle grazing, therefore has limited environmental values. Pockets of remnant vegetation are clustered along Ki-It Monger Brook, which traverses east-west through the site. A portion of Ki-It Monger Brook is classified as a Conservation Category Wetland (CCW).

Based on the key environmental outcomes RPS Group recommends the preparation and implementation of the following management plans:

- Preparation and implementation of a Ki-It Monger Brook Foreshore Management Area Report to ensure appropriate management of the Ki-It Monger Brook foreshore;
- Management of the portion of Conservation Category Wetland within the Ki-It Monger Brook through preparation of a Wetland Management Plan.
- Implementation of best practice water sensitive urban design and stormwater drainage management through Urban Water Management Plan(s);
- Planting trees as part of the landscaping works to improve and increase the amount of diverse vegetation;
- Preparation and implementation of an 'End of Life Management Plan' for the Class I Inert Landfill to ensure the landfill site is suitable for the land uses proposed.
- Management of Acid Sulfate Soils; and
- Implementation of management measures to reduce potential noise and fire impacts on future residences.

3.1.1 Vegetation

At a regional level, the remnant vegetation is primarily mapped as being the Guildford Complex, with small areas of Darling Scarp Complex and the Forrestfield Complex. The Guildford Complex has approximately less than 10% of the original (pre-European) extent remaining. The Guildford Complex is associated with Ki-It Monger Brook. The remnant trees within the Ki-It Monger Brook will be retained through the establishment of foreshore buffer areas, development setbacks, drainage retention and open space areas.

The remnant Guildford Complex is also located on the southern boundary of the Structure Plan area (Lot 1314), proposed within Public Open Space to be managed through the subdivision and development process.

A level 2 flora and vegetation assessment of the Structure Plan Area and surrounds was conducted by Ecologia (refer Appendix 1 of Appendix 4). This survey confirms there are no Threatened Ecological Communities (TECs) identified within the Structure Plan area.

The Structure Plan area has been used primarily for agricultural purposes and the majority of the land has been classified as Completely Degraded (Ecologia 2016). Stands of remnant vegetation associated with the Ki-It Monger Brook have been classified as 'Degraded'. Five vegetation units were found to occur within the Structure Plan area. The five vegetation units were associated with the agricultural land use and were rated as either "Completely Degraded" or "Degraded". The only vegetation units identified as being in "Excellent Condition" are located outside of Structure Plan area and are not currently identified for future urban development.

A Remnant Vegetation Management Plan will be prepared to identify and manage vegetation suitable for retention vegetation, outside of the Ki-it Monger Brook.

3.1.2 Flora

A total of 102 vascular plant taxa were recorded within the Structure Plan area and surrounds. Of these, 43.1% are native and 56.9% are introduced species.

No Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999 listed or Wildlife Conservation Act 1950 listed Threatened Flora, Priority flora or other flora species of significance were recorded in the Structure Plan area.

A literature review identified one Threatened flora taxon, *Acacia anomala* that has previously been recorded in Bush Forever No. 86 site located to the north-east of the Structure Plan Area. Based on historical land use, vegetation units mapped and condition, this species is considered likely to occur within the Bush Forever No.86 area but not within the Structure Plan area.

3.1.3 Bush Forever

The Structure Plan area is in close proximity on its northern site boundary (within Lot 857) to Bush Forever Site No. 86. The Bush Forever site is some 43ha of bushland associated with regionally significant vegetation and fauna habitat, including black cockatoo foraging and roosting habitat.

The vegetation within Bush Forever Site No. 86 includes *Eucalyptus accedens*, *E wandoo* woodlands, *E wandoo*, *C. calophylla* and *E. marginata* Open Forest to woodland with *Allocasuarina humilis* and *Calytrix angulata* (Government of Western Australia, 2000).

3.1.4 Fauna

The Structure Plan area exhibits a high level of disturbance from historic clearing of native vegetation and mostly comprises cleared agricultural paddocks. Consequently, it is highly unlikely that these areas provide suitable habitat for significant fauna species.

Potential habitat areas would include intermittent remnant native vegetation along the Ki-It Monger Brook. The creek line also allows for the movement of native fauna from the western portion of the site to areas of larger remnant vegetation to the east.

Consequently, through retention of vegetation within Ki-it Monger Brook the limited existing habitat within the Structure Plan area will be retained. Additionally, preservation of the adjacent Bush Forever site No. 86 north- east of the Structure Plan area will assist with retaining fauna habitat.

Based on the fauna habitats remaining within the Structure Plan area, the key species that could potentially be impacted through development of the site are listed below:

- Scattered stands, or individual *Eucalyptus rudis* trees within the creek lines:
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)
- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)
- Baudin's Black Cockatoo (*Calyptorhynchus baudinii*).
- The banks of the seasonal creek line may support the following migratory bird species:
- Rainbow Bee-eater (*Merops ornatus*) – migratory

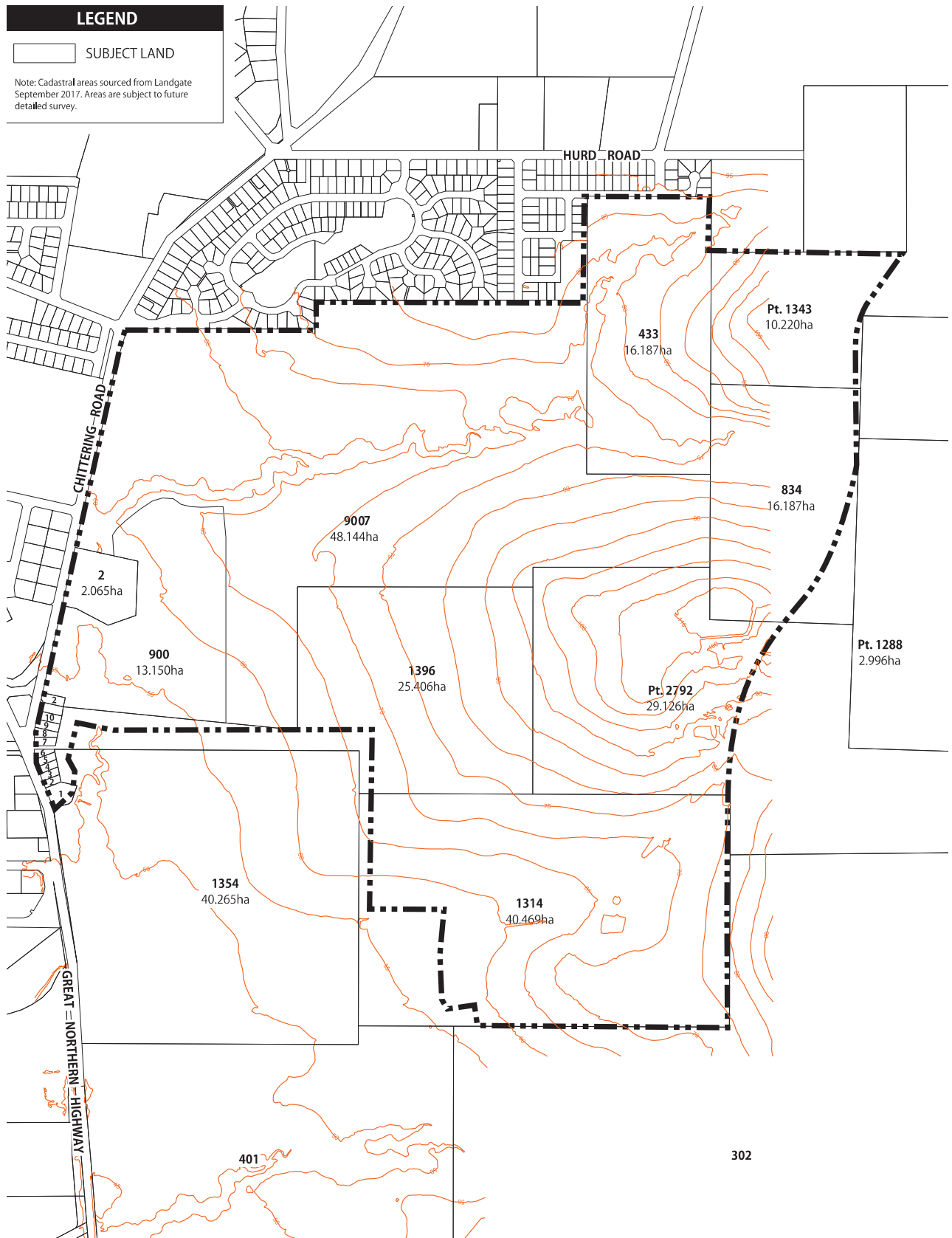
The proposed management and use of the Ki-it Monger Brook and water features on the site (dams) will replicate the pre-development conditions associated with both surface and groundwater availability to the existing vegetation. Therefore avifauna, in particular rainbow bee-eaters, can continue to utilise the creek area and the surrounding buffer after seasonal rain events.

Potential habitat within the Structure Plan area for black cockatoo species comprises poor foraging quality *Eucalyptus rudis* trees within the creek line and the occasional marri tree. These trees will be preserved in the Ki-it Monger Brook and the location of the road creek crossings will be selected to minimise the impacts to the existing mature trees.

Fauna habitat outside of the Structure Plan area (Bush Forever Site No.86) comprises more intact vegetation structure and potentially provides fauna habitat for the Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) and Baudin's Black Cockatoo (*Calyptorhynchus baudinii*).

The Structure Plan responds to the objectives outlined in EPA Bulletin No. 20 Protection of natural areas through planning and development (EPA 2013).

FIGURE 7: Topography



3.2 Landform and Soils

The landform of the Structure Plan and its surrounds is unique and consists of a series of valleys and hill-tops. Located at the foothills of the Darling Scarp, this creates a topographical range from approximately 120 metres Australian Height Datum (m AHD) in the east, where the foothills begin down to approximately 50m AHD to the south-west, where the relatively flat landscape of the Swan Coastal Plain commences (refer Figure 7). A substantial proportion of the site could be categorised as having moderate to steep slope of 5% or more. Whilst only a portion of the site is excess of 10%, development on steeper land will need to be sensitively design and delivered. On steeper land generally, a combination of civil, landscape and built form solutions will need to address character and functional considerations.

The majority of the Structure Plan area is composed of Silty Sands that are described as strong brown, firm, friable and dispersive in parts. The eastern section of the site includes Siltstone whilst the south-western boundary is dominated by Pebbly silt associated with the Guildford Formation. Two small sections of the Structure Plan area on the eastern boundary has been mapped as granite.

The Department of Environment and Regulation (DER) has compiled broad-scale mapping of the risk of acid sulphate soils for regions of Western Australia. The Structure Plan area has not been assigned an Acid Sulfate Soils (ASS) risk rating and it is assumed there is a “low to no” known risk of ASS occurring within 3m of the natural soil surface (or deeper).

A search of the DER’s Contaminated Sites database indicates that no registered contaminated sites were recorded within the Structure Plan area or lands immediately surrounding the site.

3.3 Groundwater and Surface Water

3.3.1 Groundwater

The Structure Plan area is located within the Bandy Spring Sub-area of the Swan Groundwater Area and is managed under the Gnangara Groundwater Areas Allocation Plan. The Bandy Spring Sub-area contains the Superficial Aquifer and Fractured Rock West Aquifer. A review of allocation limits identified that the Superficial Aquifer was fully allocated. The Fractured Rock West Aquifer is not expected to provide significant yields. The confirmed aquifers of the Swan Confined Groundwater sub-area (Leederville and Yarragadee North aquifers) extend beneath the western section of the site, which are also fully allocated. Through consultation with the Department of Water (DoW) and the City of Swan, it was agreed that groundwater could be abstracted from the Superficial Aquifer in the adjacent Cockman Bluff Sub-area and piped across the sub-area boundary to the development site to service its irrigation requirements.

Regional groundwater mapping by the Department of Water indicates groundwater migrates towards Ellen Brook, located approximately 2.3 km to the west. In the Perth Groundwater Atlas the May 2003 groundwater contours just extend onto the western boundary of the Structure Plan area and range from 50 m AHD in the north to 45 m AHD in the south. Groundwater levels monitored from on-site bores ranged from 30.49 m AHD to 77.89 m AHD. Due to the significant depth to groundwater over the majority of the site, a complete 18 month groundwater monitoring program (covering two winter peaks) has not been undertaken. The only two bores with relatively shallow groundwater levels are located near a dam at the landfill facility and the Ki-it Monger Brook respectively and hence it is interpreted the groundwater levels are influenced by localised water conditions.

3.3.2 Surface Water

The key water feature of the Structure Plan area is Ki-It Monger Brook which flows east to west across the northern part of the Structure Plan area. It then runs along the south side of the site, before crossing under Great Northern Highway at the site’s south-west corner, until it confluences with Ellen Brook approximately 2.3km south-west of the site. A number of smaller drainage tributaries contribute to the Ki-it Monger Brook including a minor unnamed drainage course that traverses the southern section of the site and discharges into Ki-it Monger Brook near the site’s south-west corner.

The Ki-it Monger Brook has been considerably modified including the constriction of dams and installation of culverts on the site which restrict flows as well as the clearing of riparian vegetation. In particular, a major dam located in the centre of the site has a major impact on flows downstream, as flows only occur once the water level reaches the height of the culverts installed in the dam wall.

3.3.3 Wetlands and Waterways

The Structure Plan area includes two wetlands that occur within sections of the Ki-it Monger Brook; one is classified as a Conservation Category Wetland (CCW) (UFI 12681) and one is a Multiple Use Wetland (MUW) which is likely to have few important ecological attributes and functions remaining.

A botanical assessment was conducted detailing the spatial extent and characteristics of the wetlands within the Structure Plan area, in particular the CCW (UFI 12681). There were no significant flora species recorded or likely to occur along Ki-it Monger Brook.

Both the CCW and MUW within Ki-it Monger Brook had vegetation condition rated as ‘Degraded’ with no or scattered native understorey plants, litter, high grazing levels and dominated by weeds. There were no differences in the vegetation type, floristic composition, condition or values in the CCW section of the Ki-it Monger Brook, the MUW section or the un-classified section (i.e. parts of the Ki-it Monger Brook that were surveyed but are not classified as a CCW or MUW).

Based on the current biophysical condition of Ki-it Monger Brook within the Structure Plan area, it is proposed to retain the foreshore area to the extent of the banks for the majority of the site. The width of the foreshore area will vary along its extent, ranging from approximately 120m at its widest and 10m at the narrowest point, incorporating both sides of the bank.

3.4 Heritage

A search of the Department of Indigenous Affairs (DIA) Aboriginal Heritage Inquiry System (AHIS) database identified one registered Aboriginal site of mythological significance within the Structure Plan area, being the Ki-It Monger Brook 2 (Site ID 3583). The desktop search also identified one 'Other Heritage Place' within the Structure Plan area, being the Bullya Spring (Site ID 22669).

Ethnoscience were engaged to carry out a desktop Aboriginal heritage assessment of the Structure Plan area and surrounds (refer Appendix 6).

A search of the Heritage Council's database resulted in no matches for European Heritage within the Structure Plan area.

3.5 Existing Movement Networks

A Transport Assessment, prepared by Transcore (refer Appendix 5), identified the following characteristics of the existing movement network.

3.5.1 Great Northern Highway

The Structure Plan area is located immediately east of Great Northern Highway, a 'Primary Regional Roads' reservation under the MRS; this providing excellent access to the broader Perth metropolitan region. A portion of Great Northern Highway road widening is anticipated within the Structure Plan area adjacent in accordance with the current MRS reservation (Clause 42 refers).

Great Northern Highway is classified as a 'Primary Distributor' by the MRWA with existing average weekday traffic volumes of ~14,362 vehicles per day to the south of Bullsbrook Road and ~10,503 vehicles per day south of Rutland Road. It is constructed as a two-lane (without median) rural highway adjacent to the Structure Plan area.

The posted speed limit on Great Northern Highway is 60km/h through the Bullsbrook town centre and adjacent to the Structure Plan area, increasing to 80km/h south of Butternab Road and 100km/h south of Lage Road.

All of the intersections along Great Northern Highway in the Bullsbrook area operate under priority control (i.e. Stop or Give Way control).

3.5.2 Chittering Road

The MRWA designates Chittering Road as a 'Regional Distributor' road with existing average weekday traffic volumes of ~6,205 vehicles per day to the east of Great Northern Highway and ~4,705 vehicles per day to the east of Hurd Road. It is a two-lane road, 7.4m wide between kerbs, within the Bullsbrook town centre and reverts to two-lane rural road standard northeast of Hurd Road.

All of the intersections along Chittering Road in the Bullsbrook area operate under priority control (i.e. Stop or Give Way control).

3.5.3 Existing Pedestrian and Cyclist Networks

There are currently no pedestrian or cyclist facilities within the Structure Plan (except for the recently constructed residential areas) area or on the adjacent extent of Great Northern Highway. Footpaths however are provided through the Bullsbrook town centre.

Chittering Road has a 2.0m shared path on one side within the Bullsbrook town centre and on both sides in the vicinity of the existing high school and primary school site.

3.5.4 Existing Public Transport

The closest existing bus route to the Structure Plan area is Bus Route 311 (Midland Station – Bullsbrook).

Route 311 runs on Great Northern Highway adjacent to the Structure Plan area. It provides six bus services each way on weekdays and two on Saturdays, Sunday and public holidays. Existing bus service time are primarily designed for journeys to and from work, school and other trips to and from Midland during business hours such as shopping or personal business trips.

4.0 Design Philosophy

The existing site conditions highlight opportunities and constraints the Structure Plan design must respond, these include:

- Undulating landform presents opportunities to create distinct urban villages;
- The Darling Range provides a dramatic landscape backdrop;
- The heavily vegetated Ki-It Monger Brook is a stunning natural asset and source of amenity, health, history, retreat, fun and discovery with the core creek area to be retained;
- Opportunity to provide ecological corridor linking the site to existing Bullsbrook green network;
- Offer of diverse views resulting from unique valley and hilltops;
- Vehicle access required from Chittering Road and Great Northern Highway;
- The Chittering Road realignment will provide the major north-south connection through the site in the form of an attractive transit boulevard;
- The centrally located existing homestead will be retained and integrated into the master plan design; and
- Steep topographic provides will need to be sensitively designed and delivered.

The Structure Plan design has taken into consideration the environmental and physical attributes within and external to the site, as well as acknowledging abutting land uses and how these can best be addressed with regard to interfacing with future residential land uses.

4.1 Concept Plan

A Concept Plan has been prepared to support the Structure Plan and provide an overview on the future pattern of subdivision and development. The Concept Plan is subject to detailed refinement at the subdivision stage.

The Concept Plan proposes an urban layout utilising an interconnected road network and open space system which embraces the existing landform and amenity, including the Ki-It Monger Brook. The design encourages safe pedestrian movements within the site, and to connect to regional infrastructure to various City of Swan community nodes.

The Concept Plan has been predicated on the following design principles:

A. Immersed in the Landscape

Views play a significant role in defining the sense of place. Spatially there are six areas on the site, each with a defined view shed, sense of enclosure or openness, and elevation, all of which enjoy views back to the scarp backdrop:

- Intimate middle valley featuring an elevated creek link;
- Larger lower valley with creek link and some long views;
- Flats has views to the scarp and creek line tree tops;
- Rise includes view to the scarp and creek line;
- Peak is an elevated long open space and city views; and
- Upper valley is elevated with clear views down to the creek line.



4.1.1 Connected by Nature

Ki-It Monger Brook provides a 4.2km contiguous ecological link which runs centrally through the estate and along the western boundary to provide a natural green setting. Walking and cycling paths set amongst avenues of existing and retained trees will provide the entire community with convenient access to the Brook, Town Centre, Playing fields and Primary School. The southern extent of the Brook is positioned on a meandering topographical low-point culminating in the Kingsford Town Centre where it takes on a more urban character before returning to nature. Within the Brook, the community will be able to engage with nature in various ways, without compromising ecological values.

4.1.2 Transit Village

The Bullsbrook Town site will over time have good access to public transport via a Rapid Transit Service line which is intended to service the Swan Urban Growth Corridor and Ellenbrook. Kingsford Estate will make a significant contribution to this, with an 'Activity Corridor' boulevard extending north-south through the site as a realignment of Chittering Road. For the boulevard to support walking, cycling and residential frontages it will need to be designed based on leading best practice. It is proposed that a bus stop terminus would be located adjacent to the Kingsford Town Centre consistent with the DSP.

4.1.3 Connected Open Space Network

New Bullsbrook will consist of a contiguous network of open spaces, with the primary objective of connecting the community with Brook, topographical points of interest, the Village Centre and the transit boulevard. The Green Loop will be the major open space connection, consisting of a series of local open spaces that punctuate the movement experience around the site. Highly identifiable within the landscape will be the public open space in the south east, formed around a large stand of retained trees on a knoll. The open space located on the central knoll within the Hill-Top Village plays a very important role in the urban structure. It is effectively a pivot point for aligning a series of avenues that provide visually and physical connectivity to other open spaces, including other high points, the existing Bullsbrook community facilities and the Village Centre.

4.1.4 Integrated Village Centre Heart / Town Centre

Being in the privileged position of the only landholding located next to the existing town, New Bullsbrook master planning and placemaking will focus on integration with the existing town to optimise mutual benefits. The Town Centre will become the nexus between Bullsbrook and New Bullsbrook. Fronting the Brook and Great Northern Highway, the centre will have a strong presence within the town and will be highly accessible. The southern connection will provide excellent access to Great Northern Highway generally, while the northern connection will link directly into the existing centre of town. To the north, the Brook and its network of walking and cycling trails will connect directly into the hub of existing community facilities, including Bullsbrook College, the new library, community centre and café.

The Kingsford Town Centre will over time offer the existing and future community district level retail, education, a diversity of public spaces, services, lifestyle, rapid transit, more urban living choices and, above all, a place for the entire community to come together.

A separate 'Precinct Plan' for the Town Centre has been lodged with the City of Swan and WA Planning Commission (July 2021).

4.2 Village of three neighbourhoods

Kingsford Estate will consist of three distinct neighbourhoods: Brook, Heart and Hilltop.

Brook

The lifeblood of New Bullsbrook and focal point of this neighbourhood will be Ki It Monger Brook. The design response to the Brook will be to integrate the two sides of the neighbourhood, and connect the other neighbourhoods and the broader community with the rich Indigenous and European heritage of the site. Defining the edges of this neighbourhood will be existing housing to the north, proposed avenues to the east and south, together with the Brook and Bush Forever to the west.

Heart

This neighbourhood will be the 'Heart' and soul of the New Bullsbrook Village. It will be where the needs and aspirations of the community are most proudly on display. Activity will be at its greatest in this neighbourhood, with its concentration of the Village Centre, transit terminus, urban housing, playing fields, clubhouse and primary school.

Hill-Top

This neighbourhood is distinguished by its desirable elevated location east along 3 hilltops, each with its own public open space focal point. Tree-lined avenues and the Brook define the western edge of the neighbourhood, while the scarp makes for a picturesque eastern boundary.

4.3 Land Use

In accordance with the DSP the Structure Plan will be developed for urban purposes, comprising largely of Residential land uses with a District Centre co-located with a Primary School and District Open Space to be provided within the southern portion of the Structure Plan.

Ki-It Monger Brook will be leveraged as an area of existing amenity. Where possible, areas of POS have been positioned to allow for the retention of existing trees and co-located with natural low points of the site.

An overview of the Structure Plan land uses is provided in Table 1.

TABLE 1: Land Composition

LAND USES	AREA (HA)	PERCENTAGE
Residential	106.28 ha	51.3%
Private Clubs and Institutions (Church)	2.06 ha	1.0%
Recreation (Core Creek)	13.20 ha	6.37%
Recreation (Public Open Space)	24.88 ha	12%
1:1 year drainage	1.90 ha	0.92%
Road Reserves	59 ha	28.41%
Total Kingsford Estate	207.32 ha	100%

4.3.1 District Activity Centre / Town Centre

The “Kingsford Town Centre”, is planned at the southern end of the Structure Plan area to service the Kingsford Estate and wider Bullsbrook population. This centre is identified in the Bullsbrook DSP as a District Activity Centre will significantly contribute to the provision of employment opportunities and self-sufficiency in the area.

In accordance with State Planning Policy 4.2 – Activity Centres, and SPP 7.2 Precinct Design Guidelines a separate Precinct Plan for the Town Centre has been prepared and lodged with the City of Swan. The Structure Plan however has taken the future development of the District Activity Centre into consideration to ensure the future development of this site is not prejudiced by the surrounding land use planning.

4.4 Sensitive Interface

A nursery is located adjacent to the Structure Plan area, south of the proposed District Activity Centre. The generic separation distance from a nursery is 100m (EPA 2015). The generic buffer is primarily based on potential noise impacts.

In regards to interface management, the Town Centre and playing fields are proposed adjacent to the nursery site to manage the long-term interface. The design outcome ensures no sensitive land uses are located within 100m of the nursery.

It should also be noted that the land south of the Structure Plan area (including the nursery) has been identified as future residential land in the DSP.

4.5 Residential

4.5.1 Projected Dwellings

The Structure Plan proposes approximately 2,355 lots dwellings, within a residential density range of R5 to R50, over 106 ha.

Under Perth and Peel @ 3.5 million 'Connected City' scenario new urban areas are to use a minimum average residential target of 15 dwellings per gross hectare of Urban zoned land, and occupancy rate of 2.95 people per dwelling.

The indicative total dwelling yield of 2,355 equates to a total residential estimate of 6947 at 2.95 persons per household (based on Perth and Peel @ 3.5 million average people per household for greenfield locations).

Based on Liveable Neighbourhoods 'Site Hectare' definition, the Structure Plan 'developable area' equate to 106ha to be developed for residential purposes and excludes non-residential land uses including streets, laneways and POS. Based on 2,355 dwellings, the Structure Plan estimates 22 dwellings per site hectare, this complies with LN target of 22 dwellings per site hectare.

The projected dwelling yields across the Structure Plan area are subject to subdivision design and detailed review of drainage and environmental constraints. Preferred lot mix and market demand at the time of land release will also influence final dwelling yields.

4.6 Residential Density Coding

The Structure Plan offers a range of density code 'bands' commensurate with the topographic and natural constraints of the site. These bands range from R5-R15, R10-R30, R20, R20-R30 and R20-R40.

The lower density of the nominated range represents a base code for the Precinct with the higher density to be allocated in accordance with the locational criteria outlined in Part 1, Clause 4.6.

The broad R5 to R40 density range offers a flexible minimum and average lot product in response to topographic and environmental constraints, as well as proximity to the Kingsford Townsite and key transport routes. The range also seeks to maximise opportunities for diversity in lot product and housing typologies, enabling the Structure Plan design to evolve to suit market demand at the time of staging release.

A specific density coding will be allocated to residential lots at the time of subdivision application.

Within each of the above density bands, density will generally increase in response to amenity and decrease in response to topography.

4.6.1 Residential R5 - R15 Precinct

This density coding 'band' applies to the areas located farthest from the Kingsford Town Centre, on the steepest topography in the north-eastern portion of the structure plan area, as a sensitive transition to the Darling Scarp. A mix of lots is envisaged, encompassing larger lifestyle lots with built form designed sensitively to building envelopes and more traditional homes.

The R5 density coding will apply as the base code. The relatively higher densities between R10 and R15 will be located in general proximity to public open space, key distributor roads and bus routes.

The lower R5 density code also applies to lots located directly adjacent to the rural zoned land to the east.

4.6.2 Residential R10 – R30 Precinct

Located away from the Kingsford Town Centre, on steeper topography and for the eastern portion as a context sensitive transition to the scarp. A mix of residential lot types and built form is proposed, ranging from larger lots to cottage lots.

The R10 density coding will apply as the base code. The relatively higher density coding within the 'band' will generally apply to lots in proximity to public open space, key distributor roads and bus routes.

Proximity generally defines those lots within a 250m walkable catchment of a public open space area and within a 200m walkable catchment of designated public transport route.

The lower R10 density code also applies to lots located directly adjacent to the rural zoned land to the east.

4.6.3 Residential R20 Precinct

Located on the northern boundary of the Structure Plan area, this small isolated cell will deliver residential lots in keeping with the existing residential area to the north and west.

4.6.4 Residential R20 - R30 Precinct

Located in the northern portion of the Structure Plan area on generally flat land. The R20 code will apply as the base code. A mix of residential lot types and built form is proposed.

The higher R30 density code will apply to 'Residential' zoned lots where the following criteria is met;

- a. the lot is created within a 100m walkable catchment of a public open space; and

This R-code range will allow for the delivery of project homes for first homebuyers while also reflecting the benefits of locating R30 lots / homes close to or overlooking POS.

4.6.5 Residential R20 – R40 Precinct

Located adjacent the Town Centre and includes the gently sloping land running north-south between the Ki-it Monger Brook and the southern boundary of the structure plan. The R20 code will apply as a base code. The R30 coded lots are intended to be located in close proximity to or overlooking POS. The R40 coded lots will provide some housing diversity / affordability close to the primary school and town centre.

5.0 Implementation

5.1 Acoustic

Transportation Noise Assessment's have been prepared by Herring Storer to address the adjoining regional and district road networks (refer Appendix 2).

These assessment were undertaken in accordance with the WAPC's updated State Planning Policy 5.4 – Road and Rail Transportation Noise and Freight Considerations in Land Use Planning (SPP 5.4), with the key findings as follows.

The acoustic assessment's carried out for the Structure Plan area found that without mitigation, 'noise targets' set by SPP 5.4 would be exceeded for dwellings close to Chittering Road.

5.1.1 Pearce RAAF Base

With respect to potential noise from the Pearce RAAF Base, the acoustic assessment found that the development is located outside the Australian Noise Exposure Forecast (ANEF) 20 contour. Hence, residential development without any requirement for noise amelioration, is acceptable within this development.

5.1.2 Great Northern Highway

To mitigate the noise impacts for Great Northern Highway, two design options are provided:

- An access road be constructed between the first row of residences and Great Northern Highway, such that residences front Great Northern Highway. 'Quiet House' Design is required for the 'first row' of dwellings fronting Great Northern Highway.
- If the first row of residences to the Great Northern Highway is located at or outside the 60 dB(A) contour, then with the inclusion of a 2 metre highback fence, residences may back on to Great Northern Highway (i.e. back yards to the Great Northern Highway). To then achieve compliance "Quiet House" design requirements as outlined for either Packages "A" or "B" would be required, depending on dwelling setbacks.

All affected residential lots will require a notification on Title where noise targets are exceeded.

5.1.3 Chittering Road

The results of the acoustic assessment indicate that noise received at residences located adjacent to Chittering Road would, with the exception of a small section of the development, comply with the above acoustic criteria. Apart from this small section where development could occur within the 55 dB(A) contour, there are no acoustic requirements.

For the section of the development within the 55 dB(A) contour, standard construction would be acceptable and only notification on titles would be required.

The recommendations above for both Great Northern Highway and Chittering Road are made for single storey dwellings. Specialist acoustic advice should be sought for double storey dwellings.

5.2 Bush Fire Management

An updated Bushfire Management Plan (BMP) (13 September 2021) has been prepared by Strategen (refer Appendix 1); this report prepared in accordance with the WAPC's Guidelines for Planning in Bushfire-Prone Areas 2015, and SPP 3.7: Planning in Bushfire Prone Areas, and the Australian Standard AS3959-2009 Construction of buildings in bushfire prone areas (AS3959) (Standards Australia 2009).

The assessment of the existing vegetation within the Structure Plan area (Figure 4 of Appendix 1) identified that vegetation within the Ki-It Monger Brook foreshore area and internal Conservation Category Wetland (CCW) on Lot 1354 Great Northern Highway as permanent extreme bushfire hazard considerations. The adjacent Bush Forever Site No.86 was also identified as an 'extreme' bushfire hazard. All other woodland, shrubland and grassland within the Structure Plan area were assigned 'moderate' levels of bushfire hazard.

With respect to the post-development scenario, the BMP takes a precautionary approach to the allocation of bushfire hazard levels. As such, the 'extreme' and 'moderate' levels of bushfire hazard identified in the pre-development assessment remain consistent in the post-development assessment with the exception of cleared areas which represent a 'low' bushfire hazard.

The post-development scenario will be revisited at the subdivision stage where further detailed landscaping and lot layouts will be available.

It should be noted that where of dwellings are within 100m of vegetation assessed as having 'extreme' or 'moderate' bushfire hazard level implementation of increased building construction standards may be required.

The proposed movement network (explored further in Section 5.3) appropriately satisfies the requirements of the Guidelines for Planning in Bushfire Prone Areas with suitable linkages proposed to future and existing development on adjacent landholdings. Two primary north-south linkages traverse the Structure Plan area, ensuring all residents and visitors of the development are provided with at least two vehicular access routes connecting to the surrounding public network at all times. In total, five significant access and egress points are proposed by the Structure Plan.

5.3 Proposed Movement Network

An updated Transport Impact Assessment (September 2021), prepared by Transcore, identifies projected traffic volumes and suggested road hierarchies in and adjacent to the Structure Plan area (Appendix 5 refers). Key findings from the report include:

Access to the Structure Plan area is proposed via the following key entry points:

- A roundabout treatment at the intersection of Chittering Road and Maroubra Avenue to allow full movement connection into the Structure Plan area.
- A key 4-way intersection on Great Northern Highway, near the District Activity Centre. This may either be a signalised intersection or a roundabout.
- A key 3-way intersection on Chittering Road, south of Sacri. This is the northern access point of the Chittering Road re-alignment through the site.
- Two major access and egress points are provided within the south of the Structure Plan area, which will connect to future development sites.
- One additional major access point is provided to the north, linking with existing residential development.
- Other minor points of access and egress, to be detailed at future planning stages, will be provided within the Structure Plan area to ensure a legible road network.

The proposed road hierarchy for the Structure Plan area is illustrated in Figure 4.

The road hierarchy focuses on the provision of three key north-south roads:

- The existing Chittering Road which is re-aligned to enter the Structure Plan area. The existing portion of Chittering Road connecting with Maroubra Road is an Integrator B. The portion of Chittering Road south of Maroubra Road is a Neighbourhood Connector A which provides access into the Structure Plan;
- Neighbourhood Connector A road which runs within the Structure Plan to the west. This provides connection from the District Activity Centre and the future school site to northern section of the Structure Plan across Ki-It Monger Brook.
- Neighbourhood Connector A which runs within the Structure Plan to the east. This provides connection through the Structure Plan area to the hinterland to the north.

The road network is based on a modified grid format; this provides a legible road hierarchy providing residents with defined directional ('way finding') routes to key nodes within and around the site. The key north-south roads serve as the connection into the Structure Plan area and the feeder roads to all lower order Neighbourhood Connectors and Access Streets.

Where lots front a road over with a volume of 5,000vpd or more, they are to be designed either so vehicles entering the street can do so travelling forward or provided with alternate forms of vehicle access.

A description of each of the proposed internal roads included in the Structure Plan area is provided herein.

5.3.1 Integrator B

Integrator B roads are proposed in the Structure Plan area in two locations:

- Along the existing Chittering Road alignment, north of Maroubra Avenue; and
- From the four-way intersection of Great Eastern Highway to the District Activity centre, connecting to two Neighbourhood Connector A roads;

With respect to the existing Chittering Road alignment through to Marourabra Road, a variation to the standard LN Integrator B cross section of 25.0m – 29.2m is proposed at 20m. The variation is incorporated on the basis that this existing section of Chittering Road is constrained by land nominated as Bush Forever on its western boundary and Public Open Space, landscaping or proposed frontage roads within the Structure Plan area on its eastern boundary.

The constraints on the eastern boundary negate the requirements for on-street parking for this section of Chittering Road and substantially reduces the verge width required for underground services.

The 20.0m cross section includes 7.0 of trafficable pavement, two 1.5m cycle lanes, 2.0m median strip and 4.0m verges to both sides. The design intent is to maximise retention of existing trees and, overall, to create a low speed environment that will help integrate the existing town with the site. An indicative depiction of this cross-section is provided below as Figure 17.

The southern Integrator B section, connecting through to Great Northern Highway, is expected to have a road design and width in accordance with LN. The road design may consist of a cross-section between 25.0m and 27m.

This 2-lane boulevard style road may comprise 7.5m wide pavements, incorporating 3.2m carriageways, 1.8m cycle lane and 2.5m on-street parking bays, a 3.0 - 4.0m central median and 3.5m – 5.0m verges to provide a suitable space in which to accommodate landscaping and a shared path.

Verges may be further reduced if parking is embayed. An indicative depiction of this cross-section is provided below as Figure 18.

Width of the road design will respond accordingly to environmental and urban design factors such as tree retention and proximity to the District Activity Centre.

Integrator B roads are suitable for traffic flows up to 15,000vpd and can accommodate traffic flows up to 20,000vpd with suitable intersection treatments.

FIGURE 8: Intergrator B Cross Section 20m

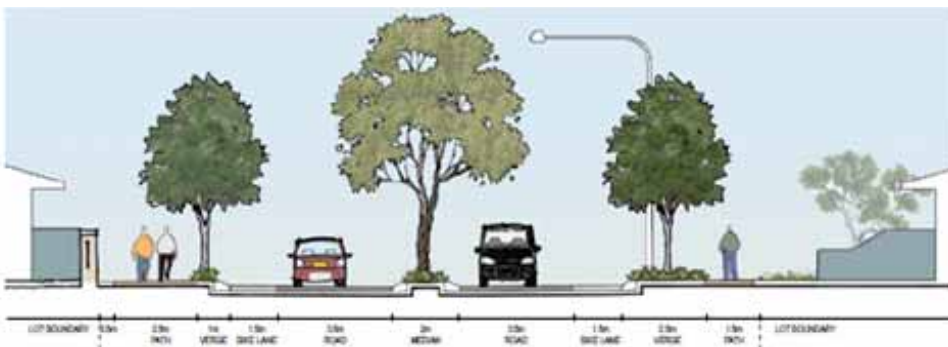
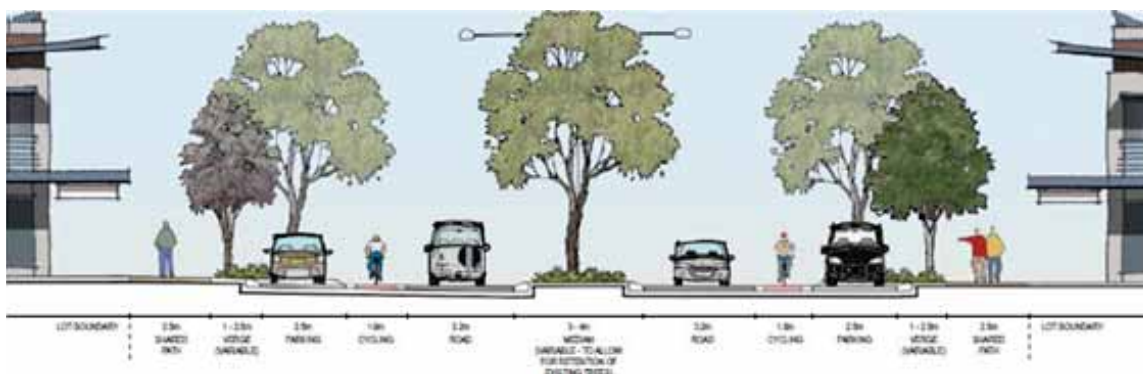


FIGURE 9: Intergrator B Corss Section 25-27m



5.3.2 Neighbourhood Connectors

A mix of Neighbourhood Connector A and B roads are proposed throughout the Structure Plan area and primarily facilitate key east-west linkages.

5.3.3 Neighbourhood Connector A

The western 'north-south' Neighbourhood Connector A will provide a key spinal road linkage from development in the north, to future District Activity Centre and school site.

The main difference between Integrator B and Neighbourhood Connector A cross-sections is the width of the median (6.0m compared to 2.0m).

The road design will generally consist of a 7.1m single carriageway which incorporates 2.1m on-street parking, a 1.5m cycle path and 3.5m trafficable pavement. The Neighbourhood Connector A also includes a 4.1m verge (which may be reduced if parking is embayed) and a 2.0m median.

Where the Neighbourhood Connector A acts as an extension of the existing Chittering Road alignment a reduced road reserve of 20.0m may be accepted where on-street parking is not required. An indicative depiction of this cross-section is provided below as Figure 19.

The road design may potentially widen to accommodate a 'living stream'. The 'living stream' is intended to convey stormwater within dedicated road reserve and provide a 'green-link' as reflected in the Landscape Strategy.

The road design under both scenarios (status quo and 'living stream') will be sufficient to accommodate shared paths, dedicated on-street parking, landscaping/tree planting and provision of infrastructure services.

Neighbourhood Connector A roads may accommodate traffic volumes up to 7,000vpd.

5.3.4 Neighbourhood Connector B

The proposed Neighbourhood Connector B roads provide supplementary east-west connectivity within the Structure Plan area. The primary difference between Neighbourhood Connector B and Neighbourhood Connector A is the lack of a median strip as well as dedicated cycle path.

The road design will generally incorporate a 19.4m cross section which comprises a 7m wide trafficable pavement and 6.2m wide verges on both sides which incorporate on-street parking, footpath and landscaping. Similar to Neighbourhood Connector A, the verge width may be reduced if embayed parking is provided.

Alternatively, subject to detailed design, a reduced trafficable pavement width of 6m may be proposed and offset with a median strip and/or additional landscaping as well as potential for footpaths on both sides of the street.

Neighbourhood Connector B roads are suitable for traffic flows up to 3,000 vpd.

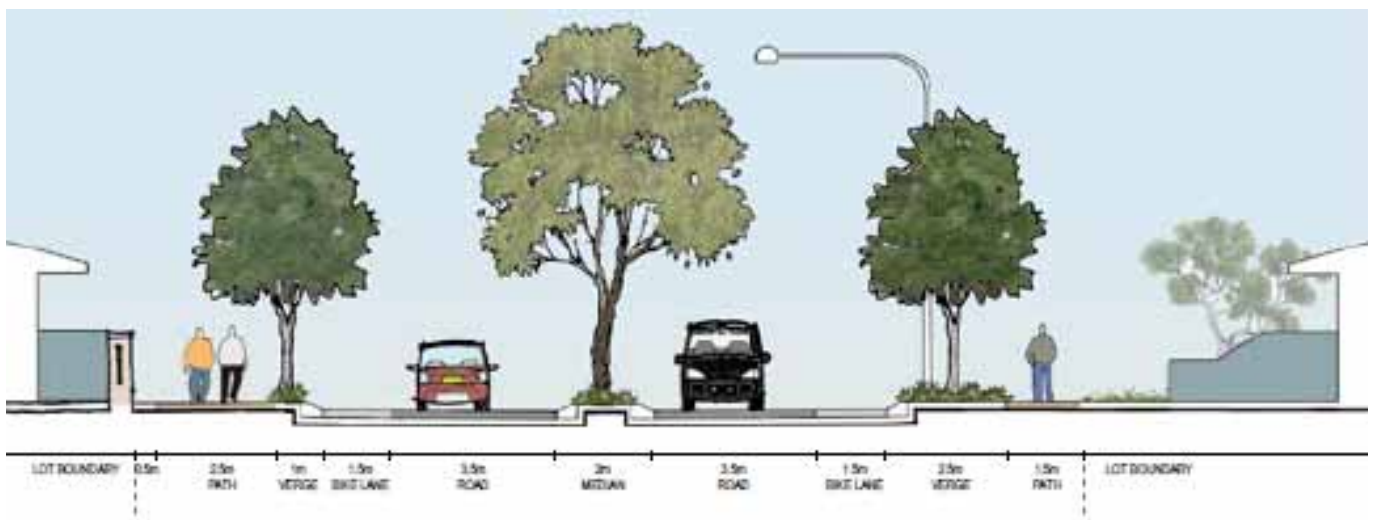
5.3.5 Access Streets

Generally, local access streets serving residential land uses will comprise 16m road reserves with 5.5m wide trafficable pavement, 4.0m verges to each side (incorporating 1.5m footpaths) as well as the opportunity for a 2.5m on-street parking bay to one side.

Projected traffic volumes for this type of road are expected to be less than 1,000 vpd.

Where fronting public open space, Access Street verges may be reduced to minimum 2.5m depending on the location and alignment of services, street parking and pedestrian traffic.

FIGURE 10: Neighbourhood Connector A Cross Section 20m



5.3.6 Public Transport

The Structure Plan area currently has access to the 311 bus service which runs on Great Northern Highway adjacent to the Structure Plan area. The 311 provides six bus services each way on weekdays and two on Saturdays, Sundays and public holidays. It is also noted that the DSP envisages a bus depot within the DAC or surrounds.

The Structure Plan design allows for bus services on all of the proposed Neighbourhood Connector and Integrator B roads, which are a suitable standard to accommodate bus services. This allows flexibility for the Public Transport Authority to plan future bus routes within this area.

5.3.7 Pedestrian and Cycle Infrastructure

In accordance with the requirements of Liveable Neighbourhoods, paths are to be provided to both sides of all Integrator B and Neighbourhood Connector roads, with at least one side being a shared path.

All Access Streets are to have a shared path or footpath on at least one side of the carriageway subject to local demand.

5.4 Landscape Strategy

A Landscape Strategy (Appendix 6), including a Landscape Master Plan has been prepared by Emerge Associates in support of the Structure Plan.

The positioning and configuration of POS areas is influenced by the desire to provide a continuous east-west 'green-link' through the Structure Plan area; this to enhance and improve pedestrian connectivity and synergy between key POS areas.

The 'green-link' and 'linear' POS layout will enable a safe, attractive and appealing pedestrian link (focus) across the entire Structure Plan area. Also of importance is the role it will play in providing a drainage function.

A total of 15 'neighbourhood' POS areas and one 'local' POS area is proposed throughout the Structure Plan area. These areas of POS will generally be informal in nature and characterised by revegetation and native parkland plantings to encourage passive recreation uses. Additionally, they will provide local residents with areas of localised turf for informal active recreation.

POS 17 is significantly larger than the other 'neighbourhood' POS providing approximately 2.94ha of creditable open space. The purpose of this POS is primarily to provide for the retention of trees in an area nominated as a 'specific commitment area' under the Draft Green Growth Plan.

Linkages with adjoining residential streets and the linear POS network will provide the necessary access to these significant areas of POS. The POS areas will form an interconnected series of spaces along the linear park network, each with the potential to offer rest areas for elderly or disabled residents, or exercise stations for others.

Drainage areas may be required within these areas of POS. Where drainage is required landscaped basins will be provided to serve a recreational and amenity function. Drainage swales catering for events greater than a 1:5 event will have turf to enable multiple use and ease of maintenance.

Within each POS, the extent of hardscape and 'urbanity' of the space will increase in proximity to the Town Centre.

The POS are proposed to create areas of local amenity within 400m of most dwellings.

5.4.1 Linear Open Space Network

In order to address the requirements of retaining site topography and the principles of protecting existing trees and ecological linkages where possible, the Structure Plan has incorporated a series of linear open spaces.

The design intent of these spaces is to rehabilitate existing vegetation as well as incorporate existing stands of isolated trees and drainage alignments. Through respecting the existing topography in these areas, the linear POS will provide a necessary drainage function as well as provide visual amenity to the public realm.

As surrounding lots and roads required imported fill to ensure suitable structural conditions for housing, these linear parks will sit at a lower grade. This will ensure that drainage will flow towards these areas and discrete biofiltration and detention basins will be incorporated along the length of the linear parks. A system of inlet and overflow structures will ensure designated parkland areas are kept dry and usable.

Linear parks and widened road reserves, as well as serving environmental and drainage function, also provide an efficient means of supporting a legible cycle and pedestrian network. This network will be designed to encourage passive surveillance from overlooking residents in accordance with Liveable Neighbourhoods and best practice in terms of 'Designing out Crime'.

5.4.2 Living Streams

Due to the requirement to convey stormwater reliably away from high use areas; a system of shallow 'living streams' will be created in the larger POS areas, broader sections of linear parkland and widened road reserves. This system will see to mimic pre-development flows and enable upstream bio-filtration and recharge of the groundwater table.

Through the linear parks the living stream may include an interface with a dual use path (DUP). There will be native shrub planting on the banks and nature reed/sedge planting to enhance nutrient uptake. Bank stabilisation is to be incorporated into the design and a variety of tree species will be used to provide a diverse tree canopy. Treatment along the length of the stream will be dependent upon the width of the corridor and the engineering constraints. The living stream will provide not only a viable drainage function but also a variety of ecological zones and restoration opportunities.

5.4.3 Ki-It Monger Brook

The Ki-it Monger Brook provides a valuable natural landscape resource that contains existing remnant vegetation along a natural drainage corridor. Existing remnant vegetation is in a degraded state, however rehabilitation works will be undertaken interlaced with passive recreation opportunities through walking trails and formalised parkland nodes.

The interface area with the Ki-It Monger Brook will consist of rehabilitated endemic planting interlaced with passive recreation opportunities through walking trails and formalised parkland nodes. These nodes will form Neighbourhood POS and provide settings for picnics and informal gatherings as well as opportunities to incorporate nature play areas. Supplemental planting adjacent to the Ki-it Monger Brook will limit direct public access and where possible an informal dual use path system may extend along the length of the interface area to define public use and to discourage turf and weed encroachment. It is not proposed that any drainage be introduced into the interface areas beyond that required to maintain pre-development flows.

FIGURE 11: Ki-it Monger Brook Cross Section



5.4.4 Street Trees

Where possible, the retention of existing stands of scattered and isolated trees may be incorporated into public open space or through the creation of wider road reserves.

Street trees are a desirable design element to increase shade and amenity. The selection and placement of street trees may very dependant of the road hierarchy. It is proposed that along major roads, street trees will form a strong visual avenue, and not impede traffic flow, safety or sightlines.

In residential streets, the roads may vary in character from precinct to precinct; however they are characterised as smaller scale pedestrian friendly environments. Therefore, street trees may be of a smaller scale and take advantage of passive solar principles allowing summer shade and winter sun. As the road reserve widths may vary to allow for the retention of existing vegetation and the interconnection of the linear park network, it may be possible to retain clusters or groupings of trees within road reserve. This will be investigated and reviewed at the detailed design stage.

5.5 Public Open Space Contribution

A POS Schedule has been prepared for the Structure Plan area (refer Table 3) which illustrates compliance with the 10% creditable POS requirement in accordance with Liveable Neighbourhoods. The location of each area of POS is identified on Figure 21.

The areas of POS within the Structure Plan area have been separated into broad categories based on their specific treatments and design. The Structure Plan proposes a total of 15 areas of creditable Public Open Space (POS).

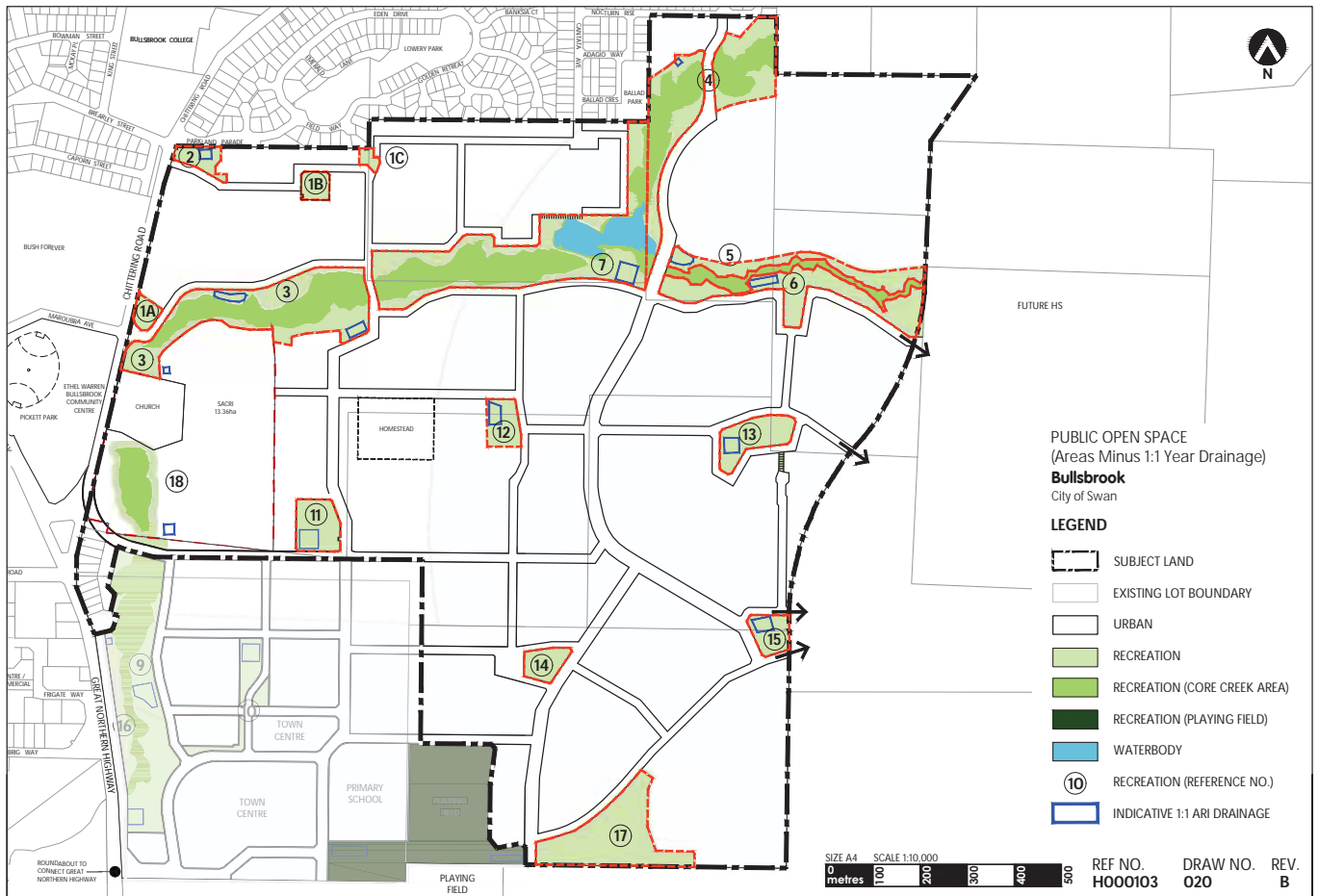
TABLE 2: Public Open Space Schedule

GROSS SITE AREA			207.32 ha
DEDUCTIONS			
Church	2.06 ha		
Recreation (Core Creek Area)	13.20 ha		
1:1 Year Drainage	1.66 ha	16.92ha	
Gross Subdivisible Area			190.4 ha
Public Open Space @ 10%			19.04 ha
PUBLIC OPEN SPACE CONTRIBUTION			
May Comprise:			
Minimum 80% unrestricted public open space		15.23 ha	
Maximum 20% restricted use public open space		3.81 ha	19.04 ha
UNRESTRICTED PUBLIC OPEN SPACE SITES			
Local and Neighbourhood Parks (area minus 1:1 year drainage area)			
1A		0.30 ha	
1B		0.35 ha	
1C		0.16 ha	
1 (Total 1A + 1B + 1C)	total		0.81 ha
2			0.47 ha
3			2.87 ha
4			1.45 ha
5			1.40 ha
6			2.12 ha
7			3.61 ha
8			
9			PP
10			PP
11			0.98 ha
12			0.67 ha
13			1.67 ha
14			0.72 ha
15			0.49 ha
16			PP
17			2.94 ha
18			1.16 ha
TOTAL			21.36 ha
RESTRICTED USE PUBLIC OPEN SPACE SITES			
Drainage filtration area between 1:1 and 1:5 year (forms part of the local and neighbourhood parks)	0.70 ha		
TOTAL			22.06 ha
Public Open Space Provision	0.70 ha	21.43 ha	11.59 %

(PP - included in Precinct Plan)

The POS Schedule will be continually reviewed under the more detailed subdivision and engineering design stages, as drainage provision, earthworks and nett residential development cells are further adjusted.

FIGURE 12: Public Open Space



5.6 Water Management

A Local Water Management Strategy (LWMS) has been prepared for the Structure Plan area developed in accordance with Better Urban Water Management (WAPC 2008), State Planning Policy 2.9 Water Resources (WAPC 2006) and Planning Bulletin 92 Urban Water Management (WAPC 2008) (Appendix 3 refers).

The below information represents a summary of the primary objectives and strategies outlined in the LWMS report:

- Utilise fit for purpose water sources throughout the development by abstracting groundwater from the Perth Superficial Aquifer from the Cockman Bluff Subarea.
- Achieve a consumption target for water of 100 kL/ person/yr, including not more than 40–60 kL/person/year scheme water through the use of water efficient fixtures and fittings within households, as well as encouraging homeowners to install rainwater tanks (amongst other water wise practices in the home).
- Retain and treat stormwater runoff from constructed impervious surfaces from the first 15 mm rainfall event. To achieve this the majority of lots will have onsite soakwells whilst bio-retention basins will be used for retaining, treating and infiltrating the first 15mm rainfall event from road reserves and a small number of connected lots.
- Investigate opportunities to incorporate street-scale infiltration devices (e.g. tree pits and rain gardens) where possible.
- Incorporate a pit and pipe system to ensure roads will remain passable in the 5-year rainfall event.
- Protection of infrastructure and assets from flooding by ensuring habitable floor levels provide a minimum 0.5m vertical clearance from watercourse flood levels and 0.3m clearance from local drainage systems.
- Provide storage and delineate flow paths for the 1% AEP event. This will be achieved by providing flood storage to maintain the pre-development hydrology of the Ki-it Monger Brook and provide flood paths for overland flows within the Structure Plan area along road reserves.
- Maintain clearance between the finished lot levels and groundwater level of at least 1.2m.
- Groundwater quality leaving the site should be the same, or better, than that entering the site. This can be managed through the minimisation of fertilizer and pesticide use in Public Open Space and streetscapes.
- Utilise appropriate structural and non-structural measures to reduce nutrient loads to the Ki-it Monger Brook and downstream waterways.

- The LWMS also provides a comprehensive summary of the existing environmental values of the Structure Plan area, which are based on site-specific studies undertaken and review of publicly available data. The characteristics and environmental values of the Structure Plan area and guidance provided by National and State policies and guidelines relevant to urban water management have guided the design criteria and propose a contemporary best practice approach to achieving the design objectives for water management.

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 can be achieved within the spatial allocation of the Structure Plan, and that the requirements of the relevant State and local government policies and guidelines will be satisfied.

5.7 Services and Infrastructure

A Servicing Report (Appendix 7 refers) has been prepared in support of the Structure Plan and is summarised herein.

5.7.1 Ground Conditions

The following is a summary of the investigative reporting provided by Galt Geotechnical Consultants and is an overview of the likely soil types that will be encountered and proposed remedial measures.

Mapping indicates that the site is underlain by a variety of soil and rock types. The western part comprises mainly soil deposits while the eastern part is underlain by shallow rock and rock outcrop. The following notes are relevant:

- Generally soils over the western portion of the site are sandy overlaying clay/sandy clay.
- Generally soils over the eastern portion of the site are clays/ clayey sand overlaying rock (siltstone/gravel/gneiss).
- The soils are generally moderate to high reactive clay/clays soils with high percentage fines and low permeability.
- The site is predominantly classed as M abd S, with some existing class A in the northern portion of the site.
- The general remediation suggested is:
 - Strip 100mm topsoil and grub, remove deleterious material.
 - All excavated sand shall be reused as inert structural fill. The underlying clayey sand can be used for bulk fill (non-structural) only.
 - Proof roll and lay inert clean structural fill with less than 5% fines at depths relevant to required classifications (>1.8m fill for class A, 1-1.8m fill for class S).
- For areas where subgrade has >0.5m inert structural fill a CBR of 12 can be adopted for pavement design.
- Drainage can be managed via infiltration only where clean sandy fill is present to a depth of 1.2m. Detailed geotechnical investigations are required prior to further development.

It is recommended that an allowance is made to fill the class M areas of the site by either 0.7m or 1.5m respectively to achieve class S or A classifications in accordance AS2870- 2011 "Residential Slabs and Footings". This is based on the conservative assumption there is an average of 300mm of sandy fill overlaying the site. Ultimately this will have to be confirmed by intrusive geotechnical investigations.

5.7.2 Sewage

The Water Corporation (WC) advised the project engineers (JDSi) that the development is located within the current scheme planning and a connection to gravity sewer has been provisioned for. The current Bullsbrook WWTP only services the Bullsbrook town centre and is near capacity.

The Water Corporation has recently advised that the WWTP will be converted into a major transfer station with the additional flows created by the landholdings being rezoned to be pumped from Bullsbrook to Ellenbrook via a major transfer pipeline. The Water Corporation has advised that this project should be completed by mid 2023.

5.7.3 Water Supply

The Water Corporation (WC) has advised that the Structure Plan area is located within the current scheme planning and a connection to water reticulation has been provisioned for under an upgrade of the existing infrastructure located within Great Northern Highway (GNH).

The WC had completed the planning study for the delivery of additional water services to the Bullsbrook area. This included supply to the residential area on the eastern side of Great Northern Highway and Chittering Road including the proposed development site. WC advised that supply to the Structure Plan area would be via a new DN300 distribution main between Great Northern Hwy and Hurd Road installed to the west of the site along Chittering Road.

5.7.4 Power Supply

The Western Power Network Capacity Mapping Tool indicates that there is enough capacity to feed the estimated ultimate 2500+ lots. JDSi can advise that a feasibility study was recently undertaken that indicates the remaining capacity on the existing 22kV feeder adjacent to the development was approximately 4MVA. Beyond the initial supply, reinforcement of the upstream 22kV feeder line, and voltage regulator may also be required. The development will also require a number of transformers, switchgear units and associated low voltage cable and pillar infrastructure to service the lots.

5.7.5 Telecommunications

NBN will be the primary telecommunication service provider for the Structure Plan area. NBN Co has advised that the development can be serviced from their existing infrastructure in the vicinity of the site.

After NBN connectivity for the development has been established at the boundary of the development, connections of future subdivision lots to the network will thereafter be managed stage by stage.

5.7.6 Gas

The Bullsbrook area currently has no reticulated gas network. Reticulated gas is not considered to be an essential service and as such is not required as a condition of subdivision. It is usual practice to install gas reticulation network for the subdivision within a common civil trench at no cost to the developer. If there is an extension required to connect to the nearest high pressure gas main the developer will be required to pay for the trenching to the gas main as a headworks cost.

Consideration may be given to the option of the developer funding the installation of a “dormant” internal gas network to the subdivision vested with ATCo Gas that could be connected into ATCo mains at some point in the future. ATCo have agreed in principle to assess such a proposal and ensure the design meets with ATCo standards.

5.7.7 Roads

The traffic movement patterns for the Bullsbrook area have changed substantially when the Perth Darwin National Highway was constructed with most heavy vehicle traffic moving to the new road from Great Northern Highway. This change has reduced the movements of heavy vehicles adjacent to the Structure Plan area, promoting improved traffic conditions for local vehicles.

All internal roads will be developed to the standards of the City of Swan.

5.7.8 Stormwater Management & Drainage

The Structure Plan area is subject to a drainage strategy which proposes the management of runoff through a pit and pipe system within road reserves, with outfall into bioretention swales incorporated into POS areas. Lot runoff will generally be managed via onsite infiltration where possible.

5.8 Staging

The development of the Structure Plan area will be implemented in multiple stages and is indicative as the timing, location and composition of the future stages will be dependent on market demand.

The staging has commenced in the north-western portion of the site, with access provided via Chittering Road and developed for Display Village, Sales Office and ‘first release’ residential purposes.

The staging will move eastwards and southwards with a view to deliver the District Activity Centre /Town Centre.

The provision of engineering infrastructure and primary internal road network will also need to be staged to suit development demand and/or suitable access at an early stage. A detailed programme for this will be prepared as part of ongoing detailed planning and design of service infrastructure.

Appendix 1

Bushfire Management Plan

(Strategen JBS&G)

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: Kingsford Residential Estate

Suburb: Bullsbrook

State: WA

P/code: 6084

Local government area: City of Swan

Description of the planning proposal: Amended Structure Plan

BMP Plan / Reference Number: 60919/137,082

Version: R03 Rev 5

Date of Issue: 13/09/2021

Client / Business Name: Okeland Communities

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)?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
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)?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Is the proposal any of the following special development types (see SPP 3.7 for definitions)?		
Unavoidable development (in BAL-40 or BAL-FZ)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Strategic planning proposal (including rezoning applications)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Minor development (in BAL-40 or BAL-FZ)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
High risk land-use	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Vulnerable land-use	<input type="checkbox"/>	<input checked="" type="checkbox"/>

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 amended Structure Plan constitutes 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	BPAD37803	31/08/2022
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 13/09/2021

Okeland Communities
Bushfire Management Plan (amended Structure Plan)
Kingsford Residential Estate, Bullsbrook

13 September 2021
60919/137,082 (Rev 5)

JBS&G Australia Pty Ltd T/A Strategen-JBS&G

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Appendix B	Summer wind profiles for Pearce RAAF weather station
Appendix C	Landscape Masterplan (Emerge 2019)
Appendix D	City of Swan Fire Hazard Reduction Notice (as amended)

1. Introduction

1.1 Background

Okeland Communities is developing Kingsford Residential Estate in Bullsbrook as part of an approved Structure Plan, subdivision and staged clearance process. This strategic level Bushfire Management Plan (BMP Rev 5) has been updated to capture detail from the proposed amended Structure Plan in relation to anticipated zoning of new "Residential Development" land in the eastern portion of the site.

The project area applies to the following properties incorporated within the amended Structure Plan area:

- Lots 2, 3, 4, 5, 6 and 2510 Great Northern Highway
- Lots 2 (D061060), 2 (D024417) 7, 8, 9, 10, 1396, 900 and 901 Chittering Road
- Lot 1165 Hurd Road.

The amended Structure Plan (Figure 1) identifies the previously approved Structure Plan and Precinct Plan areas, as well as areas relating to the amended Structure Plan component to the east, which is primarily proposed for residential development, Public Open Space (POS) and neighbourhood connector roads.

A portion of the project area is designated as bushfire prone on the WA *Map of Bushfire Prone Areas* (DFES 2019; Plate 1) due to the extent of on-site and adjacent vegetation. As a result, Strategen-JBS&G has prepared this BMP to inform strategic planning and fulfil the following key objective:

1. Accompany submission of the amended Structure Plan in order to meet planning requirements triggered under Policy Measure 6.3 of *State Planning Policy 3.7 Planning in Bushfire-Prone Areas* (SPP 3.7; WAPC 2015).

The following information is required as part of this BMP to accompany the amended Structure Plan to address SPP 3.7 Policy Measure 6.3:

- results of a Bushfire Hazard Level (BHL) assessment determining the applicable hazard level(s) across the subject land in accordance with methodology set out in *Guidelines for Planning in Bushfire-Prone Areas* (the Guidelines; WAPC 2017) – refer to Section 2.3, Section 2.4, Figure 5 and Figure 6
- identification of any bushfire hazard issues arising from the relevant assessment – refer to Section 2.5
- clear demonstration that compliance with the bushfire protection criteria in the Guidelines can be achieved in subsequent planning stages – refer to Section 4 and Table 3

This BMP has been prepared in accordance with the Guidelines and addresses the above information requirements to satisfy SPP 3.7 specific to the strategic planning stage for this project.

1.2 Purpose and application of the plan

The purpose of this BMP is to provide strategic level guidance on how to plan for and manage the bushfire risk to future assets of the project area by demonstrating a commitment from the developer to implement a range of bushfire management measures at future planning stages. The BMP outlines how future on-site assets can be protected during the summer months when the threat from bushfire is at its peak. This is particularly relevant when existing fire appliances in the area may be unable to offer an immediate emergency suppression response; therefore, development planning and design should aim to provide mitigation strategies that protect future life and property from bushfire as a priority.

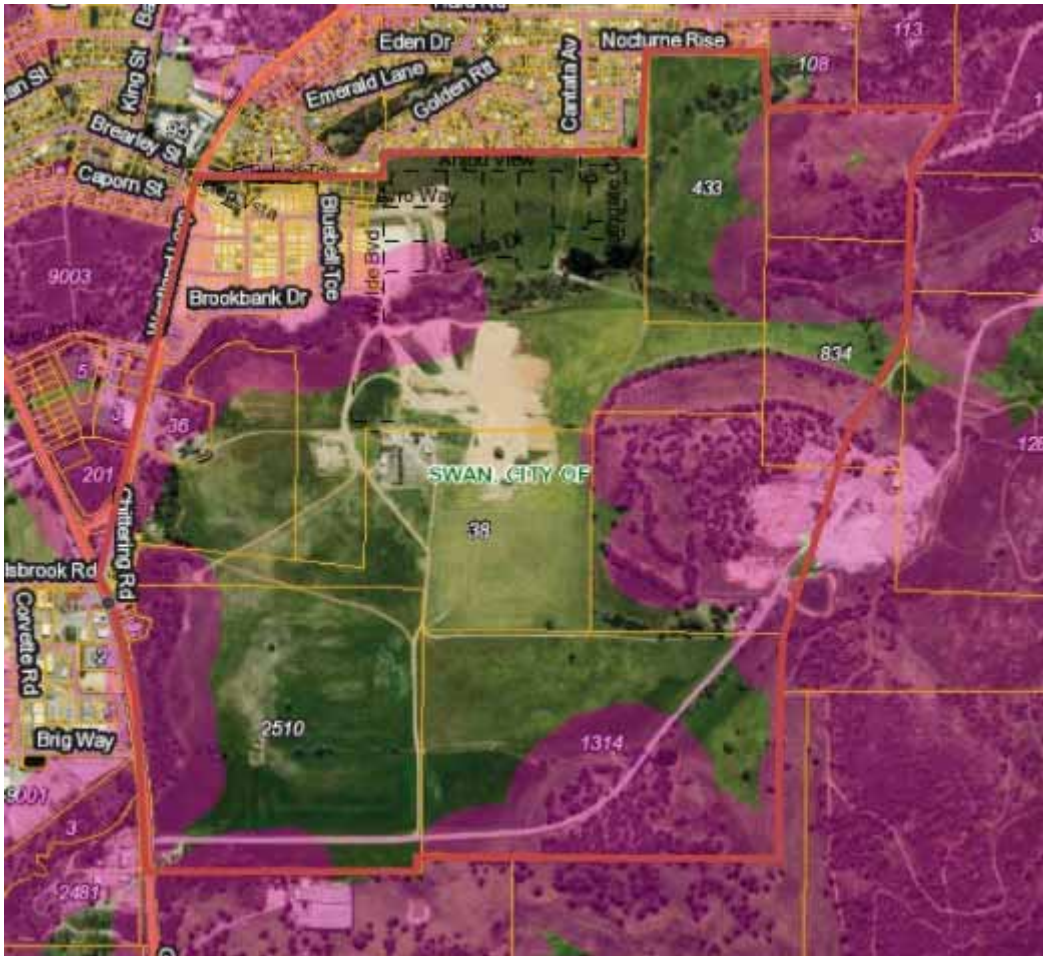
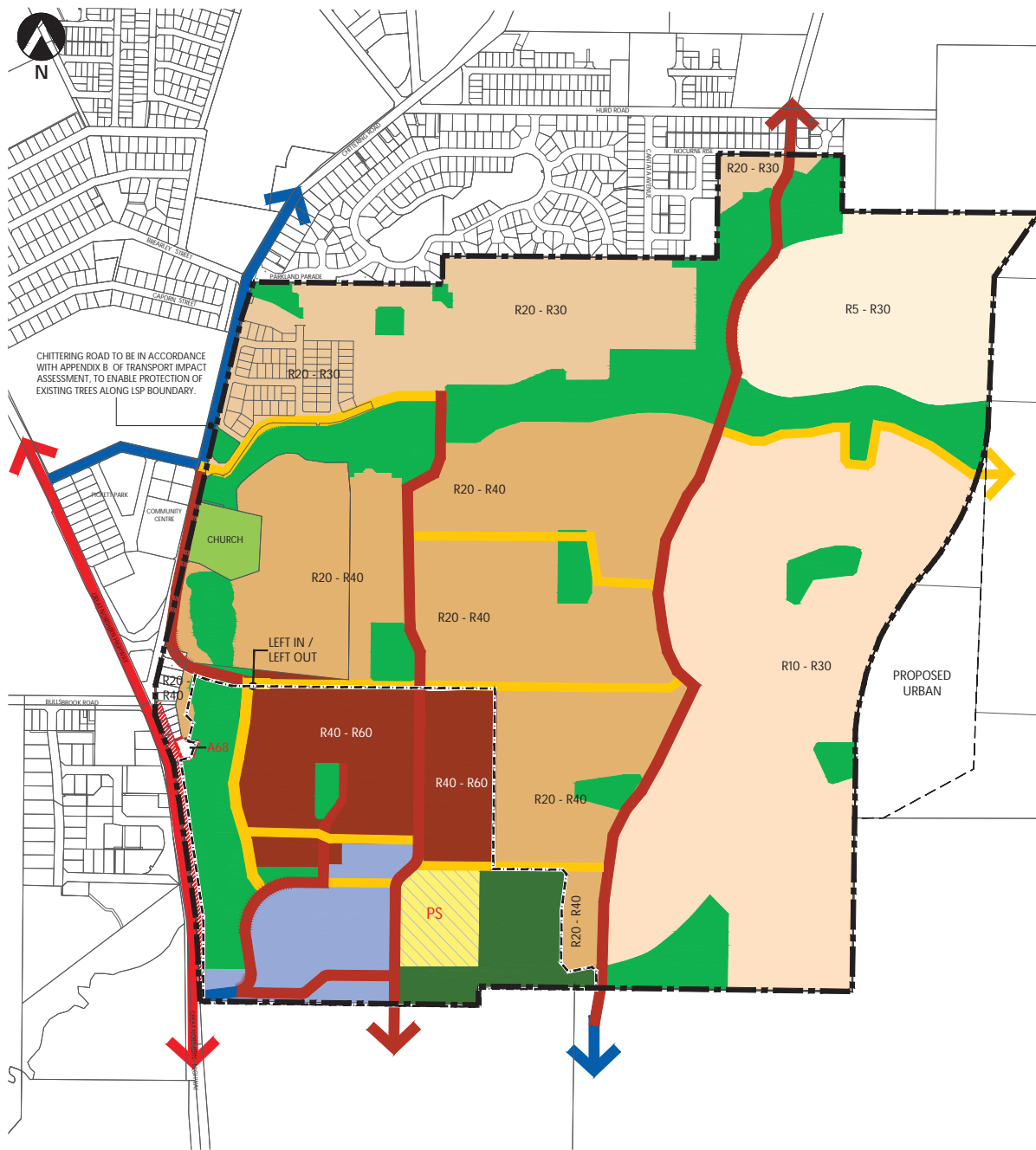


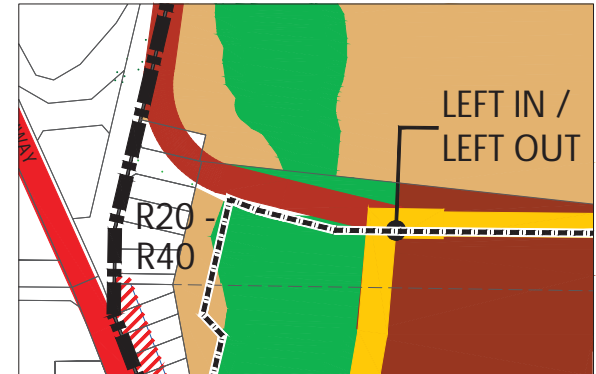
Plate 1: WA Map of Bushfire Prone Areas (DFES 2019)



CHITTERING ROAD TO BE IN ACCORDANCE WITH APPENDIX B OF TRANSPORT IMPACT ASSESSMENT, TO ENABLE PROTECTION OF EXISTING TREES ALONG LSP BOUNDARY.

LEFT IN / LEFT OUT

- LEGEND**
- LOCAL STRUCTURE PLAN BOUNDARY (254.61ha)
 - AREA SUBJECT TO FUTURE PRECINCT PLAN
- ZONES**
- RESIDENTIAL (R5-R30)
 - RESIDENTIAL (R10-R30)
 - RESIDENTIAL (R20-R30)
 - RESIDENTIAL (R20-R40)
 - RESIDENTIAL (R40-R60)
 - GENERAL COMMERCIAL
 - PUBLIC PURPOSE - PRIMARY SCHOOL
 - RECREATION
 - DISTRICT OPEN SPACE
 - PRIVATE CLUBS AND INSTUTIONS
 - PRIMARY REGIONAL ROAD
 - ADDITIONAL USES - SERVICE STATION
- RESERVES**
- PRIMARY DISTRIBUTOR
 - INTEGRATOR B
 - NEIGHBOURHOOD CONNECTOR A
 - NEIGHBOURHOOD CONNECTOR B



ENLARGEMENT



CADASTRAL INFORMATION
SOURCE: MNG
YYMDD: 161017
DWG REF: 97797de-006a
PROJECTION: PCG94

HATCH | RobertsDay

1:10,000
SIZE A3
0 metres 100 200 300 400 500

W ADD PROPOSED URBAN AREA
V NEIGHBOURHOOD CONNECTOR ADJUSTED
U UPDATE WITH ACP
T UPDATE WITH ACP
S UPDATE TEXT AND PLAN
REV DESCRIPTION

210811 SB TT
210129 SB DRAFT
210121 SB DRAFT
201106 SB DRAFT
200707 II EVDL
YYMDD DRAWN APPRD

KINGSFORD LOCAL STRUCTURE PLAN
Bullsbrook
City of Swan

REF NO. DRAW NO. REV.
AMX BUL RD1 107 W

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

2. Spatial consideration of bushfire threat

2.1 Existing site characteristics

2.1.1 Location

The project area comprises the following lots in Bullsbrook, located in the City of Swan:

- Lots 2, 3, 4, 5, 6 and 2510 Great Northern Highway
- Lots 2 (D061060), 2 (D024417) 7, 8, 9, 10, 1396, 900 and 901 Chittering Road
- Lot 1165 Hurd Road.

The project area is bound by the following (Figure 2):

- North: existing urban residential development
- South: adjacent rural land
- East: adjacent rural land
- West: Chittering Road, existing urban residential development (northwest), various City-owned land/reserves including Bullsbrook Bush Fire Brigade, vegetated Lots 9003 and 201 (west) and existing light industry (southwest).

2.1.2 Zoning and land use

The project area is currently zoned 'Residential Development' under provisions of the City of Swan Local Planning Scheme No 17.

Undeveloped portions of the project area currently contain grassland used for the grazing of livestock, while the Bullsbrook landfill facility occupies an area east of the site.

2.1.3 Assets

Aside from newly developed portions of the Stages 1 and 2 subdivision approval areas within the site, the project area contains limited property assets in the form of a farmhouse and associated outbuildings. Ongoing urban development will significantly increase these critical assets in that the number of residents, visitors and built assets will be intensified across the subject land.

2.1.4 Access

The project area is currently accessed via Chittering Road from the west and via numerous farm roads accessed from the driveway of the Bullsbrook landfill facility to the south and southeast. The driveway for the Bullsbrook landfill facility is accessed via Great Northern Highway (Figure 2). Aside from newly developed portions of the Stages 1 and 2 subdivision approval areas within the site, there are currently no bituminised access ways constructed within the project area, only a network of farm tracks and private driveways.

2.1.5 Water and power supply

Aside from newly developed portions of the Stages 1 and 2 subdivision approval areas within the site and the existing house within the project area (which are connected to the local power and reticulated water supply), the majority of the project area is not currently serviced by power or reticulated water.



Legend Project area Cadastral boundary POS Proposed road reserve Roads (MRWA)	Scale 1:12,000 at A4				Kingsford Residential Estate, Bullsbrook, WA SITE OVERVIEW FIGURE 2 	
	Coord. Sys. GDA 1994 MGA Zone 50			Z		
	Job No: 61312					
	Client: Amex Bullsbrook Unit Trust					
	Version: A		Date: 31-Aug-2021			
Drawn By: jcrute		Checked By: CT				

2.2 Existing fire environment

2.2.1 Classified vegetation

Pre-development vegetation classifications have been assessed for this site in accordance with methodology contained within *AS 3959–2018 Construction of Buildings in Bushfire-Prone Areas* (AS 3959; SA 2018). Strategen-JBS&G assessed vegetation classifications within the project area and adjacent 150 m through on-ground site investigation on 12 August 2016 and numerous additional assessments thereafter to support various stages of subdivision and clearance approval through to July 2021.

A summary of vegetation within the project area is provided below and depicted in Figure 3:

- Class B woodland occurs in association within Ki-It Monger Brook, which bisects the project area in the north, then aligns north-south along the site's western boundary
- other small pockets of Class B woodland are scattered throughout the site where canopy cover over grass is more dense
- Class G grassland occurs on all land occupied by pasture grasses/weeds with minimal canopy cover
- non-vegetated areas occur where vegetation has been removed for the construction of tracks, roads, firebreaks and buildings, excluded from classification under Clause 2.2.3.2 (e)
- low threat managed land occurs throughout newly landscaped areas adjacent to Ki-It Monger Brook and landscaping around the existing residence, excluded from classification under Clause 2.2.3.2 (f).

A summary of existing vegetation on land adjacent to the project area is provided below and depicted in Figure 3:

- Class A forest occurs to the east and northeast within properties vegetated with typical intact three tiered Jarrah/Marri forest fuels
- Class B woodland occurs:
 - * along the continuation of Ki-It Monger Brook to the southwest and east
 - * throughout numerous small remnants and linear arrangements to the south and east, including around the existing landfill facility
 - * opposite Chittering Road to the west within vegetated Lot 9003
- Class C shrubland occurs opposite Chittering Road to the west within vegetated Lot 201
- Class D scrub occurs opposite Great Northern Highway to the southwest
- non-vegetated areas to the north, west and south occur where vegetation has been removed for the construction of roads, residential development and the Bullsbrook townsite and these are excluded from classification under Clause 2.2.3.2 (e)
- areas where the vegetation is managed in a low threat, minimal fuel condition such as road verges and managed landscaping are excluded from classification under Clause 2.2.3.2 (f).

Strategen-JBS&G has compiled geo-referenced photographs taken during on-ground site investigation, which are contained in Appendix A and demonstrate the location, direction and classification of the pre-development vegetation extent observed.

Strategen-JBS&G emphasises that the vegetation extent discussed above and mapped in Figure 3 demonstrates pre-development (current) site conditions and does not consider any vegetation modification that will occur as part of proposed development.

2.2.2 Site topography

Strategen-JBS&G assessed pre-development site topography within the project area and adjacent land through a review of topographic contours and on-ground verification (Figure 3). Topographic elevation on site ranges from approximately 120 mAHD (Australian Height Datum) in the northeast and 44 mAHD in the southwest of the project area.

Aside from vegetation within Ki-It Monger Brook, vegetation within the project area is upslope or on flat land relative to proposed development. Ki-It Monger Brook is situated within a narrow, steep-sided gully, with slopes ranging from 4–14 degrees. However, an average down-slope of >0–5 degrees provides a more appropriate reflection of the effective slope under the vegetation with respect to potential bushfire behaviour for the purposes of BAL assessment in recognition that the short, sharp slope variations associated with the banks of Ki-It Monger Brook would not contribute significantly to predominant fire behaviour characteristics for this bushfire scenario.

Classified vegetation identified opposite Chittering Road and Great Northern Highway to the west of the project area was confirmed to be subject to a slight down-slope of >0–5 degrees in relation to proposed development.

2.2.3 Bushfire weather conditions

Worst case bushfire weather conditions

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 bushfire occurrence is at its peak. Worst case (adverse) bushfire weather conditions can 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 dangers, which are consistent with very high temperatures, low relative humidity and very strong winds. Based on the predominant summer climatic conditions of the local area, 'Extreme' and 'Catastrophic' fire dangers normally occur less than 5% of the time during the designated bushfire season, which equates to around six days between December and March (McCaw & Hanstrum 2003).

Predominant bushfire weather conditions

Predominant bushfire weather conditions are those that occur 95% of the time during the designated bushfire season. For Bullsbrook, these generally correlate with average January climatic conditions.

Mean January 9:00 am and 3:00 pm wind profiles for Pearce RAAF weather station (approximately 1 km west of the project area) are contained in Appendix B. These illustrate that the predominant winds during the designated bushfire season are from the east in the morning averaging around 17.9 km/h and from the southwest in the afternoon averaging around 20.4 km/h (BoM 2016).

Mean January 9:00 am and 3:00 pm relative humidity for Pearce RAAF weather station is approximately 48% and 30% respectively, with the January mean maximum temperature peaking at around 33.5°C (BoM 2016).

The predominant bushfire weather conditions discussed above correlate with an average Fire Danger Index (FDI) rating of 'High', as determined using the Commonwealth Science and Industrial Research Organisation (CSIRO) Fire Danger and Fire Spread Calculator (CSIRO 1999).

2.2.4 Bushfire history, fuel age, risk of ignition and potential ignition source

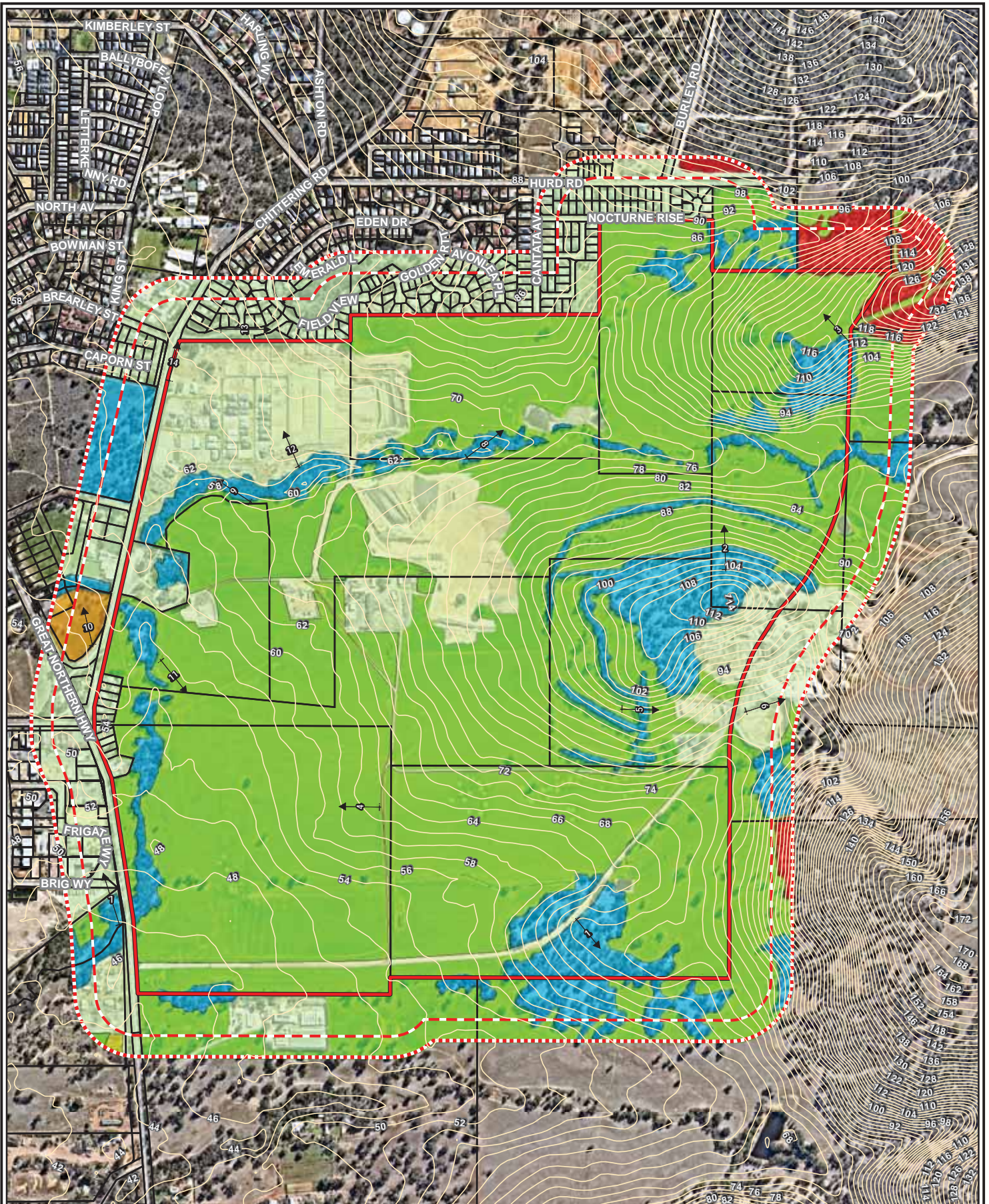
Bushfire history in the project area is infrequent and there is a lack of recent fire evidence over most of the project area; however, recent bushfires in the Perth Hills in 2011, Stoneville/Parkerville in 2013 and Wooroloo in 2021 have highlighted the need to consider bushfire planning for future developments in the area.

Available fuel loads within native vegetation areas are patchy and inconsistent due to variations in vegetation density, litter depth, trash height and the fragmented nature of the vegetation. Rural land to the south, east and west of the project area is a combination of unmanaged grassland, managed low fuels and woodland vegetation.

Since most bushfires are ignited by people, the current ignition risk is low due to the low levels of residency, public access and visitation throughout the site and surrounding rural landholdings. However, Strategen-JBS&G considers that the ignition risk, particularly within the project area, may increase following development intensification and increased levels of public access and resident occupancy at the bushland interface.

The potential sources of ignition in the area are expected to be from:

- deliberately lit fire (i.e. arson)
- lightning strike
- accidental causes, such as vehicle accidents and sparks from vehicle exhausts/machinery
- escapes from fuel hazard reduction burning
- pole-top fires
- incorrect disposal of cigarettes.



Legend	
	Project area
	100m assessment area
	150m assessment area
	Cadastral boundary
	Topographic contours (mAHD)
	Photo point directions
Vegetation classification	
	Class A Forest
	Class B Woodland
	Class C Shrubland
	Class D Scrub
	Class G Grassland
	Clause 2.2.3.2 (e) & (f)
	Roads (MRWA)

Scale 1:12,000 at A4	
Coord. Sys. GDA 1994 MGA Zone 50	
Job No: 61312	
Client: Amex Bullsbrook Unit Trust	
Version: A	Date: 31-Aug-2021
Drawn By: jcrute	Checked By: CT

**Kingsford Residential Estate,
Bullsbrook, WA**

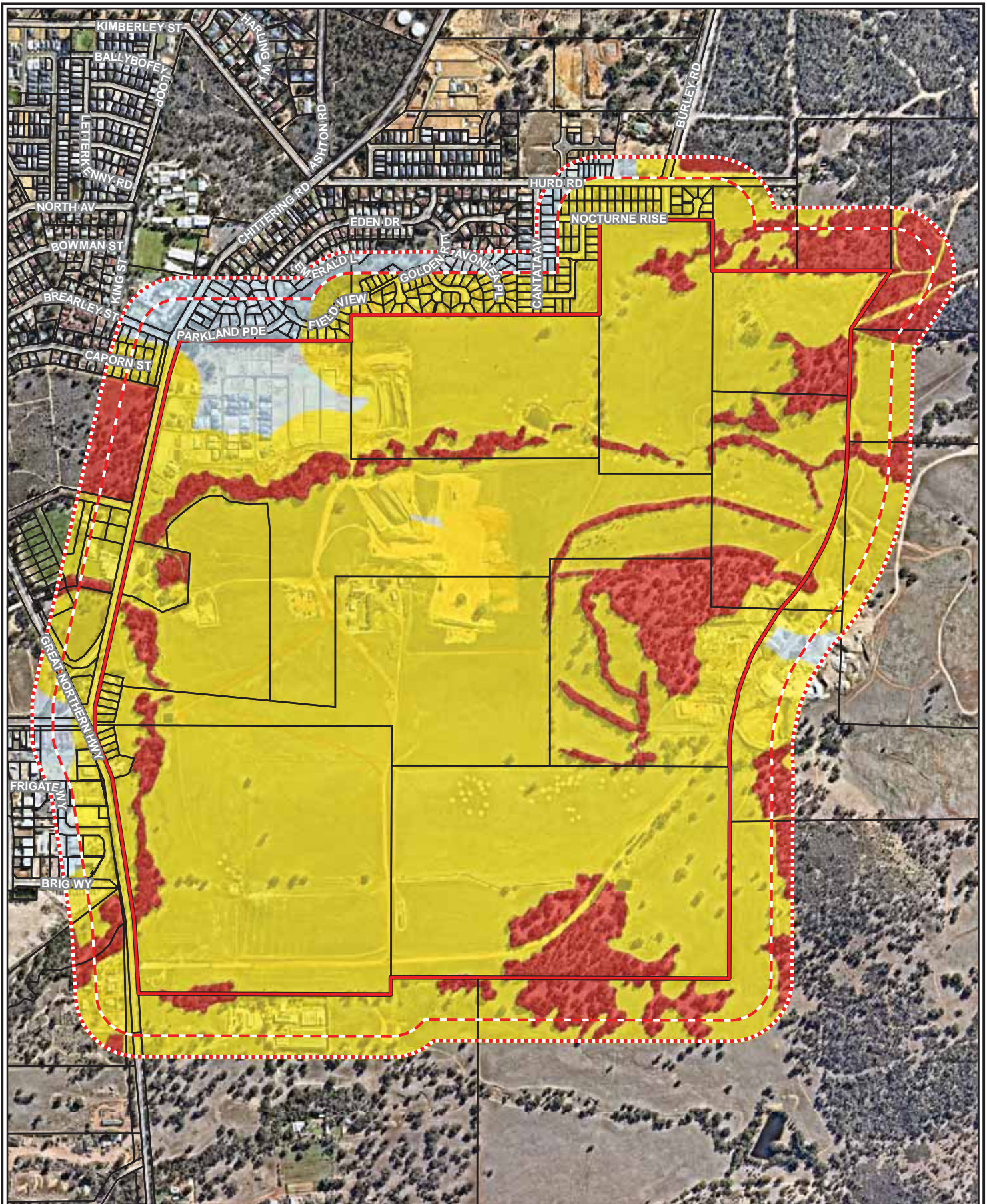
**PRE-DEVELOPMENT
VEGETATION CLASS
AND EFFECTIVE SLOPE**

FIGURE 3

2.3 Pre-development bushfire hazard level assessment

Pre-development bushfire hazard levels have been assessed for this site in accordance with methodology contained within the Guidelines, as per assessment results provided in Section 2.2. Strategen-JBS&G has mapped the existing bushfire hazard levels within the project area and adjacent land to indicate location and severity of pre-development bushfire risk and to enable the comparison between pre-and post-development risk. A summary of results is provided below and depicted in Figure 4:

1. All areas of Class A forest, Class B woodland and Class D scrub have been assigned an 'Extreme' bushfire hazard level. These include:
 - (a) existing Jarrah-Marri forest vegetation to the east and northeast
 - (b) existing woodland vegetation along Ki-It Monger Brook
 - (c) existing woodland vegetation retained in pockets and linear arrangements throughout the broader landscape east and south of the site
 - (d) existing woodland and scrub vegetation adjacent west of Chittering Road and Great Northern Highway.
2. All areas of Class C shrubland have been assigned a 'Moderate' bushfire hazard level. This includes existing vegetation within Lot 201 adjacent west of Chittering Road.
3. All areas of Class G grassland have been assigned a 'Moderate' bushfire hazard level. This includes the predominate rural extent within and adjacent south and east of the project area comprising pasture grasses.
4. All areas within 100 m of 'Extreme' and 'Moderate' hazards have been assigned a 'Moderate' bushfire hazard level.
5. All remaining areas that are currently excluded from classification under Clauses 2.2.3.2 (e) and (f) of AS 3959 have been assigned a 'Low' bushfire hazard level. This includes a portion of the existing approved and developed subdivisional area within the site and a small portion of land internal to the landfill facility east of the site.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- Hazard level Extreme
- Hazard level Moderate
- Hazard level Low
- Roads (MRWA)

Scale 1:12,000 at A4 0 100 200 metres

Coord. Sys. GDA 1994 MGA Zone 50 Z

Job No: 61312

Client: Amex Bullsbrook Unit Trust

Version: A Date: 31-Aug-2021

Drawn By: jcrute Checked By: CT

**Kingsford Residential Estate,
Bullsbrook, WA**

**PRE-DEVELOPMENT
BUSHFIRE HAZARD LEVELS**

FIGURE 4



2.4 Post development bushfire hazard level assessment

2.4.1 Proposed development cells

The amended Structure Plan (Figure 1) depicts urban development cells throughout the project area. Unless shown specifically as POS for conservation purposes, the majority of urban development cells will be modified from their current grassland/woodland state to reflect broad-scale non-vegetated and low threat managed areas, which will be excluded from classification under Clauses 2.2.3.2 (e) and (f). On this basis, these areas in a post-development state will comprise a low bushfire hazard level, or a moderate bushfire hazard level if situated within 100 m of pre-existing moderate/extreme hazards.

2.4.2 Proposed public open space

The amended Structure Plan (Figure 1) and approved amended Landscape and Irrigation Strategy depicts numerous POS areas throughout the site (refer to Appendix C for Landscape Masterplan). POS areas proposed throughout the site are also shown spatially in Figure 2. The proposed POS typologies include:

- Linear POS: open spaces which provide a connection between smaller recreational nodes (neighbourhood POS) and specifically allows an integration/connection with the Ki-It Monger Brook. Provides legibility and sense of place for local residents. Also enables retention of existing trees and allows for low level drainage conveyance through the site.
- Neighbourhood POS: located throughout the development (3000–5000 m²) and provides local residents with areas of turf and planting for informal kick-about play and passive uses. Also provides seating areas under shelter/shade and are typically within 400 m of most dwellings. Are able to service approximately 600 dwellings within the surrounding area.
- District POS/Playing Fields: approximately 2.5–7 ha and notionally able to serve three neighbourhoods. Provides local residents and community with an open area capable for servicing district sports, events and gatherings. Caters for the combination of passive (including informal play areas) and active recreation and are generally within 1 km of most dwellings. Natural and human made changes in elevation need to be considered in context to district POS as they also serve a drainage function to the development.
- Civic POS: provision for a main street and town/village square within Bullsbrook development. Predominantly hard paved and located at the conjunction of major thoroughfares and town/village centre in order to provide a landmark for community gatherings and events.
- Conservation and Buffer Areas: as the proposed development area includes the Ki-It Monger Brook, conservation and buffer zones are designed to rehabilitate/protect the natural assets of the site to the benefit of the environment and greater community. These areas will provide opportunities for passive recreation (walking trails) and serve a critical role in drainage detention.
- Ki-It Monger Brook: the Ki-It Monger Brook will become the primary POS and ecological corridor of the development. It represents a unique asset which serves a critical ecological role. Sensitive design will ensure existing vegetation will be retained and rehabilitated. This objective will be achieved by designating nodes for recreational/educational opportunities, allowing for vegetated areas to be retained and protected along the existing Brook corridor. Continuous pedestrian/cycling paths will link these interspersed nodes, which include amenities in the form of play spaces, boardwalks and interpretative signage.

Based on the above descriptions and conceptual information contained in the approved amended Landscape and Irrigation Strategy, it is likely that only Conservation/Buffer Areas and Ki-It Monger Brook will comprise post-development classified vegetation in the form of retained/rehabilitated Class B woodland. As such, Strategen-JBS&G's post-development bushfire hazard level assessment depicts these post-development hazards.

Strategen-JBS&G has analysed proposed drainage areas and notes that the majority of these occur in isolated areas of POS that will likely be excludable under one or a combination of Clauses (b), (c), (d) and/or (f) of AS3959. In addition, proposed revegetation of the Ki-It Monger Brook and mapped wetlands is to be in accordance with an approved Foreshore and/or Wetland Management Plan.

As planning stages progress and greater levels of landscaping detail become available, the spatial areas of post-development classified vegetation throughout POS will be accurately mapped to ensure appropriate bushfire responses are incorporated into subdivision design.

2.4.3 Post-development bushfire hazard level assessment

A summary of the post-development bushfire hazard levels are provided below and depicted in Figure 5:

1. Class B woodland associated with proposed Conservation POS areas (as per the approved amended Landscape and Irrigation Strategy) has been assigned an 'Extreme' bushfire hazard level. This includes the conservation component of Ki-It Monger Brook and additional conservation areas to the south and northeast.
2. All classified vegetation assessed outside of the project area will remain as per pre-development conditions, with the corresponding hazards as mapped in Figure 4
3. All areas within 100 m of 'Extreme' and 'Moderate' hazards have been assigned a 'Moderate' bushfire hazard level.
4. All remaining areas that are currently or proposed to be excluded from classification under Clauses 2.2.3.2 (e) and (f) of AS 3959 have been assigned a 'Low' bushfire hazard level. This includes the majority of the internal development footprint, future low threat POS areas and adjacent existing urban development areas to the north and west.

2.5 Identification of bushfire hazard issues

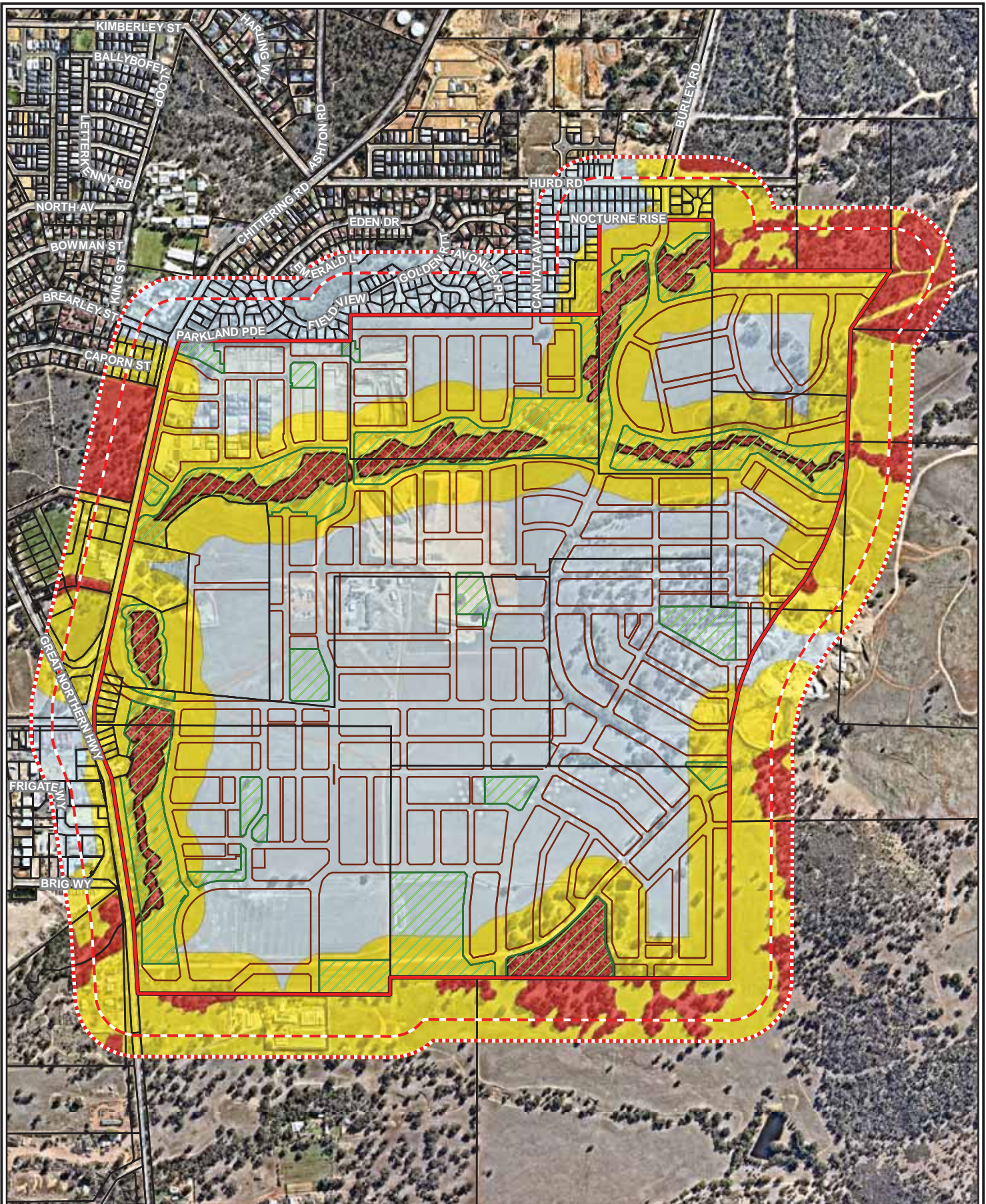
Strategen-JBS&G considers a fire front approaching the site from the northeast to be the worst-case bushfire scenario. This is due to the long bushfire run through forest and woodland vegetation within Burley Park northeast of the project area (approximately 1.5 km in length and within spotting distance from longer bushfire runs to the northeast). Under standard morning weather conditions in summer, the likely prevailing winds from the east may be capable of directing a bushfire towards the project area and the resulting fire behaviour has the potential to escalate over this time and contribute significantly elevated levels of radiant heat and ember attack on the proposed development. However, the proposed clearing and intensification of development on this site will result in a lower overall bushfire hazard level than currently exists. The construction of roads throughout the project area will also enable direct fire suppression at the road and vegetation interfaces.

A similar issue occurs to the southwest during standard afternoon conditions. This is due to the bushfire run through woodland vegetation associated with Ki-it Monger Brook vegetation that exits southwest of the project area (approximately 2.0 km in length). Under standard afternoon conditions in summer, the likely prevailing winds from the southwest may be capable of directing a bushfire towards the project area and the resulting fire behaviour has the potential to escalate over this time and contribute moderate to elevated levels of radiant heat and ember attack on the proposed development.

The majority of on-site vegetation is proposed to be cleared to enable development of a significant urban built footprint amongst areas of landscaped/managed POS and interfacing roads to conservation areas. Therefore, for the purposes of strategic level planning to guide the amended Structure Plan process, Strategen-JBS&G does not consider the current on-site vegetation extent to be an unmanageable bushfire hazard issue since these hazards will be managed through a staged clearing process and ongoing fuel management that will be undertaken in and around individual development stages.

Based on the above information, Strategen-JBS&G considers that the bushfire hazards within and adjacent to the project area and the associated bushfire risk is readily manageable through standard management responses and compliance with acceptable solutions outlined in the Guidelines and AS 3959. These management measures will need to be factored in to subdivision design as early as possible to ensure a suitable, compliant and effective bushfire management outcome is achieved to ensure protection of future life and property assets.

Demonstration of compliance with the relevant requirements of SPP 3.7, the Guidelines and AS 3959 at future planning stages will predominantly depend on Okeland Communities' ability to coordinate the timing and staging of clearing and development works within the project area in the aim of avoiding bushfire impacts from temporary vegetation.



Legend Project area 100m assessment area 150m assessment area Cadastral boundary POS Conservation area 		Hazard level Extreme Moderate Low Proposed road reserve Roads (MRWA)		Scale 1:12,000 at A4 	Kingsford Residential Estate, Bullsbrook, WA
		Coord. Sys. GDA 1994 MGA Zone 50 		POST-DEVELOPMENT BUSHFIRE HAZARD LEVELS	
		Job No: 61312 			FIGURE 5
		Client: Amex Bullsbrook Unit Trust 			
		Version: A 	Date: 31-Aug-2021 		
		Drawn By: jcrute 	Checked By: CT 		

File Name: W:\Projects\1\Open\Amex Bullsbrook Unit Trust\61312 Kingsford Bullsbrook LSP BMP addendum\GIS\Maps\R01_Rev_A\61312_05_PostDevBHLs.mxd
 Image Reference: www.nearmap.com - Imagery Date: 25. April 2021.

3. Bushfire management 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. In this respect, Strategen-JBS&G has outlined a range of bushfire management measures that Okeland Communities will need to commit to implementing at future planning stages once an adequate level of detail is available to confirm the location and design of such measures.

Strategen-JBS&G considers that on implementation of the proposed management measures outlined in the following subsections, the project area will be able to be developed with a manageable level of bushfire risk whilst maintaining full compliance with the Guidelines and AS 3959.

3.1 Separation distances and fuel management

The post-development bushfire hazard levels depicted in Figure 5 demonstrate that all future habitable development within the site will, on completion, be located in areas subject to ‘moderate’ or ‘low’ bushfire hazard levels. In addition, future BMPs prepared to accompany the subdivision/development application stages will be required to demonstrate that all future habitable development will, on completion, be subject to a rating of BAL-29 or lower. This will be achieved through implementation of Asset Protection Zones (APZs), staging buffers and fuel management within on-site POS, as detailed in Sections 3.1.1, 3.1.2 and 3.1.3.

3.1.1 Asset Protection Zones (APZs)

APZs (or other forms of low threat separation) will be implemented at all interfaces where proposed development abuts classified vegetation to ensure future assets are afforded an appropriate level of low fuel defensible space and to prevent development in high risk areas such as Bushfire Attack Level (BAL)-40/FZ.

The width of APZs is required to provide sufficient separation distance for proposed development areas to achieve a BAL of BAL-29 or lower, which will meet compliance with acceptable solutions A1.1 and A2.1. The potential range of APZ widths relevant to the project area are provided in Table 1 and the final alignment and width of APZs will depend on the classification and effective slope of the interfacing vegetation.

Table 1: Potential range of APZ widths relevant to the project area

Vegetation class	Effective slope	Minimum APZ width to achieve BAL-29 or lower
Class A forest	Up-slope and flat land	21 m
	Down-slope >0-5 degrees	27 m
Class B woodland	Up-slope and flat land	14 m
	Down-slope >0-5 degrees	17 m
Class D scrub	Down-slope >0-5 degrees	15 m
Class C shrubland	Up-slope and flat land	9 m
Class G grassland	Up-slope and flat land	8 m
	Down-slope >0-5 degrees	9 m

The fuel load throughout the APZ is required to be maintained at less than 2 tonnes per hectare on a regular and ongoing basis (e.g. through regular slashing and weed control). Individual trees can be retained within the APZ; however, a minimum of 10 m separation between tree canopies is generally required. APZs are required to meet the criteria for low threat vegetation managed in a minimal fuel condition in accordance with Schedule 1 APZ standards of the Guidelines and Clause 2.2.3.2 (f) of AS 3959 and this can be achieved most effectively using one or a combination of the following:

- existing/proposed sealed roads and managed road verges (roads can be most effective for use within an APZ as they also provide public and emergency access at the vegetation interface)
- regularly managed/landscaped lawns, gardens or POS
- other sealed areas including driveways and car parks
- building setbacks.

No buildings are permitted within the APZ. Indicative alignment and width of APZs for this site will be determined once proposed lot layout is confirmed at the subdivision stage. This is to be documented in a brief addendum to this BMP or in a revised BMP to accompany future subdivision applications where appropriate. APZs/sufficient low threat separation are to be implemented around each stage of subdivision prior to the clearance of subdivision conditions and are to be wholly contained within the lot subject to the subdivision.

3.1.2 On-site staging buffers

Vegetation clearing will occur throughout the project area on a staged basis and in advance where necessary to ensure building construction is not inhibited by a temporary vegetation extent located on a future development stage that is yet to be cleared/managed. This can be achieved by ensuring each approved stage subject to construction is surrounded by a low threat staging buffer of sufficient width prior to building construction. Once the buffers are created, they will need to be maintained on a regular and ongoing basis at a fuel load less than 2 t/ha to achieve a low threat minimal fuel condition all year round until such time that the buffer area is developed as part of the next development stage. Where staging buffers cannot be wholly contained within the lot subject to the subdivision, APZs are to be implemented around each stage of subdivision prior to the clearance of subdivision conditions, and are to be wholly contained within the lot subject to the subdivision. This will manage the bushfire risk from on-site temporary vegetation during development staging. This measure will be confirmed following confirmation of proposed lot layout and development staging provisions and will be documented in a brief addendum to this BMP or a revised BMP to accompany future subdivision applications where appropriate.

3.1.3 Fuel management within on-site POS

As outlined in Section 2.4.2, clearing and fuel management within on-site POS will be undertaken to ensure these areas do not result in the introduction of bushfire hazards. The required works may include slashing of understorey grasses and weed control on a regular and ongoing basis to maintain fuel loads at less than 2 t/ha and achieve a low threat minimal fuel condition all year round.

Should any POS result in retention or introduction of bushfire hazards, then these areas may trigger application of AS3959 and require the provision of APZs and increased building construction standards for adjacent development areas. This is not considered to be a planning or compliance issue since adequate separation will be established between proposed development areas and each POS area.

A more detailed plan for on-site POS areas will be determined at the subdivision stage in concert with proposed lot layout. Any subsequent bushfire management measures that need to be implemented in response to the proposed POS concepts will be documented in a brief addendum to this BMP or a revised BMP to accompany future subdivision applications where appropriate.

3.2 BAL assessment and increased building construction standards

The majority of on-site vegetation, except for conservation POS, is proposed to be cleared to enable development of a significant urban built footprint. Therefore, the predominant BAL impact to future assets will be around the perimeter the project area and conservation POS areas. Measures will need to be put in place (such as those outlined in Section 3.1) to ensure all habitable development is avoided in areas of BAL-40/FZ so that a rating of BAL-29 or lower can be achieved with provision of a suitable APZs where required.

Once proposed lot layout is confirmed at the subdivision stage, as well as a suitable approach to manage the risk from adjacent bushfire hazard areas, a BAL contour map will need to be prepared to inform the indicative BAL impact over the site, as well as the necessary APZ separation requirements for proposed development areas. This process will inform those lots that require increased building construction standards.

The development design process will ensure a rating of BAL 29 or lower is achieved by incorporating the necessary APZs discussed in Section 3.1.1, which will meet the necessary acceptable solutions and performance criteria of Element 1 and Element 2 of the Guidelines. BAL contours and APZs will be depicted in a brief addendum to this BMP or a revised BMP to accompany future subdivision applications where appropriate.

3.3 Vehicular access

3.3.1 Public roads

The indicative public road network outlined in the amended Structure Plan is appropriate for the purposes of satisfying the intent of Element 3 of the Guidelines at this strategic planning stage in that multiple access routes to the surrounding public road network are proposed, no non-compliant dead-ends have been identified and suitable linkages are proposed with future development on adjacent landholdings.

Subsequently, members of the public and emergency services will be able to move safely throughout the development at all times. This will be confirmed as part of subdivision design whereby a minimum of two different vehicular access routes will be provided for all stages of development, both of which connect to the surrounding public road network, provide safe access and egress to two different destinations and are available to all residents/the public at all times and under all weather conditions. This will meet the criteria of acceptable solution A3.1. Additionally, two vehicular access routes are to be provided for each internal stage of subdivision prior to the clearance of subdivision conditions. Should temporary vehicular access to a second access route be required, particularly in the early stages of development, then compliant Emergency Access Ways (EAWs) will need to be considered to achieve this.

Strategen-JBS&G advises that cul-de-sacs, battle-axe blocks and private driveways longer than 50 m should be avoided as part of future subdivision design. Should any permanent cul-de-sacs be proposed, acceptable solution A3.3 will be met to ensure the cul-de-sacs are unavoidable, restricted to a maximum length of 200 m and the cul-de-sac head/s meet a minimum 17.5 m diameter. Should any battle-axe lots be proposed, acceptable solution A3.4 will be met to ensure battle-axe legs are unavoidable, are a maximum length of 600 m and a minimum width of 6 m. Should any private driveways longer than 50 m be proposed, acceptable solution A3.5 will be met to ensure compliance with requirements of the Guidelines.

Should any temporary EAWs be required, acceptable solutions A3.6 will be met to ensure compliance with requirements of the Guidelines. It is not anticipated that Fire Service Access Routes (FSARs) will be required as part of this development.

Firebreaks will not be required throughout the residential lot component of proposed development since these lots will be of a size that will not trigger firebreak requirements; however, firebreaks may be required for larger lots (such as conservation POS) in accordance with acceptable solution A3.8 and the City of Swan annual firebreak notice as amended (Appendix D).

Technical requirements for vehicular access components that may form part of proposed development will be met in accordance with Table 2. Vehicular access components of proposed development will be confirmed as part of subdivision design and demonstration of compliance with the relevant acceptable solutions for Element 3 of the Guidelines will be documented in a brief addendum to this BMP or revised BMP to accompany future subdivision applications where appropriate.

Table 2: Vehicular access technical requirements

Technical requirement	Public road	Cul-de-sac	Battle-axe legs and private driveways longer than 50 m	Emergency access ways	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					

3.4 Reticulated water supply

All proposed development areas will be provided a reticulated water supply through extension of adjacent services. The reticulated system will ensure an all year-round supply of water is provided for each lot to meet minimum domestic and emergency water supply requirements. This will thereby meet the intent of Element 4 of the Guidelines through compliance with acceptable solution A4.1.

A network of hydrants will also be provided along the internal road network at locations which meet relevant water supply authority and DFES requirements, in particular the Water Corporation Design Standard DS 63 'Water Reticulation Standard Design and Construction Requirements for Water Reticulation Systems up to DN250'. This standard will guide construction of the internal reticulated water supply system and fire hydrant network, including spacing and positioning of fire hydrants so that the maximum distance between a hydrant and the rear of a building envelope (or in the absence of a building envelope, the rear of the lot) shall be 120 m and the hydrants shall be no more than 200 m apart.

3.5 Additional measures

Strategen-JBS&G makes the following additional recommendations to inform ongoing development stages:

1. Notification on Title: notification on Title may be lodged on all lots with a rating of BAL-12.5 or higher (either through condition of subdivision or other head of power) to ensure all landowners/proponents and prospective purchasers are aware that their lot is currently in a designated bushfire prone area and that increased building construction standards may apply to future buildings as determined by future BAL contour mapping or BAL assessment. The notification on title is also to include that the site is subject to a Bushfire Management Plan.
2. BMP addendum or revised BMP: this BMP has been prepared at a strategic level to demonstrate development compliance will be met at future planning stages. Once further development detail is available, which is expected to be at the subdivision stage, a brief addendum to this BMP or revised BMP containing the necessary development and bushfire planning detail will need to be lodged with the subdivision application/s.
3. Compliance with current City of Swan annual firebreak notice: the developer/land manager and prospective land purchasers are to comply with the current City of Swan annual firebreak notice as outlined in Appendix 4 as amended.
4. Vulnerable land uses: Bushfire Emergency Evacuation Plans (BEEPs) will need to be prepared for any vulnerable land uses (such as primary schools, childcare facilities and aged care facilities) that are located in areas subject to BAL-12.5 to BAL-29 to address requirements of SPP 3.7 Policy Measure 6.6.1. This is to be completed at the development application or building permit stage once an adequate level of detail is available to inform such planning.
5. High risk land uses: Bushfire Risk Management Plans (BRMPs) will need to be prepared for any high risk land uses (such as service stations or land uses containing proposed storage of on-site flammable materials) that are located in areas subject to BAL-12.5 to BAL-29 to address requirements of SPP 3.7 Policy Measure 6.6.1. This is to be completed at the development application or building permit stage once an adequate level of detail is available to inform such planning.

4. Proposal compliance and justification

Proposed development within the project area is required to comply with SPP 3.7 under the following policy measures:

6.2 Strategic planning proposals, subdivision and development applications

- a) Strategic planning proposals, subdivision and development applications within designated bushfire prone areas relating to land that has or will have a Bushfire Hazard Level (BHL) above low and/or where a Bushfire Attack Level (BAL) rating above BAL-LOW apply, are to comply with these policy measures.
- b) Any strategic planning proposal, subdivision or development application in an area to which policy measure 6.2 a) applies, that has or will, on completion, have a moderate BHL and/or where BAL-12.5 to BAL-29 applies, may be considered for approval where it can be undertaken in accordance with policy measures 6.3, 6.4 or 6.5.
- c) This policy also applies where an area is not yet designated as a bushfire prone area but is proposed to be developed in a way that introduces a bushfire hazard, as outlined in the Guidelines.

6.3 Information to accompany strategic planning proposals

Any strategic planning proposal to which policy measure 6.2 applies is to be accompanied by the following information prepared in accordance with the Guidelines:

- a) (i) the results of a BHL assessment determining the applicable hazard level(s) across the subject land, in accordance with the methodology set out in the Guidelines. BHL assessments should be prepared by an accredited Bushfire Planning Practitioner; or
- a) (ii) where the lot layout of the proposal is known, a BAL Contour Map to determine the indicative acceptable BAL ratings across the subject site, in accordance with the Guidelines. The BAL Contour Map should be prepared by an accredited Bushfire Planning Practitioner; and
- b) the identification of any bushfire hazard issues arising from the relevant assessment; and
- c) clear demonstration that compliance with the bushfire protection criteria in the Guidelines can be achieved in subsequent planning stages.

This information can be provided in the form of a Bushfire Management Plan or an amended Bushfire Management Plan where one has been previously endorsed.

Implementation of this BMP is expected to meet the following objectives of SPP 3.7:

- 5.1 Avoid any increase in the threat of bushfire to people, property and infrastructure. The preservation of life and the management of bushfire impact are paramount.
- 5.2 Reduce vulnerability to bushfire through the identification and consideration of bushfire risks in decision-making at all stages of the planning and development process.
- 5.3 Ensure that higher order strategic planning documents, strategic planning proposals, subdivision and development applications consider bushfire protection requirements and include specified bushfire protection measures.
- 5.4 Achieve an appropriate balance between bushfire risk management measures and, biodiversity conservation values, environmental protection and biodiversity management and landscape amenity, with consideration of the potential impacts of climate change.

In response to the above requirements of SPP 3.7, the bushfire management measures, as outlined in Section 3, have been devised for the proposed development in accordance with acceptable solutions of the Guidelines to meet compliance with bushfire protection criteria. An 'acceptable solutions' assessment is provided in Table 3 to assess the proposed bushfire management measures against each bushfire protection criteria in accordance with the Guidelines and demonstrate that the measures proposed meet the intent of each element of the bushfire protection criteria.

Table 3: Acceptable solutions assessment against bushfire protection criteria

Bushfire protection criteria	Intent	Acceptable solutions	Proposed bushfire management measures	Compliance statement
Element 1: Location	To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure	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.	Refer to Sections 3.1 and 3.2, which demonstrate that development will only occur in areas of BAL-29 or lower. No development will occur in BAL-FZ or BAL-40 areas. Refer to Sections 2.3 and 2.4, which demonstrate that development will be located within areas of low or moderate bushfire hazard. This will be further confirmed as part of a BMP addendum or revised BMP to accompany future subdivision applications where appropriate.	The measures proposed are considered to comply and meet the intent of Element 1 Location.
Element 2: Siting and design of development	To ensure that the siting and design of development minimises the level of bushfire impact	A2.1 Asset Protection Zone Every building is surrounded by an APZ, depicted on submitted plans, which meets detailed requirements (refer to the Guidelines for detailed APZ requirements).	Refer to Section 3.1, which demonstrates that minimum width APZs (or other sufficient separation) will be provided at all development-vegetation interfaces. This will be further confirmed as part of a BMP addendum or revised BMP to accompany future subdivision applications where appropriate.	The measures proposed are considered to comply and meet the intent of Element 2 Siting and design of development
Element 3: Vehicular access	To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event	A3.1 Two access routes Two different vehicular access routes are provided, both of which connect to the public road network, provide safe access and egress to two different destinations and are available to all residents/the public at all times and under all weather conditions.	Refer to Section 3.3, which demonstrates that a minimum of two different vehicular access routes will be provided for the proposed development at all times via the internal road network. This will be further confirmed as part of a BMP addendum or revised BMP to accompany future subdivision applications where appropriate.	The measures proposed are considered to comply and meet the intent of Element 3 Vehicular access

		<p>A3.2 Public road A public road is to meet the requirements in Table 4 Column 1 of the Guidelines.</p>	<p>Refer to Section 3.3, which demonstrates that all proposed public roads will meet requirements of the Guidelines (refer to Table 2). This will be further confirmed as part of a BMP addendum or revised BMP to accompany future subdivision applications where appropriate.</p>	
		<p>A3.3 Cul-de-sac (including a dead-end-road) 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), detailed requirements will need to be achieved as per Table 4 Column 2 of the Guidelines.</p>	<p>Refer to Section 3.3, which demonstrates that cul-de-sacs will be avoided where possible as part of subdivision design. If unavoidable, cul-de-sacs will comply with technical requirements of the Guidelines (refer to Table 2). This will be further confirmed as part of a BMP addendum or revised BMP to accompany future subdivision applications where appropriate.</p>	
		<p>A3.4 Battle-axe Battle-axe access legs should be avoided in bushfire prone areas. Where no alternative exists, (this will need to be demonstrated by the proponent) detailed requirements will need to be achieved as per Table 4 Column 3 of the Guidelines.</p>	<p>Refer to Section 3.3, which demonstrates that battle-axe legs will be avoided where possible as part of subdivision design. If unavoidable, battle-axe legs will comply with technical requirements of the Guidelines (refer to Table 2). This will be further confirmed as part of a BMP addendum or revised BMP to accompany future subdivision applications where appropriate.</p>	
		<p>A3.5 Private driveway longer than 50 m A private driveway is to meet detailed requirements as per Table 4 Column 3 of the Guidelines.</p>	<p>Refer to Section 3.3, which demonstrates that any private driveways longer than 50 m will meet requirements of the Guidelines (refer to Table 2). This will be further confirmed as part of a BMP addendum or revised BMP to accompany future subdivision applications where appropriate.</p>	

		<p>A3.6 Emergency access way An access way that does not provide through access to a public road is to be avoided in bushfire prone areas. Where no alternative exists (this will need to be demonstrated by the proponent), an emergency access way is to be provided as an alternative link to a public road during emergencies. An emergency access way is to meet detailed requirements as per Table 4 Column 4 of the Guidelines.</p>	<p>Refer to Section 3.3, which demonstrates that any temporary EAWs will meet requirements of the Guidelines (refer to Table 2). This will be further confirmed as part of a BMP addendum to accompany future subdivision applications where appropriate.</p>	
		<p>A3.7 Fire service access routes (perimeter roads) Fire service access routes are to be established to provide access within and around the edge of the subdivision and related development to provide direct access to bushfire prone areas for fire fighters and link between public road networks for firefighting purposes. Fire service access routes are to meet detailed requirements as per Table 4 Column 5 of the Guidelines.</p>	<p>N/A It is not anticipated that FSARs will be required as part of development.</p>	
		<p>A3.8 Firebreak width Lots greater than 0.5 hectares must have an internal perimeter firebreak of a minimum width of three metres or to the level as prescribed in the local firebreak notice issued by the local government</p>	<p>Refer to Section 3.3, which demonstrates that no firebreaks will be required for individual residential lots. However, should any firebreaks be required for larger lots (such as POS) these will meet requirements of the Guidelines and the City of Swan annual firebreak notice. This will be further confirmed as part of a BMP addendum or revised BMP to accompany future subdivision applications where appropriate.</p>	

<p>Element 4: Water</p>	<p>To ensure that water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.</p>	<p>A4.1 Reticulated areas 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.</p>	<p>Refer to Section 3.4, which demonstrates that all proposed lots will be provided a reticulated water supply and network of hydrants in accordance with local water authority, City and DFES requirements.</p>	<p>The measures proposed are considered to comply and meet the intent of Element 4 Water</p>
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5. Implementation, enforcement and review

This BMP has been prepared at a strategic level to demonstrate how development compliance will be delivered at future planning stages in accordance with the Guidelines. In this respect, the management measures documented in Section 3, where applicable, will be incorporated into development design as early as possible and confirmed at the subdivision stage. Therefore, aside from preparation of a BMP addendum or revised BMP to accompany future subdivision applications where appropriate, there are no further items to implement, enforce or review at this stage of the planning process. Any BMP addendum/s or revised BMPs prepared to accompany future subdivision application/s will need to meet the relevant commitments outlined in this strategic level BMP, address the relevant requirements of SPP 3.7 (i.e. Policy Measure 6.4) and demonstrate in detail how the proposed development will incorporate the relevant acceptable solutions to meet the performance requirements of the Guidelines. The BMP addendum/s will be required to include the following detailed information:

- proposed lot layout
- post development vegetation classifications, effective slope and separation distances
- post development BAL application requirements through preparation of a BAL contour map demonstrating that proposed development areas will achieve a rating of BAL-29 or lower
- width and alignment of compliant APZs (or other sufficient separation)
- confirmation of how bushfire management will be addressed during development staging and any specific staging measures (i.e. low threat buffers, temporary EAWs, etc)
- confirmation of how bushfire management will be addressed with regards to bushfire hazards on adjacent landholdings
- fuel management or AS 3959 application in response to on-site POS (if and where required)
- vehicular access provisions, including demonstration that a minimum of two access routes will be achieved for each stage of subdivision in accordance with acceptable solution A3.1
- water supply provisions with regards to reticulated water
- future requirements for any identified vulnerable land uses, such as provision of a Bushfire Emergency Evacuation Plan at the development application or building permit stage
- future requirements for any identified high risk land uses, such as provision of a Bushfire Risk Management Plan at the development application or building permit stage
- provisions for Notification on Title as a subdivision condition
- compliance requirements with the current City of Swan annual firebreak notice
- acceptable solutions assessment against the bushfire protection criteria
- proposed works program outlining all measures requiring implementation and the appropriate timing and responsibilities for implementation.

Based on 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 acceptable solutions outlined in the Guidelines. Strategen-JBS&G considers that on implementation of the proposed management measures, the project area will be able to be developed with a manageable level of bushfire risk whilst maintaining full compliance with the Guidelines and AS 3959.

6. 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.

Reliance on data

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.

7. References

- Department of Fire and Emergency Services (DFES) 2019, *Map of Bush Fire Prone Areas*, [Online], Government of Western Australia, available from: <http://www.dfes.wa.gov.au/regulationandcompliance/bushfireproneareas/Pages/default.aspx>, [Accessed: 13/09/2021].
- City of Swan (CoS) 2021, *City of Swan Fire Hazard Reduction Notice*, [Online], City of Swan, available from <https://www.swan.wa.gov.au/Services-support/Emergency-management/Fire/Fire-breaks-hazard-reduction> [Accessed 14/06/2021]
- Commonwealth Science and Industrial Research Organisation (CSIRO) 1999, *Fire Danger and Fire Spread Calculator*, Commonwealth Science and Industrial Research Organisation, Perth.
- Emerge Associates (Emerge) 2019, *Bullsbrook for Amex Local Structure Plan – Landscape and Irrigation Strategy*, report prepared for Amex, February 2019.
- McCaw L and Hanstrum B 2003, 'Fire environment of Mediterranean south-west Western Australia', in *Fire in Ecosystems of South-West Western Australia: Impacts and Management*, eds I Abbott & ND Burrows, Backhuys Publishers, Leiden, Netherlands, pp. 171–188.
- Standards Australia (SA) 2018, *Australian Standard AS 3959–2018 Construction of Buildings in Bushfire-prone Areas*, Standards Australia, Sydney.
- 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*, Western Australian Planning Commission, Perth.

Appendix A Georeferenced site photographs



Photo 1: Class B woodland to the south of the project area



Photo 2: Class B woodland to the east of the project area

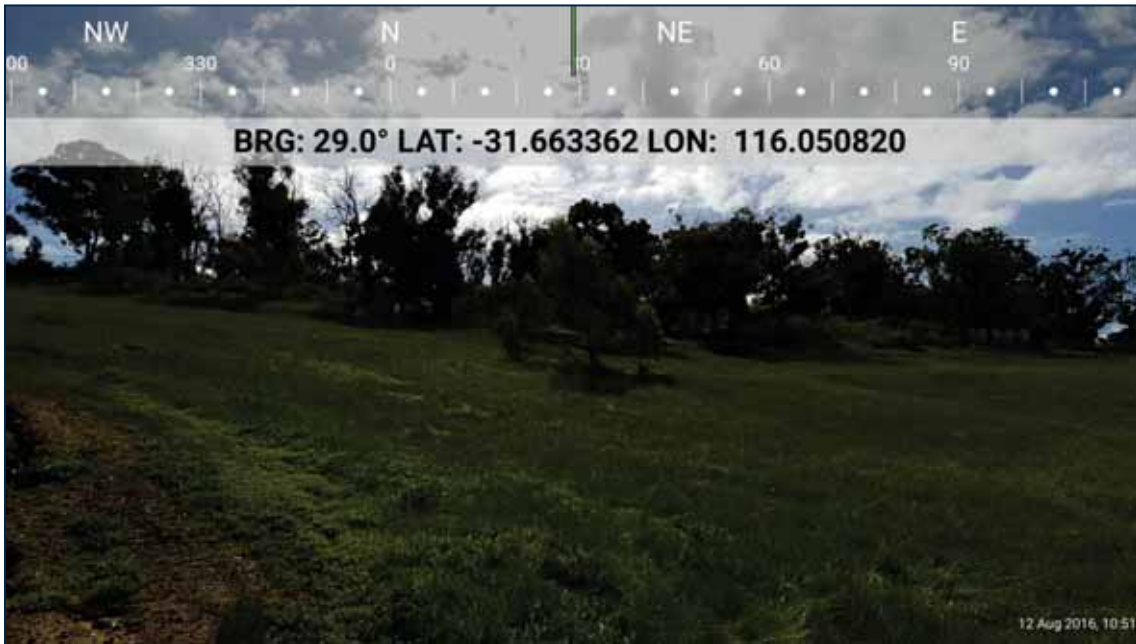


Photo 3: Class B Woodland to the northeast of the project area



Photo 4: Class G grassland to the south of the project area



Photo 5: Class G grassland to the east of the project area (Class B woodland in background)



Photo 6: Non-vegetated area excluded under Clause 2.2.3.2 (e) to the east of the project area



Photo 7: Non-vegetated areas and low threat managed vegetation excluded under Clauses 2.2.3.2 (e) and (f) to the west of the project area



Photo 8: Class B woodland within the project area



Photo 9: Class B woodland within proposed conservation POS in the west of the project area



Photo 10: Class C shrubland (foreground) to the west of the project area

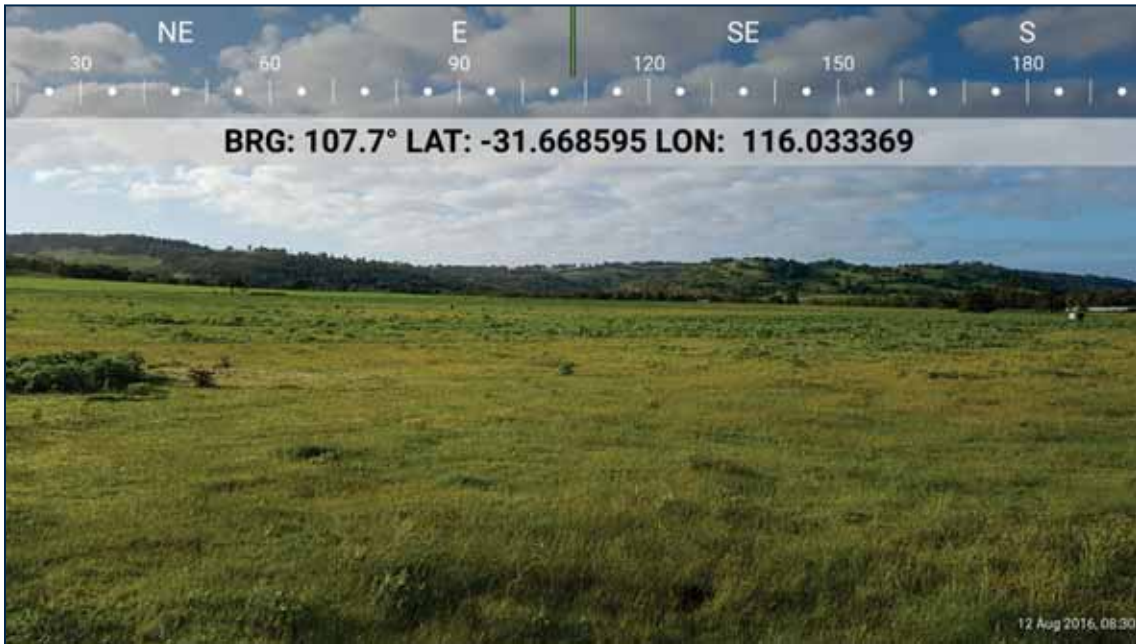


Photo 11: Class G grassland in the southwest of the project area

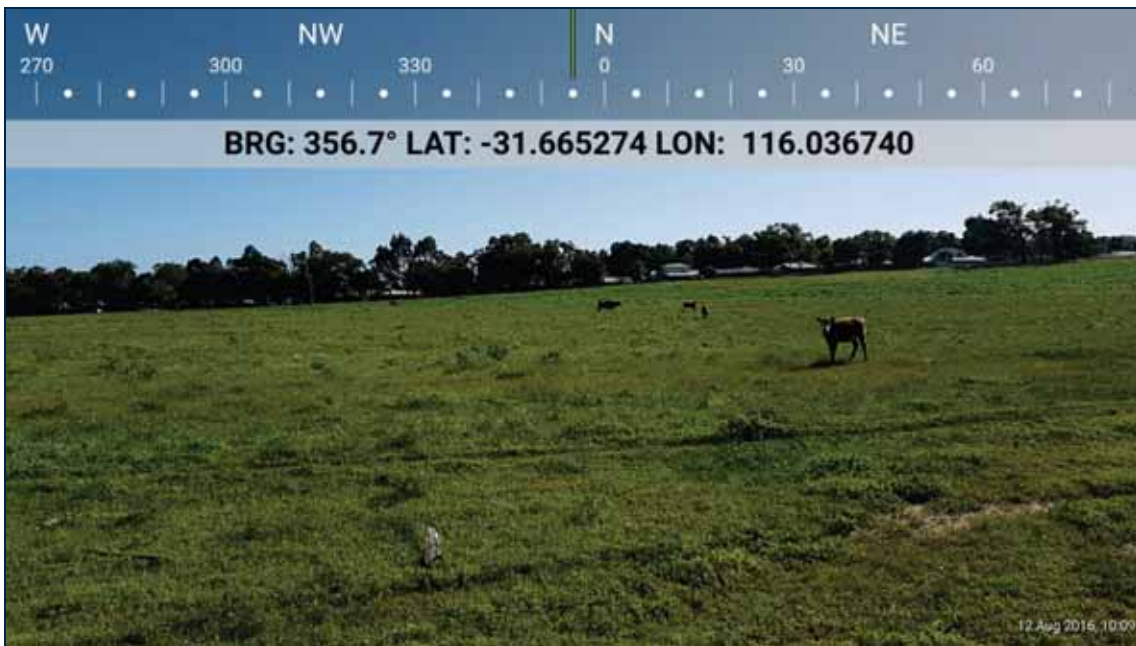


Photo 12: Class G grassland vegetation in the northwest of the project area



Photo 13: Non-vegetated areas and low threat managed vegetation excluded under Clauses 2.2.3.2 (e) and (f) to the north of the project area



Photo 14: Non-vegetated areas and low threat managed vegetation excluded under Clauses 2.2.3.2 (e) and (f) to the northwest of the project area

Appendix B Summer wind profiles for Pearce RAAF weather station

Rose of Wind direction versus Wind speed in km/h (02 Nov 1940 to 31 Oct 2011)

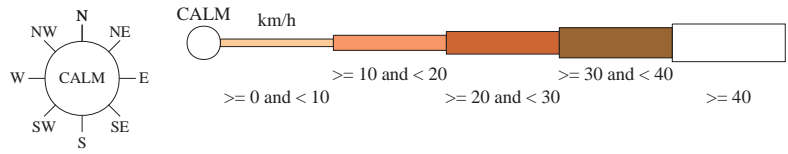
Custom times selected, refer to attached note for details

PEARCE RAAF

Site No: 009053 • Opened Jan 1937 • Still Open • Latitude: -31.6669° • Longitude: 116.0189° • Elevation 40m

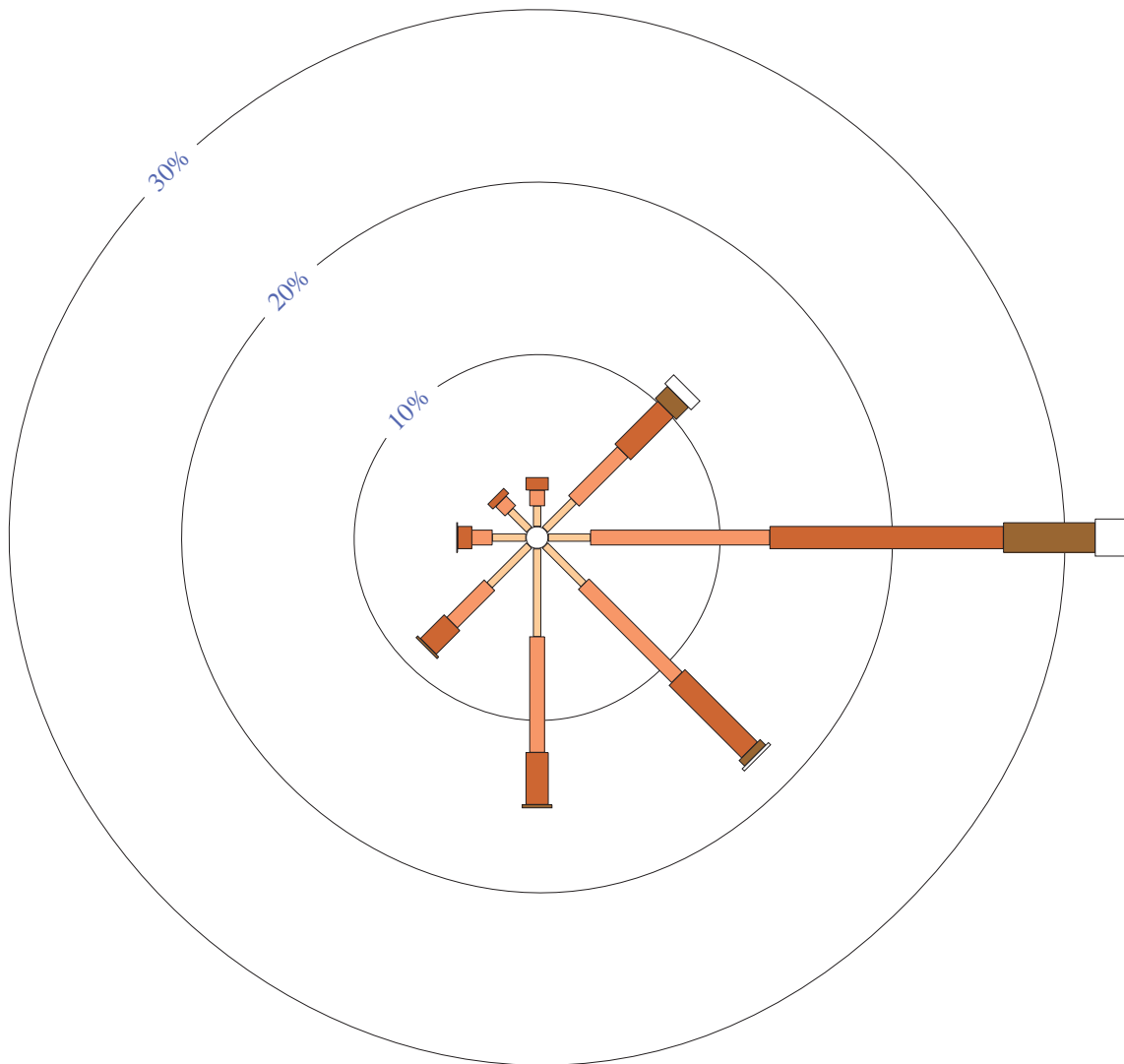
An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.



9 am Jan
1093 Total Observations

Calm 3%



Rose of Wind direction versus Wind speed in km/h (02 Nov 1940 to 31 Oct 2011)

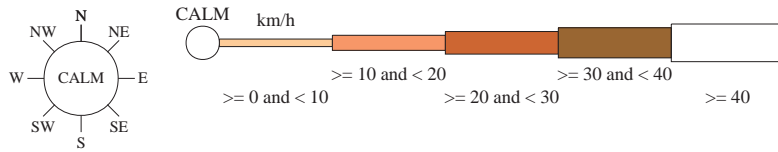
Custom times selected, refer to attached note for details

PEARCE RAAF

Site No: 009053 • Opened Jan 1937 • Still Open • Latitude: -31.6669° • Longitude: 116.0189° • Elevation 40m

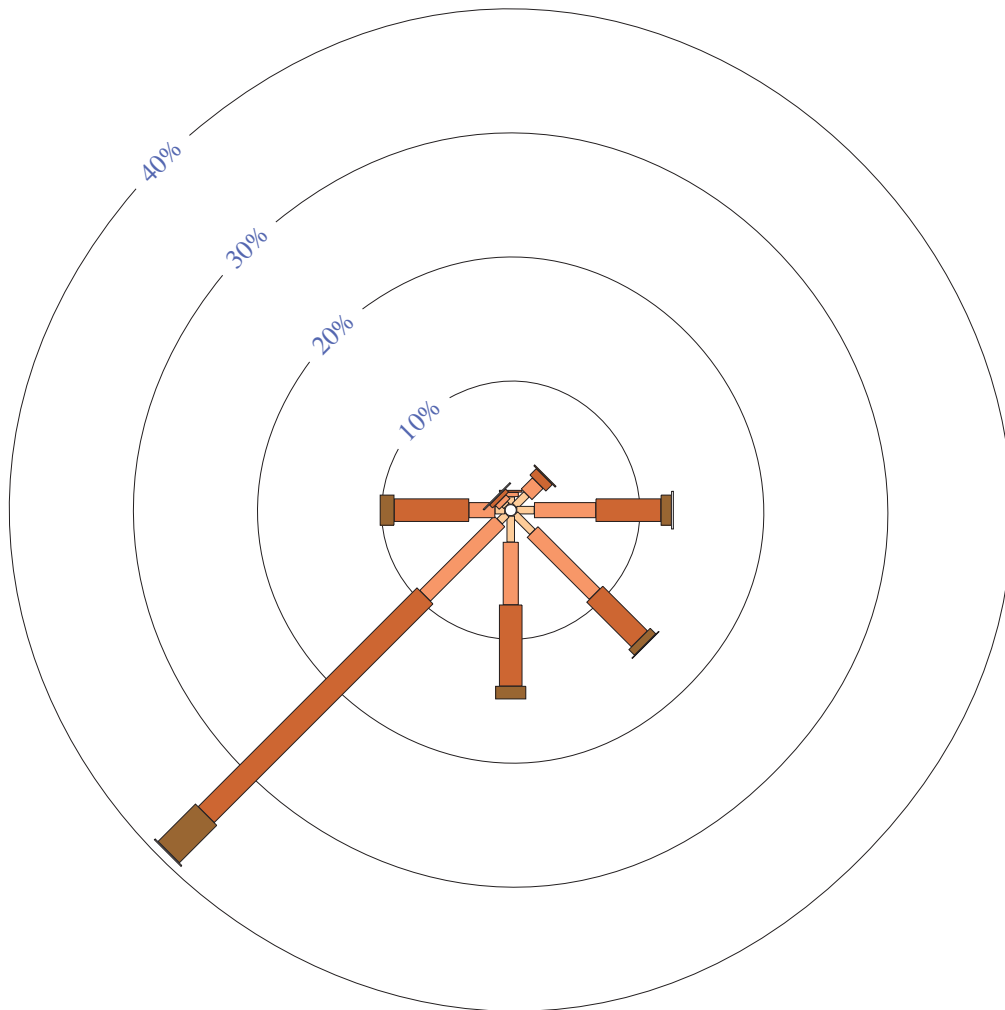
An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.



3 pm Jan
1015 Total Observations

Calm 2%



Appendix C Landscape Masterplan (Emerge 2019)

4. APPENDIX A LANDSCAPE MASTERPLAN



LEGEND

Site Boundary

POS

Indicative 1:1 ARI Drainage

Existing Dam

Existing Vegetation



Neighbourhood POS/Recreation nodes (high order)



Neighbourhood POS/Recreation nodes (low order)



Entry Statements



Green Streets



Town Centre

400m Ped Shed

800m Ped Shed

Appendix D City of Swan Fire Hazard Reduction Notice (as amended)

Bush Fires Act 1954

City of Swan

Fire Hazard Reduction Notice (Firebreak Notice)

Notice to Owners and/or Occupiers of land situated within the City of Swan.

To assist in the control of bush fires, and pursuant to Section 33 of the Bush Fires Act 1954, all owners and occupiers of land within the City of Swan are required on or before the 1st day of November, 2020, or within 14 days of becoming an owner or occupier of land after that date, must meet the fire hazard reduction conditions described in this notice and maintain these conditions up to and including the 30th day of April, 2021.

1. All land up to 5,000m² (0.5 Hectares or 1.2 Acres)

- 1) Install and maintain an asset protection zone in accordance with the requirements specified in clause 13 of this notice.
- 2) Maintain all grass to a height of no greater than 10cm.
- 3) Areas of natural vegetation to be maintained at or below 8 tonnes per hectare.
- 4) Where a property is affected by an approved bushfire management plan, property owners must still comply with all requirements in this notice and with any additional requirements outlined within that plan.

2. All land between 5,000m² and 25,000m² (0.5 - 2.5 Hectares) or (1.2 - 6.2 Acres)

- 1) Install and maintain an asset protection zone in accordance with the requirements specified in clause 13 of this notice.
- 2) Install firebreaks immediately inside and adjacent to all external property boundaries. Firebreaks need to be 3 metres wide with a 4 metre vertical height clearance free from flammable materials and overhanging branches (see section 10 in this notice for further details).
- 3) Maintain all grass to a height of no greater than 10cm.
 - a) If the land is stocked, the grass must be reduced and maintained to a height of no greater than 10cm by the 1st day of December.
- 4) Natural vegetation within 100 metres of buildings including attached and adjacent structures and essential infrastructure shall be maintained at or below 8 tonnes per hectare, by passive methods of fuel reduction that does not permanently remove or reduce the quantity or occurrence of the native plants, shrubs and trees within the subject area.
- 5) Where a property is affected by an approved bushfire management plan, property owners must still comply with all requirements in this notice and with any additional requirements outlined within that plan.

3. All land with an area greater than 25,000m² (2.5 Hectares or 6.2 Acres)

- 1) Install and maintain an asset protection zone in accordance with the requirements specified in clause 13 of this notice.
- 2) Install firebreaks immediately inside and adjacent to all external property boundaries. Firebreaks need to be 3 metres wide with a 4 metre vertical height clearance free from flammable materials and overhanging branches (see section 10 in this notice for further details).
 - a) Properties over 100 hectares require additional firebreaks to divide the land into areas not exceeding 100 hectares.
- 3) Slash or mow grass to a height no greater than 10cm immediately adjacent to firebreaks to a minimum width of 3 metres.
 - a) If the land is stocked, this grass must be reduced and maintained to a height of no greater than 10cm by the 1st day of December.
- 4) Natural vegetation within 100 metres of buildings including attached and adjacent structures and essential infrastructure shall be maintained at or below 8 tonnes per hectare, by passive methods of fuel reduction that does not permanently remove or reduce the quantity or occurrence of the native plants, shrubs and trees within the subject area.
- 5) Where a property is affected by an approved bushfire management plan, property owners must still comply with all requirements in this notice and with any additional requirements outlined within that plan.

4. Plantations

- 1) Install and maintain external and internal firebreaks, firebreaks that form compartments (cells), firebreaks and hazard reduction measures that protect neighbouring communities and essential infrastructure in accordance with the requirements of a fire management plan approved in writing by the City; or
- 2) Where no such approved fire management plan exists,
 - a) Unless the City approves an alternative plan in writing in accordance with clause 4(2)(b), install and maintain external and internal firebreaks and firebreaks that form compartments (cells), and carry out all other firebreaks and hazard reduction measures which are required in accordance with the requirements and specifications within the Department of Fire & Emergency Services 'Guidelines for Plantation Fire Protection' 2011 publication; or
 - b) If it is considered impractical for any reason to carry out the plantation requirements outlined above in clause 4 (2)(a), plantation owners and managers may apply in writing to the City to implement an alternative plan or measures in accordance with clause 4 of this notice. A Fire Management Plan may be required to be developed and submitted as part of the application.

5. Application to Vary Firebreak and Hazard Reduction Requirements

- 1) If it is considered impractical for any reason to clear firebreaks in a manner or location required by this notice, or to carry out any fire hazard reduction work or measures required by this notice, you may apply in writing on or before the 15th day of October, for approval to provide firebreaks in alternative positions or to take alternative measures to abate fire hazards on the land. Alternative firebreak application forms can be downloaded from the City of Swan website.
- 2) If permission is not granted in writing by the City prior to the 1st day of November, you shall comply with the requirements of this notice.
- 3) When permission for alternative firebreaks or fire hazard reduction measures has been granted, you shall comply with all conditions on the endorsed permit and maintain the land to the required standard throughout the period specified by this notice.
 - a) Where a property is affected by an approved bushfire management plan, property owners must comply with any additional requirements and responsibilities outlined within that plan.

6. Fuel Dumps and Depots

Remove all flammable material within 10 metres of fuel dumps, fuel ramps or where fuel drums, whether containing fuel or not, are stored.

7. Hay Stacks

Clear and maintain a firebreak completely surrounding any haystack on the land, within 60 metres of the haystack.

8. Fire Service Access (Strategic Firebreaks)

- 1) Where under a written agreement with the City, or where depicted on an approved bushfire management plan Fire Service Access (Strategic Firebreaks) are required on the land, you are required to clear and maintain the Fire Service Access (Strategic Firebreaks) a minimum of 6 metres wide along the agreed alignment to provide restricted vehicular access to emergency services and authorised vehicles.
- 2) Fire Service Access (Strategic Firebreaks) must be free from flammable material and unimpeded by obstructions including boundary fences and gates unless approved in writing by the City.
- 3) Gates may only be secured with City of Swan Fire Service padlock.
- 4) Fire Service Access (Strategic Firebreaks) shall be graded to provide a continuous 4 wheel drive trafficable surface a minimum of 4 metres wide with a 1 metre shoulder on either side.
- 5) All branches must be pruned and obstacles removed to maintain a 4 metre vertical height clearance above the full 6 metre width of the trafficable surface.

9. Emergency Access Ways

- 1) Where under a written agreement with the City, or where depicted on an approved bushfire management plan, Emergency Access Ways are required on private land, you are required to clear and maintain a vehicular access way to a minimum of 6 metres wide along the agreed alignment.
- 2) Emergency access ways must be free from flammable material and unimpeded by obstructions including boundary fences and gates unless approved in writing by the City.
- 3) Gates on Emergency Access Ways must remain unlocked at all times.
- 4) Emergency Access Ways shall be graded and have suitable drainage to provide a minimum 6 metre wide continuous trafficable surface suitable for all types of 2 wheel drive vehicles.

- 5) All branches must be pruned and obstacles removed to maintain a 4 metre vertical height clearance above the full 6 metre width of the trafficable surface.

10. Firebreak Construction

- 1) Firebreaks are to be developed and maintained clear of all obstacles and flammable materials to create a minimum of 3 metres wide trafficable surface suitable for 4 wheel drive vehicles.
- 2) Overhanging branches must be pruned to provide a 4 metre vertical clearance above the full width of the firebreak surface.
- 3) Boundary firebreaks must be aligned immediately inside and adjacent to the external property boundaries.
- 4) Alternative Firebreaks that are approved in writing by the City, or as depicted within a bushfire management plan approved in writing by the City, are to be constructed to the same standard as general firebreaks and must be constructed along the specified alignment.
- 5) Firebreaks must not terminate in a dead end.
- 6) Firebreaks may be constructed by ploughing, grading, raking, burning, chemical spraying or any other approved method that achieves the required standard.

11. Driveways

Where building sites are situated more than 50 metres from a public road,

- 1) Driveways must be maintained clear of all permanent obstacles and flammable materials to create a minimum 3 metre wide trafficable surface suitable for all types of 2 wheel drive vehicles.
- 2) Overhanging branches must be pruned to provide a 4 metre vertical clearance above the driveway.

12. Fuel Reduction – Natural Vegetation

- 1) Available bushfire fuels must be maintained at or below:
 - a) Asset Protection Zones - 2 tonnes per hectare
 - b) Hazard Separation Zones - 8 tonnes per hectare
*This requirement only applies where HSZs are depicted within a Fire Management Plan approved in writing by the City.
 - c) Natural Vegetation - 8 tonnes per hectare for areas of natural vegetation within 100 metres of buildings, attached and adjacent structures and essential infrastructure
- 2) Passive Fuel Reduction within natural vegetation may be achieved by burning, raking, pruning, weed management, removal of dead materials and any other approved method.
- 3) Permanent removal or partial clearing of natural vegetation including individual or groups of native grasses, shrubs or trees may only be carried out to meet the minimum requirements of this notice.
- 4) Permanent clearing of natural vegetation structures including individual plants, shrubs or trees, that exceeds the requirements of this notice or the specifications outlined within a bushfire management plan approved in writing by the City, is only permitted in accordance with the provisions and exemptions outlined within the Environmental Protection Act 1986, or with the approval of the Department of Water and Environmental Regulation and the City of Swan.

Note: Advice and resources on how to measure and manage native vegetation fuel loads are available from the Department of Fire and Emergency Services or the City of Swan.

13. Asset Protection Zones Specification

Asset protection zones for habitable buildings and other assets must meet the following requirements:

- 1) Extend 20 metres out from any external walls of the building, attached structures, or adjacent structures within 6 metres of the habitable building, unless varied under an approved bushfire management plan.
- 2) On sloping ground the asset protection zone distance shall increase with 1 metre for every degree in slope on the sides of the building/ structure that are exposed to down slope natural vegetation.
- 3) Asset protection zone requirements only apply within the boundaries of the lot on which the asset is located and cannot be enforced across boundaries.
- 4) Recommendation Only - Asset protection zones predominantly consist of non-flammable managed vegetation, reticulated lawns and gardens and other non-flammable features.
- 5) All grass is maintained to or under 10cm.
- 6) Fuel loads must be reduced and maintained at 2 tonnes per hectare or lower.
- 7) The crowns of trees are to be separated where possible to create a clear separation distance between adjoining or nearby tree crowns. The separation distance between tree crowns is not required to exceed 10 metres. Clearing or thinning existing trees to create distances greater than 10 metres separation between tree crowns within an asset protection zone is not required or supported by this notice and requires approval from the Department of Water and Environmental Regulation and the City of Swan.

- 8) A small group of trees within close proximity to one another may be treated as one crown provided the combined crowns do not exceed the area of a large or mature crown size for that species.
- 9) Trees are to be low pruned (or under pruned) to at least a height of 2 metres from ground.
- 10) No tree, or shrub over 2 metres high is planted within 2 metres of a building, especially adjacent to windows.
- 11) There are no tree crowns or branches hanging over buildings.
- 12) Clear and prune scrub to reduce to a sparse density (able to walk through vegetation with relative ease with minimal deviation around trees and shrubs).
- 13) Install paths or clear flammable or dry vegetation, debris and materials immediately adjacent to the building.
- 14) Wood piles and flammable materials stored a safe distance from buildings.

14. Burning

All burning must be carried out in accordance with the relevant provisions of this notice and the Bush Fires Act 1954, Health Act 1911 and the City's Consolidated Local Laws 2005.

Prohibited Period: All burning, including garden refuse and camping fires are prohibited.

Restricted Period: All burning requires a permit except for the burning of garden refuse and camping fires which are subject to the following conditions:

- 1) The fire must not be lit if the Fire Danger Rating is Very High or above, or if a Total Fire Ban or a Harvest and Vehicle Movement Ban is declared.
- 2) Only one fire is allowed at any time and it does not exceed 1 cubic metre in size.
- 3) No flammable material within 5 m of the fire.
- 4) The fire is only lit between 6 pm and 11 pm and completely extinguished by midnight.
- 5) At least one person capable of controlling the fire is in attendance at all times with adequate means of extinguishing the fire.

15. Cooking Fires

Fires for the purpose of cooking are exempt from burning period restrictions subject to the following conditions:

- 1) The fire must not be lit if the Fire Danger Rating is Very High or above, or if a Total Fire Ban or a Harvest and Vehicle Movement Ban is declared.
- 2) The fire is contained in a purpose built appliance and
 - a) at a person's home; or
 - b) an area is set aside for that purpose by the State Authority or City of Swan
- 3) No flammable material within 5 m of the fire.
- 4) At least one person capable of controlling the fire is in attendance at all times with adequate means of extinguishing the fire.

16. Compliance

- 1) In addition to the requirements of this notice, further works which are considered necessary by an Authorised Officer of the City may be required as specified in writing in a subsequent notice addressed to the land owner.
- 2) Where the owner or occupier of the land fails or neglects to comply with the requirements of this notice or a subsequent notice addressed to the land owner, the City of Swan may enter onto the land with workmen, contractors, vehicles and machinery to carry out the requisitions of the notice at the expense of the land owner.
- 3) Failure to comply with this notice and subsequent written notices may result in a penalty not exceeding \$5,000, or the issue of a \$250 infringement notice and liability for any costs incurred by the City in relation to works undertaken on behalf of the land owner
- 4) Where a property is affected by an approved bushfire management plan, property owners must still comply with all requirements in this notice and with any additional requirements outlined within that plan.

17. Definitions

'**Alternative Firebreak**' is a firebreak that is in an alternative position or alignment to the external boundaries of a property.

'**Alternative Firebreak Application**' is an application that may be made by a land owner to install firebreaks in an alternative position, or to carry out an alternative measures in lieu of general firebreaks.

'**Available Fuel**' is the bush fuel consisting of live and dead vegetation such as stubble, mulch, leaf litter, twigs, trash, scrub and other vegetation less than 6mm in diameter capable of carrying a running fire and will actually burn under prevailing conditions.

'**City**' means the City of Swan.

'Buildings, Attached and Adjacent Structures' means habitable buildings that are used as a dwelling, workplace, place of gathering or assembly, a building that is a car park, or a building used for the storage

or display of goods or produce for sale by whole sale in accordance with classes 1-9 of the Building Code of Australia. The term building includes attached and adjacent structures like garages, carports verandas or similar roofed structure(s) that are attached to, or within 6 metres of the dwelling or primary building.

'Asset Protection Zone (APZ)' is a low fuel area that is reduced of flammable vegetation and materials surrounding buildings and essential infrastructure to minimise the likelihood and impact that direct flame contact, radiant heat or ember attack may have on buildings and assets in the event of a bushfire. This area must extend out from the external walls of a building or asset a minimum of 20 metres.

'Bushfire Management Plan' or 'Fire Management Plan' is a comprehensive plan that may be placed on the certificate of title(s) of land that has been developed as a condition of development or subdivision. Bushfire Management Plans may become out dated and it's the responsibility of the property owner to review and keep them current. Where a property is affected by an approved bushfire management plan, property owners must still comply with all requirements in the Annual Fire Hazard Reduction Notice and with any additional requirements outlined within that plan.

'Emergency Access Way' is a two wheel drive trafficable, 6 metre wide access route to provide local residents, general public and emergency services alternative links to road networks at the end of cul- de-sacs or areas where access is limited during an emergency incident.

'Essential Infrastructure' or **'Critical Infrastructure'** means assets, infrastructure, systems and networks that provide essential services necessary for social and economic wellbeing and is typically public infrastructure. Assets and infrastructure, usually of a public nature, that generate or distribute electricity, water supply, telecommunications, gas and dams are typical assets that are essential to society and are often located in, or traverse areas that are prone to bushfires.

'Firebreak' is an area of land cleared of flammable material (see available fuel above) to minimise the spread of a bushfire and to provide access for firefighting services. For the purpose of this notice the term firebreak is a strip of land at minimum 3 metres with a 4 metres vertical clearance, constructed to provide a 4 wheel drive trafficable surface for access by emergency and authorised vehicles. Boundary firebreaks are installed immediately adjacent the external boundaries of a property.

'Fire Hazard' means accumulated fuel (living or dead) such as leaf litter, twigs, trash, bush, dead trees and scrub capable of carrying a running fire, but excludes standing living trees and isolated shrubs.

'Hazard Separation Zone (HSZ)' means an area extending out from an asset protection zone a distance of 80 metres unless otherwise specified, to create a graduated fuel reduction and separation from natural vegetation.

'Natural Vegetation' means natural areas of forest, woodland, shrubland, scrub, mallee or mulga.

'Passive Fuel Reduction' means lowering the amount of available fuel that will burn under prevailing conditions by means that will not permanently reduce or modify the structure or life cycle of plant, shrub, scrub or tree communities within an treated area. This is typically achieved by undertaking a cool, controlled burn of an area during cooler, damper months, or by physical removal of built up leaf litter, dead materials, weeds and slashing long dry grasses without damaging live native plants within the area.

'Plantation' is any area of native or exotic planted trees that exceeds three hectares in a gazetted town site, or elsewhere a stand of trees of 10 hectares or larger that has been planted and managed intensively for their commercial and environmental value. A plantation includes roads, firebreaks and small areas of native vegetation.

'Fire Service Access (Strategic Firebreaks)' is a firebreak that is 6 metres wide established to provide strategic access and links to road networks whilst providing a wider control/ containment line to protect town sites, estates and similar exposures during bushfire operations.

By order of the Council,

MJ Foley

Chief Executive Officer

City of Swan



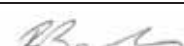

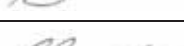

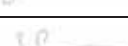
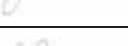
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Document Distribution

Rev No.	Copies	Recipient	Date
Rev 5	1	Craig Graham (Okeland Communities)	13/09/2021

Document Status

Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
Rev A	P Molinari	R Banks (BPAD36857)	R Banks		9/1/2017
Rev B	P Molinari (BPAD39183)	R Banks (BPAD36857)	R Banks		7/07/2017
Rev 0	P Molinari (BPAD39183)	R Banks (BPAD36857)	R Banks		18/07/2017
Rev 1	P Molinari (BPAD39183)	R Banks (BPAD36857)	R Banks		26/09/2017
Rev 2	P Molinari (BPAD39183)	R Banks (BPAD36857)	R Banks		27/11/2017
Rev 3	B Mastrangelo (BPAD45985)	Z Cockerill (BPAD37803)	Z Cockerill		15/03/2019
Rev 4	Z Cockerill (BPAD37803)	Z Cockerill (BPAD37803)	Z Cockerill		16/06/2021
Rev 5	Z Cockerill (BPAD37803)	Z Cockerill (BPAD37803)	Z Cockerill		13/09/2021



Appendix 2

Acoustic Assessment

(Herring Storer)



Our ref: 23619-1-16264-03

10 January 2019

Roberts Day
Level 2
442 Murray Street
PERTH WA 6000

Attention: Andrew Brodie
Address: Andrew.Brodie@robertsday.com.au

Dear Andrew,

**RESIDENTIAL DEVELOPMENT – LOT 1354 GREAT NORTHERN HIGHWAY, BULLSBROOK STAGES 1, 2, 5 & 7
REVIEW OF SPP 5.4 ACOUSTIC REQUIREMENTS**

As requested, we provide the following information regarding the acoustic requirements for the above stages of the proposed residential development in Bullsbrook with respect to achieving compliance with the requirements of the State Planning Policy 5.4 "Road and Rail Transport Noise and Freight Considerations In Land Use Planning" (SPP 5.4).

For reference the Structure Plan and development plan for Stages 1, 2, 5 and 7 are attached.

CRITERIA

In summary, the acoustic requirements are :

Under the Western Australian Planning Commission (WAPC) Planning Policy 5.4 "*Road and Rail Transport Noise and Freight Considerations in Land Use Planning*" (SPP5.4), we believe that the appropriate criteria for assessment for this development are as listed below for "Noise Limits".

EXTERNAL

$L_{Aeq(Day)}$ of 60 dB(A); and
 $L_{Aeq(Night)}$ of 55 dB(A).

INTERNAL

$L_{Aeq(Day)}$ of 40 dB(A) in living and work areas; and
 $L_{Aeq(Night)}$ of 35 dB(A) in bedrooms.

Noise received at an outdoor area should also be reduced as far as practicable, with an aim of achieving an L_{Aeq} of 50 dB(A) during the night period.



MODELLING

Noise model was undertaken for the revised plans attached and was based on the previous model used for the "Updated Acoustic Assessment" undertaken in February 2018 (HSA reference : 22753-3-16264-02). However, it is noted that from the MRWA Traffic Map, the percentage of heavy vehicles along Chittering Road has dropped to 3.6%. Thus the modelling takes into account this change in heavy vehicles.

Additionally, as stated in the assessment report, the difference between the $L_{Aeq,16hr}$ and the $L_{Aeq,8hr}$ for both Great Eastern Highway and Chittering Road would be greater than 5 dB(A).

As the difference between the $L_{Aeq,16hr}$ and the $L_{Aeq,8hr}$ would be greater than 5 dB(A), achieving compliance with the day period criteria will also achieve compliance with the night period criteria. Therefore, noise modelling was only undertaken for the day period. Noise contours are attached for the following scenarios :

Figure A1 - Base case for future traffic (ie without and mitigation or residences); and
Figure A2 - Future traffic with noise mitigation and residences.

Note : The noise mitigation being a 2 metre high fence to the boundary to Chittering Road for Lots 1 and 12.

COMPLIANCE WITH SPP 5.4

The noise modelling indicates that noise received at the residences located adjacent to Chittering Road would exceed the "Noise Limits". To achieve compliance with the requirements of State Planning Policy 5.4, the following are recommended :

- Quiet House design to residences, as shown on Figure M1.
- 2m high barrier to the boundary to Chittering Road for Lots 1 and 12.

Note : The barrier to Lots 1 and 12 is to achieve compliance with outdoor requirement. For the other residences facing Chittering Road, the residences themselves provide a sufficient barrier for compliance within the back yards to be achieved.

It is also noted that for residence where the noise level exceed the $L_{Aeq(Day)}$ of 55 dB(A), Notification on Titles are required. The lots requiring "Quiet House" design and / or Notification on Titles are attached in Figure M1.

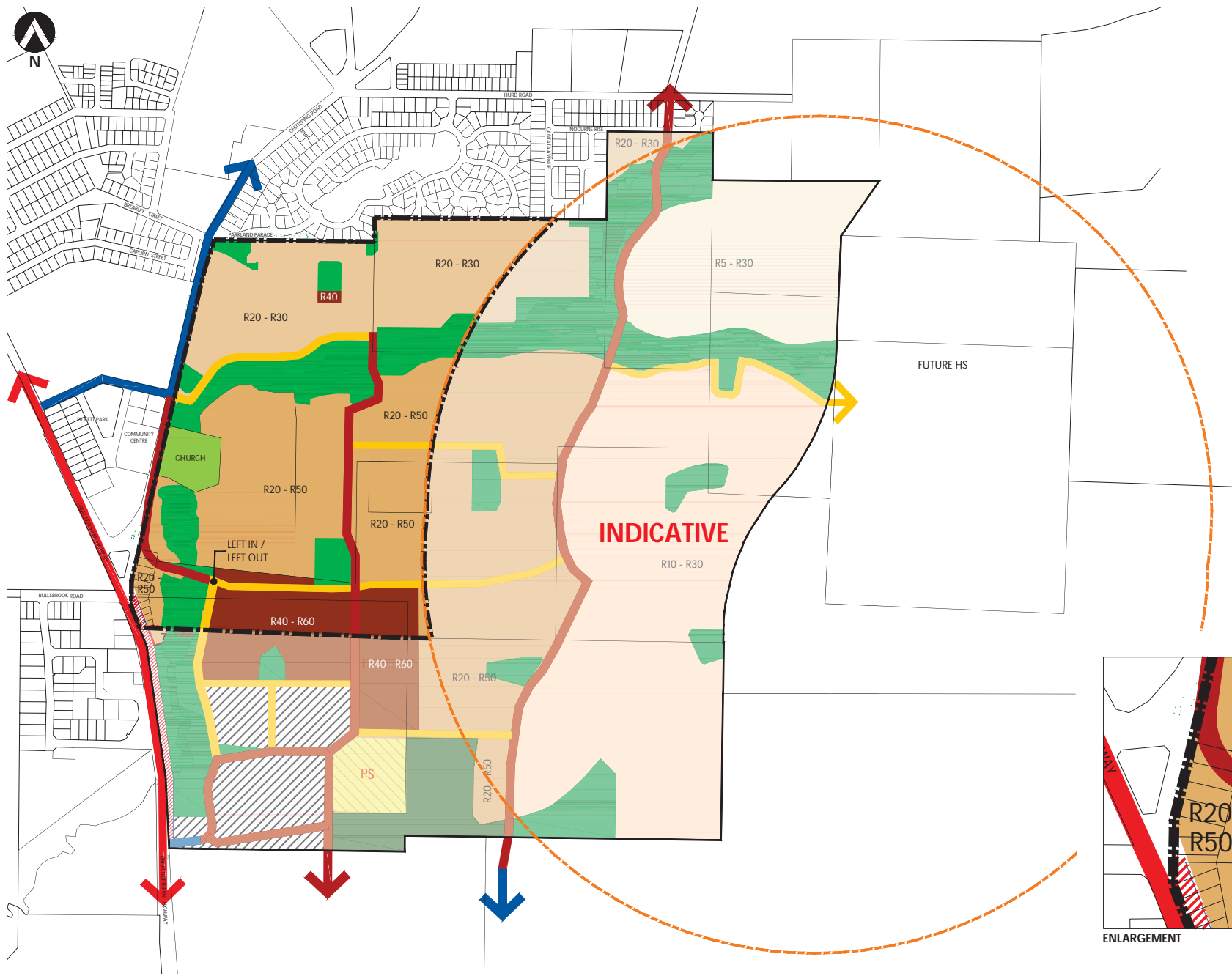
The Package A "Quiet House" design requirements for residences located adjacent to Chittering Road are attached for information.

Note : The construction requirements listed for Package A are "deemed to satisfy" construction. Alternative constructions are acceptable, provided they are supported by a report from a suitably qualified acoustic consultant.

Yours faithfully,
For **HERRING STORER ACOUSTICS**

Tim Reynolds

Att.



LEGEND

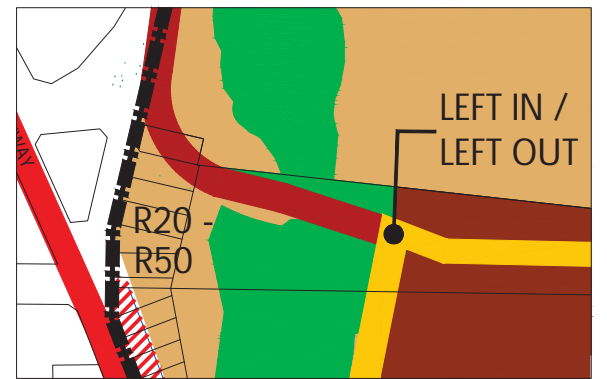
- LOCAL STRUCTURE PLAN BOUNDARY
- INDICATIVE AREA SUBJECT TO FUTURE ADDENDUMS TO APPROVED LSP
- CRUSHING PLANT & NURSERY BUFFER

ZONES

- RESIDENTIAL (R5-R30)
- RESIDENTIAL (R10-R30)
- RESIDENTIAL (R20-R30)
- RESIDENTIAL (R20-R50)
- RESIDENTIAL (R40-R60)
- AREA SUBJECT TO FUTURE ACTIVITY CENTRE STRUCTURE PLAN
- PS PUBLIC PURPOSE - PRIMARY SCHOOL
- RECREATION
- DISTRICT OPEN SPACE
- PRIVATE CLUBS AND INSTUTIONS
- PRIMARY REGIONAL ROAD
- A68 ADDITIONAL USES - SERVICE STATION

RESERVES

- PRIMARY DISTRIBUTOR
- INTEGRATOR B
- NEIGHBOURHOOD CONNECTOR A
- NEIGHBOURHOOD CONNECTOR B



CADASTRAL INFORMATION
 SOURCE: MNG
 YYMDD: 161017
 DWG REF: 97797de-006a
 PROJECTION: PCG94



1:10,000



P	NEIGHBOURHOOD CONNECTOR B UPDATE	181220	HH	AB
O	POS & LSP BOUNDARY UPDATE	181218	HH	AB
N	VARIOUS UPDATES	181031	HH	AB
M	UPDATED R40 CODE AREA	180917	HH	TT
L	UPDATED CONNECTORS	180809	HH	AB
REV	DESCRIPTION	YYMDD	DRAWN	APPR'D

LOCAL STRUCTURE PLAN
Bullsbrook
 City of Swan

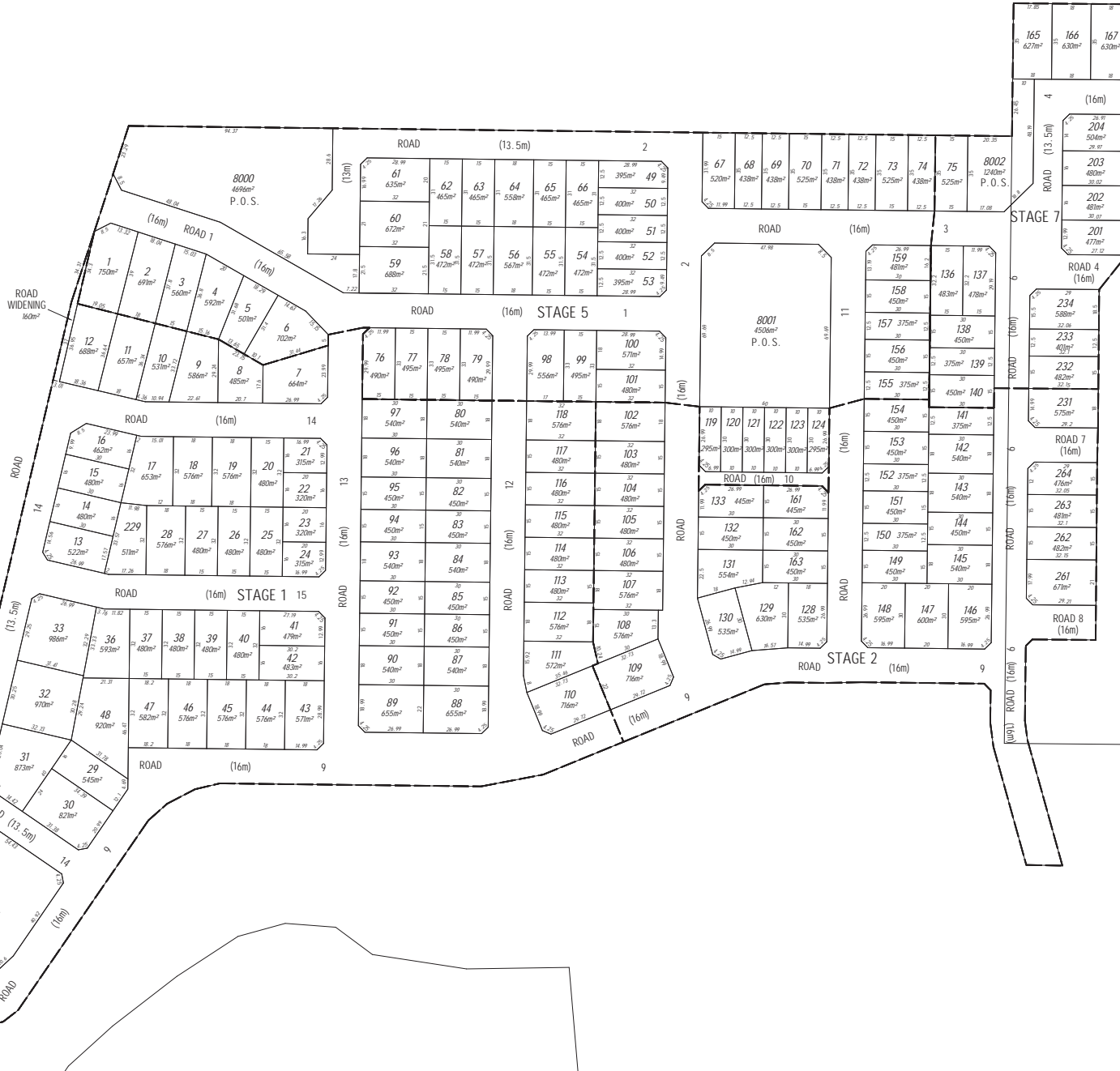
REF NO. **AMX BUL** DRAW NO. **RD1107** REV. **P**

LAND USE / STATISTICS			
STAGE 1 WAPC Ref.- NOT ISSUED			
PARCEL TYPE	MAP SYMBOL	NUMBER OF PARCELS	AREA (ha)
Traditional Lots		68	3.7181
Public Open Space	P. O. S.	1	0.3028
Road Widening	ROAD WIDENING	1	0.0160
Roads (inc. truncations)			2.0918
STAGE TOTAL		69	6.1288

LAND USE / STATISTICS			
STAGE 2 WAPC Ref.- NOT ISSUED			
PARCEL TYPE	MAP SYMBOL	NUMBER OF PARCELS	AREA (ha)
Traditional Lots		36	1.8330
Public Open Space	P. O. S.	0	0
Roads (inc. truncations)			1.1509
STAGE TOTAL		36	2.9839

LAND USE / STATISTICS			
STAGE 5 WAPC Ref.- NOT ISSUED			
PARCEL TYPE	MAP SYMBOL	NUMBER OF PARCELS	AREA (ha)
Traditional Lots		51	2.4413
Public Open Space	P. O. S.	2	0.9202
Roads (inc. truncations)			1.3224
STAGE TOTAL		53	4.6849

LAND USE / STATISTICS			
STAGE 7 WAPC Ref.- NOT ISSUED			
PARCEL TYPE	MAP SYMBOL	NUMBER OF PARCELS	AREA (ha)
Traditional Lots		16	0.8062
Public Open Space	P. O. S.	1	0.1240
Roads (inc. truncations)			0.4085
STAGE TOTAL		17	1.3387



Ver.	Description	Drawn	Date	Checked
D	Amend lots 49-66 (width of road 2 to 13.5m), truncate lots 201 & 204, amend lots 231-234 & 261-264 (width of road 5 to 16m, trunc. 231, 234, 261 & 264), truncate lot 8003, amend lots 29-36 & 48 (redesign) - remove lots 34 & 35 & truncate lot 146	SCL	21/11/2018	SOW
C	Amendments to add missing truncations over whole site, amend lot 8000, roads 1 & 2, amend lots 1 & 12 and add road widening, amend lots 119-126, 8001 (remove lots 125 & 126), amend lots 76-82, 87-90, 95-104, 109-111, 116-118 and associated roads	SCL	15/11/2018	CAY
B	Amendments through out stages 1, 2, 5 and 7	GPM	09/05/2018	CAY
A	Initial Issue	GPM	20/12/2017	CAY

SCALE 1:1000 @ A1 - 1:2000 @ A3

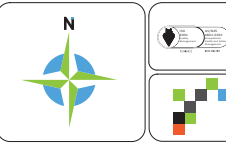
ALL DISTANCES ARE IN METRES

For a true to scale reproduction of this plan, plot it to A1 with the Paging Scaling set to None.

The contents of this plan are correct and correct as of the date stated within the revision panel. All consultants and persons wishing to refer to this data should satisfy themselves of this plan currency by contacting the MCGM Note Group.

FILES: map03020-9797
Control Register-
File Name: 9797pr-023d.dgn

PRECAL LEGEND
- Stage Boundary
- Vehicle Access Restriction



PLANNER'S DESIGN SOURCE FOR Rev D
Planner - Roberts Day
Received date - 20/11/2018
File name: AMX BUL RD1 142E Stage 1 Subdivision.dwg

ENGINEER'S DESIGN SOURCE FOR Rev
Engineer -
Received date -
Data purpose -

M.C. MULLEN NOLAN GROUP
Level 1, 2, Sabre Crescent
Janakot, W.A. 6164
PO Box 1828, Success
W.A. 6164, Australia
Offices in: Broome, Bunbury, Kununurra, Newman, Onslow, Port Hedland

Tel: (08) 6436 1599
Fax: (08) 6436 1500
info@mngsurvey.com.au
www.mngsurvey.com.au
ABN 90 009 363 313

All areas and dimensions depicted on this plan are subject to survey and Landgate registration. All cadastral information external to the stage/s which form the subject of this plan are not guaranteed and are supplied as a guide only.

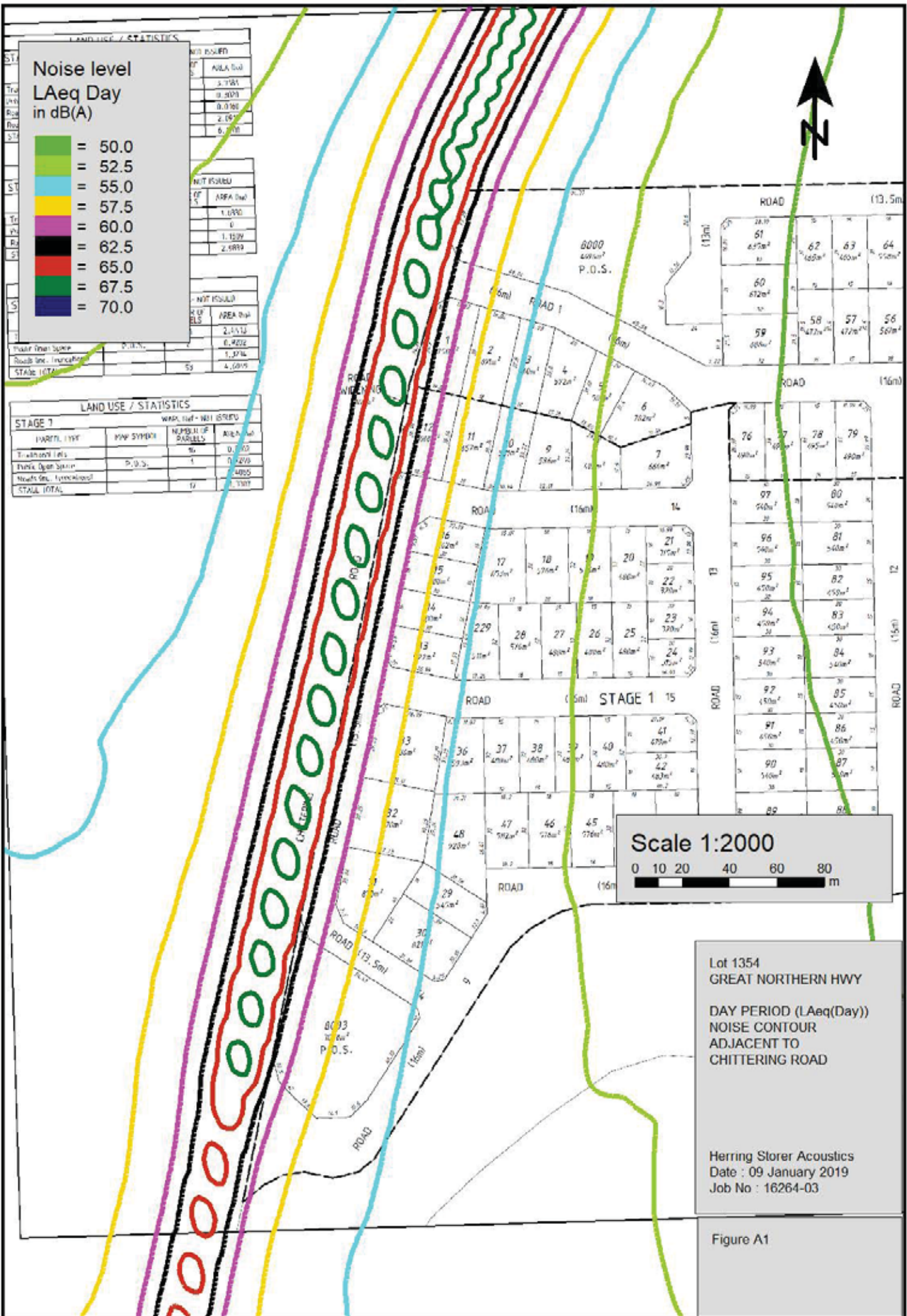
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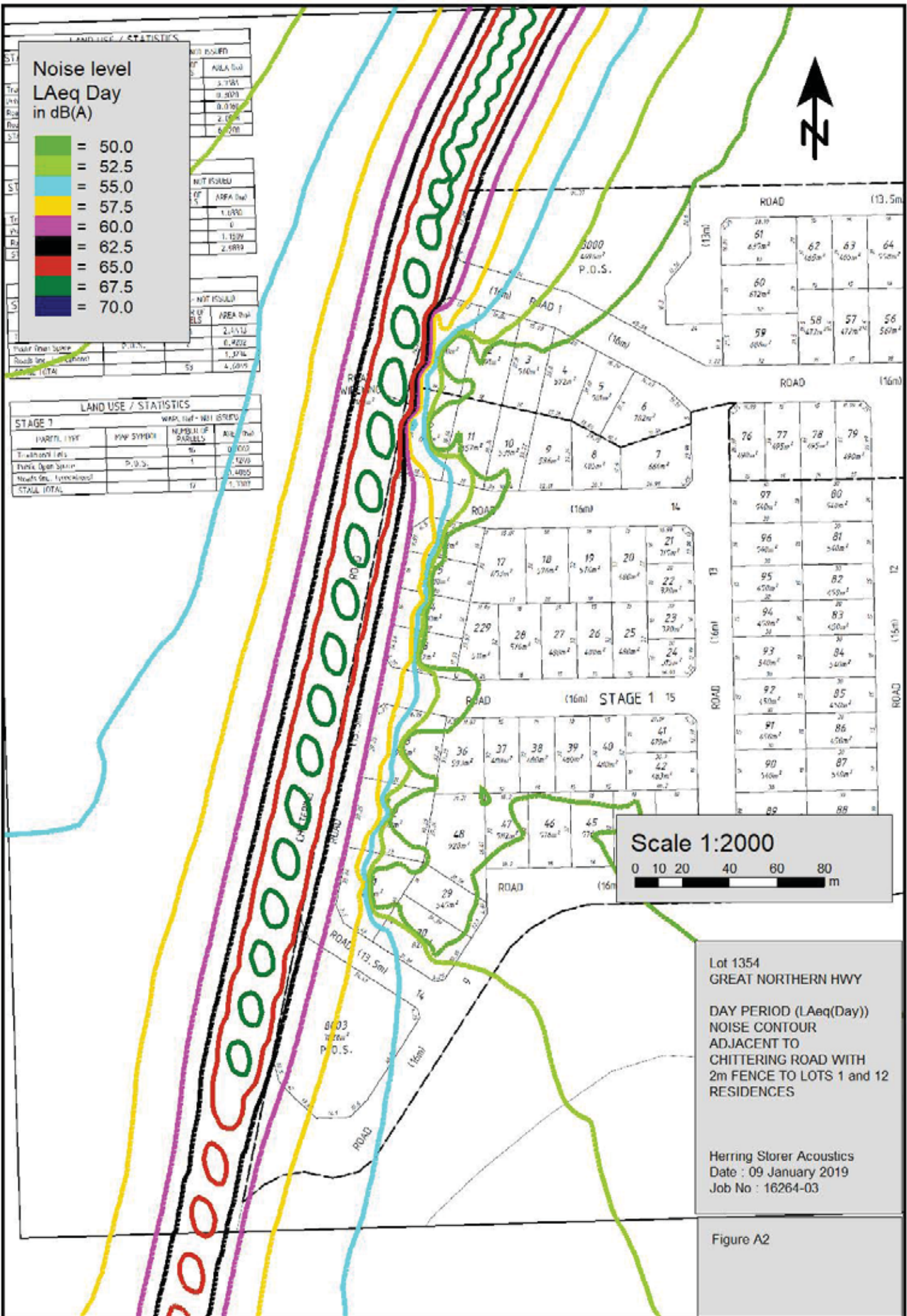
BULLSBROOK STAGES 1, 2, 5 & 7

Project Mgr.	Charlie Younge	Date	PCG94
--------------	----------------	------	-------

9797 - 023 - D

1 of 1
Number Number Version





Noise level
LAeq Day
in dB(A)

- = 50.0
- = 52.5
- = 55.0
- = 57.5
- = 60.0
- = 62.5
- = 65.0
- = 67.5
- = 70.0

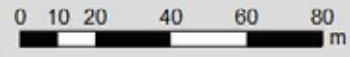
NOT ISSUED	
NO OF PLOTS	AREA (ha)
3	1.781
0	0.000
2	0.000
0	0.000

NOT ISSUED	
NO OF PLOTS	AREA (ha)
1	1.000
1	1.100
2	2.000

NOT ISSUED	
NO OF PLOTS	AREA (ha)
2	2.112
0	0.400
1	1.374
5	4.000

LAND USE / STATISTICS			
STAGE 1	WAP. SYMBO	NUMBER OF PARCELS	Area (ha)
Township lots		50	0.000
Public Open Space	P.O.S.	1	1.200
Residential		1	1.400
STAGE 1 TOTAL		52	2.600

Scale 1:2000



Lot 1354
GREAT NORTHERN HWY

DAY PERIOD (LAeq(Day))
NOISE CONTOUR
ADJACENT TO
CHITTERING ROAD WITH
2m FENCE TO LOTS 1 and 12
RESIDENCES

Herring Storer Acoustics
Date : 09 January 2019
Job No : 16264-03

Figure A2

LAND USE / STATISTICS				
STAGE 1 WAPC Ref.- NOT ISSUED				
PARCEL TYPE	MAP SYMBOL	NUMBER OF PARCELS	AREA (ha)	
Traditional Lots		68	3.7181	
Public Open Space	P. O. S.	1	0.3028	
Road Widening	ROAD WIDENING	1	0.0160	
Roads (inc. truncations)			2.0918	
STAGE TOTAL		69	6.1288	

LAND USE / STATISTICS				
STAGE 2 WAPC Ref.- NOT ISSUED				
PARCEL TYPE	MAP SYMBOL	NUMBER OF PARCELS	AREA (ha)	
Traditional Lots		36	1.8330	
Public Open Space	P. O. S.	0	0.0000	
Roads (inc. truncations)			1.1509	
STAGE TOTAL		36	2.9839	

LAND USE / STATISTICS				
STAGE 5 WAPC Ref.- NOT ISSUED				
PARCEL TYPE	MAP SYMBOL	NUMBER OF PARCELS	AREA (ha)	
Traditional Lots		51	2.4413	
Public Open Space	P. O. S.	2	0.9202	
Roads (inc. truncations)			1.3224	
STAGE TOTAL		53	4.6849	

LAND USE / STATISTICS				
STAGE 7 WAPC Ref.- NOT ISSUED				
PARCEL TYPE	MAP SYMBOL	NUMBER OF PARCELS	AREA (ha)	
Traditional Lots		16	0.8062	
Public Open Space	P. O. S.	1	0.1240	
Roads (inc. truncations)			0.4085	
STAGE TOTAL		17	1.3387	



Note : Alternative constructions are acceptable, provided they are supported by a report prepared by a suitably qualified Acoustical Consultant.

LOT 1354 GREAT NORTHERN HIGHWAY, BULLSBROOK
LOTS REQUIRING QUIET HOUSE DESIGN AND/OR NOTIFICATIONS ON TITLES
 Herring Storer Acoustics
 Job No : 16263-03
 Date : 10 January 2019

Figure M1

Ver.	Description	Drawn	Date	Checked
D	Amend lots 49-66 (width of road 2 to 13.5m), truncate lots 201 & 204, amend lots 231-234 & 261-264 (width of road 6 to 16m, trunc. 231, 234, 261 & 264), truncate lot 8003, amend lots 29-36 & 48 (redesign - remove lots 34 & 35) & truncate lot 146	SCL	21/11/2018	SOW
C	Amendments to add missing truncations over whole site, amend lot 8000, roads 1 & 2, amend lots 1 & 12 and add road widening, amend lots 119-126, 8001 (remove lots 125 & 126), amend lots 76-82, 87-90, 95-104, 109-111, 116-118 and associated roads	SCL	15/11/2018	CAY
B	Amendments through out stages 1, 2, 5 and 7	GPM	09/05/2018	CAY
A	Initial Issue	GPM	20/12/2017	CAY

SCALE 1:1000 @ A1 - 1:2000 @ A3

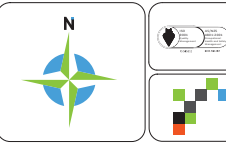
ALL DISTANCES ARE IN METRES

For a true to scale reproduction of this plan, plot it to A1 with the Paging Scaling set to None.

PRECAL LEGEND

- Stage Boundary
- Vehicle Access Restriction

FILES
 map03020-9797
 Control Register-
 File Name: 9797pr-023d.dgn



PLANNER'S DESIGN SOURCE FOR Rev D
 Planner - Roberts Day
 Received date- 20/11/2018
 File Name: AMX BUL RD1 142E Stage 1 Subdivision.dwg

ENGINEER'S DESIGN SOURCE FOR Rev
 Engineer -
 Received date-
 Data purpose-

M.C. MULLEN NOLAN GROUP
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 Janakari, W.A. 6164
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 W.A. 6164, Australia
 Offices in: Broome, Bunbury, Kununurra, Newman, Onslow, Port Hedland

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 ABN 90 009 363 313

All areas and dimensions depicted on this plan are subject to survey and Landgate registration. All cadastral information external to the stage's which form the subject of this plan are not guaranteed and are supplied as a guide only.

CLIENT:

BULLSBROOK STAGES 1, 2, 5 & 7

Project Mgr: Charlie Younge Datum: PC94

9797 - 023 - D

Job Number: 9797-023-01
 Plan Number: 023-01
 Version: 01

QUIET HOUSE DESIGN DEEMED-TO-SATISFY CONSTRUCTIONS FOR PACKAGE A

Area	Orientation to road corridor	Package A
Bedrooms	Facing	<ul style="list-style-type: none"> • Walls to R_w+C_{tr} 45dB • Windows and external door systems: Minimum R_w+C_{tr} 28dB (Table 6.4), total glazing area up to 40% of room floor area. [if R_w+C_{tr} 31dB: 60%] [if R_w+C_{tr} 34dB: 80%] • Roof and ceiling to R_w+C_{tr} 35dB (1 layer 10mm plasterboard)
	Side-on	•As above, except glazing R_w+C_{tr} values for each package may be 3dB less, or max % area increased by 20%
	Opposite	• No requirements
Indoor living and work Areas	Facing	<ul style="list-style-type: none"> • Walls to R_w+C_{tr} 45dB • Windows and external door systems: Minimum R_w+C_{tr} 25dB (Table 6.4), total glazing area limited to 40% of room floor area. [if R_w+C_{tr} 28dB: 60%] [if R_w+C_{tr} 31dB: 80%] • External doors other than glass doors to R_w+C_{tr} 26dB (Table 6.4)
	Side-on	• As above, except the glazing R_w+C_{tr} values for each package may be 3dB less, or max % area increased by 20%
	Opposite	• No requirements
Other indoor areas	Any	• No requirements

Note : Alternative constructions are acceptable, provided they are supported by a report prepared by a suitably qualified Acoustical Consultant.

MINIMUM ACOUSTIC RATING OF SELECTED EXTERNAL BUILDING EXTERIOR WALLS

Building Element	Type	$R_w + C_{tr}, dB$	Example Constructions
External wall	Steel framed	45	One row of 92mm studs at 600mm centres with – <ul style="list-style-type: none"> • resilient steel channels fixed to the outside of the studs; and • 9.5mm hardboard or 9mm fibre cement sheeting or 11mm fibre cement weatherboards fixed to the outside of the channels; and • 75mm thick glass or mineral wool insulation with a density of 11kg/m³ or • 75mm thick polyester insulation with a density of 14kg/m³, positioned between the studs; and • two layers of 16mm fire-protective grade plasterboard fixed to the inside face of the studs.
			One row of 92mm studs at 600mm centres with – <ul style="list-style-type: none"> • resilient steel channels fixed to the outside of the studs; and • one layer of 19mm board cladding fixed to the outside of the channels; and • 6mm fibre cement sheets fixed to the inside of the channels; and • 75mm thick glass or mineral wool insulation with a density of 11 kg/m³ or • 75mm thick polyester insulation with a density of 14 kg/m³, positioned between the studs; and • two layers of 16mm fire-protective grade plasterboard fixed to the inside face of the studs.
	Single leaf masonry, brick veneer	45	<ul style="list-style-type: none"> • Single leaf of 150mm brick masonry with 13mm cement render on each face.
		50	Single leaf of 90mm clay brick masonry with – <ul style="list-style-type: none"> • a row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; and • a cavity of 25mm between leaves; and • 75mm thick glass or mineral wool insulation with a density of 11kg/m³ or 75mm thick polyester insulation with a density of 14kg/m³ positioned between studs; and • one layer of 10mm plasterboard fixed to the inside face.
			Single leaf of 220mm brick masonry with 13mm cement render on each face.
			150mm thick unlined concrete panel. 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face.
	Double brick	45	Two leaves of 90mm clay brick masonry with a 20mm cavity between leaves.
		50	Two leaves of 90mm clay brick masonry with – <ul style="list-style-type: none"> • a 50mm cavity between leaves; and • 50mm thick glass wool insulation with a density of 11kg/m³ or 50mm thick polyester insulation with a density of 14 kg/m³ in the cavity; and • Where wall ties are required to connect leaves, the ties are of the resilient type.
	Two leaves of 110mm clay brick masonry with – <ul style="list-style-type: none"> • a 50mm cavity between leaves; and • 50mm thick glass wool insulation with a density of 11kg/m³ or 50mm thick polyester insulation with a density of 14 kg/m³ in the cavity. 		

MINIMUM ACOUSTIC RATING OF GLAZED ELEMENTS

Building Element	Type	Airborne weighted sound reduction rating with traffic correction R_w+C_{tr} , dB	Building element Type Airborne weighted sound
Window, uPVC, aluminium or timber frame	Sliding or double hung opening	23	<ul style="list-style-type: none"> • 4mm monolithic glass
		26	<ul style="list-style-type: none"> • Single pane glazing to R_w 33dB • 6mm monolithic or laminated glass • 6mm toughened safety glass • '6-12-6' double insulated glass unit (IGU)
		29	<ul style="list-style-type: none"> • Single pane glazing to R_w 36dB • 10mm monolithic (aka float) glass • 10mm laminated or toughened safety glass • 6mm-12mm-10mm double insulating
	Fixed sash, awning or casement type opening	26	<ul style="list-style-type: none"> • 4mm monolithic glass
		31	<ul style="list-style-type: none"> • Single pane glazing to R_w 33dB • 6mm monolithic or laminated glass • 6mm toughened safety glass • '6-12-6' double insulated glass unit (IGU)
		34	<ul style="list-style-type: none"> • Single pane glazing to R_w 36dB • 10mm monolithic (a.k.a. float) glass • 10mm laminated or toughened safety glass • 6mm-12mm-10mm double insulated glass unit (IGU)
Single external door, aluminium uPVC or timber frame	Fully glazed sliding door	24	<ul style="list-style-type: none"> • 6mm monolithic or laminated • 5 or 6mm toughened safety glass
		27	<ul style="list-style-type: none"> • 10mm monolithic or laminated • 10mm toughened safety glass
	Fully glazed hinged door	28	<ul style="list-style-type: none"> • Certified R_w 31dB acoustically rated door and frame including seals • 6mm monolithic or laminated • 5 or 6mm toughened safety glass
		31	<ul style="list-style-type: none"> • Certified R_w 34dB acoustically rated door and frame including seals • 10mm monolithic or laminated • 10mm toughened safety glass
	Solid core timber frame, side hinged	26	<ul style="list-style-type: none"> • Certified R_w 28dB acoustically rated door and frame system including seals • 35mm solid core timber
		30	<ul style="list-style-type: none"> • Certified R_w 32dB acoustically rated door and frame system including seals • 40mm solid core timber without glass insert • 40mm solid core timber with not less than 6mm

Appendix 3

Local Water Management Strategy (RPS)

MEMO

Date: 07 September 2021
Pages: 4 inc. this page
Regarding: Kingsford Local Structure Plan

Revised Local Structure Plan for Kingsford, Bullsbrook – Local Water Management Strategy

1 Background

Hatch RobertsDay, on behalf of Okeland Communities, are submitting a revised Local Structure Plan (LSP) for the Kingsford, Bullsbrook development. The revised LSP is attached in Appendix A and changes include:

- Lifting of Urban Deferment over the balance of the Kingsford landholding
- Changes to the Town Centre layout and zones as per the Town Centre Precinct Plan

2 Local water management strategy

A local water management strategy (LWMS) was previously prepared by RPS (2018) to support the 2017 LSP. The LWMS was prepared over the entire LSP area, including the Urban Deferred zone. The LWMS was approved by the Department of Water and Environmental Regulation (DWER) on 25 June 2018. The overall water management strategy and drainage discharge locations to the Ki-it Monger Brook have not changed.

An addendum to the LWMS was prepared by RPS (2021) to support the Town Centre Precinct Plan. The addendum addresses changes to the proposed layout and zones, impacts on the Town Centre and upstream catchments, and changes to modelled discharge rates (which are consistent with those prescribed in the original approved LWMS).

The water management for the revised LSP is adequately covered by the LWMS (RPS 2018) and the LWMS addendum (RPS 2021). Other than those layout changes which have already been addressed in the LWMS addendum, there are no changes to land use that will materially impact the drainage strategy and preliminary drainage design as documented in the LWMS and LWMS addendum reports. Although there may be slight changes to drainage catchments, these changes will not be clearly defined until subdivision stage and can be managed according to the key stormwater management criteria outlined in the aforementioned documents and summarised below.

3 Key stormwater management criteria

All catchments discharge to the Ki-it Monger Brook in the 100 year ARI event. Where catchments are adjacent to the brook, they will provide storage and attenuation within the foreshore public open space (POS) prior to discharge to the brook. The remaining catchments will provide storage and attenuation within local POS prior to discharging to the brook via the Town Centre. The LWMS addendum (RPS 2021)

MEMO

Date: 03 September 2021
Regarding: Kingsford Local Structure Plan

estimated a 100 year ARI pro rata discharge rate of 0.03 m³/s/ha for these catchments draining via the Town Centre.

There is flexibility for individual catchments to discharge more or less than the estimated allowable discharge rate in response to space availability for drainage infrastructure, however the LSP area should meet the overall discharge criteria outlined in the LWMS (RPS 2018). The ultimate discharge criteria at the Great Northern Highway within the Ki-it Monger Brook is 12 m³/s in the 100 year ARI 6 hour critical duration event.

4 References

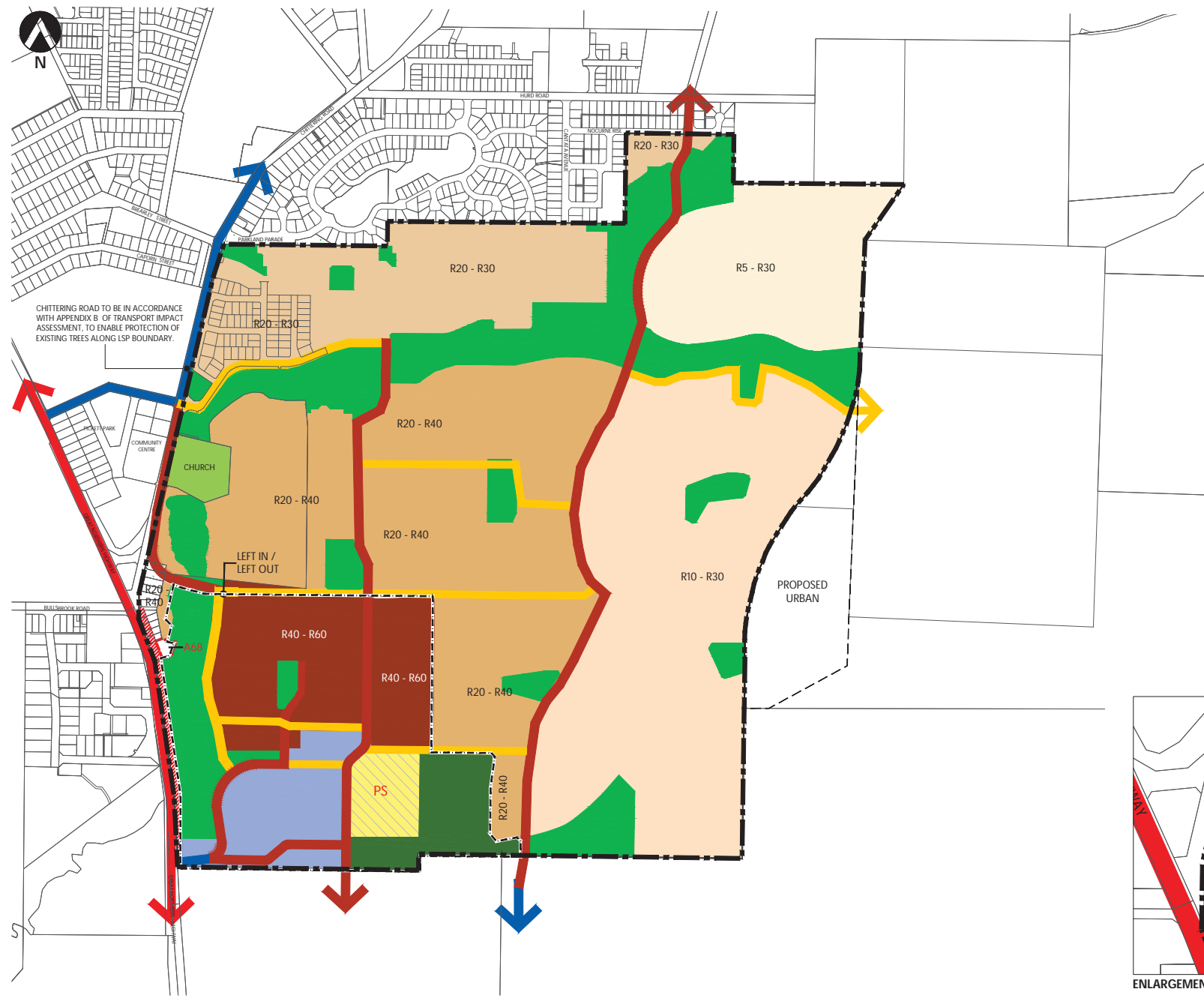
RPS (2018) *Local water management strategy – Bullsbrook Landholding*, prepared for Amex Corporation, report ref. EWP13024.007 Rev 4, May 2018.

RPS (2021) *Addendum to the Bullsbrook landholding local water management strategy*, memo dated 30 June 2021.

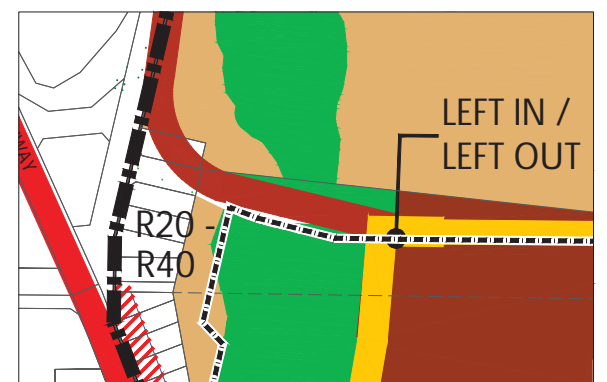
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Date: 03 September 2021
Regarding: Kingsford Local Structure Plan

Appendix A Kingsford Local Structure Plan (Hatch RobertsDay 2021)



- LEGEND**
- LOCAL STRUCTURE PLAN BOUNDARY (254.61ha)
 - AREA SUBJECT TO FUTURE PRECINCT PLAN
- ZONES**
- RESIDENTIAL (R5-R30)
 - RESIDENTIAL (R10-R30)
 - RESIDENTIAL (R20-R30)
 - RESIDENTIAL (R20-R40)
 - RESIDENTIAL (R40-R60)
 - GENERAL COMMERCIAL
 - PUBLIC PURPOSE - PRIMARY SCHOOL
 - RECREATION
 - DISTRICT OPEN SPACE
 - PRIVATE CLUBS AND INSTUTIONS
 - PRIMARY REGIONAL ROAD
 - ADDITIONAL USES - SERVICE STATION
- RESERVES**
- PRIMARY DISTRIBUTOR
 - INTEGRATOR B
 - NEIGHBOURHOOD CONNECTOR A
 - NEIGHBOURHOOD CONNECTOR B



CADASTRAL INFORMATION
 SOURCE: MNG
 YYMMDD: 161017
 DWG REF: 97797de-006a
 PROJECTION: PCG94

HATCH | RobertsDay

1:10,000
 SIZE A3
 0 metres 100 200 300 400 500

W	ADD PROPOSED URBAN AREA	210811	SB	TT
V	NEIGHBOURHOOD CONNECTOR ADJUSTED	210129	SB	DRAFT
U	UPDATE WITH ACP	210121	SB	DRAFT
T	UPDATE WITH ACP	201106	SB	DRAFT
S	UPDATE TEXT AND PLAN	200707	II	EVDL
REV	DESCRIPTION	YYMMDD	DRAWN	APPR'D

210811	SB	TT
210129	SB	DRAFT
210121	SB	DRAFT
201106	SB	DRAFT
200707	II	EVDL
YYMMDD	DRAWN	APPR'D

KINGSFORD LOCAL STRUCTURE PLAN
Bullsbrook
 City of Swan

REF NO. **AMX BUL** DRAW NO. **RD1 107** REV. **W**

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

Appendix 4

Environmental Summary Report

(RPS)

ENVIRONMENTAL SUMMARY REPORT

Bullsbrook Landholding Local Structure Plan



EEL15193.001
Rev 9
25 August 2021

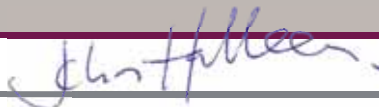
REPORT

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
Draft A	Draft for client review	KriFer	JohHal	NA	11/12/2016
Rev 0	Final for issue	KriFer	JohHal	JohHal	23/01/2017
Rev 1	Final for issue	JohHal	JohHal	JohHal	11/05/2017
Rev 2	Final for issue		SteRol	SteRol	07/07/2017
Rev 3	Final for issue	JohHal	SteRol	JohHal	12/09/2017
Rev 4	Final for issue	JohHal	JohHal	JohHal	27/11/2017
Rev 5	Final for issue	JohHal	JohHal	JohHal	07/12/2017
Rev 6	Final for issue	JohHal	JohHal	JohHal	21/12/2018
Rev 7	Final for issue	JohHal	JohHal	JohHal	10/01/2019
Rev 8	Final for issue	JohHal	JohHal	JohHal	01/08/2021
Rev 9	Final for issue	JohHal	JohHal	JohHal	25/08/2021

Approval for issue

J. Halleen



25 August 2021

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(compiled at rear of report)

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Appendices

Appendix A: Bullsbrook Project Flora & Vegetation Assessment

Appendix B: Aboriginal heritage sites

SUMMARY

Okeland Pty Ltd (Okeland) has prepared a revised Local Structure Plan (LSP) to facilitate development within a 254 hectare (ha) portion of land in East Bullsbrook (the site). The Bullsbrook site is located within the City of Swan abutting the existing Bullsbrook town site, being approximately 35 kilometres (km) north-east of Perth and approximately 12 km north of Ellenbrook. The RAAF Base Pearce is located to the west of the land, and the future South Bullsbrook Industrial Precinct is located south-west of the site. A summary of the Bullsbrook site is provided in Figure A.

This Structure Plan provides an overarching planning framework to guide and facilitate the development of the Structure Plan area for urban purposes and has been prepared in accordance with the City of Swan Local Planning Scheme No. 17, Planning and Development (Local Planning Schemes) Regulations 2015 and associated Structure Plan Framework.

The plan provides for an integrated and coordinated approach to an appropriate mix of residential land uses and infrastructure, necessary to create a new, vibrant residential community in the Swan municipality.

The Structure Plan area is zoned a mix of 'Urban', 'Urban Deferred' and 'Rural' under the Metropolitan Region Scheme (MRS) and correspondingly 'Residential Development' and 'General Rural' under the City's Local Planning Scheme (LPS) No. 17.

Consent was provided by the Western Australian Planning Commission (WAPC) for the lodgement of this amendment to the structure plan concurrently with the 'lifting of Urban Deferment' zoning. The Structure Plan demonstrates how the subject area may be suitably developed for urban use to enable the residential development of the land once the 'Urban Deferred' zone is lifted.

The updated Structure Plan has a total area of 254 ha (Figure B).

Since the advancement of the scheme amendments in 2018, the structure plan and subdivision the Kingsford residential development has been substantially advanced. The City of Swan approved the Ki-it Monger Brook foreshore and wetland management plan in 2018. DWER and the City approved the LWMS in 2018.

Existing land use zoning context

The Bullsbrook site has been identified by the Western Australian Planning Authority (WAPC) as a "Future Urban Area" in the following key planning reports:

- Directions 2031 and Beyond
- Perth and Peel Sub-Regional Strategy
- "Future Residential" in the City of Swan's draft Bullsbrook Town Site Expansion Master Plan.

The amended Structure Plan area is zoned "Urban" under the MRS and "Urban Deferred". An application to This LSP will assist in guiding the future land use zoning and development of the land subject to MRS amendment. The western portion of Lot 1354 is reserved as "Primary Regional Roads".

An amendment to the City's LPS 17 zoning and reservations is being advanced concurrently with the LSP to be consistent with the MRS 'Urban' zoning.

Concurrent with the MRS amendment, Amex is advancing this LSP for the Bullsbrook site. The LSP defines the key proposed land uses within the site including:

- Residential development
- "New" Bullsbrook town centre
- District playing fields
- Local roads
- Realignment of a portion of Chittering Road through an existing (and cleared) road reserve
- Public open space (POS)
- Primary and secondary school sites

- Ki-It Monger Brook conservation open space area
- Stormwater drainage areas.

The updated Bullsbrook LSP is shown in Figure B.

Purpose of this report

The purpose of this Environmental Summary Report is to:

1. Review of the existing environment and address key environmental factors that may be impacted as a result of future development.
2. Outline the management measures that will be adopted to mitigate any potentially significant environmental impacts from future development.
3. Facilitate the approval of the LSP with the City of Swan and the WAPC by providing a land use framework to coordinate residential subdivision and development.

Bullsbrook site environment

Historically, the LSP site has been extensively cleared for agricultural purposes and consists largely of grassed paddocks used for cattle grazing and therefore has limited environmental values. The remnant trees are predominately located along an existing seasonal creekline (Ki-It Monger Brook) and on the central and hill ridges.

The key areas of environmental value within the site are Ki-It Monger Brook and discrete pockets of remnant vegetation. The following environmental factors are addressed in this EAR, identifying management requirements through the LSP and sequential planning stages:

- Flora and vegetation
- Fauna habitat
- Hydrological processes
- Heritage
- Acid sulfate soils
- Bushfire risk.

Bush Forever Site No. 86 is located to the north of the Bullsbrook site and is not proposed for development and therefore is not included in the structure plan.

Key environmental outcomes

The LSP promotes the preparation and implementation of following key environmental management plans:

1. Ki-It Monger Brook and Wetland Management Plan, which it is anticipated, will be a requirement of subdivision. The Ki-It Monger Brook FMP will appropriately detail the location of community facilities, open space areas, possible drainage areas and access pathways. This management plan was prepared and approved by the City of Swan in 2018.
2. Remnant Vegetation Management Plan to outline management recommendations for the stand of remnant Guildford vegetation community located on the southern boundary of the site.
3. Urban Water Management Plan(s).
4. Remediation of the Class I Inert Landfill to the satisfaction of the City of Swan by the current landfill proponent. This will outline the decommissioning of the landfill site and will address the decommissioning and rehabilitation and post-rehabilitation monitoring.

Table 2 summarises the key environmental issues within the site and the proposed management responses and timing.

Table 1: Summary of key potential environmental impacts and proposed management measures

Environmental issue	Environmental objective	Applicable legislation and/or guidelines	Potential impacts	Management measures	Timing
Vegetation and flora	To maintain representation, diversity, viability, and ecological function at the species, population and community level	<ul style="list-style-type: none"> Environment Protection and Biodiversity Conservation Act 1999 Wildlife Conservation Act 1950 Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (EPA 2000). 	The LSP site is predominately located within the existing cleared paddocks on the site. Within the site, the key native vegetation areas are located within Ki-It Monger Brook and pockets of remnant vegetation on the southern boundary of Lot 1314 (Figure L).	<ol style="list-style-type: none"> The mature trees in the Ki-It Monger Brook will be retained along with representative vegetation from the Guildford Complex. The LSP incorporates the objectives of EPA Bulletin No. 20: Protection of natural areas through planning and development through: <ol style="list-style-type: none"> Ensuring adequate representation of ecological communities Protecting areas of high diversity (Bush Forever Site No. 86) Protecting areas containing rare or threatened species or communities (Bush Forever Site No. 86). Maximise size and shape of naturally vegetated areas Protect best condition naturally vegetated areas. The maintenance of flora and vegetation will be managed at the structure planning and subdivision stages through the following: <ol style="list-style-type: none"> Ki-It Monger Brook Foreshore Area Report – <u>completed</u> Remnant Vegetation Management Plan Fire Management Plan – <u>completed for approved subdivisions</u> 	Management plans will be prepared at subdivision stage
Fauna	To maintain the abundance, diversity, geographic distribution and productivity of fauna species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge	<ul style="list-style-type: none"> EPA Draft GS No. 56 EPA GS No. 54 EPBC Act (1999) Wildlife Conservation Act 1950. 	The LSP site area is predominately located within the existing cleared paddocks on the site. The potential impacts include: <ul style="list-style-type: none"> Disturbance from construction and human activities within retained vegetation, e.g. effects of noise, dust, light and vehicles Loss of fauna or injury due to collisions Introduction or spread of vermin due to introduced species or vermin 	<ol style="list-style-type: none"> The Local Structure Plan will into account the EPA Bulletin No. 20: Protection of natural areas through planning and development. Accordingly, the following environmental planning objectives will be addressed: <ol style="list-style-type: none"> Ensure adequate representation of ecological communities. Protect areas of high diversity (Bush Forever Site No. 86). Protect areas containing rare or threatened species or communities. Maximise size and shape of naturally vegetated areas. Protect best condition naturally vegetated areas. The maintenance of fauna will be managed at the structure planning and subdivision stages through the following: <ol style="list-style-type: none"> Ki-It Monger Brook Foreshore Area Report – <u>completed</u> Remnant Vegetation Management Plan Fire Management Plan – <u>completed for approved subdivisions</u> 	Management plans will be prepared at subdivision stage
Acid sulfate soils (ASS)	To maintain the quality of land and soils so that the environment values, both ecological and social, are protected.	<ul style="list-style-type: none"> Assessment Levels for Soil, Sediment and Water (Department of Environment and Conservation [DEC] 2010) Acid Sulfate Soils Guideline Series. Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DEC 2011) Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes (DEC 2013). 	Acidification and release of heavy metals from acid sulfate soils (ASS) into groundwater and seasonal freshwater environment of Ki-It Monger Brook	The final fill levels, and subsequent excavation (e.g. for sewer lines/engineering services) and dewatering requirements, will dictate whether a preliminary investigation and an ASS and Dewatering Management Plan (ASSDMP) is required to be prepared prior to development at the site occurring	ASSDMP to be prepared at subdivision stage (if required)
Hydrological processes	To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected	Better Urban Water Management (WAPC 2008).	<ul style="list-style-type: none"> Change in hydrological regime as a result of changed landforms (from earthworks), which may alter natural flows and levels Discharge of stormwater may affect the quality of groundwater and surface water 	<ul style="list-style-type: none"> Ki-It Monger Brook buffer has been defined in the Local Structure Plan in accordance with DWER's Identifying and establishing waterways foreshore areas (DoW 2012) A Local Water Management Strategy (LWMS) has been prepared and approved for the LSP in accordance with WAPC's Better Urban Water Management framework – <u>completed</u>. An Urban Water Management Plan will be completed at the subdivision stage in accordance with the Better Urban Water Management framework and to the satisfaction of the City of Swan Ki-It Monger Brook Foreshore Area Report – <u>completed</u>. Wetland Management Plan for the small Conservation Category Wetland area (UFI 12681). This wetland portion of the Ki-it Monger Brook was incorporated in the 2018 approved Ki-it Monger Brook FMP. 	LWMP been prepared to support the LSP. UWMP(s) to be prepared at subdivision stage
Wetland	To maintain the integrity and ecological functions of any wetlands within the LSP site	<ul style="list-style-type: none"> Wetlands Conservation Policy for Western Australia (Government of Western Australia 1997) Environmental Protection (Swan Coastal Plain Lakes) Policy (EPA 1992) Guideline for the Determination of Wetland Buffering Requirements (WAPC 2005b). 	<ul style="list-style-type: none"> Earthworks may directly or indirectly impact the wetlands and associated vegetation Unauthorised access, which may degrade vegetation Weed invasion Drainage, which may alter wetland function and hydrology. 	The wetland interface management treatments will be finalised and agreed through landscape plans and the City of Swan. This was completed as part of the 2018 approved Ki-it Monger Brook FMP.	Subdivision

REPORT

Environmental issue	Environmental objective	Applicable legislation and/or guidelines	Potential impacts	Management measures	Timing
Heritage	To ensure that historical and cultural associations are not adversely affected	<ul style="list-style-type: none"> • <i>Aboriginal Heritage Act 1972</i> • Guidance Statement No. 41: Assessment of Aboriginal Heritage (EPA 2004b). 	<ul style="list-style-type: none"> • There is a mythological site mapped over the Ki-It Monger Brook. Data regarding this site is not available for public viewing until permission has been sought and granted from the appropriate traditional owner group. • Excavation / construction activities may unearth and/or damage artefacts or other items of cultural Aboriginal significance 	<ul style="list-style-type: none"> • A suitably qualified cultural heritage consultant was appointed to investigate the extent of the mythological site and undertake a cultural assessment. An application for approval to disturb the Aboriginal archaeological site under Section 18 of the <i>Aboriginal Heritage Act 1972</i> has been made. • A Section 18 of the <i>Aboriginal Heritage Act 1972</i> was approved in 2018. • Be vigilant during earthworks and stop work immediately should any items be discovered. Notify the Department of Aboriginal Affairs. 	Prior to construction
Contamination	To ensure that human health is not adversely affected	<ul style="list-style-type: none"> • <i>Contaminated Sites Act 2003</i> • Department Environment Regulation Contaminated Sites Guidelines series 	A landfill site is located on Lot 2792, however the landfill ceased operations in 2020.	The landfill site ceased operations in 2020. The landfill site will be remediated but the landfill operators to DWER remediation standards.	During subdivision stage
Bushfire risk	To reduce the risk of bushfire to people, property and infrastructure.	<ul style="list-style-type: none"> • Australian Standard 3959:2009: Construction of Buildings in Bushfire-prone Areas (Standards Australia 2009) • Guidelines for Planning in Bushfire Prone Areas (Department of Planning and WAPC 2015a) • SPP 3.7: Planning in Bushfire Prone Areas (Department of Planning and WAPC 2015b). 	Future development within the LSP site will result in an increased risk to people, property and infrastructure being impacted by potential bushfires in retained vegetation along Ki-It Monger Brook	<ul style="list-style-type: none"> • Bushfire assessment and management framework will be prepared for the future Local Structure Plan includes BAL ratings. • Development and implementation of an approved Bushfire Management Plan – <u>completed for each approved subdivision</u>. 	During subdivision stage

1 INTRODUCTION

Oakland Pty Ltd (Okeland) has prepared a Local Structure Plan (LSP) to facilitate development within a 254 hectares (ha) portion of land in East Bullsbrook (the site). The Bullsbrook site is located within the City of Swan abutting the existing Bullsbrook town site, being approximately 35 kilometres (km) north-east of Perth and approximately 12 km north of Ellenbrook. The RAAF Base Pearce is located to the west of the land, and the future South Bullsbrook Industrial Precinct is located south-west of the site.

This LSP creates a framework for the future urban subdivision development of an anticipated 2,740 plus dwellings, which will ultimately house a new community in the vicinity of 8,000 plus people within a variety of lot product and dwelling types. The LSP also seeks to provide a foundation for the development of the Bullsbrook Central District Activity Centre, which will provide a key employment and activity node within the City of Swan.

The site has historically been used for agricultural pursuits, including land uses such as cropping and grazing, and is therefore degraded state and cleared of any significant vegetation. There are some areas of remnant vegetation associated with existing creek lines, however these areas are generally devoid of understorey. There are existing dwellings and other farming related structures within the site. An operational Class I inert landfill (includes crushing of building materials and a solid waste depot) is located to the east of the subject land. Once closed, the landfill is proposed to be rehabilitated in accordance with Department of Water and Environment Regulation (DWER) requirements.

1.1 Purpose of this report

The purpose of this Environmental Summary Report is to:

- Review the existing environment and address key environmental factors that may be impacted as a result of future development.
- Outline the management measures that will be adopted to mitigate any potentially significant environmental impacts from future development.
- Facilitate the approval of the LSP with the City of Swan and the Western Australian Planning Commission (WAPC) by providing a land use framework to coordinate residential subdivision and development.

The Bullsbrook LSP is shown in Figure B.

1.2 Scope of works

This Environmental Summary Report includes an assessment of the following factors:

- Biophysical factors
 - Topography
 - Geology
 - Hydrology
 - Wetlands
 - Vegetation and flora
 - Fauna
- Pollution management
 - Potential contamination
- Social surroundings
 - Heritage
 - Fire
 - Surrounding land uses including the current Class 1 landfill facility located on the site.

1.3 Planning context

A significant portion of the site has been identified by the WAPC as a “Future Urban Area” in the following key planning reports:

- Directions 2031 and Beyond
- Perth and Peel Sub-Regional Strategy
- “Future Residential” in the City of Swan’s draft Bullsbrook Town Site Expansion Master Plan (Figure C).

The Bullsbrook site has been identified by the Western Australian Planning Authority (WAPC) as a “Future Urban Area” in the following key planning reports:

- Directions 2031 and Beyond
- Perth and Peel Sub-Regional Strategy
- “Future Residential” in the City of Swan’s draft Bullsbrook Townsite Expansion Master Plan.

The amended Structure Plan area is zoned “Urban” under the MRS. This LSP will assist in guiding the future land use zoning and development of the land. The western portion of Lot 1354 is reserved as “Primary Regional Roads”.

The City’s LPS 17 zoning of the LSP area is “Residential Development” consistent with the MRS ‘Urban’ zoning. The western portion of Lot 1354 is reserved as “Primary Regional Roads”.

Concurrent with the MRS amendment, Amex is advancing this LSP for the Bullsbrook site. The LSP defines the key proposed land uses within the site including:

- Residential development
- “New” Bullsbrook town centre
- District playing fields
- Local roads
- Realignment of a portion of Chittering Road through an existing (and cleared) road reserve
- Public open space (POS)
- Primary and secondary school sites
- Ki-It Monger Brook conservation open space area
- Stormwater drainage areas.

The Bullsbrook LSP is illustrated in Figure B.

1.3.1 City of Swan Bullsbrook Townsite Land Use Master Plan

The Bullsbrook Townsite Land Use Master Plan (BTLUMP) provides a strategy for the future development of Bullsbrook town site and has been used as a base to guide design of the Structure Plan and allocation of land uses.

The BTLUMP proposes the Structure Plan area be developed for urban purposes as a mix of “District Centre”, “Future Residential”, “Conservation”, “District Open Space”, “Mixed Use”, “Public Open Space” and “Primary School”, as well as a “Rapid Transit Route” and “Rapid Transit Route Terminus” (Figure C).

The land use designations prescribed by the BTLUMP have been generally reflected by the LSP.

1.4 Environmental assessment context

1.4.1 Meeting with the Department of Water Regulation (DWER EPA Services)

RPS met with DWER EPA Services in 2013 to review the existing environment, potential environmental issues and importantly the identification of a “preferred” process for undertaking an environmental assessment of the landholdings in the context of the strategic planning undertaken by the WAPC and the City of Swan. The DWER EPA Services recognised the key environmental factors for the site were capable of being addressed through the Scheme Amendment and future planning stages.

The EPA / DWER – EPA Services has previously assessed the Bullsbrook East (Lots 3, 1165, 1396 and 60) (referred to as the Kingsford estate) on the following occasions:

- 2016 - Proposed Lifting of Urban deferment - Bullsbrook East - Portions of Lots 3, 1165, 1396, 1354 and 60
- 2017 - Metropolitan Region Scheme – Amendment 1324/41 Bullsbrook Central Urban Precinct
- 2018 – City of Swan – Local planning Scheme 17 – Amendment No. 158.

In each of the above assessments, the EPA considered the scheme amendments (or the lifting of urban deferment) is unlikely to have a significant effect on the environment and did not warrant formal assessment under Part IV of the EP Act.

1.5 Existing land uses

The majority of the site has been historically cleared to facilitate agricultural practices (Plate 1 and Plate 2) with the remnant native vegetation within the site restricted to Ki-It Monger Brook (Plate 3) and pockets of remnant vegetation.

Vegetation across the site ranges from “Completely Degraded” to “Degraded” condition. “Completely Degraded” areas occur across the vast majority of the site, consisting of cleared and grazed paddocks, dominated by pasture weeds. The small pockets of remnant plant communities were in “Degraded” condition, and contained an intact over-storey and a limited native understorey

Figure D illustrates the land uses within the site.



Plate 1: Existing agricultural land use within the site



Plate 2: Cattle grazing and existing dam within the site



Plate 3: Remnant vegetation (*Eucalyptus rudis*) within the Ki-It Monger Brook

1.5.1 Landfill site

The landfill site is an operational Class I inert landfill located within a portion of Lot 1288 Hurd Road, on the eastern boundary of the site (Figure D). The landfill is at the location of the former clay quarry site.

The site is licensed by the DWER as a prescribed premise under the *Environmental Protection Act 1986*. The licence number for the site is L8153/2004/2 which was issued in June 2011 and expired in 2020. The landfill site ceased operations in June 2020. Now closed, the landfill will be rehabilitated by the landfill operators in accordance with DWER requirements

Table 3 outlines DWER’s permitted waste types in accordance with the licence. It is noted the permitted waste is inert building material.

Table 2: Class I Inert Landfill

Category number	Category description	Category production or design capacity	Premises production or design capacity
63	Class I inert landfill site: premises on which waste (as determined by reference to the waste type set out in the document entitled “Landfill Waste Classification and waste Definitions 1996” Published by the DEC chief executive officer and as amended from time to time*) is accepted for burial	200,000 tonnes per year	More than 50,000 but not more than 500,000 tonnes per year
13	Crushing of building materials: Premises on which waste building or demolition materials (for example bricks, stone or concrete) is crushed or cleaned	50,000 tonnes per year	Not more than 50,00 tonnes per year
62	Solid waste depot: Premises on which waste is stored, or sorted, pending final disposal or reuse	5,000 tonnes per year	More than 500 but no more than 5,000 tonnes per year

* Type I non-hazardous, non-biodegradable (half-life greater than two years) wastes containing contaminant concentrations less than Class I landfill acceptance criteria (DEC Landfill Waste Classification and Waste Definitions as Amended 2009) but excluding paper and cardboard.

The ‘Urban Deferred’ land in accordance with the WAPC’s advice be transferred to a ‘Urban’ zoning noting the landfill has permanently ceased operations.

In this context, and to accommodate a sensible integrated long-term use for the former landfill site is proposed to be rehabilitated by the former landfill operators, for the land use(s) promoted in the LSP. This sequential land use is promoted by the DWER in Best Practice Environmental Management Draft Siting, Design, Operation and Rehabilitation of Landfills (DoE 2005).

1.6 Surrounding land uses

The key surrounding land uses to the Bullsbrook LSP are shown in Figure D.

1.6.1 Adjacent Lot 2430 nursery

The Swan Valley Nursery is located within Lot 2430 Great Northern Highway, adjacent to the southern boundary of site. The nursery focuses on producing herbs within enclosed greenhouses. The nursery currently operates in accordance with an approved development application and typically operates within standard working day times.

1.6.2 Residential

The existing Bullsbrook town site is located to the west of the LSP site and residential development, including a school and RAAF base, is located to the west and north-west of the subject land.

1.6.3 Rural

Land to the north, north-east, east and south-east of the LSP site are surrounded by land zoned under the LPS No. 17 for “Landscape”, “Rural Residential” and “Rural” purposes. Bush Forever Site No. 86 is located in the north of the site.

1.6.4 RAAF Base Pearce

RAAF Base Pearce is located adjacent to the township of Bullsbrook.

RAAF Base Pearce’s primary role is pilot training for the Royal Australian Air Force, the Royal Australian Navy and the Republic of Singapore Air Force. It is the home base of:

- No. 2 Flying Training School
- No. 79 Squadron
- No. 25 (City of Perth) Squadron
- Defence Support and Reform Group – Pearce
- No. 453 Squadron Detachment Pearce (Air Traffic Control)
- No. 2 Expeditionary Health Squadron Detachment Pearce
- No. 3 Security Forces Squadron Detachment Pearce
- No. 7 Wing Australian Air Force cadets.

All the aircraft fly within a corridor known as a flight path. The Department of Defence operates Noise and Flight Path Monitoring Systems (NFPMS) to provide the community with information about aircraft noise associated with military operations at RAAF Base Pearce. The Defence Department’s Aircraft Noise Exposure Forecast (ANEF) maps and NFPMS show the entire Bullsbrook landholdings are located outside of the flight corridors noise contours (Figure D). The aircraft noise contours are contained to the western side of the Great Northern Highway.

1.7 Separation distances

Residential land uses are potentially sensitive to emissions from industrial land uses. Separation distances between Industrial and Sensitive Land Uses (EPA 2015) identifies generic separation distances, developed by the EPA, to determine buffers between sensitive land uses and industrial land uses.

1.7.1 Landfill site

The Class 1 inert landfill site was subject to the following DWER approvals:

- Class 1 inert landfill site that can accept a maximum of 200,000 tonnes per year of inert waste
- Crushing of building materials building waste up to 50,000 tonnes per year
- Solid waste depot up to 5,000 tonnes per year.

The landfill site was permanently closed in 2020. The operators of the landfill site are responsible for the remediation of the landfill site.

To date the indicative Bullsbrook residential development staging plan has maintained a 1,000 m separation distance from the landfill site as illustrated in Figure 1 and Figure D. However, with the closure of the landfill site in 2020, the WAPC is concurrently with this amendment LSP advancing the ‘lifting of Urban Deferment’ zoning which will facilitate development within the former 1,000 m separation buffer area.

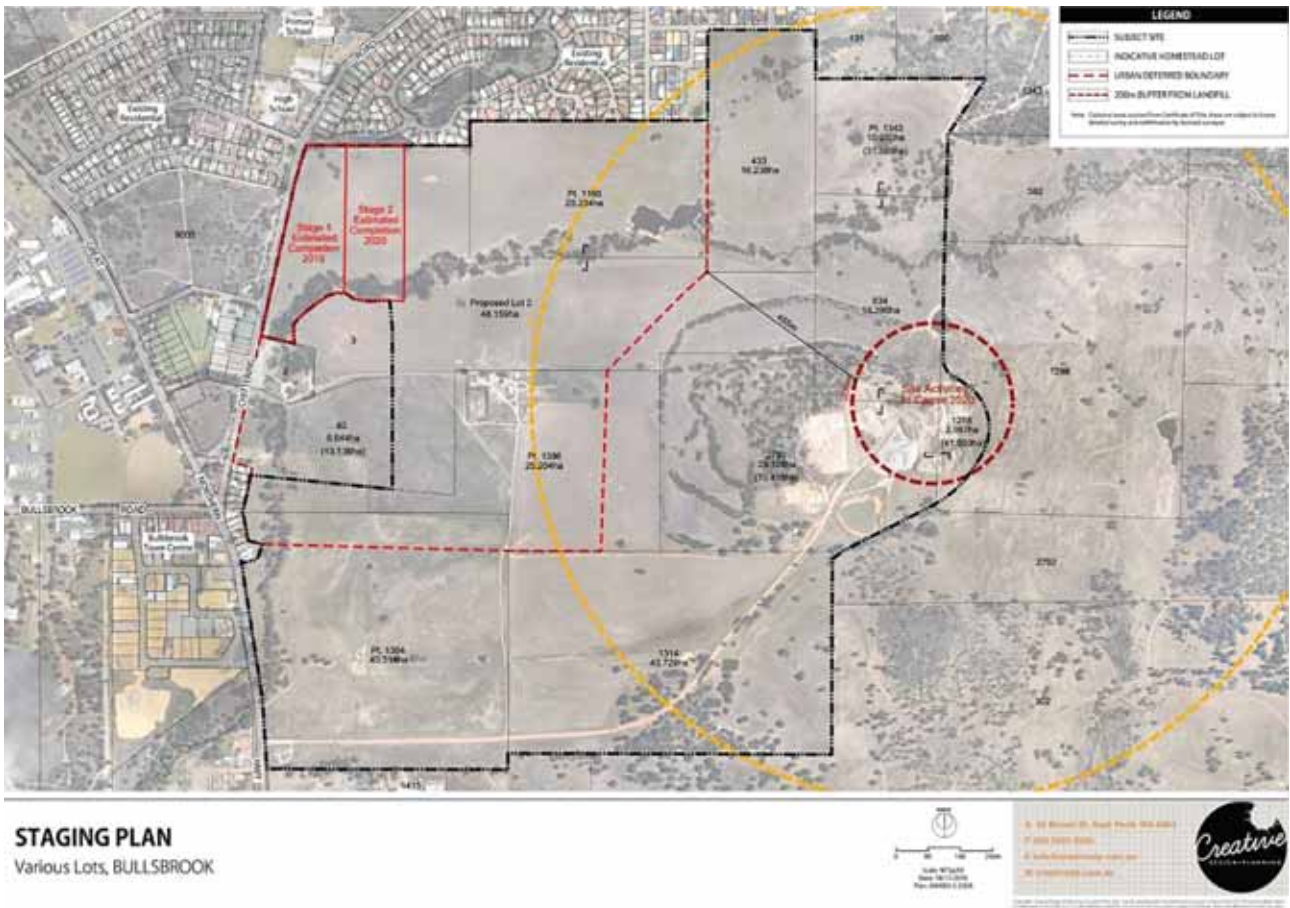


Figure 1: Bullsbrook development indicative staging plan and landfill buffer distance

1.7.2 Nursery

The generic separation distance from a nursery is 100 m (EPA 2015). Figure D shows that the buffer from the Swan Valley Nursery is located over a small portion of Lot 1354.

The generic buffer is primarily based on potential noise impacts. It is noted that since the nursery operations are enclosed within large greenhouse sheds, and is setback from the property boundary by approximately 20 m to 30 m.

Regarding the interface management, the structure plan has located commercial development and the District Open Space adjacent to the nursery site to manage the long-term interface. It should also be noted that land south of the LSP site (including the nursery) has been identified as future residential land in the Bullsbrook master plan.

2 LEGISLATION AND REGULATION

2.1 Legislation and regulations

Urban development within the site will comply with environmental legislation and regulations. A summary of the key state and Commonwealth legislation and regulations is listed in Table 4.

Table 3: Key state and Commonwealth legislation and regulations

State legislation	
<i>Aboriginal Heritage Act 1972</i>	<i>Heritage of Western Australia Act 1950</i>
<i>Conservation and Land Management Act 1984</i>	<i>Land Administration Act 1997</i>
Conservation and Land Management Regulations 2002	<i>Planning and Development Act 2005</i>
<i>Environmental Protection Act 1986</i>	<i>Rights in Water and Irrigation Act 1914</i>
<i>Contaminated Sites Act 2003</i>	<i>Wildlife Conservation Act 1950</i>
Environment Protection Regulations 1987	Environmental Protection (Peel Inlet – Harvey Estuary) Policy 1992
Environmental Protection (Noise) Regulations 1997	
Commonwealth legislation	
<i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i>	Environment Protection and Biodiversity Conservation Regulations 2000

2.1.1 Applicable guidelines and standards

Development of the site is required to comply with applicable guidelines and standards developed by the EPA. These guidelines and standards assist proponents and the general public to understand the minimum requirements for the protection of elements of the environment that the EPA expects to be met during the assessment process.

Table 4 details the key EPA standards, guidelines and state planning policies relevant to the site.

Table 4: Applicable EPA standards, guidelines and state planning policies

EPA position statements
Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia
Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection
EPA Environmental Assessment Guidelines
Environmental Assessment Guideline No. 8: Environmental factors and objectives
Environmental Assessment Guideline No. 9: Application of significance framework in the environmental impact assessment process
EPA guidance statements
Guidance Statement No. 33: Environmental Guidelines for Planning and Development
Guidance Statement No. 41: Aboriginal Heritage Assessment
Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia
Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia
State planning policies
State Planning Policy No. 3.7: Planning for Bushfire Risk Management
State Planning Policy 2.4: Basic Raw Materials

2.2 Relevant planning and environmental policies and guidelines

2.2.1 Draft North-East Sub-regional Planning Framework – towards Perth and Peel@3.5million (WAPC 2015)

The Bullsbrook site is identified as an “Urban Expansion Area” in the Draft North-East Sub-regional Planning Framework (WAPC 2015). This Class of Action provides for existing, new and proposed urban development. This includes residential land uses and associated functions such as employment, education, retail, civic facilities, light industry and open space.

It is noted that the Environmental Protection Authority’s (EPA) Interim Strategic Advice on the Perth and Peel@3.5million is supportive of the sub-regional planning framework proposed.

2.2.2 Draft Perth and Peel Green Growth Plan for 3.5 million

Figure 2 illustrates the draft Perth and Peel Green Growth Plan for 3.5 million mapping specifically noting the areas mapped as ‘specific commitments” and “broad commitments and values”.

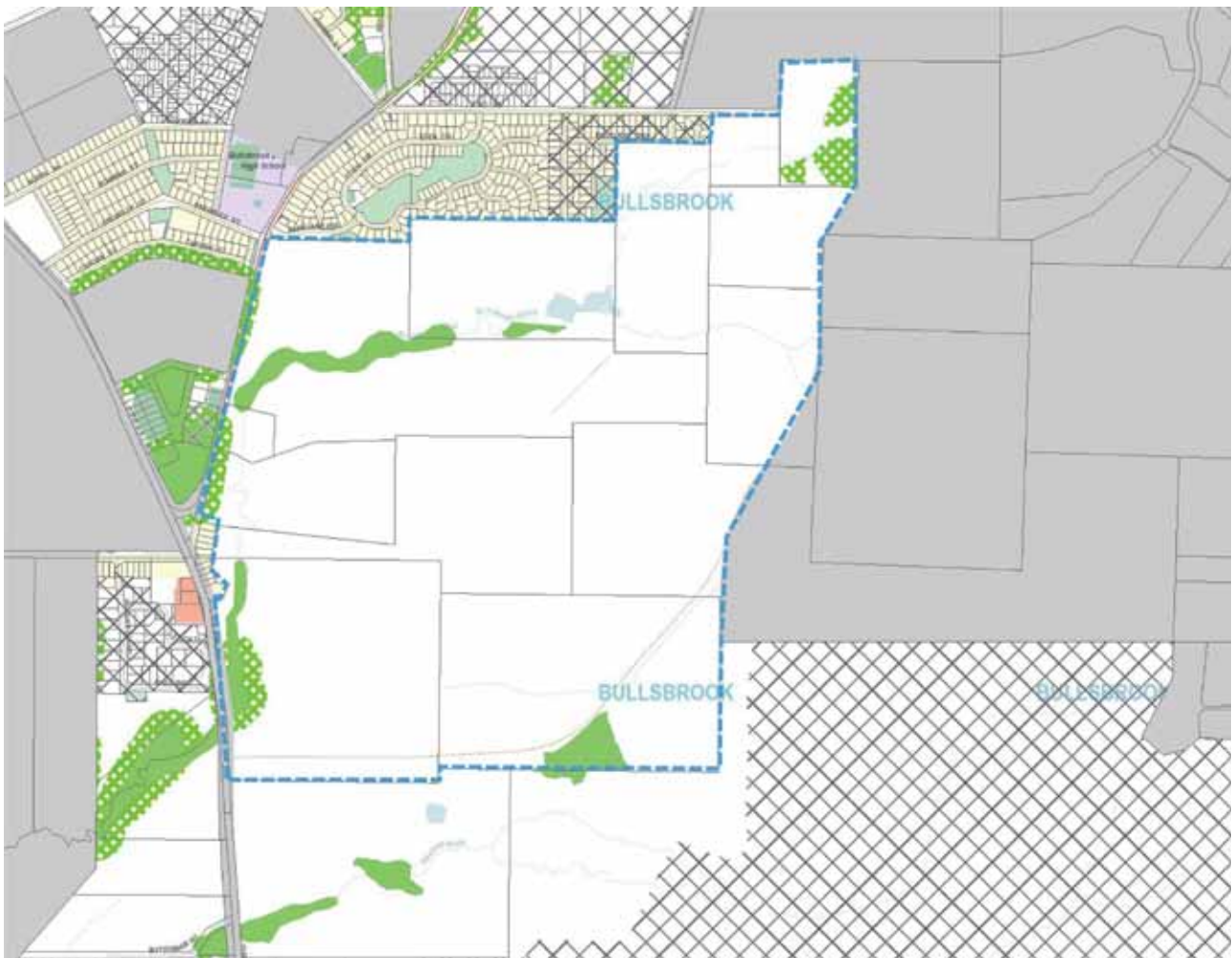


Figure 2: Draft Perth and Peel Green Growth Plan for 3.5 million spatial mapping of the Bullsbrook site

The LSP accommodates the ‘specific commitment areas” as defined in the draft Perth and Peel Green Growth Plan for 3.5 million in particular the Ki-It Monger Brook and the stand of Guildford complex native vegetation on the southern boundary. This report outlines the key management measures to be undertaken at subdivision for the Ki-It Monger Brook and the stand of Guildford complex native vegetation.

2.2.3 State Planning Policy 2.4 (SPP 2.4 Basic Raw Materials)

This policy sets out the matters which are to be considered and given effect to by the WAPC and local governments in considering zoning, subdivision and development applications for extractive industries.

The policy has identified a “basic raw materials key extraction area” within partial Lots 2792, 3 and 834. The Priority Resource Area is approximately 32.6 ha. The location of the “basic raw materials key extraction area” is shown in Figure 3.

Kaolinite clays had been excavated from the Bullsbrook site since 1980, with a void been formed in the southern side of the hill. In 2004, the EPA, the WAPC and the City of Swan approved clay extraction by Midland Brick. The void from the earlier Midland Brick clay excavation is currently being used as a Class 1 inert landfill site.

In 2004, the City of Swan approved an extractive industry licence and the WAPC approved a Development Application at the basic raw material resource location. The EPA assessed the clay excavation proposal in 2004 and determined the proposal to be “Not Assessed – Public Advice Given”.

Clay excavation ceased several years ago, however, geotechnical investigations has delineated a potential deposit of clay to the west. This deposit is within an area of approximately 1.4 ha, which has a significant volume of resource overburden which (if the clay is removed via excavation) will be stockpiled and potentially incorporated in the engineering fill to restore the land surface for future land use.

2.2.4 EPA Bulletin No. 20 (EPB No. 20) Protection of natural areas through planning and development

The Structure Plan will incorporate the objectives outlined in EPA Bulletin No. 20 (EPB No. 20) Protection of natural areas through planning and development (EPA 2013) outlined below.

2.2.4.1 Locate development on cleared land

The structure plan focuses on (in accordance with the master plan and the WAPC’s “Future Urban Expansion Area”) locating the development in historically cleared areas.

2.2.4.2 Minimising fire risk

Minimising development in naturally vegetated areas is highly compatible with minimising the risk of fire and its potential impacts on the community. A fire risk assessment report and management strategy will be undertaken in accordance with the Planning for Bushfire Protection Guidelines (WAPC and FESA 2010).

2.2.4.3 Protect large consolidated naturally vegetated areas

The largest extent of consolidated naturally vegetated areas on the site is located outside of the proposed future development area as outlined in the City’s master plan and the WAPC’s “Future Urban Expansion Area”. These large areas of remnant vegetation are located in the eastern Lots 857 (Bush Forever Site No. 86) and 1343 and along the scarp in Lots 1256, 6 and 1391. The structure plan will identify and plan for the retention of consolidated naturally vegetated areas.

The remnant vegetation along the Ki-It Monger Brook and pockets within the proposed future urban area as outlined in the LSP (Figure B).

2.2.4.4 Ecological linkages

Maintaining the ecological linkages along the Ki-It Monger Brook, which connects with the large naturally vegetated areas in the eastern portion of the site, will be established in the structure plan.

2.2.5 City of Swan Local Biodiversity Strategy

The City of Swan has one of the largest areas of natural environmental in the Perth Metropolitan area. The City in 2015 reviewed and updated its Local Biodiversity Strategy with the following goals:

Protection: The Goal is to formalise the long-term preservation of Local Natural Areas. This may be achieved through reservation, conservation covenant or inclusion in a conservation purpose zoning.

Retention: The Goal is to use a variety of processes available to ensure the retention of natural areas to ensure its continued existence and viability
(City of Swan 2015)

In relation to the Bullsbrook site, the City's Local Biodiversity Strategy identifies portions (i.e. the CCW and the Ki-It Monger Brook adjacent to the Great Northern Highway) as "Potential Significant Local Natural Areas". The Level 2 Vegetation and Flora Report survey concludes there are significant stands of *Eucalyptus rudis* within the Ki-It Monger Brook.

In accordance with the Local Biodiversity Strategy the vegetation in the Ki-It Monger Brook and the vegetation in the Brook (except for the creek road crossing) will be retained and managed after development, as outlined in the LSP (Figure B).

3 EXISTING ENVIRONMENT

3.1 Biophysical factors

3.1.1 Topography

The site is located at the foothills of the Darling Scarp and is generally of high relief. The site ranges in elevation from approximately 120 metres Australian Height Datum (m AHD) in the east, where the laterised foothills begin down to approximately 50 m AHD to the south-west, where the relatively flat landscape of the Swan Coastal Plain commences (Figure E).

3.1.2 Environmental geology

Geological mapping (Gozzard 1982) indicates that the site is dominated by three main surficial geological units (Figure F):

- **Msg – Silty Sands:** The majority of the site is comprised of silty sand (Msg) that is described as strong brown, firm, friable and dispersive in parts. This unit occasionally has pebbly horizons with little matrix containing quartzite, quartz granite and laterite pebbles of colluvium origin.
- **Sti – Siltstone:** This is located on the eastern section of the site and is identified as white thinly bedded well laminated, fine-grained, with some large ferruginous concretions and laminae, which is occasionally micaceous.
- **Mgs1 – Pebbly Silt:** The south-western boundary of the site is dominated by pebbly silt associated with the Guildford Formation (Mgs1). This geological unit is described as strong brown silt with occasional coarse grained, laterite, quartz and heavily weathered granite pebbles with some fine to medium-grained quartz sand of alluvial origin.
- **GR – Granite:** Two small sections of the site on the eastern boundary have been mapped as granite, fine to coarse grained that ranges in composition from granodiorite to granite, with adamellite being the most common.

3.1.2.1 Site investigations

A geotechnical assessment was completed for the site by Galt Geotechnics (2014), which included the excavation of 79 test pits to depths of 0.6 m and 2.5 m as well as permeability testing. The main results from the Geotechnical Investigation include:

- Soil permeability ranged from 0.1 m/day to 6.8 m/day.
- Field tests indicated that there are potential acid sulfate soils (PASS) on the site.
- Galt (2014) identified three broad subsurface condition types including
 - Class S of slightly reactive clays
 - Class A mostly sand and rock
 - Class M of moderately reactive clay sites.

3.1.2.2 Acid sulfate soils

DWER broad-scale acid sulfate soil (ASS) risk mapping is based on surface geology mapping and provides a broad-scale indication of the risk of occurrence of ASS. The site has not been assigned an ASS risk rating and it is assumed there is a “low to no” known risk of ASS occurring within three metres of the natural soil surface (or deeper).

3.1.3 Hydrology

3.1.3.1 Aquifers

The site is located within the Bandy Spring Sub-area of the Swan Groundwater Area and is managed under the Gngara Groundwater Areas Allocation Plan (DoW 2009). The Bandy Spring Sub-area contains the Superficial aquifer and Fractured Rock West aquifer. A review of allocation limits identified that the Superficial aquifer was fully allocated. The Fractured Rock West aquifer is not expected to provide significant yields. The confined aquifers of the Swan Confined Groundwater sub-area (Leederville and Yarragadee North aquifers) extend beneath the western section of the site, which are also fully allocated.

Through consultation with Department of Water and Environmental Regulation (DWE) and the City of Swan, it was agreed that groundwater could be abstracted from the Superficial aquifer in the adjacent Cockman Bluff Sub-area and piped across the sub-area boundary to the development site to service its irrigation requirements. To support this, RPS has completed a drilling program and Level 2 Hydrogeological Assessment (RPS 2016).

The site is not located within a Public Drinking Water Source Protection area.

3.1.3.2 Groundwater levels

In September 2015, six monitoring bores (MB-1 to MB-6) were installed across the site. Drilling occurred to a depth of 18 mbgl (apart from MB-4 which was drilled to 11 mbgl). The locations of the bores are shown in Figure G.

During installation, only four of these bores encountered groundwater. At the time of installation, groundwater elevations ranged from approximately 76 m AHD at MW-3 down to approximately 30 m AHD at MB-1 (RPS 2016).

Groundwater levels were monitored from these bores and three other bores on the site (MW-1, MW-2 and MW-3) on two occasions in September and October 2015 and then again in November 2016. MB-3 and MB-4 were dry on all occasions, while the depth to water measured from the other bores ranged from 1.08 mbtoc (MW-1 November 2016) to 17.51 mbtoc (MB-1 November 2016). Groundwater levels monitored from the bores ranged from 30.49 m AHD (MB-1 November 2016) to 77.89 m AHD (MW-3 November 2016). Groundwater contours have been generated from the October monitoring event, ranging from 75 m AHD to 30 m AHD, as illustrated on Figure G.

3.1.3.3 Groundwater quality

Physico-chemical parameters were measured in the field as part of the three groundwater monitoring events, and samples were collected and sent to a NATA accredited laboratory to be analysed for a suite of nutrients as part of the September 2015 and November 2016 monitoring events.

pH ranged from acidic to slightly acidic, while uncompensated electrical conductivity ranged from 138 $\mu\text{S}/\text{cm}$ (MW-2) to 2060 $\mu\text{S}/\text{cm}$ (MB-1). Nutrient concentrations were found to be elevated, in particular total nitrogen (TN) and total phosphorus (TP). TN results ranged from below the laboratory limit of reporting (LoR) (MB-2) to 5.8 mg/L (MW-2), while TP results ranged from 0.03 mg/L (MW-1) to 17 mg/L (MB-1). Nine of the 12 groundwater samples had TN and TP concentrations above the ANZECC (2000) guidelines for lowland rivers in south-west Australia and eight of the TP results were also above the WQIP long term targets. Some of the results for NO_x, NH₄ and filterable reactive phosphorus were also above the ANZECC guidelines.

3.1.3.4 Surface water

The main hydrological feature of the site is the Ki-It Monger Brook, which flows east to west across the northern part of the site. It then runs along the south side of the site, before crossing under Great Northern Highway at the site's south-west corner, until it confluences with Ellen Brook approximately 2.3 km south-west of the site. A number of smaller drainage tributaries contribute to the Ki-It Monger Brook including a minor unnamed drainage course that traverses the southern section of the site and discharges into Ki-It Monger Brook near the site's south-west corner. The pre-development surface water features are illustrated in Figure H.

The Ki-It Monger Brook has been considerably modified including the construction of dams and installation of culverts on the site which restrict flows, as well as the clearing of riparian vegetation. In particular, a major dam located in the centre of the site has a major impact on flows downstream, as flows only occur once the water level reaches the height of the culverts installed in the dam wall (RPS 2013a). The location of the dams and culverts installed across the area is shown in Figure 3.



Figure 3: Dam and culvert locations across the site

3.1.3.5 Flood levels of the Ki-It Monger Brook

RPS completed hydrological and hydraulic modelling to determine the flood levels and extent during a 1:100 Average Exceedance Probability (AEP) flood event of the Ki-It Monger Brook. The modelling identified that the 1% AEP flood was largely confined to the existing channel as shown in Figure I. Finished lot levels will be at least 0.5 m above the 1% AEP flood level of the Ki-It Monger Brook.

3.1.3.6 Ki-It Monger Brook foreshore area

As part of the District Water Management Strategy prepared for the site, the DWER highlighted the requirement for a desktop and on-site biophysical assessment and justification of the foreshore of the Ki-It Monger Brook in a foreshore area report. The foreshore area is defined as the land that adjoins or directly influences a waterway, the area of transition between the edge of the waterway and the furthest extent of riparian vegetation.

The determination of the Ki-It Monger Brook foreshore and buffer was based on the following:

5. Biophysical assessment which included:
 - a. The CCW area of the Ki-It Monger Brook
 - b. Remnant riparian vegetation (Level 2 vegetation and flora survey)
 - c. Any valuable habitat areas
 - d. Soil types, including identifying any soil types that historically may have supported riparian vegetation and erosion risk

- e. Heritage
- 6. Ki-It Monger Brook bank survey and site assessment
- 7. Stormwater flood modelling
- 8. Review of current and proposed land uses promoted in the LSP.

The foreshore assessment was also undertaken in accordance with Operational Policy 4.3: Identifying and establishing waterways foreshore areas (DoW 2012) and Determining Foreshore Reserves (Water and Rivers Commission 2001).

Table 5 summarises the findings of the foreshore and buffer assessment. Further details on the foreshore assessment are provided in the Bullsbrook LWMS.

Table 5: Foreshore assessment for the Ki-It Monger Brook

Biophysical criteria	Site considerations
Topography and landform	Ki-It Monger Brook has a strongly defined drainage channel. The topography of the site grades down towards the creekline on both sides of the Ki-It Monger Brook, as shown on Figure E. The elevation of the sites ranges from approximately 120 m AHD in the east to 50 m AHD in the south-west.
Soils	<p>Environmental geology mapping (REF) has identified the majority of the Ki-It Monger Brook within the site to be underlain by silty sands (Msg), with the south western section of Ki-It Monger Brook underlain by pebbly silt (Mgs1) (Figure F). The definitions of these units are:</p> <ul style="list-style-type: none"> • Msg – Silty Sands – is described as strong brown, firm, friable and dispersive in parts. This unit occasionally has pebbly horizons with little matrix containing quartzite, quartz granite and laterite pebbles of colluvium origin. • Mgs1 – Pebbly Silt – associated with the Guildford Formation. This geological unit is described as strong brown silt with occasional coarse grained, laterite, quartz and heavily weathered granite pebbles with some fine to medium-grained quartz sand of alluvial origin.
Floodway and flood plain	RPS has identified that the flooding for the 1% AEP is fully confined to the existing channel of the brook for most of the site, except for near the major dam. The area of flooding in the 1% AEP event for the Ki-It Monger Brook is shown in Figure I.
Riparian vegetation	<p>The majority of the Guildford Complex is associated with the Ki-It Monger Brook. The remnant trees within the Ki-It Monger Brook will be retained through the establishment of the foreshore area, drainage retention and open space areas.</p> <p>A two-phase, Level 2 flora and vegetation assessment of the Bullsbrook site was conducted by Ecologia (2016). This survey identified the remnant riparian vegetation of Ki-It Monger Brook to be:</p> <ul style="list-style-type: none"> • Er1: <i>Eucalyptus rudis</i> subsp. <i>rudis</i> low open forest, over mixed weed species dominated by <i>*Avena barbata</i>, <i>*Lolium rigidum</i> and <i>*Oxalis per-caprae</i> and other common species included <i>Corymbia calophylla</i>, <i>Gomphocarpus fruticosus</i>, <i>*Solanum linnaenum</i>, <i>*Brixa maxima</i>, <i>*Moraea flaccida</i> (Figure J). <p>This vegetation unit was identified to be in a “Degraded” condition (on the Bush Forever scale), supporting no or very few native understorey plants, litter, high grazing levels and dominated by weeds (Figure L).</p>
Habitat areas	<p>The vegetation immediately outside of the creek channel has been historically cleared of native vegetation and the land used for agricultural purposes, and therefore does not provide significant habitat values.</p> <p>During the desktop search, no significant flora species were recorded or identified likely to occur along the creekline. During the site survey no <i>Commonwealth Environment Protection and Biodiversity Conservation (EPBC) 1999 Act</i> listed or <i>Wildlife Conservation Act 1950</i> listed Threatened flora, Priority flora or other flora species of significance were recorded in the study area, and thus Ki-It Monger Brook within the site boundary has not been identified to be required for the survival of such species.</p>
Adjacent land use pressures	Residential housing is proposed to be developed around the foreshore reserve. Roads will be constructed to the north and south of the foreshore reserve as part of the development. Drainage basins will be installed in the POS surrounding the foreshore.
Heritage	A search of the Department of Aboriginal Affairs (DAA) Aboriginal Heritage Inquiry System (AHIS) database identified one registered site (AHIS ID 3525), which covers the extent of the site, in addition to one other heritage place, 22669 Bullya Spring, which is associated with mythological, natural features and as a water source. This heritage place is not located on the Ki-It Monger Brook (Figure N). A suitably qualified cultural heritage consultant will be appointed to investigate the extent of the site and undertake a cultural assessment of the mythological site.

Biophysical criteria	Site considerations
Recreational amenity	<p>Until recently, the site was used for grazing, with full animal access into the brook, with no public access.</p> <p>The LSP proposes to align areas of Public Open Space (which will be landscaped and used for drainage, pathways and recreational amenity, i.e. built form structure such as playgrounds, barbecue) adjacent to the core creek area. The Public Open Space areas and core creek area is shown in LSP – Figure B</p>

3.1.3.7 Ki-It Monger Brook foreshore area definition

The foreshore area is defined as the land that adjoins or directly influences a waterway, the area of transition between the edge of the waterway and the furthest extent of riparian vegetation.

Based on the current biophysical condition of Ki-It Monger Brook within the site boundary, it is proposed to retain the foreshore area to the extent of the banks of the Ki-It Monger Brook for the majority of the site.

The width of the foreshore area will vary along its extent and at its widest points will be up to approximately 120 m associated with the major dam that will be retained on site, and the narrowest point will be approximately 10 m, incorporating both sides of the bank.

The proposed foreshore area has been overlaid on each of the figures attached at the rear of this report, to show that the proposed foreshore area contains (Figure I):

- All remnant riparian vegetation
- All habitat areas and landforms associated with Ki-It Monger Brook including the CCW UFI 12681 and the existing dams
- Flooding from the 1% AEP event.

The physical demarcation between Ki-It Monger Brook foreshore area and other areas of the development will include roads, dual use paths and fencing, in accordance with an approved Landscape Master Plan.

The proposed realignment of a portion of Chittering Road is within an existing (and cleared) road reserve and at the location of historically installed culverts.

3.1.3.8 Southern drainage line

There is an unnamed artificial agricultural drain that traverses the southern section of the site (Figure I). This mapped drainage line flows south from the major dam near the clay extraction site to two smaller dams, at which point the drainage line traverses west until it reaches Lot 1354. For minor storm events this drainage line then runs south, parallel to the gravel road through a small culvert under the access road for the clay extraction and landfill site and discharges to a dam south of the site boundary. Pre-development flood modelling undertaken using XPSWMM identified that in major events, this drainage line is likely to have insufficient capacity and be overtopped, resulting in sheet flow in a south-westerly direction over Lot 1354. This uncontrolled flow is likely to then be intercepted a small drain alongside the landfill access road, which flows into the neighbouring lot to the south via a culvert under the access road. As such, the agricultural drain does not form a tributary to the Ki-It Monger Brook. Further details of the pre-development flood modelling are included in the LWMS.

With the majority of the constructed agricultural drain being cleared of native vegetation, it has no or very limited ecological value. The Level 2 vegetation and flora survey mapped this agricultural drain area as being in a “completely degraded” condition (Ecologia 2016). There is no associated riparian vegetation, with only scattered marri (*Corymbia calophylla*) within an agricultural paddock. The LSP seeks to retain these marri trees, where practical, within road reserves.

Test pitting undertaken as part of the geotechnical investigation did not identify the soil type along this drainage line to be associated with a waterway and was consistent with other test pits. The section of the drainage line that runs across Lot 1314 is quite eroded.

Due to this drainage line being a constructed agricultural drain which is not a tributary of the Ki-It Monger Brook, the post-development drainage plan for this is to be a piped drainage system to open space areas, with bio-retention areas retaining and treating runoff from the first 15 mm rainfall event. Overland flow paths across Lot 1354 will be maintained utilising the road reserve.

3.1.4 Wetlands

Hill et al. (1996) categorised wetlands occurring on the Swan Coastal Plain into levels of protection and management categories. Three management categories are recognised and are described below:

- Conservation Category Wetlands – are the highest priority wetlands that support high levels of attributes and functions and account for approximately 20 per cent of the wetlands. The management objectives are to preserve and protect existing conservation values.
- Resource Enhancement Wetlands – have been partly modified but still support substantial functions and attributes and the objective is to manage, restore and protect towards improving their conservation value.
- Multiple Use Wetlands – have few important ecological attributes and functions remaining and the use, development and management should be considered in the context of ecologically sustainable development. About 72% of wetlands have been degraded to the extent that they are not a priority for conservation.

There are two wetlands that occur within sections of the Ki-It Monger Brook; one is classified as a Conservation Category Wetland (CCW) (UFI 12681) and one is a Multiple Use Wetland which is likely to have few important ecological attributes and functions remaining (Figure H).

A botanical assessment was conducted detailing the spatial extent and characteristics of the wetlands within the Bullsbrook LSP site, in particular the CCW section of the Ki-It Monger Brook. Three relevés were sampled within the Conservation Category section, three were sampled in the Multiple Use section, and seven were sampled in areas along the Ki-It Monger Brook that have not been classified as wetland.

Ki-It Monger Brook occurs on the flat/plain for the majority of its length and extends into the drainage valley slopes in between the hills to the east. It is mapped as vegetation unit Er1: *Eucalyptus rudis* subsp. *rudis* low open forest over mixed *weed species dominated by **Avena barbata*, **Lolium rigidum* and **Oxalis pes-caprae* other common species include *Corymbia calophylla*, **Gomphocarpus fruticosus*, **Solanum linnaeanum*, **Briza maxima*, **Moraea flaccida*.

There were no significant flora species recorded or likely to occur along Ki-It Monger Brook.

Both the CCW and MU wetlands within Ki-It Monger Brook had vegetation condition rated as “Degraded” with no or scattered native understorey plants, litter, high grazing levels and dominated by weeds (Plate 4 and Plate 5).

There were no differences in vegetation type, floristic composition, condition or values in the CCW section of the Ki-It Monger Brook, the Multiple Use section or the unclassified section.



Plate 4: Existing CCW environment



Plate 5: Great Northern Highway culvert within the CCW

3.1.5 Vegetation

3.1.5.1 Regional vegetation

At a regional level, the majority of the remnant vegetation in the site is mapped as being the Guildford Complex, with small areas of Darling Scarp Complex and the Forrestfield Complex (Figure J). Descriptions of these vegetation complexes are summarised below:

- The Guildford Complex is described as a mixture of open forest to tall open forest of *Corymbia calophylla*–*Eucalyptus wandoo*–*E. marginata* and woodland of *E. Wandoo* (with rare occurrences of *E. Lane-poolei*). Minor components include *E. Rudis*–*Melaleuca raphiophylla*.
- The Forrestfield Complex is dominated by open forest of *C. Calophylla*–*E. Wandoo*–*E. Marginata* (on the heavier soils) to open forest of *E. Marginata*–*C. Calophylla*, *Allocasuarina fraseriana*–*Banksia* spp. (on the sandier soils). Fringing woodland of *E. Rudis* and *Melaleuca raphiophylla* are in gullies and watercourses.
- Darling Scarp Complex vegetation ranges from a low open woodland to lichens according to the depth of the soil. Woodland components chiefly *E. Wandoo*, with *E. laeliae* in the north, *E. haematoxylon* in the south, and *C. Calophylla* throughout the region.

Table 6 identifies the extent of these vegetation complexes remaining upon the Swan Coastal Plain / Perth Metropolitan Region and within the site.

Table 6: Native vegetation extents across the site

Vegetation complex	Swan Coastal Plain/Perth Metropolitan region (IBRA)		Remaining extent (ha)
	Original Pre-European extent (ha/%)	Remaining extent (ha/%)	Bullsbrook site boundary
Guildford	92,340 ha (100%)	4,936 ha (5.3%)	9.6
Forrestfield	21,210 (100%)	2,448 (11.5%)	0.05
Darling Scarp	35,512 (100%)	14,649 (41.3%)	64.8

Source: Perth and Peel@3.5million (EPA 2015)

Coloured cells indicate vegetation complexes with approximately less than 10% of the original (pre-European) extent remaining (purple), less than 30% remaining (orange) and over 30% remaining (green). The 10% and 30% ecological thresholds are defined in national and state policies on native vegetation protection and biodiversity conservation (EPA, 2008; EPA, 2000).

The majority of the Guildford Complex is associated with the Ki-It Monger Brook. The remnant trees within the Ki-It Monger Brook will be retained through the establishment of setbacks, drainage retention and open space areas. The estimated 100-year ARI flood plain mapping provides the basis for development setbacks from the Ki-It Monger Brook and establishes the foreshore buffer area in accordance with the DWER Operational Policy 4.3: Identifying and establishing waterways foreshore areas (DoW 2012). This effectively ensures the trees in Kit-it Monger Brook are retained.

The remnant Guildford Complex is also located on the southern boundary of Lot 1314 will be retained through the LSP and managed through the subdivision and development process (Figure M).

3.1.5.2 Threatened ecological communities

No threatened ecological communities (TECs) have been identified within the Bullsbrook LSP site.

3.1.5.3 Remnant vegetation

A two-phase, Level 2 flora and vegetation assessment of the Bullsbrook site was conducted by Ecologia. A total of six quadrats and 27 relevés were sampled floristically. In addition, traverses to target flora of conservation significance, introduced flora and to provide opportunistic collections of taxa not recorded within the quadrats were conducted. A summary of the vegetation complexes is provided below.

The level 2 Bullsbrook Project Flora and Vegetation Assessment Report (Ecologia 2016) is provided in Appendix 1.

Seven vegetation units were mapped in the larger Bullsbrook site (Figure K). The five vegetation units were associated with the agricultural land use and were either rated as either “Completely Degraded” (Unit Ab) or “Degraded” (Units CcAp, Er1, Er2 and EwCc):

- Ab (mixed weed species): Recorded in the areas which have been cleared for agriculture on the flats and lower hill slopes and mapped as 293.6 ha or 60.9% of the entire Bullsbrook site.
- Ccap (*Corymbia calophylla* low woodland, over +/- *Acacia pulchella* sparse low shrubland, over mixed weed species): Recorded on the hill tops and mid slopes which have not been completely cleared and mapped as 41.6 ha or 8.6% of the of the entire Bullsbrook site.
- Er1 (*Eucalyptus rudis* subsp. *Rudis* low open forest, over mixed weed species): Recorded along the Kit-Monger Brook and the drainage valley slopes in between the hills to the east of the project area and was mapped as 37.0 ha or 7.7% of the entire Bullsbrook site.
- Er2 (*Eucalyptus rudis* subsp. *Rudis* low open forest, over mixed weed species): Recorded as the strip of trees planted for stabilisation, rather than along the Ki-It Monger Brook and was therefore separated from Er1 and mapped as 4.2 ha or 0.9% of the entire Bullsbrook site.
- Ewcc (+/- *Eucalyptus wandoo* subsp. *Wandoo* and *Corymbia calophylla* open low woodland, over isolated **Solanum linnaeanum* mid-shrubs, over mixed weed species): Recorded on the mostly cleared hill slopes towards the eastern slopes and mapped as 17.4 ha or 3.6% of the entire Bullsbrook site. Note this vegetation complex is outside of the site.

Two units were classified as being in “Excellent” condition with disturbances limited to low density non-invasive weeds and common vehicle/animal tracks. These vegetation units are outside of the LSP and are not proposed to be the subject of future development.

3.1.5.4 Vegetation condition

The site has been used for agricultural purposes and the majority of the land has been classified as “Completely Degraded” (Ecologia, 2016). Stands of remnant vegetation and remnant vegetation associated with Ki-It Monger Brook have been classified as “Degraded”.

The only vegetation in “Excellent Condition” is located outside of areas identified for future urban development (Figure L).

3.1.6 Flora

3.1.6.1 Priority flora species

A total of 102 vascular plant taxa were recorded from the study area. Of these, 44 (43.1%) are native and 58 (56.9%) are introduced species. No *Commonwealth Environment Protection and Biodiversity Conservation (EPBC) 1999 Act* listed or *Wildlife Conservation Act 1950* listed Threatened flora, Priority flora or other flora species of significance were recorded in the study area.

The literature review identified one Threatened flora taxon, *Acacia anomala* that has previously been recorded at three locations within the north-eastern portion of the Bullsbrook site (i.e. in Bush Forever Site No. 86). Based on historical land use, vegetation units mapped and condition, this species is considered likely to occur within the Bush Forever area in the east but not within the LSP site.

There were 60 weed species recorded, one of which is a Weed of National Significance (WONS) (*Asparagus asparagoides*) and one is a Declared Plant (*Zantedeschia aethiopica*).

3.1.7 Bush Forever Site No. 86

A dedicated 43 ha Bush Forever site occurs on the northern site boundary (within Lot 857). The Bush Forever site conserves regionally significant vegetation and fauna habitat including black cockatoo foraging and roosting habitat.

The vegetation includes *Eucalyptus accedens*, *E wandoo* woodlands, *Eucalyptus accedens*, *E wandoo*, *C. calophylla* and *E. marginata* Open Forest to woodland with *Allocasuarina humilis* and *Calytrix angulata* (Government of Western Australia 2000).

Figure J illustrates the location of Bush Forever Site No. 86.

Bush Forever Site No. 86 also provides an ecological link for remnant jarrah and marri vegetation within the adjacent Lot 1343 and the eastern scarp, Lots 1256 and 1391. This provides a significant fauna consolidated habitat and linkage. The Bush Forever site and remnant vegetation areas on the eastern scarp are outside of the LSP area and the City of Swan’s Bullsbrook Townsite Expansion Master Plan area.

3.2 Fauna

3.2.1 Habitat

The LSP site area exhibits a high level of disturbance from historic clearing of native vegetation and mostly comprises cleared agricultural paddocks (Figure A). Consequently, it is highly unlikely that these areas provide suitable habitat for significant fauna species.

Potential habitat that does remain within the site includes intermittent remnant native vegetation along the Ki-It Monger Brook, which has some habitat value for native fauna species. The creekline also allows for the movement of native fauna from the western portion of the site to areas of larger remnant vegetation to the east.

The remnant vegetation associated with Ki-It Monger Brook will be retained.

Consequently, through retention of Bush Forever Site No. 86 and vegetation within Ki-It Monger Brook, the majority of the limited existing habitat within the site will be retained (Figure L).

3.2.2 Significant fauna species

The Commonwealth Department of the Environment (DotE) website for matters of National Environmental Significance (NES) protected under the EPBC Act indicates a number of listed fauna species that may potentially utilise this habitat.

Based on the fauna habitats remaining within the LSP site, the key species that could potentially be impacted through development of the site are listed below:

- Scattered stands, or individual *Eucalyptus rudis* trees within the creeklines
 - Forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*)
 - Carnaby's black cockatoo (*Calyptorhynchus latirostris*)
 - Baudin's black cockatoo (*Calyptorhynchus baudinii*)
- The banks of the seasonal creekline may support the following migratory bird species
 - Rainbow bee-eater (*Merops ornatus*) – migratory.

The proposed management and use of the Ki-It Monger Brook and water features on the site (dams) will replicate the pre-development conditions associated with both surface and groundwater availability to the existing vegetation. Therefore avifauna, in particular rainbow bee-eaters, can continue to utilise the brook area and the surrounding buffer after seasonal rain events.

Potential habitat on the site for black cockatoo species comprises poor foraging quality *Eucalyptus rudis* trees within the creekline and the occasional marri tree. These trees will be preserved in the Ki-It Monger Brook. As outlined previously, the location of the proposed brook / creek crossings (for road connections) will be selected to minimise the impacts to the existing mature trees within the brook.

Further fauna habitat on site, outside of the proposed future development areas, has been retained as Bush Forever Site No. 86, which links to large areas of remnant jarrah and marri vegetation within the adjacent Lot 1343 and the eastern scarp, Lots 1256 and 1391. This habitat comprises more intact vegetation structure and potentially provides fauna habitat for the Carnaby's black cockatoo (*Calyptorhynchus latirostris*) and Baudin's black cockatoo (*Calyptorhynchus baudinii*).

Future local structure planning for the site will respond to the objectives outlined in EPA Bulletin No. 20 (EPB No. 20) – Protection of natural areas through planning and development (EPA 2013).

3.3 Potential contamination

The DWER's Contaminated Sites Database indicated that no registered contaminated sites were recorded within the site or lands immediately surrounding the site.

3.3.1 Landfill

An operational landfill licensed by the DWER is located on Lot 2792 (Figure D).

The long-term land use as identified in the City of Swan's Bullsbrook Townsite Expansion Master Plan is for the landfill site to be rehabilitated for sequential land use in accordance with the LSP and future subdivision approvals. This sequential land use is promoted by the DWER in Best Practice Environmental Management Draft Sitting, Design, Operation and Rehabilitation of Landfills (DoE 2005).

The landfill permanently ceased operations in 2020, the landfill is now being rehabilitated, by the landfill operators, in accordance with DWER requirements.

3.4 Social surroundings

3.4.1 Heritage

3.4.1.1 Aboriginal heritage

A search of the Department of Aboriginal Affairs (DAA) Aboriginal Heritage Inquiry System (AHIS) database identified one registered Aboriginal site of mythological significance (AHIS ID 3583) in addition to eight heritage places (Figure N, Appendix 2).

Mythological site AHIS ID 3583 has been registered and meets the definition of a site, under Section 5 of the *Aboriginal Heritage Act 1972*; however data regarding the site is not available for public viewing until permission has been sought and granted from the appropriate traditional owner group.

A suitably qualified cultural heritage consultant (Dr Edward McDonald) has been appointed to investigate the extent of the site and has undertaken a cultural assessment of the mythological site.

3.4.1.2 European heritage

A search of the State Heritage Office's database indicated there are no places listed on the Register of Heritage Places within the site.

3.4.2 Fire

Fire protection will be taken into consideration during all planning phases of land development (WAPC 2010), noting that the site is largely cleared.

The WAPC's Planning Guidelines: Planning for Bushfire Protection (WAPC 2010) outlines the range of matters that will be addressed at various stages of the planning process, to provide an appropriate level of protection to life and property from bushfires and avoid inappropriately located or designed land use, subdivision and development on land where a bushfire risk is identified.

4 POTENTIAL IMPLICATIONS FOR DEVELOPMENT

This section details potential environmental impacts and proposes management measures to address the identified impact. Each environmental factor is addressed in the same format, using a series of four sub-headings as follows.

Environmental objective – states the EPA’s objective for the identified environmental factor in accordance with EAG No. 8: Environmental factors and objectives (EPA 2013).

Applicable guidelines, standards and policies – the environmental factor is placed in context of the appropriate policy framework.

Potential impacts – describes the identified potential environmental impacts that might arise from the proposed development. This may take the form of impacts of the development on the environment, or constraints the environment might represent to realise the project successfully.

Based on the assessment of environmental and social factors undertaken above, potential impacts to the following factors are possible:

- Flora and vegetation
- Fauna habitat
- Hydrological processes
- Heritage
- Acid sulfate soils
- Bushfire risk.

Management response – details proposed environmental management responses to address the potential impacts.

4.1 Flora and vegetation

4.1.1 Environmental objective

To maintain representation, diversity, viability, and ecological function at the species, population and community level.

4.1.2 Applicable guidelines, standards and policies

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Wildlife Conservation Act 1950*
- Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (EPA 2000)
- City of Swan Local Biodiversity Strategy (2015).

4.1.3 Potential impacts

The site has been historical used for agriculture, and therefore has been largely cleared of native vegetation, with the majority of vegetation remaining comprising mixed weed species dominated by **Avena barbata*, **Lupinus cosentinii*, **Bromus diandrus* and **Triticum aestivum* (Figure K).

The only remnant vegetation present within the site is illustrated in Figure M. Vegetation identified for retention is located within Ki-It Monger Brook and comprises *Eucalyptus rudis* subsp. *rudis* species.

Road crossing across the Ki-It Monger Brook will be required as shown in the LSP, which includes the realignment of Chittering Road through an existing (and cleared) road reserve. The Ki-It Monger Brook crossings will be kept to a minimum and located in areas which minimise the loss of trees within the creekline. Aside from the road crossing(s) the Ki-It Monger Brook vegetation is proposed to be preserved.

The area of Guildford vegetation complex identified in the draft Perth–Peel Green Growth Strategy (Figures C and 13) will be retained and managed.

4.1.4 Management response

Flora and vegetation within the Kit-it Brook and remnant stands of vegetation location in the LSP site will be managed through the following:

1. An approved Ki-It Monger Brook Foreshore Management Plan was prepared and approved by the City of Swan in 2018. The Ki-It Monger Brook Foreshore Management Plan detail protocols, management actions and timing for commitments to mitigate potential impacts to the native vegetation within Ki-It Monger Brook during and post-construction, including:
 - a. Delineation of areas to be retained
 - b. Erosion and dust control during construction
 - c. Proposed landscaping treatment
 - d. Weeds management
 - e. Access management
 - f. The Ki-It Monger Brook Foreshore Management Plan also addresses the mapped wetland (CCW) portion of the Ki-It Monger Brook.
2. Remnant Vegetation Management Plan (Guildford complex on the southern border). This management plan will be underpinned by the following objectives:
 - a. Retain and protect remnant vegetation areas identified in the future Local Structure Plan (e.g. control access, prevent rubbish dumping, weed control)
 - b. Revegetate through resurfacing and replanting.

4.1.4.1 EPA Bulletin No. 20 (EPB No. 20) Protection of natural areas through planning and development

The future local structure plan for the site will respond to the objectives outlined in EPA Bulletin No. 20 (EPB No. 20) – Protection of natural areas through planning and development (EPA 2013), outlined below.

- Locate development on cleared land
 - The structure plan will focus on (in accordance with the master plan and the WAPC’s “Future Urban Expansion Area”) locating proposed future development in historically cleared areas. As mentioned previously, the majority of remnant vegetation within the site is restricted to Ki-It Monger Brook and will therefore be retained within the structure plan
- Minimising fire risk
 - Minimising development in naturally vegetated areas is highly compatible with minimising the risk of fire and its potential impacts on the community. A fire risk assessment report and management strategy will be undertaken in accordance with the Planning for Bushfire Protection Guidelines (WAPC and FESA 2010)
- Protect large consolidated naturally vegetated areas
 - The largest extent of consolidated naturally vegetated areas are located outside of the LSP, within Lots 857 (Bush Forever Site No. 86) and 1343 and along the scarp in Lots 1256 and 6 (Figure M). The majority of remnant vegetation within the site is restricted to Ki-It Monger Brook. The structure plan for the site addresses these areas of remnant vegetation along the Ki-It Monger Brook
- Ecological linkages
 - Maintaining the ecological linkages along the Ki-It Monger Brook, which connects with the large naturally vegetated areas in the eastern portion of the site, will be established in the structure plan.

4.2 Fauna

4.2.1 Environmental objective

To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.

4.2.2 Applicable guidelines, standards and policies

- *Environment Protection and Biodiversity Act 1999.*
- *Wildlife Conservation Act 1950.*
- Guidance Statement No 33: Environmental Guidance for Planning and Development.

4.2.3 Potential impact

Fauna habitat located within the LSP site is largely limited to *Eucalyptus rudis* subsp. *rudis* low open forest over mixed weed species along Ki-It Monger Brook. This vegetation also provides an ecological link through the site.

The vegetation associated with Ki-It Monger Brook will be retained and protected within the Structure Plan and future subdivision. Consequently, no significant fauna habitat or ecological linkages within the LSP site will be impacted through future development and most significant habitat within the site is proposed for retention.

Bush Forever Site No. 86 also provides an ecological link for remnant jarrah and marri vegetation within the adjacent Lot 1343 and the eastern scarp, Lots 1256 and 1391 (Figure M). This provides a significant fauna consolidated habitat and linkage.

4.2.4 Management response

The estimated 100-year ARI flood plain mapping provides the basis for development setbacks from the Ki-It Monger Brook and establishes the foreshore area in accordance with the DWER Operational Policy 4.3: Identifying and establishing waterways foreshore areas (DoW 2012).

The Ki-It Monger Brook Foreshore Management Plan details the protocols, management actions and timing for commitments to mitigate potential impacts to native vegetation providing significant fauna habitat.

4.3 Hydrological processes

4.3.1 Environmental objective

To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance are protected.

4.3.2 Applicable guidelines, standards and policies

- Better Urban Water Management (WAPC 2008).

4.3.3 Potential impacts

The key potential impacts identified include:

- Changes in hydrological regime as a result of changed landforms (from earthworks), which may alter natural flows and levels
- Discharge of stormwater may affect the quality of groundwater and surface water.

4.3.4 Management response

In accordance with the WAPC Better Urban Water Management guidelines (WAPC 2008) the following water management actions will be undertaken at the appropriate planning stage:

- A Local Water Management Strategy (LWMS) was prepared to support the LSP and approved in 2018. The LWMS is consistent with the objectives of the DWMS (RPS 2016b).
- A Foreshore Area Report for the Ki-Ilt Monger Brook to determine the foreshore area will be submitted with the LWMS.
- UWMPs will be prepared at the subdivision stage of development.

The LWMS has been prepared consistent with the DWMS. The LWMS will achieve integrated water management through the following design objectives:

- Water conservation and water use efficiency
 - Developments should aim to achieve a target of less than 100 kL per person per year, and where a non-drinking water source is available, should achieve a target of not more than 60 kL/person/yr.
 - Waterwise landscaping techniques should be employed in POS and irrigation should be restricted during the day.
- Stormwater management
 - The one year one hour ARI event should be retained at source through the use of retention (soakage) or stage devices.
 - Floodways are to be maintained with respect to their ecological value and current hydraulic capacity; and should be restored if required so they function as an ecological environment and a healthy watercourse.
 - Flood detention/storage areas shall be incorporated into POS and located outside defined floodways. Where the one year critical duration ARI event has already been retained (i.e. part of the initial losses), this volume does not need to be accommodated again in the detention/storage areas.
 - To reduce health risks from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November to May, detained immobile stormwater is fully infiltrated within a time period not exceeding 96 hours.
 - Swales/vegetated bioretention systems are to be sized at a minimum of 2% of the constructed impervious area from which they receive run-off.
 - Residential development may not occur within floodways.
 - Minimum habitable floor levels shall be a minimum of 0.5 m above the 100 year ARI flood level in rivers or main drainage networks.
 - Minimum habitable floor levels shall be a minimum of 0.3 m above the 100 year ARI flood level in local drainage networks.
 - Defined major arterial roads should remain passable in the 100 year ARI event and minor roads passable in the 5 year ARI event.
- Groundwater management
 - Where a perched water table exists or the predicted maximum groundwater level is at or within 1.2 m of natural ground levels, measures should be implemented to ensure that adequate separation of building floor slabs from groundwater is achieved. This may include lowering the groundwater levels where possible, the importation of clean fill or installation of subsoil drainage.
 - Proposals to lower groundwater levels must demonstrate no or negligible impact on groundwater dependent ecosystems. In particular where subsoil drainage is proposed within the groundwater capture zones of wetlands, designs must be developed with consideration of ecological water requirements for groundwater dependent ecosystems.

- Nutrient management
 - Where subsoil drainage is installed for groundwater level or soil moisture control, a treatment system (such as a swale or biofilter) at each subsoil drain outlet point will be required.
 - Clean fill imported onto the site is to have a capacity to reduce phosphorus export via soil leaching, while also meeting soil permeability and soil compaction criteria specified by the City of Swan.
 - Manage groundwater quality at pre-development (winter) concentrations and if possible, improve the quality of water leaving the development area to maintain and restore ecological systems in the catchment.
 - If the pollutant outputs of the development exceed catchment ambient conditions, the proponent shall achieve water quality improvements within the development area. If catchment ambient conditions have not been determined, the development should meet relevant water quality guidelines stimulated in ANZECC (2000).
 - Prior to the construction of flood detention/storage areas, phosphorus retention index testing (PRI) will be undertaken to measure the PRI of the soils. A PRI of less than 10 is considered low and will require amendment.
- Wetlands
 - Ecological water requirements will be determined by the proponent and will include the determination of hydrological buffers to wetlands to confirm where subsoil drainage is not suitable thus ensuring there is minimal impact on wetland water levels.

4.3.4.1 Wetlands

1. Ecological water requirements will be development by the proponent and will include the determination of hydrological buffers to wetlands to determine where subsoil drainage is not allowed so there is minimal impact on wetland water levels.
2. Urban Water Management Plan(s) will be prepared to support subdivision activities.
3. The Ki-It Monger Brook Foreshore Management Plan addresses the CCW area. The wetland interface management treatments and agreed through landscape plans have been approved by the City of Swan.
4. The estimated 100-year ARI flood plain mapping provides the basis for development setbacks from the Ki-It Monger Brook and establishes the foreshore buffer area in accordance with the DWER Operational Policy 4.3: Identifying and establishing waterways foreshore areas (DoW 2012).

4.4 Acid sulfate soils

4.4.1 Environmental objective

To maintain the quality of land and soils so that the environment values, both ecological and social, are protected.

4.4.2 Applicable guidelines, standards and policies

- Assessment Levels for Soil, Sediment and Water (Department of Environment and Conservation (DEC) 2010).
- Acid Sulfate Soils Guideline Series. Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DEC 2011).
- Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes (DEC 2013).

4.4.3 Potential impacts

ASS soils are stable when left undisturbed, however exposure to air during excavation or dewatering activities can set off a reaction resulting in acidity (sulfuric acid) being produced.

The potential impacts relate to the potential for oxidation of excavated or in-situ ASS generating acidic conditions and possibly releasing metals into groundwater and the surrounding freshwater environment of Ki-It Monger Brook.

4.4.4 Management response

The final fill levels and engineering service excavation requirements will determine if an ASS investigation and an ASS and Dewatering Management Plan (ASSDMP) is required to be prepared prior to subdivision.

If required, the ASSDMP will outline the soil management measures, the groundwater and dewatering effluent monitoring measures and the contingency management measures required to minimise any environmental impacts to the satisfaction of the DWER.

4.5 Site contamination

4.5.1 Environmental objective

To ensure previous land uses within and surrounding the site, do not impact on future development of the site.

4.5.2 Applicable guidelines, standards and policies

- *Contaminated Sites Act 2003.*

4.5.3 Potential impact

The LSP site has been used for grazing and agricultural purposes and there is very little likelihood of any potential contamination over the majority of the site.

The Class 1 Landfill Site is located within the site on Lot 2792.

4.5.4 Management response

A 1,000 m buffer was maintained until the landfill closure in 2020 from any urban development.

The landfill ceased operations in 2020, the landfill is now being rehabilitated in accordance with DWER requirements.

4.6 Fire

4.6.1 Environmental objective

To reduce the risk of bushfire to people, property and infrastructure.

4.6.2 Applicable guidelines, standards and policies

- Australian Standard AS 3959:2009, Construction of Buildings in Bushfire-prone Areas (Standards Australia 2009)
- Guidelines for Planning in Bushfire Prone Areas (Department of Planning and WAPC 2015a)
- SPP 3.7: Planning for in Bushfire Prone Areas (Department of Planning and WAPC 2015b).

4.6.3 Potential impacts

Vegetation retained within Ki-It Monger Brook will present a risk to future residential development within the site.

Vegetation retained to the east of the site will also pose a potential risk to future development.

4.6.4 Management response

In accordance WAPC guidelines, a Fire Management Plan will be required to be prepared at subdivision stage (WAPC, 2014).

4.7 Aboriginal heritage

4.7.1 Environmental objective

To ensure that historical and cultural associations are not adversely affected.

4.7.2 Applicable guidelines, standards and policies

- *Aboriginal Heritage Act 1972*
- Guidance Statement No. 41: Assessment of Aboriginal Heritage (EPA 2004b).

4.7.3 Potential impacts

Mythological site 3583 for the Ki-It Monger Brook is the only registered Aboriginal heritage site located within the site.

Other potential impacts of the proposed development on Aboriginal heritage sites are related primarily to direct disturbance of sites during including excavation and construction activities which may unearth or damage artefacts or other items of cultural Aboriginal significance.

4.7.4 Management response

- Consultation with the traditional owners has been undertaken by Amex on site.
- An application for approval to disturb the Aboriginal archaeological site under Section 18 of the *Aboriginal Heritage Act 1972* has been made.
- The Section 18 of the *Aboriginal Heritage Act 1972* application was approved in 2018.
- Be vigilant during earthworks and stop work immediately should any items be discovered.

4.7.5 Noise

A small section of the Bullsbrook LSP site in the north will abut the Great Northern Highway. This has potential noise implications for residential development. An appropriately qualified acoustic consultant has been engaged to prepare an acoustic assessment. This assessment will identify the noise impacts relevant to the site and any proposed treatment measures to be implemented as part of the future residential development.

5 CONCLUSION

In the Executive summary, Table 1 details the following key environmental factors, potential impacts and proposed management response to the LSP for:

- Vegetation and flora
- Fauna
- Hydrology
- Contamination
- Acid sulfate soils
- Fire
- Aboriginal heritage.

This report concludes that through the implementation of the proposed management measures summarised below, the implementation of the structure plan through future subdivision and development will meet the EPA's and the City of Swan's environmental objectives.

- The landfill ceased operations in 2020, the landfill is now being rehabilitated in accordance with DWER requirements
- The Structure Plan has an approved LWMS.
- The structure plan provides an appropriate interface with the neighbouring herb nursery this includes locating the District Open Space and large commercial development at the boundary closest to the nursery.
- A Ki-It Monger Brook Foreshore Management Plan was prepared and approved by the City of Swan in 2018. The management plan commenced implementation in late 2018 to the satisfaction of the City.
- The approved Ki-It Monger Brook Foreshore Management Plan is inclusive of the wetland portion of the Ki-It Monger Brook.
- A Remnant Vegetation Management Plan will be prepared for the vegetation identified to be retained (outside of the Ki-It Monger Brook) on the southern boundary of the site.
- An Urban Water Management Plan(s) have been completed at each the subdivision stages to the satisfaction of the City of Swan.
- A Fire Management Plan will be prepared at subdivision stage in accordance WAPC guidelines.

The amendment(s) promoted the preparation and implementation of following key environmental management plans:

1. Ki-it Monger Brook Management Plan, which it is anticipated, will be a requirement of subdivision. The Ki-it Monger Brook FMP will appropriately detail the location of community facilities, open space areas, possible drainage areas and access pathways.
2. Remnant Vegetation Management Plan to outline management recommendations for the stand of remnant Guildford vegetation community located on the southern boundary of the site.
3. Wetland Management Plan for the Conservation Category Wetland (CCW) area and buffer will be prepared and implemented as a condition of subdivision.
4. Urban Water Management Plan(s).

Table 7 illustrates the status of the Kingsford development's environmental management framework.

Table 7: Kingsford residential development environmental management status

Time frames	Key environmental
Undertaken for the MRS and LPS amendments	<ul style="list-style-type: none"> • Vegetation and flora assessment • Wetland assessment • Ki-It Monger Brook flood modelling / hydrology studies • Environmental Assessment Report • District Water Management Strategy (DWMS) – approved 2017
MRS and LPS amendment	<ul style="list-style-type: none"> • This Environmental Assessment Report
Local Structure Plan	<ul style="list-style-type: none"> • Local Water Management Strategy • Ki-It Monger Brook and wetland buffers associated the structure plan • Bushfire Management Plan
Subdivision and management plan approval status	<ul style="list-style-type: none"> • The following management plan have been prepared, approved and implemented: • Ki-it Monger Brook foreshore and wetland management plan – approved in 2018 • Ki-it Monger Brook – foreshore area report – approved as part of the LWMS in 2018 • Local Water Management Strategy – approved in 2018 • Hydrogeological Assessment Report – approved 2018 • Urban Water Management Plan(s) for approved subdivisions

6 REFERENCES

- City of Swan. 2015. Local Biodiversity Strategy. City of Swan, Western Australia.
- Department of Water. 2009. Gnangara Groundwater Areas Allocation Plan. Government of Western Australia, Perth.
- Ecologia. 2016. Bullsbrook Project, Flora & Vegetation Assessment. Prepared for RPS Group Pty Ltd.
- Galt Geotechnics. 2014. Geotechnical Study – Various Lots Great Northern Highway Bullsbrook. Prepared for Mirvac.
- GHD. 2012. Report for Bullsbrook Townsite Area, Regional Water Management Strategy.
- RPS. 2013a. Estimate of Flood Levels and Extent of Flooding at Ki-It Monger Brook, Bullsbrook.
- RPS. 2016a. Level 2 Hydrogeological Assessment, Vispo Holdings Pty Ltd's Bullsbrook Landholding.
- RPS. 2016B. District Water Management Strategy, Bullsbrook Landholding. Prepared for Amex Corporation.
- Swan Catchment Council. (2004). Swan Region Strategy for Natural Resource Management. Midland, Western Australia.
- Water and Rivers Commission. (2001). Position Statement: Wetlands. Perth, Western Australia.
- Western Australian Planning Commission. 2015a. State Planning Policy 3.7 Planning in Bushfire Prone Areas. Government of Western Australia, Perth.
- Western Australian Planning Commission. 2015b. Guidelines for Planning in Bushfire Prone Areas. Government of Western Australia, Perth.

Figures



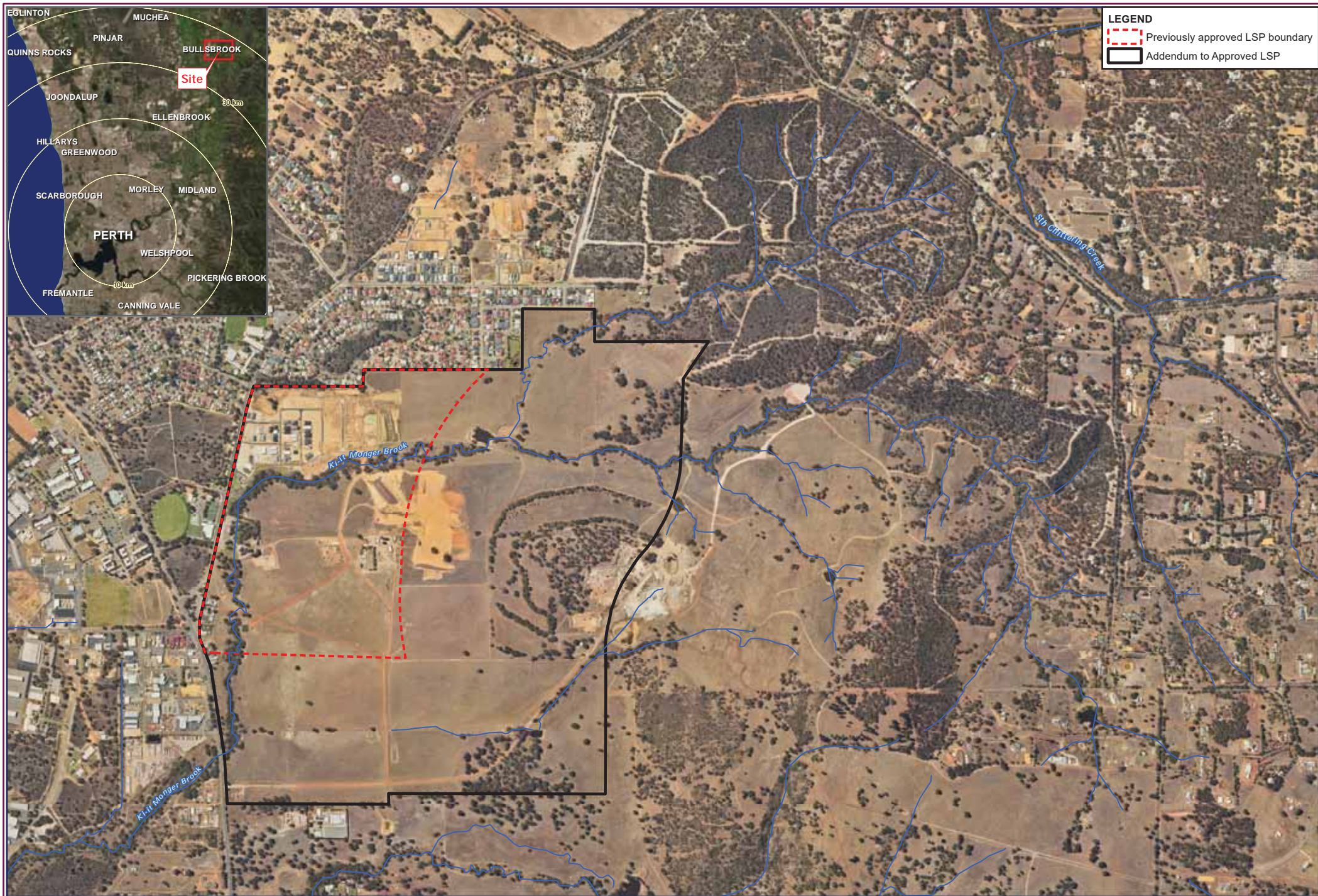
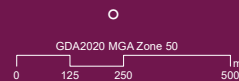


Figure A

Site location

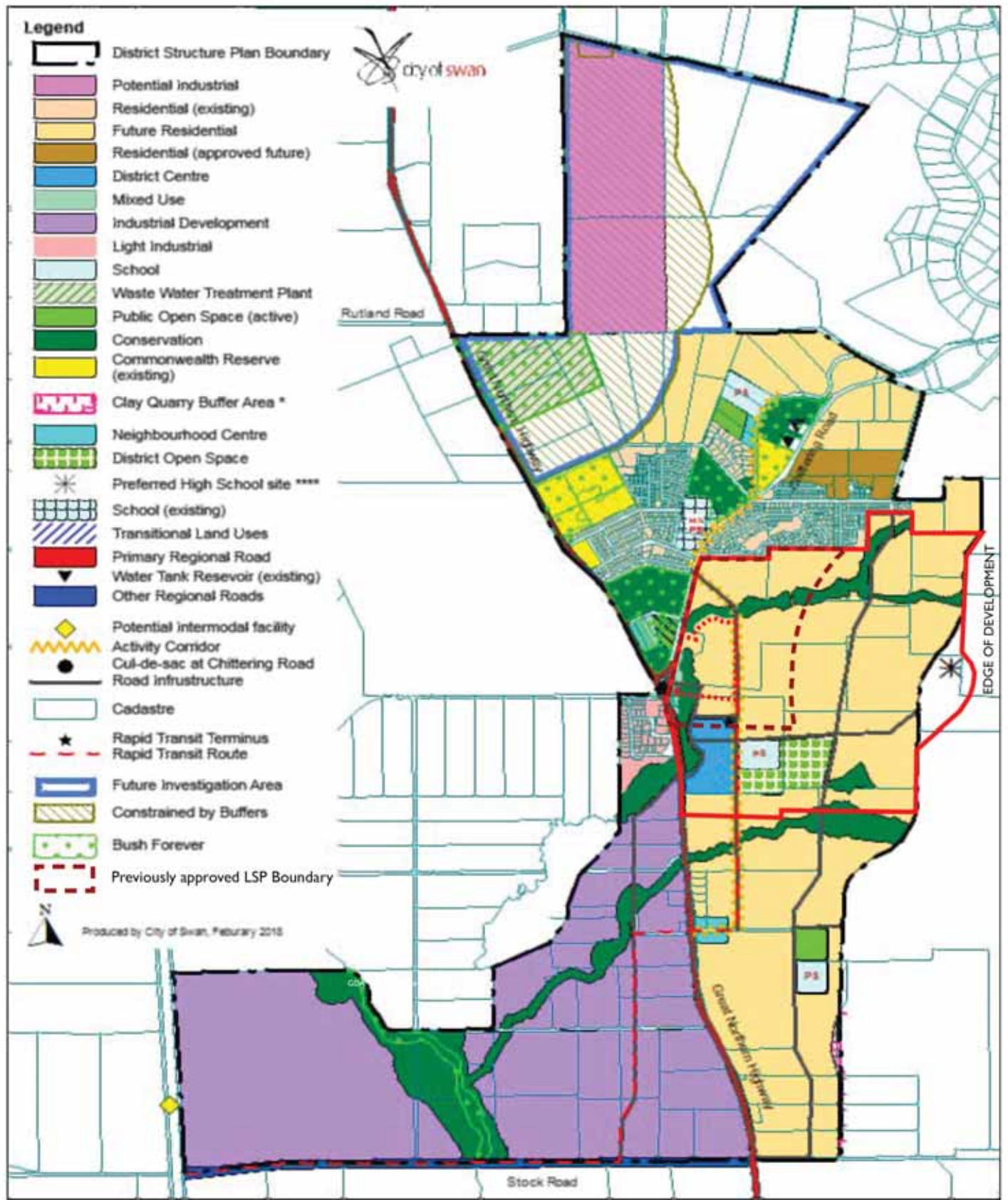
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Source: Cadastre - Landgate, 2020 Orthophoto - Landgate, Jan 2021



* The existing 500 metre clay quarry buffer may be reduced in the future, upon agreement of all relevant parties. This buffer is subject to detailed mapping.

** Transitional land uses are required along the western edge of the Great Northern Highway (refer Section 3.1.2 of the Bullsbrook Townsite District Structure Plan report).

*** The location, design and size of the DOS is to be refined through the local structure planning stage.

**** In the event that an additional high school site is required, its siting and location should be determined prior to supporting the first major structure plan. Refer to Section 3.6.1 of the Bullsbrook Townsite District Structure Plan report.

Figure C
City of Swan - Bullsbrook Masterplan (2013)





Figure D

Surrounding land use

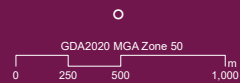
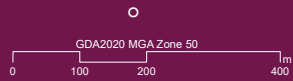




Figure E

Topography



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Figure F

Geology

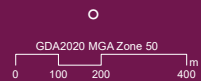
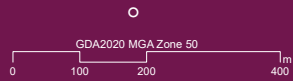




Figure G

GW contours and bores



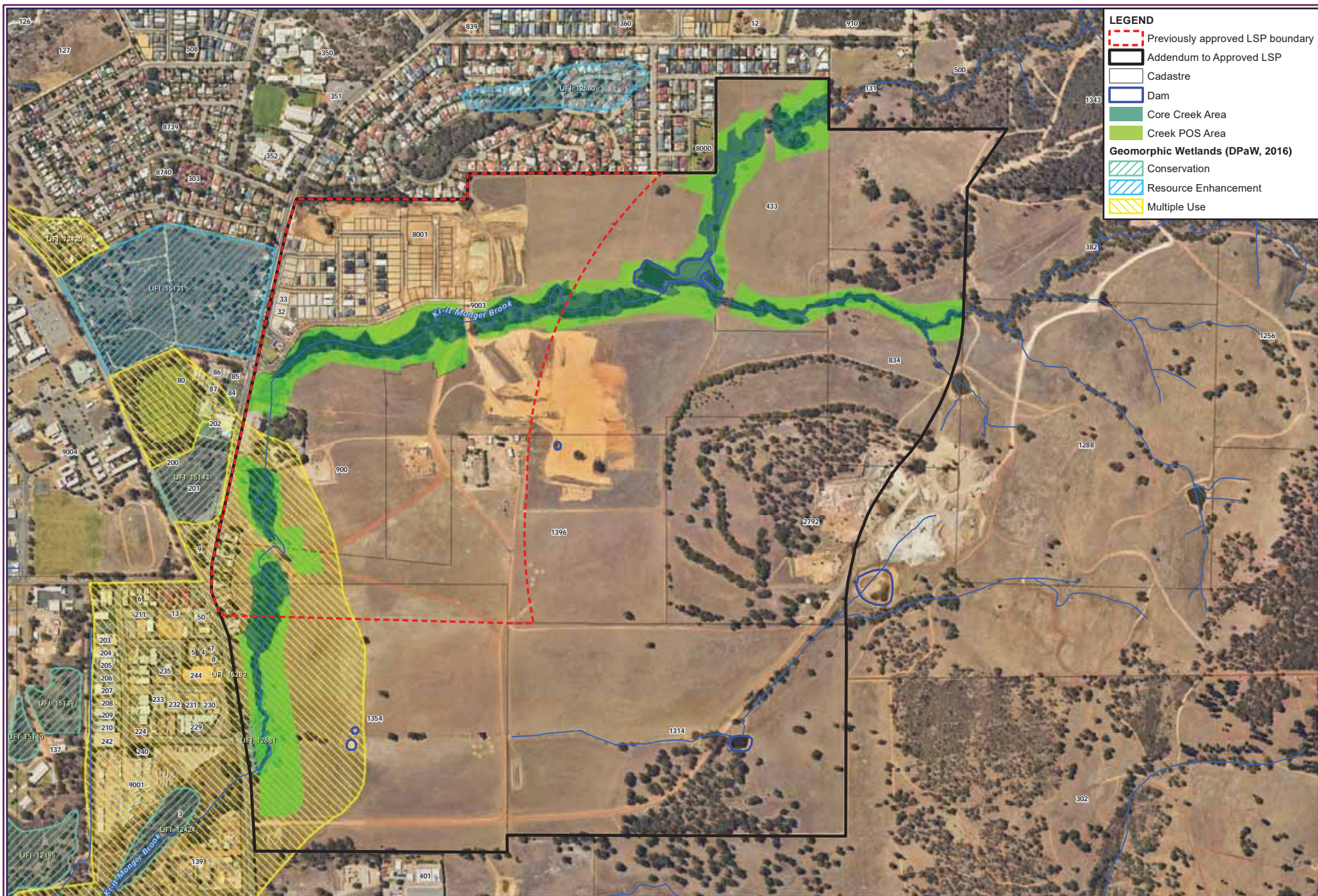
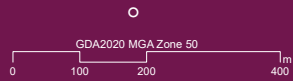


Figure H

Wetlands mapping and habitat area



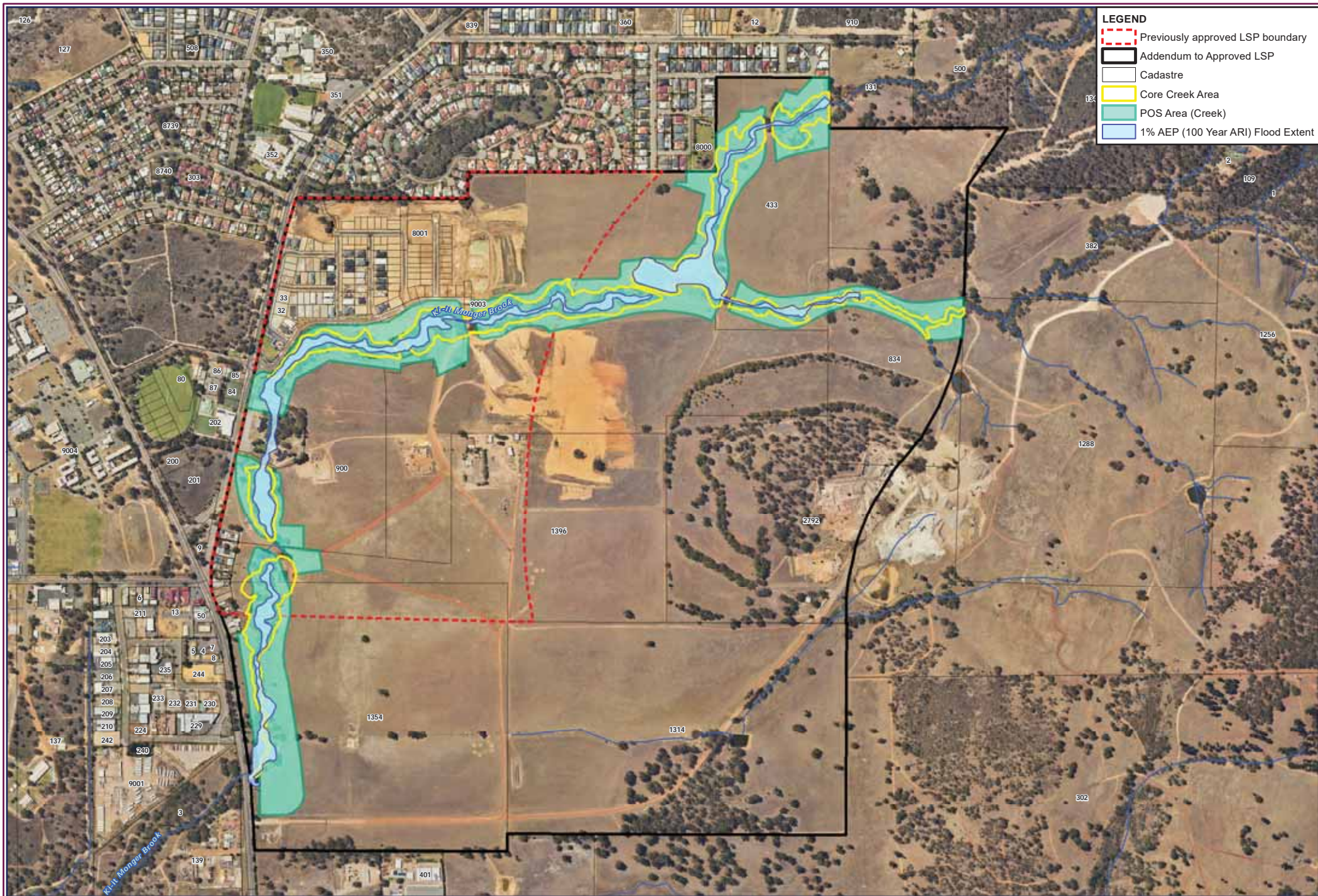
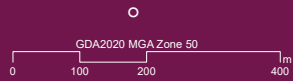
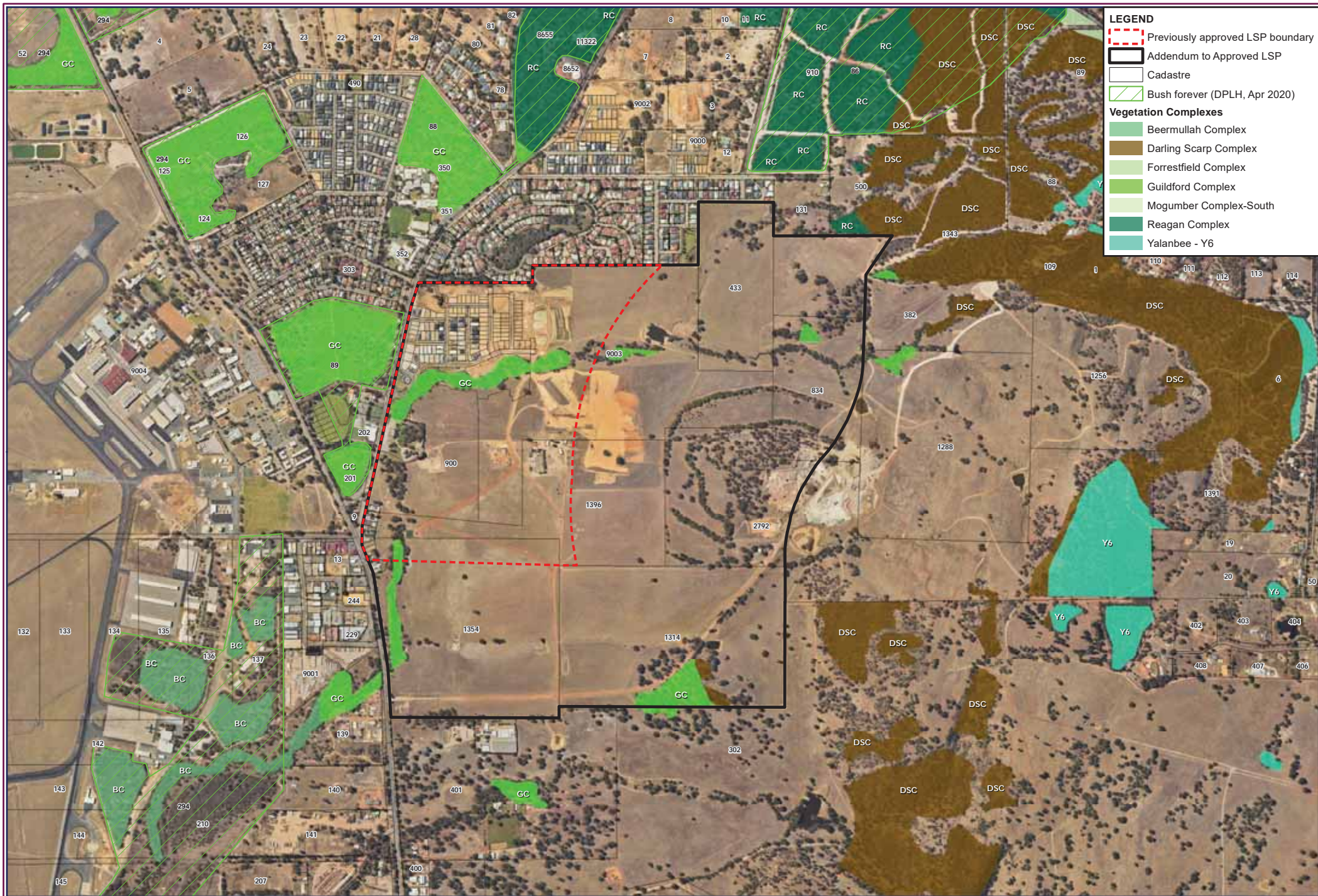


Figure 1
1% AEP (100 year ARI) flood extent



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LEGEND

- Previously approved LSP boundary
- Addendum to Approved LSP
- Cadastre
- Bush forever (DPLH, Apr 2020)

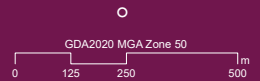
Vegetation Complexes

- Beerullah Complex
- Darling Scarp Complex
- Forrestfield Complex
- Guildford Complex
- Mogumber Complex-South
- Reagan Complex
- Yalanbee - Y6

Figure J

Vegetation Complexes

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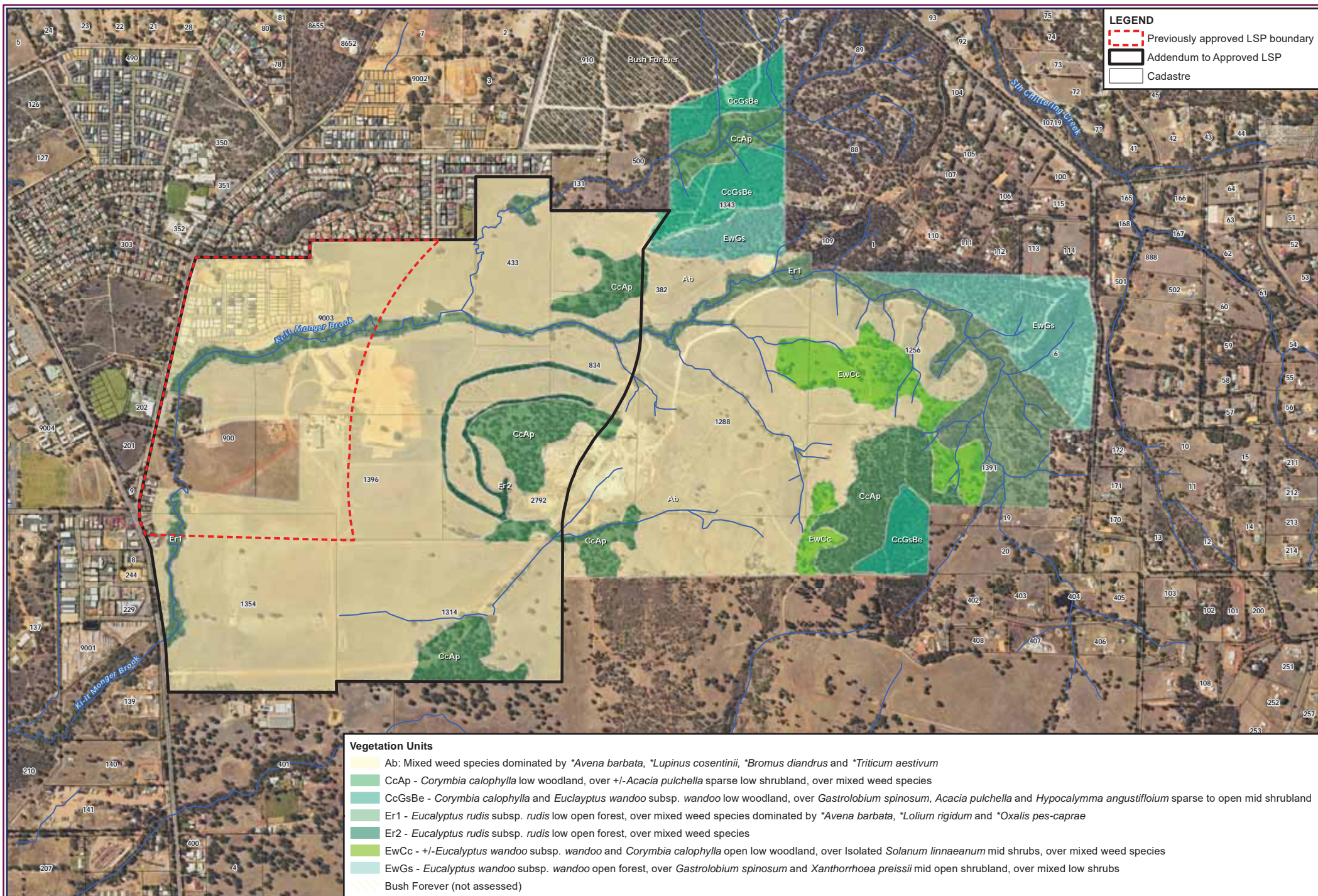
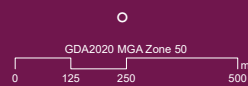
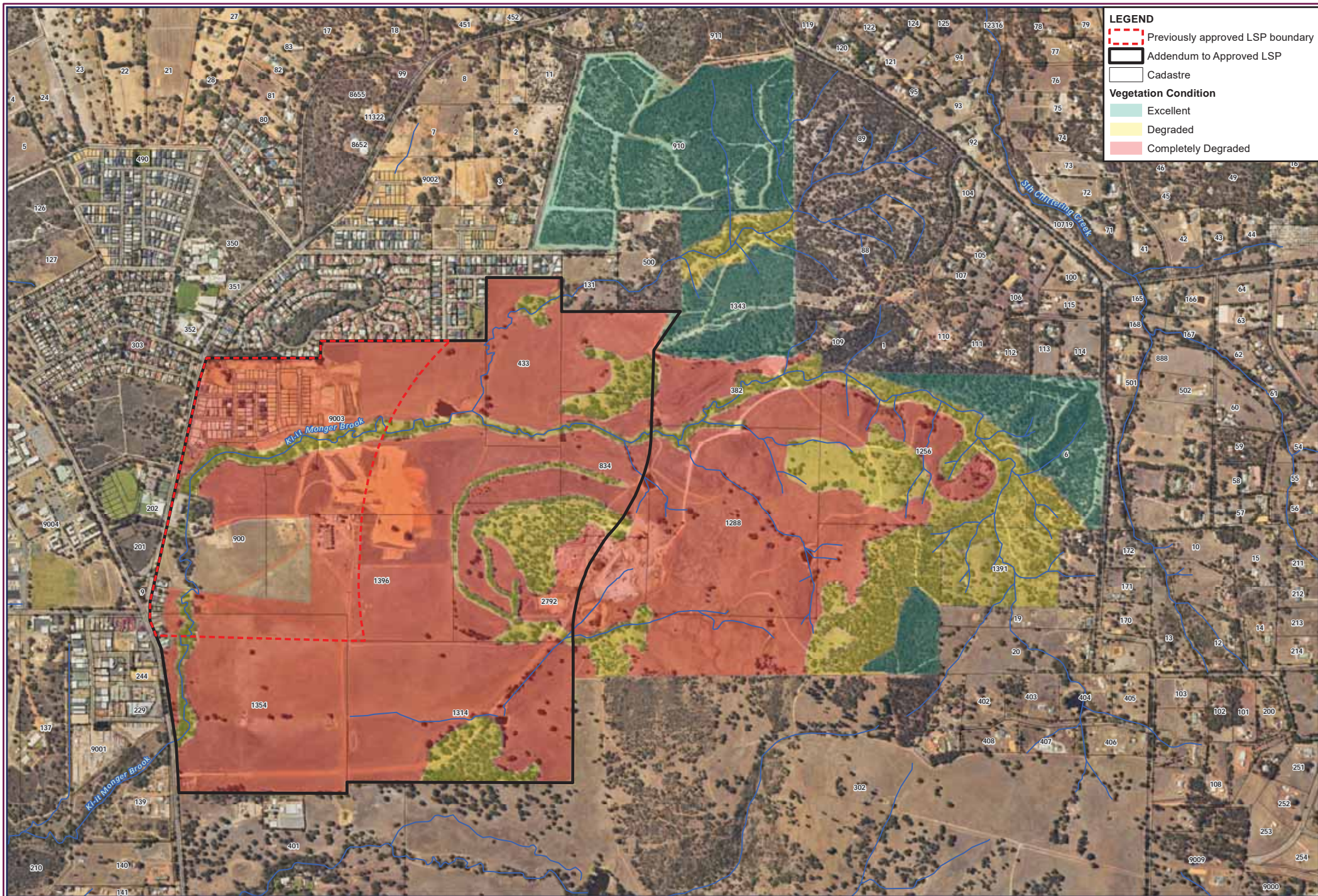


Figure K

Vegetation Units





LEGEND

- Previously approved LSP boundary
- Addendum to Approved LSP
- Cadastre

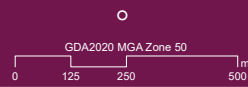
Vegetation Condition

- Excellent
- Degraded
- Completely Degraded

Figure L

Vegetation condition

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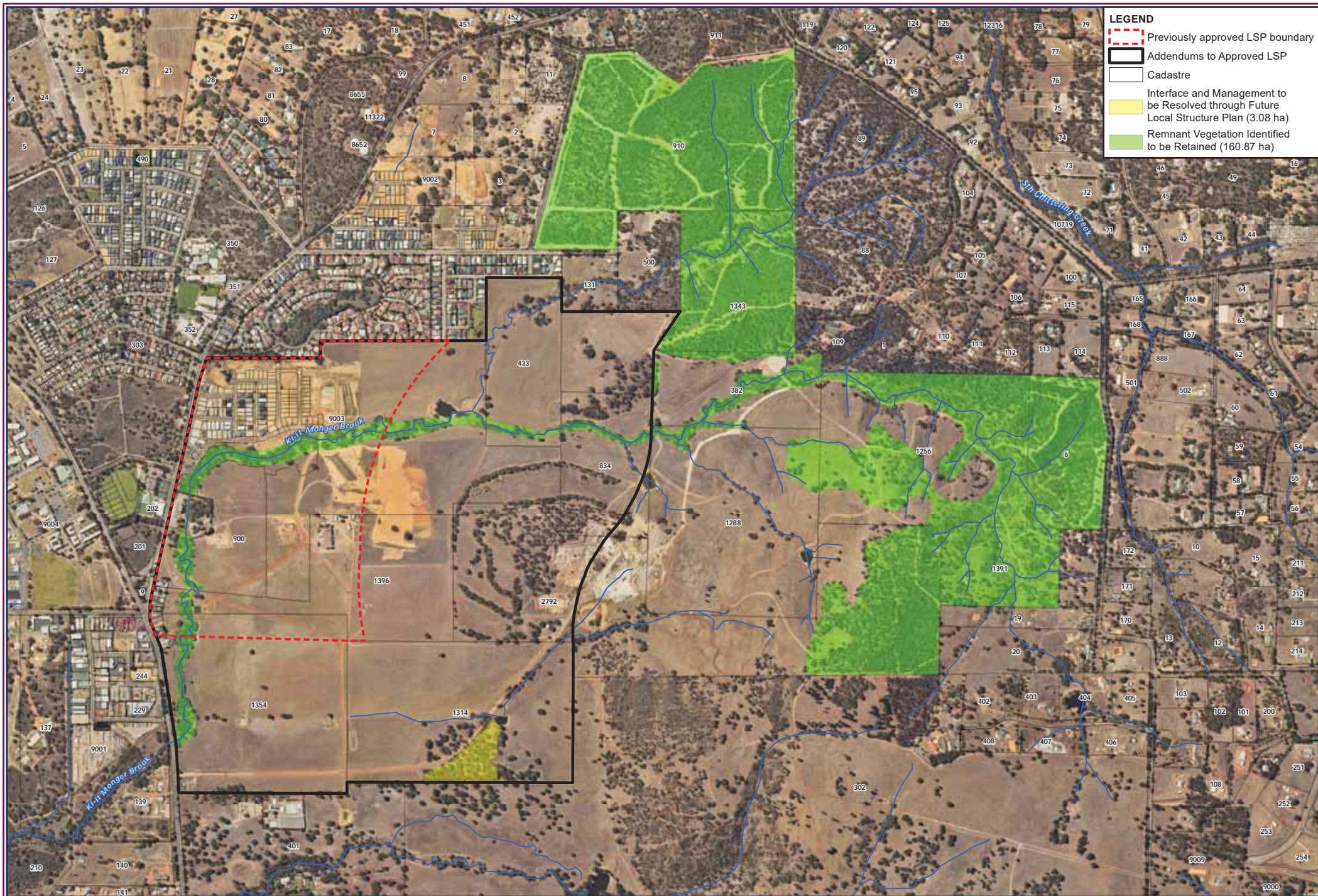


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LEGEND

- Previously approved LSP boundary
- Addendums to Approved LSP
- Cadastre
- Interface and Management to be Resolved through Future Local Structure Plan (3.08 ha)
- Remnant Vegetation Identified to be Retained (160.87 ha)

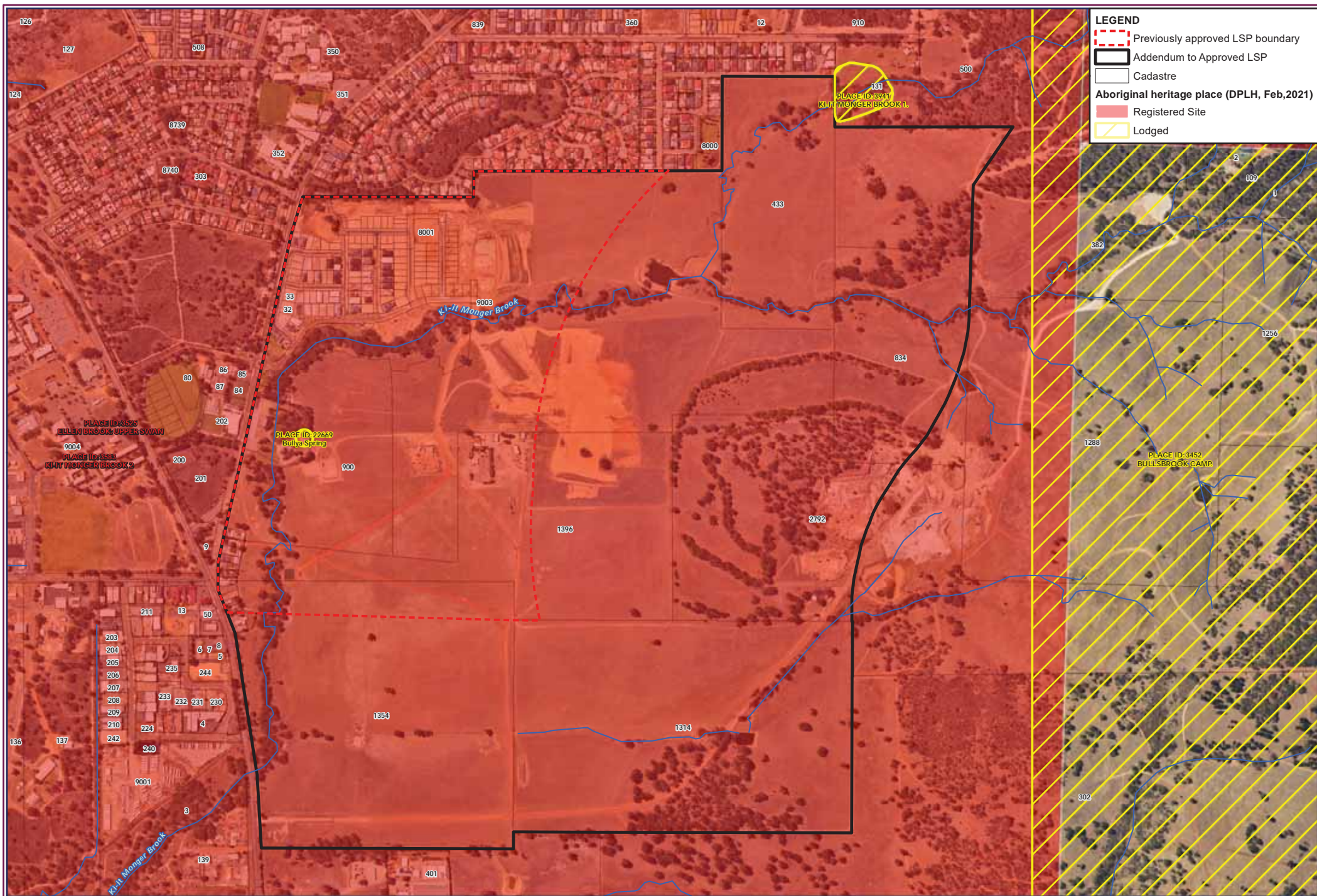
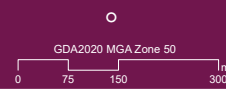


Figure N

Aboriginal heritage



Appendix A

Bullsbrook Project Flora & Vegetation Assessment



July 2016



*Providing sustainable environmental strategies,
management and monitoring solutions
to industry and government.*



**RPS GROUP PTY LTD
BULLSBROOK PROJECT
FLORA & VEGETATION ASSESSMENT**

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Document status			<i>ecologia</i> reference: 1621/1671		
Rev	Author	Reviewer	Approved for issue		
			Name	Distributed to	Date
0	Melissa Hay	Mike Young Shaun Grein	Shaun Grein	John Halleen	31/05/2016
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ACRONYMS

BAM Act	<i>Biosecurity and Agriculture Management Act 2007</i>
BOM	Bureau of Meteorology
CALM	Department of Conservation and Land Management (now DPaW)
DAFWA	Department of Agriculture and Food Western Australia
DEC	Department of Environment and Conservation (now DPaW)
DoE	Department of Environment
DoW	Department of Water
DPaW	Department of Parks and Wildlife (formerly DEC)
DSEWPaC	Department of the Sustainability, Environment, Water, Population and Communities
ESA	Environmentally Sensitive Area
EPA	Environmental Protection Authority
EP Act	<i>Environmental Protection Act 1986</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ESCAVI	Executive Steering Committee for Australian Vegetation Information
IBRA	Interim Biogeographic Regionalisation for Australia
NVIS	National Vegetation Information System
PEC	Priority Ecological Community
RPS	RPS Group Pty Ltd
TEC	Threatened Ecological Community
TPFL	Threatened and Priority flora Database
TPList	Threatened and Priority flora List
WAHERB	Western Australian Herbarium
WAOL	Western Australian Organism List
WONS	Weeds of National Significance
WC Act	<i>Wildlife Conservation Act 1950</i>

EXECUTIVE SUMMARY

Introduction

RPS Group Pty Ltd (RPS) is providing environmental and planning services for an area of 'Rural'-zoned land, immediately east of the Bullsbrook townsite and 35 km north-east of Perth, which consists of 15 Lots (or portions of) totalling 249 ha in area (the Development area). The landholding has been identified by the Western Australian Planning Authority (WAPC) as an area of future urban expansion. RPS requires an understanding of the status of the remnant vegetation, wetlands and flora, including Threatened and Priority flora, within the 482 ha Project area (the Project area). The northern portion of the Project area includes a Bush Forever site (Burley Park and Adjacent Bushland, Bullsbrook) that is not intended to be developed, and was therefore not surveyed during this assessment. Excluding the Bush Forever site, the total area (the study area) surveyed, which includes Lot 382 and portions of Lots 1288 and 2792 is 439 ha (the 'study area').

Methodology

A two-phase, Level 2 flora and vegetation assessment of the study area was conducted. The initial Spring phase of the survey was conducted on 24 October 2014, while the second Autumn phase was conducted between 16 and 17 May 2016. A survey effort equivalent to four person days was expended in total across both phases. A total of six quadrats and 27 relevés were sampled floristically in the study area. In addition, traverses to target flora of conservation significance, introduced flora and to provide opportunistic collections of taxa not recorded within the quadrats were conducted.

Flora

A total of 102 vascular plant taxa were recorded from the study area. Of these, 44 (43.1%) are native and 58 (56.9%) are introduced species. No Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) 1999 Act* listed or Western Australian *Wildlife Conservation Act 1950* listed Threatened Flora, Priority flora or other flora species of significance were recorded in the study area.

The literature review identified one Threatened flora taxon, *Acacia anomala* that has previously been recorded at three locations within the Project area. This species is highly likely to occur within the remnant bush areas in the east of the Project area, though not within the Development area itself.

There were 60 weed species recorded, of which one is a Weed of National Significance (WONS) (*Asparagus asparagoides*) and one is a Declared Plant (*Zantedeschia aethiopica*).

Vegetation

Seven vegetation units were mapped in the study area, with five units occurring within the development area. Five were associated with the agricultural land use and were either rated as either 'Completely Degraded' (Unit Ab) or 'Degraded' (Units CcAp, Er1, Er2 and EwCc):

- Ab (Mixed weed species). Recorded in the areas which have been cleared for agriculture on the flats and lower hill slopes and mapped as 293.6 ha or 60.9% of the Project area
- CcAp (*Corymbia calophylla* low woodland, over +/-*Acacia pulchella* sparse low shrubland, over mixed weed species). Recorded on the hill tops and mid slopes which have not been completely cleared and mapped as 41.6 ha or 8.6% of the Project area.
- Er1 (*Eucalyptus rudis* subsp. *rudis* low open forest, over mixed weed species). Was recorded along the Kit-Monger Brook and the drainage valley slopes in between the hills to the east of the Project area and was mapped as 37.0 ha or 7.7% of the Project area.
- Er2 (*Eucalyptus rudis* subsp. *rudis* low open forest, over mixed weed species). Was recorded as the strip of trees planted for stabilisation, rather than along the creekline and was therefore separated from Er1 and mapped as 4.2 ha or 0.9% of the Project area.
- EwCc (+/-*Eucalyptus wandoo* subsp. *wandoo* and *Corymbia calophylla* open low woodland, over isolated **Solanum linnaeanum* mid shrubs, over mixed weed species). Recorded on the

mostly cleared hill slopes towards the east of the Project area and mapped as 17.4 ha or 3.6% of the Project area.

Two units were classified as being in 'Excellent' condition with disturbances limited to low density non-invasive weeds and common vehicle/animal tracks:

- EwGs (*Eucalyptus wandoo* subsp. *wandoo* open forest, over *Gastrolobium spinosum* and *Xanthorrhoea preissii* mid open shrubland, over isolated mixed low shrubs). Recorded along the steep escarpment and valley walls and was mapped as 24.5 ha or 5.1% of the Project area.
- CcGsBe (*Corymbia calophylla* and *Eucalyptus wandoo* subsp. *wandoo* low woodland, over *Gastrolobium spinosum*, *Acacia pulchella* and *Hypocalymma angustifolium* sparse to open mid shrubland, over *Bossiaea eriocarpa* sparse low shrubland). Recorded on the hill tops and gentle mid and foot slopes of the Darling plateau 20.3 ha or 4.2% of this unit was mapped from the Project area, though only 0.21ha or 0.08% occurs within the proposed Development area

Both remnant vegetation units within the study area are considered significant as they are remnant units that are locally scarce, restricted in distribution and provide a role of refuge for flora. They provide potential suitable habitat for a Threatened flora species (*Acacia anomala*) and overlay two IBRA regions. However, none of vegetation unit EwGs and only 0.21ha of CcGsBe, occur with the proposed Development area

The CcGsBe unit supports a floristic suite that resembles the Endangered TEC: '*Corymbia calophylla* – *Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain'. Species common to both CcGsBe and this TEC include *Xanthorrhoea preissii*, *Eucalyptus wandoo*, *Acacia pulchella*, *Bossiaea eriocarpa*, *Hibbertia hypericoides*, *Hypocalymma angustifolium* and *Lepidosperma angustatum*.

The remnant vegetation in the study area corresponds with the Darling Scarp and Yalanbee Vegetation Complexes, which have 41.96% and 47.6%, respectively, of their pre-European extents remaining.

Wetland Assessment

The Ki-it Monger Brook is associated with vegetation unit Er1: *Eucalyptus rudis* subsp. *rudis* low open forest, over mixed weed species dominated by **Avena barbata*, **Lolium rigidum* and **Oxalis pes-caprae* and other common species included: *Corymbia calophylla*, **Gomphocarpus fruticosus*, **Solanum linnaeanum*, **Briza maxima*, **Moraea flaccida*.

The entire length of the Ki-it Monger Brook, including the Conservation Category wetland section, was categorised as 'Degraded' supporting no or very few native understorey plants, litter, high grazing levels and was dominated by weeds. There were no significant differences in the vegetation structure, floristic composition, condition or values between the Conservation Category section of the Ki-it Monger Brook, the Multiple Use section and the un-classified section.

1 INTRODUCTION

1.1 PROJECT BACKGROUND

RPS Group Pty Ltd (RPS) is delivering planning services for an area of 'Rural' zoned land immediately east of the Bullsbrook townsite, consisting of Lots 3, 1165, 1396, 433, 1354, 1314, 2792, 834, 1343, 382, 1288, 1391, 857, 6 and 1254. A significant portion of this land has been identified by the Western Australian Planning Authority (WAPC) as a "Future Urban Expansion" and for residential development in the City of Swan's draft Bullsbrook Townsite Expansion Master Plan. The proposed development area, referred to as the 'Development area' in this report, consists of 15 Lots (or portions of) totalling 249 ha. The Project area (482 ha) is located immediately east of the Bullsbrook townsite and approximately 35 km north-east of Perth within the City of Swan (Figure 1.1).

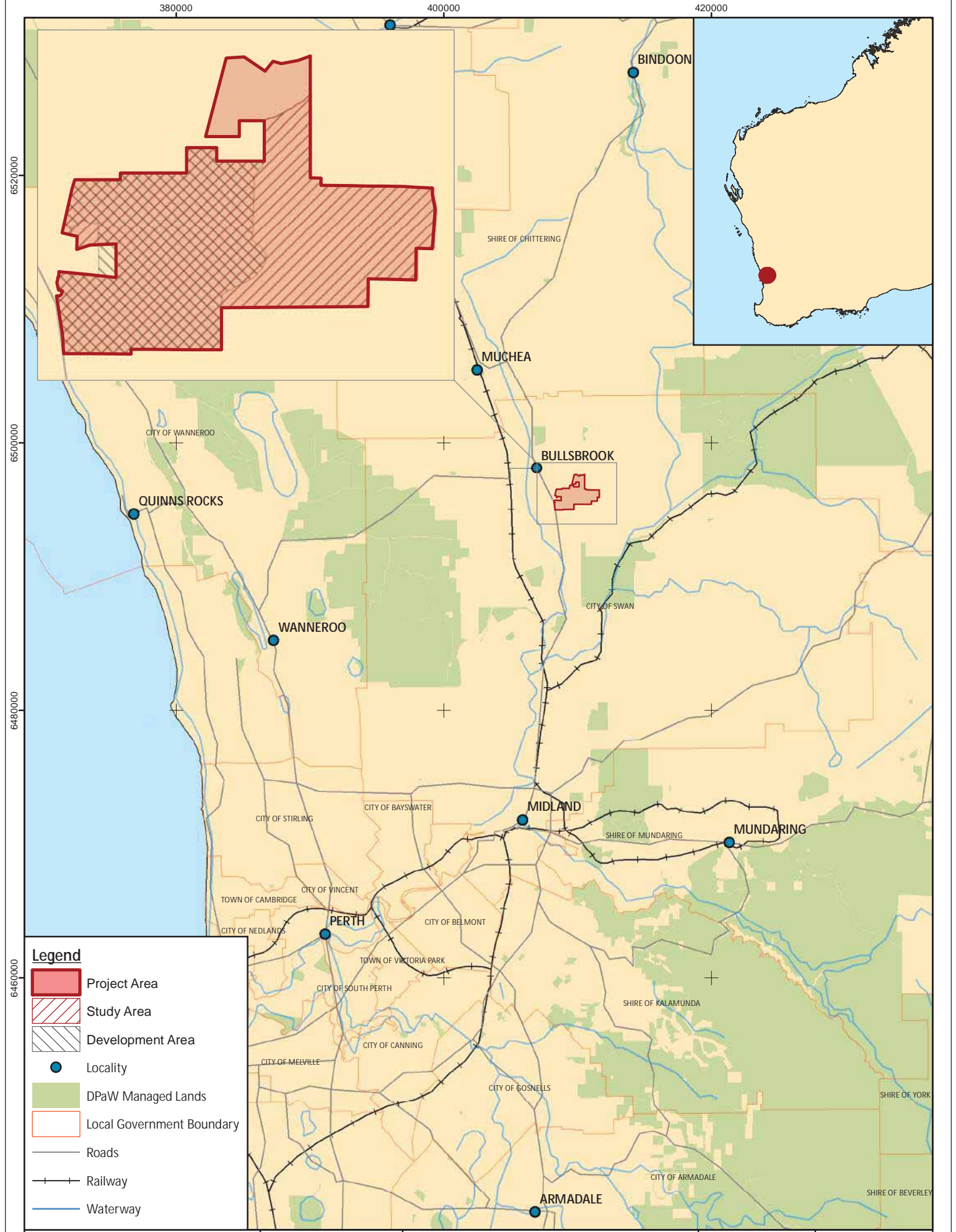
RPS requires an understanding of the status of the remnant vegetation, wetlands and flora, including Threatened and Priority flora, within the Project area to support future development of the site. The northern portion of the Project area form a portion (ie 43 ha) of the Burley Park and Adjacent Bushland Bush Forever site that will not be developed, and was therefore not surveyed in the field as part of this assessment. However, although occurring outside of the Project Area, Lot 382 and portions of Lots 1288 and 2792, were also surveyed. Excluding the portion of the Bush Forever site, the total area surveyed for this flora and vegetation assessment is 439 ha and is referred to as the 'study area' in this report (Figure 1.1).

In order to assess the status of the remnant vegetation, RPS commissioned *ecologia* Environment (*ecologia*) to undertake a two-phase, Level 2 flora and vegetation assessment at the study area and as the study area is located on the Swan Coastal Plain, a wetland assessment was also conducted.

1.2 LEGISLATIVE FRAMEWORK

This assessment was undertaken as part of the WA Environmental Impact Assessment process. It considered the following government guidance documents:

- Position Statement 3: Terrestrial biological surveys as an element of biodiversity protection (EPA 2002a);
- Position Statement 4: Environmental protection of wetlands (EPA 2002b);
- Guidance Statement 51: Terrestrial flora and vegetation surveys for environmental impact assessment (EPA 2004d);
- A methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia (DPaW 2013); and
- Technical Guide: Flora and vegetation surveys for environmental impact assessment (EPA & DEC 2015).



Legend

- Project Area
- Study Area
- Development Area
- Locality
- DPaW Managed Lands
- Local Government Boundary
- Roads
- Railway
- Waterway

0 6 12
 Kilometres

Absolute Scale - 1:350,000



Regional location of the Project area

Figure: 1.1
 Project ID: 1621

Drawn: MY
 Date: 29/06/2016

Coordinate System
 Name: GDA 1994 MGA Zone 50
 Projection: Transverse Mercator
 Datum: GDA 1994

1.3 SURVEY OBJECTIVES

The Environmental Protection Authority's (EPA) objectives with regard to the management of native flora and vegetation are to:

- Avoid adverse impacts on biological diversity comprising the different plants and the ecosystems they form, at the levels of genetic, species and ecosystem diversity;
- Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities;
- Protect Threatened flora consistent with the provisions of the *Wildlife Conservation Act 1950*; and
- Protect other flora species of conservation significance.

The primary objective of this assessment is to provide sufficient information to the EPA to assess the impact of the proposed development on the flora and remnant vegetation of the study area, thereby ensuring that the EPA's objectives will be upheld.

Specifically providing:

- A review of background information (including existing environment review and database searches);
- An inventory of all flora species, including species of conservation significance and introduced species recorded;
- A map and detailed description of vegetation types (to National Vegetation Information Systems (NVIS) Level V: Association) occurring in the study area and an assessment of which vegetation units potentially represent TEC or PECs;
- A wetland assessment, associated with seasonal flowing creekline; Ki-it Monger Brook, in order to support any potential submissions to the Department of Parks and Wildlife (DPaW) for management classification;
- A map of the vegetation condition and discussion on the type of disturbances encountered; and
- A review of significance, including the conservation status, of species and vegetation recorded at the study area.

1.4 DEFINITIONS

1.4.1 Significant Flora

As described in EPA Guidance Statement 51 (EPA 2004b), flora may be considered conservation significant if it is:

- Declared Rare (Threatened, EPBC Act and/or WC Act, categories provided in Appendix A); or
- Priority flora (categories are provided in Appendix A).

Other reasons that flora may be significant include:

- Range extensions,
- Keystone species,
- Relic species,
- Potential novel or new species,
- Restricted subspecies, varieties or naturally occurring hybrids; and
- Local endemism and/or a restricted distribution.

1.4.2 Introduced Flora

1.4.2.1 Weeds of National Significance

At a national level there are 32 weeds listed as Weeds of National Significance (WONS). *The Commonwealth National Weeds Strategy: A Strategic Approach to Weed Problems of National Significance* (2012b) describes broad goals and objectives to manage these weeds.

1.4.2.2 Declared Pests (Weeds)

The *Biosecurity and Agriculture Management Act 2007* (BAM Act) (Department of Agriculture and Food Western Australia; DAFWA 2007) seeks to prevent serious animal and plant pests and diseases from entering the State and becoming established, and to minimise the spread and impact of any that are already present.

The current Declared Pest, Western Australian Organism List (WAOL) was published in November 2015 (DAFWA 2013). The BAM Act categorises Declared Pests in one of three control categories; C1 Exclusion, C2 Eradication and C3 Management. These are described in Appendix A.

1.4.2.3 Environmental Weeds

A second and much more extensive categorisation of weeds has been developed by DPaW in the State Environmental Weed Strategy (Department of Conservation and Land Management (CALM) 1999). Weeds listed as Environmental Weeds are ranked into four control categories; Low, Mild, Moderate or High. These are described in Appendix A.

1.4.3 Significant Vegetation

As described in EPA Guidance Statement 51 (EPA 2004b), vegetation may be considered conservation significant if it is:

- Listed as a Threatened Ecological Community (TEC, categories provided in Appendix A); or
- The known post-European extent is below a threshold level.

Other reasons that vegetation may be significant include:

- Scarcity (based on likely distribution and landform type);
- Unusual species (based on other surveys conducted in the area);
- Novel combination of species (based on other surveys conducted in the area);
- A role as refuge (based on if the vegetation provides refuge for flora during any stress i.e. drought, fire etc. and can include gorges, phreatophytic species etc.);
- A role as a key habitat for threatened species or large populations representing a significant proportion of the local to regional total population of a species;
- Being representative of the range of a unit, at the extremes of range, recently discovered range extensions, outliers or isolated outliers of a main range; and
- A restricted distribution (based on other surveys conducted in the area).

In addition to that listed in Guidance Statement No. 51, vegetation is considered significant if it is:

- A state listed TEC or Priority Ecological Communities (PECs, categories provided in Appendix A).

1.4.4 Number of Plants Estimates

When there was only a cover (percentage density) or a description available for records of significant flora or weeds, the number of plants was estimated from these covers or descriptions based on the information provided in Table 1.1.

Table 1.1: Number of plants estimated for records with only a cover or a description

Cover or description	No. of plants assumed for shrubs, herbs and trees	No. of plants assumed for grasses
No cover or number	1	1
Infrequent, not common, occasional, rare, scattered, sparse	1	1
Common, locally common, frequent	30	500
Abundant	50	1,000
<1% cover	1	1
1-2% cover	5	10
2-10 % cover	10	50
10-30 % cover	20	100
30-70 % cover	30	500
70-100 % cover	40	1,000

1.4.5 Criteria to Determine Likelihood of Occurrence

The criteria listed in Table 1.2 are used to determine the likelihood of occurrence of significant flora and vegetation (TEC/PECs) within the Project area as part of the literature review.

Table 1.2: Criteria used to assess the likelihood of occurrence of significant flora and vegetation

Likelihood	Criteria Significant Flora	Criteria TEC/PEC
Previously recorded	Taxon has previously been recorded in the Project area.	TEC/PEC (not including buffer) has previously been recorded in the Project area.
High	Due to the proximity of previous records (<5 km) or the presence of suitable habitat, the taxon is considered highly likely to occur within the Project area.	Due to the proximity of previous records (<5 km) or the presence of suitable habitat/geology, the TEC/PEC is considered highly likely to occur within the Project area.
Moderate	The habitat specificity of the taxon is broadly defined and habitat could possibly occur at the study area and there are records within 20 km of the Project area or there is insufficient information available to exclude the possibility of occurrence at the Project area.	The habitat specificity is broadly defined and habitat could possibly occur at the Project area, there are records within 20 km of the Project area or there is insufficient information available to exclude the possibility of occurrence at the Project area.
Low	The habitat specificity of the taxon is well defined from previous records and the habitat is considered unlikely to be present within the Project area; or there are no records within 20 km of the Project area.	The habitat specificity is well defined from previous records and the habitat is considered unlikely to be present within the Project area; or there are no records within 20 km of the Project area.

1.4.6 Managed Lands/Conservation Estate

The National Reserve System is a network of protected areas managed for conservation under international guidelines. The objective of placing areas of bushland into the Conservation Estate is to achieve and maintain a comprehensive, adequate and representative reserve system for Western Australia.

1.4.7 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are areas that require special protection due to aspects such as landscape, wildlife of historical value and are declared under Section 51B of the *Environmental Protection Act 1986* (EP Act).

1.4.8 Bush Forever Sites

The Bush Forever strategy is a 10 year strategic plan that was published by the Western Australia Planning Commission. Bush Forever formally commenced in 2000 to protect approximately 51,200 ha of regionally significant bushland within approximately 290 Bush Forever sites across Western Australia.

1.4.9 Geomorphic Wetlands

Wetlands are areas that are permanently, seasonally or intermittently inundated with water and can include lakes (permanently inundated basins), sumplands (seasonally inundated basins), damplands (seasonally waterlogged basins), playas (intermittently inundated basins), palusplains (seasonally waterlogged flats), barlkarras (intermittently inundated flats), paluslopes (seasonally waterlogged slopes) and palusmonts (seasonally waterlogged highlands) (Hill *et al.* 1996).

Hill *et al.* (1996) categorised wetlands occurring on the Swan Coastal Plain into levels of protection and management categories. Three management categories are recognised and are described below:

- *Conservation Category Wetlands:* are the highest priority wetlands that support high levels of attributes and functions and account for approximately 20 percent of the wetlands. The management objectives are to preserve and protect existing conservation values;
- *Resource Enhancement Wetlands:* have been partly modified but still support substantial functions and attributes and the objective is to manage, restore and protect towards improving their conservation value; and
- *Multiple Use Wetlands:* have few important ecological attributes and functions remaining and the use, development and management should be considered in the context of ecologically sustainable development. About 72% of wetlands have been degraded to the extent that they are not a priority for conservation.

Wetland mapping is available in the Geomorphic Wetlands Swan Coastal Plain dataset, which displays the location, boundary, classification (wetland type) and the management category.

2 LITERATURE REVIEW

2.1 EXISTING ENVIRONMENT

2.1.1 Biogeographic Region

The Interim Biogeographic Regionalisation for Australia (IBRA) (Version 7) classifies the Australian continent into regions (bioregions) of similar geology, landform, vegetation, fauna and climate characteristics, and has currently 89 recognised regions (DSEWPac 2012a). The Project area is located across the boundary of the Swan Coastal Plain and the Jarrah Forest IBRA regions (Figure 2.1).

The Swan Coastal Plain IBRA region is comprised of two subregions, the Swan Coastal Plain and the Dandaragan Plateau. The Project area straddles both of these subregions:

- The Dandaragan Plateau subregion is characterised by Cretaceous marine sediments and mantled by sands and laterites. Vegetation is characterised by *Banksia* low woodland, Jarrah-Marri woodland, Marri woodland and by scrub heaths on laterite pavement and on gravelly sandplains (Desmond 2001).
- The Swan Coastal Plain subregion is characterised by a low lying coastal plain mainly covered by woodlands. Vegetation is dominated by *Banksia* or Tuart on sandy soils. *Casuarina obesa* is characteristic on outwash plains and Paperbark in swampy areas. In the east Jarrah woodland are seen on elevated plains (Mitchell *et al.* 2002).

The Jarrah Forest IBRA region is comprised of two subregions, the Northern Jarrah Forest and the Southern Jarrah Forest. The Project area is located in the Northern Jarrah Forest subregion:

- The Northern Jarrah Forest subregion is characterised by Jarrah-Marri Forest over lateritic gravel. Woodlands of Wandoo and Marri are seen on clayey soils in the east and in areas with Mesozoic sediment, Jarrah forests occur with a variety of other flora species (Williams and Mitchell 2001).

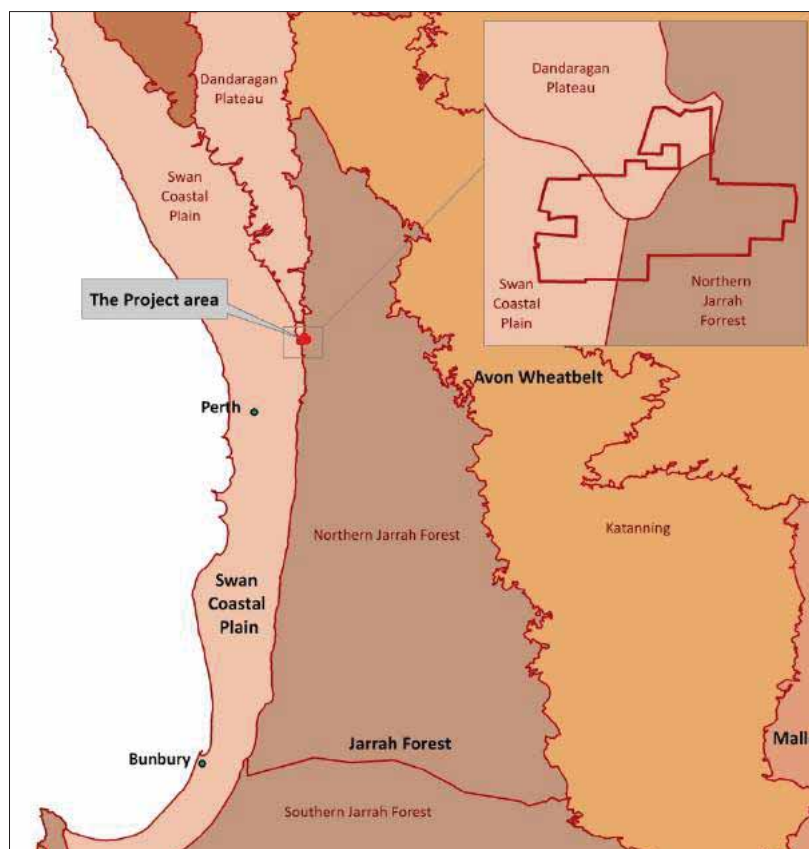


Figure 2.1: IBRA biogeographic regions and subregions of the Project area

2.1.2 Climate

The Project area experiences a dry Mediterranean climate with a hot dry summer from December to March and a mild winter from June to August. Data from approximately 2 km south of the Project area (weather station Pearce RAAF; Bureau of Meteorology (BoM) station number 9053), indicate that the annual mean maximum temperature is 25.2°C and the mean minimum temperature is 12.2°C. The mean annual rainfall is 667.2 mm with the majority of rain falling between June to August (BoM 2016). Section 3.1.2 presents climate data for the Project area in more detail.

2.2 MANAGED AND SIGNIFICANT LANDS

2.2.1 DPaW Managed Lands

There are no DPaW managed lands within the Project area. The closest are Walyunga National Park located 2.5 km south, Bullsbrook Nature Reserve located 3.5 km north-west and conservation reserve 46564 located 2.5 km north of the Project area (Figure 2.2).

2.2.2 ESAs

A number of known ESAs occur at the Project area, including the bush forever site in the northern area and buffers surrounding the conservation category wetlands to the west (Figure 2.2 and Figure 2.3). TECs are present to the south-west of the Project area (Section 2.3.2.6).

2.2.3 Bush Forever

There is one Bush Forever Site (Site 86) located within the Project area, and three additional sites occurring within 1 km of the Project area (Table 2.1, Figure 2.2 and Figure 2.3). Vegetation complexes and structural units associated with these sites are described in Table 2.11, Section 2.3.2.4 (Department of Environmental Protection 2000).

Table 2.1: Bush Forever sites within or in close proximity to the Project area

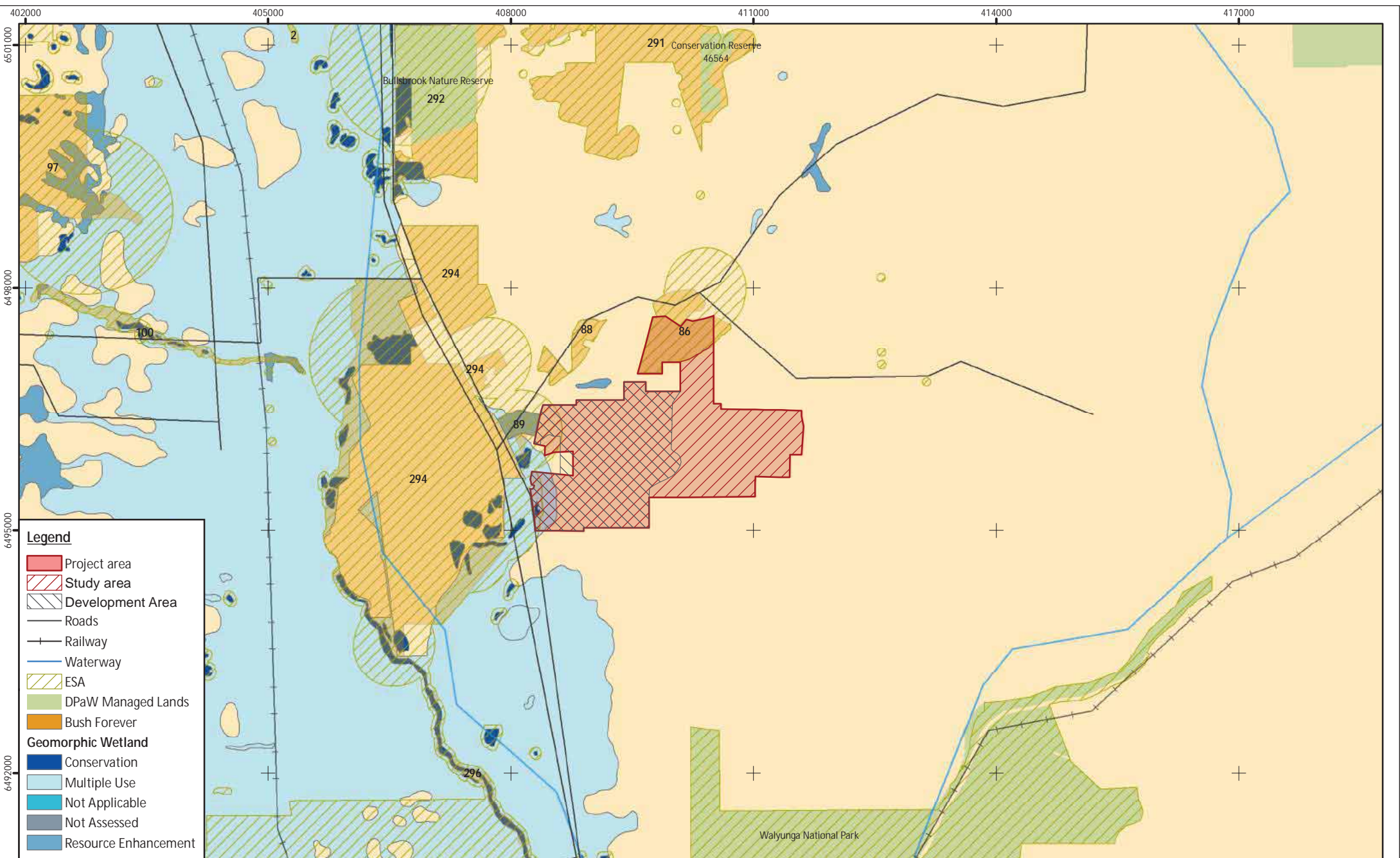
Site	Name	Location
86	Burley Park and Adjacent Bushland, Bullsbrook	43 ha within northern portion of Project area
88	Ashton Road Bushland, Bullsbrook	300 m north
89	Maroubra Avenue Bushland, Bullsbrook	Adjacent west
294	Pearce Aerodrome and Adjacent Bushland, Bullsbrook	100 m west

2.2.4 Wetlands

There are a number of geomorphic wetlands to the south-west of the Project area associated with the Ki-it Monger Brook. Two occur within the Project area; one is classified as a Conservation Category (Palusplain) Wetland (UFI 2691) which may support high levels of attributes and functions and one is a Multiple Use Palusplain Wetland which is likely to have few important ecological attributes and functions remaining (Table 2.2, Figure 2.3).

Table 2.2: Geomorphic wetlands occurring within the Project area

UFI	Wetland Name	Classification	Evaluation	Location
7577	n/a	Palusplain	Multiple Use	0.7 ha within south-west area of Project area
2691	n/a	Palusplain	Conservation	18.2 ha within south-west area of Project area



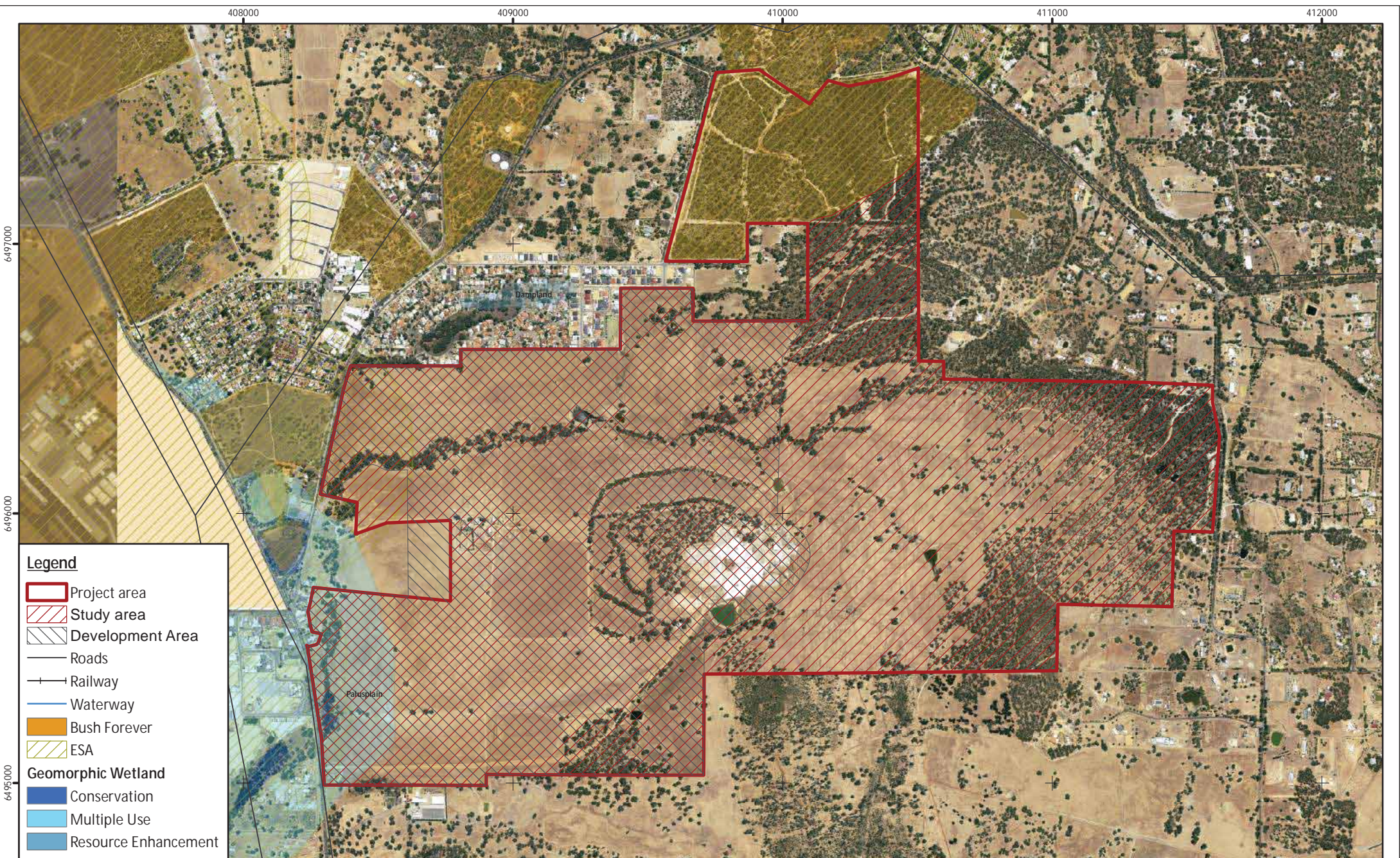
Managed and significant lands in the vicinity of the Project area

Figure: 2.2
Project ID: 1621

Drawn: MY
Date: 29/06/2016

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994



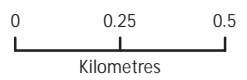


Legend

- Project area
- Study area
- Development Area
- Roads
- +— Railway
- Waterway
- Bush Forever
- ESA

Geomorphic Wetland

- Conservation
- Multiple Use
- Resource Enhancement



Absolute Scale - 1:18,000



Geomorphic Wetlands, ESAs and Bush Forever sites at the Project area

Figure: 2.3
Project ID: 1621

Drawn: MY
Date: 29/06/2016

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

2.3 PREVIOUSLY KNOWN FLORA AND VEGETATION SURVEYS

A search of the databases listed in Table 2.3 was undertaken for the literature review, prior to the field surveys, to determine species and communities previously recorded in the vicinity or within the Project area.

Table 2.3: Flora and vegetation databases searched for the literature review

Database	Custodian	Search Details
EPBC Act Protected Matters Database	DoE	Records of EPBC Act significant species within 5 km of the Project area.
Threatened and Priority flora Database (TPFL)	DPaW	Records of significant flora within 5 km of the Project area (Search reference 38-1014FL).
Threatened and Priority flora List (TPList)	DPaW	Records of significant flora by place names within 5 km of the Project area (Search reference 38-1014FL).
Western Australian Herbarium Specimen Database (WAHERB)	DPaW	Records of significant flora within 5 km of the Project area (Search reference 38-1014FL).
Threatened and Priority Ecological Communities Database	DPaW	Records of TEC/PECs within 10 km of the Project area (Search reference 37-01014EC).
Nature Map	DPaW	All flora records within 3 km circle of the centre point of the Project area.

In addition surveys that encompassed the Project area, or have been conducted in the vicinity of the area and are publically available, were included in the literature review. These are listed in Table 2.4.

Table 2.4: Previous flora and vegetation assessments used for the literature review

Reference	Location	Description
Beard (1981) / Shepherd <i>et al.</i> (2001)	Encompassed Project area	Vegetation survey conducted by Beard across Western Australia (mapped at 1:1,000,000 for the Swan area). This mapping was subsequently reinterpreted to reflect the NVIS standards and digitised by Shepherd.
Heddle <i>et al.</i> (1980)	Encompassed Project area	Broad vegetation complexes based on vegetation in association with landforms and underlying geology.
Gibson <i>et al.</i> (1994)	Encompassed west section of Project area	Floristic community types in super groups were described for the Swan Coastal Plain.
(Chittering Landcare Centre 2008)	6 km west of Project area	Foreshore assessment, flora and fauna survey for three areas in the Lower Ellen Brook catchment.
360 Environmental (2012)	8 km south-west of Project area	Level 2 flora and vegetation survey for the North Ellenbrook Project area.
Emerge Associates (2013)	10 km north of Project area	Level 2 flora and vegetation survey for the PT Lot M1313 Great Northern Highway Project area.

2.3.1 Flora

There were 103 native flora species identified from the Nature Map database searches as occurring within 3 km of the centre point of the Project area. The most common native families were Fabaceae and Myrtaceae (8 taxa each) and Poaceae and Asparagaceae (7 taxa each) and the most common genera were *Styloidium* (5 taxa) and *Acacia*, *Hakea* and *Xanthorrhoea* (3 taxa each). A potential species list is provided in Appendix B. Additionally, 20 Threatened (Table 2.6) and 36 Priority flora taxa (Table 2.7) were recorded during the literature review and these are listed and discussed overleaf.

2.3.1.1 Species Richness

The species richness of the Level 2 flora and vegetation assessments conducted in the vicinity of the Project area are listed in Table 2.5.

Table 2.5: Species richness for surveys conducted in the vicinity of the Project area

Reference	Survey	Area (ha)	Description	Number of native species	Number of introduced species	Most common native families	Most common native genera
360 Environmental (2012)	Level 2 One phase	1,000	Most of the area surveyed were native bushland	181 (80.1%)	45 (19.9%)	Myrtaceae (16 taxa) Cyperaceae (8 taxa)	<i>Styloidium</i> (8 taxa) <i>Lomandra</i> (6 taxa)
Emerge Associates (2013)	Level 2 One phase	150	Most of the area surveyed was disturbed	72 (68%)	34 (32%)	Myrtaceae (21 taxa) Fabaceae (12 taxa)	<i>Eucalyptus</i> (9 taxa) <i>Melaleuca</i> (6 taxa)

2.3.1.2 Threatened Flora

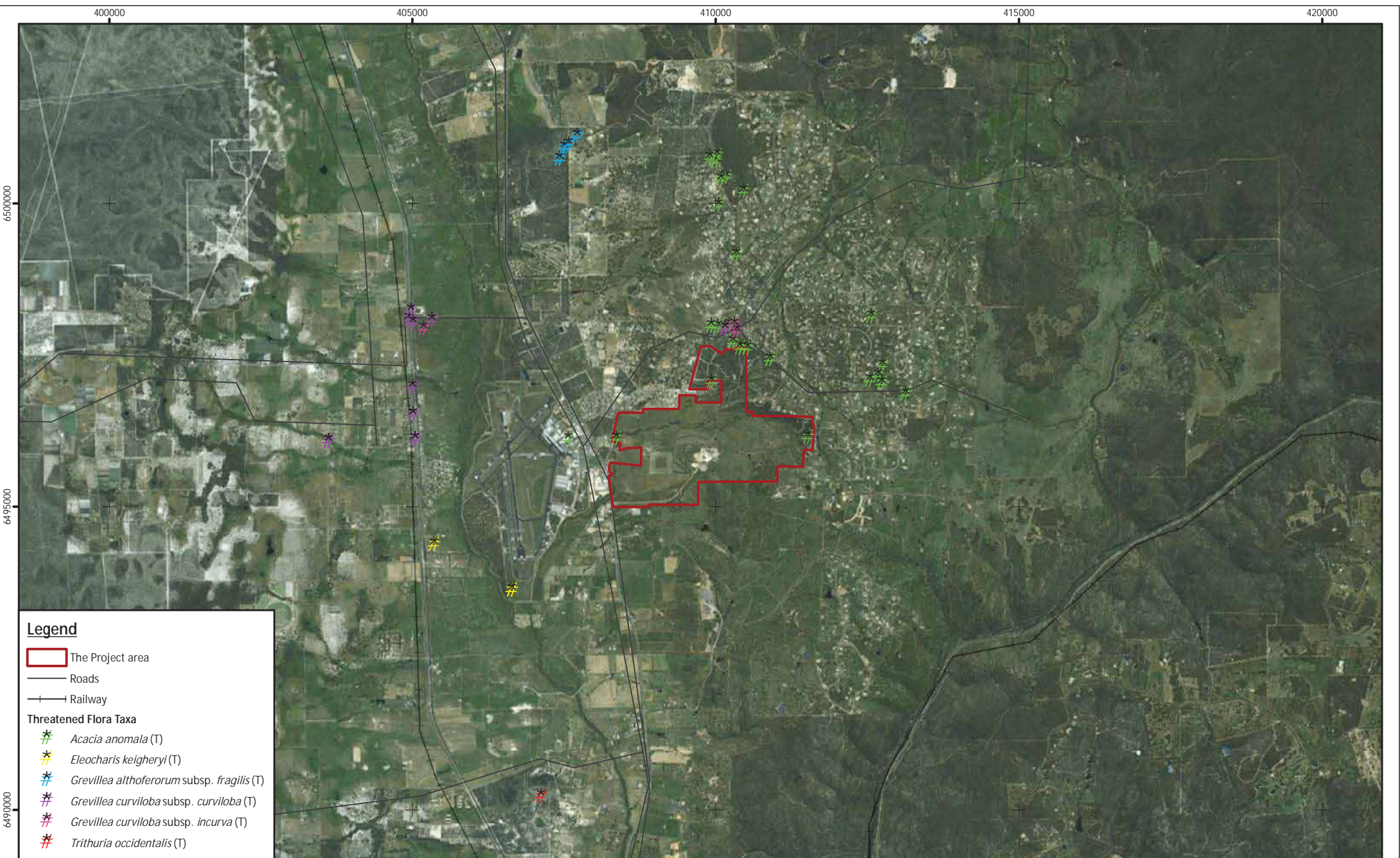
Six Threatened flora taxa have been previously recorded within 5 km of the Project area, of which one, *Acacia anomala*, has previously been recorded with four records (three locations) within the Project Area. Two Threatened flora taxa have a high likelihood of occurrence – *Grevillea curviloba* subsp. *curviloba* and *Grevillea curviloba* subsp. *incurva* – and the remaining three have a moderate or low likelihood of occurrence (Figure 2.4, Table 2.6).

In addition to these six taxa, 15 other Threatened flora taxa were recorded during the database searches or other surveys conducted in the area, but have no known locations from within 5 km of the Project area itself (Table 2.6).

An assessment on the likelihood of the Threatened taxa occurring within the Project area was conducted (Table 2.6), using the criteria listed in Table 1.2.

Table 2.6: Threatened flora recorded during the literature review

Status	Taxa	Habitat	Distance from study area	Likelihood of occurrence at the Project area
Threatened	<i>Acacia anomala</i>	Lateritic soils. Slopes.	Recorded	Previously recorded (from Bush Forever Site 86)
Threatened	<i>Andersonia gracilis</i>	White/grey sand, sandy clay, gravelly loam. Winter-wet areas, near swamps.	> 5 km	Low
Threatened	<i>Anigozanthos viridis</i> subsp. <i>terraspectans</i>	Grey sand, clay loam. Winter-wet depressions.	> 5 km	Low
Threatened	<i>Caladenia huegelii</i>	Grey or brown sand, clay loam.	> 5 km	Low
Threatened	<i>Centrolepis caespitosa</i>	White sand, clay. Salt flats, wet areas.	> 5 km	Low
Threatened	<i>Chamelaucium</i> sp. Gingin (N.G.marchant 6)	Undulating plain. Yellow dry sand. Hillslopes.	> 5 km	Low
Threatened	<i>Conospermum densiflorum</i> subsp. <i>unicephalatum</i>	Clay soils. Low-lying areas.	> 5 km	Low
Threatened	<i>Darwinia foetida</i>	Grey sand. Winter wet areas. Poorly drained.	> 5 km	Low
Threatened	<i>Eleocharis keigheryi</i>	Clay, sandy loam. Emergent in freshwater: creeks, claypans.	2.3 km south-west	Moderate
Threatened	<i>Eucalyptus balanites</i>	Sandy soils with lateritic gravel.	> 5 km	Low
Threatened	<i>Eucalyptus leprophloia</i>	White or grey sand over laterite. Valley slopes.	> 5 km	Low
Threatened	<i>Grevillea althoferorum</i> subsp. <i>fragilis</i>	Undulating plain. Grey sand over yellow sand.	4.5 km north	Moderate
Threatened	<i>Grevillea christineae</i>	Valley slope outcrop. Brown sand / loam / clay over granite boulder.	> 5 km	Low
Threatened	<i>Grevillea corrugata</i>	Gravelly loam. Roadsides.	> 5 km	Low
Threatened	<i>Grevillea curviloba</i> subsp. <i>curviloba</i>	Grey sand. Winter-wet heath.	0.3 km north	High
Threatened	<i>Grevillea curviloba</i> subsp. <i>incurva</i>	Sand, sandy loam. Winter-wet heath.	0.3 km north	High
Threatened	<i>Grevillea flexuosa</i>	Red-brown sand with laterite & gravel, sand over granite. Ridgetop plateau & associated breakaways.	> 5 km	Low
Threatened	<i>Thelymitra dedmaniarum</i>	Granite.	> 5 km	Low
Threatened	<i>Thelymitra stellata</i>	Sand, gravel, lateritic loam.	> 5 km	Low
Threatened	<i>Trithuria occidentalis</i>	Muddy clay.	4.8 km south	Low



Legend

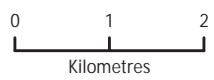
The Project area

— Roads

—+— Railway

Threatened Flora Taxa

- ✱ *Acacia anomala* (T)
- ✱ *Eleocharis keigheryi* (T)
- ✱ *Grevillea althoferorum* subsp. *fragilis* (T)
- ✱ *Grevillea curviloba* subsp. *curviloba* (T)
- ✱ *Grevillea curviloba* subsp. *incurva* (T)
- ✱ *Trithuria occidentalis* (T)



Absolute Scale - 1:80,000



Threatened flora recorded at or in the vicinity of the Project area

Figure: 2.4
Project ID: 1621

Drawn: MH
Date: 12/05/2016

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

2.3.1.3 Priority flora

Sixteen Priority flora taxa have been recorded within 5 km of the Project area (Figure 2.5), none of which have previously been recorded within the Project area itself. On the basis of the desktop assessment, two of these taxa; *Schoenus capillifolius* (P3) and *Stylidium longitubum* (P3) are considered to have a high likelihood of occurrence within the study area (Table 2.7), although this was not borne out from the field assessment results (Section 5.1).

In addition to these 16 taxa, 20 other Priority flora were identified from the database searches or other previous surveys in the vicinity, but are not known from within 5 km of the Project area (Table 2.7).

Table 2.7: Priority flora recorded during the literature review

Status	Taxa	Habitat	Distance from study area	Likelihood of occurrence at the study area
Priority 1	<i>Drosera sewelliae</i>	Laterite & silica sand soils.	> 5 km	Low
	<i>Gastrolobium crispatum</i>	Yellow or brown sandy loam, red laterite soils. Steep gullies, slopes, ridges, breakaways.	> 5 km	Low
	<i>Hibbertia glomerata</i> subsp. <i>ginginensis</i>	Sand, brown clay, laterite. Near roadsides.	4.8 km north	Moderate
Priority 2	<i>Gastrolobium nudum</i>	Red-brown clay, brown loam, gravel, laterite, granite. Flats, slopes, hilltops, ridges, valleys, breakaways.	> 5 km	Low
	<i>Grevillea candolleana</i>	Laterite, lateritic loam. Hillsides.	> 5 km	Low
	<i>Schoenus</i> sp. Bullsbrook (J.J. Alford 915)	Low lying flat, grey peaty sand over clay.	4.8 km south	Low
	<i>Stenanthemum sublineare</i>	Littered white sand. Coastal plain.	> 5 km	Low
	<i>Stylidium aceratum</i>	Seasonal swamp; Black damp sand and sandy soils.	3.5 km north	Low
	<i>Stylidium squamellosum</i>	Brown to red-brown clay loam. Winter-wet habitats and depressions, open woodland, shrubland.	4.4 km north	Low
	<i>Tetralia</i> sp. Chandala (G.J. Keighery 17055)	Mound spring, black peaty sand. Swamps.	> 5 km	Low
Priority 3	<i>Acacia drummondii</i> subsp. <i>affinis</i>	Lateritic gravelly soils.	> 5 km	Low
	<i>Acacia oncinophylla</i> subsp. <i>oncinophylla</i>	Granitic soils, occasionally on laterite.	> 5 km	Low
	<i>Adenanthos cygnorum</i> subsp. <i>chamaephyton</i>	Grey sand, lateritic gravel.	4 km north	Low
	<i>Chamaescilla gibsonii</i>	Clay to sandy clay. Winter-wet flats, shallow water-filled claypans.	> 5 km	Low
	<i>Cyathochaeta teretifolia</i>	Grey sand, sandy clay. Swamps, creek edges.	> 5 km	Low
	<i>Eryngium pinnatifidum</i> subsp. <i>Palustre</i> (G.J. Keighery 13459)	Clay, sandy clay. Claypans, seasonally wet flats.	4.7 km north	Low
	<i>Guichenotia tuberculata</i>	Sand clay over laterite, sand.	4.6 km west	Moderate
	<i>Haemodorum loratum</i>	Grey or yellow sand, gravel.	> 5 km	Low
	<i>Halgania corymbosa</i>	Gravelly soils, soils over granite.	> 5 km	Low
	<i>Meionectes tenuifolia</i>	Sand or clay. Wetlands and Swamps.	> 5 km	Low
	<i>Persoonia rudis</i>	White, grey or yellow sand, often over laterite.	3.8 km north-west	Low
	<i>Platysace ramosissima</i>	Sandy soils.	4.6 km north-west	Low
	<i>Schoenus capillifolius</i>	Brown mud. Claypans – but see Section 5.1	0.6 km west	High
	<i>Stylidium asteroideum</i>	Shallow/flat drainage line with damp sand/loam/clay.	> 5 km	Low
	<i>Stylidium longitubum</i>	Sandy clay, clay. Seasonal wetlands – but see Section 5.1	0.7 km west	High
	<i>Stylidium paludicola</i>	Winter-wet flats; brown sandy-clay.	> 5 km	Low
	<i>Stylidium trudgenii</i>	Margins of winter-wet swamps, depressions. Grey sand, dark grey to black sandy peat.	> 5 km	Low
<i>Verticordia serrata</i> var. <i>linearis</i>	White sand, gravel. Open woodland.	4.7 km west and north	Low	
Priority 4	<i>Centrolepis caespitosa</i>	White sand, clay. Salt flats, wet areas.	0.7 km west	Moderate
	<i>Darwinia pimelioides</i>	Loam, sandy loam. Granite outcrops.	> 5 km	Low
	<i>Drosera occidentalis</i> subsp. <i>occidentalis</i>	Sandy and clayey soils. Swamps and wet depressions.	4.7 km west	Low
	<i>Hydrocotyle lemnoides</i>	Swamps.	4.6 km west	Low
	<i>Oxymyrrhine coronata</i>	Slope with dry laterite gravel and boulders.	3.5 km north	Low
	<i>Synaphea grandis</i>	Laterite.	> 5 km	Low
	<i>Tripterococcus paniculatus</i>	Grey, black or peaty sand. Winter-wet flats.	> 5 km	Low

Status	Taxa	Habitat	Distance from study area	Likelihood of occurrence at the study area
	<i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>	Sand, sandy clay. Winter-wet depressions.	> 5 km	Low

400000

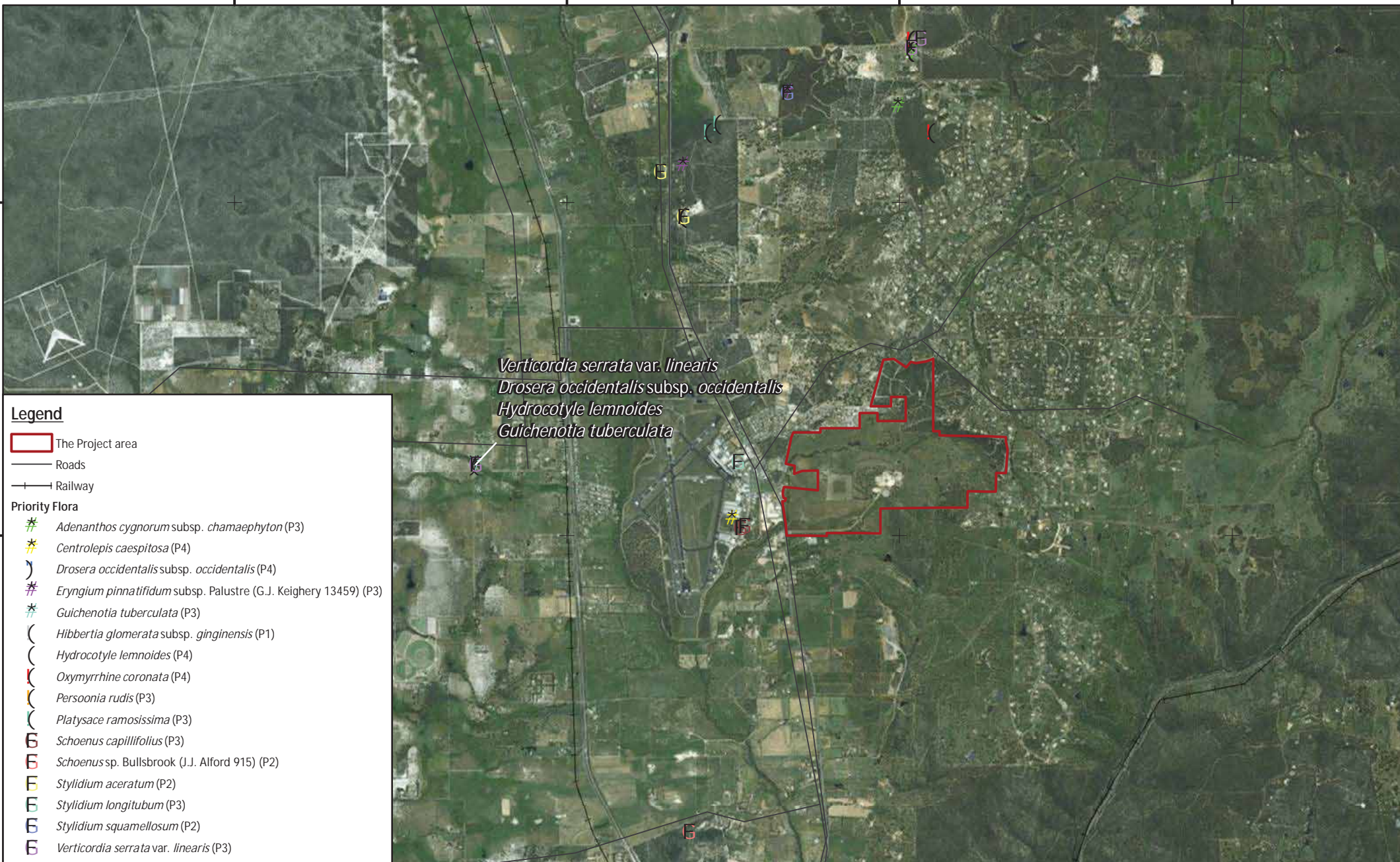
405000

410000

415000

6500000

6495000

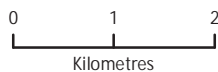


Legend

- The Project area
- Roads
- +— Railway

Priority Flora

- # *Adenanthos cygnorum* subsp. *chamaephyton* (P3)
- # *Centrolepis caespitosa* (P4)
-) *Drosera occidentalis* subsp. *occidentalis* (P4)
- # *Eryngium pinnatifidum* subsp. *Palustre* (G.J. Keighery 13459) (P3)
- * *Guichenotia tuberculata* (P3)
- (*Hibbertia glomerata* subsp. *ginginensis* (P1)
- (*Hydrocotyle lemnoides* (P4)
- (*Oxymyrrhine coronata* (P4)
- (*Persoonia rudis* (P3)
- (*Platysace ramosissima* (P3)
- E *Schoenus capillifolius* (P3)
- E *Schoenus* sp. *Bullsbrook* (J.J. Alford 915) (P2)
- E *Stylidium aceratum* (P2)
- E *Stylidium longitubum* (P3)
- E *Stylidium squamellosum* (P2)
- E *Verticordia serrata* var. *linearis* (P3)



Absolute Scale - 1:75,000



Priority flora recorded at or in the vicinity of the Project area

Figure: 2.5
 Project ID: 1621

Drawn: MY
 Date: 30/05/2016

Coordinate System
 Name: GDA 1994 MGA Zone 50
 Projection: Transverse Mercator
 Datum: GDA 1994

2.3.1.4 Introduced Flora

Seventy-seven introduced plant species were recorded from the literature review as occurring in the vicinity of the Project area. Of these, seven were classified as WONS, one as a Declared Plant (for the whole of the state) and the remaining 69 as permitted environmental weeds. The WONS and declared weeds are listed below and the environmental weeds are listed in the potential species list in Appendix B.

- WONS: *Asparagus asparagoides* (Asparagus), *Chrysanthemoides monilifera* (Bitou Bush), *Genista* sp., *Lantana camara* (Lantana), *Lycium ferocissimum* (African Boxthorn), *Rubus fruticosus* aggregate (Blackberry) and *Salvinia molesta* (Salvinia).
- Declared (C3): *Zantedeschia aethiopica* (Arum Lily).

The percentage of introduced flora recorded from the two previous Level 2 flora and vegetation assessments undertaken in the vicinity of the Project area are listed in Table 2.5. Both surveys had expectedly high percentages of introduced species with 19.9% (360 Environmental 2012) and 32% (Emerge Associates 2013) of the total species recorded introduced.

2.3.2 Vegetation

2.3.2.1 Beard and Shepherd

Beard *et al.* mapped the vegetation of Western Australia over a series of maps from 1974 to 1981 and separated the state in various provinces and districts. The west of the Project area occurs within the Drummond Sub-district and the east occurs within the Dale Sub-district of the South-west Botanical Province. The Beard vegetation mapping was subsequently reinterpreted to reflect the National Vegetation Information System (NVIS) standards, revised taxonomy and was digitised by Shepherd *et al.* (2001). Two vegetation associations and one mosaic of these two associations were mapped within the Project area and are presented below in Table 2.8. Both of the associations are very widespread across Western Australia and have been mapped extensively in the south-west.

Table 2.8: Beard vegetation units mapped at the study area

Code	Description	Current Extent (ha)	Pre-European extent (ha)	Remaining (%)
3	Medium forest; Jarrah-Marri	1,860,865	2,707,678	68.7
4	Medium woodland; Marri & Wandoo	276,471	1,127,124	24.5
1020	Mosaic: 3/4	1,669	5,610	29.7

2.3.2.2 Heddle Vegetation Complexes

The vegetation of the Swan Coastal Plain has been mapped at a regional scale by Heddle *et al.* (1980) in correlation to the major geological units of Churchward and McArthur (1980). The Project area supports five vegetation complexes: Darling Scarp, Forrestfield, Guildford, Reagan and Yalanbee and these are presented in Table 2.9.

Table 2.9: Heddle vegetation complexes mapped at the study area

Complex	Landform	Vegetation	Area (ha) & description in Project area	Pre-European Extent (ha)	2015 extent (ha, %)
Darling Scarp Complex	Scarp	Vegetation ranges from a low open woodland to lichens according to the depth of the soil. Woodland components chiefly <i>E. wandoo</i> , with <i>E. laeliae</i> in the north, <i>E. haematoxylon</i> in the south, and <i>C. calophylla</i> throughout the region.	64.8 ha - associated with the steep slopes of the eastern side of the Project area. Generally in Good condition.	35,512	14,649 (41.3%)
Forrestfield Complex	Foothills	Dominated by open forest of <i>C. calophylla</i> - <i>E. wandoo</i> - <i>E. marginata</i> (on the heavier soils) to open forest of <i>E. marginata</i> - <i>C. calophylla</i> , <i>Allocasuarina fraseriana</i> - <i>Banksia</i> spp. (on the sandier soils). Fringing woodland of <i>E. rudis</i> and <i>Melaleuca rhaphiophylla</i> are in gullies and watercourses.	0.1 ha - a very small area mapped with a patch of Guildford complex on a Completely degraded area.	21,210	2,448 (11.5%)

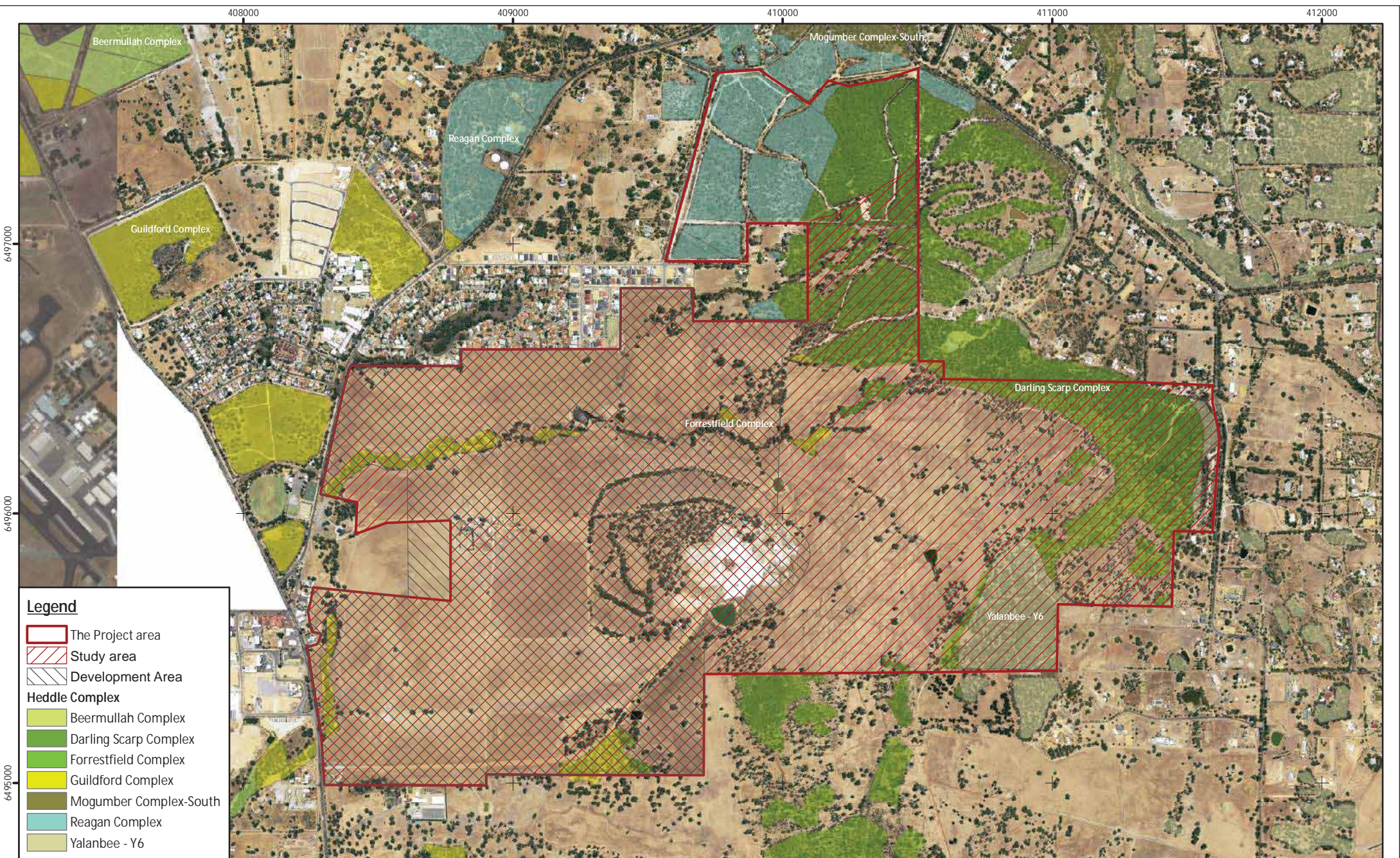
Complex	Landform	Vegetation	Area (ha) & description in Project area	Pre-European Extent (ha)	2015 extent (ha, %)
Guildford Complex	Pinjarra Plain	A mixture of open forest to tall open forest of <i>C. calophylla</i> – <i>E. wandoo</i> – <i>E. marginata</i> and woodland of <i>E. wandoo</i> (with minor components occurrences of <i>E. lane-poolei</i>). Minor components include <i>E. rudis</i> and <i>M. raphiophylla</i> .	9.6 ha - mostly associated with the Ki-Monger Brook that runs through the Project area as well as a small area in the southern area of the Project area.	92,340	4,936 (5.3%)
Reagan Complex	Gingin scarp	Vegetation ranges from low open woodland of <i>Banksia</i> species and <i>E. tottiana</i> to closed heath depending on the depth of the soil	23.0 ha - associated with the Bush Forever site in the northern section of the Project area. Not to be developed.	9,081	3,035 (33.4%)
Yalanbee	Darling Plateau	Open forest of <i>E. marginata</i> – <i>C. calophylla</i>	14.8 ha - associated with the hill top in the south-east of the Project area. Some areas are in Good condition, mostly is degraded.	199,021	93,351 (46.9%)

2.3.2.3 Gibson FTCs

Gibson *et al.* (1994) floristically sampled 22 quadrats within 8 km of the Project area which were assigned to nine FTCs (Table 2.10). Four of these FTCs represent either TECs or PECs and are considered significant (Table 2.10, Table 2.14).

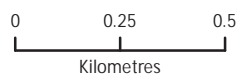
Table 2.10: FTCs recorded within 8 km of the Project area

FTC	Status	Description	Typical and common species
3c	TEC	<i>Eucalyptus calophylla</i> – <i>Xanthorrhoea preissii</i> woodlands and shrublands	<i>Eucalyptus calophylla</i> , <i>Xanthorrhoea preissii</i> , * <i>Briza maxima</i> , <i>Burchardia umbellata</i> , <i>Cyathochaeta avenacea</i> , <i>Neurachne alopecuroidea</i> , * <i>Romulea rosea</i> , <i>Acacia pulchella</i> , <i>Dryandra nivea</i> , <i>Gompholobium marginatum</i> , <i>Hypocalymma angustifolium</i> , <i>Caesia micrantha</i> , <i>Drosera menziesii</i> subsp. <i>penicillaris</i> , * <i>Hypochaeris glabra</i> , <i>Lepidosperma</i> sp., <i>Loxocarya flexuosa</i> , <i>Mesomelaena tetragona</i> , <i>Opercularia vaginata</i> , <i>Sowerbaea laxiflora</i> , <i>Stipa Pycnostachya</i> , <i>Tetraria octandra</i> , <i>Thysanotus manglesianus/patersonii</i> .
5	-	Mixed shrub damplands	* <i>Hypochaeris glabra</i> , <i>Hypolaena exsulca</i> and <i>Siloxerus humifusus</i> , <i>Kunzea ericifolia</i> , <i>Pericalymma ellipticum</i> , * <i>Aira caryophylla</i> , * <i>Briza maxima</i> , * <i>Briza minor</i> , <i>Caladenia flava</i> , <i>Mitrasacme paradoxa</i> , <i>Quinetia urvillei</i> , <i>Trachymene pilosa</i> , * <i>Ursinia anthemoides</i> .
6	-	Weed dominated wetland on heavy soils	* <i>Hypochaeris glabra</i> and * <i>Briza maxima</i> , <i>Hypocalymma angustifolium</i> , * <i>Ehrharta calycina</i> , * <i>Ehrharta longiflora</i> , * <i>Monadenia bracteata</i> , * <i>Romulea rosea</i> , * <i>Ursinia anthemoides</i> .
7	TEC	Herb rich saline shrubland sin clay pans	* <i>Briza minor</i> , <i>Centrolepis aristata</i> and <i>Philydrella pygmaea</i> , <i>Melaleuca viminea</i> , <i>Brachyscome bellidioides</i> , * <i>Briza maxima</i> , <i>Centrolepis polygyna</i> , * <i>Cicendia filiformis</i> , <i>Goodenia micrantha</i> , * <i>Hypochaeris glabra</i> , <i>Pogonolepis stricta</i> , <i>Polypompholyx multifida</i> , <i>Schoenus odontocarpus</i> , <i>Siloxerus humifusus</i> , <i>Thysanotus manglesianus/patersonii</i> .
11	-	Wet forests and woodlands	<i>Eucalyptus rudis</i> , <i>Astartea aff. fascicularis</i> , * <i>Briza maxima</i> , <i>Lepidosperma longitudinale</i> , * <i>Hypochaeris glabra</i> .
15	TEC – WC Act	Forests and woodlands of deep seasonal wetlands	<i>Melaleuca raphiophylla</i> , <i>Melaleuca teretifolia</i> , <i>Cotula coronopifolia</i> , <i>Crassula natans</i> , * <i>Cynodon dactylon</i> , <i>Isolepis producta</i> , <i>Lemna disperma</i> , <i>Triglochin procerum</i> .
21c	PEC	Low lying <i>Banksia attenuata</i> woodlands or shrublands	<i>Banksia attenuata</i> , <i>Banksia menziesii</i> , <i>Gompholobium tomentosum</i> , <i>Kunzea ericifolia</i> , <i>Leucopogon conostephioides</i> , <i>Petrophile linearis</i> , <i>Scholtzia involucrata</i> , * <i>Briza maxima</i> , * <i>Hypochaeris glabra</i> , <i>Lomandra caespitosa</i> , <i>Lyginia barbata</i> , <i>Thysanotus manglesianus/patersonii</i> , <i>Trachymene pilosa</i> , <i>Burchardia umbellata</i> , <i>Caladenia flava</i> , <i>Dasyopogon bromeliifolius</i> , <i>Drosera erythrorhiza</i> , <i>Hypolaena exsulca</i> , <i>Lomandra hermaphrodita</i> , <i>Patersonia occidentalis</i> , <i>Stylidium brunonianum</i> , <i>Stylidium repens</i> , * <i>Ursinia anthemoides</i> .
23a	-	<i>Banksia attenuata</i> – <i>Banksia menziesii</i> woodlands	<i>Banksia attenuata</i> , <i>Banksia menziesii</i> , <i>Bossiaea eriocarpa</i> , <i>Gompholobium tomentosum</i> , <i>Leucopogon conostephioides</i> , <i>Petrophile linearis</i> , <i>Scholtzia involucrata</i> , <i>Adenanthos cygnorum</i> , <i>Calytrix flavescens</i> , <i>Conostephium pendulum</i> , <i>Eriostemon spicatus</i> , <i>Hibbertia hypericoides</i> , <i>Hibbertia subvaginata</i> , <i>Hovea trisperma</i> , <i>Xanthorrhoea preissii</i> , <i>Burchardia umbellata</i> , <i>Conostylis juncea</i> , <i>Dampiera linearis</i> , <i>Drosera erythrorhiza</i> , * <i>Hypochaeris glabra</i> , <i>Lomandra hermaphrodita</i> , <i>Lyginia barbata</i> , <i>Patersonia occidentalis</i> , <i>Schoenus curvifolius</i> , <i>Stylidium piliferum</i> , <i>Trachymene pilosa</i> .
28	-	Spearwood <i>Banksia attenuata</i> or <i>Banksia attenuata</i> – <i>Eucalyptus</i> woodlands	<i>Banksia attenuata</i> , <i>Hibbertia hypericoides</i> , <i>Xanthorrhoea preissii</i> , <i>Acacia pulchella</i> var. <i>pulchella</i> , <i>Conostephium pendulum</i> , <i>Gompholobium tomentosum</i> , <i>Petrophile linearis</i> , <i>Burchardia umbellata</i> , <i>Drosera erythrorhiza</i> , <i>Loxocarpa flexuosa</i> , <i>Mesomelaena pseudostygia</i> , <i>Trachymene pilosa</i> .



Legend

- The Project area
- Study area
- Development Area
- Heddle Complex**
- Beerullah Complex
- Darling Scarp Complex
- Forrestfield Complex
- Guildford Complex
- Mogumber Complex-South
- Reagan Complex
- Yalanbee - Y6



Absolute Scale - 1:18,000



Heddle complexes mapped within the Project area

Figure: 2.6
Project ID: 1621

Drawn: MY
Date: 29/06/2016

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

2.3.2.4 Bush Forever site vegetation

Vegetation complexes and structural units associated with the four Bush Forever sites within, or in close proximity to, the Project area are provided in Table 2.11.

Table 2.11: Vegetation Complexes and structural units of Bush Forever sites within or in close proximity to the Project area

Site	Vegetation Complex and Structural Unit(s)
86	<p>Mogumber Complex – South (Dandaragan Plateau) Reagan Complex (Dandaragan Plateau) Uplands: <i>Eucalyptus accedens</i> and <i>E. wandoo</i> Woodland; <i>Eucalyptus accedens</i>, <i>Corymbia calophylla</i> and <i>Eucalyptus marginata</i> Open Forest to Woodland; <i>Allocasuarina humilis</i> and <i>Calytrix angulata</i> Open Heath; <i>Corymbia calophylla</i> and <i>Eucalyptus marginata</i> Low Woodland to Low Open Forest; <i>Eucalyptus marginata</i> and <i>E. accedens</i> Woodland Wetlands: <i>Eucalyptus rudis</i> and <i>Corymbia calophylla</i> Woodland to Open Forest</p>
88	<p>Reagan Complex (Dandaragan Plateau) Guildford Complex Uplands: <i>Corymbia calophylla</i> and <i>E. marginata</i> Open Woodland; <i>Corymbia calophylla</i> and <i>E. wandoo</i> Woodland to Open Forest; <i>Eucalyptus marginata</i> Woodland; scattered <i>Corymbia calophylla</i> over <i>Banksia attenuata</i> and <i>B. menziesii</i> Low Woodland; mixed Open Low Heath</p>
89	<p>Guildford Complex Uplands: <i>Eucalyptus wandoo</i> Open Woodland Wetlands: <i>Eucalyptus wandoo</i> Open Woodland; <i>Hakea prostrata</i>, <i>Jacksona sternbergiana</i>, <i>Daviesia horrida</i> and <i>Xanthorrhoea preissii</i> Shrubland; <i>Hypoclaymma nhustifolium</i> Open Low Heath; Sedgeland, Herbland</p>
294	<p>Reagan Complex (Dandaragan Plateau) Guildford Complex Yanga Complex Beermullah Complex Uplands: <i>Banksia attenuata</i> and <i>B. menziesii</i> Woodland with scattered <i>Eucalyptus tottiana</i>; <i>Corymbia calophylla</i> Woodland; <i>Eucalyptus wandoo</i> Tall Woodland. Wetlands: <i>casuarina obesa</i> Woodland; <i>Acacia saligna</i> Low Woodland; Scattered <i>Eucalyptus wandoo</i> over <i>Xanthorrhoea preissii</i>, <i>Acacia lasiocarpa</i> var. <i>bracteolata</i> and <i>Hycalymma angustifolium</i> Open Low Heath; <i>Kunzea</i> aff. <i>recurva</i> Shrubland; <i>Melaleuca raphiophylla</i> Low Woodland to Forest; <i>Viminaria juncea</i> Tall Shrubland; <i>Pericalymma</i> Open Heath; <i>Melaueca</i> species Tall Open Scrub; <i>Haklea trifurcata</i>, <i>Allocasuarina humilis</i> and <i>Xanthorrhoea preissii</i> Open Heath; <i>Borya scirpoidea</i> Herbland; Mixed Herbland and <i>Meeboldina coangustata</i> Closed Sedgeland</p>

2.3.2.5 Vegetation from surveys conducted in the local area

360 Environmental (2012) statistically delineated fourteen vegetation units during a Level 2 flora and vegetation assessment within the remnant bushland in the North Ellenbrook survey area, 8 km south-west of the Project area (Table 2.12). Of these, two PECs are likely to be represented at this survey site: 'Swan Coastal Plain *Banksia attenuata*-*Banksia menziesii* woodlands' and 'Low lying *Banksia attenuata* woodlands or shrublands' NEQ4, NER8, NEQ14.

Table 2.12: Vegetation recorded at the North Ellenbrook survey area

Code	Description
	Banksia and Pricklybark woodlands on dune crests and slopes
BaBmEt	<i>Banksia attenuata</i> , <i>Banksia menziesii</i> , <i>Eucalyptus tottiana</i> low woodland over <i>Scholtzia involucrata</i> and <i>Beaufortia elegans</i> high shrublands over <i>Eremaea pauciflora</i> var. <i>pauciflora</i> , <i>Astroloma xerophyllum</i> , <i>Croninia kingiana</i> and <i>Leucopogon conostephioides</i> low shrublands.
Et	<i>Eucalyptus tottiana</i> low open woodland over <i>Adenanthos cygnorum</i> var. <i>cygnorum</i> scattered tall shrubs to high open shrubland over <i>Beaufortia elegans</i> , (<i>Verticordia nitens</i>) open heath and <i>Eremaea pauciflora</i> var. <i>pauciflora</i> low open shrubland
	Vegetation on the sandy parts of swales and flats
BaBmBi	<i>Banksia attenuata</i> , <i>Banksia ilicifolia</i> , <i>Banksia menziesii</i> low woodland over <i>Xanthorrhoea preissii</i> , <i>Xanthorrhoea brunonis</i> subsp. <i>brunonis</i> shrubland over <i>Calytrix flavescens</i> , <i>Conostephium pendulum</i> , <i>Adenanthos obovatus</i> , <i>Eremaea pauciflora</i> var. <i>pauciflora</i> low open shrublands over <i>Phlebocarya ciliata</i> , <i>Patersonia occidentalis</i> , <i>Dasyopogon bromeliifolius</i> low herblands.
BeEp	<i>Beaufortia elegans</i> open heath over <i>Eremaea pauciflora</i> var. <i>pauciflora</i> low shrubland.
BiXp	<i>Banksia ilicifolia</i> scattered low trees over <i>Xanthorrhoea preissii</i> shrubland over <i>Eremaea pauciflora</i> var. <i>pauciflora</i> , <i>Melaleuca seriata</i> low shrublands over <i>Lyginia barbata</i> , <i>Alexgeorgea nitens</i> open sedgelands.
Cc	<i>Corymbia calophylla</i> woodland over <i>Xanthorrhoea preissii</i> scattered shrubs to open shrubland.
CcEm	<i>Eucalyptus marginata</i> subsp. <i>marginata</i> , <i>Corymbia calophylla</i> scattered trees over <i>Banksia ilicifolia</i> , <i>Banksia attenuata</i> scattered low trees to low open woodland (patches) over <i>Xanthorrhoea preissii</i> shrublands over <i>Hypocalymma angustifolium</i>

Code	Description
	Banksia and Pricklybark woodlands on dune crests and slopes
	scattered low shrubs to low shrublands over <i>Hypolaena exsulca</i> open sedgeland.
EmBiXp	<i>Eucalyptus marginata</i> subsp. <i>marginata</i> scattered trees over <i>Banksia attenuata</i> , <i>Banksia ilicifolia</i> , <i>Nuytsia floribunda</i> scattered low trees over <i>Xanthorrhoea preissii</i> shrubland over <i>Dielsia stenostachya</i> , * <i>Pentstemon airoides</i> very open grassland/sedgeland.
	Dampland vegetation
Er	<i>Eucalyptus rudis</i> open forest over <i>Xanthorrhoea preissii</i> , <i>Astartea scoparia</i> high open shrubland over <i>Lepidosperma longitudinale</i> , <i>Dielsia stenostachya</i> open sedgeland.
Kg	<i>Kunzea glabrescens</i> closed scrub over <i>Aotus gracillima</i> open shrubland over <i>Schoenus efoliatus</i> , <i>Dielsia stenostachya</i> very open sedgeland.
Mp	<i>Melaleuca preissiana</i> , (<i>Banksia littoralis</i>) low closed forest over <i>Xanthorrhoea preissii</i> open shrubland, <i>Astartea scoparia</i> and <i>Cyathochaeta teretifolia</i> , <i>Dielsia stenostachya</i> , <i>Lepidosperma longitudinale</i> open sedgeland.
MpAs	<i>Melaleuca preissiana</i> low woodland over <i>Astartea scoparia</i> open heath over <i>Hypocalymma angustifolium</i> low open shrubland over <i>Dielsia stenostachya</i> , <i>Cyathochaeta teretifolia</i> sedgeland.
MpPeAs	<i>Melaleuca preissiana</i> low woodland over open shrubland over <i>Pericalymma ellipticum</i> var. <i>ellipticum</i> , <i>Astartea scoparia</i> , <i>Regelia inops</i> , <i>Xanthorrhoea preissii</i> shrublands and <i>Hypocalymma angustifolium</i> low shrublands.
MpRi	<i>Melaleuca preissiana</i> scattered low trees over <i>Regelia inops</i> , (<i>Xanthorrhoea preissii</i>) open to closed heath.

Emerge Associates (2013) delineated eight vegetation communities during a Level 2 flora and vegetation assessment at the Great Northern Highway survey area, 10 km north of the Project area (Table 2.13). Of these, BaBm is likely to represent the PEC 'Low lying *Banksia attenuata* woodlands or shrublands'

Table 2.13: Vegetation recorded at the Great Northern Highway survey area

Code	Description
	Banksia and Pricklybark woodlands on dune crests and slopes
BaBm	Open woodland of <i>Eucalyptus tottiana</i> , <i>Banksia attenuata</i> and <i>Banksia menziesii</i> over low open shrubland of <i>Eremaea pauciflora</i> var. <i>calyptra</i> , <i>Xanthorrhoea preissii</i> over open tussock grassland of * <i>Ehrharta calycina</i> with <i>Dasypogon bromeliifolius</i> on grey sands.
MpJp	Open woodland of <i>Melaleuca preissiana</i> over open sedgeland of <i>Juncus pallidus</i> over grassland of * <i>Cynodon dactylon</i> in saturated black loams with free-standing water at the surface.
MoJp	Tall open shrubland of <i>Melaleuca osullivanii</i> over open sedgeland of <i>Juncus pallidus</i> over closed forbland of * <i>Cotula coronopifolia</i> , * <i>Briza maxima</i> and * <i>Lotus subbiflorus</i> in saturated black loams.
Rehab	Rehab: Revegetated areas of mixed native and introduced <i>Eucalyptus</i> and <i>Melaleuca</i> species.
MpJa	Woodland of <i>Melaleuca preissiana</i> over sedgeland of * <i>Juncus acutus</i> subsp. <i>acutus</i> over grassland of * <i>Cynodon dactylon</i> in saturated black loams.
MpPg	Woodland of <i>Melaleuca preissiana</i> over mixed pasture grasses.
Pasture	Cleared pastures with isolated paddock trees.
MoCp	Tall shrubland of <i>Melaleuca osullivanii</i> over sparse rushland of <i>Dielsia stenostachya</i> over forbland of * <i>Cotula coronopifolia</i> , <i>Angianthus preissianus</i> and * <i>Hordeum hystris</i> in damp grey/black sands.

Chittering Landcare Centre (2008) conducted a foreshore, flora and fauna assessment at three locations within the Lower Ellenbrook Catchment. Of these, Bingham Road is 2 km west, Muchea North Drain is 8 km north and Brand Highway is 11 km north of the Project area. The following was recorded:

- Brand Highway: *Melaleuca viminea* open low forest, over various weed species. This was categorised as in C3 condition with a high grazing levels, high levels of erosion, no understorey, evidence of a salt scald and tree death.
- Bingham Road: *Eucalyptus rudis* and/or *Acacia saligna* open low woodland. This was categorised as in C1 condition where the foreshore supports remnant trees over pasture or weeds.
- Muchea North Drain: *Melaleuca raphiophylla* scattered low trees, over pasture or weeds. This was categorised as in C1 condition where the foreshore supports healthy perennial vegetation, over a high weed infestation.

2.3.2.6 TECS/PECS

Five EPBC Act and two WC Act-listed TECs occur within 10 km of the Project area (Figure 2.7, Table 2.14). Of these, three have buffers that intersect the Project area, however the boundaries of the TECs themselves do not occur within. On the basis of this desktop information and the criteria listed in Table 1.2 (see Table 2.14), two TECs were considered to have a 'High' likelihood of occurrence within the Project area based. However following analysis of the field data, only one of these TECs is potentially present in the study area (see Section 5.2 for discussion of possible TEC presence in the Bush Forever block in the Project area, to the north of the study area).

Four PECs occur within 10 km of the Project area (Figure 2.7, Table 2.14) of which none occur within. Three PECs have been given a 'Moderate' likelihood of occurrence within the Project area based on the criteria listed in Table 1.2.

Table 2.14: TECs and PECs occurring within 10 km of the Project area

Status	FCT	Name		Location	Likelihood of occurrence
TEC - EPBC Act					
Endangered (WC Act - CR)	Mounds Springs	Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)		4 km north-west of Project area	Low – no likely habitat
Endangered (WC Act - EN)	Muchea limestone	Shrublands and woodlands on Muchea Limestone		Buffer intersects west of Project area	Low – no likely habitat
Endangered (WC Act - CR)	SCP3a	<i>Corymbia calophylla</i> – <i>Kingia australis</i> woodlands on heavy soils, Swan Coastal Plain – See Section 5.2		Buffer intersects north of Project area	High – possible habitat in the northern section of the Project area (outside of Development area), close proximity
Endangered (WC Act - CR)	SCP3c	<i>Corymbia calophylla</i> – <i>Xanthorrhoea preissii</i> woodlands and shrublands, Swan Coastal Plain – See Section 5.2		Buffer intersects west of Project area	High – possible habitat in the northern section of the Project area (outside of Development area), close proximity
Critically endangered (WC Act - VU)	SCP07	Claypans of the Swan Coastal Plain, includes:	Herb rich saline shrubland in clay pans	4 km north-west of Project area	Low – no likely habitat
	SCP08		Herb rich shrublands in clay pans	Immediately west of Project area	Low – no likely habitat
TEC - WC Act					
Vulnerable	SCP15	Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain		1.6 km south-west of Project area	Low – no likely habitat
Vulnerable	SCP18	Shrublands on calcareous silts of the Swan Coastal Plain		7 km south-west of Project area	Low – no likely habitat
PECs					
Priority 3	SCP22	<i>Banksia ilicifolia</i> woodlands, Southern Swan Coastal Plain		8 km south-west of Project area	Moderate – habitat not well defined, records within 20 km
Priority 3	SCP21c	Low lying <i>Banksia attenuata</i> woodlands or shrublands		5 km south-west of Project area	Low – no likely habitat
Priority 3	SCP25	Southern <i>Eucalyptus gomphocephala</i> - <i>Agonis flexuosa</i> woodlands		10 km north-west of Project area	Moderate – habitat not well defined, records within 20 km
Priority 3	SCP23b	Swan Coastal Plain <i>Banksia attenuata</i> – <i>Banksia menziesii</i> woodlands		7 km south-west of Project area	Moderate – habitat not well defined, records within 20 km

Note: CR = Critically Endangered, EN = Endangered, VU = Vulnerable listing under the WC Act.

399000

406000

413000

SHIRE OF CHITTERING

MUCHEA

BULLSBROOK

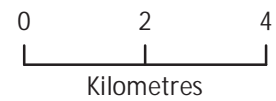
CITY OF SWAN

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Legend

- Project Area
- Study Area
- Development Area
- Roads
- Railway
- Waterway
- DPaW Managed Lands
- TEC - EPBC Act**
- Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)
- Shrublands and woodlands on Muchea Limestone
- Eucalyptus calophylla* - *Kingia australis* woodlands on heavy soils, Swan Coastal Plain
- Eucalyptus calophylla* - *Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain
- Herb rich saline shrublands in clay pans
- Herb rich shrublands in clay pans
- TEC - WC Act**
- Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain
- Shrublands on calcareous silts of the Swan Coastal Plain
- PEC**
- Banksia ilicifolia* woodlands
- Low lying *Banksia attenuata* woodlands or shrublands
- Southern *Eucalyptus gomphocephala* - *Agonis flexuosa* woodlands
- Swan Coastal Plain *Banksia attenuata* - *Banksia menziesii* woodlands



Absolute Scale - 1:125,000



TECs & PECs recorded within 10 km of the project area

Figure: 2.7
Project ID: 1621

Drawn: MY
Date: 29/06/2016

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

3 METHODOLOGY

This flora and vegetation assessment was carried out in accordance with EPA Guidance for a Level 2 flora and vegetation survey and encompassed both a pre-field desktop assessment and a two phase field survey of the 439 ha study area (i.e. excluding the Bush Forever site, comprising the other 43 ha in the north of the 482 ha Project area). While the remnant vegetation present in the east of the study area was sampled as part of this assessment, effort was focused on the cleared areas in the west of the study area which are primary area that are proposed for future development.

3.1 FIELD SURVEY

3.1.1 Survey Timing

A two-phase, Level 2 flora and vegetation assessment was conducted in the study area. The initial (Spring) phase was conducted on 24 October 2014, and the second (Autumn) phase was conducted from 16 to 17 May 2016. A survey effort equivalent to four person days was expended undertaking the surveys.

3.1.2 Weather Preceding the Survey

Rainfall data are available from the RAAF Bureau of Meteorology (BoM) station 9053, directly adjacent to the study area from 1937 to 2016 (Figure 3.1) (BoM 2016). Rainfall for three months prior to the field surveys is discussed below:

- Phase 1: 246.9 mm was recorded in July to September, 60.4 mm less mm than the long-term average of 307.3 mm for the same period; and
- Phase 2: 171 mm was recorded in February to April, 107.2 mm more than the long-term average of 63.8 mm for the same period.

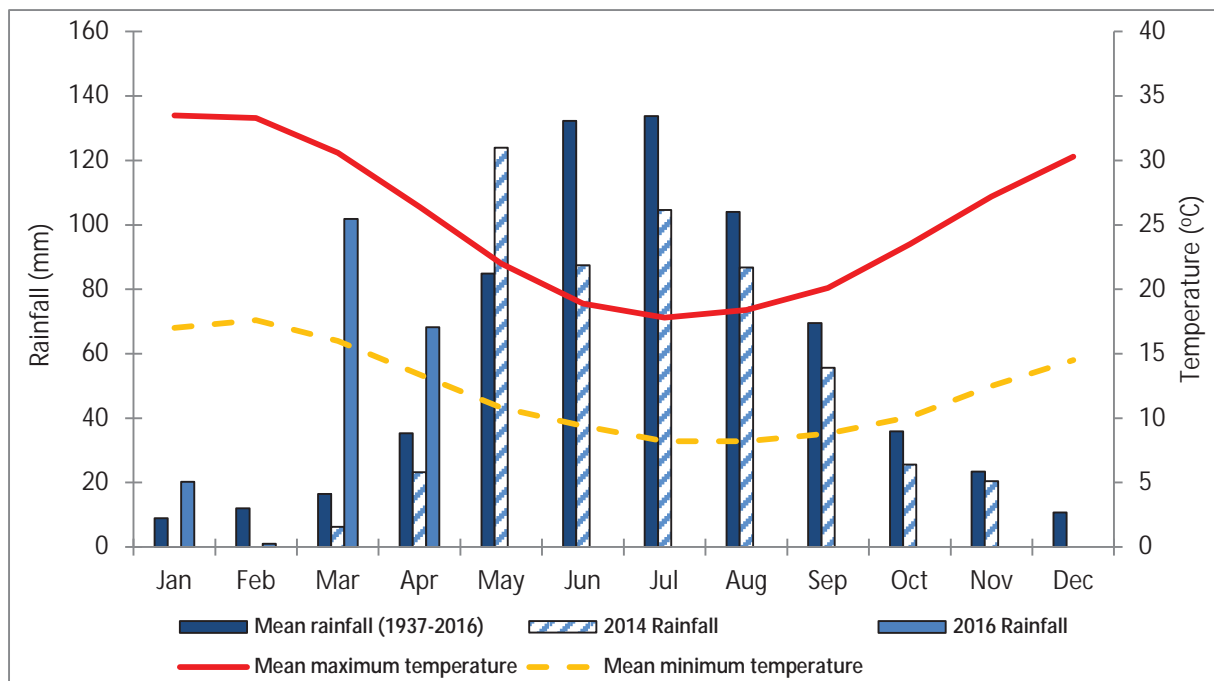


Figure 3.1: Climate data at Pearce RAAF BoM station (1937-2016)

3.1.3 Survey Techniques and Intensity

The survey was conducted using a combination of quadrats/relevés and traverses to delineate the vegetation units present, provide a floristic inventory and target significant flora, vegetation and introduced flora. Quadrat, releve and traverse locations were selected using a combination of aerial

photography, topographic features, land systems and field observations in order to ensure capture of the diversity of vegetation and habitats present.

3.1.3.1 Quadrats and Relevés

Quadrats were sampled in vegetation that was in '4 - Good' or better condition, and relevés were sampled when vegetation was in a '6 – Degraded or Poor' or '7 – Completely Degraded' condition.

A total of six quadrats (10 m x 10 m) and 27 relevés were established and sampled within the study area, six relevés of which were sampled during both phases. Site information for each quadrat and relevé is presented in Appendix C and they are mapped on Figure 3.2.

The following parameters were recorded at each quadrat:

- All observed flora species and the average height, percentage cover (using the ranges cited by NVIS) and observable presence/absence of fruit/flowers for each;
- Vegetation structure (National Vegetation Information System (NVIS) Level V);
- Vegetation condition scale (Trudgen 1991), which is based on the criteria in Table XX;
- Estimated time since fire;
- GPS co-ordinates of all corners;
- Panorama digital photograph of the vegetation, taken from the north-west corner facing south-east;
- The landform element (morphological type, position and element type);
- The presence of rock outcrops (type and abundance);
- Soil type (colour, profile, field texture and surface type); and
- Slope and aspect.

Relevés also have the aforementioned data collected, however only the dominant flora species are recorded in a non-bounded, representative, 10 m x 10 m area.

3.1.3.2 Traverses

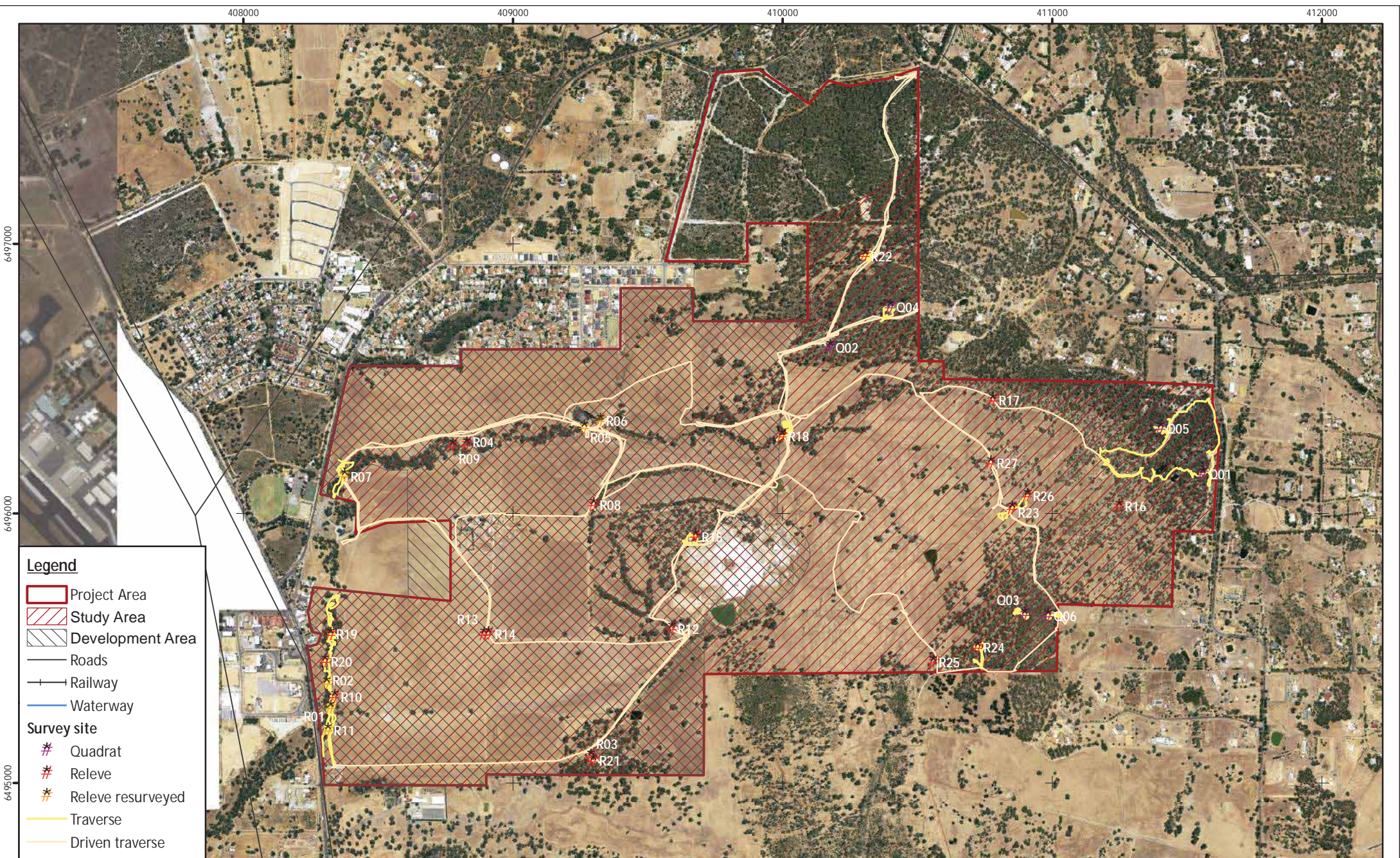
Traverses were conducted at the study area to allow a series of opportunistic observations to be recorded on the flora and vegetation of the study area. Parameters recorded during a traverse can include:

- A GPS track log, which includes the location and date of the traverse;
- Any significant or introduced flora taxa encountered, with an estimated number of plants;
- Any flora taxa encountered that have not yet been recorded within survey sites with an estimated number of plants;
- Notes on vegetation units: including extent, changes in dominant species etc.;
- Notes on vegetation condition: based on the criteria described by Trudgen (1991), shown in Appendix A, including condition rating and disturbance types; and
- Notes on fire history: including extent, fire age and intensity.

Driving traverses were also conducted and larger, more noticeable introduced flora species and significant flora were recorded. Traverses are mapped on Figure 3.2.

3.1.3.3 Targeted Significant Flora and Vegetation Traverses

Significant flora and vegetation identified during the literature review as potentially occurring were targeted by conducting traverses in habitats that have the potential to support them and in areas where they have previously been recorded. Additionally, habitats with intermittent and restricted distributions were searched during the survey and included the creek line and the steep western facing scarp.

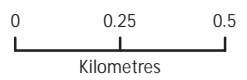


Legend

- Project Area
- Study Area
- Development Area
- Roads
- + Railway
- Waterway

Survey site

- Quadrat
- Relieve
- Relieve resurveyed
- Traverse
- Driven traverse



Absolute Scale - 1:18,000



Flora quadrats, relieves and traverses surveyed at the study area

Figure: 3.2
Project ID: 1621

Drawn: MY
Date: 29/06/2016

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

3.1.3.4 Wetland Assessment

An assessment was conducted detailing the spatial extent and characteristics of the wetlands at the study area, in particular the Conservation Category wetland section of the Ki-it Monger Brook. Three relevés were sampled within the Conservation Category section, three were sampled in the Multiple Use section and seven were sampled in areas along the Ki-it Monger Brook that have not been classified.

Notes were taken on key wetland characteristics including vegetation structure, floristic composition, soil type, soil moisture and topography to determine the attributes and functions of the wetland.

3.2 DATA INTERPRETATION AND ANALYSIS

3.2.1 Vegetation Mapping

Vegetation mapping is the delineation of plant communities or vegetation units based on distinctive characteristics that these communities share, such as the vegetation structure, dominant species and species composition. A combination of aerial photography, the vegetation unit grouping during statistical analysis (Section 3.2.1.1) and ground truthing was used to interpret the vegetation patterns of the study area and allow for the vegetation mapping.

Vegetation is described based on the National Vegetation Information System (NVIS) methodology (ESCAVI 2003), and is described to one hierarchical level (known as vegetation units):

- Broad floristic formation level (Level III) where the dominant growth form, crown cover, height and dominant land cover genus are described for the upper or most ecologically or structurally dominant stratum.

3.2.1.1 Statistical Analysis

Statistical analysis provides an objective means of defining vegetation units and provides insight into the hierarchical relationship between communities based on the degree of similarity in species composition and abundance.

Multivariate analysis was conducted using the site by species matrix data collected from the six quadrats and 27 relevés that were sampled during the field survey. In order to best align the vegetation analysis, the data from the species by site matrix was treated in that:

- Data was transformed to cover weighted;
- Taxa were removed from the data or grouped together if they could not be confidently identified to a consistent taxonomic level and there was a possibility of confusion with other similar taxa; and
- Annual taxa were removed.

This site by species matrix was then used to perform a cluster analysis to produce a dendrogram of dissimilarity between the quadrats. Cluster analysis was performed on the cover weighted site by species matrix using an association matrix of the Bray-Curtis coefficient with the multivariate program PATN™. The resultant dendrogram was used in the definition of hierarchy of vegetation assemblages. The site by species matrix used for the analysis is provided in Appendix D.

3.2.2 Taxonomy

Nomenclature of the species recorded follow the protocols of the West Australian Herbarium (Western Australian Herbarium 1998-2015).

3.3 PROJECT TEAM

The flora and vegetation assessment described in this document was planned, coordinated and executed under the licences and by those summarised in Table 3.1.

Table 3.1: Project team and licences

Project Staff Name	Qualification	Role	Project role
Shaun Grein	B.Sc, Grad.Dip. Nat. Resources, MBA	Managing Director/Principal Environmental Scientist	Reporting, QA
Matthew Macdonald	PhD	Principal Ecologist	Quality control
Melissa Hay	Bsc (Hons)	Senior botanist	Field survey phase 2, reporting
Gaby Martinez	Bsc (Hons)	Ecologist	Field survey phase 1
Udani Sirisena	PhD	Botanist/taxonomist	Field survey phase 1, plant identifications
Andrew Craigie	PhD	Botanist/taxonomist	Plant identifications
Licences			
The flora and vegetation assessment described in this report was conducted under the authorisation of the following licences issued by DPaW:			
Name	Licence Number	Licence	
Udani Sirisena	SL 010 543	Licence to collect flora for scientific purposes	
Gaby Martinez	SL 010 974	Licence to collect flora for scientific purposes	
Melissa Hay	SL 011 068	Licence to collect flora for scientific purposes	

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4 RESULTS

4.1 FLORA

A total of 102 vascular plant taxa were recorded from the study area. Of these 44 (43.1%) were native and 58 (56.9%) were introduced. The composition of the flora of the study area is summarised in Table 4.1. A complete list of taxa recorded is included in Appendix E.

Table 4.1: Floristic information at the study area

Native or Introduced	Number of taxa recorded	Number annuals	Number of families	Number of genera	Number of families represented by a single taxon	Number of genera represented by a single taxon
Native	52	1	28	38	18	30
Introduced	59	36	25	46	18	35
Total	111	37	48	83	33	64

The families and genera represented by the greatest number of taxa, and the most frequently recorded species at the study area are listed in Table 4.2. The most species-rich native families were Fabaceae, Protoaceae and Myrtaceae, and *Hakea* and *Styloidium* were the most species-rich genera.

Table 4.2: Most commonly recorded families, genera and taxa

Native or Introduced	Most taxa per family	Most taxa per genus	Most frequently recorded taxa
Native	Fabaceae (9 taxa) Protoaceae (4 taxa) Myrtaceae (4 taxa)	<i>Acacia</i> (5 taxa) <i>Lepidosperma</i> , <i>Styloidium</i> (2 taxa)	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> (19 records) <i>Eucalyptus wandoo</i> subsp. <i>wandoo</i> (14 records)
Introduced	Poaceae (19 taxa) Fabaceae (6 taxa) Asteraceae (6 taxa)	<i>Oxalis</i> , <i>Trifolium</i> (3 taxa) <i>Sonchous</i> , <i>Cyperus</i> , <i>Cenchrus</i> , <i>Avena</i> , <i>Ehrharta</i> , <i>Briza</i> , <i>Vulpia</i> , <i>Bromus</i> , <i>Solanum</i> (2 taxa)	* <i>Avena barbata</i> (28 records) * <i>Gomphocarpus fruticosus</i> (21 records)
Combined	Poaceae (21 taxa) Fabaceae (15 taxa) Asteraceae (6 taxa)	<i>Acacia</i> (6 taxa) <i>Oxalis</i> , <i>Lepidosperma</i> , <i>Styloidium</i> , <i>Hakea</i> , <i>Trifolium</i> (3 taxa)	* <i>Avena barbata</i> (28 records) * <i>Gomphocarpus fruticosus</i> (21 records)

4.1.1 Flora of Conservation Significance

No EPBC Act or WC Act-listed Threatened Flora, Priority flora or other flora of conservation significance were recorded within the study area.

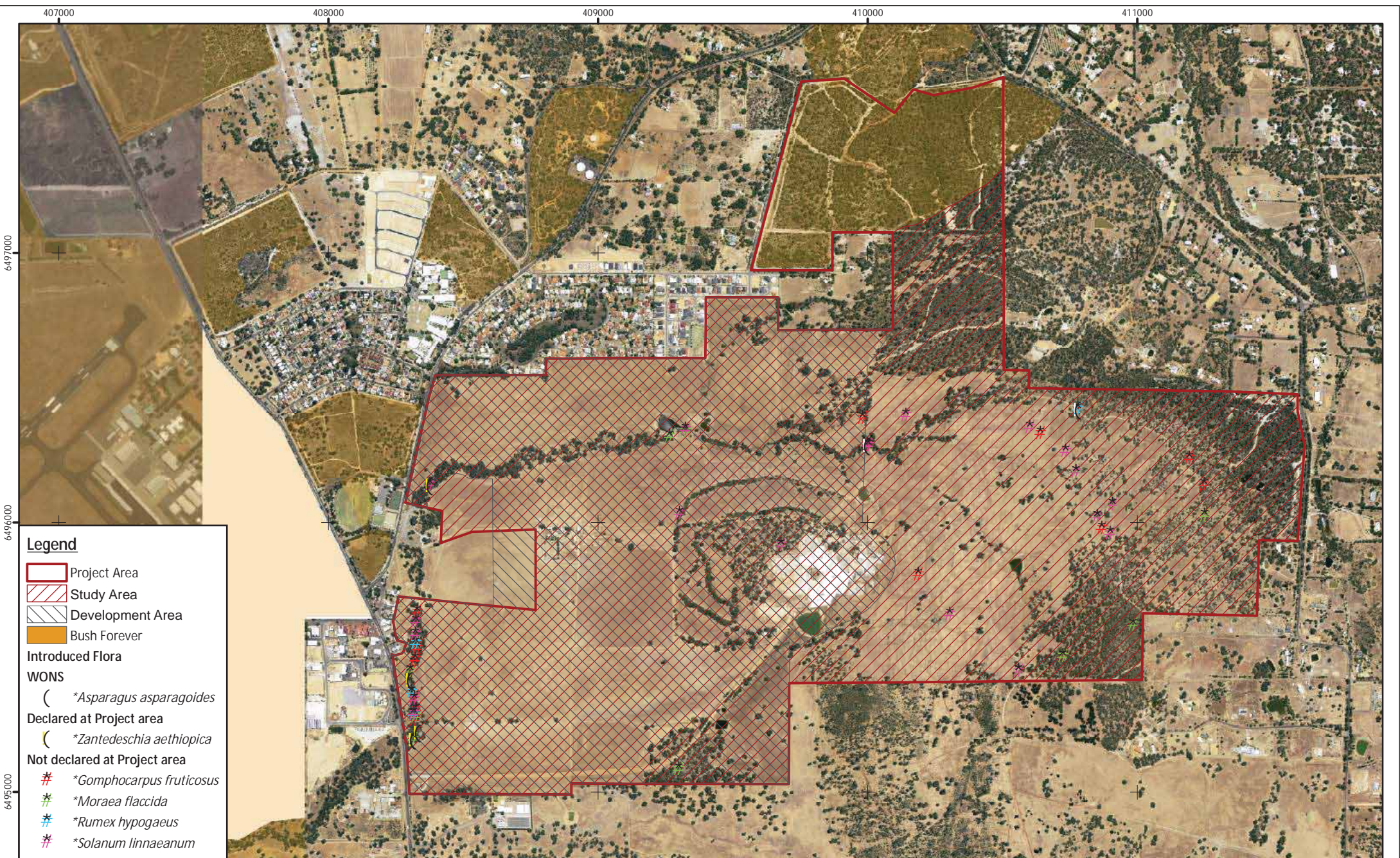
4.1.2 Introduced Flora

Introduced species made up the dominant component of the species of the study area with 56.9% of all taxa recorded introduced. Sixty introduced flora species were recorded in the study area. Of these taxa, one was a WONS, one was a Declared Pest at the study area, four are Declared Pests but not for the area and the remaining 54 were environmental weeds. The weeds recorded in the study area are listed in Table 4.3, coordinates provided in Appendix F and they are mapped in Figure 4.1 to Figure 4.3.

Table 4.3: Introduced flora recorded from the study area

Taxon	Number of locations		# of plants
	Phase 1	Phase 2	
WONS			
* <i>Asparagus asparagoides</i>	-	2	2
Declared - at the Project area			
* <i>Zantedeschia aethiopica</i>	2	4	5
Declared – not at the Project area			
* <i>Gomphocarpus fruticosus</i>	2	21	95
* <i>Moraea flaccida</i>	3	16	196
* <i>Rumex hypogaeus</i>	-	4	8
* <i>Solanum linnaeanum</i>	2	17	886
Environmental			
* <i>Acacia ?baileyana</i>	-	1	4
* <i>Acacia podalyriifolia</i>	-	1	5
* <i>Arctotheca calendula</i>	5	11	89
* <i>Avena barbata</i>	13	21	17,294
* <i>Avena fatua</i>	2	-	110

Taxon	Number of locations		# of plants
	Phase 1	Phase 2	
* <i>Babiana angustifolia</i>	1	-	3
* <i>Bougainvillea glabra</i>	-	1	1
* <i>Briza maxima</i>	9	-	241
* <i>Briza minor</i>	5	-	23
* <i>Bromus diandrus</i>	8	-	830
* <i>Bromus hordeaceus</i>	4	-	152
* <i>Cenchrus clandestinus</i>	1	-	1
* <i>Cenchrus setaceus</i>	-	1	5
* <i>Cynodon dactylon</i>	-	9	416
* <i>Cyperus involucratus</i>	-	2	7
* <i>Cyperus tenuiflorus</i>	-	1	1
* <i>Digitaria ciliaris</i>	-	1	20
* <i>Ehrharta calycina</i>	1	-	500
* <i>Ehrharta longiflora</i>	2	-	11
* <i>Eragrostis curvula</i>	-	2	25
* <i>Erodium botrys</i>	-	1	100
* <i>Fumaria capreolata</i>	1	-	5
* <i>Hesperantha falcata</i>	5	-	18
* <i>Hordeum leporinum</i>	8	-	300
* <i>Hypochaeris glabra</i>	2	1	2
* <i>Lolium rigidum</i>	9	9	582
* <i>Lotus angustissimus</i>	2	-	25
* <i>Lupinus cosentinii</i>	4	3	65
* <i>Lysimachia arvensis</i>	2	3	27
* <i>Melia azedarach</i>	-	1	1
* <i>Monoculus monstrosus</i>	1	-	1
* <i>Olea europaea</i> subsp. <i>europaea</i>	-	1	1
* <i>Orobanche minor</i>	1	-	5
* <i>Oxalis corniculata</i>	-	8	53
* <i>Oxalis pes-caprae</i>	6	10	200
* <i>Oxalis purpurea</i>	-	10	61
* <i>Pentameris airoides</i>	2	1	120
* <i>Raphanus raphanistrum</i>	2	5	24
* <i>Ricinus communis</i>	-	1	5
* <i>Schinus molle</i>	-	1	2
* <i>Solanum nigrum</i>	-	4	18
* <i>Sonchus asper</i>	1	-	1
* <i>Sonchus oleraceus</i>	2	4	15
* <i>Stachys arvensis</i>	1	4	9
* <i>Trachyandra divaricata</i>	2	-	2
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	6	1	38
* <i>Trifolium arvense</i> var. <i>arvense</i>	1	-	1
* <i>Trifolium campestre</i> var. <i>campestre</i>	5	-	5
* <i>Triticum aestivum</i>	2	-	1,001
* <i>Tropaeolum majus</i>	-	1	1,000
* <i>Typha ?orientalis</i>	-	1	100
* <i>Ursinia anthemoides</i>	2	-	2
* <i>Vulpia bromoides</i>	1	-	10
* <i>Vulpia myuros</i>	2	-	11



Legend

- Project Area
- Study Area
- Development Area
- Bush Forever

Introduced Flora

WONS

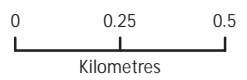
- (**Asparagus asparagoides*

Declared at Project area

- (**Zantedeschia aethiopic*

Not declared at Project area

- # **Gomphocarpus fruticosus*
- * **Moraea flaccida*
- * **Rumex hypogaeus*
- * **Solanum linnaeanum*



Absolute Scale - 1:18,000



Introduced flora - WONS and Declared Plants recorded

Figure: 4.1
Project ID: 1621

Drawn: MY
Date: 29/06/2016

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

408000

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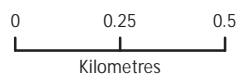
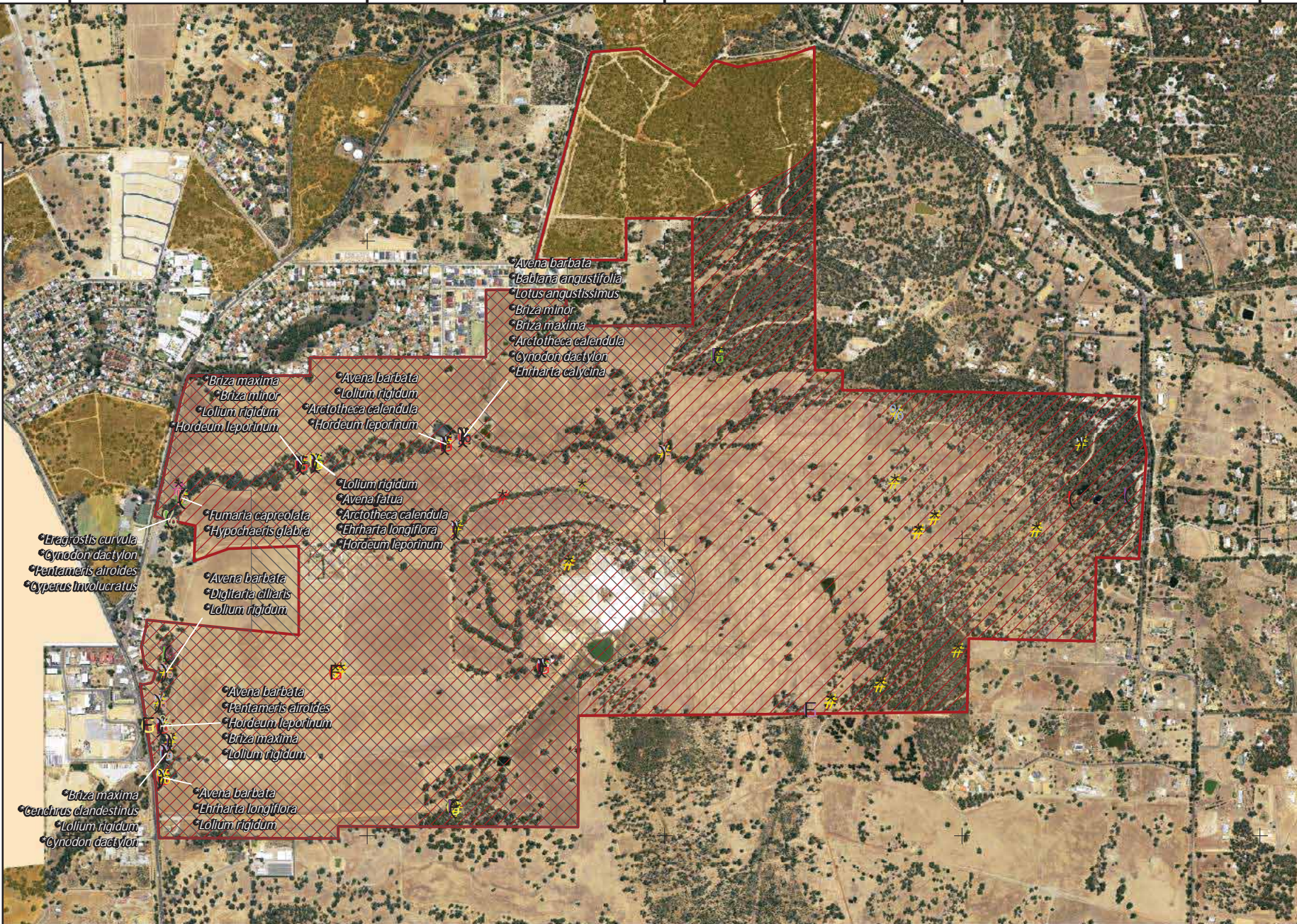
6495000

Legend

- Project Area
- Study Area
- Development Area
- Bush Forever

Environmental weeds

- ✠ **Acacia ?baileyana*
- ✠ **Acacia podalyriifolia*
- ✠ **Arctotheca calendula*
- ✠ **Avena barbata*
- ✠ **Avena fatua*
- ✠ **Babiana angustifolia*
- ✠ **Bougainvillea glabra*
- B **Briza maxima*
- F **Briza minor*
- B **Bromus diandrus*
- F **Bromus hordeaceus*
- B **Cenchrus clandestinus*
- B **Cenchrus setaceus*
- % **Cynodon dactylon*
- % **Cyperus involucratus*
- % **Cyperus tenuiflorus*
- % **Digitaria ciliaris*
- % **Ehrharta calycina*
- % **Ehrharta longiflora*
- (**Eragrostis curvula*
- (**Erodium botrys*
- (**Fumaria capreolata*
- (**Hesperantha falcata*
- (**Hordeum leporinum*
- (**Hypochaeris glabra*
-) **Lolium rigidum*
-) **Lotus angustissimus*



Absolute Scale - 1:18,000



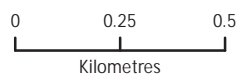
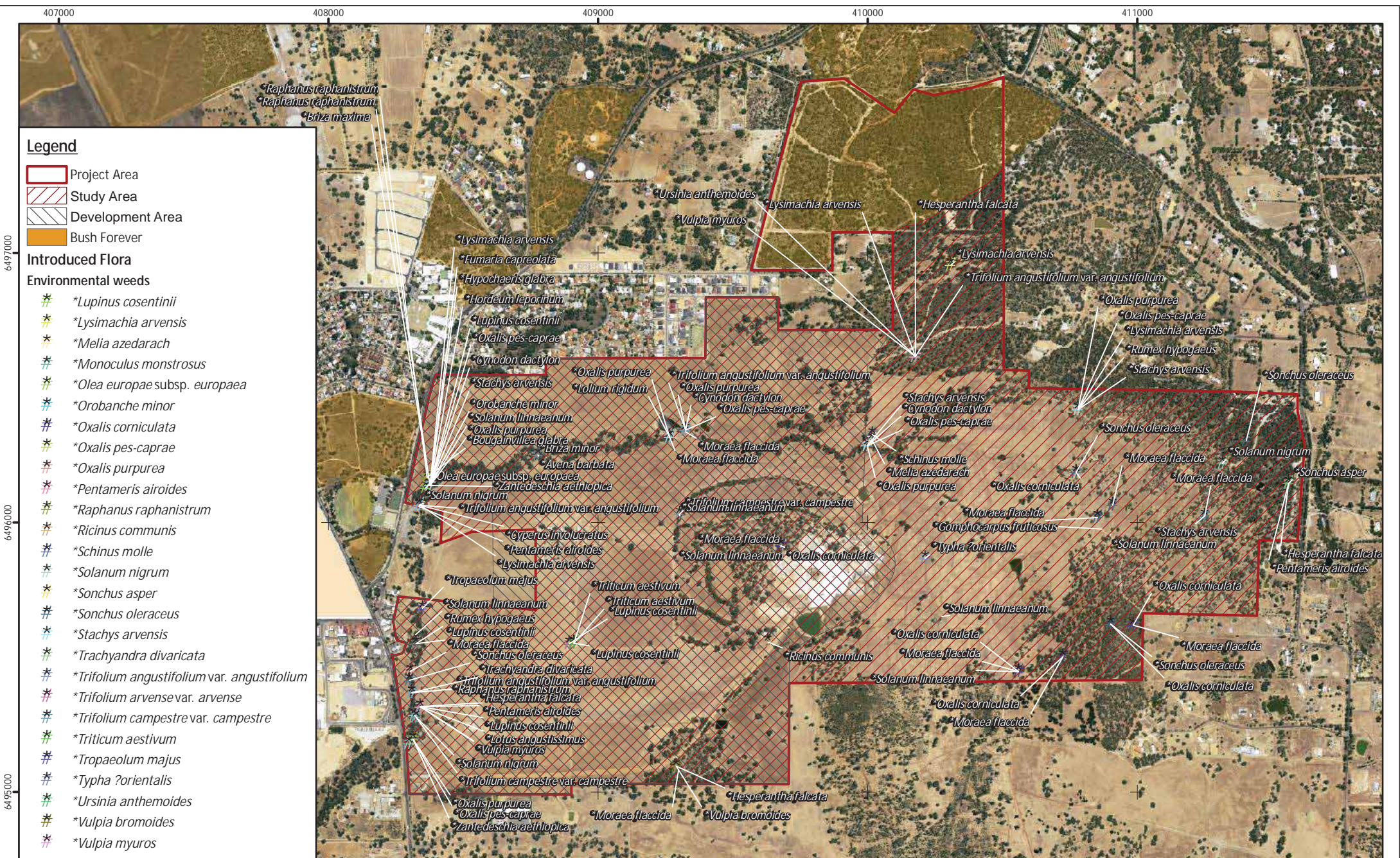
Introduced flora - Environmental weeds Map A

Due to the the large number of weed taxa recorded relative to the scale of this map, this is indicative only. For the definitive point dataset of environmental weed locations, refer to Appendix F.

Figure: 4.2
Project ID: 1621

Drawn: MY
Date: 29/06/2016

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994



Absolute Scale - 1:18,000



Introduced flora - Environmental weeds Map B

Due to the the large number of weed taxa recorded relative to the scale of this map, this is indicative only. For the definitive point dataset of environmental weed locations, refer to Appendix F.

Figure: 4.3
Project ID: 1621

Drawn: MY
Date: 29/06/2016

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

4.2 VEGETATION

Seven vegetation units were mapped from the study area, of which five occur within the Development area. These are described in Table 4.4, and include associated species and landforms, survey sites, mean species richness and condition. The dendrogram used to delineate the units, which also includes quadrats and relevés representing additional vegetation units outside of the Development area, is shown in Figure 4.4 and mapping is provided in Figure 4.5.

Five vegetation units were associated with the agricultural land use:

- Ab (Mixed weed species). Recorded in the areas which have been cleared for agriculture on the flats and lower hill slopes and mapped as 213.36 ha or 85.42% of the Development area (NB: this vegetation unit is not represented in the dendrogram, as the relevés only contained annual species).
- CcAp (*Corymbia calophylla* low woodland, over +/-*Acacia pulchella* sparse low shrubland, over mixed weed species). Recorded on the hill tops and mid slopes which have not been completely cleared and mapped as 20.3 ha or 8.12% of the Development area.
- Er1 (*Eucalyptus rudis* subsp. *rudis* low open forest, over mixed weed species). Was recorded along the Kit-Monger Brook and the drainage valley slopes in between the hills to the east of the Project area and was mapped as 11.7 ha or 4.69% of the Development area.
- Er2 (*Eucalyptus rudis* subsp. *rudis* low open forest, over mixed weed species). Was recorded as the strip of trees planted for stabilisation, rather than along the creekline and was therefore separated from Er1 and mapped as 4.24 ha or 1.7% of the Project area.
- EwCc (+/-*Eucalyptus wandoo* subsp. *wandoo* and *Corymbia calophylla* open low woodland, over isolated **Solanum linnaeanum* mid shrubs, over mixed weed species). Recorded on the mostly cleared hill slopes towards the east of the Project area and was not mapped within the Development area.

Two units were associated with remnant vegetation:

- EwGs (*Eucalyptus wandoo* subsp. *wandoo* open forest, over *Gastrolobium spinosum* and *Xanthorrhoea preissii* mid open shrubland, over isolated mixed low shrubs). Recorded along the steep escarpment and valley walls this unit was mapped from the central and northern portions of the Project area, though it was not mapped within the Development area.
- CcGsBe (*Corymbia calophylla* and *Eucalyptus wandoo* subsp. *wandoo* low woodland, over *Gastrolobium spinosum*, *Acacia pulchella* and *Hypocalymma angustifolium* sparse to open mid shrubland, over *Bossiaea eriocarpa* sparse low shrubland). Recorded on the hill tops and gentle mid and foot slopes of the Darling plateau with 0.21 ha or 0.08% mapped as occurring within the Development area.

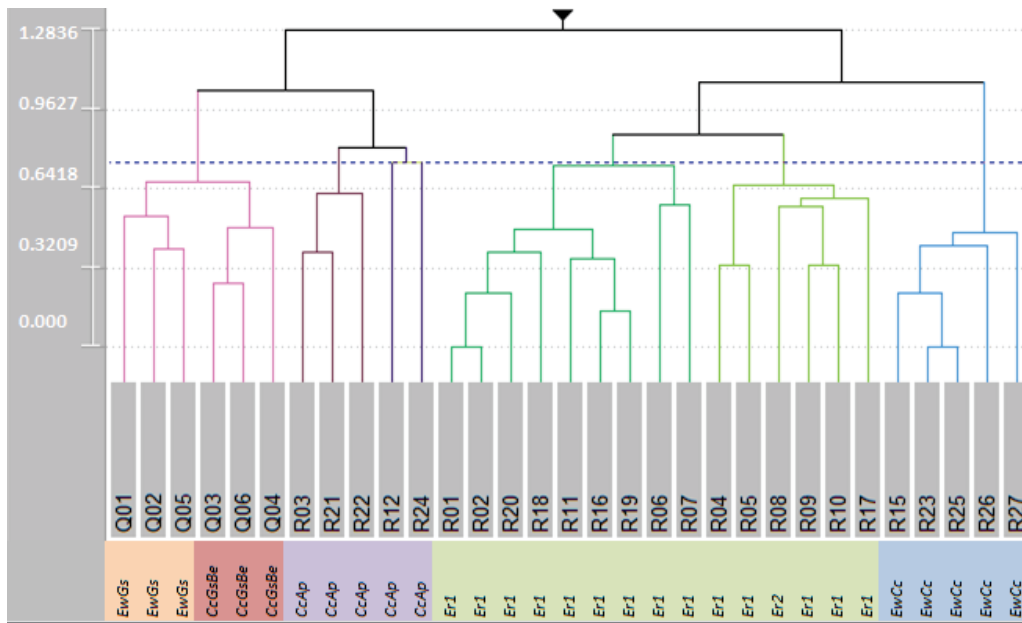







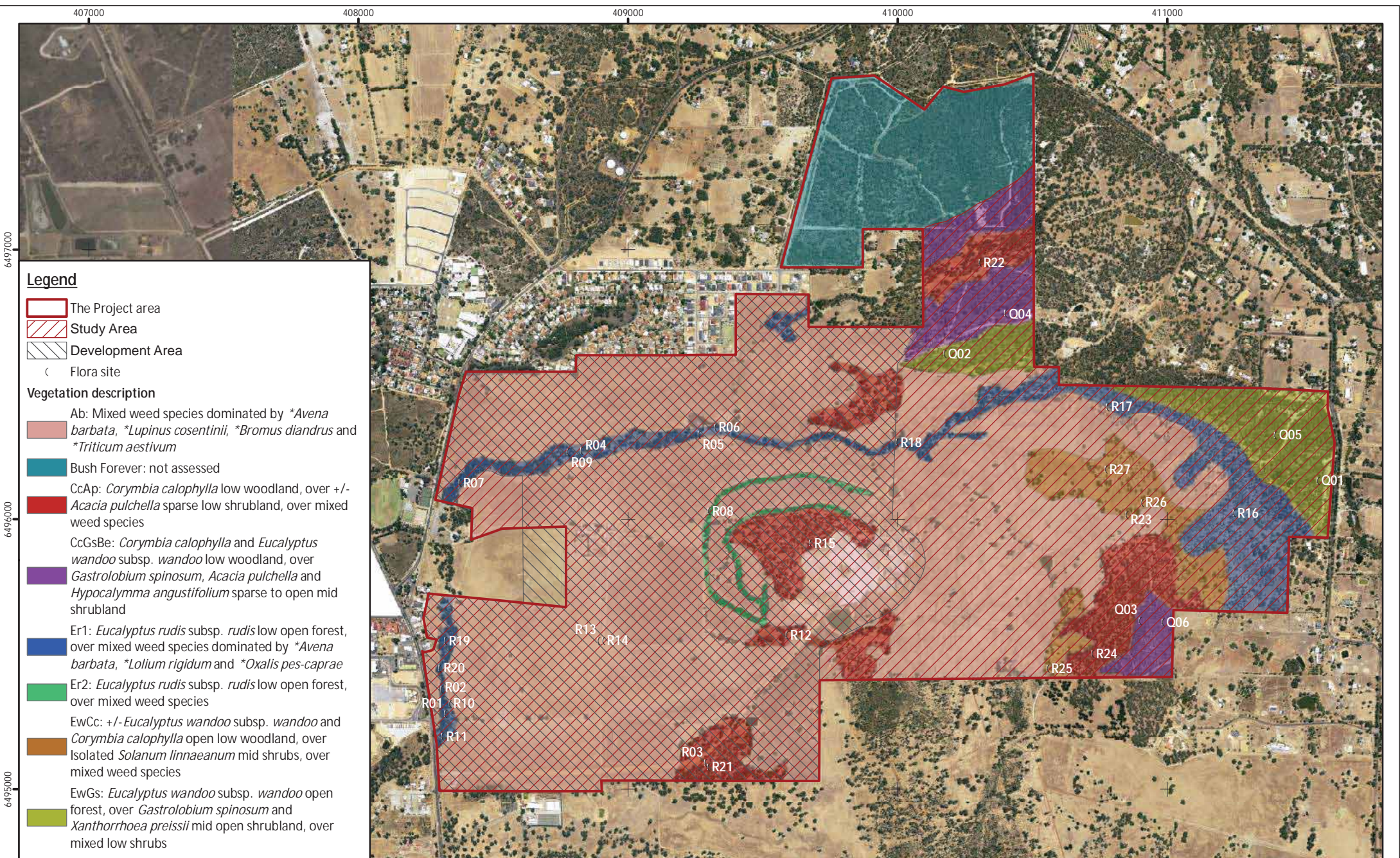
Figure 4.4: Dendrogram of vegetation units recorded

Table 4.4: Vegetation units mapped from the study area

Unit	Description (NVIS Level VI)	Associated species	Area in study area, landform, sites and floristic details	Photograph
EwGs	<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i> open forest, over <i>Gastrolobium spinosum</i> and <i>Xanthorrhoea preissii</i> mid open shrubland, over mixed low shrubs.	<p>*<i>Avena barbata</i> <i>Burchardia congesta</i> <i>Hakea lissocarpa</i> *<i>Hesperantha falcata</i> <i>Hibbertia hypericoides</i> subsp. <i>hypericoides</i> <i>Hypocalymma angustifolium</i> <i>Neurachne alopecuroidea</i> <i>Thomasia foliosa</i> *<i>Ursinia anthemoides</i></p>	<p>Landform: Steep west or south-west facing scarp and valley edges brown-grey loamy sand, no or few lateritic rocks. Area: 24.5 ha of Project area Sites: Q01, Q02, Q05 Mean total species richness: 16.0 ± 4.0 Mean perennial species richness: 12.3 ± 3.1 Mean weed species richness: 4.7 ± 2.5 Average condition: 2-Excellent</p>	
CcGsBe	<i>Corymbia calophylla</i> and <i>Eucalyptus wandoo</i> subsp. <i>wandoo</i> low woodland, over <i>Gastrolobium spinosum</i> , <i>Acacia pulchella</i> and <i>Hypocalymma angustifolium</i> sparse to open mid shrubland, over <i>Bossiaea eriocarpa</i> sparse low shrubland.	<p><i>Burchardia congesta</i> <i>Hakea lissocarpa</i> <i>Hibbertia commutata</i> <i>Lepidosperma leptostachyum</i> <i>Macrozamia riedlei</i> <i>Phyllanthus calycinus</i> <i>Trymalium odoratissimum</i> subsp. <i>odoratissimum</i> <i>Thysanotus patersonii</i> <i>Xanthorrhoea preissii</i></p>	<p>Landform: Flat hill top, gentle mid slopes, brown-grey loamy sand, common lateritic rocks. Area: 0.21 ha (0.08%) of Development area Sites: Q03, Q04, Q06 Mean total species richness: 18.3 ± 2.5 Mean perennial species richness: 17.0 ± 1.7 Mean weed species richness: 1.7 ± 1.5 Average condition: 2-Excellent</p>	

Unit	Description (NVIS Level VI)	Associated species	Area in study area, landform, sites and floristic details	Photograph
CcAp	<p><i>Corymbia calophylla</i> low woodland, over +/- <i>Acacia pulchella</i> sparse low shrubland, over mixed weed species dominated by *<i>Avena barbata</i> and *<i>Lolium rigidum</i></p>	<p>*<i>Arctotheca calendula</i> *<i>Avena barbata</i> *<i>Briza maxima</i> <i>Hakea erinacea</i> <i>Hibbertia commutata</i> *<i>Moraea flaccida</i> <i>Nuytsia floribunda</i></p>	<p>Landform: Flat hill top, gentle mid slopes, brown-grey loamy sand, common lateritic rocks. Area: 20.27 ha (8.12%) of the Development area Sites: R03, R21, R22, R12, R24 Mean total species richness: 8.3 ± 2.3 Mean perennial species richness: 6.3 ± 0.6 Mean weed species richness: 2.7 ± 2.1 Average condition: 6 - Degraded</p>	
Er1	<p><i>Eucalyptus rudis</i> subsp. <i>rudis</i> low open forest, over mixed weed species dominated by *<i>Avena barbata</i>, *<i>Lolium rigidum</i> and *<i>Oxalis pes-caprae</i></p>	<p>*<i>Arctotheca calendula</i> *<i>Briza maxima</i> *<i>Bromus diandrus</i> <i>Corymbia calophylla</i> *<i>Cynodon dactylon</i> <i>Eucalyptus wandoo</i> subsp. <i>wandoo</i> *<i>Gomphocarpus fruticosus</i> *<i>Hordeum leporinum</i> <i>Juncus pallidus</i> *<i>Moraea flaccida</i> *<i>Oxalis purpurea</i></p>	<p>Landform: Drainage line low hill slopes near drainage line. Area: 11.7 ha (4.69%) of the Development area Sites: R01, R02, R04, R05, R06, R07, R09, R10, R11, R16, R17, R18, R19, R20 Mean total species richness: 13.2 ± 5.1 Mean perennial species richness: 4.9 ± 2.8 Mean weed species richness: 10.9 ± 4.3 Average condition: 6 - Degraded</p>	

Unit	Description (NVIS Level VI)	Associated species	Area in study area, landform, sites and floristic details	Photograph
Er2	<p><i>Eucalyptus rudis</i> subsp. <i>rudis</i> low open forest, over mixed weed species dominated by *<i>Avena barbata</i></p>	<p>*<i>Hordeum leporinum</i> *<i>Lolium rigidum</i> *<i>Solanum linnaeanum</i> *<i>Trifolium campestre</i> var. <i>campestre</i></p>	<p>Landform: Plantation strip on low hillslope Area: 4.24 ha (1.70%) of the Development area Sites: R08 Total species richness: 6 Perennial species richness: 2 Weed species richness: 5 Average condition: 6 - Degraded</p>	
Ab	<p>Mixed weed species dominated by *<i>Avena barbata</i>, *<i>Lupinus cosentinii</i>, *<i>Bromus diandrus</i> and *<i>Triticum aestivum</i>.</p>	<p>*<i>Arctotheca calendula</i> *<i>Trifolium angustifolium</i> var. <i>angustifolium</i> *<i>Trifolium arvense</i> var. <i>arvense</i> *<i>Trifolium campestre</i> var. <i>campestre</i></p>	<p>Landform: Cleared pasture land. Area: 213.36 ha (85.42%) of the Development area Sites: R13, R14 Mean total species richness: 6.0 ± 0.0 Mean perennial species richness: 0 Mean weed species richness: 6.0 ± 0.0 Average condition: 7 – Completely Degraded</p>	

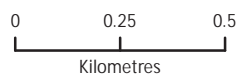


Legend

- The Project area
- Study Area
- Development Area
- Flora site

Vegetation description

- Ab: Mixed weed species dominated by *Avena barbata*, *Lupinus cosentinii*, *Bromus diandrus* and *Triticum aestivum*
- Bush Forever: not assessed
- CcAp: *Corymbia calophylla* low woodland, over +/- *Acacia pulchella* sparse low shrubland, over mixed weed species
- CcGsBe: *Corymbia calophylla* and *Eucalyptus wandoo* subsp. *wandoo* low woodland, over *Gastrolobium spinosum*, *Acacia pulchella* and *Hypocalymma angustifolium* sparse to open mid shrubland
- Er1: *Eucalyptus rudis* subsp. *rudis* low open forest, over mixed weed species dominated by *Avena barbata*, *Lolium rigidum* and *Oxalis pes-caprae*
- Er2: *Eucalyptus rudis* subsp. *rudis* low open forest, over mixed weed species
- EwCc: +/- *Eucalyptus wandoo* subsp. *wandoo* and *Corymbia calophylla* open low woodland, over isolated *Solanum linnaeanum* mid shrubs, over mixed weed species
- EwGs: *Eucalyptus wandoo* subsp. *wandoo* open forest, over *Gastrolobium spinosum* and *Xanthorrhoea preissii* mid open shrubland, over mixed low shrubs



Absolute Scale - 1:18,000



Vegetation mapping at the study area

Figure: 4.5
Project ID: 1621

Drawn: MY
Date: 05/07/2016

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

4.2.1 Vegetation Condition

The majority of the Project area (81.6%) was characterised by high levels of disturbance and subsequently rated as 'Completely Degraded' or 'Degraded'. The remaining 18.3%, which was rated as 'Excellent', was associated with the remnant vegetation, including the Bush Forever site in the north of the Project area. A vegetation condition map is provided in Figure 4.7.

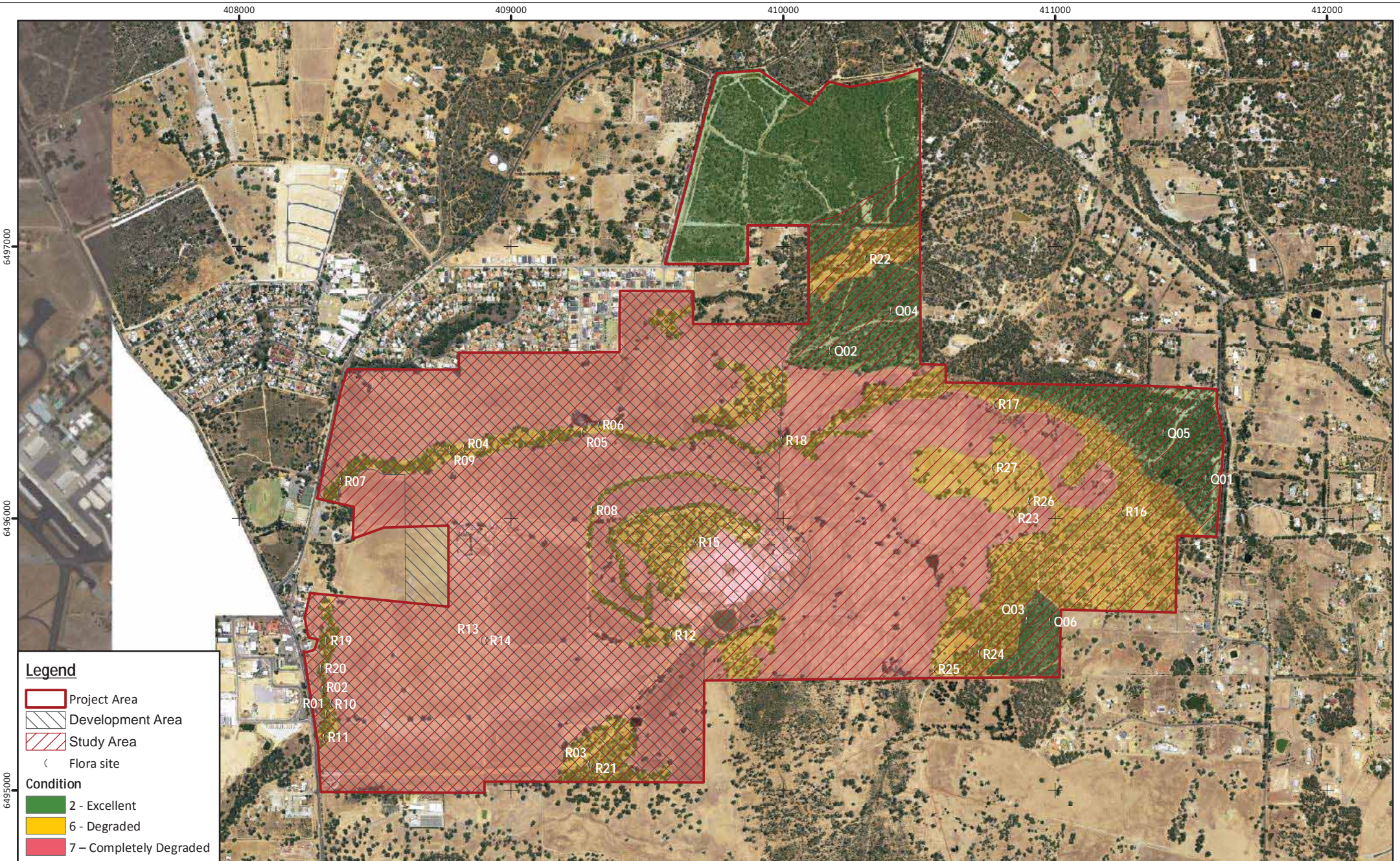
One vegetation unit – Ab – was rated as 'Completely Degraded' and mapped as covering 213.36 ha or 85.42% of the Development area (Figure 4.7). This was the parkland cleared for agriculture on the lower hill slopes and flats, containing no native species or perennials.

Four vegetation units were rated as 'Degraded' – CcAp, Er1, Er2 and EwCc – and were mapped as 36.22 ha or 14.50% of the Project area (Figure 4.7). These were areas on the higher and steeper hill slopes that had patches of native trees left un-cleared and along the Kit-Monger Brooke and were characterised by no or possibly scattered native understorey plants, litter, high grazing levels and domination by weeds. Trees were noticeably unhealthy in these areas, with upper foliage and branches often seen dead or dying (Figure 4.6).

One vegetation unit was rated as 'Excellent' – CcGsBe – which was mapped as occurring over 0.21 ha or 0.08% in the north-eastern portion of the Development area (Figures 4.5 and 4.7) with more significant areas along the steep escarpment and valley walls, hill slopes and tops in the eastern portion of the Project area. Disturbances to this unit included a low density of non-invasive weeds and common vehicle/animal tracks. There were also trees that were noticeably unhealthy in these areas (Figure 4.6).



Figure 4.6: Tree health in unit EwCc (left) and CcGsBe (right)

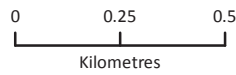


Legend

- Project Area
- Development Area
- Study Area
- Flora site

Condition

- 2 - Excellent
- 6 - Degraded
- 7 - Completely Degraded



Absolute Scale - 1:18,000



Vegetation condition mapping of the study area

Figure: 4.7
Project ID: 1621

Drawn: MY
Date: 29/06/2016

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

4.3 WETLAND ASSESSMENT

The section of the Ki-it Monger Brook within the Project area been been classified into two wetland management categories: Conservation and Multiple Use Category (Figure 2.3). The remainder of the Ki-it Monger Brook is unclassified.

The Brook occurs on the flat/plain for the majority of its length, and extends into the drainage valley slopes in between the hills to the east of the Project area (Table 4.5). It is mapped as vegetation unit Er1: *Eucalyptus rudis* subsp. *rudis* low open forest, over mixed weed species dominated by **Avena barbata*, **Lolium rigidum* and **Oxalis pes-caprae* throughout the whole Project area and other common species include; *Corymbia calophylla*, **Gomphocarpus fruticosus*, **Solanum linnaeanum*, **Briza maxima*, **Moraea flaccida*. The mean species richness of this vegetation unit is 13.2, of which the mean weed species richness is 10.9 and the mean perennial species richness is 4.9.

Its condition was rated as 'Degraded' with no or scattered native understorey plants, litter, high grazing levels and domination by weeds. Erosion was generally minor, however there were some areas with deep trenches cutting into the plain (Table 4.5).

There were no significant flora species recorded or likely to occur along the creekline. The WONS, **Asparagus asparagoides* was recorded within the unclassified section and the Declared Pest, **Zantedeschia aethiopica* was recorded within the Conservation, Multiple Use and Unclassified Categories (Figure 4.1).

The surface layer was characterised by common creek stones along the bed and a brown clay-loam along the banks. Small pools of water were observed commonly along the length of the creekline at no more than 30 cm deep (Table 4.5).

Table 4.5: Characteristics of the Kit-Monger Brook

Description	Photographs	
Conservation Category characteristics		
Multiple Use Category characteristics		

Description	Photographs	
Unclassified wetland characteristics		
Litter and fencing in the Multiple Use Category section		
Bank erosion (left) and water pooling (Right) in the Multiple Use Category section		
Surface layer (right) and water pooling (Right) in the Conservation Category section		

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5 DISCUSSION

5.1 FLORA OF SIGNIFICANCE

No EPBC Act or WC Act-listed Threatened Flora, Priority flora or other flora of conservation significance were recorded in the study area during the current survey. All flora species recorded occurred within their known range and are well represented outside the study area.

One Threatened flora taxon, *Acacia anomala*, has previously been recorded at three locations in the Project area (Figure 2.4). These locations were visited for confirmation, but the taxon was not found. It is likely that the records to the east were not found because the exact location was not provided when conducting database searches, and therefore this taxon is still considered highly likely to occur within these areas. The record to the west that falls on the edge of the Ki-it-Monger Brook is likely to be a database location error, however, as this is a cleared paddock with no native species in the vicinity of the point.

Two Threatened flora taxa, *Grevillea curviloba* subsp. *curviloba* and *Grevillea curviloba* subsp. *incurva*, are considered to have a high likelihood of occurrence in the Project area. While these taxa are highly likely to occur within the Bush Forever site comprising the portion of the Project area to the north of the field study area, neither the study area nor the Development area contains any habitat that is likely to support these species.

Based on the desktop study data two Priority flora taxa, *Schoenus capillifolius* and *Stylidium longitubum*, were considered to have a high likelihood of occurrence in the Project area. Following the field survey, however, it is considered unlikely that they occur because the habitats that they could occur in are highly grazed and devoid of mostly all native understorey species.

5.2 VEGETATION OF SIGNIFICANCE

Both remnant vegetation units within the study area are considered significant. As they are remnant units they are scarce, restricted in distribution and provide a role of refuge for flora. They provide habitat for Threatened species (*Acacia anomala*), and are on an area that spans over two IBRA regions.

The remnant vegetation at the study area was mapped as the Darling Scarp and Yalanbee Vegetation Complexes (Heddlé *et al*, 1980), which have 41.96% and 47.6%, respectively, of their pre-European extent remaining.

Based on the desktop study information, two Endangered TECs were considered to have a high likelihood of occurrence in the Project area. Following the field survey, *Corymbia calophylla* – *Kingia australis* woodlands on heavy soils, Swan Coastal Plain, was considered unlikely to occur in the study or Development area as *Kingia australis* was not recorded during the survey. However, both TEC's are highly likely to occur within the Bush Forever block in the north of the Project area.

Floristic correlation with the '*Corymbia calophylla* – *Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain' TEC were noted in the CcGsBe unit in the study area. While *Xanthorrhoea preissii* was not a dominant component of unit CcGsBe in the study area, it did occur at all three quadrats but at a low density. Other species common to both CcGsBe and the TEC include a co-dominance of *Eucalyptus wandoo*, *Acacia pulchella*, *Bossiaea eriocarpa*, *Hibbertia hypericoides*, *Hypocalymma angustifolium* and *Lepidosperma angustatum*. However, only a small portion (0.21 ha) of the CcGsBe unit was mapped within the proposed Development area.

The Conservation Category wetland section of the Ki-it Monger Brook was mapped as vegetation unit Er1: *Eucalyptus rudis* subsp. *rudis* low open forest, over mixed weed species and was classified as 'Degraded' with no or scattered native understorey plants, litter, high grazing levels and dominated by weeds. There were no differences in vegetation type, floristic composition, condition or values in

the Conservation Category section of the Ki-it Monger Brook, the Multiple Use section or the unclassified section.

5.3 FLORA AND VEGETATION SURVEY LIMITATIONS AND CONSTRAINTS

Limitations of the current survey are summarised in Table 5.1. The survey was undertaken focusing on the areas that are likely to be developed, and included the already disturbed areas throughout the Project area.

Table 5.1: Summary of survey limitations

Constraint	Relevant (yes/no)	Comment
Sources of information and availability of contextual information (i.e. pre-existing background versus new material)	No	Broad scale (1:1,000,000) vegetation mapping by Shepherd <i>et al</i> (2001), Beard (1981) and Heddle (1980) is available. The Floristic data from Gibson <i>et al.</i> (1994) are also available.
The scope (i.e. what life forms were sampled)	No	The vascular flora of the study area was sampled in accordance with Guidance Statement 51.
Proportion of flora collected and identified (based on sampling, timing and intensity)	No	52 native and 59 introduced species were recorded in the study area. Of these, 37 were annuals (33.3%). Higher sampling intensity in the remnant vegetation would be likely to increase the number of native species, but this area is unlikely to be developed; therefore, the survey intensity was focused on the areas that are proposed for development, and in these areas intensity is considered more than adequate.
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	No	As the development is proposed to occur only within the areas already disturbed, the survey intensity is considered more than adequate. However, if the remnant bushland to the east of the Project area is to be proposed for development in future, exact locations of the Threatened flora taxa, <i>Acacia anomala</i> would need to be determined.
Mapping reliability	No	Good quality aerial imagery was available and the number and spatial distribution of quadrats was considered adequate for definition of vegetation within the study area.
Timing/weather/season/cycle	No	Two phases were surveyed in Spring and Autumn. While below average rainfall occurred before the Spring survey, above average rainfall occurred before the Autumn survey.
Disturbances (e.g. fire, flood, accidental human intervention)	No	There were no natural or human interventions that constrained the survey of the study area.
Intensity (in retrospect, was the intensity adequate?)	No	A two phase Level 2 survey over four person days was conducted at the study area. Considering the development is occurring in the already disturbed areas, this is considered more than adequate to assess the flora and vegetation at the study area.
Resources	No	A total of 4 person-days were expended.
Access issues	No	All parts of the study area were accessible by walking from existing vehicle tracks.
Experience levels (e.g. degree of expertise in plant identification to taxon level)	No	The senior botanist, who was responsible for planning, reporting and conducting the survey, has ten years' of experience conducting botanical surveys. The taxonomist(s) responsible for plant identifications has a Doctorate in botanical taxonomy and has completed identifications for many projects within WA.

6 CONCLUSIONS

6.1 FLORA AND VEGETATION

The majority of the Project area was characterised by 'Completely Degraded' or 'Degraded' vegetation units. Land clearing, grazing, weed densities and litter were common disturbances. Sixty species of weeds recorded within the Project Area, of which one is a WONS (**Asparagus asparagoides*) and one is a Declared Plant (**Zantedeschia aethiopica*).

There were no conservation significant flora species recorded in the study area during the survey. Nonetheless, it is considered highly likely that the Threatened flora taxon *Acacia anomala* may occur in the two remnant vegetation units to the east of the Project area, and that *Grevillea curviloba* subsp. *curviloba* and *Grevillea curviloba* subsp. *incurva* may occur in the Bush Forever site (Site 89) in the north. However, given the small area (0.21 ha) of the CcGsBe unit mapped within the Development area, it is considered unlikely that either significant taxa occurs within this area.

Two remnant vegetation communities were mapped within the study area, though only a small portion of the CcGsBe unit occurs within the Development area. Both are considered significant, as they are scarce, restricted in distribution and provide a role of refuge for flora. They are likely to provide habitat for Threatened species (*Acacia anomala*), and are on an area that spans two IBRA regions. One of these remnant units (CcGsBe) contains similarities to the Endangered TEC: '*Corymbia calophylla* – *Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain'. Species common to both CcGsBe and this TEC include *Xanthorrhoea preissii*, *Eucalyptus wandoo*, *Acacia pulchella*, *Bossiaea eriocarpa*, *Hibbertia hypericoides*, *Hypocalymma angustifolium* and *Lepidosperma angustatum*.

The Conservation Category wetland section of the Ki-it Monger Brook was rated as 'Degraded' with no or scattered native understorey plants, litter, high grazing levels and domination by weeds. There was no difference in vegetation type, condition or values between the Conservation Category section of the Ki-it Monger Brook, the other Multiple Use section and the un-classified section.

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7 REFERENCES

- 360 Environmental. 2012. North Ellenbrook Level 2 Flora and Vegetation Survey. Prepared for Greg Rowe and Associates. July 2012.
- Beard, J. S. 1981. Vegetation Survey of Western Australia: The Vegetation of the Swan Area. Map and Explanatory Memoirs, 1: 100,000 series. Vegmap Publications, Perth.
- BoM. 2016. Bureau of Meteorology. Available at: <http://www.bom.gov.au>. Commonwealth of Australia, Canberra.
- CALM. 1999. Environmental Weed Strategy for Western Australia. Department of Conservation and Land Management, Government of Western Australia, Western Australia.
- Chittering Landcare Centre. 2008. Foreshore Assessment, Flora and Fauna Survey for the Drainage Nutrient Intervention Program (DNIP) in the Lower Ellen Brook Catchment. March 2008.
- Churchward, H. M. and McArthur, W. M. 1980. Landforms and Soils of the Darling System. In: Atlas of Natural Resources, Darling System, Western Australia. Perth, Pinjarra and Collie Sheets. Department of Conservation and Environment, Western Australia.
- DAFWA. 2007. Biosecurity and Agriculture Management Act 2007. As at 01 May 2013. Department of Agriculture and Food Western Australia. Government of Western Australia, South Perth.
- DAFWA. 2013. Western Australian Organism List (WAOL) - Declared pest list. Available at <http://www.biosecurity.wa.gov.au/organisms/export/PER-DP>. Department of Agriculture and Food Western Australia. Government of Western Australia., South Perth.
- Department of Environmental Protection. 2000. Bush Forever Volume 2: Directory of Bush Forever Sites. Western Australia, Department of Environment Protection, Perth.
- Desmond, A. 2001. Swan Coastal Plain 1 (SWA1 - Dandaragan Plateau subregion). Department of Conservation and Land Management, Perth, Western Australia.
- DPaW. 2013. A methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia. Department of Parks and Wildlife, August 2013.
- DSEWPaC. 2012a. Interim Biogeographic Regionalisation for Australia (IBRA), Version 7. Australian Government Department of Sustainability, Environment, Water, Population and Communities.
- DSEWPaC. 2012b. Weeds of National Significance (WONS). Department of Sustainability, Environment, Water, Population and Communities. Commonwealth of Australia. Available at: <http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html>.
- Emerge Associates. 2013. Flora and vegetation report PT Lot M1313 Great Northern Highway Muchea. Prepared for Westbridge Property Group Pty Ltd. January 2013.
- EPA. 2002a. Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection. . Environmental Protection Authority, Western Australia.
- EPA. 2002b. Position Statement No. 4: Environmental Protection of Wetlands. Environmental Protection Authority. November 2004. Environmental Protection Authority, Western Australia.
- EPA. 2004a. Environment Protection (Clearing of Native Vegetation) Regulations 2004. As at 17 April 2009. Environmental Protection Authority. State Law Publisher, Western Australia.
- EPA. 2004b. Guidance for the Assessment of Environmental Factors. Guidance Statement 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. Environmental Protection Authority, Western Australia.

- EPA. 2004c. Guidance Statement No. 51: Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986). Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. No. 51. June. Environmental Protection Authority, Western Australia.
- EPA. 2004d. Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia. Guidance for the Assessment of Environmental Factors No. 51. Environmental Protection Authority, Western Australia.
- EPA & DEC. 2015. Technical Guide - Flora and Vegetation Surveys for Environmental Impact Assessment. Technical Report of the Environmental Protection Authority and the Department of Parks and Wildlife (eds. K Freeman, G Stack, S Thomas, N Woolfrey), Perth, Western Australia.
- ESCAVI. 2003. Australian Vegetation Attribute Manual: National Vegetation Information System (NVIS). Executive Steering Committee for Australian Vegetation Information System (ESCAVI), Australian Government Department of Environment and Heritage, Canberra.
- Gibson, N., Keighery, B. J., Burbidge, A. H., and Lyons, M. N. 1994. A Floristic survey of the southern Swan Coastal Plain. Unpublished Report for the Australian Heritage Commission. Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.).
- Hedde, E. M., Loneragan, O. W., and Havel, J. J. 1980. Vegetation complexes of the Darling System, Western Australia. Atlas of natural resources of the Darling System, Western Australia. Department of Environment and Conservation, Perth, Western Australia.
- Hill, A. L., Semeniuk, C. A., Semeniuk, V., and Del Marco, A. 1996. Wetlands of the Swan Coastal Plain. Water and Rivers Commission, Perth.
- Kendrick, P. and McKenzie, N. 2001. Pilbara 1 (PIL1 - Chichester subregion). A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions. Department of Conservation and Land Management, Perth, Western Australia.
- Mitchell, D., Williams, K., and Desmond, A. 2002. Swan Coastal Plain 2 (SWA2 - Swan Coastal Plain subregion). Department of Conservation and Land Management, Perth, Western Australia.
- Shepherd, D. P., Beeston, G. R., and Hopkins, A. J. M. 2001. Native vegetation in Western Australia: Extent, type and status. Technical Report 249. Department of Agriculture, South Perth, Western Australia.
- Trudgen, M. E. 1991. Vegetation Condition Scale. In: National Trust (WA) 1993 Urban Bushland Policy. National Trust of Australia (WA), Wildflower Society of WA (Inc.), and the Tree Society (Inc.), Perth, Western Australia.
- Western Australian Herbarium. 1998-2015. FloraBase - The Western Australian Flora. Government of Western Australia Department of Parks and Wildlife. Available at: <http://florabase.dpaw.wa.gov.au/>.
- Williams, K. and Mitchell, D. 2001. Jarrah Forest 1 (JF1 - Northern Jarrah Forest subregion). A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002. Department of Conservation and Land Management., Perth, Western Australia.

APPENDIX A DEFINITIONS

Threatened (WC Act) and Priority flora Categories

Code	Definition
T	Threatened flora – (Declared Rare Flora – Extant) Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such (Schedule 1 under the <i>Wildlife Conservation Act 1950</i>).
X	Presumed Extinct Flora (Declared Rare Flora - Extinct) Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such Schedule 2 under the <i>Wildlife Conservation Act 1950</i> .
P1	Priority One – Poorly Known Species Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2	Priority Two – Poorly Known Species Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	Priority Three – Poorly Known Species Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities 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 localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
P4	Priority Four – Rare, Near Threatened and other species in need of monitoring (a) Rare. 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) 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) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5	Priority Five - Conservation Dependent species Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Threatened flora (EPBC Act) Categories

Code	Definition
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time, the species is the focus of a specific conservation programme, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Definition of codes for Threatened Ecological Communities

Code	Definition
PD: Presumed Totally Destroyed	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant
CR: Critically Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
EN: Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future.
VU: Vulnerable	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it 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.

Definition of codes for Priority Ecological Communities

Code	Definition
P1: Priority One	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or Pastoral lands, urban areas, active mineral leases) and for which current threats exist. 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	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat 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	<p>(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:</p> <p>(ii) Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;</p> <p>(iii) Communities made up of large, and/or widespread occurrences that may or 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, and inappropriate fire regimes.</p> <p>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.</p>
P4: Priority Four	<p>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.</p> <p>(a) 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.</p> <p>(b) 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 Vulnerable.</p> <p>(c) Ecological communities that have been removed from the list of threatened communities during the past five years.</p>
P5: Priority Five	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.

Control categories for Declared Pests (Weeds)

Declared plant category	Description
C1 - Exclusion	Pests assigned to this category are not established in WA and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 - Eradication	Pests assigned to this category are present in WA in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 - Management	Pests assigned to this category are established in WA 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.

Definition of codes for vegetation condition

Vegetation condition (EPA & DPaW 2015)	Vegetation condition (Keighery 1994)	Criteria
1	Pristine	Pristine or nearly so, no obvious sign of disturbance or damage caused by human activities.
2	Excellent	Vegetation structure intact; disturbance affecting individual species; weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
3	Very good	Vegetation structure altered; obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires; the presence of some more aggressive weeds; dieback; logging and grazing.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires; the presence of some very aggressive weeds; partial clearing; dieback and grazing.
6	Degraded or Poor	Basic vegetation structure severely impacted by disturbance. Scope for regeneration by not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires; the presence of some very aggressive weeds at high density; partial clearing; dieback and grazing.
7	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.

Categorisation of environmental weeds

Criteria	Description
Invasiveness	Ability to invade bushland in good to excellent condition or ability to invade waterways.
Distribution	Wide current or potential distribution including consideration of known history of widespread distribution elsewhere in the world.
Environmental impacts	Ability to change the structure, composition and function of ecosystems. In particular an ability to form single-species stands.
Category	Scoring System
High	A species which scores yes to all three of the above criteria. A rating of high indicates a species that should be prioritised for control and/or research.
Moderate	A species which scores yes for two of the above criteria. A rating of moderate indicates a species which should be monitored. Control or research should be directed to it if funds are available.
Mild	A species which scores yes to one of the criteria. A mild rating indicates monitoring or control if appropriate.
Low	A species which does not score yes for any of the criteria. A low rating indicates a low requirement for monitoring.

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APPENDIX B POTENTIAL SPECIES LIST

Species recorded during the literature review			
Family	Taxa	Family	Taxa
Amaranthaceae	<i>Ptilotus drummondii</i> var. <i>drummondii</i>	Cyperaceae	<i>Schoenus nanus</i>
Apiaceae	<i>Daucus glochidiatus</i>	Cyperaceae	<i>Tetralia capillaris</i>
Apiaceae	<i>Eryngium pinnatifidum</i> subsp. <i>pinnatifidum</i>	Cyperaceae	<i>Tetralia octandra</i>
Apiaceae	<i>Homaloscladium homalocarpum</i>	Dilleniaceae	<i>Hibbertia commutata</i>
Apiaceae	<i>Xanthosia candida</i>	Dilleniaceae	<i>Hibbertia hypericoides</i>
Apiaceae	<i>Xanthosia huegelii</i>	Dioscoreaceae	<i>Dioscorea hastifolia</i>
Apocynaceae	* <i>Gomphocarpus fruticosus</i> (Declared Pest - s22(2), C3 not for Project area)	Droseraceae	<i>Drosera erythrorhiza</i>
Araceae	* <i>Zantedeschia aethiopica</i> (Declared Pest - s22(2), C3 whole of state)	Droseraceae	<i>Drosera macrantha</i>
Araliaceae	<i>Hydrocotyle callicarpa</i>	Elaeocarpaceae	<i>Tetralia nuda</i>
Araliaceae	<i>Trachymene pilosa</i>	Ericaceae	<i>Leucopogon polymorphus</i>
Asparagaceae	* <i>Asparagus asparagoides</i> (WONS)	Ericaceae	<i>Leucopogon pulchellus</i>
Asparagaceae	<i>Chamaescilla corymbosa</i>	Fabaceae	* <i>Chamaecytisus palmensis</i>
Asparagaceae	<i>Dichopogon capillipes</i>	Fabaceae	* <i>Genista</i> sp. (WONS)
Asparagaceae	<i>Laxmannia squarrosa</i>	Fabaceae	* <i>Lotus subbiflorus</i>
Asparagaceae	<i>Lomandra nigricans</i>	Fabaceae	* <i>Lupinus cosentinii</i>
Asparagaceae	<i>Sowerbaea laxiflora</i>	Fabaceae	* <i>Ornithopus pinnatus</i>
Asparagaceae	<i>Thysanotus manglesianus</i>	Fabaceae	* <i>Trifolium angustifolium</i>
Asparagaceae	<i>Thysanotus tenellus</i>	Fabaceae	* <i>Trifolium arvense</i> var. <i>arvense</i>
Asteraceae	* <i>Arctotheca calendula</i>	Fabaceae	* <i>Trifolium cernuum</i>
Asteraceae	* <i>Chrysanthemoides monilifera</i> (WONS)	Fabaceae	* <i>Trifolium subterraneum</i>
Asteraceae	* <i>Conyza bonariensis</i>	Fabaceae	<i>Acacia alata</i> var. <i>alata</i>
Asteraceae	* <i>Conyza parva</i>	Fabaceae	<i>Acacia oncinophylla</i> subsp. <i>oncinophylla</i> (Priority 3)
Asteraceae	* <i>Cotula coronopifolia</i>	Fabaceae	<i>Acacia pulchella</i> var. <i>pulchella</i>
Asteraceae	* <i>Dittrichia graveolens</i>	Fabaceae	<i>Acacia saligna</i>
Asteraceae	* <i>Hypochoeris glabra</i>	Fabaceae	<i>Bossiaea eriocarpa</i>
Asteraceae	* <i>Lactuca serriola</i>	Fabaceae	<i>Bossiaea spinescens</i>
Asteraceae	* <i>Sonchus asper</i>	Fabaceae	<i>Gastrolobium spinosum</i>
Asteraceae	* <i>Sonchus oleraceus</i>	Fabaceae	<i>Gompholobium marginatum</i>
Asteraceae	* <i>Ursinia anthemoides</i>	Fabaceae	<i>Templetonia drummondii</i>
Asteraceae	* <i>Vellereophyton dealbatum</i>	Gentianaceae	* <i>Centaurium erythraea</i>
Asteraceae	<i>Craspedia variabilis</i>	Goodeniaceae	<i>Scaevola glandulifera</i>
Asteraceae	<i>Lagenophora huegelii</i>	Haemodoraceae	<i>Conostylis setosa</i>
Asteraceae	<i>Quinetia urvillei</i>	Haemodoraceae	<i>Haemodorum discolor</i>
Asteraceae	<i>Trichocline spathulata</i>	Haemodoraceae	<i>Haemodorum simplex</i>
Boryaceae	<i>Borya sphaerocephala</i>	Haloragaceae	<i>Gonocarpus cordiger</i>
Campanulaceae	* <i>Wahlenbergia capensis</i>	Hemerocallidaceae	<i>Caesia micrantha</i>
Campanulaceae	<i>Wahlenbergia preissii</i>	Hemerocallidaceae	<i>Tricoryne elatior</i>
Caryophyllaceae	* <i>Minuartia mediterranea</i>	Iridaceae	* <i>Gladiolus caryophyllaceus</i>
Celastraceae	<i>Stackhousia monogyne</i>	Iridaceae	* <i>Moraea flaccida</i> (Declared Pest - s22(2), C3 not for Project area)
Centrolepidaceae	<i>Aphelia</i> sp. <i>Albany</i>	Iridaceae	* <i>Romulea rosea</i>
Colchicaceae	<i>Burchardia congesta</i>	Iridaceae	* <i>Watsonia</i> sp.
Cucurbitaceae	* <i>Citrullus lanatus</i>	Iridaceae	<i>Patersonia juncea</i>
Cyperaceae	* <i>Cyperus congestus</i>	Lamiaceae	<i>Hemigenia barbata</i>
Cyperaceae	* <i>Isolepis marginata</i>	Lauraceae	<i>Cassytha pomiformis</i>
Cyperaceae	<i>Gahnia aristata</i>	Linaceae	* <i>Linum trigynum</i>
Cyperaceae	<i>Lepidosperma leptostachyum</i>	Myrtaceae	* <i>Leptosperma laevigatum</i>
Cyperaceae	<i>Schoenus grammatophyllus</i>	Myrtaceae	<i>Calothamnus quadrifidus</i>

Species recorded during the literature review			
Family	Taxa	Family	Taxa
Myrtaceae	<i>Calothamnus sanguineus</i>	Poaceae	* <i>Vulpia myuros forma myuros</i>
Myrtaceae	<i>Corymbia calophylla</i>	Poaceae	<i>Austrostipa campylachne</i>
Myrtaceae	<i>Eucalyptus accedens</i>	Poaceae	<i>Austrostipa elegantissima</i>
Myrtaceae	<i>Eucalyptus wandoo subsp. wandoo</i>	Poaceae	<i>Dichelachne crinita</i>
Myrtaceae	<i>Hypocalymma angustifolium</i>	Poaceae	<i>Microlaena stipoides</i>
Myrtaceae	<i>Leptospermum erubescens</i>	Poaceae	<i>Neurachne alopecuroidea</i>
Myrtaceae	<i>Melaleuca parviceps</i>	Poaceae	<i>Rytidosperma setaceum</i>
Oleaceae	* <i>Olea europaea</i>	Poaceae	<i>Tetrarrhena laevis</i>
Onagraceae	* <i>Oenothera glazioviana</i>	Polygalaceae	<i>Comesperma ciliatum</i>
Orchidaceae	* <i>Disa bracteata</i>	Polygonaceae	* <i>Rumex crispus</i>
Orchidaceae	<i>Caladenia longicauda subsp. longicauda</i>	Polygonaceae	* <i>Rumex vesicarius</i>
Orchidaceae	<i>Caladenia marginata</i>	Polygonaceae	<i>Muehlenbeckia adpressa</i>
Orchidaceae	<i>Cyanicula sericea</i>	Primulaceae	* <i>Lysimachia arvensis</i>
Orchidaceae	<i>Microtis media subsp. densiflora</i>	Proteaceae	<i>Grevillea pilulifera</i>
Orchidaceae	<i>Pterostylis vittata</i>	Proteaceae	<i>Hakea erinacea</i>
Orchidaceae	<i>Thelymitra crinita</i>	Proteaceae	<i>Hakea incrassata</i>
Orobanchaceae	* <i>Bartsia trixago</i>	Proteaceae	<i>Hakea lissocarpha</i>
Oxalidaceae	<i>Oxalis perennans</i>	Proteaceae	<i>Isopogon asper</i>
Papaveraceae	* <i>Fumaria capreolata</i>	Proteaceae	<i>Petrophile striata</i>
Phormiaceae	<i>Dianella revoluta var. divaricata</i>	Pteridaceae	<i>Cheilanthes austrotenuifolia</i>
Phyllanthaceae	<i>Phyllanthus calycinus</i>	Rhamnaceae	<i>Trymalium angustifolium</i>
Pinaceae	* <i>Pinus pinaster</i>	Rosaceae	* <i>Rubus fruticosus aggregate (WONS)</i>
Pinaceae	* <i>Pinus radiata</i>	Rubiaceae	* <i>Galium divaricatum</i>
Pittosporaceae	<i>Marianthus candidus</i>	Rutaceae	<i>Boronia ovata</i>
Plantaginaceae	* <i>Kickxia elatine subsp. elatine</i>	Salviniaceae	* <i>Salvinia molesta (WONS)</i>
Poaceae	* <i>Aira caryophyllea</i>	Santalaceae	<i>Leptomeria cunninghamii</i>
Poaceae	* <i>Avena barbata</i>	Solanaceae	* <i>Lycium ferocissimum (WONS)</i>
Poaceae	* <i>Avena fatua</i>	Solanaceae	* <i>Solanum nigrum</i>
Poaceae	* <i>Brachypodium distachyon</i>	Stylidiaceae	<i>Levenhookia pusilla</i>
Poaceae	* <i>Briza maxima</i>	Stylidiaceae	<i>Stylidium amoenum</i>
Poaceae	* <i>Briza minor</i>	Stylidiaceae	<i>Stylidium brunonianum</i>
Poaceae	* <i>Bromus diandrus</i>	Stylidiaceae	<i>Stylidium bulbiferum</i>
Poaceae	* <i>Cenchrus ciliaris</i>	Stylidiaceae	<i>Stylidium calcaratum</i>
Poaceae	* <i>Cortaderia selloana</i>	Stylidiaceae	<i>Stylidium caricifolium</i>
Poaceae	* <i>Cynodon dactylon</i>	Typhaceae	* <i>Typha orientalis</i>
Poaceae	* <i>Ehrharta brevifolia</i>	Verbenaceae	* <i>Lantana camara (WONS)</i>
Poaceae	* <i>Ehrharta calycina</i>	Verbenaceae	* <i>Verbena sp.</i>
Poaceae	* <i>Ehrharta longiflora</i>	Xanthorrhoeaceae	<i>Xanthorrhoea acanthostachya</i>
Poaceae	* <i>Hordeum hystrix</i>	Xanthorrhoeaceae	<i>Xanthorrhoea gracilis</i>
Poaceae	* <i>Lolium perenne</i>	Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>
Poaceae	* <i>Lolium rigidum</i>	Zamiaceae	<i>Macrozamia riedlei</i>
Poaceae	* <i>Pennisetum clandestinum</i>		
Poaceae	* <i>Pentameris airoides</i>		
Poaceae	* <i>Polypogon monspeliensis</i>		
Poaceae	* <i>Urochloa mutica</i>		
Poaceae	* <i>Vulpia bromoides</i>		

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APPENDIX C SITE DATA

Site:	Q01		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Quadrat (10x10m)	NW corner (GDA94):	50J 411560mE, 6496144mN
Habitat:	Hillslope (midslope, steep west-facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	2 (Excellent, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Weeds, animal tracks		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Daucus glochidiatus</i>	1		Herb
<i>Dianella revoluta</i>	1		Herb
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>	70		Tree - low
<i>Gastrolobium retusum</i>	1		Herb
<i>Gastrolobium spinosum</i>	20		Shrub - low
<i>Goodenia coerulea</i>	0.1		Herb
<i>Hakea lissocarpa</i>	1		Shrub - low
<i>Hesperantha falcata</i>	1		Herb
<i>Hibbertia hypericoides</i> subsp. <i>hypericoides</i>	1		Shrub - low
<i>Inadequate material</i>	0.1		Herb
<i>Isopogon</i> sp.	1		Shrub - low
<i>Monoculus monstrosus</i>	1		Herb
<i>Neurachne alopecuroidea</i>	1		Tussock grass - low
<i>Pentameris airoides</i>	1		Tussock grass - low
<i>Sonchus asper</i>	1		Herb
<i>Stylidium affine</i>	1		Herb
<i>Stylidium bulbiferum</i>	0.1		Herb
<i>Thomasia foliosa</i>	1		Shrub - low
<i>Thysanotus patersonii</i>	0.1		Climber
<i>Ursinia anthemoides</i>	0.1		Herb
<i>Xanthorrhoea preissii</i>	2		Shrub - mid

Site:	Q02		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Quadrat (10x10m)	NW corner (GDA94):	50J 410176mE, 6496615mN
Habitat:	Hillslope (hilltop, moderate south facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	2 (Excellent, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Weeds, animal tracks		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>	1		Tussock grass - low
<i>Briza maxima</i>	1		Tussock grass - low
<i>Burchardia congesta</i>	1		Herb
<i>Eucalyptus wandoo subsp. wandoo</i>	50		Tree - low
<i>Gastrolobium spinosum</i>	10		Shrub - mid
<i>Hakea lissocarpa</i>	1		Shrub - mid
<i>Hesperantha falcata</i>	1		Herb
<i>Hypocalymma angustifolium</i>	1		Shrub - mid
<i>Inadequate material</i>	1		Shrub - low
<i>Lysimachia arvensis</i>	1		Herb
<i>Neurachne alopecuroidea</i>	1		Tussock grass - low
<i>Thomasia foliosa</i>	1		Shrub - low
<i>Trifolium angustifolium var. angustifolium</i>	1		Herb
<i>Ursinia anthemoides</i>	1		Herb
<i>Vulpia myuros</i>	1		Tussock grass - low
<i>Xanthorrhoea preissii</i>	3		Shrub - mid
<i>Xanthosia candida</i>	1		Herb

Site:	Q03		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Quadrat (10x10m)	NW corner (GDA94):	50J 410900mE, 6495623mN
Habitat:	Hillslope (midslope, gentle east facing slope)		
Surface layer:	Brown sandy-clay loam, with common pebbles, stones and boulders of laterite		
Vegetation condition:	2 (Excellent, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Weeds, animal tracks		

Phase 2



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Acacia pulchella</i>		5	Shrub - mid
<i>Bossiaea eriocarpa</i>		30	Shrub - low
<i>Burchardia congesta</i>		0.1	Herb
<i>Corymbia calophylla</i>		50	Tree - low
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>		2	Tree - low
<i>Gastrolobium spinosum</i>		1	Shrub - mid
<i>Hakea lissocarpha</i>		0.1	Shrub - mid
<i>Hibbertia commutata</i>		0.1	Shrub - low
<i>Hypocalymma angustifolium</i>		5	Shrub - mid
<i>Macrozamia riedlei</i>		0.1	Shrub - low
<i>Mesomelaena ?stygia</i> subsp. <i>stygia</i>		5	Sedge - low
<i>Oxalis corniculata</i>		2	Herb
<i>Phyllanthus calycinus</i>		0.1	Shrub - low
<i>Trymalium odoratissimum</i> subsp. <i>odoratissimum</i>		0.1	Shrub - mid
<i>Sonchus oleraceus</i>		4	Herb
<i>Stylidium repens</i>		0.1	Herb
<i>Xanthorrhoea preissii</i>		3	Shrub - low
<i>Xanthosia candida</i>		0.1	Shrub - low

Site:	Q04		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Quadrat (10x10m)	NW corner (GDA94):	50J 410401mE, 6496763mN
Habitat:	Hillslope (hilltop, gentle slope)		
Surface layer:	Brown sandy-clay loam, with few granite pebbles		
Vegetation condition:	2 (Excellent, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Weeds, animal tracks		

Phase 2



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Acacia pulchella</i>		5	Shrub - mid
<i>Acacia ?applanata</i>		0.1	Shrub - low
<i>Burchardia congesta</i>		0.1	Herb
<i>Corymbia calophylla</i>		2	Tree - low
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>		15	Tree - low
<i>Gastrolobium spinosum</i>		80	Shrub - mid
<i>Hibbertia commutata</i>		0.1	Shrub - low
<i>Hypocalymma angustifolium</i>		0.1	Shrub - mid
<i>Lepidosperma leptostachyum</i>		0.1	Shrub - low
<i>Lepidosperma squamatum</i>		5	Sedge - low
<i>Lasiopetalum floribundum</i>		0.1	Shrub - low
<i>Patersonia occidentalis</i>		0.1	Sedge - low
<i>Stylidium affine</i>		0.1	Herb
<i>Thomasia foliosa</i>		0.1	Shrub - low
<i>Thysanotus patersonii</i>		0.1	Climber
<i>Xanthorrhoea preissii</i>		1	Shrub - low

Site:	Q05		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Quadrat (10x10m)	NW corner (GDA94):	50J 411402mE, 6496313mN
Habitat:	Hillslope (midslope, steep west-facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	2 (Excellent, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Weeds, animal tracks		

Phase 2



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>		5	Tussock grass - low
<i>Exocarpos ?sparteus</i>		0.1	Shrub - low
<i>Burchardia congesta</i>		0.1	Herb
<i>Eucalyptus wandoo subsp. wandoo</i>		70	Tree - low
<i>Gastrolobium spinosum</i>		20	Shrub - mid
<i>Hakea undulata</i>		0.1	Shrub - mid
<i>Hibbertia hypericoides subsp. hypericoides</i>		0.1	Shrub - low
<i>Hypocalymma angustifolium</i>		0.1	Shrub - mid
<i>Lolium rigidum</i>		0.1	Tussock grass - low
<i>Thomasia foliosa</i>		0.1	Shrub - low
<i>Xanthorrhoea preissii</i>		15	Shrub - mid
<i>Xanthosia candida</i>		0.1	Shrub - low

Site:	Q06		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Quadrat (10x10m)	NW corner (GDA94):	50J 410985mE, 6495619mN
Habitat:	Hillslope (midslope, gentle east facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	2 (Excellent, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Weeds, animal tracks		

Phase 2



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Acacia pulchella</i>		5	Shrub - mid
<i>Avena barbata</i>		50	Tussock grass - low
<i>Banksia sessilis</i> var. <i>sessilis</i>		0.1	Shrub - tall
<i>Bossiaea eriocarpa</i>		20	Shrub - low
<i>Burchardia congesta</i>		0.1	Herb
<i>Corymbia calophylla</i>		20	Tree - low
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>		10	Tree - low
<i>Gastrolobium spinosum</i>		5	Shrub - mid
<i>Lasiopetalum floribundum</i>		0.1	Shrub - low
<i>Hakea lissocarpa</i>		0.1	Shrub - mid
<i>Hibbertia commutata</i>		1	Shrub - low
<i>Hypocalymma angustifolium</i>		20	Shrub - mid
<i>Lepidosperma leptostachyum</i>		4	Shrub - low
<i>Macrozamia riedlei</i>		0.1	Shrub - low
<i>Moraea flaccida</i>		10	Herb
<i>Oxalis corniculata</i>		1	Herb
<i>Phyllanthus calycinus</i>		1	Shrub - low
<i>Desmodium flexuosum</i>		2	Sedge - low
<i>Trymalium odoratissimum</i> subsp. <i>odoratissimum</i>		1	Shrub - mid
<i>Thysanotus patersonii</i>		0.1	Climber
<i>Xanthorrhoea preissii</i>		0.1	Shrub - low

Site:	R01		
Botanist:	Udani Sirisena & Melissa Hay	Date:	24/10/2014 & 17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 408324mE, 6495277mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-black sandy-clay loam on banks and bed		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>	60	80	Tussock grass - low
<i>Briza maxima</i>	1		Tussock grass - low
<i>Briza minor</i>	0.1		Tussock grass - low
<i>Bromus diandrus</i>	5		Tussock grass - low
<i>Cynodon dactylon</i>		20	Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>	50	50	Tree - low to mid
<i>Gomphocarpus fruticosus</i>	0.1	0.1	Shrub - mid
<i>Hordeum leporinum</i>	20		Tussock grass - low
<i>Juncus pallidus</i>	0.1	0.1	Rush - low
<i>Lolium rigidum</i>	5	5	Tussock grass - low
<i>Moraea flaccida</i>	0.1	10	Herb
<i>Oxalis pes-caprae</i>	5	30	Herb
<i>Oxalis purpurea</i>		10	Herb
<i>Raphanus raphanistrum</i>	0.1	0.1	Herb
<i>Sonchus oleraceus</i>	0.1		Herb
<i>Trachyantra divaricata</i>	0.1		Herb
<i>Trifolium angustifolium</i> var. <i>angustifolium</i>	5		Herb
<i>Trifolium campestre</i> var. <i>campestre</i>	1		Herb

Site:	R02		
Botanist:	Udani Sirisena & Melissa Hay	Date:	24/10/2014 & 17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 408310mE, 6495369mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-white sandy-clay loam on banks, with common pebbles of quartz and granite along drainage line		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>	60	80	Tussock grass - low
<i>Briza maxima</i>	5		Tussock grass - low
<i>Bromus diandrus</i>	10		Tussock grass - low
<i>Cynodon dactylon</i>		3	Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>	70	70	Tree - low
<i>Gomphocarpus fruticosus</i>	0.1	0.1	Shrub - mid
<i>Hordeum leporinum</i>	1		Tussock grass - low
<i>Juncus pallidus</i>	0.1	0.1	Rush - low
<i>Lolium rigidum</i>	10	3	Tussock grass - low
<i>Moraea flaccida</i>		0.1	Herb
<i>Oxalis pes-caprae</i>	1	20	Herb
<i>Oxalis purpurea</i>		1	Herb
<i>Raphanus raphanistrum</i>	0.1	0.1	Herb
<i>Rumex hypogaeus</i>		0.1	Herb
<i>Sonchus oleraceus</i>	1		Herb
<i>Trachyandra divaricata</i>	0.1		Herb
<i>Trifolium angustifolium</i> var. <i>angustifolium</i>	5		Herb

Site:	R03		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Releve	NW corner (GDA94):	50J 409289mE, 6495096mN
Habitat:	Hillslope (footslope, gentle west-facing slope)		
Surface layer:	Brown-white sandy-clay loam, with no rocks		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Acacia pulchella</i>	2		Shrub - low
<i>Avena barbata</i>	20		Tussock grass - low
<i>Briza maxima</i>	5		Tussock grass - low
<i>Bromus hordeaceus</i>	5		Tussock grass - low
<i>Corymbia calophylla</i>	20		Tree - low
<i>Hakea erinacea</i>	0.1		Shrub - low
<i>Hesperantha falcata</i>	5		Herb
<i>Hibbertia commutata</i>	0.1		Shrub - low
<i>Nuytsia floribunda</i>	1		Shrub - tall
<i>Vulpia bromoides</i>	1		Tussock grass - low
<i>Xanthorrhoea preissii</i>	2		Shrub - low

Site:	R04		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Releve	NW corner (GDA94):	50J 408829mE, 6496254mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-white sandy-clay loam on banks and bed		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>	1		Herb
<i>Avena fatua</i>	10		Tussock grass - low
<i>Avena barbata</i>	70		Tussock grass - low
<i>Bromus hordeaceus</i>	10		Tussock grass - low
<i>Ehrharta longiflora</i>	1		Tussock grass - low
<i>Eucalyptus rudis subsp. rudis</i>	20		Tree - low
<i>Eucalyptus wandoo subsp. wandoo</i>	1		Tree - low
<i>Hordeum leporinum</i>	20		Tussock grass - low
<i>Juncus pallidus</i>	0.1		Rush - low
<i>Lolium rigidum</i>	10		Tussock grass - low

Site:	R05		
Botanist:	Udani Sirisena & Melissa Hay	Date:	24/10/2014 & 17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 409265mE, 6496316mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-white sandy-clay loam on banks and bed, with many boulders of granite		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		0.1	Herb
<i>Avena barbata</i>	20	40	Tussock grass - low
<i>Bromus diandrus</i>	1		Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>	60	60	Tree - low
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>	10	10	Tree - low
<i>Hordeum leporinum</i>	1		Tussock grass - low
<i>Lolium rigidum</i>	1	0.1	Tussock grass - low
<i>Moraea flaccida</i>		5	Herb
<i>Oxalis pes-caprae</i>	1	5	Herb
<i>Oxalis purpurea</i>		1	Herb
<i>Sonchus oleraceus</i>		0.1	Herb
<i>Stachys arvensis</i>		0.1	Herb

Site:	R06		
Botanist:	Udani Sirisena & Melissa Hay	Date:	24/10/2014 & 17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 409325mE, 6496342mN
Habitat:	Plain - edge of dam		
Surface layer:	Brown-white sandy-clay loam on banks and bed		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>	2	2	Herb
<i>Avena barbata</i>	40	50	Tussock grass - low
<i>Briza maxima</i>	0.1		Tussock grass - low
<i>Briza minor</i>	0.1		Tussock grass - low
<i>Bromus diandrus</i>	20		Tussock grass - low
<i>Corymbia calophylla</i>	2	2	Tree - low
<i>Cynodon dactylon</i>		5	Tussock grass - low
<i>Ehrharta calycina</i>	30		Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>	20	20	Tree - low to mid
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>	10	10	Tree - low
<i>Haemodorum laxum</i>	0.1		Herb
<i>Hesperantha falcata</i>	2		Herb
<i>Hypochoeris glabra</i>	0.1		Herb
Inadequate material	0.1		Tussock grass - low
Inadequate material	0.1		Herb
<i>Lolium rigidum</i>	20	20	Tussock grass - low
<i>Lotus angustissimus</i>	2		Herb
<i>Lupinus cosentinii</i>	0.1		Herb
<i>Moraea flaccida</i>	0.1	8	Herb
<i>Neurachne alopecuroidea</i>	0.1		Tussock grass - low
<i>Oxalis pes-caprae</i>	2	10	Herb
<i>Oxalis purpurea</i>		2	Herb
<i>Solanum linnaeanum</i>	0.1		Shrub - mid
<i>Trifolium angustifolium</i> var. <i>angustifolium</i>	0.1		Herb
<i>Trifolium campestre</i> var. <i>campestre</i>	0.1		Herb

Site:	R07		
Botanist:	Udani Sirisena & Melissa Hay	Date:	24/10/2014 & 17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 408377mE, 6496136mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-white sandy-clay loam on banks and bed		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>	40	70	Tussock grass - low
<i>Brizia maxima</i>	5		Tussock grass - low
<i>Corymbia calophylla</i>	5	5	Tree - low
<i>Cynodon dactylon</i>		5	Tussock grass - low
<i>Eucalyptus rudis subsp. rudis</i>	40	40	Tree - low
<i>Fumaria capreolata</i>	2		Climber
<i>Gastrolobium spinosum</i>	0.1	0.1	Shrub - mid
<i>Hakea lissocarpa</i>	0.1	0.1	Shrub - low
<i>Hordeum leporinum</i>	5		Tussock grass - low
<i>Hypochaeris glabra</i>	2	0.1	Herb
<i>Juncus pallidus</i>	0.1	0.1	Rush - low
<i>Lupinus cosentinii</i>		0.1	Herb
<i>Lysimachia arvensis</i>	2		Herb
<i>Orobanche minor</i>	2		Herb
<i>Oxalis pes-caprae</i>	2	10	Herb
<i>Oxalis purpurea</i>		0.1	Herb
<i>Raphanus raphanistrum</i>		0.1	Herb
<i>Solanum linnaeanum</i>		0.1	Shrub - mid
<i>Stachys arvensis</i>	2		Herb
<i>Zantedeschia aethiopica</i>		0.1	Herb

Site:	R08		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Releve	NW corner (GDA94):	50J 409301mE, 6496030mN
Habitat:	Hillslope (midslope, gentle west facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	7 (Completely degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Re-vegetated strip with planted species, high level weeds, litter		



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>	60		Tussock grass - low
<i>Eucalyptus rudis subsp. rudis</i>	80		Tree - low
<i>Hordeum leporinum</i>	1		Tussock grass - low
<i>Lolium rigidum</i>	1		Tussock grass - low
<i>Solanum linnaeanum</i>	0.1		Shrub - low
<i>Trifolium campestre var. campestre</i>	1		Herb

Site:	R09		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Releve	NW corner (GDA94):	50J 408778mE, 6496250mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-black sandy-clay loam on banks and bed		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>	60		Tussock grass - low
<i>Briza maxima</i>	1		Tussock grass - low
<i>Briza minor</i>	0.1		Tussock grass - low
<i>Bromus diandrus</i>	1		Tussock grass - low
<i>Eucalyptus rudis subsp. rudis</i>	80		Tree - low
<i>Hordeum leporinum</i>	1		Tussock grass - low
<i>Lolium rigidum</i>	1		Tussock grass - low
<i>Trifolium campestre var. campestre</i>	1		Herb

Site:	R10		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Releve	NW corner (GDA94):	50J 408340mE, 6495317mN
Habitat:	Plain - cleared paddock		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	7 (Completely degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Parkland cleared		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>	20		Tussock grass - low
<i>Eucalyptus rudis subsp. rudis</i>	0.1		Shrub - low
<i>Hesperantha falcata</i>	1		Herb
<i>Lotus angustissimus</i>	30		Herb
<i>Lupinus cosentinii</i>	50		Herb
<i>Pentameris airoides</i>	10		Tussock grass - low
<i>Vulpia myuros</i>	0.1		Tussock grass - low

Site:	R11		
Botanist:	Udani Sirisena & Melissa Hay	Date:	24/10/2014 & 17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 408314mE, 6495194mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-black sandy-clay loam on banks and bed		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		0.1	Herb
<i>Avena barbata</i>	50	80	Tussock grass - low
<i>Briza maxima</i>	2		Tussock grass - low
<i>Briza minor</i>	1		Tussock grass - low
<i>Bromus diandrus</i>	2		Tussock grass - low
<i>Cynodon dactylon</i>		3	Tussock grass - low
<i>Ehrharta longiflora</i>	0.1		Tussock grass - low
<i>Eucalyptus rudis subsp. rudis</i>	50	50	Tree - low to mid
<i>Lolium rigidum</i>	5	7	Tussock grass - low
<i>Lupinus cosentinii</i>		0.1	Herb
<i>Moraea flaccida</i>		5	Herb
<i>Oxalis pes-caprae</i>	2	10	Herb
<i>Oxalis purpurea</i>		0.1	Herb
<i>Raphanus raphanistrum</i>		0.1	Herb
<i>Zantedeschia aethiopica</i>	0.1	0.1	Herb

Site:	R12		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Releve	NW corner (GDA94):	50J 409590mE, 6495570mN
Habitat:	Hillslope (midslope, gentle east facing slope)		
Surface layer:	Brown-white sandy-clay loam, with no rocks		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>	1		Herb
<i>Avena fatua</i>	1		Tussock grass - low
<i>Briza maxima</i>	1		Tussock grass - low
<i>Briza minor</i>	1		Tussock grass - low
<i>Bromus diandrus</i>	1		Tussock grass - low
<i>Corymbia calophylla</i>	60		Tree - low
<i>Hordeum leporinum</i>	1		Tussock grass - low
<i>Lolium rigidum</i>	1		Tussock grass - low

Site:	R13		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Releve	NW corner (GDA94):	50J 408893mE, 6495550mN
Habitat:	Plain - cleared paddock		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	7 (Completely degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Parkland cleared		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>	25		Tussock grass - low
<i>Arctotheca calendula</i>	1		Herb
<i>Bromus diandrus</i>	40		Tussock grass - low
<i>Lupinus cosentinii</i>	30		Herb
<i>Trifolium angustifolium</i> var. <i>angustifolium</i>	5		Herb
<i>Trifolium arvense</i> var. <i>arvense</i>	0.1		Herb

Site:	R14		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Releve	NW corner (GDA94):	50J 408910mE, 6495551mN
Habitat:	Plain - cleared paddock		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	7 (Completely degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Parkland cleared		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>	0.1		Tussock grass - low
<i>Arctotheca calendula</i>	1		Herb
<i>Lupinus cosentinii</i>	1		Herb
<i>Trifolium angustifolium</i> var. <i>angustifolium</i>	1		Herb
<i>Trifolium campestre</i> var. <i>campestre</i>	1		Herb
<i>Triticum aestivum</i>	90		Tussock grass - low

Site:	R15		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 409678mE, 6495912mN
Habitat:	Hillslope (hilltop, gentle slope)		
Surface layer:	Brown sandy-clay loam, with few granite pebbles		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Acacia pulchella</i>		0.1	Shrub - mid
<i>Arctotheca calendula</i>		0.1	Herb
<i>Avena barbata</i>		90	Tussock grass - low
<i>Corymbia calophylla</i>		10	Tree - low
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>		20	Tree - low
<i>Moraea flaccida</i>		0.1	Herb
<i>Oxalis corniculata</i>		0.1	Herb
<i>Rytidosperma setaceum</i>		3	Tussock grass - low
<i>Solanum linnaeanum</i>		0.1	Shrub - mid

Site:	R16		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 411249mE, 6496024mN
Habitat:	Hillslope (footslope, moderate west-facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		3	Herb
<i>Avena barbata</i>		80	Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		25	Tree - low
<i>Gomphocarpus fruticosus</i>		0.1	Shrub - mid
<i>Moraea flaccida</i>		5	Herb
<i>Sonchus oleraceus</i>		0.1	Herb
<i>Stachys arvensis</i>		0.1	Herb

Site:	R17		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410780mE, 6496418mN
Habitat:	Drainage line on footslope		
Surface layer:	Brown-white sandy-clay loam on banks, with common pebbles and stones of granite along drainage line		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Asparagus asparagoides</i>		0.1	Climber
<i>Avena barbata</i>		80	Tussock grass - low
<i>Cyperus tenuiflorus</i>		0.1	Sedge - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		80	Tree - low
<i>Lepidosperma leptostachyum</i>		0.1	Shrub - low
<i>Lysimachia arvensis</i>		0.1	Herb
<i>Oxalis pes-caprae</i>		3	Herb
<i>Oxalis purpurea</i>		1	Herb
<i>Rumex hypogaeus</i>		0.1	Herb
<i>Stachys arvensis</i>		0.1	Herb

Site:	R18		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 409999mE, 6496285mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-white sandy-clay loam on banks, with few pebbles and stones of quartz and granite along drainage line		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		0.1	Herb
<i>Asparagus asparagoides</i>		0.1	Climber
<i>Avena barbata</i>		90	Tussock grass - low
<i>Cynodon dactylon</i>		0.1	Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		50	Tree - low
<i>Gomphocarpus fruticosus</i>		1	Shrub - mid
<i>Juncus pallidus</i>		0.1	Rush - low
<i>Lolium rigidum</i>		15	Tussock grass - low
<i>Oxalis pes-caprae</i>		10	Herb
<i>Oxalis purpurea</i>		0.1	Herb
<i>Solanum linnaeanum</i>		0.1	Shrub - mid
<i>Stachys arvensis</i>		0.1	Herb

Site:	R19		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 408324mE, 6495550mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-white sandy-clay loam on banks, with few pebbles and stones of quartz and granite along drainage line		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		0.1	Herb
<i>Avena barbata</i>		70	Tussock grass - low
<i>Cynodon dactylon</i>		5	Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		50	Tree - low to mid
<i>Gomphocarpus fruticosus</i>		0.1	Shrub - mid
<i>Lolium rigidum</i>		5	Tussock grass - low
<i>Lupinus cosentinii</i>		0.1	Herb
<i>Moraea flaccida</i>		0.1	Herb
<i>Oxalis pes-caprae</i>		40	Herb
<i>Oxalis purpurea</i>		20	Herb
<i>Rumex hypogaeus</i>		0.1	Herb
<i>Sonchus oleraceus</i>		0.1	Herb

Site:	R20		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 408303mE, 6495448mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-white sandy-clay loam on banks, with common pebbles and stones of quartz and granite along drainage line		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>		80	Tussock grass - low
<i>Cynodon dactylon</i>		3	Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		60	Tree - low to mid
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>		15	Tree - low
<i>Gomphocarpus fruticosus</i>		0.1	Shrub - mid
<i>Juncus pallidus</i>		1	Rush - low
<i>Lepidosperma squamatum</i>		0.1	Sedge - low
<i>Lolium rigidum</i>		5	Tussock grass - low
<i>Moraea flaccida</i>		1	Herb
<i>Oxalis pes-caprae</i>		20	Herb
<i>Oxalis purpurea</i>		3	Herb

Site:	R21		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 409299mE, 6495081mN
Habitat:	Hillslope (footslope, gentle west-facing slope)		
Surface layer:	Brown sandy-clay loam, with few granite pebbles		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Acacia pulchella</i>		3	Shrub - mid
<i>Avena barbata</i>		90	Tussock grass - low
<i>Corymbia calophylla</i>		40	Tree - low
<i>Hibbertia commutata</i>		0.5	Shrub - low
<i>Lepidosperma leptostachyum</i>		1	Shrub - low
<i>Moraea flaccida</i>		3	Herb
<i>Nuytsia floribunda</i>		1	Shrub - tall

Site:	R22		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410307mE, 6496953mN
Habitat:	Drainage line on hillslope (footslope, moderate west-facing slope)		
Surface layer:	Brown-white sandy-clay loam on banks, with common pebbles of quartz and granite along drainage line		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Acacia pulchella</i>		2	Shrub - mid
<i>Acacia saligna</i> subsp. <i>lindleyi</i>		1	Shrub - tall
<i>Corymbia calophylla</i>		60	Tree - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		15	Tree - low
<i>Hakea erinacea</i>		0.1	Shrub - mid
<i>Lepidosperma squamatum</i>		2	Sedge - low
<i>Lysimachia arvensis</i>		5	Herb

Site:	R23		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410852mE, 6496017mN
Habitat:	Hillslope (midslope, gentle east facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		10	Herb
<i>Avena barbata</i>		90	Tussock grass - low
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>		10	Tree - low
<i>Moraea flaccida</i>		10	Herb
<i>Oxalis corniculata</i>		5	Herb
<i>Rytidosperma setaceum</i>		2	Tussock grass - low
<i>Solanum linnaeanum</i>		0.1	Shrub - mid
<i>Sonchus oleraceus</i>		0.1	Herb

Site:	R24		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410724mE, 6495501mN
Habitat:	Hillslope (hilltop, gentle slope)		
Surface layer:	Brown sandy-clay loam, with many pebbles, stones and boulders of laterite		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		10	Herb
<i>Avena barbata</i>		60	Tussock grass - low
<i>Corymbia calophylla</i>		40	Tree - low
<i>Dioscorea hastifolia</i>		0.1	Climber
<i>Jacksonia floribundum</i>		5	Shrub - tall
<i>Moraea flaccida</i>		5	Herb
<i>Oxalis corniculata</i>		10	Herb
<i>Phyllanthus calycinus</i>		0.1	Shrub - low

Site:	R25		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410558mE, 6495446mN
Habitat:	Hillslope (footslope, gentle west-facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		2	Herb
<i>Avena barbata</i>		70	Tussock grass - low
<i>Avena barbata</i>		0.1	Tussock grass - low
<i>Eucalyptus wandoo subsp. wandoo</i>		60	Tree - low
<i>Moraea flaccida</i>		30	Herb
<i>Oxalis corniculata</i>		1	Herb
<i>Rytidosperma setaceum</i>		0.1	Tussock grass - low
<i>Solanum linnaeanum</i>		0.1	Shrub - mid

Site:	R26		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410907mE, 6496063mN
Habitat:	Drainage line on hillslope (midslope, moderate east-facing slope)		
Surface layer:	Brown sandy-clay loam, with few granite boulders		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		10	Herb
<i>Avena barbata</i>		90	Tussock grass - low
<i>Cheilanthes distans</i>		0.1	Herb
<i>Eucalyptus rudis subsp. rudis</i>		10	Tree - low
<i>Moraea flaccida</i>		10	Herb
<i>Oxalis corniculata</i>		5	Herb
<i>Rytidosperma setaceum</i>		2	Tussock grass - low
<i>Solanum linnaeanum</i>		0.1	Shrub - mid
<i>Sonchus oleraceus</i>		0.1	Herb

Site:	R27		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410773mE, 6496186mN
Habitat:	Hillslope (footslope, gentle west-facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>		70	Tussock grass - low
<i>Corymbia calophylla</i>		30	Tree - low
<i>Moraea flaccida</i>		20	Herb
<i>Oxalis corniculata</i>		2	Herb
<i>Solanum linnaeanum</i>		0.1	Shrub - mid
<i>Sonchus oleraceus</i>		0.1	Herb

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APPENDIX D SITE BY SPECIES MATRIX

Taxon	OPP	Q01	Q02	Q03	Q04	Q05	Q06	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27			
<i>Acacia ?baileyana</i>	0.1																																				
<i>Acacia ?applanata</i>					0																																
<i>Acacia podalyriifolia</i>	0.1																																				
<i>Acacia pulchella</i>				5	5		5				2											0.1															
<i>Acacia saligna</i> subsp. <i>lindleyi</i>																																					
<i>Acacia urophylla</i>	0.1																																				
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	1																																				
<i>Arctotheca calendula</i>												1	0.1	2				0.1	1	1	1	0.1	3		0.1	0.1				10	10	2	10				
<i>Asparagus asparagoides</i>																									0.1	0.1											
<i>Avena barbata</i>		1					5	50	80	80	20		40	50	70	60	60	30	80		25	0.1	90	80	80	90	70	80	90		90	60	70	90	70		
<i>Avena fatua</i>											10									1																	
<i>Babiana angustifolia</i>	0.1																																				
<i>Banksia armata</i> var. <i>armata</i>	1																																				
<i>Banksia sessilis</i> var. <i>sessilis</i>								0.1																													
<i>Bossiaea eriocarpa</i>				30				20																													
<i>Bougainvillea glabra</i>	0.1																																				
<i>Briza maxima</i>			1						1	5	5			0.1	5		1	2	1																		
<i>Briza minor</i>								0.1						0.1			0.1	1	1																		
<i>Bromus diandrus</i>								5	10				1	20			1	2	1	40																	
<i>Bromus hordeaceus</i>																																					
<i>Burchardia congesta</i>		1	0.1	0.1	0.1	0.1																															
<i>Cenchrus clandestinus</i>	0.1																																				
<i>Cenchrus setaceus</i>	0.1																																				
<i>Cheilanthes distans</i>																																			0.1		
<i>Corymbia calophylla</i>				50	2		20				20			2	5								10						40	60		40				30	
<i>Cynodon dactylon</i>								20	3		20			5	5				3							0.1	5	3		40	60		40				
<i>Cyperus involucreatus</i>	0.1																																				
<i>Cyperus tenuiflorus</i>																									0.1												
<i>Daucus glochidiatus</i>		1																																			
<i>Desmodium flexuosus</i>							2																														
<i>Dianella revoluta</i>		1																																			
<i>Digitaria ciliaris</i>																																					
<i>Dioscorea hastifolia</i>																																			0.1		
<i>Drosera macrantha</i>	0.1																																				
<i>Ehrharta calycina</i>														30																							
<i>Ehrharta longiflora</i>											1							0.1																			
<i>Eragrostis curvula</i>	0.1																																				
<i>Eriochilus dilatatus</i> subsp. <i>undulatus</i>	0.1																																				
<i>Erodium botrys</i>	0.1																																				
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>									50	70		0.1	60	20	40	80	80	0.1	50				25	80	50	50	60		15		15			10			
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>		70	50	2	15	70	10					20	10	10								2		20				15			10						
<i>?Exocarpos sparteus</i>						0.1																															
<i>Fumaria capreolata</i>																	2																				
<i>Gastrolobium retusum</i>	1																																				
<i>Gastrolobium spinosum</i>	20	10	1	80	20	5									0.1																						
<i>Gomphocarpus fruticosus</i>								0.1	0.1														0.1			1	0.1	0.1									
<i>Goodenia coerulea</i>	0.1																																				
<i>Haemodorum laxum</i>														0.1																							
<i>Hakea erinacea</i>											0.1																									0.1	
<i>Hakea lissocarpa</i>	1	1	0.1				0.1								0.1																						
<i>Hakea undulata</i>							0.1																														
<i>Hesperantha falcata</i>	1	1									5				2																						
<i>Hibbertia commutata</i>				0.1	0.1			1			0.1																									0.5	
<i>Hibbertia hypericoides</i> subsp. <i>hypericoides</i>	1						0.1																														
<i>Hordeum leporinum</i>									20	1		20	1			5	1	1			1																
<i>Hypocalymma angustifolium</i>			1	5	0.1	0.1	20																														
<i>Hypochoeris glabra</i>														0.1	0.1																						
<i>Isopogon</i> sp. 1 (inadequate material)	1																																				
<i>Jacksonia stembergiana</i>																																				5	
<i>Juncus pallidus</i>								0.1	0.1		0.1															0.1		1									
<i>Lasiopetalum floribundum</i>					0.1		0.1																														
<i>Lepidosperma leptostachyum</i>					0.1		4																			0.1										1	
<i>Lepidosperma</i> sp. 1 (inadequate material)																																					
					5																																

Taxon	OPP	Q01	Q02	Q03	Q04	Q05	Q06	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27			
<i>Lepidosperma squamatum</i>					5																					0.1											
<i>Lolium rigidum</i>						0.1		5	3		10	0.1	20			1	1		7	1					15	5	5										
<i>Lotus angustissimus</i>													2					30																			
<i>Lupinus cosentinii</i>													0.1	0.1				50	0.1		30	1				0.1											
<i>Lysimachia arvensis</i>			1																					0.1													
<i>Macrozamia riedlei</i>				0.1			0.1																						5								
<i>Melia azedarach</i>	0.1																																				
<i>Monoculus monstrosus</i>		1																																			
<i>Moraea flaccida</i>							10	10	0.1			5	8					5					0.1	5			0.1	1	3		10	5	30	10	20		
<i>Neurachne alopecuroidea</i>		1	1										0.1																								
<i>Nuytsia floribunda</i>										1																			1								
<i>Olea europaea subsp. europaea</i>	0.1																																				
<i>Orobanche minor</i>															2																						
<i>Oxalis corniculata</i>				2			1																0.1														
<i>Oxalis pes-caprae</i>								30	20			5	10	10				10							3	10	40	20									
<i>Oxalis purpurea</i>								10	1			1	2	0.1				0.1							1	0.1	20	3									
<i>Paterersonia occidentalis</i>					0.1																																
<i>Pentameris alroides</i>		1																																			
<i>Phyllanthus calycinus</i>				0.1			1																														
<i>Raphanus raphanistrum</i>								0.1	0.1							0.1			0.1																		
<i>Ricinus communis</i>	0.1																																				
<i>Rumex hypogaeus</i>									0.1																0.1		0.1										
<i>Rytidosperma setaceum</i>																								3									2		0.1	2	
<i>Schinus molle</i>	0.1																																				
<i>Solanum linnaeanum</i>													0.1	0.1	0.1								0.1			0.1						0.1		0.1	0.1	0.1	
<i>Solanum nigrum</i>	0.1																																				
<i>Sonchus asper</i>		1																																			
<i>Sonchus oleraceus</i>				4				0.1	1				0.1											0.1			0.1								0.1	0.1	
<i>Stachys arvensis</i>													0.1		2									0.1	0.1	0.1											
<i>Stylidium affine</i>		1				0.1																															
<i>Stylidium bulbiferum</i>		0.1																																			
<i>Stylidium repens</i>				0.1																																	
<i>Thomasia foliosa</i>		1	1			0.1	0.1																														
<i>Thysanotus patersonii</i>		0.1				0.1		0.1																													
<i>Trachyantra divaricata</i>								0.1	0.1																												
<i>Trifolium angustifolium</i> var. <i>angustifolium</i>				1					5	5				0.1																							
<i>Trifolium arvense</i> var. <i>arvense</i>																																					
<i>Trifolium campestre</i> var. <i>campestre</i>								1						0.1		1	1																				
<i>Triticum aestivum</i>																																					
<i>Tropaeolum majus</i>	0.1																																				
<i>Trymalium odoratissimum</i> subsp. <i>odoratissimum</i>					0.1		1																														
<i>Typha ?orientalis</i>	0.1																																				
<i>Ursinia anthemoides</i>		0.1	1																																		
<i>Vulpia bromoides</i>										1																											
<i>Vulpia myuros</i>			1														0.1																				
<i>Xanthorrhoea preissii</i>		2	3	3	1	15	0.1				2																										
<i>Xanthosia candida</i>			1	0.1		0.1																															
<i>Zantedeschia aethiopica</i>	0.1														0.1				0.1																		

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APPENDIX E FLORA SPECIES LIST

Family	Taxon	Phase 1	Phase 2
Anacardiaceae	* <i>Schinus molle</i>		x
Apiaceae	<i>Daucus glochidiatus</i>	x	
Apiaceae	<i>Xanthosia candida</i>	x	x
Apocynaceae	* <i>Gomphocarpus fruticosus</i> (Declared Pest - not at Project area)	x	x
Araceae	* <i>Zantedeschia aethiopica</i> (Declared Pest - at Project area)	x	x
Asparagaceae	* <i>Asparagus asparagoides</i> (WONS)		x
Asparagaceae	<i>Thysanotus patersonii</i>	x	x
Asphodelaceae	* <i>Trachyandra divaricata</i>	x	
Asteraceae	* <i>Arctotheca calendula</i>	x	x
Asteraceae	* <i>Hypochaeris glabra</i>	x	x
Asteraceae	* <i>Monoculus monstrosus</i>	x	
Asteraceae	* <i>Sonchus asper</i>	x	
Asteraceae	* <i>Sonchus oleraceus</i>	x	x
Asteraceae	* <i>Ursinia anthemoides</i>	x	
Brassicaceae	* <i>Raphanus raphanistrum</i>	x	x
Colchicaceae	<i>Burchardia congesta</i>	x	x
Cyperaceae	* <i>Cyperus involuocratus</i>		x
Cyperaceae	* <i>Cyperus tenuiflorus</i>		x
Cyperaceae	<i>Lepidosperma leptostachyum</i>		x
Cyperaceae	<i>Lepidosperma</i> sp.1 (Inadequate material)		x
Cyperaceae	<i>Lepidosperma squamatum</i>	x	x
Dilleniaceae	<i>Hibbertia commutata</i>	x	x
Dilleniaceae	<i>Hibbertia hypericoides</i> subsp. <i>hypericoides</i>	x	x
Dioscoreaceae	<i>Dioscorea hastifolia</i>		x
Droseraceae	<i>Drosera macrantha</i>		x
Euphorbiaceae	* <i>Ricinus communis</i>		x
Fabaceae	<i>Acacia ?baileyana</i>		x
Fabaceae	<i>Acacia ?applanata</i>		x
Fabaceae	* <i>Acacia podalyriifolia</i>		x
Fabaceae	<i>Acacia pulchella</i>	x	x
Fabaceae	<i>Acacia saligna</i> subsp. <i>lindleyi</i>		x
Fabaceae	<i>Acacia urophylla</i>		x
Fabaceae	<i>Bossiaea eriocarpa</i>	x	x
Fabaceae	<i>Gastrolobium retusum</i>	x	
Fabaceae	<i>Gastrolobium spinosum</i>	x	x
Fabaceae	<i>Jacksonia sternbergiana</i>		x
Fabaceae	* <i>Lotus angustissimus</i>	x	
Fabaceae	* <i>Lupinus cosentinii</i>	x	x
Fabaceae	* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	x	x
Fabaceae	* <i>Trifolium arvense</i> var. <i>arvense</i>	x	
Fabaceae	* <i>Trifolium campestre</i> var. <i>campestre</i>	x	
Geraniaceae	* <i>Erodium botrys</i>		x
Goodeniaceae	<i>Goodenia coerulea</i>	x	
Haemodoraceae	<i>Haemodorum laxum</i>	x	
Iridaceae	* <i>Babiana angustifolia</i>	x	
Iridaceae	* <i>Hesperantha falcata</i>	x	
Iridaceae	* <i>Moraea flaccida</i> (Declared Pest - not at Project area)	x	x
Iridaceae	<i>Patersonia occidentalis</i>		x
Juncaceae	<i>Juncus pallidus</i>	x	x
Lamiaceae	* <i>Stachys arvensis</i>	x	x
Loranthaceae	<i>Nuytsia floribunda</i>	x	x
Malvaceae	<i>Lasiopetalum floribundum</i>		x
Malvaceae	<i>Thomasia foliosa</i>	x	x
Meliaceae	* <i>Melia azedarach</i>		x
Myrtaceae	<i>Corymbia calophylla</i>	x	x
Myrtaceae	<i>Eucalyptus rudis</i> subsp. <i>rudis</i>	x	x
Myrtaceae	<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>	x	x
Myrtaceae	<i>Hypocalymma angustifolium</i>	x	x
Nyctaginaceae	* <i>Bougainvillea glabra</i>		x
Oleaceae	* <i>Olea europaea</i> subsp. <i>europaea</i>		x
Orchidaceae	<i>Eriochilus dilatatus</i> subsp. <i>undulatus</i>		x
Orobanchaceae	* <i>Orobanche minor</i>	x	
Oxalidaceae	* <i>Oxalis corniculata</i>		x
Oxalidaceae	* <i>Oxalis pes-caprae</i>	x	x
Oxalidaceae	* <i>Oxalis purpurea</i>		x
Papaveraceae	* <i>Fumaria capreolata</i>	x	
Phormiaceae	<i>Dianella revoluta</i>	x	
Phyllanthaceae	<i>Phyllanthus calycinus</i>		x

Family	Taxon	Phase 1	Phase 2
Poaceae	* <i>Avena barbata</i>	X	X
Poaceae	* <i>Avena fatua</i>	X	
Poaceae	* <i>Briza maxima</i>	X	
Poaceae	* <i>Briza minor</i>	X	
Poaceae	* <i>Bromus diandrus</i>	X	
Poaceae	* <i>Bromus hordeaceus</i>	X	
Poaceae	* <i>Cenchrus clandestinus</i>	X	
Poaceae	* <i>Cenchrus setaceus</i>		X
Poaceae	* <i>Cynodon dactylon</i>		X
Poaceae	* <i>Digitaria ciliaris</i>		X
Poaceae	* <i>Ehrharta calycina</i>	X	
Poaceae	* <i>Ehrharta longiflora</i>	X	
Poaceae	* <i>Eragrostis curvula</i>		X
Poaceae	* <i>Hordeum leporinum</i>	X	
Poaceae	* <i>Lolium rigidum</i>	X	X
Poaceae	<i>Neurachne alopecuroidea</i>	X	
Poaceae	* <i>Pentameris airoides</i>	X	X
Poaceae	<i>Rytidosperma setaceum</i>	X	X
Poaceae	* <i>Triticum aestivum</i>	X	
Poaceae	* <i>Vulpia bromoides</i>	X	
Poaceae	* <i>Vulpia myuros</i>	X	
Polygonaceae	* <i>Rumex hypogaeus</i> (Declared Pest - not at Project area)		X
Primulaceae	* <i>Lysimachia arvensis</i>	X	X
Proteaceae	<i>Hakea erinacea</i>	X	X
Proteaceae	<i>Hakea lissocarpa</i>	X	X
Proteaceae	<i>Hakea undulata</i>		X
Proteaceae	<i>Isopogon</i> sp. 1 (inadequate material)	X	
Proteaceae	<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>		X
Proteaceae	<i>Banksia armata</i> var. <i>armata</i>		X
Proteaceae	<i>Banksia sessilis</i> var. <i>sessilis</i>		X
Pteridaceae	<i>Cheilanthes distans</i>		X
Restionaceae	<i>Desmocladus flexuosus</i>		X
Rhamnaceae	<i>Trymalium odoratissimum</i> subsp. <i>odoratissimum</i>		X
Santalaceae	? <i>Exocarpos sparteus</i>		X
Solanaceae	* <i>Solanum linnaeanum</i> (Declared Pest - not at Project area)	X	X
Solanaceae	* <i>Solanum nigrum</i>		X
Stylidiaceae	<i>Stylidium affine</i>	X	X
Stylidiaceae	<i>Stylidium bulbiferum</i>	X	
Stylidiaceae	<i>Stylidium repens</i>		X
Tropaeolaceae	* <i>Tropaeolum majus</i>		X
Typhaceae	* <i>Typha ?orientalis</i>		X
Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>	X	X
Zamiaceae	<i>Macrozamia riedlei</i>		X

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APPENDIX F INTRODUCED FLORA LOCATIONS

Taxon	Easting	Northing	Estimated number of plants
WONS & Declared Pest - s22(2) (C3, whole of state)			
* <i>Asparagus asparagoides</i>	410780	6496418	1
* <i>Asparagus asparagoides</i>	409999	6496285	1
Declared Pest - s22(2) (C3, whole of state)			
* <i>Zantedeschia aethiopica</i>	408377	6496136	1
* <i>Zantedeschia aethiopica</i>	408314	6495194	1
* <i>Zantedeschia aethiopica</i>	408332	6495220	1
* <i>Zantedeschia aethiopica</i>	408302	6495413	1
* <i>Zantedeschia aethiopica</i>	408314	6495194	1
Environmental Weed			
* <i>Acacia ?baileyana</i>	409721	6496169	4
* <i>Acacia podalyriifolia</i>	409454	6496133	5
* <i>Arctotheca calendula</i>	409265	6496316	1
* <i>Arctotheca calendula</i>	408314	6495194	1
* <i>Arctotheca calendula</i>	409678	6495912	1
* <i>Arctotheca calendula</i>	409999	6496285	1
* <i>Arctotheca calendula</i>	408324	6495550	1
* <i>Arctotheca calendula</i>	409325	6496342	5
* <i>Arctotheca calendula</i>	410559	6495446	5
* <i>Arctotheca calendula</i>	411249	6496024	10
* <i>Arctotheca calendula</i>	410852	6496017	20
* <i>Arctotheca calendula</i>	410724	6495501	20
* <i>Arctotheca calendula</i>	410908	6496063	20
* <i>Arctotheca calendula</i>	408829	6496254	1
* <i>Arctotheca calendula</i>	409590	6495570	1
* <i>Arctotheca calendula</i>	408893	6495550	1
* <i>Arctotheca calendula</i>	408910	6495551	1
* <i>Avena barbata</i>	410559	6495446	1
* <i>Avena barbata</i>	411402	6496313	50
* <i>Avena barbata</i>	409265	6496316	500
* <i>Avena barbata</i>	410985	6495619	500
* <i>Avena barbata</i>	409325	6496342	500
* <i>Avena barbata</i>	410724	6495501	500
* <i>Avena barbata</i>	408377	6496136	1,000
* <i>Avena barbata</i>	408324	6495550	1,000
* <i>Avena barbata</i>	410559	6495446	1,000
* <i>Avena barbata</i>	410773	6496186	1,000
* <i>Avena barbata</i>	408324	6495277	1,000
* <i>Avena barbata</i>	408310	6495369	1,000
* <i>Avena barbata</i>	408314	6495194	1,000
* <i>Avena barbata</i>	411249	6496024	1,000
* <i>Avena barbata</i>	410780	6496418	1,000
* <i>Avena barbata</i>	408303	6495448	1,000
* <i>Avena barbata</i>	409678	6495912	1,000
* <i>Avena barbata</i>	409999	6496285	1,000
* <i>Avena barbata</i>	409299	6495081	1,000
* <i>Avena barbata</i>	410852	6496017	1,000
* <i>Avena barbata</i>	410908	6496063	1,000
* <i>Avena barbata</i>	410176	6496615	10
* <i>Avena barbata</i>	409289	6495096	100
* <i>Avena barbata</i>	409301	6496030	1
* <i>Avena barbata</i>	408778	6496250	1
* <i>Avena barbata</i>	408340	6495317	100
* <i>Avena barbata</i>	408893	6495550	30
* <i>Avena barbata</i>	408910	6495551	1
* <i>Avena fatua</i>	408829	6496254	100
* <i>Avena fatua</i>	409590	6495570	10
* <i>Babiana angustifolia</i>	409322	6496336	3
* <i>Bougainvillea glabra</i>	408366	6496167	1
* <i>Briza maxima</i>	410176	6496615	10
* <i>Briza maxima</i>	408324	6495277	10
* <i>Briza maxima</i>	408310	6495369	50
* <i>Briza maxima</i>	409289	6495096	50
* <i>Briza maxima</i>	409325	6496342	1
* <i>Briza maxima</i>	408377	6496136	50
* <i>Briza maxima</i>	408778	6496250	10
* <i>Briza maxima</i>	408314	6495194	50

Taxon	Easting	Northing	Estimated number of plants
* <i>Briza maxima</i>	409590	6495570	10
* <i>Briza minor</i>	408324	6495277	1
* <i>Briza minor</i>	409325	6496342	1
* <i>Briza minor</i>	408778	6496250	1
* <i>Briza minor</i>	408314	6495194	10
* <i>Briza minor</i>	409590	6495570	10
* <i>Bromus diandrus</i>	408324	6495277	50
* <i>Bromus diandrus</i>	408310	6495369	100
* <i>Bromus diandrus</i>	409265	6496316	10
* <i>Bromus diandrus</i>	409325	6496342	100
* <i>Bromus diandrus</i>	408778	6496250	10
* <i>Bromus diandrus</i>	408314	6495194	50
* <i>Bromus diandrus</i>	409590	6495570	10
* <i>Bromus diandrus</i>	408893	6495550	500
* <i>Bromus hordeaceus</i>	408263	6495372	1
* <i>Bromus hordeaceus</i>	408262	6495372	1
* <i>Bromus hordeaceus</i>	409289	6495096	50
* <i>Bromus hordeaceus</i>	408829	6496254	100
* <i>Cenchrus clandestinus</i>	408324	6495277	1
* <i>Cenchrus setaceus</i>	410488	6495423	5
* <i>Cynodon dactylon</i>	409999	6496285	1
* <i>Cynodon dactylon</i>	408310	6495369	50
* <i>Cynodon dactylon</i>	408314	6495194	50
* <i>Cynodon dactylon</i>	408303	6495448	50
* <i>Cynodon dactylon</i>	409325	6496342	50
* <i>Cynodon dactylon</i>	408377	6496136	50
* <i>Cynodon dactylon</i>	408324	6495550	50
* <i>Cynodon dactylon</i>	408324	6495277	100
* <i>Cynodon dactylon</i>	408336	6496059	15
* <i>Cyperus involucratus</i>	408324	6495376	2
* <i>Cyperus involucratus</i>	408336	6496064	5
* <i>Cyperus tenuiflorus</i>	410780	6496418	1
* <i>Digitaria ciliaris</i>	408329	6495612	20
* <i>Ehrharta calycina</i>	409325	6496342	500
* <i>Ehrharta longiflora</i>	408829	6496254	10
* <i>Ehrharta longiflora</i>	408314	6495194	1
* <i>Eragrostis curvula</i>	408329	6495612	20
* <i>Eragrostis curvula</i>	408336	6496067	5
* <i>Erodium botrys</i>	411372	6496132	100
* <i>Fumaria capreolata</i>	408377	6496136	5
* <i>Gomphocarpus fruticosus</i>	408324	6495277	1
* <i>Gomphocarpus fruticosus</i>	408310	6495369	1
* <i>Gomphocarpus fruticosus</i>	411249	6496024	1
* <i>Gomphocarpus fruticosus</i>	408324	6495550	1
* <i>Gomphocarpus fruticosus</i>	408303	6495448	1
* <i>Gomphocarpus fruticosus</i>	409999	6496285	1
* <i>Gomphocarpus fruticosus</i>	409981	6496385	10
* <i>Gomphocarpus fruticosus</i>	410187	6495805	15
* <i>Gomphocarpus fruticosus</i>	408325	6495305	1
* <i>Gomphocarpus fruticosus</i>	408319	6495350	1
* <i>Gomphocarpus fruticosus</i>	408317	6495474	1
* <i>Gomphocarpus fruticosus</i>	411248	6496138	1
* <i>Gomphocarpus fruticosus</i>	408320	6495267	2
* <i>Gomphocarpus fruticosus</i>	410724	6495501	2
* <i>Gomphocarpus fruticosus</i>	410869	6495974	2
* <i>Gomphocarpus fruticosus</i>	408330	6495529	30
* <i>Gomphocarpus fruticosus</i>	408322	6495489	4
* <i>Gomphocarpus fruticosus</i>	408319	6495285	5
* <i>Gomphocarpus fruticosus</i>	408328	6495665	5
* <i>Gomphocarpus fruticosus</i>	410641	6496326	5
* <i>Gomphocarpus fruticosus</i>	411194	6496233	5
* <i>Hesperantha falcata</i>	411560	6496144	1
* <i>Hesperantha falcata</i>	410176	6496615	1
* <i>Hesperantha falcata</i>	409289	6495096	10
* <i>Hesperantha falcata</i>	409325	6496342	5
* <i>Hesperantha falcata</i>	408340	6495317	1
* <i>Hordeum leporinum</i>	408324	6495277	100

Taxon	Easting	Northing	Estimated number of plants
* <i>Hordeum leporinum</i>	408310	6495369	10
* <i>Hordeum leporinum</i>	408829	6496254	100
* <i>Hordeum leporinum</i>	409265	6496316	10
* <i>Hordeum leporinum</i>	408377	6496136	50
* <i>Hordeum leporinum</i>	409301	6496030	10
* <i>Hordeum leporinum</i>	408778	6496250	10
* <i>Hordeum leporinum</i>	409590	6495570	10
* <i>Hypochaeris glabra</i>	408377	6496136	1
* <i>Hypochaeris glabra</i>	409325	6496342	1
* <i>Lolium rigidum</i>	411402	6496313	1
* <i>Lolium rigidum</i>	409265	6496316	1
* <i>Lolium rigidum</i>	408310	6495369	50
* <i>Lolium rigidum</i>	408324	6495277	50
* <i>Lolium rigidum</i>	408324	6495550	50
* <i>Lolium rigidum</i>	408303	6495448	50
* <i>Lolium rigidum</i>	408314	6495194	50
* <i>Lolium rigidum</i>	409999	6496285	100
* <i>Lolium rigidum</i>	409325	6496342	100
* <i>Lolium rigidum</i>	408829	6496254	100
* <i>Lolium rigidum</i>	409301	6496030	10
* <i>Lolium rigidum</i>	408778	6496250	10
* <i>Lolium rigidum</i>	409590	6495570	10
* <i>Lotus angustissimus</i>	409325	6496342	5
* <i>Lotus angustissimus</i>	408340	6495317	20
* <i>Lupinus cosentinii</i>	408377	6496136	1
* <i>Lupinus cosentinii</i>	408314	6495194	1
* <i>Lupinus cosentinii</i>	408324	6495550	1
* <i>Lupinus cosentinii</i>	409325	6496342	1
* <i>Lupinus cosentinii</i>	408340	6495317	30
* <i>Lupinus cosentinii</i>	408893	6495550	30
* <i>Lupinus cosentinii</i>	408910	6495551	1
* <i>Lysimachia arvensis</i>	410780	6496418	1
* <i>Lysimachia arvensis</i>	410307	6496953	10
* <i>Lysimachia arvensis</i>	408338	6496065	10
* <i>Lysimachia arvensis</i>	410176	6496615	1
* <i>Lysimachia arvensis</i>	408377	6496136	5
* <i>Melia azedarach</i>	410015	6496307	1
* <i>Monoculus monstrosus</i>	411560	6496144	1
* <i>Moraea flaccida</i>	408310	6495369	1
* <i>Moraea flaccida</i>	409678	6495912	1
* <i>Moraea flaccida</i>	408324	6495550	1
* <i>Moraea flaccida</i>	408303	6495448	1
* <i>Moraea flaccida</i>	409299	6495081	10
* <i>Moraea flaccida</i>	409265	6496316	10
* <i>Moraea flaccida</i>	408314	6495194	10
* <i>Moraea flaccida</i>	411249	6496024	10
* <i>Moraea flaccida</i>	410724	6495501	10
* <i>Moraea flaccida</i>	409325	6496342	10
* <i>Moraea flaccida</i>	410985	6495619	20
* <i>Moraea flaccida</i>	408324	6495277	20
* <i>Moraea flaccida</i>	410852	6496017	20
* <i>Moraea flaccida</i>	410908	6496063	20
* <i>Moraea flaccida</i>	410773	6496186	20
* <i>Moraea flaccida</i>	410559	6495446	30
* <i>Moraea flaccida</i>	409322	6496336	2
* <i>Olea europaea subsp. europaea</i>	408360	6496128	1
* <i>Orobanche minor</i>	408377	6496136	5
* <i>Oxalis corniculata</i>	409678	6495912	1
* <i>Oxalis corniculata</i>	410985	6495619	1
* <i>Oxalis corniculata</i>	410559	6495446	1
* <i>Oxalis corniculata</i>	410900	6495623	5
* <i>Oxalis corniculata</i>	410773	6496186	5
* <i>Oxalis corniculata</i>	410852	6496017	10
* <i>Oxalis corniculata</i>	410908	6496063	10
* <i>Oxalis corniculata</i>	410724	6495501	20
* <i>Oxalis pes-caprae</i>	410780	6496418	10
* <i>Oxalis pes-caprae</i>	409265	6496316	10

Taxon	Easting	Northing	Estimated number of plants
* <i>Oxalis pes-caprae</i>	409325	6496342	20
* <i>Oxalis pes-caprae</i>	408377	6496136	20
* <i>Oxalis pes-caprae</i>	408314	6495194	20
* <i>Oxalis pes-caprae</i>	409999	6496285	20
* <i>Oxalis pes-caprae</i>	408310	6495369	20
* <i>Oxalis pes-caprae</i>	408303	6495448	20
* <i>Oxalis pes-caprae</i>	408324	6495277	30
* <i>Oxalis pes-caprae</i>	408324	6495550	30
* <i>Oxalis purpurea</i>	408377	6496136	1
* <i>Oxalis purpurea</i>	408314	6495194	1
* <i>Oxalis purpurea</i>	409999	6496285	1
* <i>Oxalis purpurea</i>	408310	6495369	1
* <i>Oxalis purpurea</i>	409265	6496316	1
* <i>Oxalis purpurea</i>	410780	6496418	1
* <i>Oxalis purpurea</i>	409325	6496342	5
* <i>Oxalis purpurea</i>	408303	6495448	10
* <i>Oxalis purpurea</i>	408324	6495277	20
* <i>Oxalis purpurea</i>	408324	6495550	20
* <i>Pentameris airoides</i>	408336	6496059	10
* <i>Pentameris airoides</i>	411560	6496144	10
* <i>Pentameris airoides</i>	408340	6495317	100
* <i>Raphanus raphanistrum</i>	408324	6495277	1
* <i>Raphanus raphanistrum</i>	408310	6495369	1
* <i>Raphanus raphanistrum</i>	408377	6496136	1
* <i>Raphanus raphanistrum</i>	408314	6495194	1
* <i>Raphanus raphanistrum</i>	408366	6496167	20
* <i>Ricinus communis</i>	409629	6495556	5
* <i>Rumex hypogaeus</i>	408310	6495369	1
* <i>Rumex hypogaeus</i>	410780	6496418	1
* <i>Rumex hypogaeus</i>	408324	6495550	1
* <i>Rumex hypogaeus</i>	408316	6495284	5
* <i>Schinus molle</i>	410017	6496326	2
* <i>Solanum linnaeanum</i>	408377	6496136	1
* <i>Solanum linnaeanum</i>	409678	6495912	1
* <i>Solanum linnaeanum</i>	409999	6496285	1
* <i>Solanum linnaeanum</i>	410852	6496017	1
* <i>Solanum linnaeanum</i>	410559	6495446	1
* <i>Solanum linnaeanum</i>	410908	6496063	1
* <i>Solanum linnaeanum</i>	410773	6496186	1
* <i>Solanum linnaeanum</i>	410734	6496261	100
* <i>Solanum linnaeanum</i>	410003	6496282	10
* <i>Solanum linnaeanum</i>	410899	6495955	10
* <i>Solanum linnaeanum</i>	408318	6495342	1
* <i>Solanum linnaeanum</i>	408317	6495288	1
* <i>Solanum linnaeanum</i>	408325	6495629	1
* <i>Solanum linnaeanum</i>	410141	6496395	200
* <i>Solanum linnaeanum</i>	408323	6495584	4
* <i>Solanum linnaeanum</i>	410602	6496349	500
* <i>Solanum linnaeanum</i>	410304	6495654	50
* <i>Solanum linnaeanum</i>	409325	6496342	1
* <i>Solanum linnaeanum</i>	409301	6496030	1
* <i>Solanum nigrum</i>	411315	6496220	10
* <i>Solanum nigrum</i>	408298	6495179	1
* <i>Solanum nigrum</i>	408319	6495285	2
* <i>Solanum nigrum</i>	408337	6496064	5
* <i>Sonchus asper</i>	411560	6496144	1
* <i>Sonchus oleraceus</i>	410852	6496017	1
* <i>Sonchus oleraceus</i>	410908	6496063	1
* <i>Sonchus oleraceus</i>	410773	6496186	1
* <i>Sonchus oleraceus</i>	411404	6496303	1,000
* <i>Sonchus oleraceus</i>	411249	6496024	1
* <i>Sonchus oleraceus</i>	409265	6496316	1
* <i>Sonchus oleraceus</i>	408324	6495550	1
* <i>Sonchus oleraceus</i>	410900	6495623	10
* <i>Sonchus oleraceus</i>	408300	6495414	1
* <i>Sonchus oleraceus</i>	408324	6495277	1
* <i>Sonchus oleraceus</i>	408310	6495369	1

Taxon	Easting	Northing	Estimated number of plants
* <i>Stachys arvensis</i>	409265	6496316	1
* <i>Stachys arvensis</i>	411249	6496024	1
* <i>Stachys arvensis</i>	410780	6496418	1
* <i>Stachys arvensis</i>	409999	6496285	1
* <i>Stachys arvensis</i>	408377	6496136	5
* <i>Trachyandra divaricata</i>	408324	6495277	1
* <i>Trachyandra divaricata</i>	408310	6495369	1
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	408336	6496064	5
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	410176	6496615	1
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	408324	6495277	10
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	408310	6495369	10
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	409325	6496342	1
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	408893	6495550	10
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	408910	6495551	1
* <i>Trifolium arvense</i> var. <i>arvense</i>	408893	6495550	1
* <i>Trifolium campestre</i> var. <i>campestre</i>	408324	6495277	1
* <i>Trifolium campestre</i> var. <i>campestre</i>	409325	6496342	1
* <i>Trifolium campestre</i> var. <i>campestre</i>	409301	6496030	1
* <i>Trifolium campestre</i> var. <i>campestre</i>	408778	6496250	1
* <i>Trifolium campestre</i> var. <i>campestre</i>	408910	6495551	1
* <i>Triticum aestivum</i>	408910	6495551	1
* <i>Triticum aestivum</i>	408910	6495551	1,000
* <i>Tropaeolum majus</i>	408349	6495680	1,000
* <i>Typha ?orientalis</i>	410213	6495866	100
* <i>Ursinia anthemoides</i>	411560	6496144	1
* <i>Ursinia anthemoides</i>	410176	6496615	1
* <i>Vulpia bromoides</i>	409289	6495096	10
* <i>Vulpia myuros</i>	410176	6496615	10
* <i>Vulpia myuros</i>	408340	6495317	1

Datum GDA94, Zone 50J

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Appendix B

Aboriginal heritage sites





Search Criteria

Site 3583

Disclaimer

Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist. Consultation with Aboriginal communities is on-going to identify additional sites. The AHA protects all Aboriginal sites in Western Australia whether or not they are registered.

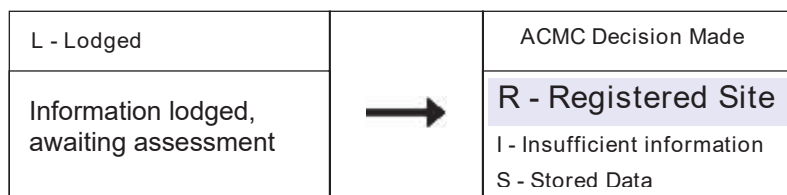
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Legend

Restriction	Access	Coordinate Accuracy
N No restriction	C Closed	Accuracy is shown as a code in brackets following the site coordinates.
M Male access only	O Open	[Reliable] The spatial information recorded in the site file is deemed to be reliable, due to methods of capture.
F Female access	V Vulnerable	[Unreliable] The spatial information recorded in the site file is deemed to be unreliable due to errors of spatial data capture and/or quality of spatial information reported.

Status



Spatial Accuracy

Index coordinates are indicative locations and may not necessarily represent the centre of sites, especially for sites with an access code "closed" or "vulnerable". Map coordinates (Lat/Long) and (Easting/Northing) are based on the GDA 94 datum. The Easting / Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '5000000:Z50' means Easting=5000000, Zone=50.

Sites Shown on Maps

Site boundaries may not appear on maps at low zoom levels



List of Registered Aboriginal Sites with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
3583	R	C	N	Ki-It Monger Brook 2	Ceremonial, Mythological, Modified Tree		*Registered Informant names available from DIA.	Not available for closed sites	S02408



Legend

- Selected Heritage Sites
- Registered Sites
- Town
- Map Area
- Search Area

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Search Criteria

Site 3525

Disclaimer

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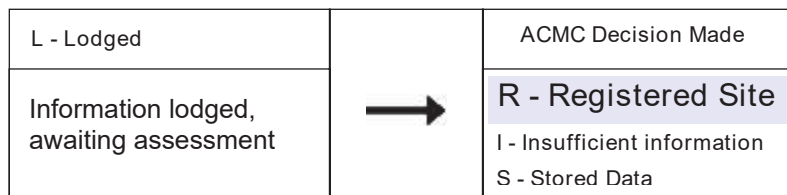
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Legend

Restriction	Access	Coordinate Accuracy
N No restriction	C Closed	Accuracy is shown as a code in brackets following the site coordinates.
M Male access only	O Open	[Reliable] The spatial information recorded in the site file is deemed to be reliable, due to methods of capture.
F Female access	V Vulnerable	[Unreliable] The spatial information recorded in the site file is deemed to be unreliable due to errors of spatial data capture and/or quality of spatial information reported.

Status



Spatial Accuracy

Index coordinates are indicative locations and may not necessarily represent the centre of sites, especially for sites with an access code "closed" or "vulnerable". Map coordinates (Lat/Long) and (Easting/Northing) are based on the GDA 94 datum. The Easting / Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '5000000:Z50' means Easting=5000000, Zone=50.

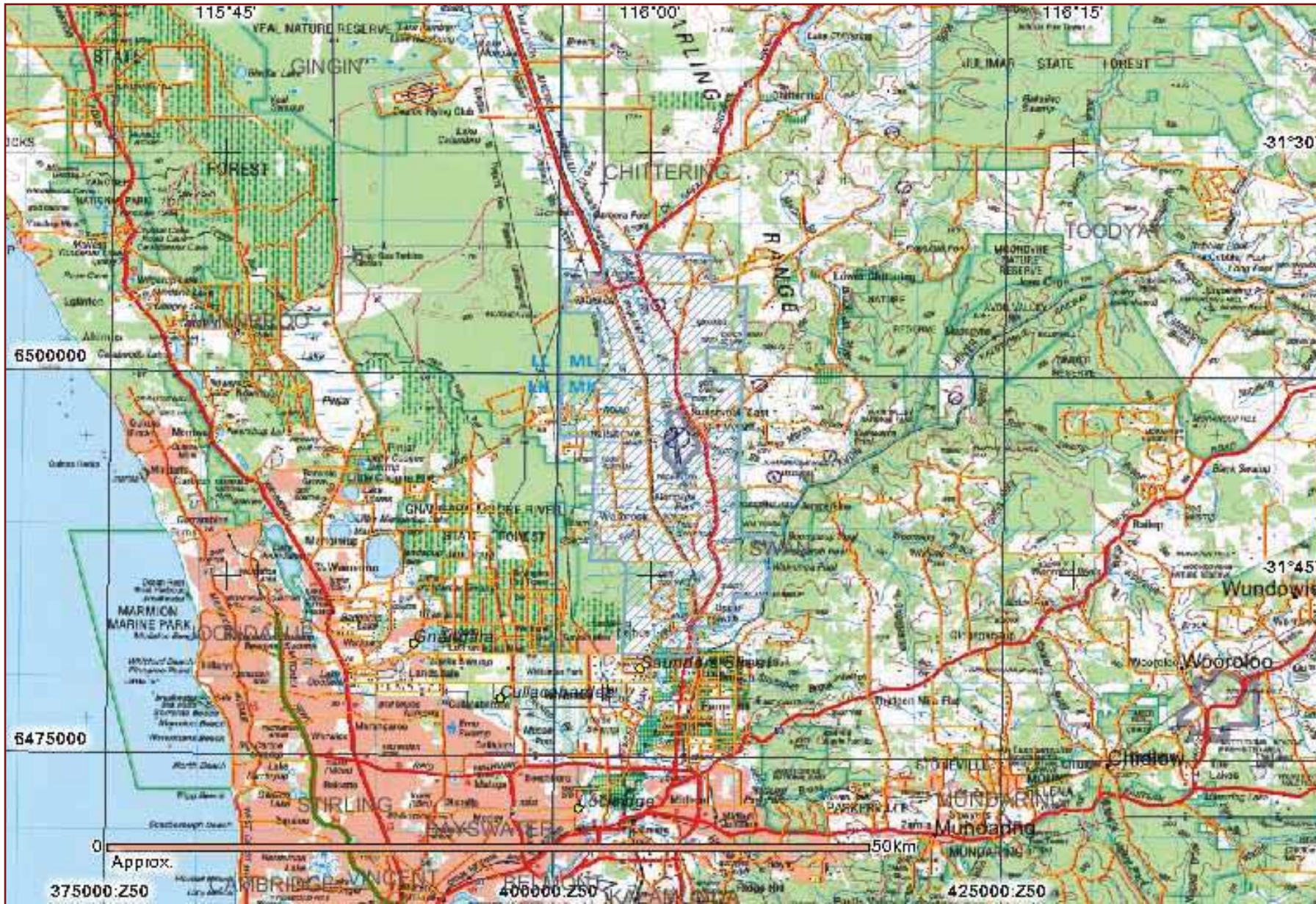
Sites Shown on Maps

Site boundaries may not appear on maps at low zoom levels



List of Other Heritage Places with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
3525	I	C	N	Ellen Brook: Upper Swan	Mythological		*Registered Informant names available from DIA.	Not available for closed sites	S02516



Legend

- Selected Heritage Sites
- Other Heritage Places
- Town
- Map Area
- Search Area

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Search Criteria

Site 3941

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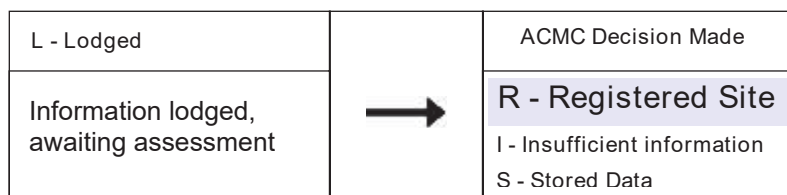
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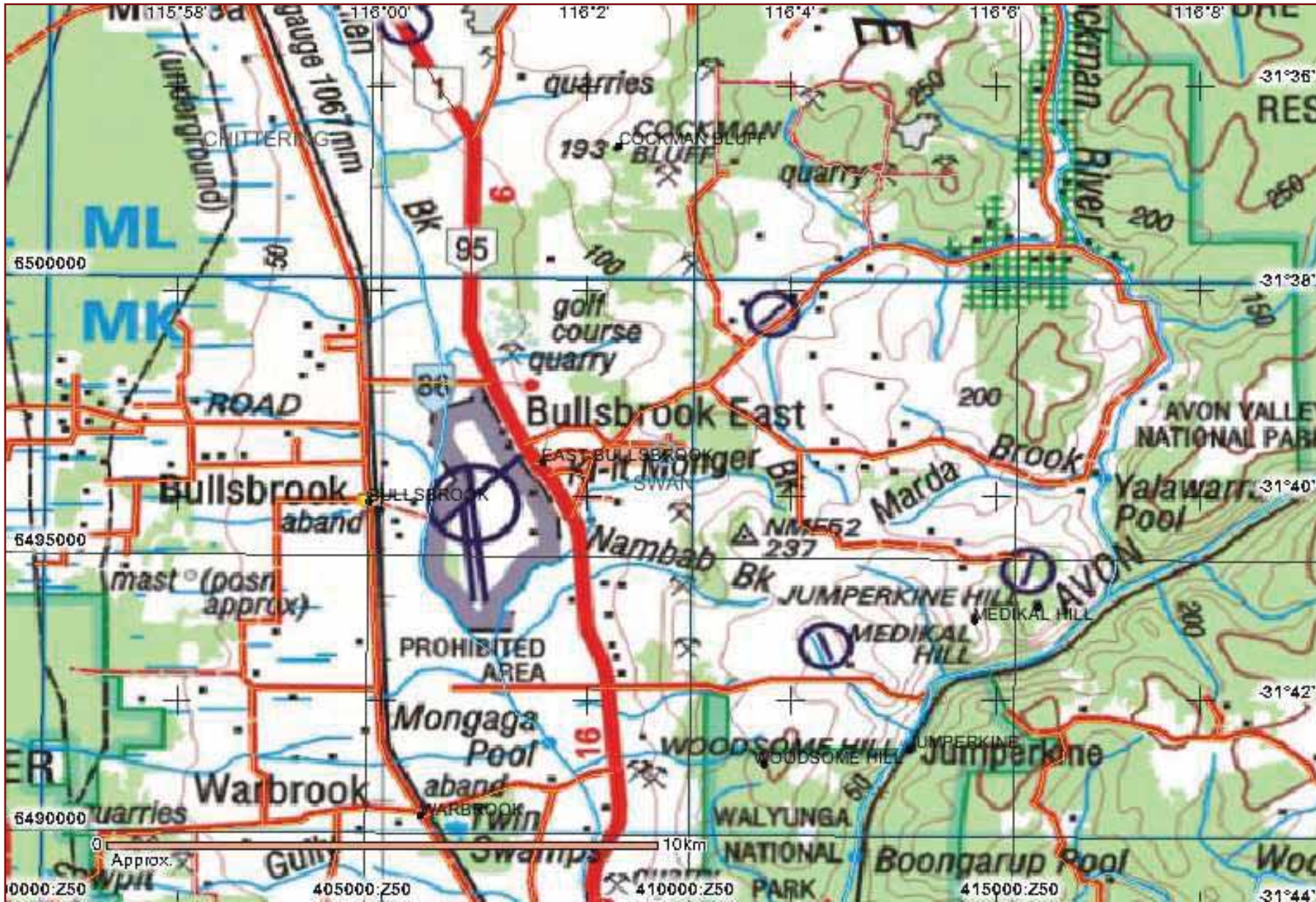
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List of Other Heritage Places with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
3941	I	O	N	Ki-It Monger Brook 1.	Artefacts / Scatter	Camp		409553mE 6496882mN Zone 50 [Reliable]	S01480



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- Town
- Map Area
- Search Area

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Search Criteria

Site 22669

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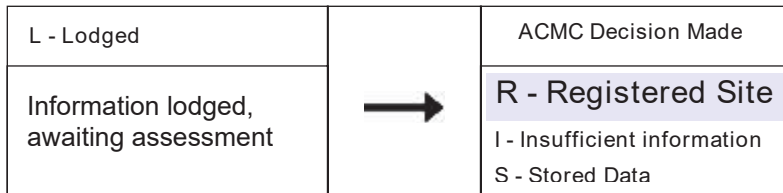
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Status



Spatial Accuracy

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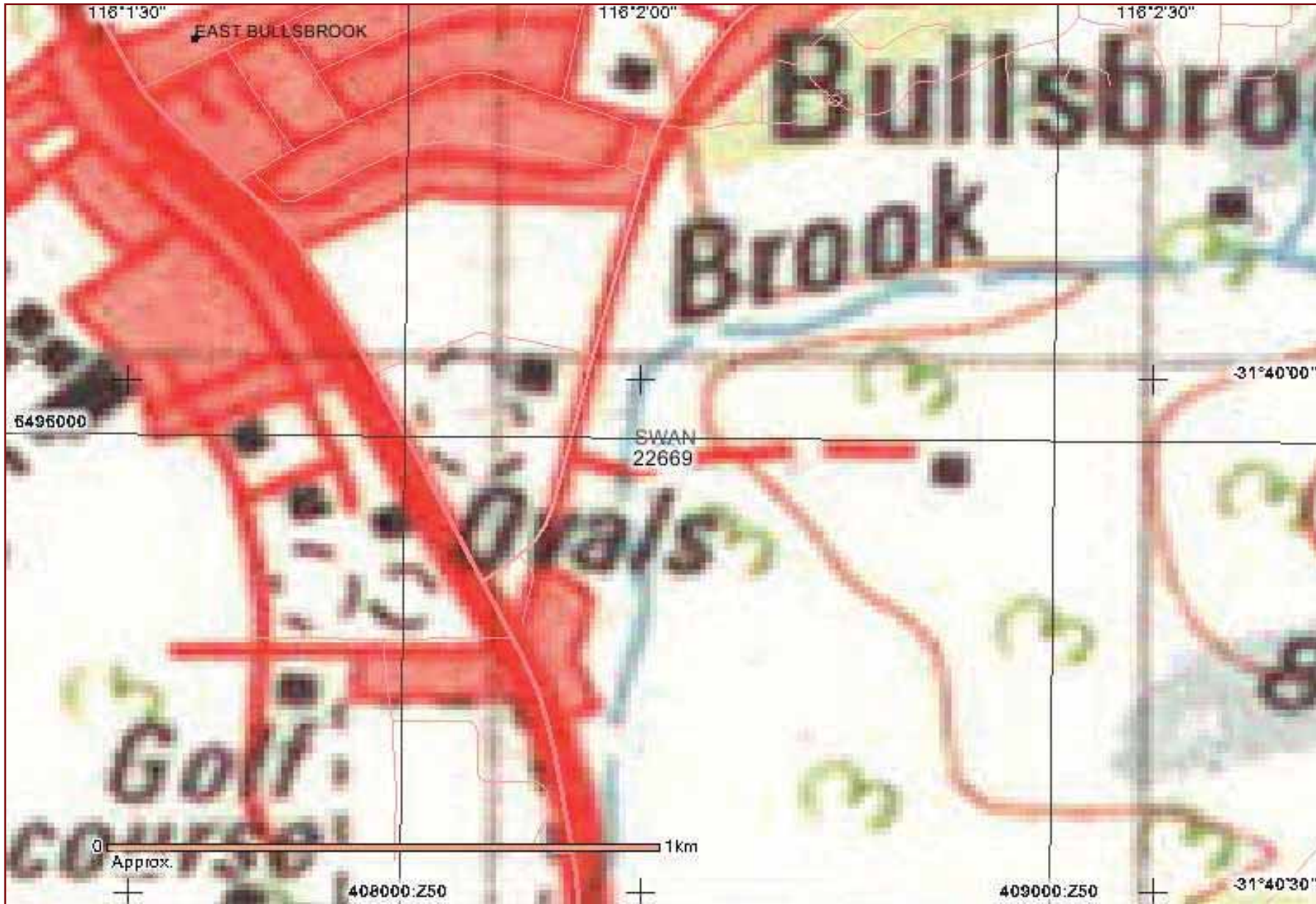
Sites Shown on Maps

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List of Other Heritage Places with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
22669	L	O	N	Bullya Spring	Mythological	Natural Feature, Water Source	*Registered Informant names available from DIA.	408402mE 6495971mN Zone 50 [Unreliable]	



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Appendix 5

Transport Impact Assessment

(Transcore)



transport planning
traffic engineering
modelling

Kingsford Local Structure Plan, Bullsbrook

Transport Impact Assessment

PREPARED FOR:
Okeland Communities

September 2021

Document history and status

Author	Revision	Approved by	Date approved	Revision type
R White	r01		16/12/2016	
R White	r01a	B Bordbar	27/01/2017	
R White	r01b	B Bordbar	9/06/2017	Revised
R White	r01c	B Bordbar	5/07/2017	Revised
R White	r01d	B Bordbar	20/09/2017	Revised
A Rasouli	r01e	B Bordbar	20/09/2017	Revised
A Rasouli	r01f	B Bordbar	26/09/2017	Revised
R White	r01g	B Bordbar	4/12/2017	Revised
R White	r01h	B Bordbar	2/02/2018	Revised
R White	r01i	B Bordbar	8/08/2018	Revised
R White	r01j	B Bordbar	7/02/2019	Revised
R White	r01k	B Bordbar	14/02/2019	Revised
R White	r01l	B Bordbar	13/09/2021	Revised

File name: t16274-rw-r01l.docx

Author: Robin White

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Client: Okeland Communities

Project: Bullsbrook Local Structure Plan

Document revision: r01l

Project number: t16.274

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APPENDIX B: TYPICAL ROAD CROSS-SECTIONS

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1 Introduction

This Transport Impact Assessment has been prepared by Transcore on behalf of Okeland Communities with regard to the Kingsford Local Structure Plan at Bullsbrook in the City of Swan.

The subject site is located on the southeast side of the existing Bullsbrook townsite as shown in **Figure 1**.

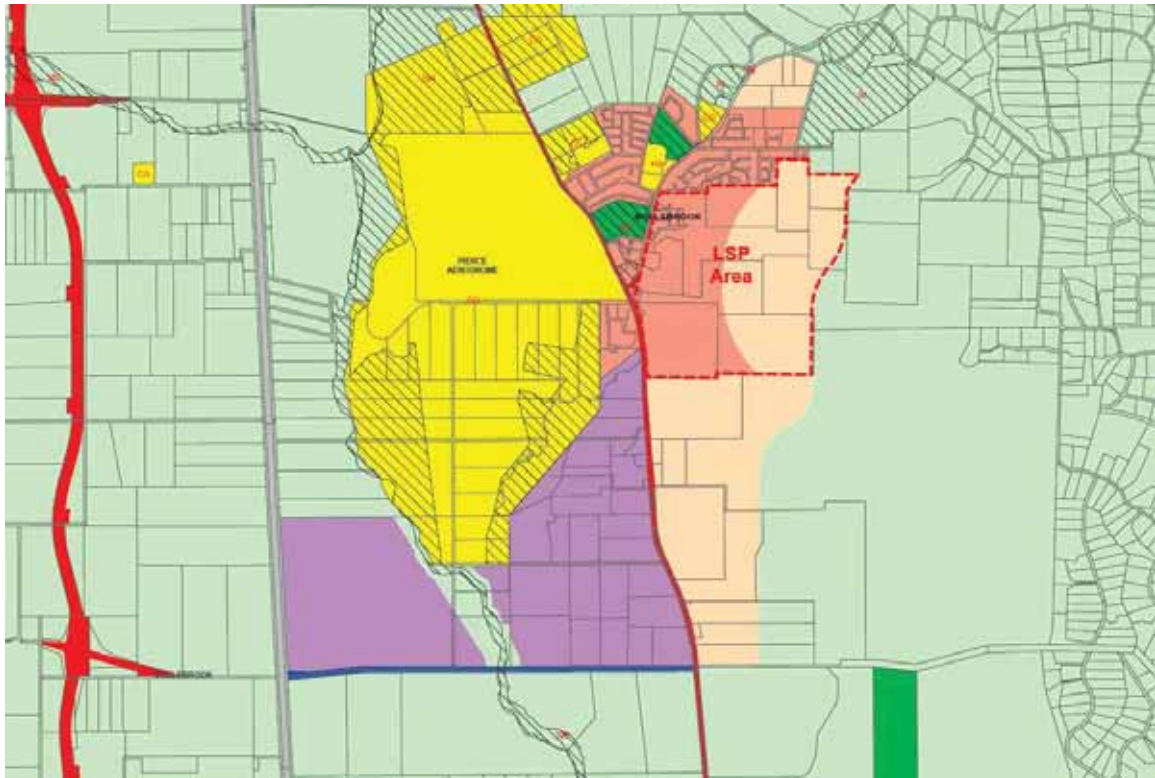


Figure 1: Site location

Urban development of this site is envisaged in the City of Swan's *Bullsbrook Townsite District Structure Plan* (approved April 2018). Separate applications have already been lodged for lifting of the Urban Deferment from the Urban Deferred zoned land within the site and for rezoning from Rural to Urban for the remainder of the site.

2 Proposed Local Structure Plan

The proposed Local Structure Plan (LSP) for this site is included at **Appendix A**.

This site is part of one of the urban expansion areas identified in the Western Australian Planning Commission (WAPC) Perth and Peel @ 3.5million (draft, May 2015) report and its supporting North-East Sub-regional Planning Framework (draft, May 2015). That urban expansion area also extends further north and south of Bullsbrook on the eastern side of Great Northern Highway.

The City of Swan's Bullsbrook Townsite District Structure Plan (approved April 2018) (BTDSP) and the previous version called the Bullsbrook Townsite Land Use Master Plan (2014) (BTLUMP), also reflects a similar extent of future urban development around the Bullsbrook Townsite, as shown in **Figure 2**.

The BTDSP indicates that Bullsbrook townsite is anticipated to grow to approximately 6600 dwellings by 2031 with a potential further 2800 dwellings beyond 2031. It also proposes a district activity centre of 10,000m² net lettable area of commercial floor space by 2031, which is ultimately expected to grow to 20,000m² NLA.

The proposed LSP area shown in Appendix A includes the Sacri site on the southeast side of Chittering Road (the church site and land immediately east and south of the church). This LSP area is anticipated to yield approximately 2740 residential lots. It would also include a primary school site and the proposed district activity centre site shown in the BTDSP.

The BTDSP proposes two north south spine road corridors through the subject site parallel to Great Northern Highway. One is an activity corridor on the eastern side of the district activity centre, which would connect from Chittering Road in the north to Great Northern Highway at Lage Road. The other spine road would connect from Chittering Road in the north to Great Northern Highway at Stock Road at the southern end of the BTLUMP area, as shown in **Figure 2**.

The alignment of the westernmost of these two spine roads will be on the eastern side of the district activity centre as proposed in the BTDSP but will then run westwards to connect to an extension of Chittering Road within the LSP area. This will also function as the proposed activity corridor adjacent to the district activity centre as envisaged by the BTDSP.

The activity corridor is identified in BTDSP as a potential rapid transit corridor route connecting to the rapid transit route planned at Ellenbrook. This potential future public transport route option is maintained in the proposed LSP for this site.

The BTDSP (and the previous BTLUMP) proposes a new 4-way intersection on Great Northern Highway adjacent to the district activity centre. It anticipated a future signalised intersection at that location based on Main Roads Western Australia (MRWA) practice in 2014 when the BTLUMP report was being prepared (which was also in accordance with the intersection treatment indicated in that vicinity (nominally

at Big Way) in the 2011 MRWA Great Northern Highway West Swan to Muchea Access Strategy report) but more recent discussions with MRWA advised that this should be planned as a roundabout instead in accordance with current MRWA practice.

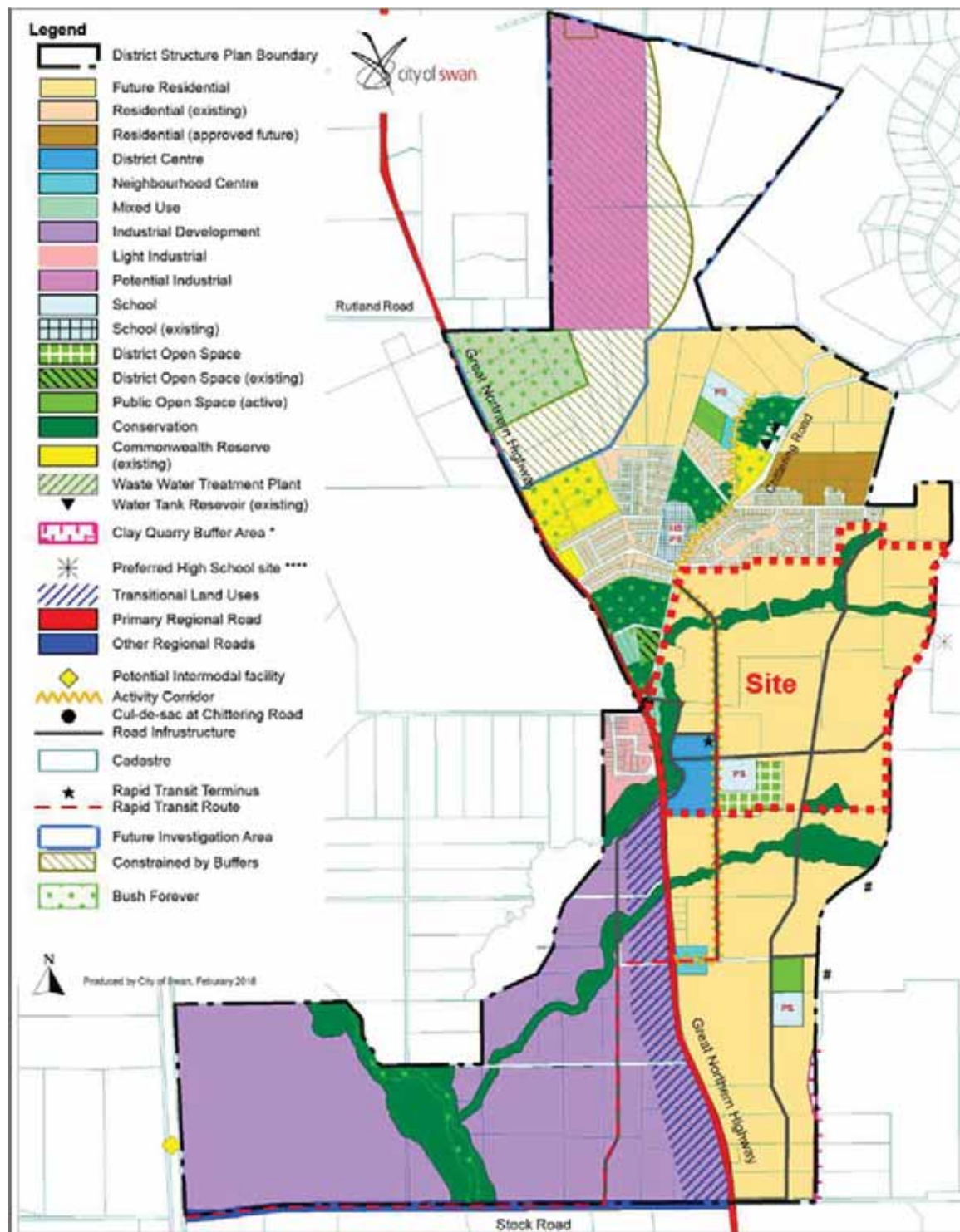


Figure 2: Bullsbrook Townsite District Structure Plan (2018)

3 Existing Situation

3.1 Existing Land Use

Existing land uses within the subject site are predominantly rural, plus a closed quarry on Lot 2792 accessed from Great Northern Highway, as shown in **Figure 3**. The first stages of residential subdivision have commenced in the northwest corner of the subject site with access into the site from Chittering Road.



Figure 3: Existing Land Use

North and west is the existing Bullsbrook townsite residential area as can be seen in **Figure 3**.

The existing Bullsbrook town centre is located around the Bullsbrook Road and Chittering Road intersections on Great Northern Highway. Commercial and light industrial development extends along the western side of Great Northern Highway opposite the subject site and RAAF Pearce Aerodrome is further to the west with main access from Great Northern Highway north of Chittering Road.

3.2 Existing Road Network

The existing road network and its classification in the Main Roads WA functional road hierarchy is illustrated in Error! Reference source not found..

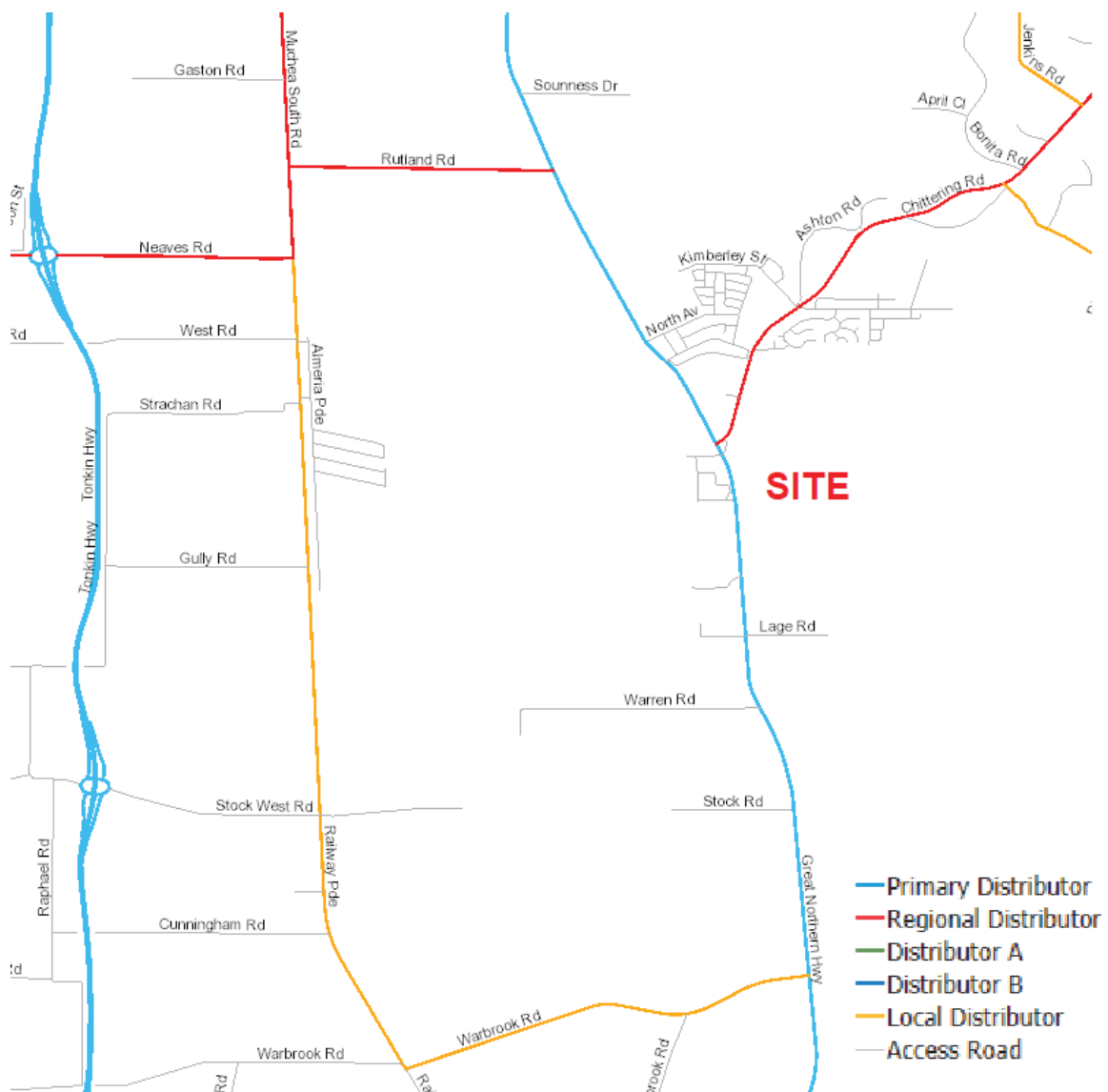


Figure 4: Existing road hierarchy

Great Northern Highway is constructed as a two-lane rural highway (without median) adjacent to the subject site. A painted median is added through the Bullsbrook town centre with traffic islands and right turn lanes at key intersections.

The posted speed limit on Great Northern Hwy is 60km/h through the Bullsbrook townsite and adjacent to the subject site but increases to 80km/h south of Butternab Road and 100km/h south of Lage Road, as shown in **Figure 5**.

Great Northern Highway is classified as a Primary Distributor in the Main Roads WA functional road hierarchy and is covered by a Primary Regional Roads reservation (a red road) in the MRS, as shown in **Figure 1**. It is a State road under the care and control of Main Roads WA.

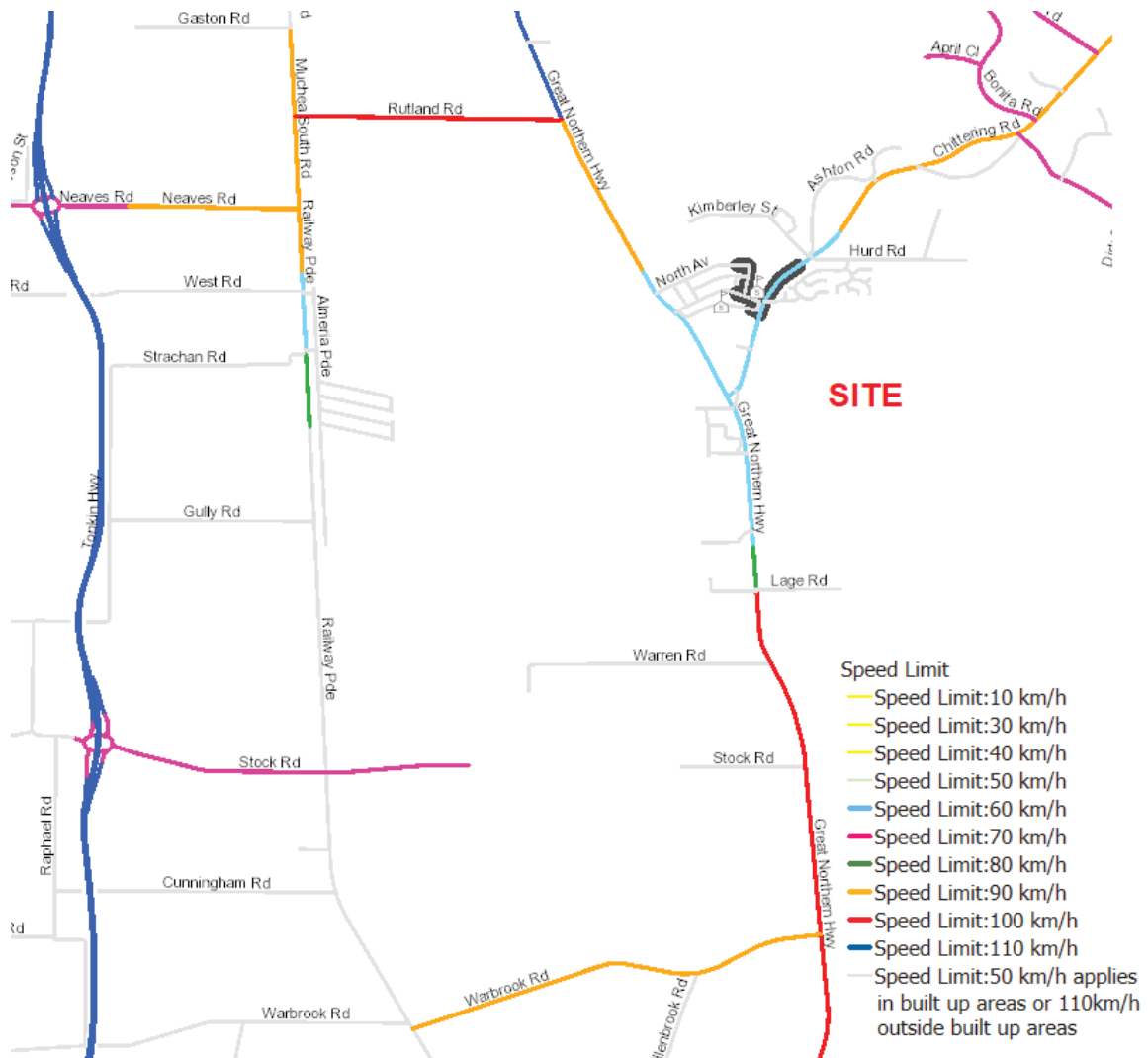


Figure 5: Existing speed limits

Chittering Road is constructed as a two lane road 7.4m wide between kerbs within the Bullsbrook townsite and reverts to two-lane rural road standard northeast of Hurd Road.

It has a posted speed limit of 60km/h within the townsite and increases to 90km/h northeast of Hurd Road. A 40km/h school zone applies in the vicinity of the high school and primary school site before and after school hours on school days.

Chittering Road is classified as a Regional Distributor in the Main Roads WA functional road hierarchy. It is a local authority road under the care and control of the City of Swan.

All of the intersections along Great Northern Highway and Chittering Road in this area operate under priority control (i.e. Stop or Give Way control), except for a new single-lane roundabout recently constructed at the Chittering Rd / Maroubra Ave / Brookbank Dr intersection to provide access into the first stages of residential subdivision development in this LSP area.

3.3 Existing Traffic Volumes

Existing average weekday traffic (AWT) volumes on the study area road network have been obtained from Main Roads WA and are summarised in **Table 1**.

Table 1: Existing Traffic Volumes

Road Name	Location	AWT (HV)	AM Peak	PM Peak	Date
Great Northern Hwy	South of Bullsbrook Rd	8,502 (19.9%)	662vph 0700-0800	748vph 1530-1630	2020/21
Great Northern Hwy	North of Rutland Rd	4,190 (20.9%)	329vph 0815-0915	405vph 1515-1615	2020/21
Chittering Rd	700m east of Great Northern Hwy	5,990 (13.6%)	522vph 0800-0900	585vph 1515-1615	2020/21

3.4 Heavy Vehicle Routes

Restricted Access Vehicle (RAV) Network routes are designated for access by large heavy vehicle combinations that require special permits for each trip. Main Roads WA manages the RAV Networks and the permits for trucks to use them. **Figure 6** shows the roads that are permitted for use by RAV Networks 3, (light blue), 4 (dark blue), 5 (light green), 6 (dark green) and 7 (light purple) vehicles. RAV Networks 2, 3 and 4 permit access by a number of vehicle combinations up to 27.5m long and RAV Networks 5, 6 and 7 (which includes Great Northern Highway) extend this to vehicles up to 36.5m long including double road trains.

It should be noted that RAV Networks 2 to 7 on this section of Great Northern Highway now have the following condition imposed, since the Tonkin Highway extension (NorthLinkWA project) was opened in April 2020 and took over as the primary freight route in this corridor:

“This section of road must not be used as a through route. This section of road may be used as access to pick-up goods, deliver goods, or garage vehicles to properties located on this section of road, or on roads only accessible via this section of road. Drivers must carry documentation as proof of local delivery, pickup or garaging address.”

However, Great Northern Highway is still the high wide load route in this corridor, so even wider or higher vehicles and loads can be permitted.



Figure 6: Restricted Access Vehicles Network

3.5 Public Transport

The closest existing bus route to the subject site is Bus Route 311 (Midland Station – Bullsbrook), as shown in **Figure 7**.

Route 311 runs on Great Northern Highway adjacent to the subject site. It provides six bus services each way on weekdays and two on Saturdays, Sundays and public holidays.

Existing bus service times are primarily designed for journeys to and from work, school and other trips to and from Midland during business hours such as shopping or personal business trips.

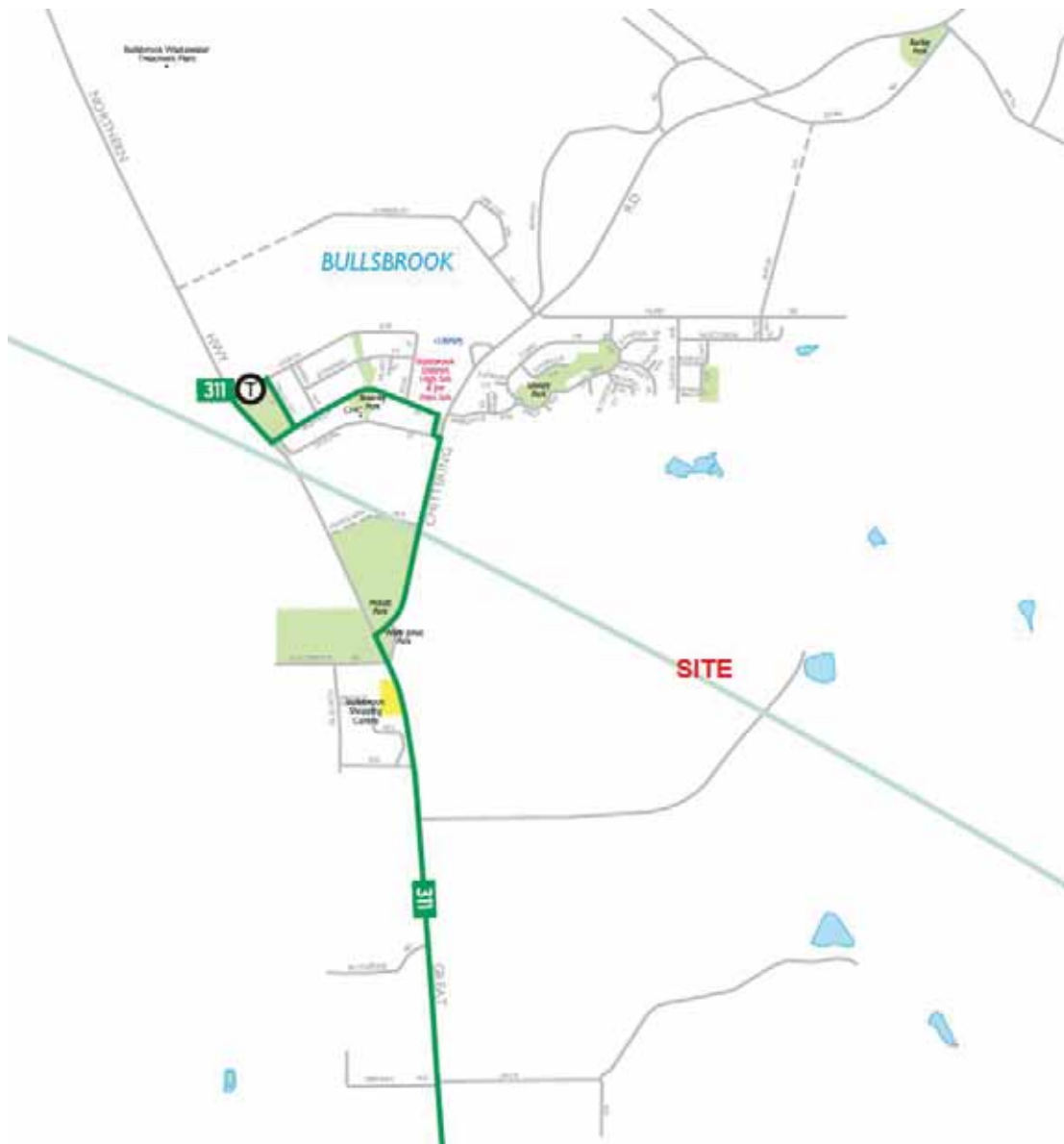


Figure 7: Existing bus routes

3.6 Pedestrian and Cyclist Facilities

A comprehensive path network is progressively being constructed as part of each stage of subdivision development within the LSP area.

There are no formal pedestrian or cyclist facilities on Great Northern Highway adjacent to the subject site although footpaths are provided through the Bullsbrook town centre.

Chittering Road has a 2m shared path on one side within the Bullsbrook townsite and on both sides in the vicinity of the existing high school and primary school site.

3.7 Changes to Surrounding Road Network

The Tonkin Highway extension (NorthLink WA project) was completed in April 2020. Traffic volumes on Great Northern Highway through Bullsbrook and the proportion of heavy vehicles have both reduced significantly as a result of completion of that project.

The BTLUMP report included as an appendix the *Bullsbrook Development Traffic Modelling and Analysis Report for City of Swan* (July 2013). This included details of MRWA regional operational model (ROM) traffic forecasts for 2031 for the BTLUMP area. The traffic model shows future traffic volumes of 20,700vpd on Great Northern Hwy south of Stock Road and 27,200vpd on Chittering Road northeast of the townsite. The high volume of traffic flows modelled between Chittering Road (northeast) and Great Northern Hwy (south) was the reason why the two north south spine road routes east of Great Northern Hwy were indicated in the BTLUMP as described in section 2.

However, liaison with the City of Swan during the preparation of this LSP prompted the City to review the land use assumptions modelled for BTLUMP. City officers subsequently confirmed that the land use data modelled for 2031 was correct in terms of total numbers but the large traffic zones modelled had resulted in a substantial population component being modelled as accessing Chittering Road at the northeast end of the townsite instead of being modelled as separate zones representing northern extension of the townsite itself and the rural-residential areas accessed from Chittering Road northeast of the townsite. Therefore, further disaggregation of the modelled traffic zones has been undertaken for this LSP transport impact assessment and significantly reduced the modelled traffic flows on Chittering Road, as discussed in section 6. The revised traffic modelling also reflects full development of the South Bullsbrook Industrial Precinct in accordance with traffic modelling for the BTLUMP Transport Impact Assessment undertaken for the City of Swan by Transcore in November 2017 and subsequent revised modelling for BTLUMP Precinct Traffic Contributions (October 2019) for the City of Swan, which takes into consideration the refusal of Metropolitan Region Scheme Amendment 1325/41 which would have rezoned land from Rural to Urban Deferred in the North Bullsbrook Precinct.

4 Proposed Transport Network

4.1 Road Hierarchy

The proposed hierarchy of roads in and around the subject site is illustrated in **Figure 8** using the road hierarchy defined in the Western Australian Planning Commission Liveable Neighbourhoods (LN) policy.



Figure 8: Proposed road hierarchy

The classification of roads in **Figure 8** is based on preliminary analysis of future traffic flows at section 6.3 of this report. All of the roads identified on the LSP form sufficiently long and continuous routes to be classified as integrator arterials or neighbourhood connectors.

Integrator B roads are suitable for traffic flows up to 15,000vpd and can accommodate traffic flows up to 20,000vpd with suitable intersection treatments.

Neighbourhood Connector A roads are suitable for up to 7000vpd but some degree of flexibility with this upper limit may be appropriate in localised situations to avoid overdesigning some lengths of road. The main difference between Integrator B and Neighbourhood Connector A cross-sections is only the width of the median (6m versus 2m) and Liveable Neighbourhoods policy does allow for the median of an Integrator B to be reduced in width on sections that do not require right turn lanes in the median.

Neighbourhood Connector B roads are suitable for traffic flows up to 3000vpd but again some degree of flexibility with this upper limit should be considered appropriate in localised situations.

Standard cross-sections from the WAPC Liveable Neighbourhoods policy for these Integrator and Neighbourhood Connector roads are shown in Appendix B. Further discussion of potential reduction of these road reserve widths is also included in **Appendix B**.

One variation required is that the section of north south Neighbourhood Connector A spine road on the eastern side of the district activity centre, with the primary school site on its eastern side, is to have parking bays increased to 2.5m wide.

The existing section of Chittering Road adjacent to the LSP area and its extension and realignment across the southern corner of the Sacri landholding has Bush Forever land on the western side and POS, landscaping or proposed frontage roads within the LSP area, which will remove any requirement for on-street parking on these sections of Chittering Rd and substantially reduce the verge width required for underground services along Chittering Road. It is therefore proposed that the existing 20m road reserve width of these sections of Chittering Road will accommodate a suitable upgrading of Chittering Road, as shown in the indicative cross sections in Appendix B. Transcore understands that this proposed road cross section for Chittering Road has been developed in consultation with the City of Swan with support from the City's technical officers as tree retention along Chittering Road was considered a high priority.

The standard integrator arterial and neighbourhood road reserve widths elsewhere within the LSP area are proposed to be as follows (see Appendix B for indicative cross sections):

- 27m Integrator B
- 24.4m Neighbourhood Connector A
- 19.4m Neighbourhood Connector B

4.2 Public Transport

The existing bus service along Great Northern Hwy and Chittering Road adjacent to the site is noted in section 3.5 and the potential future rapid transit route along the north south activity corridor identified in the BTLUMP is noted in section 2.

All of the proposed neighbourhood connectors and integrator B roads shown on **Figure 8** would be of suitable standard to accommodate bus services through this area, providing suitable options for one, two or three bus routes to service this area. This allows suitable flexibility for the Public Transport Authority to plan future bus routes within this area.

4.3 Pedestrian and Cyclist Facilities

All of the proposed neighbourhood connectors and integrator B roads shown on **Figure 8** would have paths on both sides in accordance with Liveable Neighbourhoods guidelines, including a shared path on one side (or in the median amongst trees on one section of the eastern Neighbourhood Connector A spine road).

Paths would be required on at least one side of all roads in accordance with Liveable Neighbourhoods guidelines.

On-street cycle lanes are normally included only on Neighbourhood Connector A roads and above, due to traffic flows above 3000vpd on these categories of roads.

The resultant path network within the LSP area is indicated in **Figure 9** (source: Emerge Associates, with notes added by Transcore). This also includes indicative location of additional shared path (or dual use path) links on the local road network and along foreshore reserves. The standard and location of all paths would be subject to agreement with the City of Swan at subdivision stage.

The potential for provision of cycle lanes physically separated from motorised traffic will be investigated at subdivision stage in proximity to the primary school.



Figure 9: Pedestrian / Cycle Network

5 Integration with Surrounding Area

The Bullsbrook Townsite District Structure Plan (BTDSP) provides an overall plan to ensure coordination of future development of the subject site and the surrounding area. The proposed local structure plan for the subject site respects the principles and external connections of the BTDSP to ensure that good connectivity and integration with the surrounding area are achieved.

6 Analysis of the Transport Network

6.1 Assessment Period

The traffic assessment undertaken for the subject site is based on the 2031 ROM modelling undertaken for the BTLUMP, with full development of all land uses within the subject site taken into consideration, including ultimate full development of the Kingsford Town Centre (district activity centre).

6.2 Traffic Generation

The traffic flows generated by the land uses in the LSP area and the wider BTDSP / BTLUMP area for the traffic modelling undertaken for this assessment have been derived directly from a subarea trip matrix from the ROM model used for the BTLUMP traffic study. To check that the modelled traffic flows for the LSP area are consistent with the land uses anticipated in the LSP area a separate calculation of traffic generation has also been undertaken.

For that traffic generation calculation the daily traffic generation rate used in the LSP area is 8 vehicle trips per day (vpd) per dwelling, which corresponds to peak hour trip generation rates recommended in the Western Australian Planning Commission (WAPC) Transport Impact Assessment Guidelines (2016). The anticipated yield of approximately 2,740 dwellings of the LSP area will therefore generate approximately 22,000vpd.

A typical primary school of 540 students would generate approximately 1080vpd but based on advice from City of Swan officers it has already been modelled as 600 students (1200vpd) to reflect potential student numbers with the numbers of young families likely when the area is first established.

Trip rates published in the NSW Guide to Traffic Generating Developments indicate a 20,000m² shopping centre would generate traffic flows of approximately 15,600vpd on a busy weekday.

6.3 Traffic Flow Forecasts

The subarea trip matrix from the ROM model used for the BTLUMP traffic study has been progressively adjusted and refined based on principles advised by the City of Swan's traffic modelling consultant (Urbsol) in 2017 and subsequent changes as the BTDSP has evolved.

This included redistribution of a proportion of the "Chittering Road" (zone 546) trips to a new north Bullsbrook zone, addition of a 400-lot rural-residential zone southeast of the BTLUMP area accessed via extension of Lage Road, addition of two southern primary school zones and further refinement of the traffic zone system. The revised

traffic modelling also reflects full development of the South Bullsbrook Industrial Precinct in accordance with traffic modelling for the BTLUMP Transport Impact Assessment and BTLUMP Precinct Traffic Contributions report undertaken for the City of Swan by Transcore in November 2017 and June 2018, respectively. The revised trip matrix has increased the number of traffic zones (including external zones) from 14 to 45 and maintains the pattern of internal and external trips from the original subarea trip matrix, except that LSP area trip generation has been revised to reflect current proposed distribution of residential density in the LSP area, the industrial precinct does become a more significant destination for local work trips from the BTLUMP area, traffic generation of zones in the northern and southern urban precincts has been rationalised to better match these future development areas (outside of the LSP area) and rationalisation of access to future urban land uses previously modelled south of Stock Road.

The trip matrix was subsequently further revised to remove the trips allocated to the part of the northern urban precinct that has been excluded from future urban development as a result of refusal of MRS Amendment 1325/41.

Further revision of the trip matrix has been undertaken for this latest revision of the TIA report including revisions within the LSP area and deletion of a potential second high school site previously proposed to the east outside of the LSP area, based on updated advice from the Department of Education.

The resultant 2031 daily trip matrix has been assigned onto the proposed road network of the LSP area and the surrounding BTLUMP area in an EMME transport model by Transcore.

The resultant total daily traffic flows on the modelled road network are shown in the EMME traffic volume diagram at Appendix C. A second diagram (a "selected links" plot) is also included which only shows those traffic flows that are generated by or attracted to the land uses in the LSP area. Traffic flows in and adjacent to the LSP area are also shown in **Figure 10**.

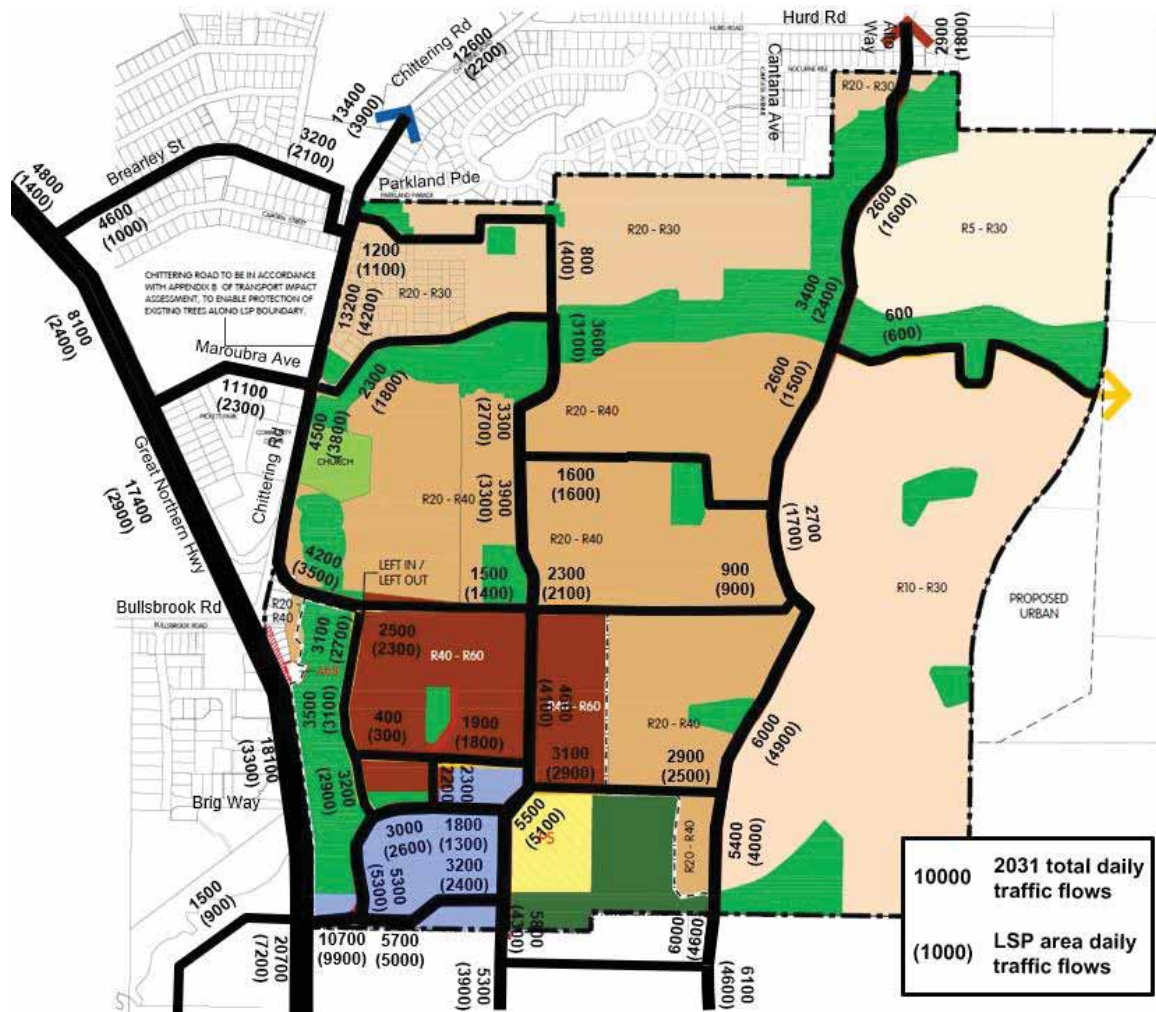


Figure 10: 2031 traffic flows

6.4 Roads and Intersections

The anticipated future road network around the subject site has been detailed in section 4 of this transport impact assessment, including discussion of the proposed road hierarchy in section 4.1.

The key intersection for the proposed LSP area is the proposed 4-way intersection on Great Northern Highway near the district activity centre. This would either be a signalised intersection as previously proposed in the BTLUMP or a roundabout, as currently advised by MRWA. A roundabout would need to be large enough to accommodate the largest size vehicle permitted on Great Northern Highway (36.5m B-double and dog trailer configuration and high wide load vehicles). Current plans for this proposed roundabout are based on a central island diameter of approximately 52m.

Another important intersection for the LSP area will be the intersection of Chittering Road and Maroubra Avenue. A 4-way roundabout has now been constructed at this

intersection, to allow a full movement connection into the LSP area north of the Sacri landholding.

The intersection where the neighbourhood connector B road intersects Chittering Road in the vicinity of the existing Brearley Street intersection has not been able to be designed as a full movement intersection to the satisfaction of the City of Swan. Instead this road will connect to Chittering Road approximately 40m south of the existing Parkland Parade intersection and will be restricted to left in / left out only. The existing full-movement T-intersections at Parkland Pde and Brearley St on Chittering Road will be retained. A right turn lane has recently been constructed on Chittering Road at the Brearley St intersection as part of the road network upgrades for this LSP area.

The Neighbourhood Connector A road on the western side of the district centre will have a left in / left out intersection treatment at its northern end to restrict traffic flows on this link and the Chittering Road extension / realignment to the north. This is intended to encourage a greater proportion of traffic to use the north south spine road on the eastern side of the district centre instead.

The location of these two proposed key intersection roundabouts and the two left in / left out intersections are shown on **Figure 11**.

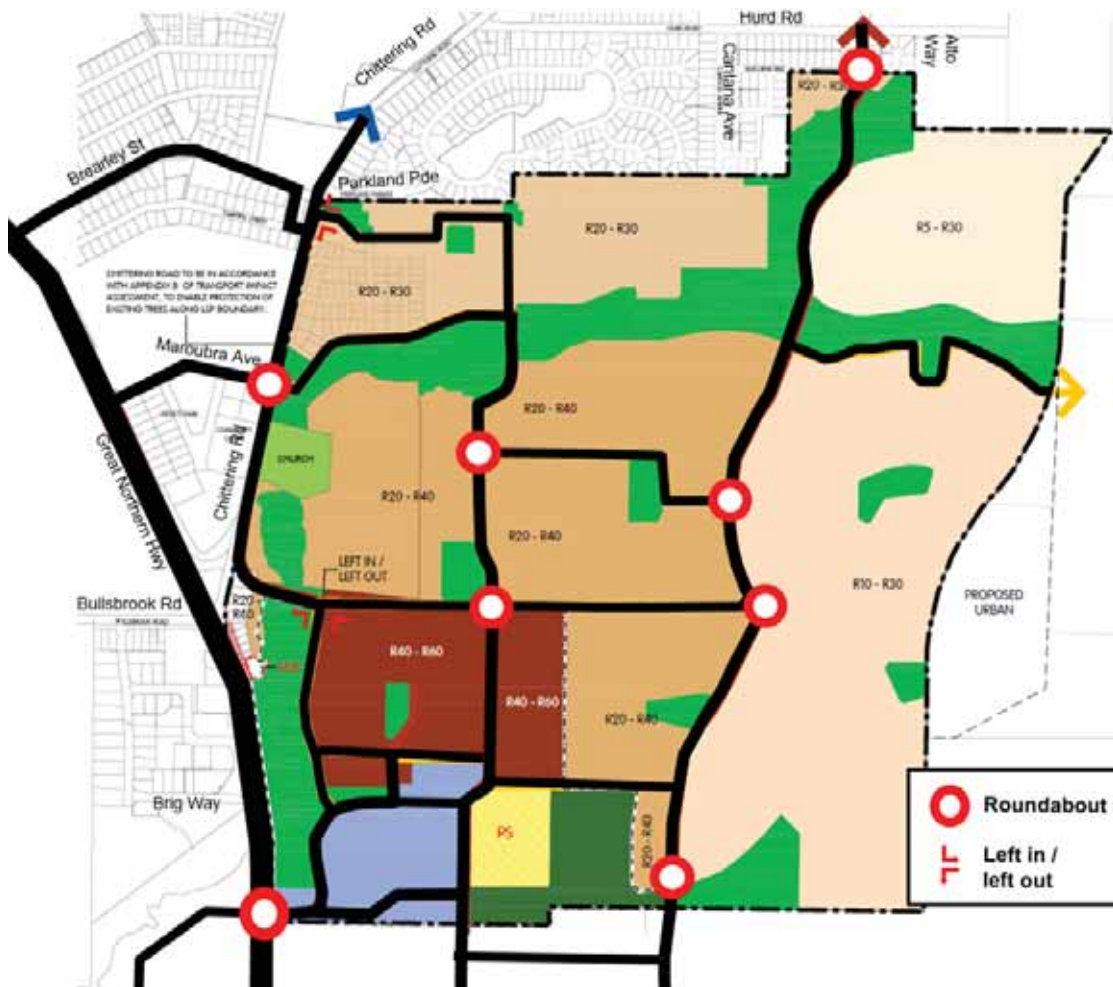


Figure 11: Key intersections

Other intersections within the LSP area will be relatively straightforward to determine at subdivision stage when the local road network is identified. Roundabouts or priority-controlled intersections will be appropriate within this area. Anticipated locations of some of the 4-way intersections that would be constructed as roundabouts are also illustrated in **Figure 11**.

The Hurd Rd / Alto Way / Burley Rd intersection on the eastern spine road is located outside of the LSP area and not directly addressed in **Figure 11**. This would be relatively close to the roundabout proposed at Nocturne Rise and would not warrant another roundabout as the eastern section of Hurd Road currently only provides access to a few dwellings. A potential intersection treatment is illustrated in **Figure 12** (source: JDSi Consulting Engineers), which would make the north south spine road the priority road and offset the eastern leg of Hurd Road at this intersection. This intersection treatment would be subject to further investigation in consultation with the City of Swan as part of planning for the future upgrade of this north south spine road north of the LSP area.



Figure 12: Potential Hurd Rd / Alto Way / Burley Rd intersection treatment

6.5 Intersection Analysis

Intersection capacity analysis has been undertaken for the key Great Northern Highway intersection near the district activity centre as a dual-lane 4-way roundabout for the weekday AM peak and PM peak hour flows that correspond to the modelled 2031 daily traffic flows in **Figure 10**. Based on current Main Roads WA requirements this analysis includes division of heavy vehicles into four separate types of vehicles (Austroads classes 2-5, 6-9, 10 and 11) so that the performance characteristics of the significant numbers of 19m semi-trailers, 27.5m B-doubles and 36.5m double road trains on Great Northern Highway are specifically taken into consideration.

The Chittering Rd / Maroubra Ave intersection has also been analysed as a single-lane 4-way roundabout to confirm that this new roundabout will be a suitable treatment at that location for the future traffic flows.

Capacity analysis of these intersections has been undertaken using the SIDRA computer software package. SIDRA is an intersection modelling tool commonly used by traffic engineers for all types of intersections. SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

- Degree of Saturation is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for infrequent traffic flow up to one for saturated flow or capacity.
- Level of Service is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of service, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).
- Average Delay is the average of all travel time delays for vehicles through the intersection.
- 95% Queue is the queue length below which 95% of all observed queue lengths fall.

The results of the SIDRA analysis are summarised in **Appendix D** and satisfactory intersection performance is shown for each of the intersection options shown in **Appendix D**.

6.6 Access to Frontage Properties

The WAPC Liveable Neighbourhoods policy requires that "*Development along integrator B and neighbourhood connector streets with ultimate vehicle volumes over 5,000 vehicles per day should be designed either so vehicles entering the street can do so travelling forward, or are provided with alternative forms of vehicle access.*"

One alternative suggested in Liveable Neighbourhoods involves wider lots with paired driveways and protected reversing areas in the parking lane but the City of Swan has advised that this strategy will not be supported in this LSP area.

Accordingly, there is to be no direct driveway access to residential development on zoned land within the LSP area from Great Northern Highway, Chittering Road or other roads carrying more than 5,000vpd. On Great Northern Highway no direct driveway access is proposed to any development on zoned land within the LSP area.

This restriction will apply to the higher density residential lots fronting the north south spine road on the eastern side of the district activity centre and some sections of the eastern spine road within the LSP area as traffic volumes on these roads will be in excess of 5,000vpd when this area is fully developed. Therefore, all lots along these sections will have access from rear laneways, side roads or frontage roads parallel to the spine road.

The proposed Chittering Road realignment / extension through to the north south spine road on the eastern side of the district activity centre will be the "activity corridor" proposed in the BTLUMP and is an important element of the identity and function of the new Bullsbrook Townsite.

Recognising its classification generally as a Neighbourhood Connector A, and an Integrator B (Town Centre Main Street) on the section adjacent to the primary school, and the requirements of Liveable Neighbourhoods it is intended to have two distinct frontage treatments as follows:

- Rear lane access through the Town Centre to enable a variety of density housing types that front directly to the street, provide a cottage style street appearance with street front parking and controlled access; and
- No direct residential lot access to the remaining section, consistent with the country character of the existing Bullsbrook Townsite and Chittering Road frontage in particular.

It is intended that the existing sections of Chittering Road adjacent and to the north of the site would maintain the existing road reserve and access arrangements.

All of the other roads in the LSP area are expected to carry less than 5,000vpd, so no restriction on vehicular access is required.

7 Conclusions

This transport impact assessment relates to the Kingsford Local Structure Plan (LSP) at Bullsbrook in the City of Swan.

Urban development of this site is envisaged in the City of Swan's Bullsbrook Townsite District Structure Plan (approved April 2018) (BTDSP) and the previous version called the Bullsbrook Townsite Land Use Master Plan (2014) (BTLUMP). Separate applications have already been lodged for lifting of the Urban Deferment from the Urban Deferred zoned land within the site and for rezoning from Rural to Urban for the remainder of the site.

The proposed LSP area (including the Sacri landholding) will accommodate approximately 2,740 dwellings, a primary school site and the future district activity centre of up to 20,000m² net lettable area that will serve as the expanded town centre for the planned future growth of Bullsbrook townsite.

Future traffic flows within the LSP area and the surrounding BTDSP area have been modelled in consultation with the City of Swan utilising revised and refined trip matrices consistent with Main Roads WA ROM traffic modelling previously undertaken for the BTLUMP study.

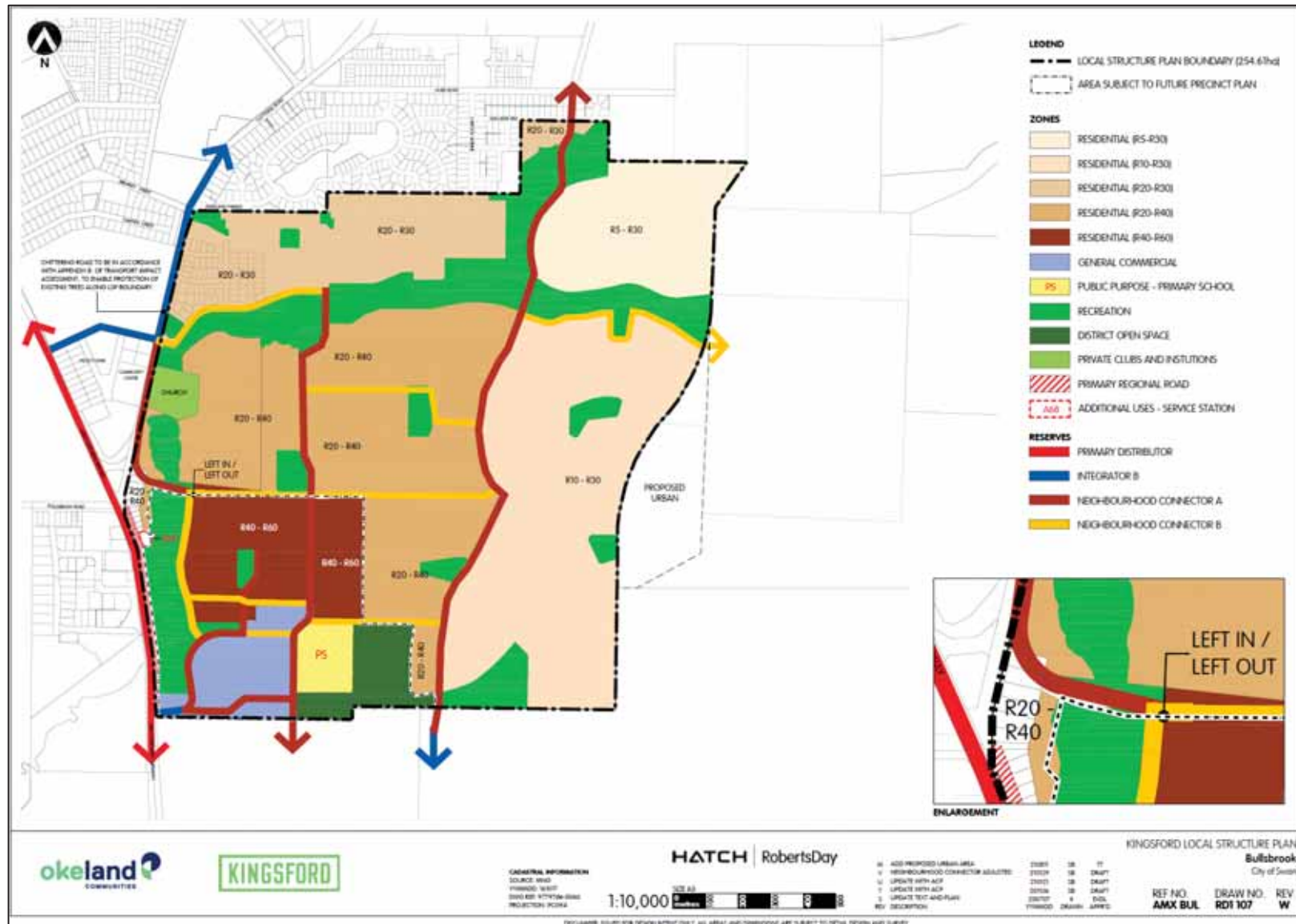
Two new north south spine road links are required through the subject site to support the road network planning of the BTDSP and these are provided for in the proposed LSP plan developed for the subject site. The alignment of the westernmost of these two spine roads will be on the eastern side of the district activity centre then run westwards to connect to an extension of Chittering Road within the LSP area. This will also function as a proposed activity corridor adjacent to the district activity centre that could also accommodate a future rapid transit route envisaged by the BTDSP.

The key intersection for the proposed LSP area is the proposed 4-way intersection on Great Northern Highway near the district activity centre. Main Roads WA has advised that this should be planned ultimately as a dual-lane roundabout. Intersection capacity analysis confirms this roundabout would be able to accommodate the projected 2031 traffic flows.

The recently constructed single-lane 4-way roundabout at the Chittering Rd / Maroubra Ave / Brookbank Dr intersection has also been analysed to confirm that this roundabout would be a suitable treatment at that location to accommodate the future traffic flows when this area is fully developed.

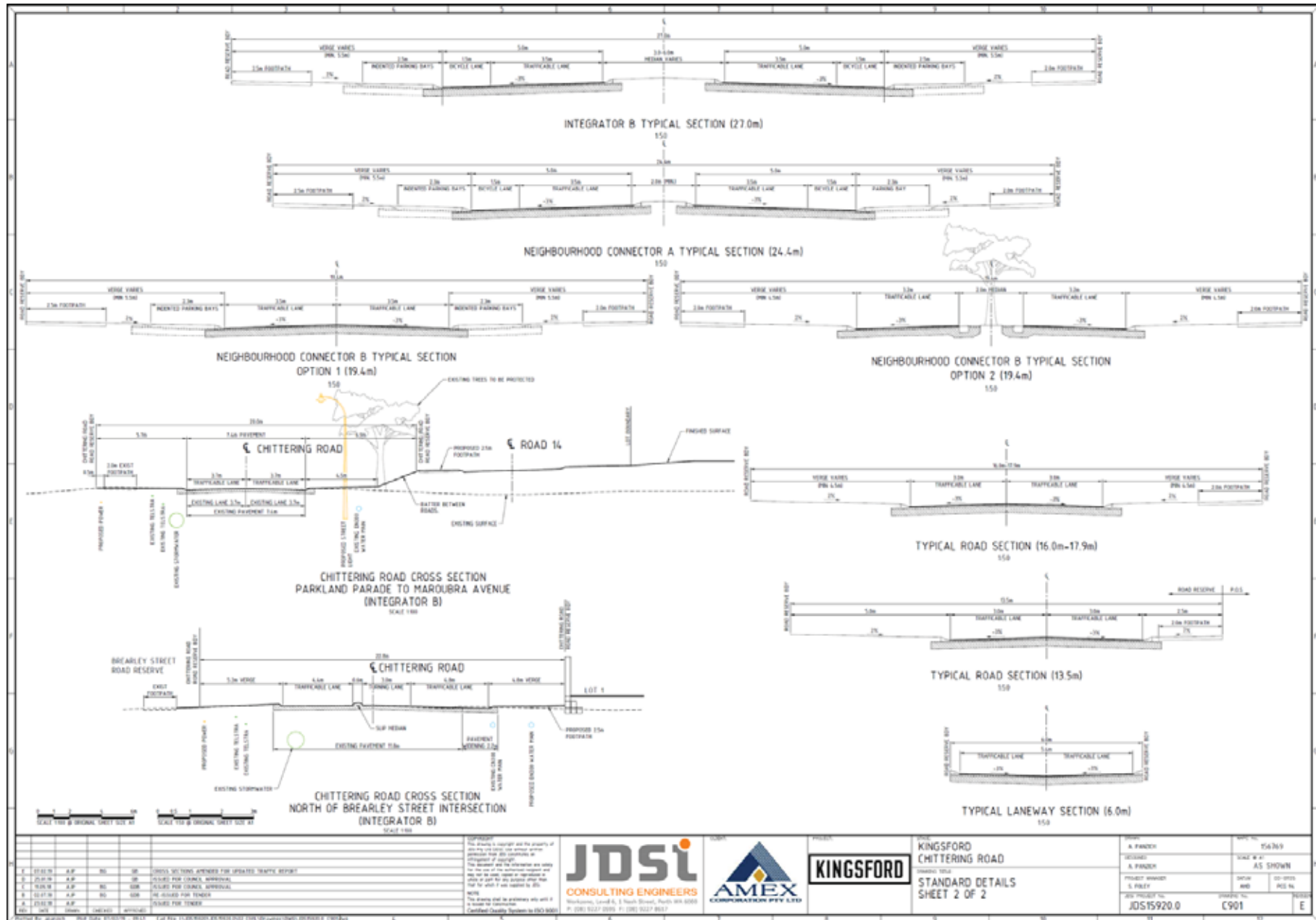
Appendix A

LOCAL STRUCTURE PLAN



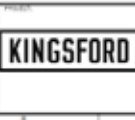
Appendix B

TYPICAL ROAD CROSS-SECTIONS



NO.	DATE	BY	CHKD	DESCRIPTION
1	12/11/19	A.P.	BS	ISSUED FOR TENDER
2	12/11/19	A.P.	BS	ISSUED FOR TENDER
3	12/11/19	A.P.	BS	ISSUED FOR TENDER
4	12/11/19	A.P.	BS	ISSUED FOR TENDER
5	12/11/19	A.P.	BS	ISSUED FOR TENDER
6	12/11/19	A.P.	BS	ISSUED FOR TENDER
7	12/11/19	A.P.	BS	ISSUED FOR TENDER
8	12/11/19	A.P.	BS	ISSUED FOR TENDER
9	12/11/19	A.P.	BS	ISSUED FOR TENDER
10	12/11/19	A.P.	BS	ISSUED FOR TENDER

NOTES:
 1. The drawings shall be read in conjunction with the contract documents.
 2. The drawings shall be read in conjunction with the contract documents.
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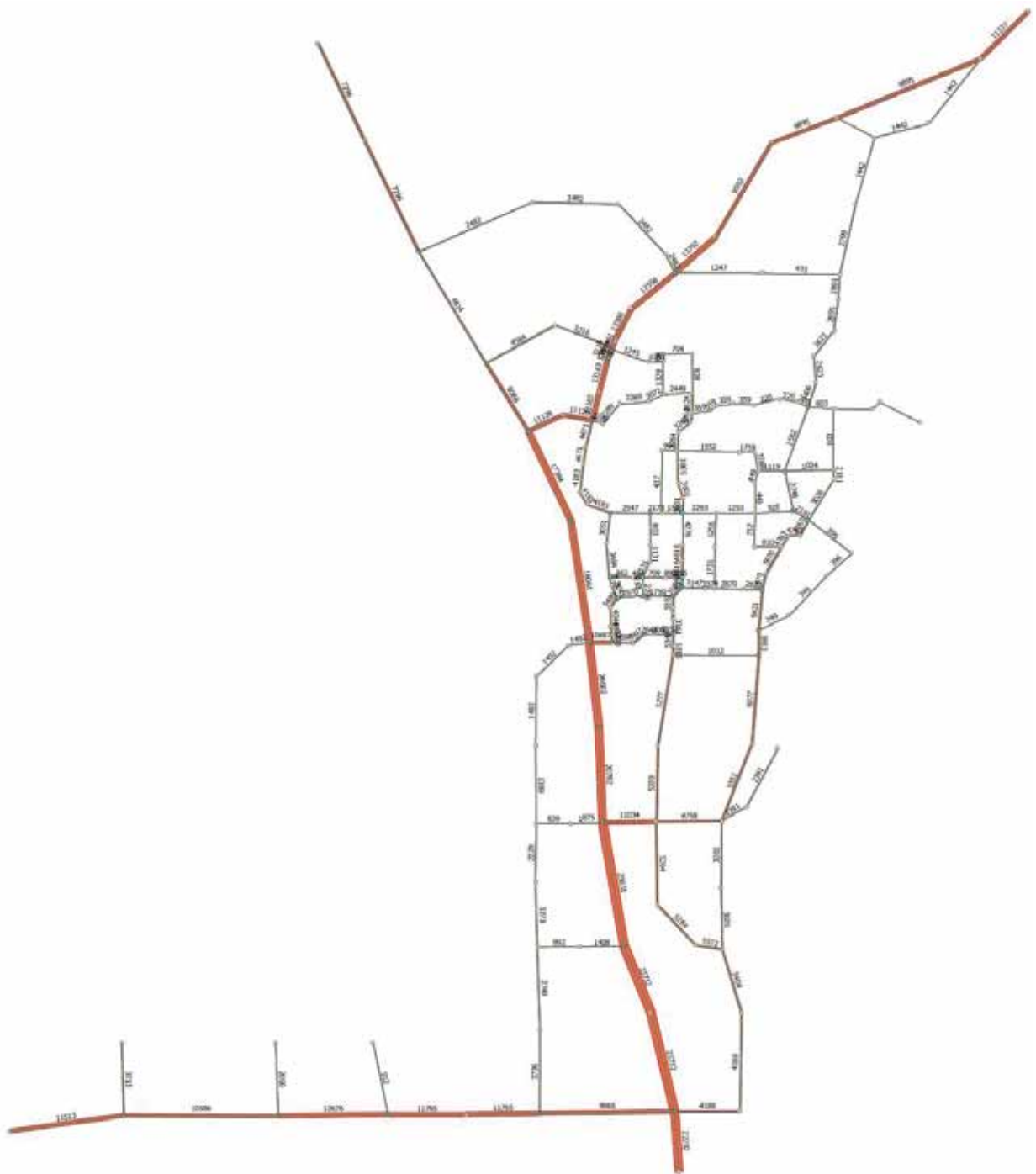


PROJECT: KINGSFORD CHITTERING ROAD
 DRAWING TITLE: STANDARD DETAILS SHEET 2 OF 2

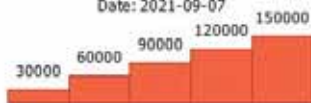
DATE: 15/6/19	SCALE: AS SHOWN
PROJECT NUMBER: JDS15920.0	DRAWING NUMBER: C901
PROJECT MANAGER: S. POLEY	DESIGNER: S. POLEY
CHECKED: S. POLEY	DATE: 15/6/19
APPROVED: S. POLEY	DATE: 15/6/19

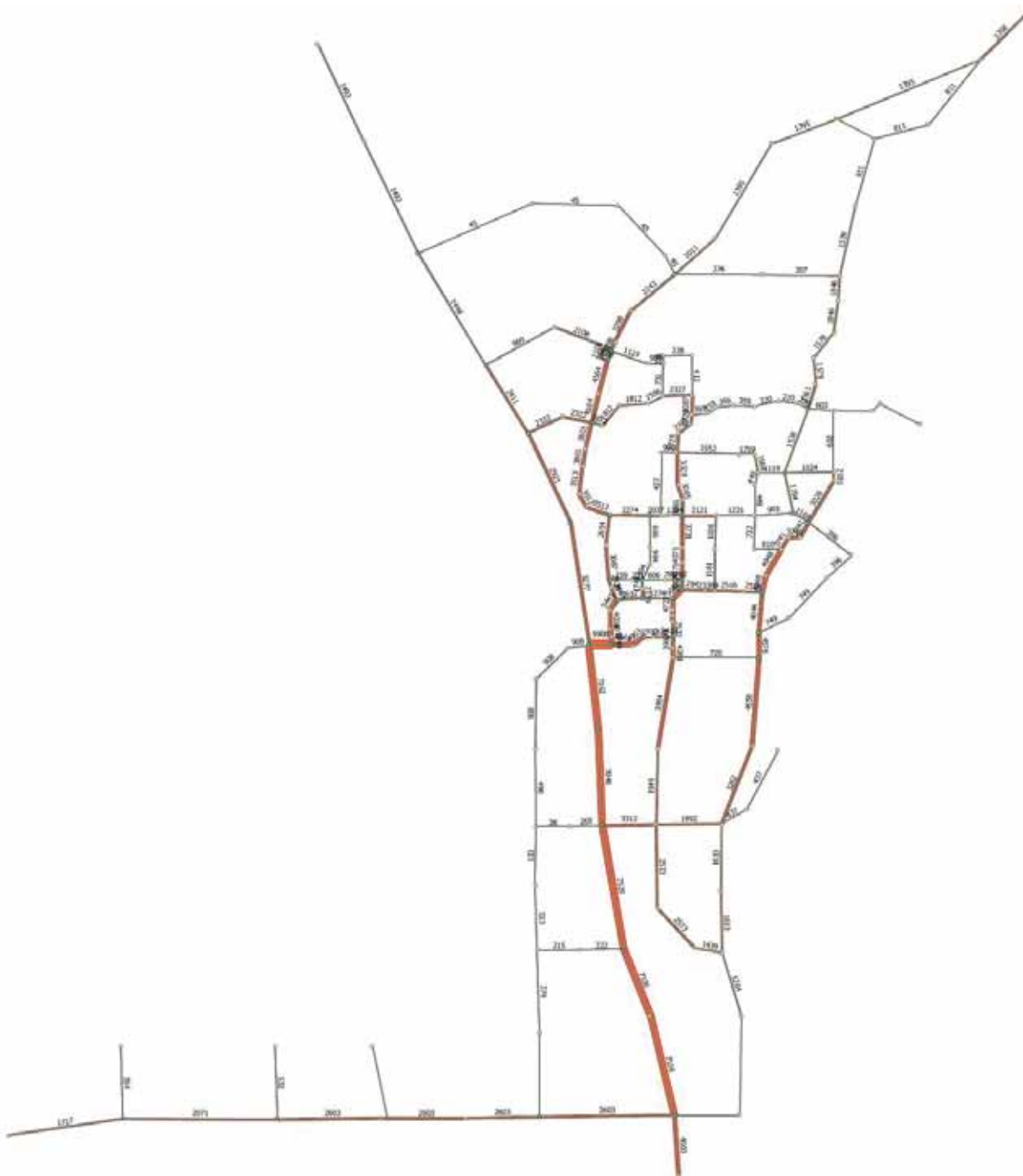
Appendix C

2031 TRAFFIC VOLUMES



Scenario 38: 2031 Bullsbrook LSP 2021 Amendment
 Date: 2021-09-07





Scenario 38: 2031 Bullbrook LSP 2021 Amendment
 Traffic to/from selected links
 Date: 2021-09-07



Traffic flows with trip origin and/or destination within the LSP area.

Appendix D

SIDRA INTERSECTION ANALYSIS

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.

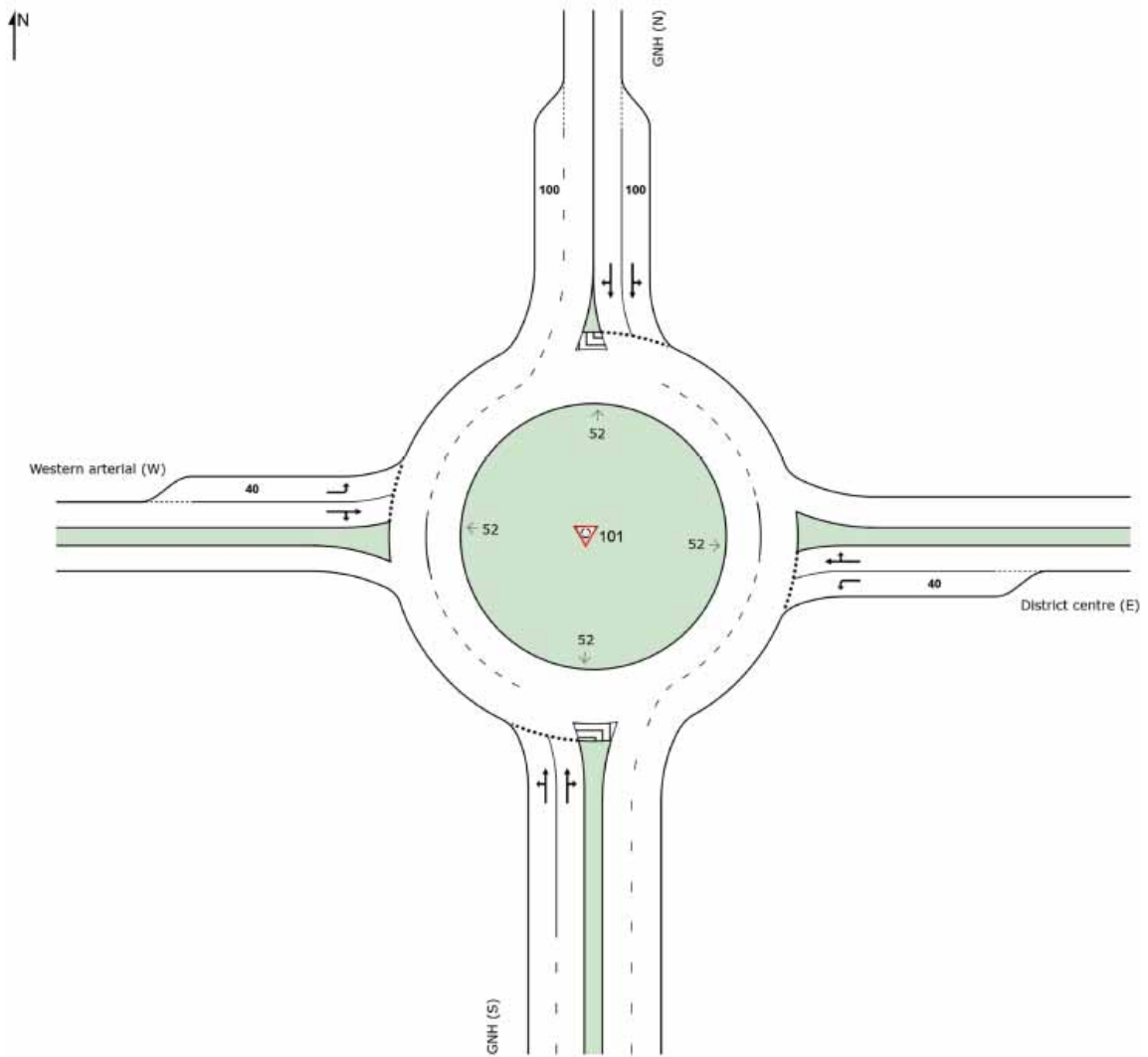


Figure D1. Great Northern Hwy / Bullsbrook district centre ultimate dual-lane roundabout layout analysed in SIDRA

Table D1a. SIDRA results – Great Northern Hwy / Bullsbrook district centre dual-lane roundabout – 2031 weekday AM peak with full development

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES		DEMAND FLOWS		Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE		Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
		[Total veh/h]	[HV] %	[Total veh/h]	[HV] %				[Veh. veh]	[Dist] m				
South: GNH (S)														
1	L2	10	10.0	11	10.0	0.209	3.8	LOS A	0.9	8.6	0.40	0.33	0.40	55.9
2	T1	405	22.7	426	22.7	0.246	3.7	LOS A	1.2	10.6	0.39	0.41	0.39	57.4
3	R2	177	3.3	186	3.3	0.246	10.3	LOS B	1.2	10.6	0.39	0.49	0.39	48.3
Approach		592	16.7	623	16.7	0.246	5.6	LOS A	1.2	10.6	0.39	0.43	0.39	55.2
East: District centre (E)														
4	L2	449	3.3	473	3.3	0.353	3.5	LOS A	1.4	11.0	0.51	0.52	0.51	53.3
5	T1	86	3.3	91	3.3	0.274	3.5	LOS A	1.0	7.5	0.50	0.71	0.50	53.7
6	R2	178	3.3	187	3.3	0.274	10.5	LOS B	1.0	7.5	0.50	0.71	0.50	54.4
Approach		713	3.3	751	3.3	0.353	5.2	LOS A	1.4	11.0	0.51	0.59	0.51	53.7
North: GNH (N)														
7	L2	105	3.3	111	3.3	0.315	3.3	LOS A	1.5	13.7	0.31	0.30	0.31	45.7
8	T1	693	22.7	729	22.7	0.315	2.9	LOS A	1.5	13.7	0.32	0.32	0.32	58.8
9	R2	40	10.0	42	10.0	0.315	10.4	LOS B	1.4	13.2	0.34	0.34	0.34	57.2
Approach		838	19.7	882	19.7	0.315	3.3	LOS A	1.5	13.7	0.32	0.32	0.32	57.4
West: Western arterial (W)														
10	L2	12	10.0	13	10.0	0.014	5.4	LOS A	0.0	0.4	0.47	0.52	0.47	55.7
11	T1	15	3.3	16	3.3	0.021	3.3	LOS A	0.1	0.6	0.46	0.49	0.46	36.3
12	R2	10	10.0	11	10.0	0.021	10.9	LOS B	0.1	0.6	0.46	0.49	0.46	55.4
Approach		37	7.3	39	7.3	0.021	6.1	LOS A	0.1	0.6	0.46	0.50	0.46	47.9
All Vehicles		2180	13.3	2295	13.3	0.353	4.6	LOS A	1.5	13.7	0.40	0.44	0.40	55.7

Table D1b. SIDRA results – Great Northern Hwy / Bullsbrook district centre dual-lane roundabout – 2031 weekday PM peak with full development

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES		DEMAND FLOWS		Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE		Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
		[Total veh/h]	[HV] %	[Total veh/h]	[HV] %				[Veh. veh]	[Dist] m				
South: GNH (S)														
1	L2	10	10.0	11	10.0	0.399	3.5	LOS A	1.9	18.3	0.33	0.29	0.33	56.4
2	T1	764	22.7	804	22.7	0.470	3.8	LOS A	2.6	21.8	0.32	0.38	0.32	57.7
3	R2	442	3.3	465	3.3	0.470	10.0	LOS B	2.6	21.8	0.31	0.50	0.31	48.0
Approach		1216	15.5	1280	15.5	0.470	6.0	LOS A	2.6	21.8	0.32	0.42	0.32	54.8
East: District centre (E)														
4	L2	224	3.3	236	3.3	0.178	3.1	LOS A	0.7	5.2	0.43	0.46	0.43	53.8
5	T1	43	3.3	45	3.3	0.134	3.0	LOS A	0.5	3.5	0.43	0.64	0.43	54.1
6	R2	89	3.3	94	3.3	0.134	10.0	LOS A	0.5	3.5	0.43	0.64	0.43	54.8
Approach		356	3.3	375	3.3	0.178	4.8	LOS A	0.7	5.2	0.43	0.53	0.43	54.1
North: GNH (N)														
7	L2	262	3.3	276	3.3	0.323	4.2	LOS A	1.9	15.9	0.53	0.46	0.53	44.3
8	T1	486	22.7	512	22.7	0.323	4.1	LOS A	1.9	15.9	0.54	0.46	0.54	57.5
9	R2	28	10.0	29	10.0	0.323	11.6	LOS B	1.6	15.3	0.54	0.46	0.54	56.1
Approach		776	15.7	817	15.7	0.323	4.4	LOS A	1.9	15.9	0.53	0.46	0.53	53.8
West: Western arterial (W)														
10	L2	23	10.0	24	10.0	0.034	7.9	LOS A	0.1	1.1	0.64	0.69	0.64	54.9
11	T1	37	3.3	39	3.3	0.051	5.2	LOS A	0.3	2.0	0.69	0.59	0.69	35.7
12	R2	10	10.0	11	10.0	0.051	12.7	LOS B	0.3	2.0	0.69	0.59	0.69	54.8
Approach		70	6.5	74	6.5	0.051	7.1	LOS A	0.3	2.0	0.67	0.62	0.67	44.9
All Vehicles		2418	13.5	2545	13.5	0.470	5.4	LOS A	2.6	21.8	0.41	0.45	0.41	54.1

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.

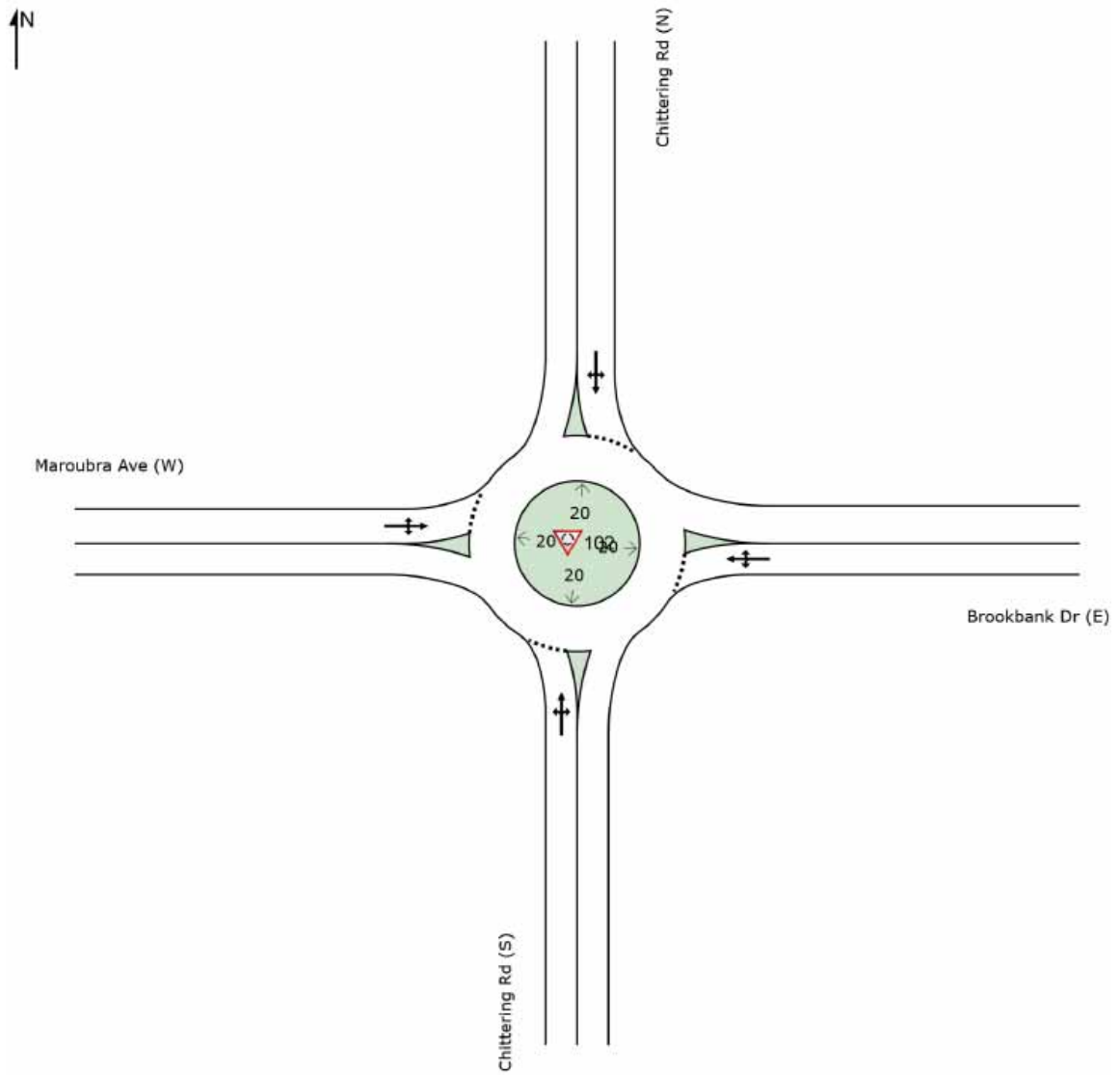


Figure D2. Chittering Rd / Maroubra Ave roundabout layout analysed in SIDRA

**Table D2a. SIDRA results – Chittering Rd / Maroubra Ave roundabout – 2031
weekday AM peak with full development**

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES		DEMAND FLOWS		Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE		Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
		[Total veh/h]	[HV %]	[Total veh/h]	[HV %]				[Veh. veh]	[Dist m]				
South: Chittering Rd (S)														
7	L2	15	3.3	16	3.3	0.236	9.4	LOS A	1.4	10.9	0.79	0.82	0.79	44.3
8	T1	123	3.3	129	3.3	0.236	9.2	LOS A	1.4	10.9	0.79	0.82	0.79	45.2
9	R2	3	3.3	3	3.3	0.236	13.7	LOS B	1.4	10.9	0.79	0.82	0.79	45.3
Approach		141	3.3	148	3.3	0.236	9.3	LOS A	1.4	10.9	0.79	0.82	0.79	45.1
East: Brookbank Dr (E)														
10	L2	1	3.3	1	3.3	0.309	11.1	LOS B	2.0	15.2	0.86	0.91	0.86	43.0
11	T1	127	3.3	134	3.3	0.309	10.9	LOS B	2.0	15.2	0.86	0.91	0.86	43.9
12	R2	35	3.3	37	3.3	0.309	15.4	LOS B	2.0	15.2	0.86	0.91	0.86	44.0
Approach		163	3.3	172	3.3	0.309	11.8	LOS B	2.0	15.2	0.86	0.91	0.86	43.9
North: Chittering Rd (N)														
1	L2	13	3.3	14	3.3	0.712	3.5	LOS A	5.4	45.3	0.35	0.55	0.35	45.2
2	T1	206	3.3	217	3.3	0.712	3.2	LOS A	5.4	45.3	0.35	0.55	0.35	46.3
3	R2	694	16.2	731	16.2	0.712	8.0	LOS A	5.4	45.3	0.35	0.55	0.35	45.8
Approach		913	13.1	961	13.1	0.712	6.8	LOS A	5.4	45.3	0.35	0.55	0.35	45.9
West: Maroubra Ave (W)														
4	L2	210	16.2	221	16.2	0.272	3.8	LOS A	1.3	10.8	0.33	0.50	0.33	46.3
5	T1	44	3.3	46	3.3	0.272	3.3	LOS A	1.3	10.8	0.33	0.50	0.33	47.8
6	R2	40	3.3	42	3.3	0.272	7.9	LOS A	1.3	10.8	0.33	0.50	0.33	47.9
Approach		294	12.5	309	12.5	0.272	4.2	LOS A	1.3	10.8	0.33	0.50	0.33	46.7
All Vehicles		1511	11.0	1591	11.0	0.712	7.1	LOS A	5.4	45.3	0.44	0.60	0.44	45.8

**Table D2b. SIDRA results – Chittering Rd / Maroubra Ave roundabout – 2031
weekday PM peak with full development**

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES		DEMAND FLOWS		Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE		Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
		[Total veh/h]	[HV %]	[Total veh/h]	[HV %]				[Veh. veh]	[Dist m]				
South: Chittering Rd (S)														
7	L2	37	3.3	39	3.3	0.390	5.5	LOS A	2.2	16.7	0.60	0.64	0.60	46.0
8	T1	309	3.3	325	3.3	0.390	5.3	LOS A	2.2	16.7	0.60	0.64	0.60	47.0
9	R2	7	3.3	7	3.3	0.390	9.9	LOS A	2.2	16.7	0.60	0.64	0.60	47.1
Approach		353	3.3	372	3.3	0.390	5.4	LOS A	2.2	16.7	0.60	0.64	0.60	46.9
East: Brookbank Dr (E)														
10	L2	1	3.3	1	3.3	0.095	5.1	LOS A	0.4	3.4	0.52	0.60	0.52	45.8
11	T1	64	3.3	67	3.3	0.095	4.9	LOS A	0.4	3.4	0.52	0.60	0.52	46.8
12	R2	18	3.3	19	3.3	0.095	9.4	LOS A	0.4	3.4	0.52	0.60	0.52	46.9
Approach		83	3.3	87	3.3	0.095	5.9	LOS A	0.4	3.4	0.52	0.60	0.52	46.9
North: Chittering Rd (N)														
1	L2	32	3.3	34	3.3	0.416	3.5	LOS A	2.1	17.6	0.32	0.56	0.32	45.4
2	T1	103	3.3	108	3.3	0.416	3.2	LOS A	2.1	17.6	0.32	0.56	0.32	46.5
3	R2	347	16.2	365	16.2	0.416	8.0	LOS A	2.1	17.6	0.32	0.56	0.32	46.0
Approach		482	12.6	507	12.6	0.416	6.6	LOS A	2.1	17.6	0.32	0.56	0.32	46.1
West: Maroubra Ave (W)														
4	L2	525	16.2	553	16.2	0.683	6.6	LOS A	6.2	52.3	0.71	0.79	0.82	45.3
5	T1	111	3.3	117	3.3	0.683	6.0	LOS A	6.2	52.3	0.71	0.79	0.82	46.7
6	R2	20	3.3	21	3.3	0.683	10.6	LOS B	6.2	52.3	0.71	0.79	0.82	46.8
Approach		656	13.6	691	13.6	0.683	6.7	LOS A	6.2	52.3	0.71	0.79	0.82	45.6
All Vehicles		1574	10.4	1657	10.4	0.683	6.3	LOS A	6.2	52.3	0.55	0.68	0.60	46.1

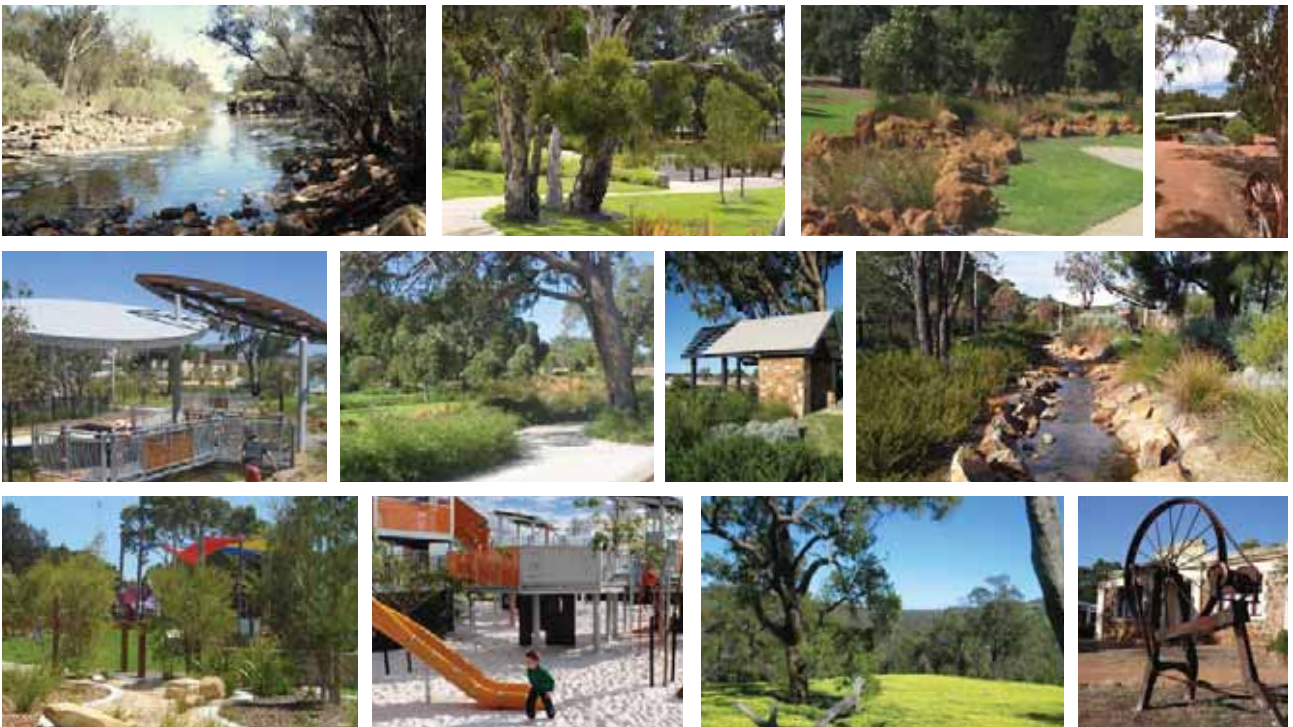
Appendix 6

Landscape Strategy

(Emerge)

August 2021
BULLSBROOK
for Okeland

Local Structure Plan - Landscape and Irrigation Strategy



REV L -30/08/2021



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1. LANDSCAPE PRINCIPLES

1.1. INTRODUCTION

The development of Bullsbrook provides the opportunity for the rural context of the existing locale to be interpreted and be sensibly projected within practical limits through the project area.

Hence the key Landscape Principles to be explored during the design phase shall be:

- The rural/village environment and the elements that define Bullsbrook as a place is an avenue that is to be explored and referenced in the design of the landscape.
- Respecting the ecological corridors/buffers and incorporating these into a linear Public Open Space (POS) network and adopting a programme of revegetation and rehabilitation.
- Understanding that the linear POS network provides the opportunity to establish a highly legible and pedestrian/cycle friendly framework within the estate.
- Retention of existing stands of scattered and isolated Eucalypts via incorporation into public open space or through the creation of wider road reserves.
- Views to the hills to the east are to be framed through the street layout and enhanced through sensitive landscape design.
- Views into the site and outwards from the site are to be screened or framed where appropriate to retain a sense of rural context.
- Appreciation that a balanced approach is required to ensure the social and recreational requirements of the future residents are balanced with the ecological and engineering constraints imposed by the site.
- Respect existing Bush Forever sites.
- Provide a balanced variety of outdoor public space for recreational and social opportunities appropriate to the size of the proposed community.
- Provide a legible network of walking and cycle paths linking the town centre and areas of public open space, schools and other community infrastructure.
- Mitigate post development drainage flows through incorporation of upstream treatment drains within the open space network and widened road reserves. Ensure drainage corridors are treated in such a way so as to allow multiple public use.



The project will be developed around offering a range of open space opportunities. The public open space within Bullsbrook has been planned to provide a network of parkland and corridors which integrate with the Ki-It Monger Brook and aims to contribute to the ecological and social fabric of the Bullsbrook community. Being strategically located, they will provide accessibility and connectivity through the development whilst also playing an important role in protecting the sites natural assets which are unique to the Bullsbrook locale.

The areas of POS within Bullsbrook have been separated into broad categories based on their specific treatments and design:

- Small Open Space
- Local and/ or Linear Open Space
- Neighbourhood Open Space
- District Open Space / Playing Fields
- Civic POS / High order Neighbourhood Open Space
- Conservation & Buffer Areas
- Ki-It Monger Brook

See Figure 7 for “Facilities Plan” which shows the locations of these POS categories. These are described in detail as follows:



2. PUBLIC OPEN SPACE TYPOLOGIES

The Public Open Space Network consists of the following and are as defined where appropriate under Liveable Neighbourhoods:

- **Linear POS:**
Open spaces which provide a connection between smaller recreational nodes (neighbourhood POS) and specifically allows an integration/connection with the Ki-It Monger Brook. Provides legibility and sense of place for local residents. Also enables retention of existing trees and allows for low level drainage conveyance through the site.
- **Neighbourhood POS:**
Located throughout the development (3,000 - 5,000m²) and provides local residents with areas of turf and planting for informal kick-about play and passive uses. Also provides seating areas under shelter/shade and are typically within 400m of most dwellings. Are able to service approx. 600 dwellings within the surrounding area.
- **District POS/Playing Fields:**
Approximately 2.5 - 7ha and notionally able to serve three neighbourhoods. Provides local residents and community with an open area capable for servicing district sports, events and gatherings. Caters for the combination of passive (including informal play areas) and active recreation and are generally within 1km of most dwellings. Natural and human made changes in elevation need to be considered in context to district POS as they also serve a drainage function to the development.
- **Civic POS:**
Provision for a main street and town/village square within Bullsbrook development. Predominantly hard paved and located at the conjunction of major thoroughfares and town/village centre in order to provide a landmark for community gatherings and events.
- **Conservation and Buffer Areas:**
As the proposed development area includes the Ki-It Monger Brook; conservation and buffer zones are designed to rehabilitate/protect the natural assets of the site to the benefit of the environment and greater community. These areas will provide opportunities for passive recreation (walking trails) and serve a critical role in drainage detention.
- **Ki-It Monger Brook**
The Ki-It Monger Brook will become the primary POS and ecological corridor of the development. It represents a unique asset which serves a critical ecological role. Sensitive design will ensure existing vegetation will be retained and rehabilitated. This objective will be achieved by designating nodes for recreational/educational opportunities; allowing for vegetated areas to be retained and protected along the existing Brook corridor. Continuous pedestrian/cycling paths will link these interspersed nodes which include amenities in the form of play spaces, boardwalks and interpretative signage.

2.1. LINEAR OPEN SPACE NETWORKS

In order to address the requirements of retaining site topography and the principle of protecting existing trees and ecological linkages, the structure plan includes a series of linear open spaces. The design intent of these spaces is to rehabilitate existing vegetation as well as incorporate existing stands of isolated trees and drainage alignments. Through respecting the existing topography in these areas, the linear POS will provide a necessary drainage function as well as provide visual amenity to the public realm.

As surrounding lots and roads require imported fill to ensure suitable structural conditions for housing, these linear parks will sit at a lower grade. This will ensure that drainage will flow towards these areas and discrete bio-filtration and detention basins will be incorporated along the length of the linear parks. A system of inlet and overflow structures will ensure designated parkland areas are kept dry and usable.

Linear parks and widened road reserves as well as serving an environmental and drainage function also provide an efficient means of supporting a legible cycle and pedestrian network. Which will be designed to encourage passive surveillance from overlooking residents in accordance with Liveable Neighbourhood guidelines and best practice in terms of 'Designing out Crime'.

2.2. NEIGHBOURHOOD PARKS

Neighbourhood Parks are to be larger POS areas catering as a destination along the linear POS network or larger individual parcels within the developed area. The landscape treatment of these spaces will be generally informal in nature and characterised by revegetation and native parkland plantings which encourage passive recreation uses. Localised areas of turf that cater for informal active recreation may also feature. Typically this park will consist of an area of retained remnant vegetation with a central built feature and playground. Path systems will link to the adjoining residential streets and to the linear POS network to provide access as necessary.

Drainage areas may be required in these open spaces, and where provided will be landscaped basins, serving a recreational and amenity function. Drainage swales catering for events greater than 1:5 within Neighbourhood POS areas will have turf to enable multiple use and ease of maintenance.

The extent of hardscape and the urbanity of the space will increase in proximity to the town centre.

2.3. DISTRICT PARK/PLAYING FIELDS

Typically covering areas between 2.5 - 7ha, district POS/Playing Fields serve a critical role in providing vegetation and large open turfed spaces capable of servicing a diverse range of passive and recreational activities. These large open spaces serve as a landmark or destination for residents and community groups as they provide amenities such as large kickabout areas, shelters, BBQ, nature play and exercise nodes. The landscape treatment of these spaces will be more formalised in nature with the provision of distinct active/passive zones amongst activities and age groups. Planting will typically be used to provide shade for resting and play areas. In addition, perimeter planting will be implemented to allow for a visual buffer between road/path networks.

Playing Fields

Located adjacent to the future zoned primary school and town/village centre, the proposed playing field represents an opportunity to co-locate amenities capable of servicing the local school, residents and the greater Bullsbrook community. Due to its potential in servicing the proposed school as well as providing for seasonal sporting activities and everyday recreational use, areas may be set aside for multipurpose fields, hardcourts, potential amenity block, carparking and a grandstand for spectators. Its capacity to allow for organised sporting and large scale community events will contribute towards nurturing social interaction and promoting local fabric within the community. All facilities will require confirmation of funding through the Developer's Contributions Scheme.

Another important aspect to District POS/Playing fields will be its critical role as a drainage area during large stormwater and flooding events.

2.4. LIVING STREAMS

Due to the requirement to convey stormwater reliably away from high use areas; a system of shallow 'living streams' will be created in the larger POS areas, broader sections of linear parkland and widened road reserves. This system will seek to mimic pre development flows and enable upstream bio-filtration and recharge of the groundwater table.

Through the linear parks the living stream may include an interface with a dual use path (DUP). There will be native shrub planting on the banks and native reed/sedge planting to enhance nutrient uptake. With planting to consist of endemic species with a variety of tree, shrub, groundcover, reed and sedge species. Bank stabilisation will be incorporated into the design and a variety of tree species will be used to provide a diverse tree canopy. Treatment along the length of the stream will be dependent upon the width of the corridor and the engineering constraints. The Living Stream will provide not only a viable drainage function but also a variety of ecological zones and restoration opportunities.



2.5. KI-IT MONGER BROOK

The Ki-It Monger Brook provides a valuable natural landscape resource that contains existing remnant vegetation along a natural drainage corridor. Adjacent to the Brook is a broad interface area which offers a reduced fire hazard area and provides a buffer from the residential development. Currently, existing remnant vegetation along the brook's interface are in a degraded state with little or no undergrowth. Works will be undertaken to remove any dead material so it becomes a reduced hazard area, with any additional planting to be in accordance with the Fire Management Plan.

Proposed planting in the interface areas shall take into consideration the recommendations of the Fire Management Report and comply with the proposed Hazard Separation Zones. Proposed plant species shall be waterwise, native species or a nominated FESA fire retardant species.

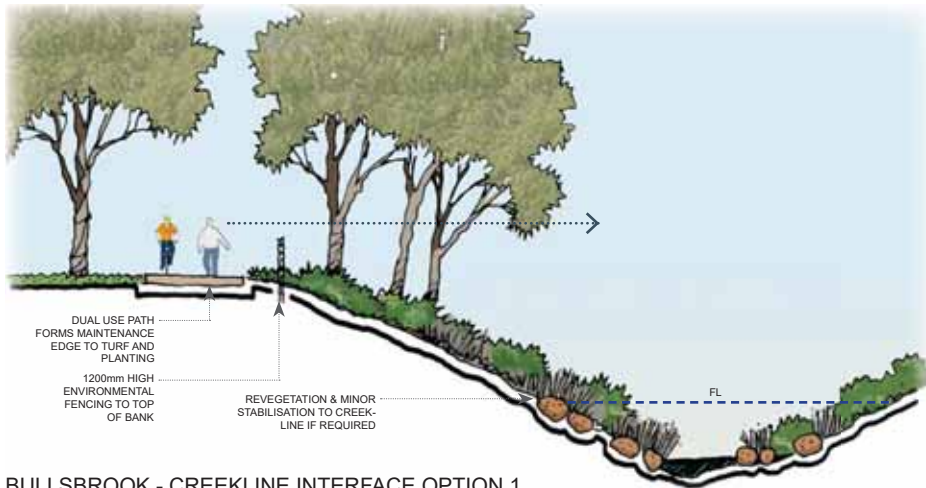
The interface areas shall consist of rehabilitated endemic planting interlaced with passive recreation opportunities through walk trails and formalised parkland nodes. These nodes will form Neighbourhood POS and provide settings for picnics and informal gatherings as well as opportunities to incorporate nature play areas. Supplemental planting adjacent to the brook shall limit direct public access and where possible an informal dual use path system shall extend along the length of the interface area to define public use and to discourage turf/weed encroachment.

- Potential exists for interpretive signage to be located along footpaths and boardwalks informing the community of the importance of local flora/fauna and the significance of the Bush forever site and interface zones.
- The dual use and pedestrian path systems shall be designed to allow vehicular crossing and access points for maintenance purposes.
- The Interface Area shall be composed of 95% endemic vegetation, with irrigation and exotic planting restricted to small recreational nodes (less than 5,000m²).
- It is not proposed that any drainage be introduced into the interface areas beyond that required to maintain pre development flows.
- Additional planting adjacent to the Ki-It Monger Brook and mapped wetland interface area is to be in accordance with an approved Foreshore and/or Wetland Management Plan.

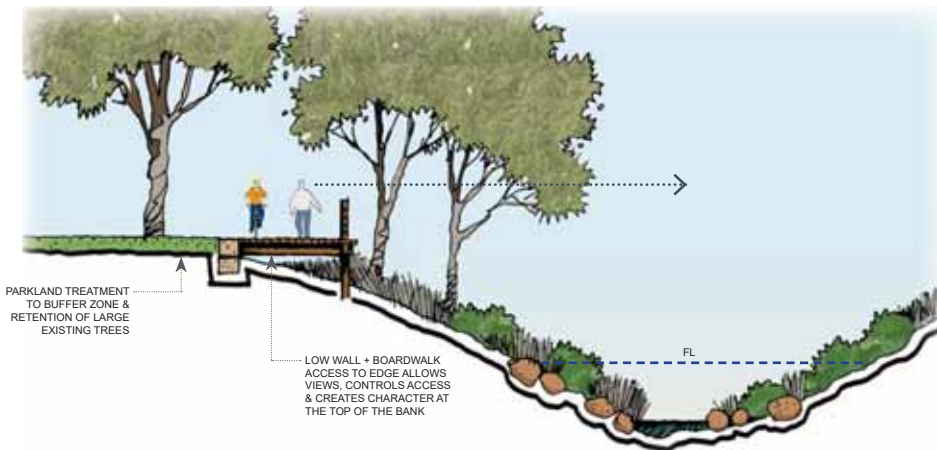


Figure: Ki-It Monger Brook through a Recreational Activity Node

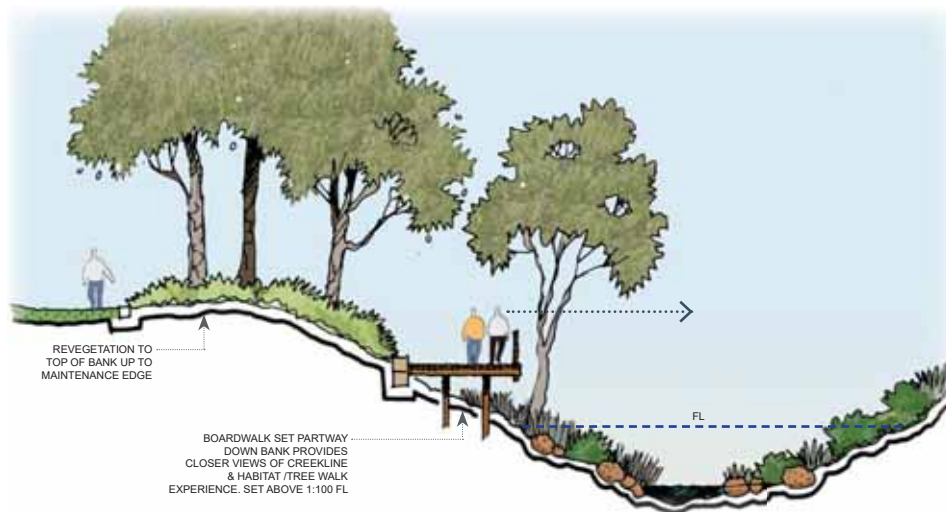




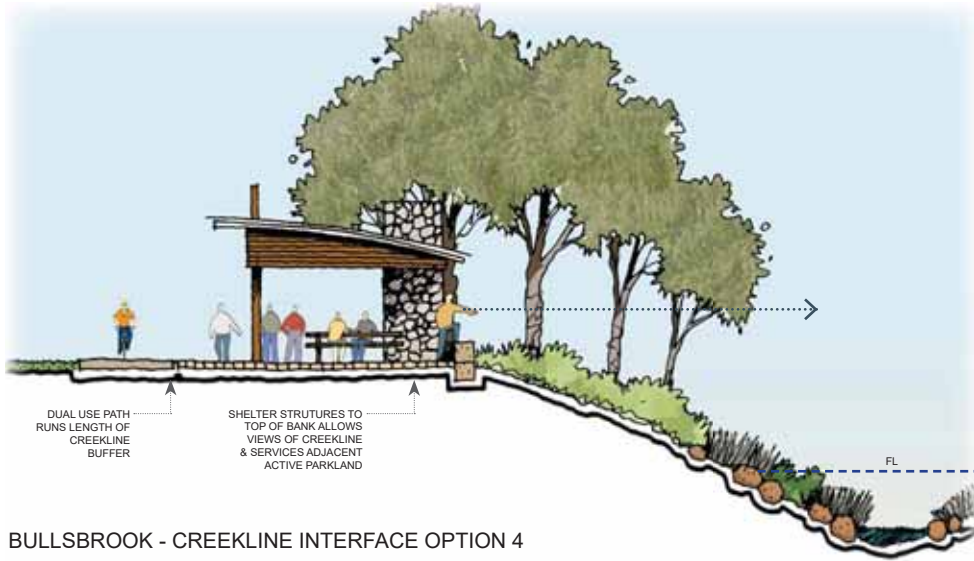
BULLSBROOK - CREEKLINE INTERFACE OPTION 1



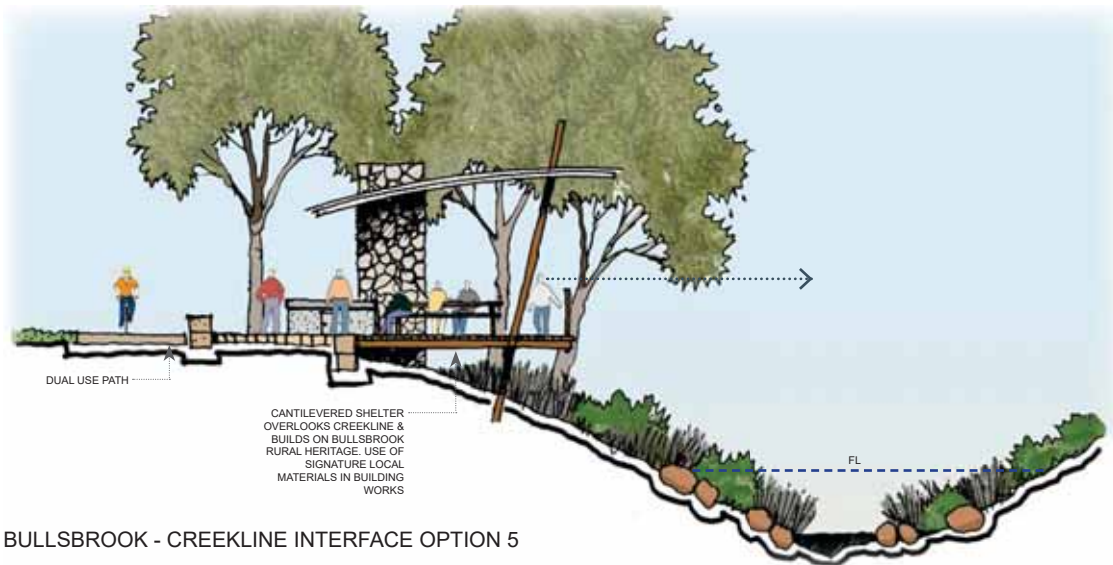
BULLSBROOK - CREEKLINE INTERFACE OPTION 2



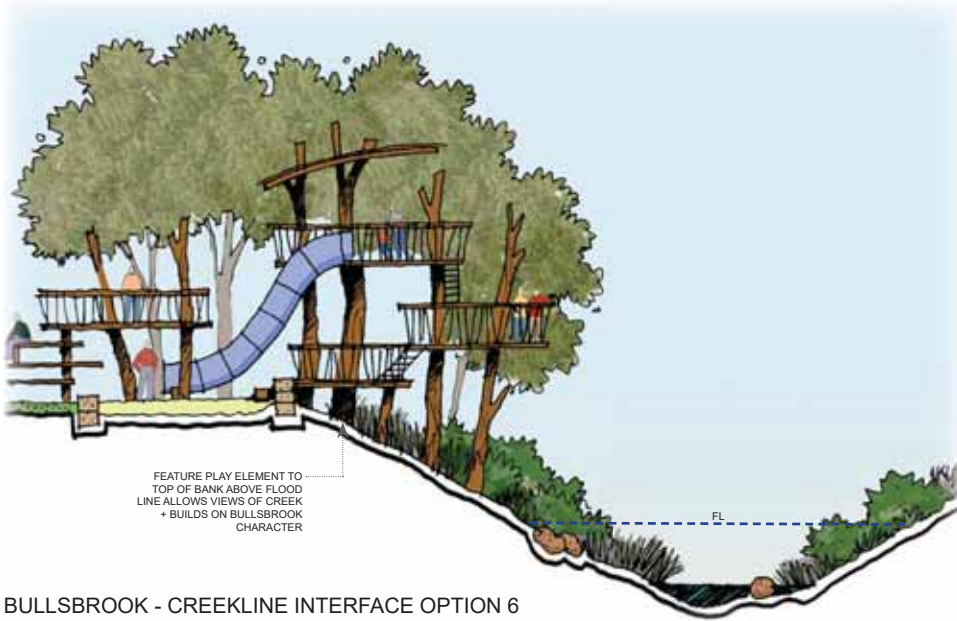
BULLSBROOK - CREEKLINE INTERFACE OPTION 3



BULLSBROOK - CREEKLINE INTERFACE OPTION 4



BULLSBROOK - CREEKLINE INTERFACE OPTION 5



BULLSBROOK - CREEKLINE INTERFACE OPTION 6



BULLSBROOK - CREEKLINE INTERFACE OPTION 7

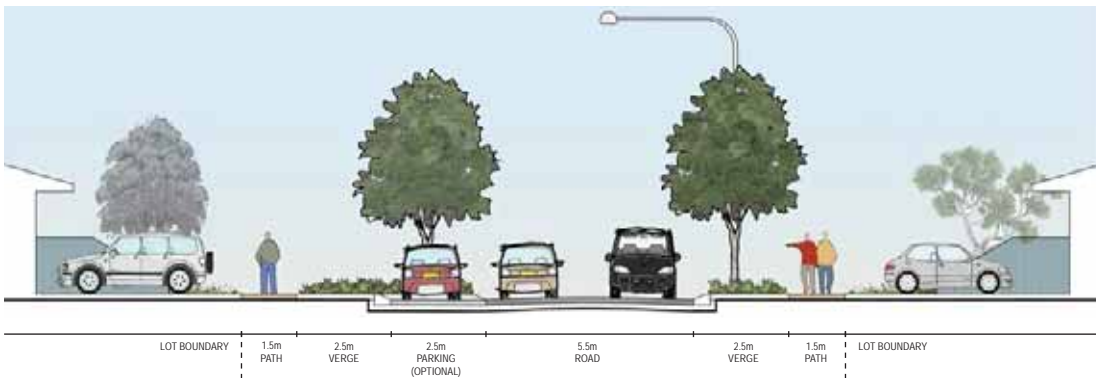
2.6. STREETSCAPES

Streetscapes throughout the development shall incorporate a variety of treatments in response to the road hierarchy system. In all cases, landscape works shall incorporate tree planting in accordance with the accepted traffic standards. Treatments may include soft works such as street trees, smaller shrubs and groundcovers.

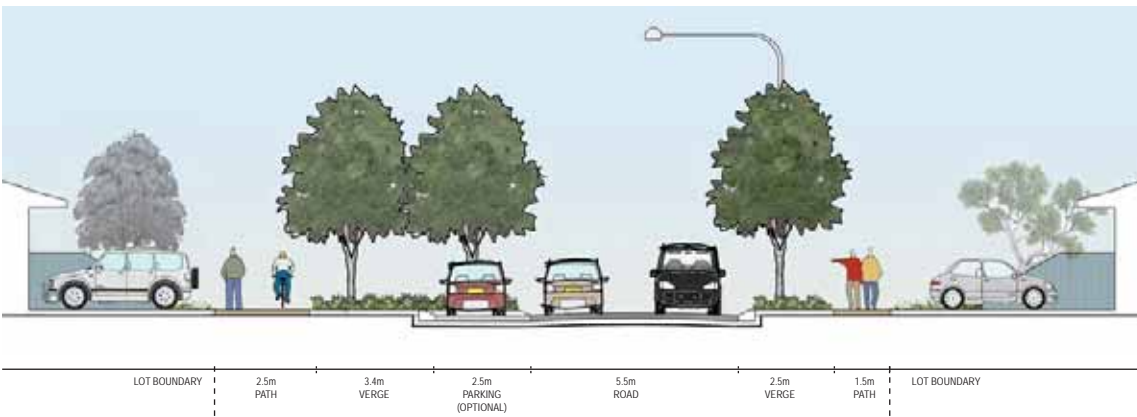
It is envisaged that the stormwater runoff from residential roads will be contained upstream mainly in a system of bio-retention basins distributed along road reserves and the linear open space network.

Tree species are yet to be allocated however it is anticipated that within the POS's predominantly native trees will be used. It is proposed that species selections for streetscapes will also include species which reference the historic and cultural influences in the area. Deciduous exotic species historically used around rural homesteads will be used for major roads and civic areas to provide landmarks and promote legibility through the street network. The timing of installation (pre or post home construction) is yet to be determined.

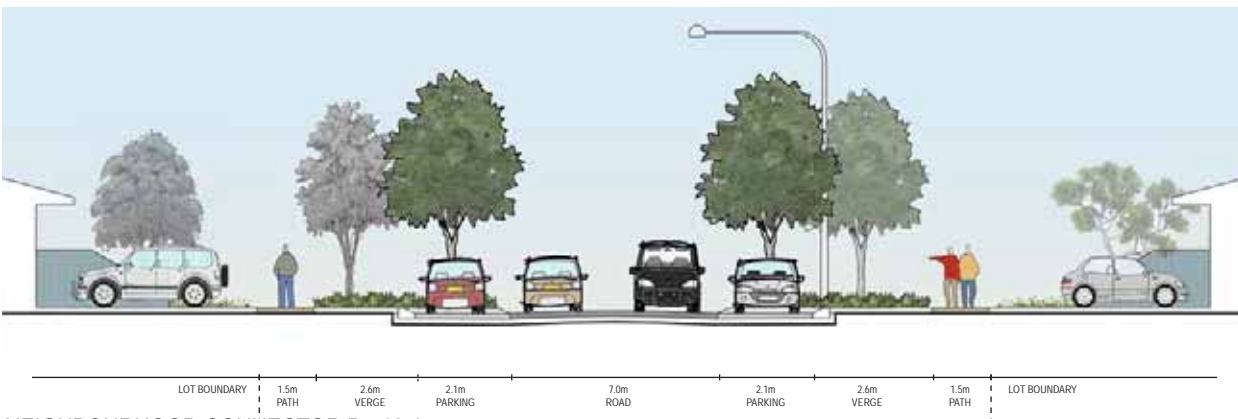
The below cross-sections are indicative only and will be subject to further detailed design at the subdivision stage. The streetscapes have taken into consideration the work undertaken by Transcore's Traffic Impact Assessment for Bullsbrook and provide an embellished/suggested approach for the incorporation of supplementary landscaping solutions.



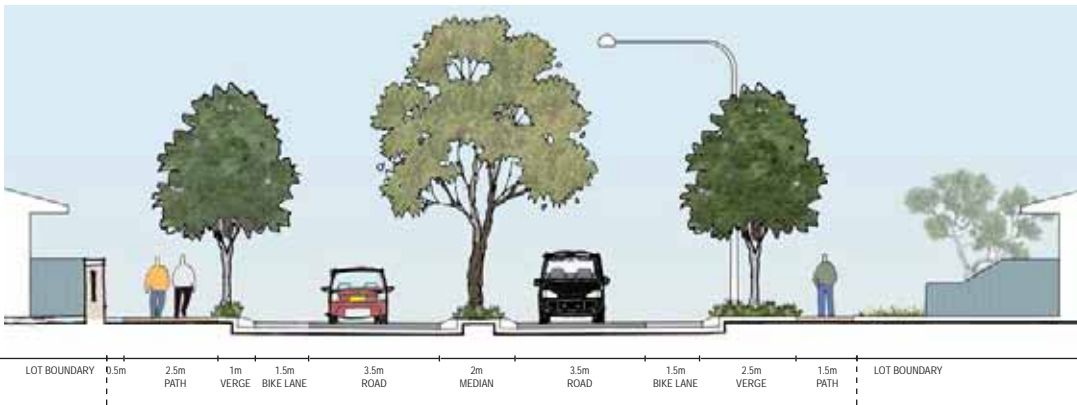
ACCESS STREET C - 16m



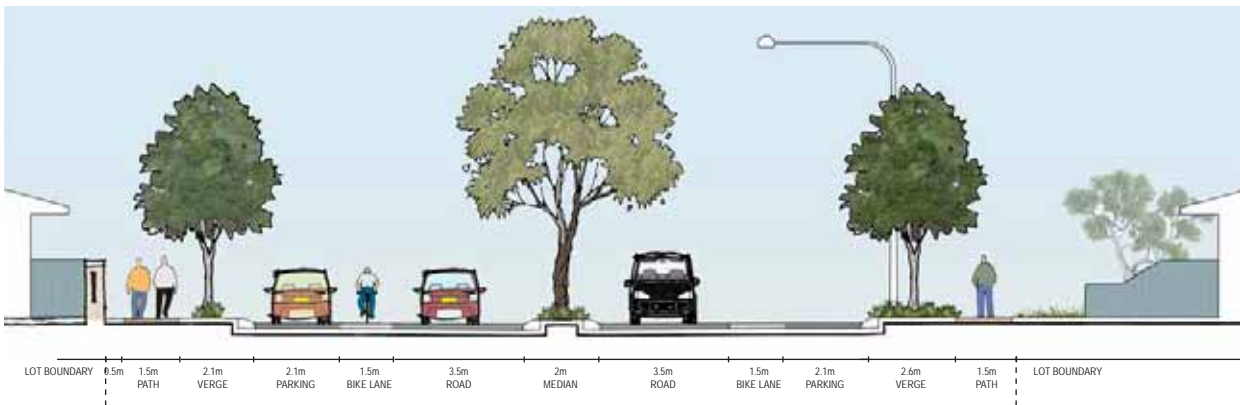
ACCESS STREET B - 17.9m



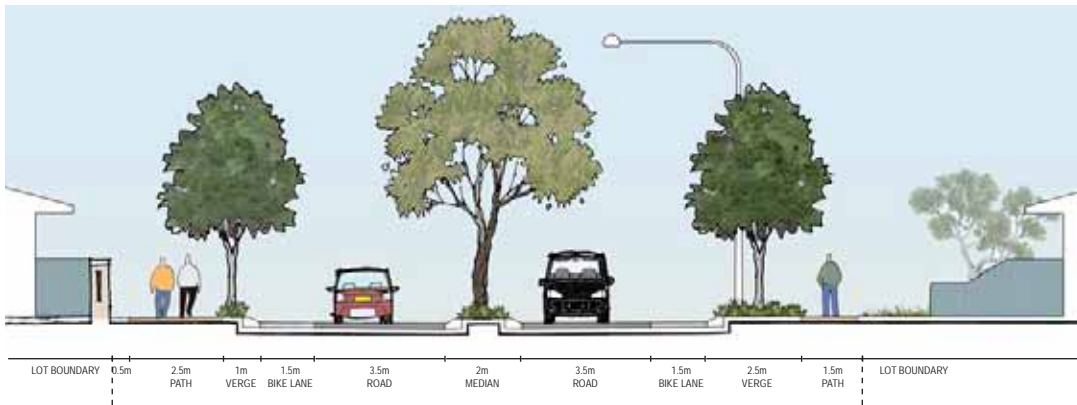
NEIGHBOURHOOD CONNECTOR B - 19.4m



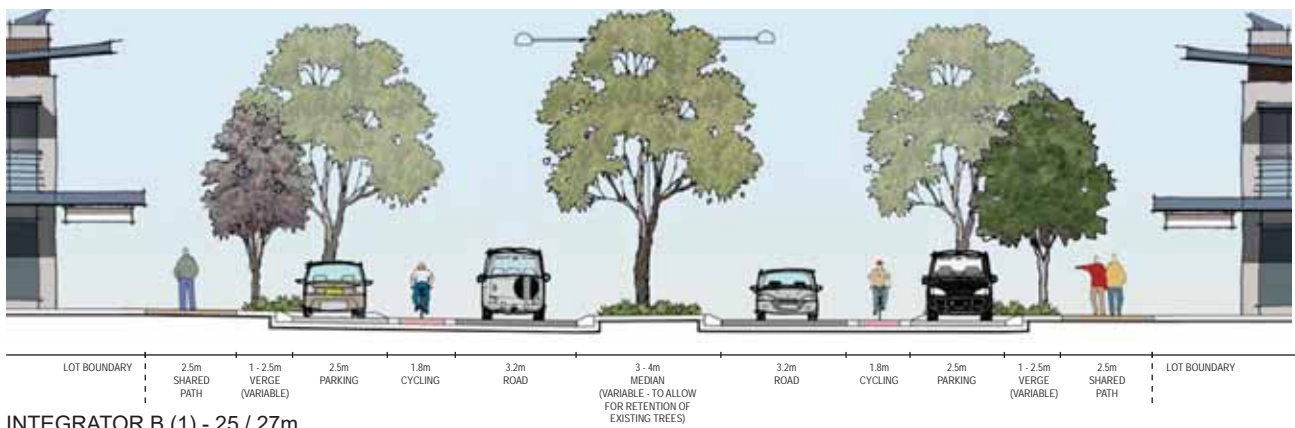
NEIGHBOURHOOD CONNECTOR A (1) - 20m



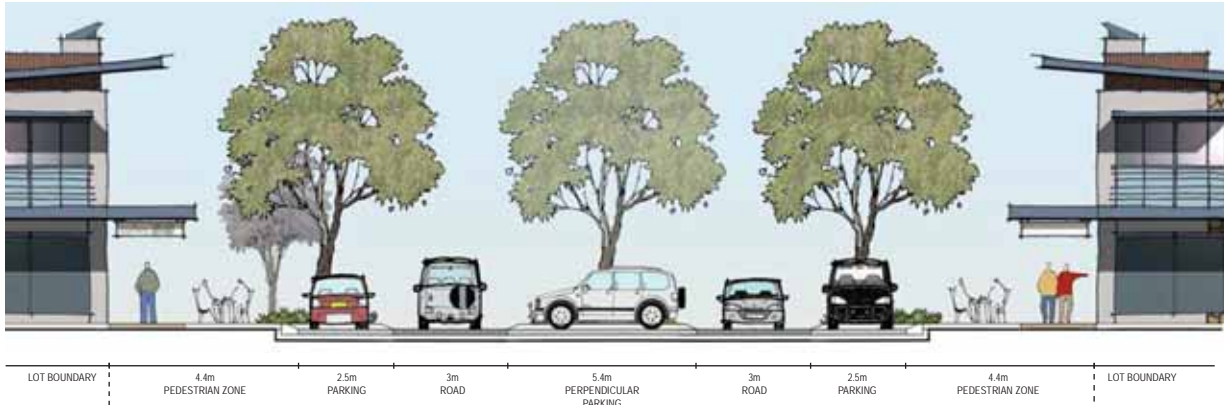
NEIGHBOURHOOD CONNECTOR A (2) - 24.4m



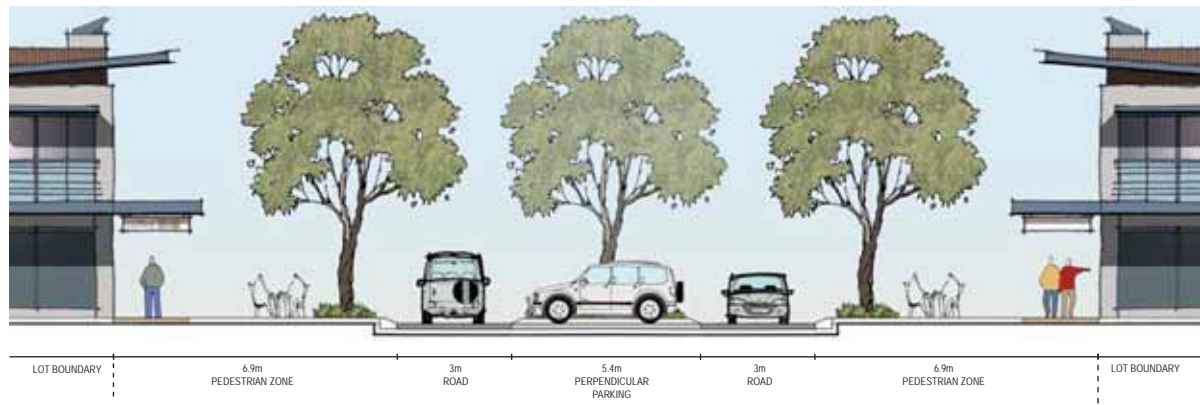
INTEGRATOR B (2) - 20m



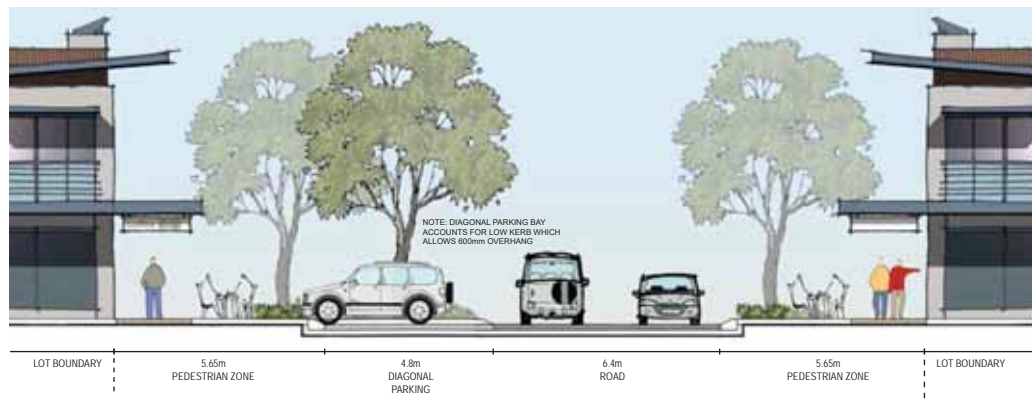
INTEGRATOR B (1) - 25 / 27m



TOWN CENTRE INTEGRATOR - 25.2m (OPTION 1)



TOWN CENTRE INTEGRATOR - 25.2m (OPTION 2)



MAIN STREET - 22.5m

2.7. PROPOSED PLANTING IN THE PUBLIC REALM

The provision of planting in public areas and streetscapes serves to provide character, shade, interest, habitat and a point of reference in major streets or feature locations. Refer to section 12 for proposed species lists.

The locations of planting and types of vegetation will include;

- Predominantly native tree species are to be nominated throughout the estate.
- Exotic specimen, shade and historical/cultural reference trees are to be nominated in high profile street or entry locations.
- Smaller scale exotic trees may be nominated in feature locations and avenue plantings to secondary residential streets,
- Bushland and habitat regeneration in disturbed areas,
- Shrub planting to screening and to provide spatial definition,
- Groundcover planting to medians, planters and areas requiring clear views,
- Reed and sedge planting to swales and watercourses,
- Irrigated grass to informal usable space and recreation areas,

The proposed mix of native species and exotic cultural plantings in feature locations will provide a variation of character and define feature points. In general POS planting shall be composed of 75% native vegetation.

The selection and placement of species shall consider adjacent elements so as to limit future maintenance and public health and safety issues. It will promote the survival and health of the existing vegetation while also provide ongoing social and visual benefits. Items of consideration may include;

- Proximity to traffic sightlines to ensure suitable view corridors,
- Proximity and alignment to underground services to ensure no adverse impact,
- Seasonal influence of shade on adjacent facilities and areas,
- Passive solar benefits influencing adjacent built form and residential dwellings,
- Provision of seasonal visual colour,
- Provision of a seasonal food source to local fauna,
- Plant selection based on suitability to local climate, soils, rainfall and temperatures,
- Selection based on reduced maintenance, trimming, pruning, fertilising and watering
- Develop a species palette with subtle variations through the development to tie in with identifiable communities.
- Buffer screening will be provided to residential or sensitive areas where required
- Fringing vegetation to the surrounding areas is to be retained and protected.



Street trees

Street trees are a desirable design element to increase shade and amenity. The selection and placement of street trees shall vary dependant of the road hierarchy. It is proposed that along major roads, street trees will form a strong visual avenue, and not impede traffic flow, safety or sightlines.

In residential streets, the roads may vary in character from precinct to precinct; however they are characterised as smaller scale pedestrian friendly environments. Therefore street trees will be of a smaller scale, and take advantage of passive solar principles allowing summer shade and winter sun. As the road reserve widths may vary to allow for the retention of existing vegetation and the interconnection of the linear park network, it may be possible to allow for clustering or grouping of trees in the road reserve. This will be reviewed at the detailed design phase.

Water Wise Planting

It is intended that local species shall be used where suitable to maximise local habitat advantage and minimise water dependence. Soil amendments will be used in order to reduce leaching and increase soil moisture holding capacity. All garden beds will be mulched to reduce water lose through evaporation.

2.8. RETAINED VEGETATION

A primary goal in the Landscape Strategy is the protection of existing vegetation. The retention of existing vegetation in defined locations caters for existing habitat, preserves natural assets and provides visual relief against the broader development area.

Vegetation Type and Quality

Whilst some of the vegetation on site has suffered through the effect of the various past land uses and management, the areas of remnant vegetation offer positive outcomes if the development can be engineered to protect these areas. The majority of remnant vegetation is aligned with the Ki-It Monger Brook or is in the form of occasional isolated individual trees in a cleared pastoral setting.

The retention of vegetation shall be maximised through minor realignment of road reserves, carriageways and lot boundaries, through the creation of tree islands in between carriageways or grade separated carriageways.

Retention and Protection

The retention and protection of defined existing trees shall occur during construction, following building works and in conjunction with maintenance. Retention and protection strategies shall include;

- Temporary fencing and signage to all retained areas and individual specimen trees
- Ripping or compaction within 5m of the drip line of existing trees to be prohibited.
- In order to restrict the spread of exotic weeds the construction of clearly defined and easily maintained boundaries between retained vegetation and ornamental landscape may include such methods as increased depth to mowing kerbs, footpaths, roads, bollards and permanent fencing.
- All works shall comply with the recommendations of the Fire Management Plan.

2.9. ENTRY TREATMENTS

The entry points as defined on the Landscape Masterplan should express the design character of the development in respect to the local context. Any signage shall be clearly legible, reflect the project's design style and comply with the local authority's signage policy.

Where appropriate, street trees and entry features will be used to promote the significant nature of these entry precincts by creating landmarks, forming strong avenues and framing views to distant feature elements. Feature planting is preferable in order to create a landmark and assist in the providing a hierarchy and legibility through the streetscape network. Landscape design options shall be tailored to meet all necessary civil design standards while expressing the character of the precinct.

2.10. DRAINAGE/STORMWATER

The development aims to utilise water sensitive urban design principles covering the following:

- Stormwater detention in POS areas to minimise downstream flows following major storm events
- Bio retention swales to collect stormwater runoff.
- Dedicated first flush areas to capture sand and silt from development areas
- Reed and fringing vegetation to swales to provide a nutrient stripping function

It is important that proposed swales/basins provide for multiple uses including recreation, storm water management and creation of natural habitat.

2.11. DRAINAGE TREATMENTS ADJACENT TO POS

All stormwater from the development will be directed into a system of drainage swales and bio-retention basins constructed along the edges of the POS and within the road reserve. These devices will be sized to treat the flows from the 1 in 1 yr event in accordance with the principles of the Department of Water, Stormwater Management Manual for Western Australia. Storm events in excess of these will be directed into outlet basins located within the POS area.



2.12. IRRIGATION STRATEGY

In general terms the project is committed to undertaking water sensitive urban design with minimal impact on existing groundwater and the preservation of water quality. The project is also committed to minimising the volume of water used for irrigation. The following principles are held.

- Minimise the extent of irrigation and the volume of water consumed
- Minimise the extent of irrigated turf
- Minimise the extent of long term irrigation usage to planted beds
- Use of hydrozoning
- Use of xeriscaping where practical.
- Utilise water harvesting techniques where practical.

Irrigation shall aim to incorporate elements of subsurface, drip and trickle water application methods. Water application shall be based on seasonal need and be constructed of reliable, readily available and cost effective fittings, infrastructure and materials. Hydrozoning principles shall be incorporated at the detailed design stage.

All irrigation shall be installed to the local authority's standard specifications and industry best practice. Maintenance minimisation processes will apply in all circumstances. Controllers shall be keyed and accessed in accordance with the local authority's standards. Irrigation shall be designed to incorporate stations that can be terminated as agreed upon planting establishment and maintenance handover to the Council in accordance with relevant policies.

Further investigation is required to ascertain the presence of a suitable groundwater source prior to the documentation of a detailed groundwater usage and irrigation strategy. The presence and volume of suitable groundwater for irrigation will influence the design of the irrigation system and the operating and storage system proposed.

A number of dams are currently located on the site which, subject to a full investigation of groundwater levels and flows may provide an opportunity to act as storage. A detailed irrigation strategy will be prepared and submitted to the City of Swan as part of the detailed landscape and irrigation approvals.



2.13. SITE FURNITURE

The provision of street furniture demonstrates detailed consideration of human use and comfort. The inclusion of quality street furniture elements reinforces the intended design character, develops a sense of community and ownership among residents and encourages outdoor use.

The location of street furniture elements should closely correspond with more intensive areas of human use, gathering and recreation. Basic functional requirements shall typically include;

- Local availability for quick and cost effective replacement or parts as may be required,
- Cost effectiveness of installation, ongoing replacement and maintenance,
- Robust design to minimise the effects of vandalism or weathering,
- Robust appropriate fixing methods to prevent theft but allow maintenance,
- Colour being defined but neutral where possible to enable the maximum chance of matching with other site elements,
- Galvanised and powder coated finishes to maximise lifespan.

Elements shall provide a visually recognisable, clear and useful function. The types of street furniture envisaged include;

- Picnic settings & seating (formal and informal)
- Shade structures
- BBQs
- Rubbish bins
- Bollards
- Cycle racks
- Drinking fountains
- Boardwalks
- Conservation fencing
- Interpretive signage

2.14. PUBLIC ART

The selection and installation of appropriate public art creates interest, social discussion and promotes a sense of community and ownership to public spaces. Public art can provide historic, social, cultural and environmental comment and act as a reference to define a local area and community values.

It is intended that public art be distributed at either high profile points or community gathering spaces to ensure its value in place making is maximised. Locations should include vista and axis views from roads or pedestrian paths, inclusion into playgrounds or placement adjacent picnic locations. Individual lighting may be desirable in some instances to provide additional importance and focus to specific pieces.

2.15. MAINTENANCE MINIMISATION

In conjunction with the detail design of public open space and verge areas to be ultimately vested and controlled by the Council, a maintenance minimisation review and asset management plan shall be undertaken by the developer to assist in assessing and reducing the likely future maintenance costs. This process may typically include;

- review of all materials to ensure fitness for purpose and lifespan requirement,
- review of the area of planting vs turf areas,
- review of plant and turf species and their specific growth habits and requirements,
- monitoring of groundwater quality and levels,
- review of irrigation materials and standards,
- implementation of sustainability and water wise principles to enable the reduction of ongoing costs through removal of some short term landscape establishment assets,
- review of all structural design to ensure fitness for purpose and lifespan.

3. IMPLEMENTATION

3.1. APPROVALS

As part of an ongoing process, after the Local Structure Plan has been endorsed by the Shire and the sub division approvals received, each POS landscape and irrigation design will be submitted as a detailed documentation package to the Shire for review and approval.

The landscape design will incorporate recreation and environmental requirements, while focusing on maintenance minimisation principles and techniques.

The developer is committed to working with the City of Swan to deliver long term outcomes in this process to reflect best practice throughout the development.

3.2. PRACTICAL COMPLETION

Upon reaching Practical Completion of the landscape and irrigation works, a meeting shall be arranged and attended by the consulting landscape architect and the relevant council officers to inspect the completed landscape works. Following this inspection the Developer's representative shall issue to council the following:

- A list of items requiring completion
- As-constructed landscape and irrigation drawings
- Details including capital costs of all physical assets for inclusion in the Councils asset register

Following Practical Completion the Developer shall organise to:

- Carry out any remedial works noted during the Practical Completion inspection without delay
- Undertake maintenance of the POS as agreed with council.

3.3. LANDSCAPE MAINTENANCE RESPONSIBILITY

The developer funded and managed landscape and irrigation maintenance period of two years will apply to all public open space areas following completion of landscape construction works.

The maintenance period commences on the date of Practical Completion. Typically the first year is an establishment period, followed by a year of landscape maintenance.

After the two year period the POS landscape and irrigation maintenance will be handed over to the Local Government Authority to control, fund and manage.

3.4. SCHEDULED HANDOVER

Three months prior to the expiration of the maintenance period (from practical completion), the Developer shall contact the relevant Council officer to initiate the handover process, which will commence with an inspection of the POS.

At the handover inspection, the Developer shall provide to the Officer:

- Details of the areas maintained
- As-constructed irrigation drawings to include changes made to the system during the maintenance period
- Warranties, manuals and logbooks.

Following handover inspection and prior to the handover date, the Developer shall:

- Rectify all defects noted during the handover inspection and others that may emerge before the handover date
- The Council shall provide written confirmation that Council accepts responsibility for maintenance and liability for the location involved.

4. APPENDIX A LANDSCAPE MASTERPLAN



LEGEND

--- Site Boundary

POS

Indicative 1:1 ARI Drainage

Existing Dam

Existing Vegetation



Neighbourhood POS/Recreation nodes (high order)



Neighbourhood POS/Recreation nodes (low order)



Entry Statements



Green Streets



Town Centre

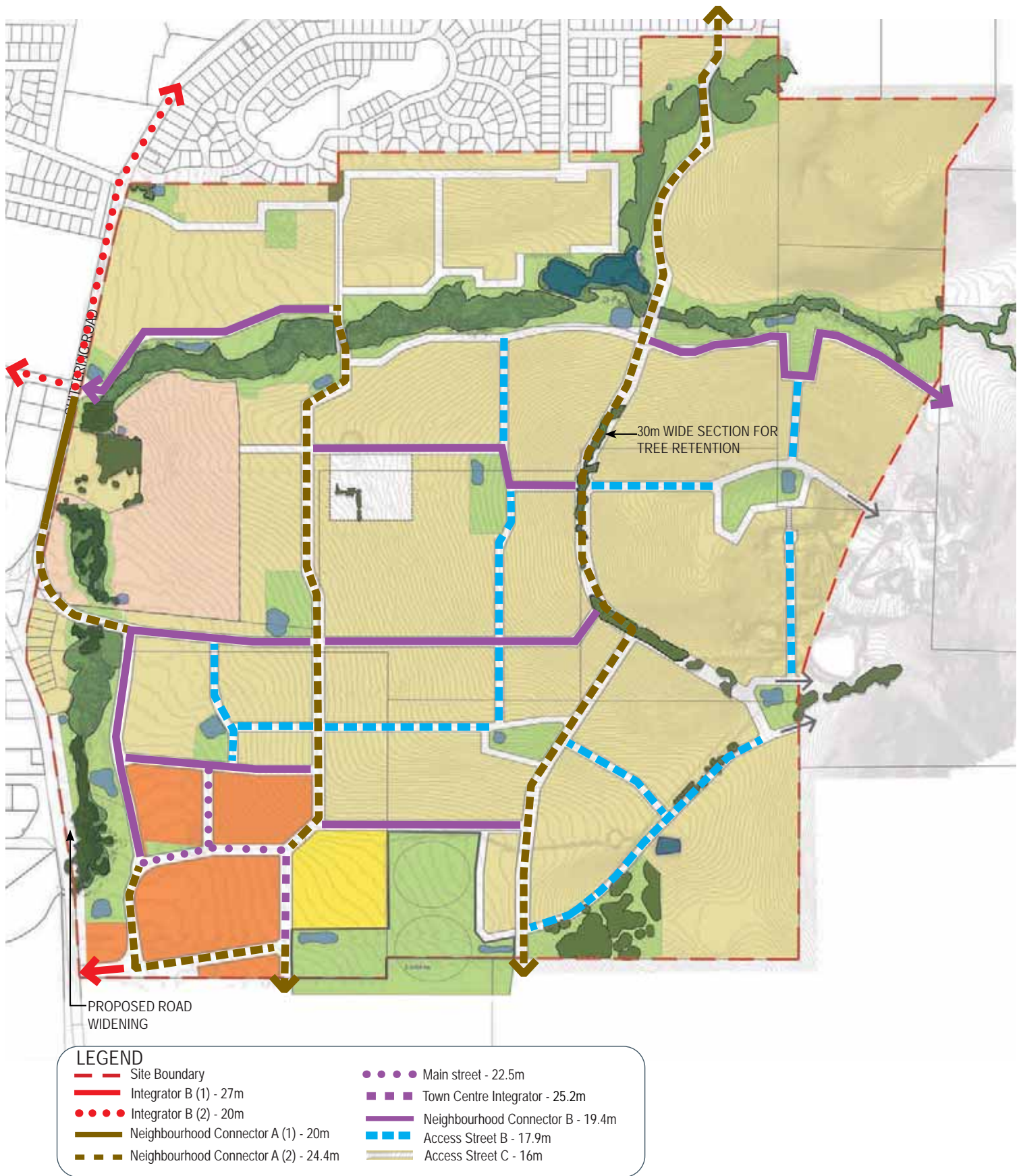
--- 400m Ped Shed

--- 800m Ped Shed

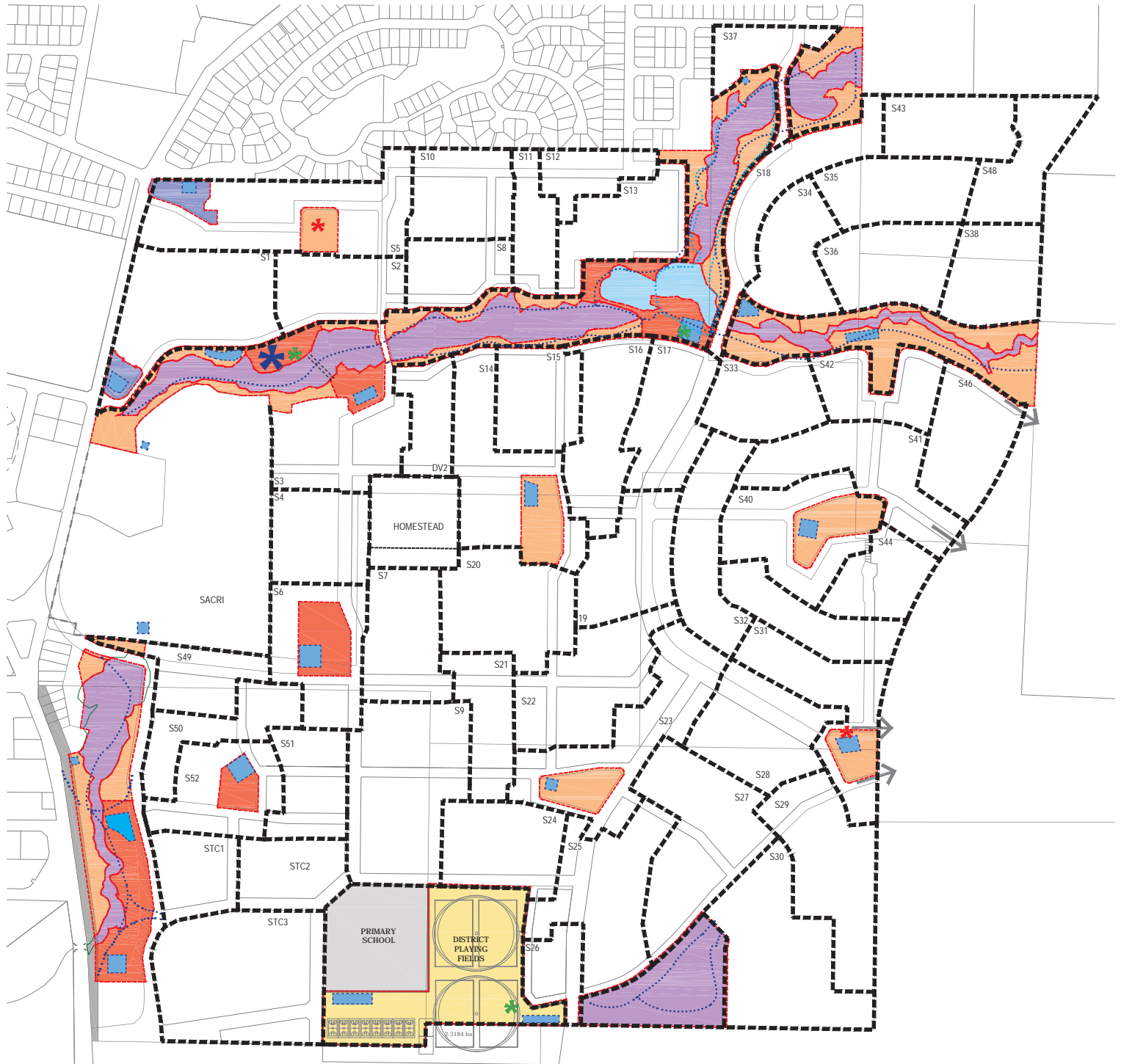
5. APPENDIX B PEDESTRIAN / CYCLE NETWORK



6. APPENDIX C STREET HIERARCHY



7. APPENDIX D FACILITIES PLAN



LEGEND

- | | | | | | |
|--|---|--|---|--|-----------------------------|
| | Landscape Zone Boundary | | Local and / or Linear Open Space | | No Formal Play Facilities |
| | Landscape Stage Boundary | | Small Open Space | | Toilet Facilities |
| | District Open Space | | Ki-it Monger Brook and Conservation Areas | | District POS |
| | Neighbourhood Open Space (High order amenity) | | Dam | | Running Track |
| | | | | | Walking Track |
| | | | | | Indicative 1:1 ARI Drainage |

NOTE: VERGE AND MEDIAN LANDSCAPE ZONES HAVE NOT BEEN DISPLAYED ON THIS DIAGRAM.

NOTE: A NETWORK OF TRAILS/PATHS FOR WALKING AND CASUAL CYCLING TO CONNECT ALL POS/CONSERVATION AREAS

8. POS STRATEGY - GREEN STREETS

BRIEF DESCRIPTION

- Retention of existing vegetation and creation of new landscape within a widened Road Reserve
- Creation of a 'Green Street' - a widened road reserve to create a sense of space and connectivity throughout the estate. This promotes legibility via creation of a landmark and establishes a hierarchy within the streets.
- Opportunity for stormwater and bio-filtration within widened road reserves
- Passive recreation opportunities
- Habitat corridors
- Opens view to hills



9. POS STRATEGY - NEIGHBOURHOOD PARKS

BRIEF DESCRIPTION

Located throughout the development, the Neighbourhood POS provides residents with open space in close proximity to their dwellings. The parks have areas of turf for passive play and informal kick about area with nodes of seating and shelter either provided by trees or built structure. A path network through and around the POS allows footpath connection to surrounding streets and other POS. Drainage will be incorporated within these areas.

SIZE (Excluding Verges)

POS 1: 3,023 sq.m	POS 6: 11,104 sq.m
POS 2: 4,679 sq.m	POS 7: 5,218 sq.m
POS 3: 4,508 sq.m	POS 8: 7,366 sq.m
POS 4: 10,767 sq.m	POS 9: 6,256 sq.m
POS 5: 10,187 sq.m	



FUNCTIONS

- Native, water wise planting. Deciduous used when and where appropriate
- Maximise shade trees with emphasis on native species
- Limited picnic facilities
- Internal path network
- Path network connecting into the broader path network
- Drainage
- Passive solar
- Historical and cultural character
- Landmark and feature planting

ENVIRONMENTAL CONSIDERATIONS

- Waterwise native planting
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to the informal turf playing area
- Source local materials where possible
- Consider the long term maintenance requirements for all materials



10. POS STRATEGY - DISTRICT POS/PLAYING FIELDS

BRIEF DESCRIPTION

- Landmark/destination for residents and community groups
- Opportunity to co-locate facilities (i.e. playing fields, junior ovals and hardcourts for future school and community)
- Provide shared amenities (i.e. shelters, BBQ areas, play and exercise nodes)
- Distinct active/passive zones amongst activities and age groups
- Promote accessibility and usage by community
- Pedestrian and cycle path along perimeter to connect into broader path network
- Playing fields with capacity for organised sporting and large scale community events
- Potential for grandstand for viewing
- Allow for drainage and stormwater flows
- Allowance for access and carparking provisions

SIZE (Excluding Verges) = 63,374 sq.m



FUNCTIONS

- Service diverse range of passive and active recreational activities
- Open area for informal/formal sports and events
- Predominantly irrigated turf for sporting fields
- Maximise shade trees
- Play elements for all ages
- Drainage
- Connection/Colocation with education facilities

ENVIRONMENTAL CONSIDERATIONS

- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to the formal turf sporting fields
- Consider stormflows and drainage requirements
- Source local materials where possible
- Consider the long term maintenance requirements for all materials



11. POS STRATEGY - CONSERVATION AREA

BRIEF DESCRIPTION

- Conservation and protection of the site

SIZE (Excluding Verges) = 30,776 sq.m

FUNCTIONS

- Conservation
- Drainage

ENVIRONMENTAL CONSIDERATIONS

- No irrigation
- Re-vegetation of native plant communities to degraded areas. Location to be determined in detail design
- Removal of weed species



12. POS STRATEGY - KI-IT MONGER BROOK

BRIEF DESCRIPTION

- Primary POS/link with development
- Existing vegetation along brook alignment to be retained
- Revegetate and rehabilitate
- Promote accessibility and usage by community
- Pedestrian and cycle paths along top of bank interconnecting with recreational nodes along linear route/network.
- Play spaces/boardwalks/interpretive/signage/educational opportunities
- Allow for drainage and stormwater flows

SIZE (Excluding Verges) = 297,608 sq.m



FUNCTIONS

- Turf - informal kick-about, play spaces and picnic areas
- Native waterwise vegetation
- Maximise shade trees
- Picnic facilities for family/friend gatherings
- Play elements for all ages
- Path network connecting into broader path network
- Drainage
- Ecological function
- Habitat
- Education
- Connection

ENVIRONMENTAL CONSIDERATIONS

- Waterwise native planting
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to the informal turf playing areas
- Source local materials where possible
- Consider the long term maintenance requirements for all materials
- Consider stormflows and drainage requirements
- Rehabilitation/revegetation
- Respect geomorphology of existing and historic creekline



13. PROPOSED PLANT PALETTE

13.1 KI-IT MONGER BROOK AND LIVING STREAM REVEGETATION

Inundated - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Baumea articulata</i>	Jointed Twig Rush
<i>Baumea juncea</i>	Bare Twig Rush
<i>Baumea vaginalis</i>	Sheath Twig Rush
<i>Bolboschoenus caldwellii</i>	Marsh Club Rush
<i>Gahnia trifida</i>	Coast Saw Sedge
<i>Juncus subsecundus</i>	Finger Rush
<i>Juncus pallidus</i>	Pale Rush
<i>Lepidosperma longitudinale</i>	Pithy Sword Sedge
<i>Leptocarpus laxus</i>	
<i>Lepyrodia glauca</i>	
<i>Meeboldina coangustata</i>	
<i>Pericalymma elipticum</i>	Swamp Teatree
Trees	
<i>Melaleuca raphiophylla</i>	Swamp Paperbark
Lower Slope - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Anigozanthus bicolour</i>	Little Kangaroo Paw
<i>Baumea articulata</i>	Jointed Twig Rush
<i>Baumea juncea</i>	Bare Twig Rush
<i>Baumea vaginalis</i>	Sheath Twig Rush
<i>Bolboschoenus caldwellii</i>	Marsh Club Rush
<i>Gahnia trifida</i>	Coast Saw Sedge
<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Juncus subsecundus</i>	Finger Rush
<i>Juncus pallidus</i>	Pale Rush
<i>Lepidosperma longitudinale</i>	Pithy Sword Sedge
<i>Leptocarpus laxus</i>	
<i>Lepyrodia glauca</i>	
<i>Meeboldina coangustata</i>	
<i>Pericalymma elipticum</i>	Swamp Teatree
<i>Regelia ciliata</i>	
<i>Scholtzia involucreta</i>	Spiked Scholtzia
Trees	
<i>Melaleuca preissiana</i>	Moonah
<i>Melaleuca raphiophylla</i>	Swamp Paperbark
<i>Taxandria linearifolia</i>	

Mid Slope - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Anigozanthus bicolour</i>	Little Kangaroo Paw
<i>Astartea scoparia</i>	
<i>Dasypogon bromefolius</i>	Pineapple Bush
<i>Kunzea glabrescens</i>	
<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Leucopogon tenuis</i>	
<i>Melaleuca incana</i>	Grey Honeymyrtle
<i>Melaleuca thymoides</i>	
<i>Regelia ciliata</i>	
<i>Scholtzia involuocrata</i>	Spiked Scholtzia
Trees	
<i>Eucalyptus rudis</i>	Flooded Gum
<i>Melaleuca preissiana</i>	Moonah
<i>Taxandria linearifolia</i>	
Upper Slope - Foreshore	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Astartea scoparia</i>	
<i>Kunzea glabrescens</i>	
<i>Leucopogon tenuis</i>	
<i>Melaleuca incana</i>	Grey Honeymyrtle
<i>Melaleuca thymoides</i>	
Trees	
<i>Corymbia calophylla</i>	Marri
<i>Euclayptus lane-poolei</i>	Salmon White Gum
<i>Eucalyptus marginata</i>	Jarrah
<i>Eucalyptus wandoo</i>	Wandoo
<i>Melaleuca preissiana</i>	Moonah
<i>Taxandria linearifolia</i>	
<i>Xanthorrhoea preissii</i>	Grass Tree
Dryland Revegetation	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Acacia divergens</i>	
<i>Acacia pulchella</i>	Prickly Moses
<i>Acacia saligna</i>	Orange Wattle
<i>Allocasuarina humilis</i>	Dwarf Sheoak
<i>Anigozanthos manglesii</i>	Mangles Kangaroo Paw
<i>Conostylis aculeata</i>	Prickly Conostylis
<i>Dampiera linearis</i>	Common Dampiera
<i>Dianella revoluta</i>	Dianella
<i>Dryandra nivea</i>	Honeypot Dryandra
<i>Ficinia nodosa</i>	Knotted Club Rush
<i>Grevillea pilulifera</i>	Woolly Flowered Grevillea
<i>Hakea ceratophylla</i>	Norned Leaf Hakea
<i>Hakea lissocarpha</i>	Honey Bush
<i>Hakea prostrata</i>	Harsh Hakea
<i>Hakea stenocarpa</i>	Narrow Fruited Hakea
<i>Hakea trifurcata</i>	Two Leaf Hakea

<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Hypocalymma robustum</i>	Swan River Myrtle
<i>Kunzea micrantha</i>	
<i>Melaleuca laterifolia</i>	Gorada
<i>Patersonia occidentalis</i>	Purple Flag
<i>Eremophila glabra</i>	Tar Bush
<i>Grevillea crithmifolia</i>	
Trees	
<i>Allocasuarina fraseriana</i>	Sheoak
<i>Corymbia calophylla</i>	Marri
<i>Eucalyptus marginata</i>	Jarrah
<i>Eucalyptus rudis</i>	Flooded Gum
<i>Eucalyptus wandoo</i>	Wandoo
<i>Nuytsia floribunda</i>	Christmas Tree

13.2 PARKLAND PLANTING (POS AREAS/BOULEVARDS)

Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Acacia cognata</i> 'Limelight'	Limelight
<i>Acacia cognata</i>	
<i>Adenanthos sericea</i>	Albany Woolly Bush
<i>Agonis flexuosa</i> 'Nana'	
<i>Anigozanthus</i> ssp.	Kangaroo Paw
<i>Carex comans</i>	
<i>Dianella</i> ssp.	Dianella
<i>Dryandra nivea</i>	Honeypot Dryandra
<i>Eremophila</i> 'Carramar Grey'	
<i>Ficinia nodosa</i>	Knotted Club Rush
<i>Grevillea crithmifolia</i>	
<i>Grevillea obtusifolia</i> 'Gin Gin Gem'	Gin Gin Gem
<i>Grevillea</i> 'Golden Lyre'	Golden Lyre
<i>Grevillea</i> 'Lollypops'	Lollypops
<i>Grevillea thelemanniana</i>	Spidernet Grevillea
<i>Lomandra</i> ssp.	Lomandra
<i>Pattersonia occidentalis</i>	Purple Flag
<i>Olearia axillaris</i>	Coastal Daisy Bush
<i>Phormium tenax</i> 'Purpurea'	Phormium
<i>Westringia fruticosa</i>	Coastal Rosemary
Trees	
<i>Agonis flexuosa</i>	Native Peppermint
<i>Brachychiton acerifolius</i>	Illawarra Flame Tree
<i>Corymbia calophylla</i>	Marri
<i>Corymbia maculata</i>	Spotted Gum
<i>Erythrina indica</i>	Coral Tree
<i>Eucalyptus marginata</i>	Jarrah
<i>Fraxinus raywoodii</i>	Claret Ash
<i>Liquidambar styraciflua</i>	Liquidambar
<i>Platanus acerifolia</i>	London Plane Tree
<i>Xanthorrhoea preissii</i>	Grass Tree

13.3 DRAINAGE BASIN PLANTING (POS AREAS / LINEAR PARKS)

Inundated - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Baumea articulata</i>	Jointed Twig Rush
<i>Baumea juncea</i>	Bare Twig Rush
<i>Baumea vaginalis</i>	Sheath Twig Rush
<i>Bolboschoenus caldwellii</i>	Marsh Club Rush
<i>Gahnia trifida</i>	Coast Saw Sedge
<i>Juncus kraussii</i>	Sea Rush
<i>Juncus subsecundus</i>	Finger Rush
<i>Juncus pallidus</i>	Pale Rush
Trees	
Species Name	Common Name
<i>Casuarina obesa</i>	Swamp Sheoak
<i>Melaleuca raphiophylla</i>	Swamp Paperbark
Lower Slope - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Anigozanthus bicolour</i>	Little Kangaroo Paw
<i>Baumea articulata</i>	Jointed Twig Rush
<i>Baumea juncea</i>	Bare Twig Rush
<i>Baumea vaginalis</i>	Sheath Twig Rush
<i>Bolboschoenus caldwellii</i>	Marsh Club Rush
<i>Gahnia trifida</i>	Coast Saw Sedge
<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Juncus kraussii</i>	Sea Rush
<i>Juncus subsecundus</i>	Finger Rush
<i>Juncus pallidus</i>	Pale Rush
Trees	
<i>Casuarina obesa</i>	Swamp Sheoak
<i>Melaleuca raphiophylla</i>	Swamp Paperbark
<i>Eucalyptus rudis</i>	Flooded Gum
Mid Slope - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Anigozanthus bicolour</i>	Little Kangaroo Paw
<i>Dampiera linearis</i>	Common Dampier
<i>Ficinia nodosa</i>	Knotted Club Rush
<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Lomandra longifolia</i>	Lomandra
Trees	
<i>Eucalyptus rudis</i>	Flooded Gum
<i>Melaleuca preissiana</i>	Moonah

Upper Slope - Foreshore	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Anigozanthus bicolour</i>	Little Kangaroo Paw
<i>Dampiera linearis</i>	Common Dampier
<i>Ficinia nodosa</i>	Knotted Club Rush
<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Lomandra longifolia</i>	Lomandra
Trees	
<i>Corymbia calophylla</i>	Marri
<i>Euclayptus lane-poolei</i>	Salmon White Gum
<i>Eucalyptus marginata</i>	Jarra
<i>Eucalyptus rudis</i>	Flooded Gum
<i>Melaleuca preissiana</i>	Moonah

13.4 STREETScape PLANTING

Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Acacia cognata</i> 'Limelight'	Limelight
<i>Agonis flexuosa</i> 'Nana'	
<i>Anigozanthus</i> ssp.	Kangaroo Paw
<i>Carex comans</i>	
<i>Dianella</i> ssp.	Dianella
<i>Eremophila</i> 'Carramar Grey'	
<i>Ficinia nodosa</i>	Knotted Club Rush
<i>Grevillea crithmifolia</i>	
<i>Grevillea obtusifolia</i> 'Gin Gin Gem'	Gin Gin Gem
<i>Grevillea thelemanniana</i>	Spider Net Grevillea
<i>Lomandra</i> ssp.	Lomandra
<i>Olearia axillaris</i>	Coastal Daisy Bush
<i>Phormium tenax</i> 'Purpurea'	Phormium
<i>Westringia fruticosa</i>	Coastal Rosemary
Trees	
<i>Agonis flexuosa</i>	Native Peppermint Tree
<i>Brachychiton acerifolius</i>	Illawarra Flame Tree
<i>Callistemon</i> 'Kings Park Special'	
<i>Corymbia calophylla</i>	Marri
<i>Corymbia maculata</i>	Spotted Gum
<i>Erythrina indica</i>	Coral Tree
<i>Eucalyptus marginata</i>	Jarra
<i>Fraxinus raywoodii</i>	Claret Ash
<i>Liquidambar styraciflua</i>	Liquidambar
<i>Platanus acerifolia</i>	London Plane Tree
<i>Ulmus parvifolia</i>	Chinese Elm

13.5 TREE SPECIES SELECTION

NATIVE SPECIES



Agonis flexuosa
Willow Myrtle



Allocasuarina fraseriana



Callistemon 'Kings Park Special'



Casuarina obesa
Samp Sheoak



Corymbia calocylla
Merrill



Eucalyptus lanedalei
Lowe White



Eucalyptus arinara
Rr



Eucalyptus rupestris
Looe



Eucalyptus obiana
Rilyr



Eucalyptus anoothite
Wite



Melaleuca reissiana
Moo



Melaleuca raioilla
wer



Nuytsia floribunda
Writree



Pandanus linearifolius



Pandanus orrea
reissii tree

EXOTIC SPECIES



Mimosa catalinae
Mimosa tree



Pinus taeda
Pine tree



Quercus californica
Oak tree



Mimosa catalinae
Mimosa tree



Liquidambar styraciflua



Jacaranda mimosifolia



Liquidambar styraciflua
Sweetgum



Platanus acerifolia
London Plane Tree



Platanus acerifolia
London Plane Tree

Appendix 7

Engineering Services Report

(JDSI)

Submission to Okeland Communities

SERVICING REPORT Bullsbrook Landholdings Revised Bullsbrook Central Structure Plan



JDS15920

Aug 2021

INTEGRITY

We are open, honest, and consistent in our principles and conduct, so we're able to build trusted relationships with our clients and partners.

RESPECT

We treat everyone with respect and dignity and develop relationships founded on understanding and trust.

ACCOUNTABILITY

We always assume responsibility for our actions and make decisions in line with our economic, social, and ethical obligations.

EXCELLENCE

We pursue excellence in everything we do, challenging ourselves to look beyond the obvious and ensure ongoing improvement.

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1 Introduction

The Bullsbrook Landholdings (the development) is located approximately 40km north east of the Perth CBD. The site is located between the existing RAAF Pearce Airbase and the Darling Scarp, delineated by Great Northern Highway and Chittering Road to the west and Taylor Road to the east.

Okeland owns approximately 269 hectares with a planned total development yield of 2500+ residential lots.

This report has been prepared by JDSi Consulting Engineers to assist Okeland Communities with the Revised Bullsbrook Central – Local Structure Plan. It summarises the results of a review of the civil engineering issues which have influenced the form of the concept plan and which are related to the future servicing of the residential development of the concept plan area.

The key objectives of this report are to highlight:

- ▶ Existing infrastructure assets.
- ▶ Advise on infrastructure requirements for the planned development.
- ▶ Demonstrate the development can be serviced in the short to medium term.
- ▶ Advise on the implementation of key infrastructure requirements.
- ▶ Existing road networks and planned road networks are capable of supporting residential development in the short to medium term.

It is proposed the site will be developed for residential and Town Centre purposes with the specific aim of delivering an estate that achieves housing density targets aligned with the WAPC strategic directions for the region, as outlined in the “Sub Regional Structure Plan” documents. This includes the provision of residential, transitional and residential rural lifestyle lots in conjunction with primary schools, commercial retail centres and district recreation facilities.

This report has been based on the civil engineering aspects of urban land uses. The report covers the engineering infrastructure requirements to service the proposed development. The engineering review has covered earthworks, roads, stormwater drainage and utility services with a particular emphasis on outlining how all major utility services will be available once the rezoning of the landholding has been completed. This report will outline completed studies or studies currently underway and show that utility services are not an impediment on the development.

The investigations and preparation of the report are largely based on preliminary advice from the various service authorities. The information is current as of August 2021 and is subject to change as development proceeds in the Perth north east corridor resulting in the extension of service infrastructure and the creation of new capacity.

2 The Study Area

The development Study Area has a total land area of approximately 254.6 hectares. This site is located to the east of Great Northern Highway and south of the existing Bullsbrook townsite.

The Study Area is predominantly cleared open pasture with confined areas of trees and vegetation. The KI-IT Brook flows from the east/Darling Scarp through the west side of the landholding and under the Great Northern Highway via a bridge.

2.1 Topography

The land is located at the foothills of the Darling Scarp and is generally steep in nature with contours ranging from RL45 to the west to RL110 to the east. The RL110 is along the boundary adjacent to the neighbouring land holdings.

2.2 Ground Conditions

The following is a summary of the investigative reporting provided by Galt Geotechnical Consultants and is an overview of the likely soil types that will be encountered and proposed remedial measures;

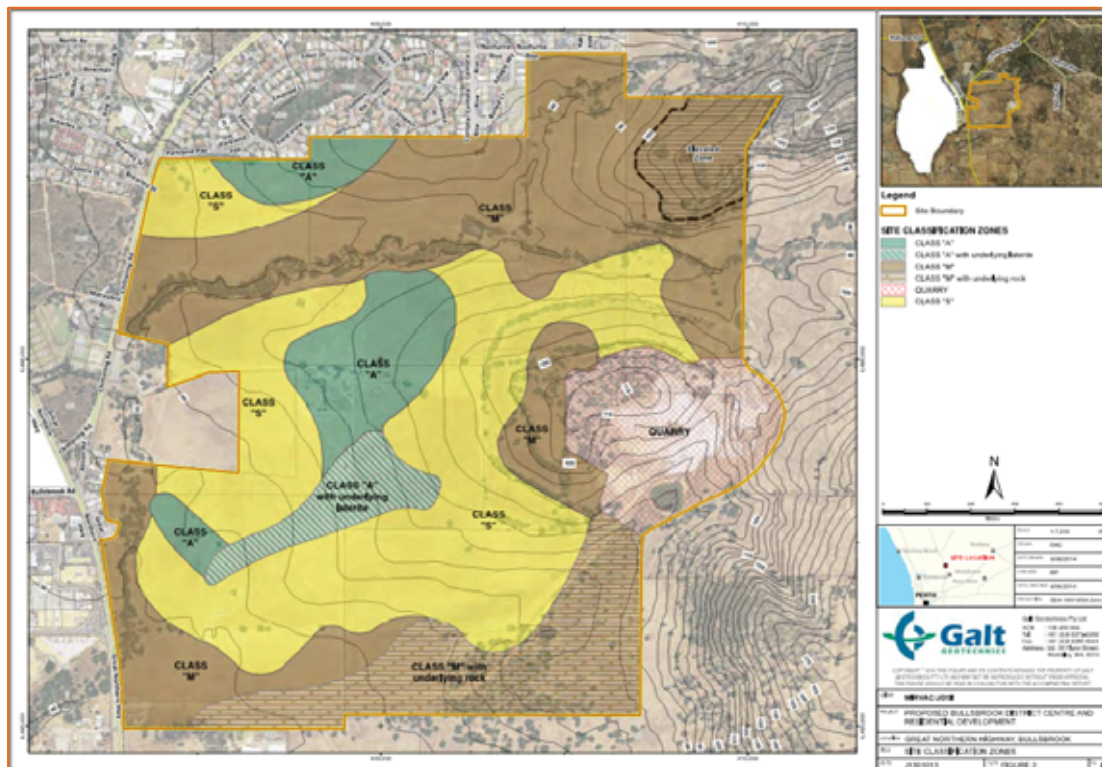
The Muchea sheet of the 1:50,000 scale Environmental Geology series of maps shows that the site is underlain by a variety of soil and rock types. The western part comprises mainly soil deposits while the eastern part of underlain by shallow rock and rock outcrop. The following notes are relevant:

1. Generally, soils over the western portion of the site are sandy overlaying clay/sandy clay. Test trenches were excavated to depths of 2.5m, typically with 0.5 to 1.0m of sand/gravelly sand cover.
2. Generally, soils over the eastern portion of the site are clays/clayey sand overlaying rock (siltstone/gravel/gneiss). Test trenches were refused at depths of 1.1 to 2.0m.
3. The soils are generally moderate to high reactive clay/clays soils with high percentage fines and low permeability.
4. The site is predominantly classed as M and S with some existing class A in the northern portion of the site.
5. The general remediation suggested is:
 - ▶ Strip 100mm topsoil and grub, remove deleterious material.
 - ▶ All excavated sand shall be reused as inert structural fill. The underlying clayey sand can be used for bulk fill (non structural) only.
 - ▶ Proof roll and lay inert clean structural fill with less than 5% fines at depths relevant to required classifications (>1.8m fill for class A, 1-1.8m fill for class S).
6. For areas where subgrade has >0.5m inert structural fill a CBR of 12 can be adopted for pavement design.
7. Drainage can be managed via infiltration only where clean sandy fill is present to a depth of 1.2m.

We would recommend that an allowance is made to fill the class M areas of the site by either 0.7m or 1.5m respectively to achieve class S or A classifications in accordance AS2870-2011 "Residential Slabs and Footings". This is based on the conservative assumption there is an average of 300mm of sandy fill overlaying the site. Ultimately this will have to be confirmed by intrusive geotechnical investigations.

Furthermore, detailed geotechnical work will be required at the time of land subdivision to confirm the assumptions and resulting building site classifications.

Refer to Galt Geotechnics drawing J1301013 002 R Rev1 (05 October 2015) for Preliminary Site Classification.





3 Wastewater

The Water Corporation advised JDSi that the development is located within the current scheme planning and a connection to gravity sewer has been provisioned for. The following provides a summary of the current advice.

The existing Bullsbrook wastewater treatment plant (WWTP) currently only caters for the existing urban zoned land within the Bullsbrook area and is currently close to full capacity. The Water Corporation is monitoring flows to the WWTP.

The Water Corporation has recently advised that the WWTP will be converted into a major transfer station with the additional flows created by the landholdings being rezoned to be pumped from Bullsbrook to Ellenbrook via a major transfer pipeline. The Water Corporation has advised that this project should be completed by mid 2023.

The land which is the subject of this report will require a pump station which is currently being designed, to be located within the south west corner of the site, adjacent to the future town centre. At a recent meeting with the Water Corporation they confirmed this pump station is on their capital works program. JDSi has received the information pack from the Water Corporation and has begun the scoping report design of this pump station. It is anticipated this pump station will be commissioned by FY22 at the latest. JDSi can confirm that servicing the landholdings via gravity sewer is possible and is not an impediment to development.



4 Water Supply

The Water Corporation has advised JDSi that the development is located within the current scheme planning and a connection to water reticulation has been provisioned for under an upgrade of the existing infrastructure located within Great Northern Highway (GNH). The following provides a summary of the advice.

The WC have recently completed the planning study for the delivery of additional water services to the Bullsbrook area. This included supply to the residential area on the eastern side of Great Northern Highway and Chittering Road including the proposed development site. WC advised that supply to the project area would be via a new DN300 distribution main between Great Northern Highway and Hurd Road installed to the west of the site along Chittering Road.

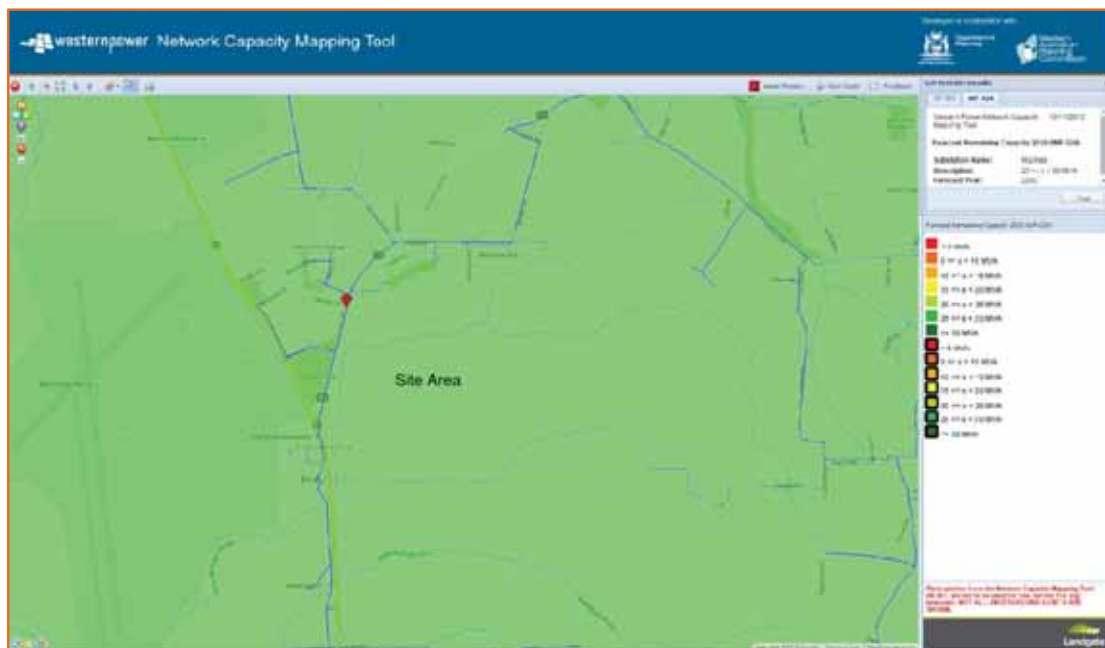
Provision of the new distribution main would include the installation of a new high level tank with 2km of DN300 inlet mains and associated pump station to convey the water from the existing Bullsbrook tank to a new tank and 2km of DN350 outlet mains to distribute the water back down to Chittering Road. JDSi can confirm that servicing the landholdings for water reticulation is possible and is not an impediment to development.

5 Power Supply

The Distribution network in this area currently provides power supply to mostly large rural lots. These lots are serviced by an existing three phase 22kV high voltage aerial network with small, lightly loaded pole top transformers. These feeders emanate from the Muchea substation. The development site is located approximately 20km south east of the Muchea 132kV / 22kV zone substation.

It will be a requirement that all existing aerial distribution lines are converted to underground cables within and bordering this development. Western Power's Network Capacity Mapping Tool indicates that there is enough capacity to feed the estimated ultimate 2500+ lots. JDSi can advise that a feasibility study was recently undertaken that indicates the remaining capacity on the existing 22kV feeder adjacent to the development was approximately 4MVA. Beyond the initial supply, reinforcement of the upstream 22kV feeder line, and voltage regulator may also be required. The development will also require a number of transformers, switchgear units and associated low voltage cable and pillar infrastructure to service the lots.

An extract below from Western Power Network Capacity Mapping Tool indicates that the forecast 2030 capacity for the area will be between 20 to 30 MVA.





6 Gas Supply

The Bullsbrook area currently has no reticulated gas network. Reticulated gas is not considered to be an essential service and as such is not required as a condition of subdivision. It is usual practice to install gas reticulation network for the subdivision within a common civil trench at no cost to the developer. If there is an extension required to connect to the nearest high pressure gas main the developer will be required to pay for the trenching to the gas main as a headworks cost.

The nearest high pressure mains are located some 13km away to the south in Ellenbrook and has recently been incorporated within ATCO's capital works programme. The timing for the gas main extension will coincide with the construction of Stock Road.

It is recommended consideration be given to the option of the developer funding the installation of a "dormant" internal gas network to the subdivision vested with ATCO Gas that could be connected into ATCO mains at some point in the future. ATCO have agreed in principle to assess such a proposal and ensure the design meets with ATCO standards.

JDSi recently contacted ATCO to obtain updated information. ATCO has advised that they have received construction costs of the new main from Ellenbrook to Bullsbrook and are confirming timing of portions of the main to begin construction in early 2022.



7 Telecommunications

JDSi has approached the national broadband installation initiative, NBN Co. to determine if the development site is located within the NBN rollout footprint. NBN Co. has advised that the development can be serviced from their existing infrastructure in the vicinity of the site. They have advised that they already have permanent equipment in the Bullsbrook exchange as well as a live network as part of the Bullsbrook Landing development.

As the development is close to the Bullsbrook exchange, NBN Co. has confirmed that there is no requirement for backhaul charges for the development.

The NBN standard process will apply to this development and therefore an application from the developer will be required prior to NBN Co commencing feasibility assessment process to provide early planning information and costing of any backhaul link.

After NBN connectivity for the development has been established at the boundary of the development, connections of subdivision lots to the network will thereafter be managed stage by stage. NBN deployment contribution fees of \$600 per premises for Single Dwelling Unit lots and \$400 per premises for Multi Dwelling Unit lots will apply.

8 Roads and Traffic

This site is located between the existing RAAF Pearce Airbase and the Darling Scarp, delineated by Great Northern Highway (GNH) and Chittering Road to the west and Taylor Road to the east. The site has excellent access to road transport infrastructure.

Chittering Road is the main connector to the local road network. It has direct access to the primary distributor for the area, the Great Northern Highway, and also acts as a district bypass providing northward connections to the regional suburbs of Western Australia between Bullsbrook and Chittering before reconnecting to GNH at Lake Chittering.

The Great Northern Highway provides the southwards road connection to the Perth Metropolitan Area. It also provides the northwards connection to the rest of Western Australia.

The Tonkin Highway extension / Perth Darwin National Highway (PDNH) has recently been completed and is the new long term transport route between the Perth Metropolitan Area and Northwest of Western Australia. This new road has reduced traffic loads on the Great Northern Highway. The new highway is located approximately 3.5km to the west of the development site.

The traffic movement patterns for the Bullsbrook area have changed substantially due to the construction of the new highway with most heavy vehicle traffic moving to PDNH from GNH. This change has reduced the movements of heavy vehicles adjacent to the development site, will promote improved traffic conditions for local vehicles and enhance the attraction of the development as the new residential townsite for Bullsbrook.

8.1 Existing Traffic Conditions

The site is bounded on two sides by existing roads, namely:

1. The Great Northern Highway lies on the western side of the development site and this road is classified as a primary distributor under the Perth metropolitan road hierarchy and is the national highway linking Perth and Darwin. The road is currently constructed as a two lane undivided paved highway with various passing lanes and turning pockets associated with intersections. The existing intersections are treated as intersections with low volume local roads.
2. Chittering Road lies on the western side of the development site and this road is classified as a district distributor B under the Perth metropolitan road hierarchy. The road is currently constructed as a two lane undivided paved road with various turning pockets associated with intersections. The existing intersections are treated as intersections with low volume local roads.

8.2 Road and Intersection Improvements

The existing roads will require improvements and upgrades which can be progressively completed to match the rate of development. As the development will be staged, the increase in traffic volumes on the GNH and Chittering Road can be managed. This will be achieved by implementing reduced speed zones, provision of controlled accesses along the frontage of the development with the GNH & Chittering Road. This will be achieved by complementing the existing GNH Access Strategy for the connections to GNH and will involve joint liaison with MRWA, the Client and relevant stakeholders.



The internal roads are proposed to be to the City of Swan's standards and are proposed to have 6.0m pavements in 16.0m road reserve for urban access roads, increasing to a 7m pavement within a 23m road reserve for Neighbourhood Connector type roads. Intersections, sweeps/corners, and roundabouts will be designed for vehicle turning movements defined in AUSTRROADS design guidelines.

The subdivision roads within the development area will need to be constructed in accordance with the IPWEA Subdivision Guidelines and read in conjunction with the City of Swan's subdivisional "Guidelines and Standards". All internal roads are owned and maintained by the City of Swan.

9 Drainage

Urban Water Management (UWM) is now a key part of any development process incorporating principles of integrating water and land use planning, considering all water sources in water planning, integrating water use and natural water processes and a total catchment integration of natural resource use and management (Ref. Stormwater Management Manual for Western Australia, DOW, April 2004 the State Water Strategy 2003 and the State Water Plan 2007).

Stormwater drainage management is a major component of an overall UWM strategy for which achievement of the principals of the plan may be facilitated through the application of Water Sensitive Urban Design (WSUD) techniques during planning, design and construction of urban development projects. Objectives of WSUD include but are not limited to the following:

- ▶ Detention of stormwater rather than rapid conveyance to maintain pre development flows for quantity management;
- ▶ Use of vegetation for filtering purposes and nutrient stripping for quality management;
- ▶ Use of stormwater to conserve potable water; and
- ▶ Water efficient landscaping.

Currently the main drainage system for the site consists of an existing creek (KI-IT Brook) that runs through the centre of the site and collects and distributes sheet flows from the Darling Scarp. The creek grades from east to west and contains a natural dam towards the centre providing detention and retardation of flows. At the western boundary of the site the creek changes direction and traverses in a north to south direction through a series of existing culverts of varying size beneath the Sacri Church land before being conveyed beneath GNH into the RAAF Pearce Airbase site.

Some of the proposed strategies that will be implemented on the site are:

- ▶ Managing runoff via a piped and pit system within road reserves with outfall into bioretention swales incorporated into POS areas adjacent the existing creek and wetlands/ponds.
- ▶ Lot runoff will be managed via onsite infiltration where it is possible to achieve 1.2m depth of clean permeable sandy soils.
- ▶ Bio retention swales will provide storage and infiltration for the 1 year 1 hour runoff volumes, with overflow into the creek for conveyance into the existing drainage system.
- ▶ Rehabilitation of the KI-IT Creek, including existing floodways / weirs, with upgrading as necessary.
- ▶ Given the natural groundwater level is some distance below existing ground level it is not expected management of a controlled ground water via subsoil drainage will be required.
- ▶ In development areas adjacent to the existing creek with perceived perched water table it is recommended at least 1.2m separation is achieved to finished earthwork levels.



10 Disclaimer

JDSi have undertaken this assessment based on limited information and subsequently assumptions have been made which, if incorrect, have potential to change costs. Major cost implications exist through factors which cannot be assured at this time including upgrading and provision of utility services, WAPC conditions of development, Local Authority Scheme Requirements, ground conditions, timing of adjacent developments, etc.

While JDSi has taken all care in the preparation of the likely development requirements and has noted key assumptions, JDSi accepts no responsibility for the accuracy of this report and provides it only as an indicative summary of engineering requirements.

If any further information is required or should you wish to clarify any issue, please contact our office.

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