Carabooda Urban Precinct District Structure Plan

Environmental Assessment Report

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Carabooda Urban Precinct District Structure Plan

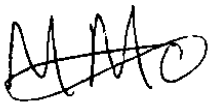
Environmental Assessment Report

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14-Jul-2026	**14-Jul-2026**	**14-Jul-2026**

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In accordance with the scope of services, WEPL has conducted environmental field monitoring and/or testing in the preparation of this report. The nature and extent of monitoring and/or testing conducted is described in this report.

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Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. To the maximum extent permitted by law, no other warranty, express or implied, is made.

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This report is intended to be read in its entirety, and sections or parts of this report should therefore not be read and relied on out of context.

WEPL will not be liable to update or revise this report to take into account any events or circumstances or facts becoming apparent after the date of this report.

Executive Summary

Western Environmental Approvals Pty Ltd (WEPL) present this Environmental Assessment Report (EAR) to inform the development of a District Structure Plan (DSP) for the Carabooda Urban Precinct, on behalf of Carabooda Landowners Pty Ltd. This EAR is intended to not only accompany the lodgement of the DSP, but to also support the referral of the subsequent Metropolitan Region Scheme (MRS) Amendment request to the Environmental Protection Authority under s38 of the *Planning and Development Act 2005*.

The Site, covering approximately 979 ha across 65 lots within the City of Wanneroo, is located 35 km north of Perth Central Business District (CBD). The proposed DSP for the Site encompasses a range of land uses, including urban residential areas, centres, schools, a transport network, conservation areas, and public open space (POS). It also identifies areas for Basic Raw Material (BRM) extraction within Lots 104, and 102.

The identification and conservation of significant areas of established bushland with identified trees and ecological communities worthy of retention is a key outcome of the Carabooda DSP proposal. The DSP will provide for approximately 241.60 ha of conservation zoned land and an additional 11.0 ha for Local Open Space for Conservation wherein environmental values will be retained. Ongoing funding will be established through an innovative Conservation Management Fund (CMF), managed by the City of Wanneroo or an identified authority or agency. This will result in:

- Establishing seed funding of $8,500,000 over the development of the Carabooda DSP through the contribution of $1,000 per lot into a CMF.
- Ensuring the management of the significant conservation areas are permanently funded and protected in the future by establishing a Specific Area Rating system (SAR) that provides an ongoing annual contribution to the CMF through the annual collection of SAR from every residential lot created in the DSP, contributing $2.76M annually into the CMF.
- Protecting and enhancing that the significant regional ecological linkage which runs from east to west across the centre of the Site through the establishment and management of the significant conservation areas in the DSP.

The Site covers a total of 979 ha and is situated 35 km north of Perth Central Business District (CBD). The majority of the Site is currently zoned Rural under the MRS and Rural Resource under the City of Wanneroo Local Planning Scheme No. 2 (LPS 2).

The proposed DSP comprises the following land uses:

- Urban (Residential).
- Centre.
- Primary School.

- High School.
- Private College.
- Transport network.
- Conservation Areas.
- Local Open Space (LOS) for Conservation.

The DSP identifies areas of Conservation and LOS for Conservation which require further review at the MRS Amendment, Local Structure Plan, or individual property level. The DSP aims to provide a strategic framework for the proposed land uses, with additional investigations to confirm the suitability of specific areas for development or conservation prior to any changes in zoning. The retention of the ecological linkage will protect environmental values, maintain connectivity with regionally significant bushland, and mitigate cumulative development impacts in line with the DSP. The project emphasises minimising environmental impacts and enhancing conservation long-term through innovative funding and management strategies.

The EAR identified the environmental constraints/considerations below:

- Flora and vegetation.
- Terrestrial fauna habitat.
- Contamination.
- Conservation areas (Bush Forever).
- Heritage.

There are no watercourses, wetlands or Public Drinking Water Source Areas within the Site.

The current DSP design provides for the retention of concentrated, high-value environmental features within Conservation Areas and LOS for Conservation . These include significant species-rich communities and degraded zones. Further environmental investigation is required to confirm the suitability of proposed urban land use or Conservation and LOS for Conservation in some areas, as indicated in the proposed DSP. For the purpose of this EAR, areas identified as proposed Conservation and LOS for Conservation or proposed residential (subject to further environmental investigation) are assumed to be used for the relevant land use.

A summary of the potential impacts and WEPLs recommendations to management have been included in Table E1.

Table E1. Summary of Potential Impacts and Recommended Management

Environmental Feature	Description of Potential Impact	Recommended Management
Remnant Native Vegetation	Approximately 333.78 ha of remnant native vegetation exists within the Site, with 13 distinct vegetation types identified. These areas include species-rich communities and degraded zones. The vegetation includes significant species such as Banksia, Eucalyptus, and Xanthorrhoea, with potential impacts from development, including clearing of habitat.	Native vegetation has been prioritised for retention to the fullest degree possible within designated conservation areas, prioritising the conservation of species-rich communities and degraded zones with high ecological value. In total, 222.23 ha of remnant native vegetation will be retained within Conservation Areas, and an additional 10.94 ha will be retained within LOS for Conservation. As such, 70% of remnant native vegetation within the DSP area will be retained. In total, over 80% of remnant native vegetation which is in Good or better condition will be retained within Conservation Areas and LOS for Conservation. A detailed vegetation management plan will be developed to guide retention, protection, and rehabilitation efforts.
Banksia Woodlands of the Swan Coastal Plain	The Site contains vegetation considered to be the Banksia Woodlands of the Swan Coastal Plain ecological community, which is a Priority 3 Ecological Community at State level and an Endangered Threatened Ecological Community at Commonwealth level.	In total, 39.26 ha (87%) of Banksia Woodlands within the DSP area will be retained and protected within conservation areas. A conservation management plan will be developed to support future stages of planning to protect and rehabilitate these areas during development.
Tuart Woodland TEC	The Site contains vegetation that is considered to be the Tuart Woodlands and Forests of the Swan Coastal Plain ecological community, which is a Priority 3 Ecological Community at State level and a Critically Endangered Threatened Ecological Community at Commonwealth level.	In total, 84.35 ha (75%) of Tuart Woodlands within the DSP area will be retained and protected within conservation areas. A conservation management plan will be developed to support future stages of planning to protect and rehabilitate these areas during development.
Honey Myrtle TEC	The Site contains vegetation that is considered to be the Honeymyrtle Shrubland on Limestone Ridges of the Swan Coastal Plain Bioregion ecological community, which is a Critically Endangered Threatened Ecological Community at both State and Commonwealth levels. No impact to this TEC is proposed.	No impacts to the Honeymyrtle Shrubland TEC are anticipated. Retention of 12.09[1] ha of Honeymyrtle Shrubland within conservation areas has been prioritised. A conservation management plan will be developed to support future stages of planning to protect and rehabilitate these areas during development.
Black Cockatoo Foraging Habitat	Foraging habitat for Carnaby's black cockatoo is present throughout the Site with varying quality, ranging from 1/10 to 7/10, with the weighted Site average	Foraging habitat for black cockatoo species is retained within areas proposed for Conservation. The DSP will retain and conserve 241.46 ha of foraging habitat for Carnaby's

[1] 0.25 ha of this TEC occurs within the Water Corporation owned land, outside of conservation areas. This is the result of inaccurate mapping, and the entirety of this TEC will be included within conservation areas.

Environmental Feature	Description of Potential Impact	Recommended Management
	quality being 3/10. High-quality areas are associated with dense Banksia spp. stands. Foraging habitat for Forest red-tailed black cockatoo is also present, ranging from 1/10 to 5/10 in quality, with the weighted Site average quality being 2/10.	black cockatoo with a weighted average quality of 5/10, and 241.46 ha of foraging habitat for Forest red-tailed black cockatoo with a weighted average quality of 3/10. Given the majority of remnant native vegetation throughout the Site is dominated by Banksia spp., retained habitat is primarily for Carnaby's cockatoo. Baudin's black cockatoo is considered a vagrant to the Site only. In addition, 11.0 ha of foraging habitat for Carnaby's black cockatoo and Forest red-tailed black cockatoo within LOS for Conservation. Of that, 5.58 ha is of higher quality for Carnaby's black cockatoo.
Black Cockatoo Roosting Habitat	Black cockatoo species utilise tall eucalypt trees (> 10 m tall) for night roosting and typically select the tallest trees in the landscape (DAWE, 2022). Roosting sites are often within 2 km of natural or artificial water sources. BCE (2024) found no signs of night roosting activity during field investigations, but tall trees suitable for roosting are abundant. Black cockatoos have been observed drinking from artificial water sources (horse troughs) within the Site.	Tall eucalypt trees suitable for roosting, particularly near water sources outside of the conservation areas will be investigated for retention in future stages of planning. Management plans will also be developed to minimise and avoid disturbances that could impact roosting activities during development.
Black Cockatoo Breeding Habitat	Within the Site, BCE (2024) recorded 1,598 trees with a DBH ≥ 50 cm that may be considered potential nesting trees. The majority of these are tuart (1,113 trees), jarrah (300 trees), and marri (65 trees). BCE (2024) categorised these trees based on the presence and suitability of hollows. However, no confirmed nesting hollows were recorded (Class 1). The majority of potential nesting trees are Class 5, showing no hollow development, however 14 trees (Class 2) have suitable hollows with chew marks indicating previous use.	Mature eucalypt trees, particularly tuart (743), jarrah (180), and marri (47) species have been prioritised for retention within Conservation areas, with 999 mature eucalyptus trees to be retained. An additional 13 will be retained within LOS for Conservation. Further, 81 trees containing suitable hollows (Class 2 and 3) will be retained, which is 72% of those within the DSP area. Retention of additional Class 2 and Class 3 trees outside the conservation areas will be investigated for retention in future stages of planning. Management plans will also be developed to minimise and avoid disturbances that could impact breeding activities during development.
Geomorphic Wetlands	No geomorphic wetlands intersect the Site. The nearest wetland is Nowergup Lake, a Conservation Category Wetland (CCW) located 200 m west. Other wetlands, including Resource Enhancement Wetlands (REW) and Multiple Use Wetlands (MUW), are mapped within 2 km of the Site.	The Site does not contain watercourses or wetlands. The Site's development will be planned to ensure that no disturbance occurs to the hydrological and ecological functions of adjacent wetlands. Future stages of planning will include appropriate setbacks and management strategies to protect the values of nearby wetlands, particularly Nowergup Lake (CCW).

Environmental Feature	Description of Potential Impact	Recommended Management
Bush Forever Site 389	BF Site 290 (Hopkins Road Bushland) is east of the Site, and BF 383 (Neerabup National Park, Lake Gnowerup Nature Reserve) is 175 m west. Regional ecological linkage (Link ID 8) runs through the Site.	The mapped regional ecological linkage (Link ID 8) to connect BF 290 and BF 383 will be retained and enhanced, preserving ecological values and reducing cumulative development impacts.
Contamination	One contaminated site was identified: the Nowergup Biosolids Facility, which is located 360 m to the southeast of the Site, and is closed and classified as Remediated for Restricted Use. There is potential for asbestos-containing materials due to old structures on the Site, as well as a possibility of contamination from previous agriculture and horticultural land uses.	Preliminary site investigations for contamination will be conducted as part of early works for development as required.
Acid Sulfate Soils	The majority of the Site has a low risk of ASS, with a small pocket (2.15 ha) in the northern portion at moderate to high risk, affecting soils within 3 m of the surface.	Investigation into the presence and extent of ASS within the Site will be undertaken at subsequent stages of planning and development, in accordance with DER (2015a) Identification and investigation of acid sulfate soils and acidic landscapes. Subsequent measures to minimise the risk of ASS disturbance will be identified in accordance with the results of the investigation and DER (2015b) Treatment and management of soil and water in acid sulfate soil landscapes.
Karstic Features	A small portion (4%) of the Site is mapped as having a High risk of karst, and a larger area (~18%) is mapped as having a Moderate risk of karst.	A desktop karst survey will be undertaken for each Local Structure Plan in accordance with City of Wanneroo *Local Planning Policy 4.13: Caves and Karstic Features.*
Public Drinking Water Source Area (PDWSA)	The Site does not intersect any mapped PDWSAs. A Priority 3 PDWSA is located approximately 670 m to the west, and a Priority 1 PDWSA is located approximately 750 m to the east.	The Site does not intersect a PDWSA. Appropriate measures will be detailed in future stages of planning to prevent contamination of groundwater or surface water, particularly in areas near these PDWSAs.
Heritage	One registered Aboriginal heritage site near Nowergup Lake (Place ID 17450) with mythological significance. Another site near Lake Neerabup (Place ID 3315), containing Orchestra Shell Cave with artifacts. Additionally, the Lime Kilns – Spiers (Place no. 14299) is a Category 2 heritage site under the City's Heritage List, and another Lime Kiln site (Wanneroo, Place no. 18338) is located adjacent to the site boundary but is not listed	Future development will comply with the Aboriginal Heritage Due Diligence Guidelines (DPLH and DPC 2013) to protect heritage sites. The Lime Kilns – Spiers site listed under the City's Heritage List will be retained and management of the Wanneroo Lime Kiln site will be detailed in future stages of planning.

Table of Contents

1. Introduction 1

1.1 Purpose and Scope 1

2. Social and Environmental Statement 7

2.1 Provision of Affordable Housing Lots and Social Housing Sites 7

2.2 Equitable Sharing of Conservation Land Provision amongst Landowners 7

2.3 Permanent Conservation Management Fund 7

3. Project History and Previous Studies 8

3.1 2024 8

3.1.1 Carabooda Rezoning Project: Flora and Vegetation Survey (PGV, 2024) 8

3.1.2 Fauna Survey (Bamford Consulting Ecologists, 2024) 8

3.2 2023 8

3.2.1 The Carabooda Rezoning Project: Flora and Vegetation Survey (PGV, 2023) 8

3.2.2 Targeted Survey - Alkimos Seawater Desalination Plant (360 Environmental, 2023) 9

3.3 2017 9

3.3.1 Flora, Vegetation, and Fauna Assessment - Strawberry Farm 235 McLennan Drive, Nowergup (MBS Environmental, 2017) 9

3.4 2014 10

3.4.1 Flora and Vegetation Survey - Lot 105 & 107 McLennan Drive (PGV, 2014) 10

3.4.2 Preliminary Environmental Assessment - Lot 105 & 107 McLennan Drive (EnviroWorks, 2014) 10

3.4.3 Conservation Management Plan - 436 Gibbs Road, Nowergup 11

4. Legislation, Policy, and Guidelines 12

4.1 Commonwealth Legislation 12

4.1.1 Environment Protection and Biodiversity Conservation Act 1999 12

4.2 State 13
4.2.1 Legislation 13
4.2.2 State Planning Policies 14
4.2.3 EPA Themes, Factors, Objectives, Guidelines, and Technical Guidance 16
4.2.4 Advice under Section 16 of the *Environmental Protection Act 1986* 17
4.3 Local Government 19
4.3.1 City of Wanneroo Local Planning Policies 19
5. Environmental Context 20
5.1 Land Use 20
5.1.1 Current Land Use 20
5.1.2 Previous Land Use and Existing Environmental Approvals 20
5.1.3 Surrounding Land Use 28
5.2 Topography, Geology and Soils 28
5.2.1 Topography 28
5.2.2 Geology 29
5.2.3 Karstic Features 29
5.2.4 Soil Landscape Mapping 30
5.2.5 Acid Sulfate Soils 31
5.3 Hydrology 34
5.3.1 Groundwater 34
5.3.2 Surface Water 34
5.3.3 Wetlands 34
5.3.4 Public Drinking Water Source Areas 36
5.4 Flora and Vegetation 40
5.4.1 Desktop Assessment 40

5.4.2 Site Surveys 46
5.5 Terrestrial Fauna 59
5.5.1 Desktop Assessment 59
5.5.2 Site Surveys 60
5.6 Ecological Linkages 75
5.7 Conservation Areas 75
5.8 Environmentally Sensitive Areas 75
5.9 Bushfire Risk 76
5.10 Contaminated Sites 79
5.11 Heritage 79
5.11.1 Native Title Agreement 79
5.11.2 Indigenous Heritage Places 79
5.11.3 European Heritage Places 80
6. Assessment of Proposed Impacts and Mitigation 83
6.1 Proposed DSP 83
6.1.1 Proposed Conservation Areas 83
6.1.2 Proposed LOS for Conservation Areas 84
6.1.3 Management of Interface between Conservation Areas and Road Reserves 84
6.2 Preliminary Assessment Against the EPA Environmental Factors 87
6.3 Residual Impacts 93
7. Other Environmental Issues 94
7.1 Cumulative Impact Assessment 94
7.2 Conservation Outcomes 94
7.3 Bushfire Management 96

8. Conclusion 97

9. References 100

Tables

Table 1. EPA Environmental Factors, Objective, Guidelines and Technical Guidance 16
Table 2. Current Operating Licenses within the Site 20
Table 3. Historic Aerial Imagery of the Site 21
Table 4. Surrounding Land Uses 28
Table 5. Geological Units within the Site 29
Table 6. Soil Landscape Units within the Site (DBCA-027) 31
Table 7. Wetland Management Categories and Objectives applied to the Swan Coastal Plain (DBCA, 2017) 35
Table 8. Geomorphic Wetlands Mapped adjacent to the Site 35
Table 9. Pre-European Vegetation Associations within the Site 40
Table 10. Current Extent of Vegetation Complexes within the Site 41
Table 11. Threatened and Priority Flora with the Potential to Occur within the Site (PGV,2024) 43
Table 12. Threatened and Priority Ecological Communities identified within 10 km of the Site (PGV, 2024) 44
Table 13. Description of Flora and Vegetation Surveys undertaken within the Site 46
Table 14 Vegetation Types Described within the Site 47
Table 15 Vegetation Condition within the Site 51
Table 16. Records of Threatened and Priority Flora within the Site 54
Table 17. Floristic Community Types Identified within the Site 56
Table 18. Extent of Threatened Ecological Communities within the Site 57
Table 19. Conservation Significant Fauna Species Expected to Occur within the Site 59
Table 20. Fauna Surveys Undertaken within the Site 60
Table 21. Vegetation Substrate Associations within the Site (BCE, 2024) 60
Table 22. Quality and Extent of Foraging Habitat for Carnaby's Black Cockatoo within the Site 66
Table 23. Quality and Extent of Foraging Habitat for Forest Red-tailed Black Cockatoo within the Site 66
Table 24. Potential Nesting Tree Class 67
Table 25. Species and Class of Potential Nesting Trees within the Site 68
Table 26. Proposed Conservation Area - Retention of Environmental Values 85
Table 27. Total Retention of Environmental Values - Conservation Areas and LOS for Conservation 87
Table 28. EPA Environmental Factors - Preliminary Assessment 88
Table 29: Summary of TECs within the DSP 94
Table 30: Regional Conservation Analysis 95

Table 31: Cumulative Impact Assessment (Carabooda and East Wanneroo DSPs) 96

Figures

Figure 1. The Site 3
Figure 2. Metropolitan Region Scheme Zones and Reserves 4
Figure 3. Surrounding Land Use and Zoning 5
Figure 4. District Structure Plan 6
Figure 5. Surface Geology (Soils) and Topography 32
Figure 6. Acid Sulfate Soil Risk 33
Figure 7. Groundwater 37
Figure 8. Surface Water Features and Wetlands 38
Figure 9. Public Drinking Water Source Areas 39
Figure 10. Regional Vegetation Associations and Complexes 42
Figure 11. Vegetation Units 50
Figure 12. Vegetation Condition 53
Figure 13. Conservation Significant Flora within the Site 55
Figure 14. Conservation Significant Ecological Communities within the Site 58
Figure 15. Vegetation Substrate Associations 62
Figure 16. Carnaby's Black Cockatoo Foraging Habitat Quality within the Site 70
Figure 17. Forest Red-tailed Black Cockatoo Foraging Habitat within the Site 71
Figure 18. Black Cockatoo Potential Nesting Trees within the Site 72
Figure 19. Remnant Native Vegetation within 15 km of the Site 73
Figure 20. Regional Black Cockatoo Roosting and Breeding Habitat 74
Figure 21. Ecological Linkages, Conservation Areas, Environmentally Sensitive Areas 77
Figure 22. Bushfire Prone Areas 78
Figure 23. Contaminated Sites 81
Figure 24. Heritage 82

1. Introduction

Acumen Development Solutions, on behalf of Carabooda Landowners Pty Ltd (the Proponent) commissioned Western Environmental Approvals Pty Ltd (WEPL) to prepare an Environmental Assessment Report (EAR) to support the lodgement of a District Structure Plan (DSP).

The area covered by the DSP (hereafter referred to as 'the Site') encompasses 65 lots across the localities of Carabooda and Nowergup, within the City of Wanneroo. A list of lots included in the DSP is provided as Appendix A. The Site covers approximately 979 ha and is situated 35 km north of Perth Central Business District (CBD) (Figure 1). The majority of the Site is currently zoned Rural under the MRS (Figure 2) and Rural Resource under the City of Wanneroo Local Planning Scheme No. 2 (LPS 2) (Figure 3).

The proposed DSP is provided as Figure 4 and includes the following land uses:

- Urban (Residential).
- Centre.
- Primary School.
- High School.
- Private College.
- Transport network.
- Conservation Areas.
- Local Open Space (LOS) for Conservation.

The DSP also identifies areas for Basic Raw Material (BRM) extraction within Lots 104, and 102.

1.1 Purpose and Scope

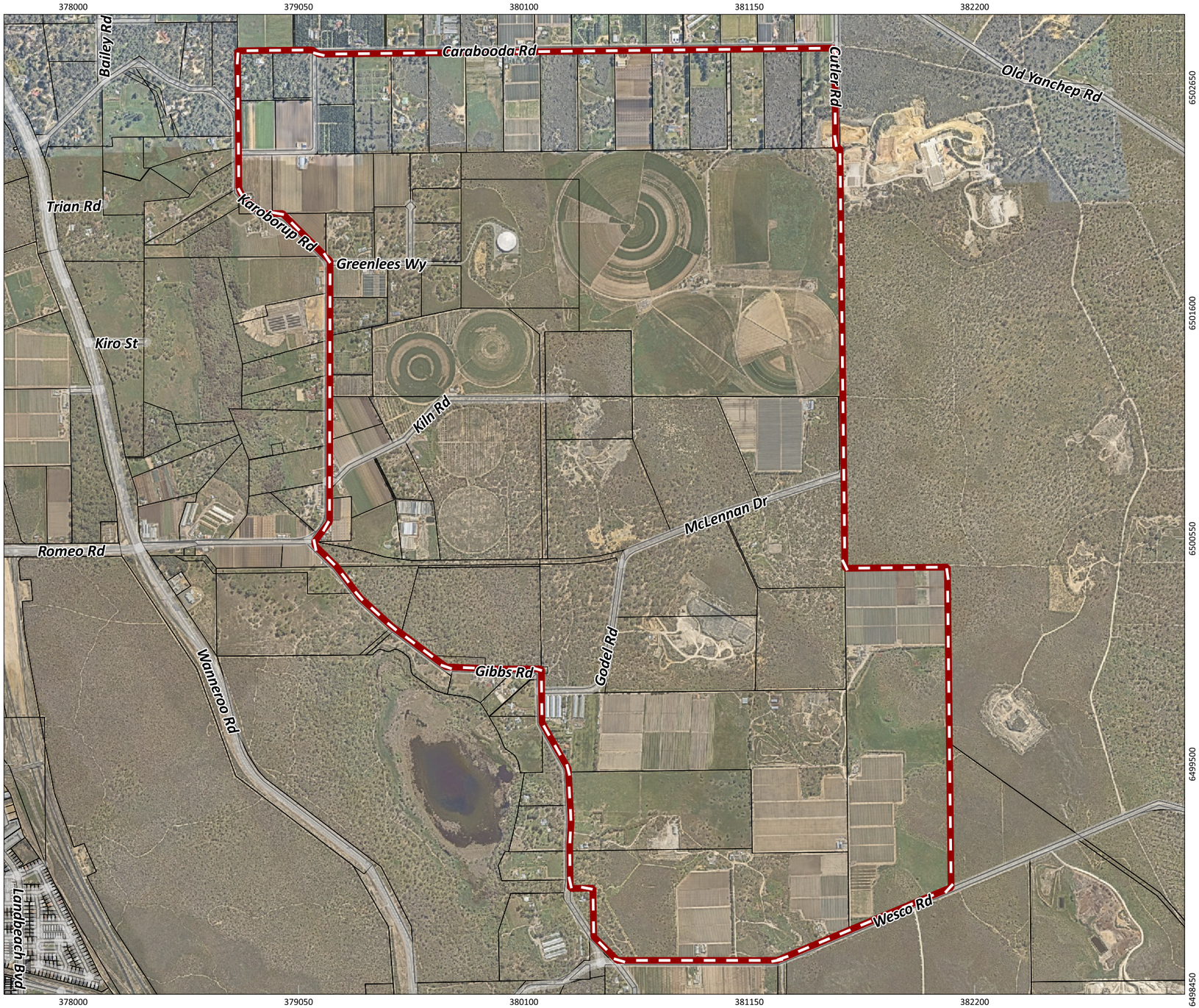
This EAR is intended to not only accompany the lodgement of the DSP, but to also support the referral of the subsequent Metropolitan Region Scheme (MRS) Amendment request to the Environmental Protection Authority under s38 of the *Planning and Development Act 2005*. The EAR includes the following:

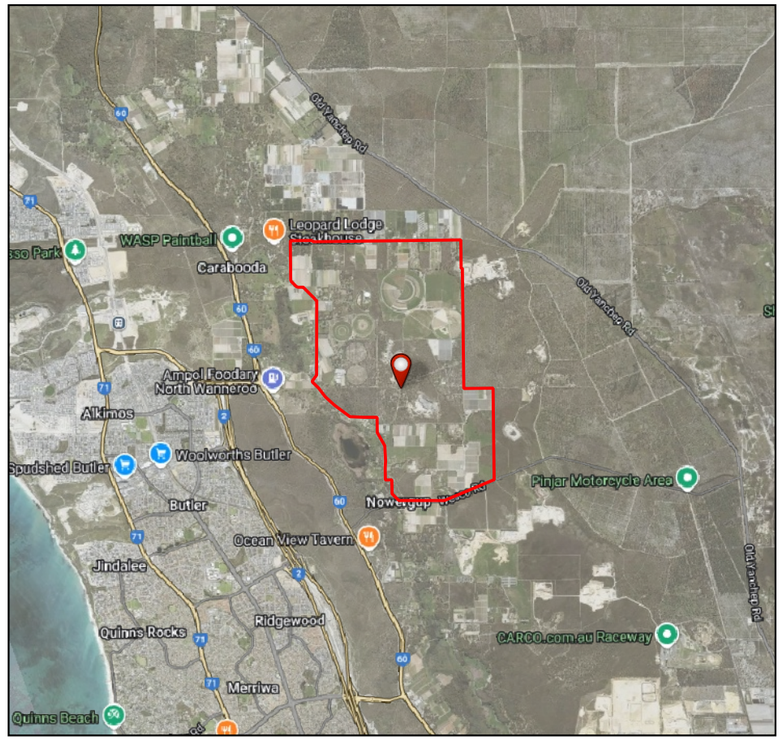
- Overview of legislation, policies, strategies and guidance that exist at the Commonwealth, State, and local levels that apply to and must be considered by the proposed development.
- Detail of the Site's environmental context through a review of existing information relating to the Site (including publicly available datasets and government-managed databases, and the results of previous site assessments).

- Preliminary assessment of the potential environmental impacts associated with future land uses under the DSP against the Environmental Protection Authority's (EPA) Environmental Factors and Objectives.

- Description of relevant approval requirements.

- Description of the likely spatial and management responses of future development to ensure that potential impacts are avoided, mitigated, and managed such that future development is environmentally acceptable and in accordance with the EPA's Environmental Factors and Objectives.





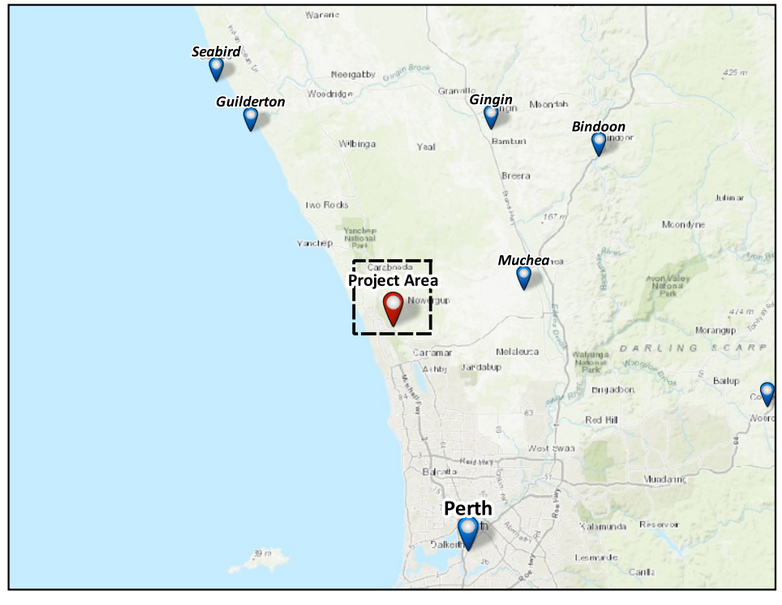


Figure 1: The Site

N

0 600 1,000 m

PROJECT/REPORT NAME	Carabooda Urban Precinct MRS Amendment Multiple lots, Carabooda and Nowergup, WA
SCALE	1:21,000
SHEET SIZE	A3 COLOUR
CLIENT	Acumen Development Solutions
COORDINATE REFERENCE SYSTEM	GDA2020 / MGA zone 50
PROJECT NUMBER	A24.019
VERSION	0
DATA SOURCE	LANDGATE AERIAL IMAGERY NOW
DRAWN BY / REVIEWED BY	JP/HS
DATE	12/12/2024

Legend

- The Site
- Cadastre (No Attributes) (LGATE-001)

Road Network

- Local Road
- Main Roads Controlled Path

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	12/12/2024

NOTES:

Cadastral boundary (LGATE-002). Base map ESRI Topo. Townsites (LGATE-248).

WESTERN ENVIRONMENTAL

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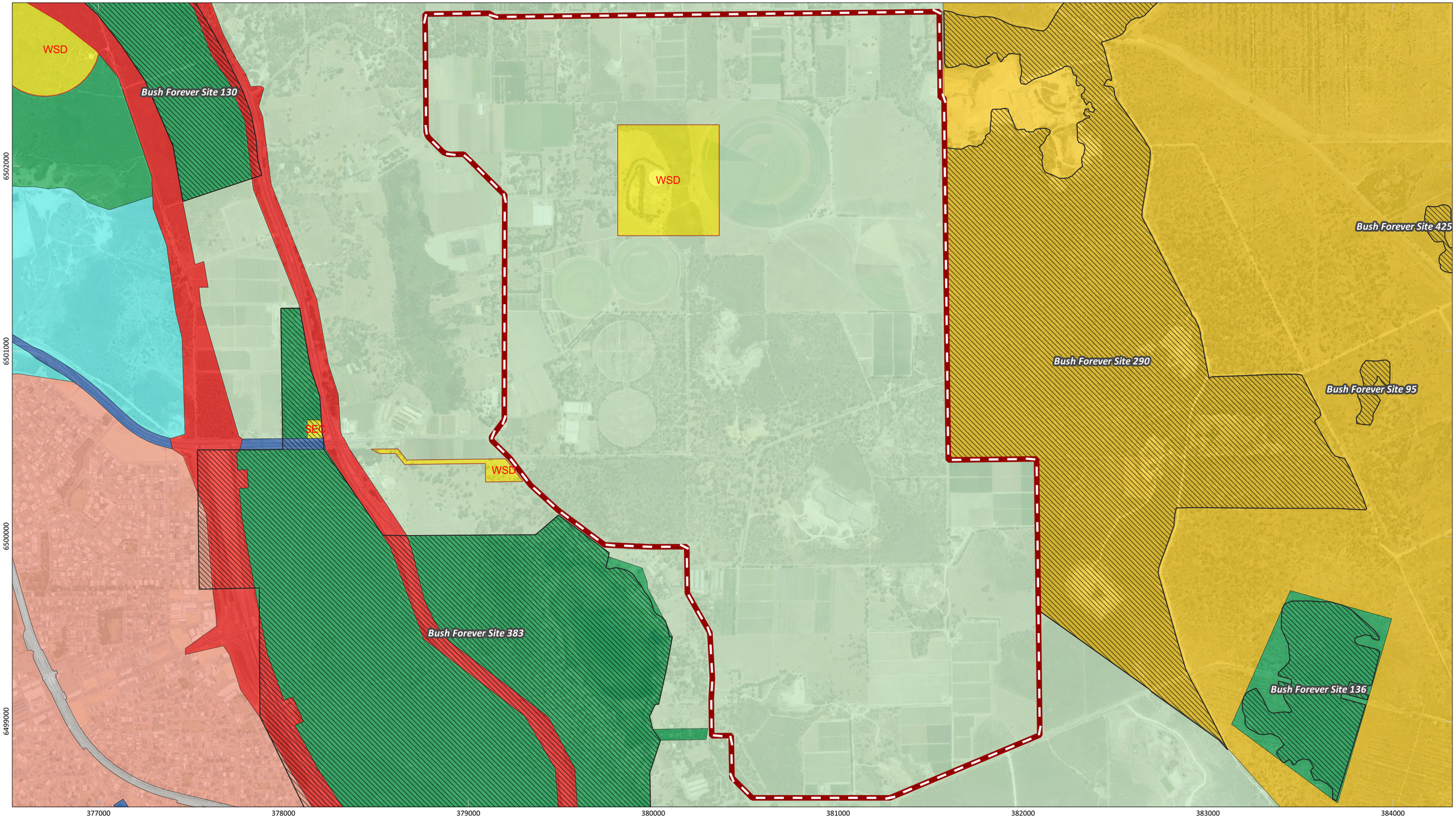


Figure 2: Metropolitan Region Scheme Zones and Reserves

N

0 0.6 1 km

PROJECT/REPORT NAME	Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA
SCALE: 1:20,000	SHEET SIZE: A3 COLOUR
CLIENT: Acumen Development Solutions	
COORDINATE REFERENCE SYSTEM: GDA2020 / MGA zone 50	PROJECT NUMBER:
VERSION: 0	
DATA SOURCE: LANDGATE AERIAL IMAGERY NOW	DRAWN BY / REVIEWED BY: JP / HS
DATE: 26/9/2025	

Legend

- The Site
- Bush Forever Areas - 2000 (DPLH-019)

Region Scheme - Zones and Reserves (DPLH-023)

- Central city area
- Other regional roads
- Parks and recreation
- Primary regional roads
- Public purposes - State Energy Commission
- Public purposes - Water Authority of WA
- Railways
- Rural
- State forests
- Urban

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	26/9/2025

NOTES:

Cadastral boundary from LANDGATE 2022

WESTERN ENVIRONMENTAL
Western Environmental Pty Ltd
08 6244 2310 |
enquiries@westenv.com.au
Level 3/25 Prowse St, West Perth WA

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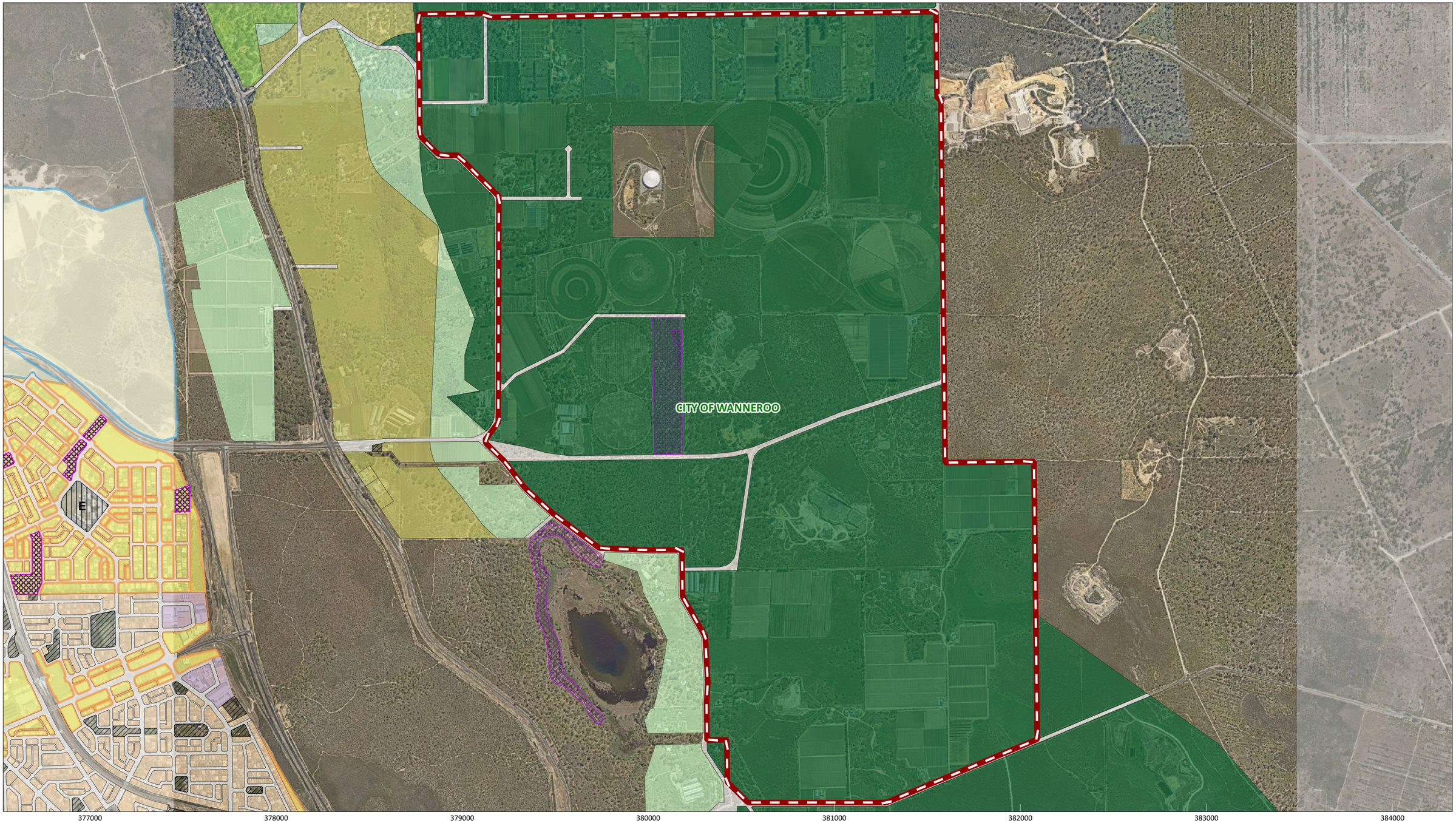


Figure 3: Surrounding Land Use and Zoning

N; 0 – 0.6 – 1 km		PROJECT/REPORT NAME Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA	
SCALE 1:20,000	SHEET SIZE A3 COLOUR	CLIENT Acumen Development Solutions	
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50		PROJECT NUMBER	VERSION 0
DATA SOURCE LANDGATE AERIAL IMAGERY NOW		DRAWN BY / REVIEWED BY JP / HS	DATE 26/9/2025

Legend

- The Site
- Offsets Register - Offsets (DWER-078)

Local Planning Scheme - Zones and Reserves (DPLH-071)

- Centre
- Drainage/waterway
- Education
- Environmental conservation reserve
- Landscape enhancement
- Light industry
- Local road
- Private community purposes
- Public open space
- Residential
- Rural
- Rural resource
- Urban development

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	26/9/2025

NOTES:

Cadastral boundary from LANDGATE 2022

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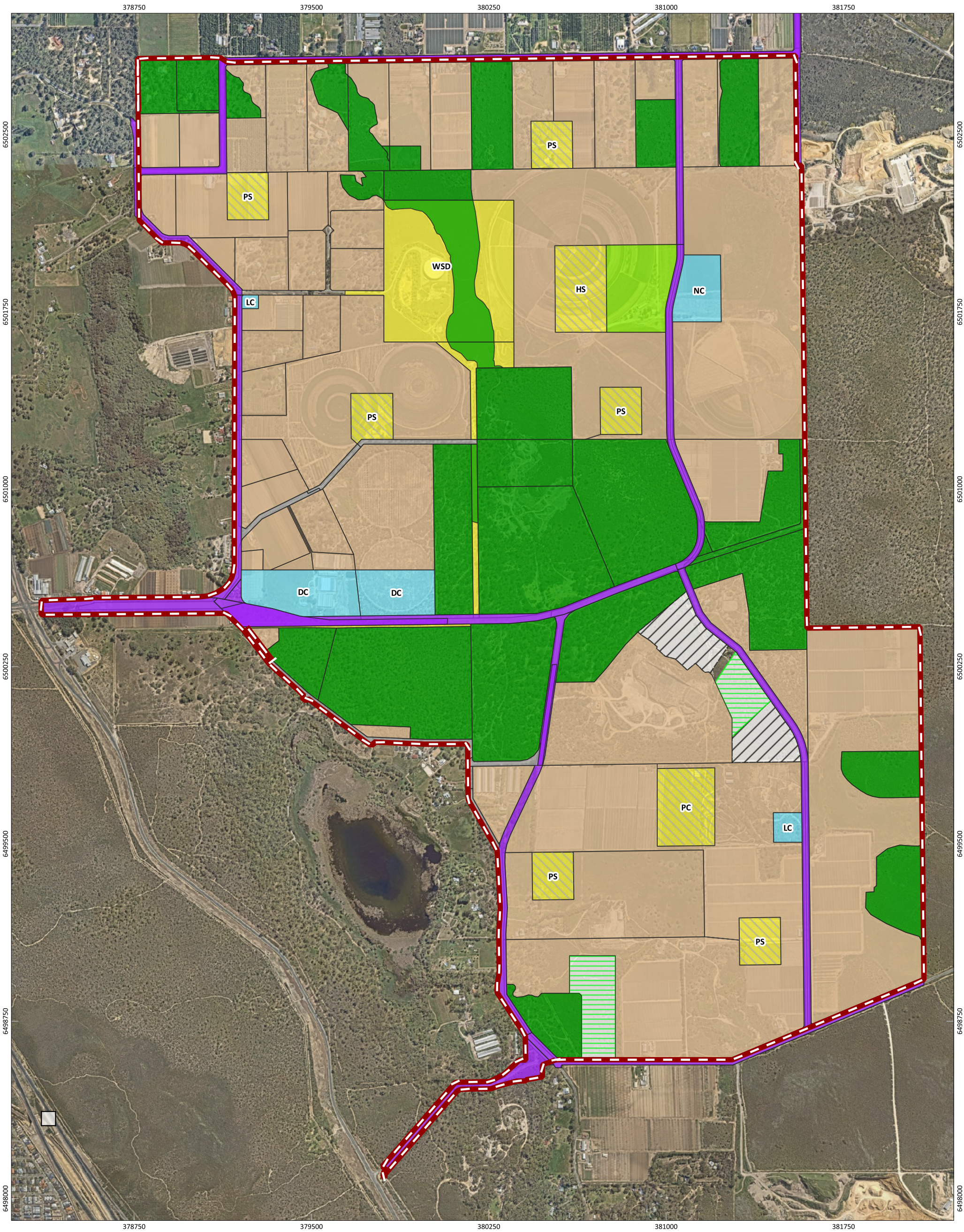


Figure 4: District Structure Plan

N; 0 200 400 m		PROJECT/REPORT NAME: Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA	
SCALE: 1:15,000	SHEET SIZE: A3 COLOUR	CLIENT: Acumen Development Solutions	
COORDINATE REFERENCE SYSTEM: GDA2020 / MGA zone 50		PROJECT: A24.019	VERSION: 0
DATA SOURCE: LANDGATE AERIAL IMAGERY NOW		DRAWN BY / REVIEWED BY: JP / HS	DATE: 21/7/2026

Legend

- The Site
- Proposed District Structure Plan
  - Residential
  - Centre
  - Water Authority of WA
  - School Site
  - Conservation
  - Potential Clearing Permit and BRM Extraction
  - Integrator A / Integrator B / Neighbourhood Connector A
  - Roads
  - Local Open Space for Conservation
  - District Open Space

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	21/7/2026

NOTES:

Cadastral boundary (LGATE-002). Label corresponds to the vegetation association number.

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2. Social and Environmental Statement

2.1 Provision of Affordable Housing Lots and Social Housing Sites

An agreement with the balance of landowners specifically allows for Acumen to commit to Government to provide one in nine residential lots as a priority for Government to purchase for affordable housing for essential workers (nurses, teachers, police, bus drivers, train drivers, child carers, etc). This reflects the same arrangements that Department of Communities maintained in similar projects where they invested 50% equity in developments such as Ellenbrook, Banksia Grove and Brighton, however this commitment does not require any capital to be placed at risk by Government. The agreement also provides for Acumen to commit to Government to provide sites for social housing establishment nearby/within activity centres, so as to allow social housing in close proximity to shops and public transport.

2.2 Equitable Sharing of Conservation Land Provision amongst Landowners

The identification and conservation of significant areas of established bushland with identified trees and ecological communities worthy of retention is a key outcome of the Carabooda DSP proposal. The Carabooda Landowner Group is working collaboratively to ensure an equitable and sustainable approach to the protection and conservation of environmental assets with future management mechanisms in place for their ongoing stewardship. This arrangement will also allow core landowners that are providing conservation lands to be fairly compensated for those contributions. The conservation contribution plan has been developed and provides for approximately 241.60 hectares of conservation land across the core landowner properties to be funded via a per lot contribution based on the estimated lot yields of contributing landowners.

2.3 Permanent Conservation Management Fund

In addition to the value of the conservation lands, the conservation contribution plan also includes a seed funding mechanism for the ongoing management of the conservation areas in perpetuity, through the contribution of $1,000 per lot into a Conservation Management Fund (CMF) to be managed by the City of Wanneroo or an identified authority or agency. This will establish a CMF of $8,500,000 over the development of the Carabooda DSP. It is envisaged that a Specific Area Rating system (SAR) would be established for Carabooda DSP area that provides an ongoing annual contribution to the CMF through the annual collection of SAR from every residential lot created in the DSP. Thereby ensuring the management of the significant conservation areas are permanently funded and protected in the future. A SAR established with an annual contribution of $300 per household, will contribute $2.76M annually into the CMF for management works (to include weed control, feral pest management, fire management, public access and maintenance, signage and associated controls). The management work could involve stewardship from the local Traditional Owners to ensure Landcare management as well as educational purposes are being achieved.

3. Project History and Previous Studies

Several ecological surveys have been undertaken within the Site, either to support the DSP or for separate projects. These are outlined below.

3.1 2024

3.1.1 Carabooda Rezoning Project: Flora and Vegetation Survey (PGV, 2024)

PGV undertook comprehensive flora and vegetation surveys over the Core 660 ha portion of the Site in 2023. This was supplemented by PGV (2024) which combined the results of the 2023 surveys with a follow-up flora and vegetation survey across the balance of the Site that was not surveyed in 2023. The 2024 survey was undertaken across five separate field days between 10 September and 24 September 2024. The results of this survey have been incorporated into the recommendation of this report, and the complete survey report is provided as Appendix B.

3.1.2 Fauna Survey (Bamford Consulting Ecologists, 2024)

The survey area was identified to support seven Vegetation and Substrate Associations (VSAs), with the majority consisting of cleared and disturbed land (VSA 7) and Tuart Open Woodland (VSA 1). Other VSAs include Banksia Woodland, Banksia Thicket, Jarrah Woodland, Melaleuca Heath, and Redheart Open Woodland. The desktop assessment conducted by (BCE, 2024) identified 222 vertebrate fauna species potentially present, with a moderately rich assemblage, including several species of conservation significance (CS1, CS2, and CS3). Additionally, five conservation-significant invertebrate species are expected, as well as potential short-range endemic (SRE) invertebrates.

The survey area is within the known range of Carnaby's and Forest Red-tailed Black-Cockatoos, with the area providing suitable foraging, breeding, and roosting habitats. The site supports abundant large trees with nesting hollows and is within proximity to known roosting and foraging sites. However, its foraging value is low to moderate, with the project area showing varying levels of habitat quality.

The complete survey report is provided as Appendix C.

3.2 2023

3.2.1 The Carabooda Rezoning Project: Flora and Vegetation Survey (PGV, 2023)

PGV (2023) undertook a flora and vegetation survey across the Core 660 ha portion of the Site between 14 September and 17 October 2023 on 8 separate field days. PGV (2023) was commissioned by the Carabooda Landowners Pty Ltd to assess the flora and vegetation values of the site as part of the investigation into the urban development potential of the Site. The results of this survey have been incorporated into the recommendations of this report, and the complete survey report is provided as Appendix D.

A senior ecologist from JBS&G visited the site in April 2023 and completed a preliminary site survey. Data from this helped to inform the work completed by PGV (2023).

3.2.2 Targeted Survey - Alkimos Seawater Desalination Plant (360 Environmental, 2023)

360 Environmental Pty Ltd, part of SLR Consulting (SLR), undertook a targeted survey of a proposed Water Corporation pipeline route for the DN1600 pipe line to East Wanneroo, from the Alkimos Seawater Desalination Plant Project, impacting several lots within the site (360 Environmental, 2023).

The survey was intended to identify any *Melaleuca* sp. Wanneroo (G. J. Keighery 16705) and *Eucalyptus argutifolia* along the proposed pipeline corridor. Three individuals of *Melaleuca* sp. Wanneroo (Endangered) were recorded during the survey, located at the following coordinates:

- -31.637495, 115.761102 (outside of the Site).
- -31.637276, 115.761725 (outside of the Site).
- -31.624878, 115.738776; located in the easement between Lots 8 and 11 of the proposed Urban Precinct.

3.3 2017

3.3.1 Flora, Vegetation, and Fauna Assessment - Strawberry Farm 235 McLennan Drive, Nowergup (MBS Environmental, 2017)

MBS Environmental undertook a flora, vegetation and fauna assessment of the Strawberry farm at 235 McLennan Drive, Nowergup (MBS Environmental, 2017). The survey recorded 104 plant taxa, including 30 introduced species. The survey did not record any conservation significant flora. The survey recorded one vegetation unit, described as a Low Open Woodland of *Banksia attenuata*, *B. menziesii* and *Eucalyptus todtiana* over shrubland dominated by *Hibbertia hypericoides*, *Eremaea* spp., *Acacia pulchella*, *Macrozamia riedlei*, *Xanthorrhoea preissii*, *Mesomelaena pseudostygia* and *Patersonia occidentalis*.

This community was identified as the Commonwealth Threatened Ecological Community (TEC) Banksia Woodlands of the Swan Coastal Plain and inferred to be most likely the Gibson et al. (1994) floristic community (FCT) SCP28 Spearwood *Banksia attenuata* or *B. attenuata - Eucalyptus woodlands*. Vegetation at the site was identified as suitable foraging habitat for Carnaby's black cockatoo and Forrest red-tailed black cockatoo (MBS Environmental, 2017).

3.4 2014

3.4.1 Flora and Vegetation Survey - Lot 105 & 107 McLennan Drive (PGV, 2014)

PGV Environmental undertook a flora and vegetation survey of Lot 105 & 107 McLennan Drive (Lots 9 and 11 of the Urban Precinct) for Urban Resources Limited (PGV Environmental, 2014). They identified 105 native and 32 introduced flora species, including eleven plants of the Priority 4 species *Jacksonia sericea* recorded on the north-western side of Lot 107 (Lot 11 of the Urban Precinct). The survey recorded ten vegetation units:

- BaBm - *Banksia attenuata*/*Banksia menziesii* Low Woodland over *Allocasuarina humilis*/*Calothamnus quadrifidus*/*Hibbertia hypericoid*es Closed Heath.
- BsXp - *B. sessilis*/*Xanthorrhoea preissii* Tall Open Scrub.
- Eg - *Eucalyptus gomphocephala* Woodland over *X. preissii*/*Melaleuca systena* Open Low Heath.
- EgBs - *E. gomphocephala* Woodland over *B. sessilis*/*X. preissii*/*H. hypericoides* Closed Heath.
- EgEm - *E. gomphocephala*/*E. marginata* Woodland over *X. preissii*/*H. hypericoides* Open Low Heath.
- EgEm - *E. gomphocephala*/*E. marginata* Woodland over *X. preissii* Shrubland and **Ehrharta calycina* Closed Grassland.
- Em - *Eucalyptus marginata* Low Woodland over *X. preissii* Shrubland.
- EmCc - *Eucalyptus marginata*/ *Corymbia calophylla* Low Woodland over *Xanthorrhoea preissii* Shrubland.
- EtBaBm - *Eucalyptus todtiana*/*Banksia attenuata*/*Banksia menziesii* Low Woodland over *Xanthorrhoea preissii*/*Hibbertia hypericoides* Closed Low Heath.
- MhMs - *Melaleuca huegelii*/*M. systena* Closed Heath.

3.4.2 Preliminary Environmental Assessment - Lot 105 & 107 McLennan Drive (EnviroWorks, 2014)

EnviroWorks Consulting undertook a Preliminary Environmental Assessment of properties in Oakford and Nowergup for Urban Resources Pty Ltd (EnviroWorks, 2014). The assessment included Lots 105 & 107 McLennan Drive (surveyed by PGV). In addition to the information provided by PGV, EnviroWorks observed three habitat trees with hollows suitable for use for breeding by black cockatoos.

3.4.3 Conservation Management Plan - 436 Gibbs Road, Nowergup

A conservation management plan was prepared for 436 Gibbs Road, Nowergup (Lot 43 of the Investigation Area) which has a conservation covenant vesting (DPaW, 2014). The report noted the conservation values of the property as including:

- Populations of Carnaby's black cockatoo and Quenda.
- Tuart woodland in Good to Very Good condition (Bassendean 998 vegetation association).
- Bassendean vegetation association 51 (poorly retained).
- Potential habitat for a number of other fauna of conservation significance.

4. Legislation, Policy, and Guidelines

Key statutory and policy documents are listed below and, where specifically relevant to the proposed rezoning, are described in detail in the following sections.

4.1 Commonwealth Legislation

4.1.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is administered by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) and seeks to balance the protection of environmental and cultural values with societal economic and social needs. Nine Matters of National Environmental Significance (MNES) are protected under the EPBC Act, which are:

- World Heritage Properties.
- National Heritage Place.
- Wetlands of international importance (listed under the Ramsar Convention).
- Listed threatened species and ecological communities.
- Migratory species protected under international agreements.
- Commonwealth Marine Areas.
- The Great Barrier Reef Marine Park.
- Nuclear actions (including uranium mines).
- Water resources, in relation to coal seam gas development and large coal mining development.

In addition, the EPBC Act confers jurisdiction over actions that have a significant impact on the environment where the actions affect, or are taken on, Commonwealth land, or are carried out by a Commonwealth agency.

Based on ecological investigations undertaken within the Site, the following MNES have been identified as relevant:

- Carnaby's black cockatoo (*Zanda latirostris*) - Endangered.
- Baudin's black cockatoo (*Zanda baudinnii*) - Endangered.
- Forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*) - Vulnerable.

- Banksia Woodlands of the Swan Coastal Plain threatened ecological community - Endangered.
- Tuart Woodlands and Forests of the Swan Coastal Plain threatened ecological community - Critically Endangered.
- Honeymyrtle Shrubland on Limestone Ridges of the Swan Coastal Plain Bioregion - Critically Endangered.

Whilst scheme amendments do not constitute an 'Action' under the EPBC Act, guidance prepared by the Commonwealth is referred to throughout this report as relevant to matters protected at both State and Commonwealth level. Where development is proposed through subsequent stages of planning, obligations under the EPBC Act will be considered for any potential impacts to MNES. This may include separate EPBC Act referrals for impacts to MNES at specific locations within the Site.

4.2 State

4.2.1 Legislation

This EAR has been prepared with reference to the following State legislation which provides for the protection and management of environmental values, heritage values, and bushfire risk associated with the Site and proposed development and seek to achieve appropriate development. These are:

- *Environmental Protection Act 1986* (EP Act).
- *Biodiversity Conservation Act 2016* (BC Act).
- *Rights in Water and Irrigation Act 1914* (RIWI Act).
- *Metropolitan Water Supply, Sewerage and Drainage Act 1909*.
- *Aboriginal Heritage Act 1972* (AH Act).
- *Contaminated Sites Act 2003* (CS Act).
- *Contaminated Sites Regulations 2006* (CS regulations).

Environmental Protection Act 1986

The EP Act is administered by the EPA and provides for the prevention, control, and abatement of pollution and environmental harm to achieve the conservation, preservation, protection, enhancement, and management of the environment and for matters incidental or connected the foregoing.

In accordance with section 38 of the *Planning and Development Act 2005* (PD Act) all proposed Schemes and amendments are to be referred to the EPA for assessment against their Environmental Principles, Factors, and Objectives. Part IV of the EP Act makes provisions for the EPA to undertake environmental impact

assessment of significant proposals, strategic proposals and land use planning schemes. The EPA uses environmental principles, factors, and associated objectives as the basis for assessing whether a proposal or land use planning scheme's impact on the environment is acceptable. The EPA then determine whether the proposed scheme amendment should be assessed, or determine that it is incapable of being made environmentally acceptable. Possible assessment levels are as follows:

- Scheme amendment not to be assessed under Part IV of the EP Act. No advice given (not appealable).
- Scheme amendment not to be assessed under Part IV of the EP Act. Advice given (not appealable).
- Assess - Environmental Review.
- Scheme incapable of being made environmentally acceptable.

Section 6 provides an assessment of the proposed re-zoning against the EPA's Environmental Principles, Factors, and Objectives to support the MRS amendment process.

Biodiversity Conservation Act 2016

The BC Act provides for the conservation and protection of biodiversity and the ecologically sustainable use of biodiversity components in WA. The BC Act provides for the protection of flora and fauna, and includes provisions for threatened ecological communities, threatening processes, critical habitats, and environmental pests.

Planning and Development Act 2005

The PD Act provides for a system of land use planning and development in the State and for related purposes. The PD Act is administered by the Department of Planning, Lands, and Heritage (DPLH). The PD Act also establishes the Western Australian Planning Commission (WAPC).

In accordance with section 38 of the PD Act, all proposed Schemes and amendments are to be referred to the EPA for assessment against their Environmental Principles, Factors, and Objectives.

4.2.2 State Planning Policies

State Planning Policies (SPP) are prepared and adopted by the WAPC under statutory procedures set out in Part 3 of the PD Act. The SPPs relevant to the proposed development are identified below:

- *State Planning Policy 2.4: Basic Raw Materials* (SPP 2.4).
- *State Planning Policy 2.5: Rural Planning* (SPP 2.5).
- *State Planning Policy 2.8: Bushland policy for the Perth Metropolitan Region* (SPP 2.8).
- *State Planning Policy 3.7: Bushfire* (SPP 3.7).

- *State Planning Policy 5.4: Road and Rail Noise* (SPP 5.4).
- *Better Urban Water Management guidelines* (WAPC, 2008).

SPP 2.4: Basic Raw Materials

SPP 2.4 is designed to facilitate the extraction of basic raw materials (BRM) close to the major markets within the Perth metropolitan region, and to avoid sensitive development near BRM resources which would otherwise inhibit extraction. The policy sets out matters to be considered and given effect to by the WAPC and local governments in considering zoning, subdivision, and development applications for extractive industries (WAPC, 2021a).

SPP 2.5: Rural Planning

SPP 2.5 provides policy guidance for managing land use transitions from rural to urban, for example. Section 5.12.5 details WAPC policy with regard to managing land use transitions between existing operators and new landowners (WAPC, 2016).

SPP 2.8: Bushland Policy for the Perth Metropolitan Region Scheme

SPP 2.8 aims to provide a policy and implementation framework that ensures bushland protection and management issues throughout the Perth metropolitan region are adequately addressed and integrated with broader land use planning and decision-making (WAPC, 2021b). The policy predominantly deals with two distinct subjects, Bush Forever areas and local bushland areas. In accordance with SPP 2.8, proposals must recognise regionally significant bushland and outline methods by which it will avoid, minimise, and offset any likely adverse impacts.

SPP 5.4: Road and Rail Noise

SPP 5.4 applies to all stages of planning in Western Australia where a noise-sensitive land use is proposed within the policy's trigger distance of specified transport routes or when new or major upgrades of road and rail are proposed. The transport routes identified are considered of key economic importance due to their high vehicle movements and/or freight handling functions.

The objectives of the policy are to:

- Protect the community from unreasonable levels of transport noise.
- Protect strategic and other significant freight transport corridors from incompatible urban encroachment.
- Ensure transport infrastructure and land use can mutually exist within urban corridors.
- Ensure that noise impacts are addressed as early as possible in the planning process.
- Encourage best-practice noise mitigation design and construction standards.

4.2.3 EPA Themes, Factors, Objectives, Guidelines, and Technical Guidance

This EAR has been prepared in accordance with the EPA themes, factors, objectives, guidelines and technical guidance detailed in Table 1, highlighting the DSP relevant factors (**in bold**).

Table 1. EPA Environmental Factors, Objective, Guidelines and Technical Guidance

Theme	Factor	Objective	Guideline and Technical Guidance
Sea	Benthic communities and habitats	To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.	• Environmental Factor Guideline - Benthic Communities and Habitats (EPA, 2016a).
	Coastal processes	To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.	• Environmental Factor Guideline - Coastal Processes (EPA, 2016b).
	Marine environmental quality	To maintain the quality of water, sediment, and biota so that environmental values are protected.	• Environmental Factor Guideline - Marine Environmental Quality (EPA, 2016c).
	Marine fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.	• Environmental Factor Guideline - Marine Fauna (EPA, 2016d).
Land	**Flora and vegetation**	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.	• Environmental Factor Guideline - Flora and Vegetation (EPA, 2016e). • Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016f).
	Landforms	To maintain the variety and integrity of distinctive physical landforms so that environmental values are protected.	• Environmental Factor Guideline – Landforms (EPA, 2016g).
	Subterranean fauna	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.	• Environmental Factor Guideline – Subterranean Fauna (EPA, 2016h). • Technical Guidance - Subterranean fauna surveys for environmental impact assessment (EPA, 2021).
	Terrestrial environmental quality	To maintain the quality of land and soils so that environmental values are protected.	• Environmental Factor Guideline - Terrestrial Environmental Quality (EPA, 2016i).
	Terrestrial fauna	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	• Environmental Factor Guideline - Terrestrial Fauna (EPA, 2016j). • Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a). • Technical Guidance - Sampling methods of short range endemic invertebrate fauna (EPA, 2016k).
Water	Inland waters	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.	• Environmental Factor Guideline - Inland Waters (EPA, 2018).
Air	Air quality	To maintain air quality and minimise emissions so that environmental values are protected.	• Environmental Factor Guideline - Air Quality (EPA, 2020b).

Theme	Factor	Objective	Guideline and Technical Guidance
People	Greenhouse gas emissions	To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable.	• Environmental Factor Guideline - Greenhouse Gas Emissions (EPA, 2023a).
	Social surroundings	To protect social surroundings from significant harm.	• Environmental Factor Guideline - Social Surroundings (EPA, 2023b).
	Human health	To protect human health from significant harm.	• Environmental Factor Guideline - Human Health (EPA, 2016l).

4.2.4 Advice under Section 16 of the *Environmental Protection Act 1986*

The EPA prepared environmental advice on the draft Carabooda DSP in April 2025, as provided in Appendix E, for the purpose of providing independent guidance on key site and cumulative environmental issues, and environmental protection needs.

Advice received on the draft DSP is summarised below:

- Protection of Areas H, I, J (noting J proposed for Basic Raw Materials [BRM], K, L, and M on Figure 4 of Appendix E) which are not currently proposed for retention but meet EPA criteria for regional significance. The EPA considers that these areas should be prioritised for retention as they provide very good and excellent quality vegetation and threatened fauna habitat.

- Additional protection of cockatoo foraging habitat. For Carnaby's cockatoo, there is 334 ha of moderate or better-quality foraging habitat on site; and although 217 ha (64%) is proposed to be retained,118 ha (36%) remains proposed to be cleared. For Forest red-tailed black cockatoo, there is 223 ha of moderate or better-quality foraging habitat; 56 ha (25%) is proposed to be cleared. The amount of clearing is a likely to be a significant environmental impact, and as detailed in the Referral guideline for 3 WA threatened black cockatoo species (DAWE 2022) likely to require referral to the Commonwealth. Additional areas protected on site should be considered, particularly where areas are aligned with roosting, nesting, quality foraging habitat or other environmental values.

- For counter-balancing significant residual impacts, see EPA advice below on consideration of environmental offsets through a lens of prioritising on site protection, and enabling restoration and enhancement opportunities.

- Protection of any cockatoo roosting sites, and potential nesting trees with suitable hollows, found during on ground surveys.

- Maintaining ecological linkages through protection of consolidated areas of vegetation and viable ecological stepping stones (in addition to the proposed maintenance of the east-west ecological linkage).

- Inclusion of buffer areas to avoid and minimise adverse impacts to conservation estate areas and any key values retained in POS.

- Consider whether infrastructure (road) alignments can be located to reduce impacts to environmental values of conservation areas and black cockatoo habitat.

- Continuation of a holistic protection focus – prioritisation of identification and protection of areas which contain multiple key values.

- Protection of any additional key environmental values in conservation estate areas, where practicable, or otherwise in POS.

In response to this advice, the DSP was revised to include:

- Additional retention and protection of flora, vegetation, and fauna habitat values within additional conservation areas totalling 7.44 ha.

- Delineation of additional areas as Local Open Space for Conservation wherein additional flora, vegetation, and fauna habitat values will be retained alongside passive recreation and amenity, totalling 11.0 ha.

The values contained within these additional conservation areas and Local Open Space for Conservation are reflected in the assessment of environmental impacts and proposed management, in section 6 of this EAR.

Upon review of the revised DSP, the EPA provided additional advice, which is provided as Appendix F and summarised below:

- The amended DSP concept plan has appropriately responded to the EPA's 4 April 2025 advice and has prioritised the protection of the significant onsite environmental values identified by the EPA.

- The amended DSP now proposes to protect approximately 75% of the remnant vegetation on site. This is consistent with the EPA's recommended approach to: retain good quality vegetation on sites and avoid clearing where possible in the first place (for the multiple benefits of this approach in environmental planning, see the EPA's submission to the Urban Greening Strategy July 2024).

- The onsite retention level of native vegetation in the amended DSP is consistent with other comparative current proposals. Adoption of high levels of onsite retention of significant environmental values for the Swan Coastal Plain could lead to significantly better environmental outcomes and efficiency of statutory processes.

- The Conservation Management Fund represents a material step forward in environmental planning and management approaches and is commended.

- The amended DSP has materially increased the likelihood that a future region scheme amendment will be consistent with EPA objectives and will not warrant a future EPA assessment.

- Some environmental matters remain to be addressed in future planning processes, but the comprehensive environmental information provided has been more than usually required at this stage of planning and has enabled the EPA to provide this early advice.

- The extent to which future planning processes can provide certainty and security of conservation areas and management (and offsets, if required), will also increase the likelihood that a future EPA assessment is not warranted.

4.3 Local Government

The City of Wanneroo have developed a number of policies, strategies, and guidelines relevant to planning and the environment, as identified in the following subsection. Reference to these documents is made throughout the report where applicable to specific environmental factors.

4.3.1 City of Wanneroo Local Planning Policies

- *Local Planning Policy 1.1: Conservation Reserves* (LPP 1.1) - the purpose of LPP 1.1 is to outline the City's minimum requirements for the identification, purpose, and management of areas to be reserved under the City's District Planning Scheme No. 2 as 'Conservation'.

- *Local Planning Policy 3.3: Fauna Management* (LPP 3.3) - the objective of LPP 3.3 is to ensure the effective management of macro-fauna by landowners and/or developers of land proposed for urban development, and to avoid the unwanted impacts of displaced macro-fauna (such as kangaroos and emus) due to habitat disturbance.

- *Local Planning Policy 4.13: Caves and Karstic Features* (LPP 4.13) - the objective of LPP 4.13 is to conserve caves and karstic features for their geological, cultural and environmental values, and to minimise risks to people and property in karst hazard areas.

- *Local Planning Policy 4.9: Subdivisions of Rural Zoned Land* (LPP 4.9) - the objective of LPP 4.9 is to ensure any subdivision of land in the General Rural or Rural Resource Zones accommodates and/or protects agricultural, horticultural, animal husbandry and basic raw material priority/key extraction areas.

- *Local Planning Policy 4.12: Heritage Places (LPP 4.12)* - the purpose of LPP 4.12 is to provide guidance for the classification and assessment of heritage places included in the City's Local Heritage Survey (LHS).

5. Environmental Context

5.1 Land Use

5.1.1 Current Land Use

The Site is currently zoned Rural under the MRS (Figure 2) and Rural Resource under the City of Wanneroo DPS 2 (Figure 3). Current land uses within the Site are highlighted in Figure 3.

The Site is comprised of numerous lots with multiple landowners, and is characterised by a mixture of rural land uses. The existing lots within the Site boundary are detailed in Appendix A.

A little under 35% of the Site is comprised of native vegetation which, based on a review of historic aerial imagery, appears to be remnant. Further, historic aerial imagery shows that some areas that were sparsely vegetated as recently as 1995, are now more densely covered. This indicates possible bush regeneration has been undertaken in some areas.

Several properties within and adjacent to the Site are registered with the Department of Primary Industries and Regional Development (DPIRD) as places associated with various types of livestock. The livestock holdings will be decommissioned prior to development. Early in the development, a survey may be needed to investigate potential contamination from these Sites as remediation may be necessary to support rezoning from rural to urban.

There are a variety of industries within and adjacent to (within 5 km) the Site, which are subject to operating licenses issued under Part V of the EP Act. These are detailed in Table 2.

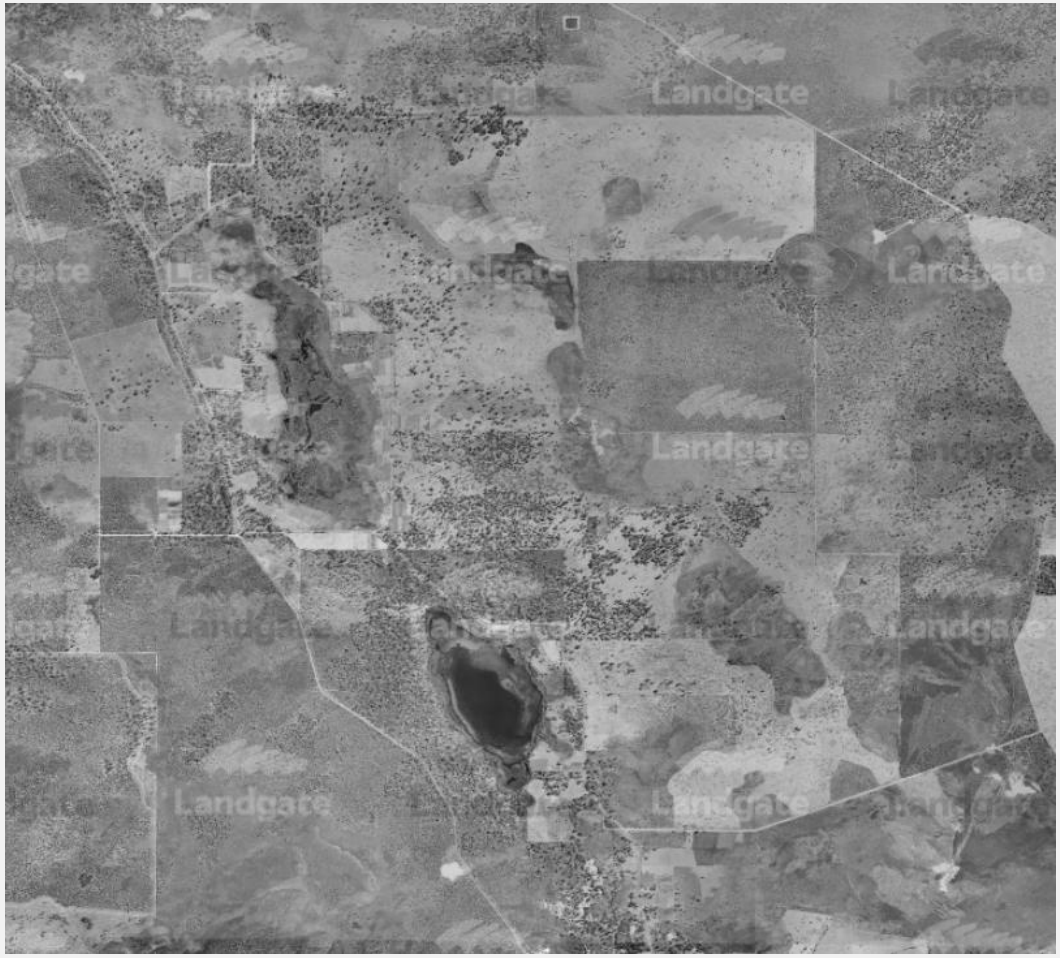
Table 2. Current Operating Licenses within the Site

License Number	Holder	Location	Activity	Expiry
L9202/2019/1	Italia Stone Group Pty Ltd	Nowergup Quarry, Godel and McLennan Drive, Nowergup	Natural limestone blocks and crushed limestone	14 May 2029
L9183/2018/2	Meteor Stone (Site Code S0017117	(Lot 11) 53 Wesco Road, Nowergup	Sandstone, limestone construction materials	4 November 2029 *No longer operating.
L9202/2019/1	Italia Stone	(Lot 106) 149 McLennan Drive, Nowergup	Sand	14 May 2029

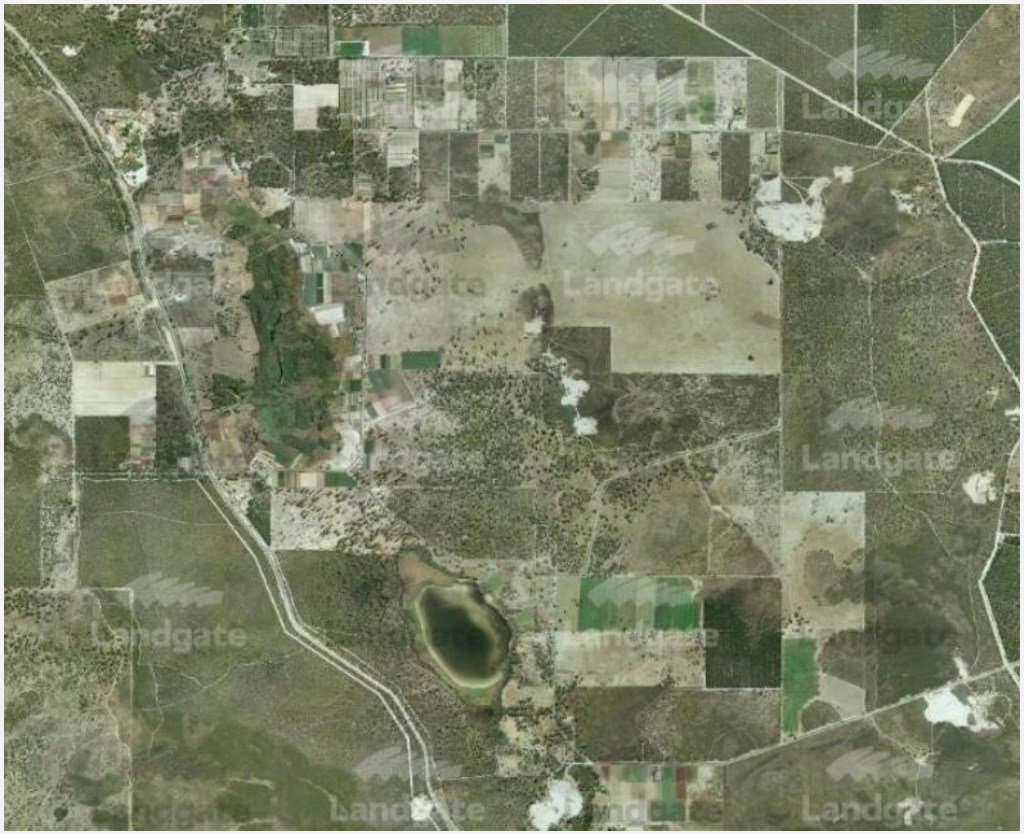
5.1.2 Previous Land Use and Existing Environmental Approvals

Approximately 625.38 ha of the Site has been previously cleared (based on the extent of remnant native vegetation reported by PGV [2024]). Clearing has been undertaken under a number of clearing permits. There are currently no active clearing permits across the Site. Lot 6 contains a registered offset site associated with CPS 688/2. The extent of clearing and development within the Site over time is detailed in Table 3.

Table 3. Historic Aerial Imagery of the Site

Date	Historical Aerial Image (Landgate, n.d.)
11/03/1965 - Some land cleared, boundaries set and road infrastructure in place.	

Date	Historical Aerial Image (Landgate, n.d.)
07/06/1977 - Subdivided in the north, south, and west of the Site and land cleared for potential agriculture use. Further clearing northeast and southeast on the Site. Some buildings for agricultural and residential purposes erected on the western boundary of the Site.	

Date	Historical Aerial Image (Landgate, n.d.)
19/06/1985 - More buildings on the north and west of the Site have been developed potentially for agricultural and residential use. Limestone manufacturing site developed northeast on the Site.	

Date	Historical Aerial Image (Landgate, n.d.)
06/02/1995 - Lawn Turf Farm northeast of the site developed, and more buildings north of this have been developed. Clearing of various limestone sites has taken place throughout the Site.	

Date	Historical Aerial Image (Landgate, n.d.)
24/12/2006 - More land on the central western part of the Site appears to have been cleared and developed for more turf manufacturing. Further land cleared for agriculture on the south boundary of the Site. Further roads throughout the site have been added.	

Date	Historical Aerial Image (Landgate, n.d.)
29/09/2016 - Further land cleared west of the turf manufacturing site developed in 2006 to expand production. More residential properties developed on the western boundary of the site.	

Date	Historical Aerial Image (Landgate, n.d.)
10/02/2024 - No obvious changes since 2016.	

5.1.3 Surrounding Land Use

The Carabooda DSP area supports a variety of existing land uses, some of which have the potential to cause amenity impacts associated with dust, noise, gaseous, or odour emissions. Such land uses applicable to the Site and surrounding area include existing poultry farms, basic raw materials, extraction, market gardens, turf farms, and nurseries. Surrounding land uses are detailed in Table 4 and shown in Figure 3.

Table 4. Surrounding Land Uses

Location in Relation to Site	Description of Land Use
North	Primarily agricultural and other rural land uses interspersed with remnant native vegetation.
East	Gnangara-Moore River State Forest and Bush Forever Site 290, with a small number of active quarries (limestone).
South	Primarily agricultural and other rural land uses, active quarries, and some dwellings.
West	Residential, agricultural, and other rural land uses present, as well as Neerabup Nature Reserve and Lake Nowergup.

Market Gardens

The Site contains a number of existing market gardens and other agricultural pursuits, which will ultimately transition to urban land uses through the implementation of the DSP. However, a range of market gardens, orchards, and plant or tree nurseries also occur in proximity to the Site.

Poultry Farms

Within the Site, there is one poultry broiler farm, which will cease operating prior to urban development. There are three poultry farms in proximity to the Site which are expected to remain operational at the time of preparing the DSP, one to the north and two to the west. A fourth poultry farm is located to the west which is non-operational/will cease operating prior to urban development. The locations of these are shown in Appendix G with an indicative 500 m buffer applied.

5.2 Topography, Geology and Soils

5.2.1 Topography

Regional topographic contour mapping (DPIRD-072) indicates that the Site is gently undulating while gradually sloping down to the west. Elevation ranges from 70 mAHD in the east adjacent to State Forest, to 20 mAHD in the west adjacent to Karoborup Road (Figure 4). Topographic contours run fairly consistently from north-east to south-west across the Site.

5.2.2 Geology

The Site forms part of the Leederville Formation, described as interbedded sandstone and siltstone, minor conglobate, scattered thin coal seams (DMIRS-016).

Regional geological mapping identifies four geological units within the Site (DMIRS, 1984; DMIRS, 1985). These are described in Table 5 and shown on Figure 4.

Table 5. Geological Units within the Site

Geological Unit	Description
S7 - Sand	Pale and olive-yellow medium to coarse-grained sub-angular quartz moderately sorted of residual origin modified by marine inundation.
LS1 - Tamala Limestone	Pale yellow-brown fine-grained angular and medium-grained rounded quartz and calcite cross-bedding minor heavy minerals.
LS2 - Limestone	As LS1 abundant karstic phenomena including caves, swallows, and dolines.
Cps - Peaty Clay	Swamp deposits mainly peaty sand, dark grey and black soft variable organic content some quartz sand in places of lacustrine origin

5.2.3 Karstic Features

Karst features are surface or subterranean and have formed by dissolution of limestone or other soluble rocks. The scale of these features can vary from millimetres to hundreds of metres or more, and can include small underground voids or cavities, caves, dolines, collapsed caves, and sculpting of limestone surfaces.

The southwestern and northwestern corners of the DSP (approximately 4% of the total DSP area) are mapped as having 'High' karst risk. These areas are likely to contain abundant karst features such as caves, dolines, and swallows. The western portion of the DSP (approximately 18% of the DSP area) is mapped as having 'Medium' karst risk. The DSP area overlaid with karst risk mapping (per City of Wanneroo LPP 4.13) is shown in Plate 1 below.

The presence of karstic landforms carries geotechnical risk and potential presence of subterranean fauna.

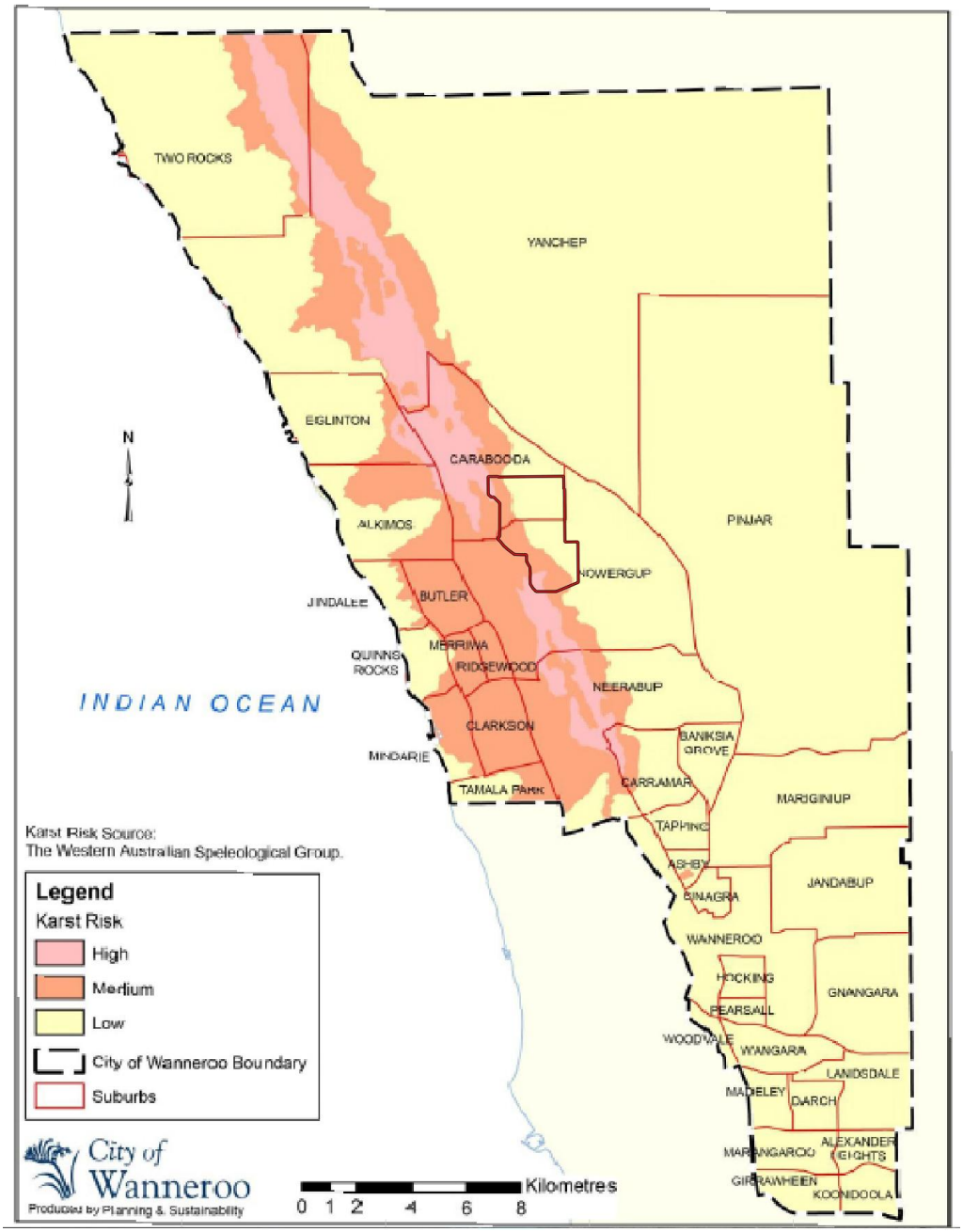


Plate 1. DSP Area overlaid on Karst Risk Mapping (Reference: Figure 1 of City of Wanneroo LPP 4.13)

5.2.4 Soil Landscape Mapping

Geology and landforms of the Perth region (Gozzard, 1982) indicates that the Site is located upon the Tamala Limestone: leached yellow sand/ eolian calcarenite system.

Regional soil landscapes and systems mapping (DPIRD-024) identifies that the Site is within the Spearwood System, which is described as sand dunes and plains, and yellow deep sands, pale deep sands and yellow/brown shallow sands. Table 6 details the soil-landscape units mapped within the Site (DBCA-027).

Table 6. Soil Landscape Units within the Site (DBCA-027)

Soil Landscape Unit	Description	Area (ha) within the Site
211Sp_Ky Karrakatta sand yellow phase	Low hilly to gently undulating terrain. Yellow sand over limestone at 1-2 m. *Banksia* spp. woodland with scattered emergent *Eucalyptus gomphocephala* and *E. marginata* and a dense shrub layer.	396.54
211Sp_Kls Karrakatta shallow soils phase	Low hills and ridges. Bare limestone or shallow siliceous or calcareous sand over limestone. Dense low shrub dominated by *Dryandra* (now *Banksia*) *sessilis*, *Melaleuca huegellii* and species of Grevillea.	208.11
211Sp_Sp Spearwood sand phase	Irregular banks of karst depressions. Some limestone outcrop. Shallow brown sands. *Banksia* spp. woodland with emergent *E. gomphocephala* and *E. marginata*; dense shrub layer.	355.12
211Sp_Kg Karrakatta sand grey phase	Irregular banks of karst depressions. Some limestone outcrop. Shallow brown sands. Banksia spp. woodland with emergent *E. gomphocephala* and *E. marginata*; dense shrub layer	0.01

5.2.5 Acid Sulfate Soils

Acid sulfate soils (ASS) are naturally occurring, iron-sulfide rich soils, sediments, or organic substrates, formed under waterlogged conditions. If exposed to air, these sulfides can oxidise and release sulfuric acid and heavy metals. This process can occur due to drainage, dewatering or excavation.

The Department of Water and Environmental Regulation (DWER) ASS Risk Mapping (DWER-055) is shown on Figure 5. The majority of the Site is mapped as having a low risk of ASS occurring. There is a small pocket of land with a high to moderate risk of ASS occurring within 3 m of the natural soil surface in the northern portion of the Site, affecting approximately 2.15 ha (Figure 6).

Further discussion of ASS risks for the Site can be found in the Integrated Water Management Framework by Pentium Water (2023).

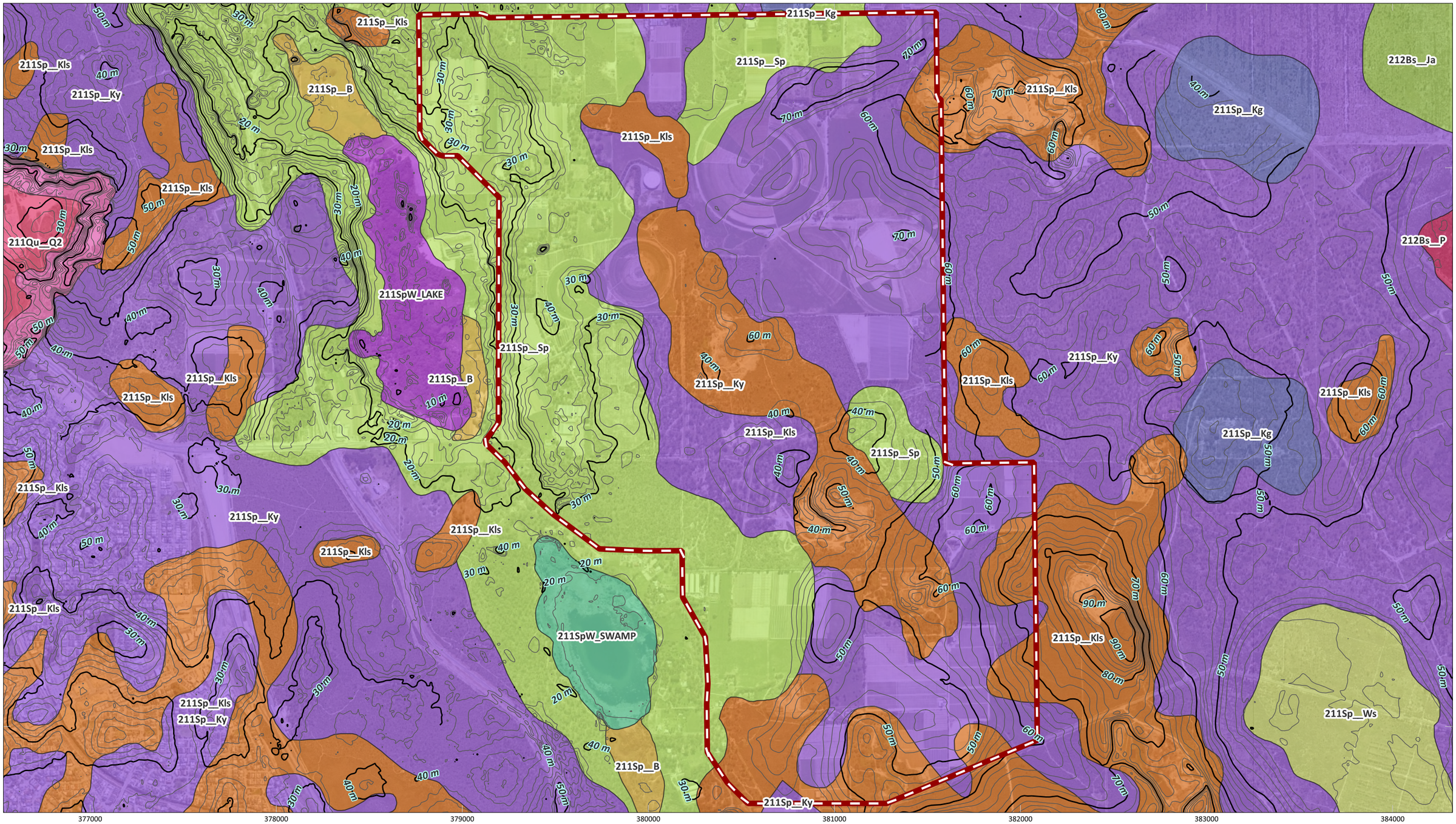


Figure 5: Surface Geology (Soils) and Topography

N

0 0.5 1 km

PROJECT/REPORT NAME	Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA
SCALE: 1:20,000	SHEET SIZE: A3 COLOUR
CLIENT: Acumen Development Solutions	
COORDINATE REFERENCE SYSTEM: GDA2020 / MGA zone 50	PROJECT NUMBER: A24.019 — VERSION: 0
DATA SOURCE: LANDGATE AERIAL IMAGERY NOW	DRAWN BY / REVIEWED BY: JP / HS — DATE: 17/1/2025

Legend

- The Site
- 2m Contours (DPIRD-072)
  - Each 5m
  - Each 1m

Soil Landscape Mapping - Best Available (DPIRD-027)

- Bassendean, Jandakot phase
- Bassendean, Pinjar phase
- Karrakatta Sand Grey phase
- Karrakatta Sand Yellow phase
- Karrakatta shallow soils phase
- Quindalup South deep sand flat phase
- Quindalup South second dune phase
- Spearwood Sand phase
- Spearwood seasonal swamps phase
- Spearwood wet, lake phase
- Spearwood wet, swamp phase
- Spearwood, Beonaddy Sand phase

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	17/1/2025

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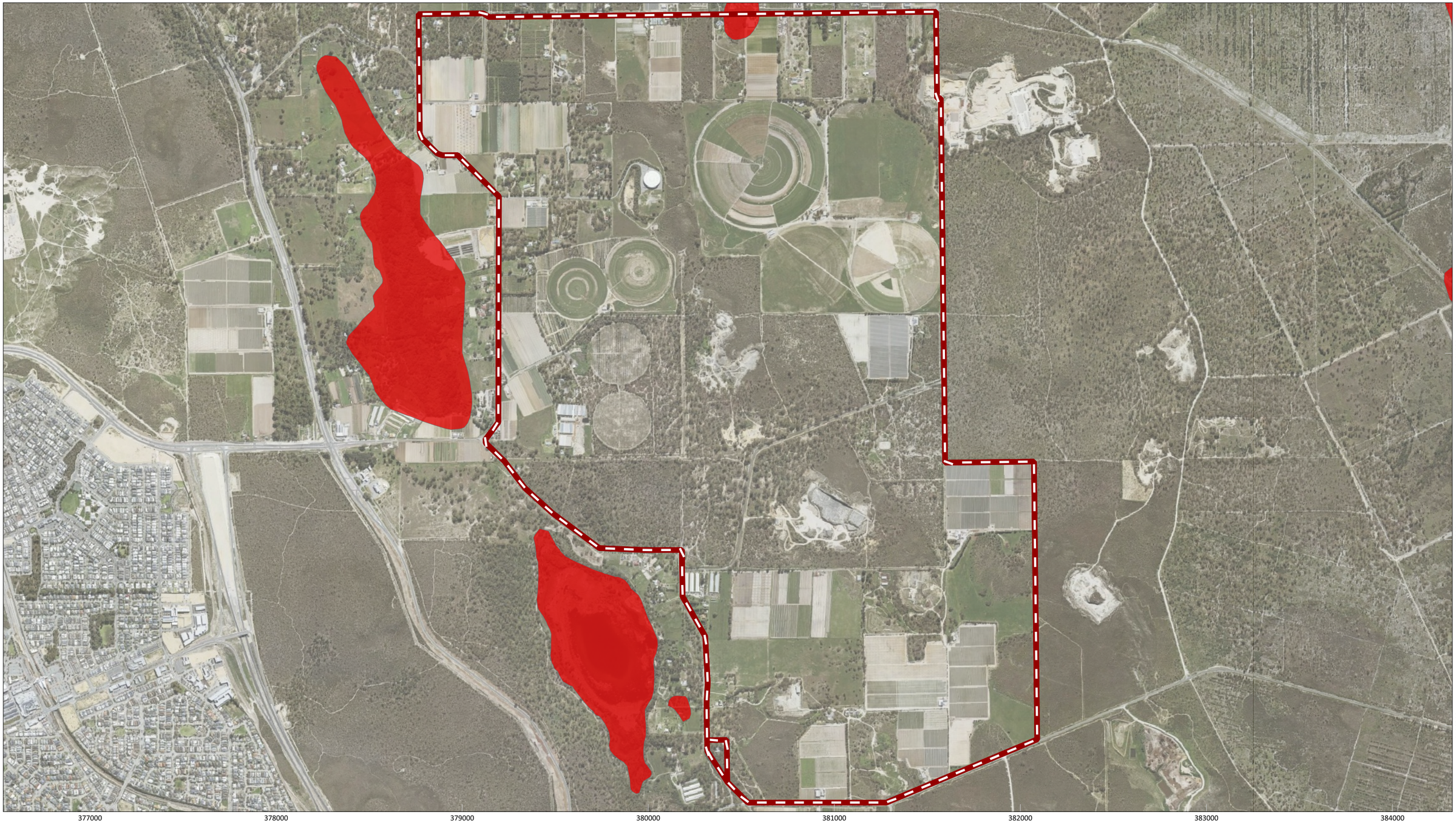


Figure 6: Acid Sulfate Soils Risk

N; 0 – 0.5 – 1 km		PROJECT/REPORT NAME: Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA	
SCALE: 1:20,000	SHEET SIZE: A3 COLOUR	CLIENT: Acumen Development Solutions	
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DATA SOURCE: LANDGATE AERIAL IMAGERY NOW		DRAWN BY / REVIEWED BY: JP / HS	DATE: 15/1/2025

Legend

The Site

Acid Sulfate Soil Risk Map, Swan Coastal Plain (DWER-055)

1 - High to moderate risk of ASS occurring within 3m of natural soil surface

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A	Original issue	JP	HS	15/1/2025

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5.3 Hydrology

There are no watercourses or wetlands within the Site, and drainage is expected to be efficient as a result of the underlying Spearwood sands.

5.3.1 Groundwater

The Site is located within the Wanneroo groundwater catchment area in the Carabooda, Nowergup, and Wanneroo Confined subareas. The Site is situated upon the Perth – Superficial Swan Level 1 aquifer, Perth – Leederville Level 2 aquifer, and Perth – Yarragadee North Level 3 aquifer. Groundwater in all areas is mostly fully allocated.

Numerous groundwater licenses and wells are located within the Site. As part of the ongoing approval process, it is recommended the Proponent determine their suitability either for use within the site or for decommissioning. Advice from the Department of Water and Environmental Regulation (DWER) should be sought on the transfer of water entitlements from the current holders.

Groundwater mapping is available within the Site through the Jandakot - Gnangara Depth to Groundwater contours (DWER-095). According to his dataset, the minimum depth to groundwater ranges across the Site from 8 m below ground level (m bgl) in the west to 59 m bgl in the east (Figure 7).

Detailed information on groundwater for the site can be found in the Integrated Water Management Framework by Pentium Water (2023).

5.3.2 Surface Water

The Site is located within the Swan Coastal Plain surface water catchment and is under the Swan Coastal surface water management area. The Site is located within the Yanchep Coastal Lakes, Wanneroo Coastal Lakes, and Swan Avon – Lower Swan sub-catchment areas (DWER, 2021c). The Site is not located within a Surface Water Area protected under the *Rights in Water and Irrigation Act 1914* (RIWI Act).

No surface water features occur within the site. The Site has no evidence of naturally occurring drainage lines or water courses, according to mapping available through DWER (DWER-031).

The nearest mapped surface water features are Nowergup Lake and Carabooda Lake which are 200 m and 350 m west of the Site, respectively (Figure 8).

5.3.3 Wetlands

Geomorphic wetlands within the Swan Coastal Plain are mapped within a database managed by DBCA (DBCA-019). Together with the location and extent, DBCA assigns management categories which identify how wetlands should be protected and/or managed. Appropriate management categories are identified by applying *A Methodology for the Evaluation of Wetlands on the Swan Coastal Plain, Western Australia* (DBCA, 2017). Three management categories are identified, as described in Table 7.

Table 7. Wetland Management Categories and Objectives applied to the Swan Coastal Plain (DBCA, 2017)

Management Category	General Description	Objectives
Conservation Category Wetland (CCW)	Wetlands which support a high level of attributes and functions.	To preserve and protect their existing conservation values through various mechanisms including: • Reservation in national parks, Crown reserves and state-owned land. • Wetland covenanting by landowners. No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate.
Resource Enhancement Wetland (REW)	Wetlands which may have been modified or degraded, but still support substantial attributes and functions.	To manage, restore and protect towards improving their conservation value and hydrological/hydrogeological regime. These wetlands have the potential to be restored or rehabilitated to Conservation category focusing on wetland functions, structure, and biodiversity value.
Multiple Use Wetland (MUW)	Wetlands with few remaining important attributes and functions.	The use, development and management of these wetlands should be considered in the context of ecologically sustainable development and best management practice catchment planning. Their role in managing the natural hydrological and hydrogeological regime of the general area should be maintained.

No geomorphic wetlands intersect the Site, as shown on Figure 8. The nearest wetland to the Site is Nowergup Lake, which is a CCW situated 200 m west of the Site. Table 8 provides details of mapped wetlands within 2 km of the Site (DBCA-019).

Table 8. Geomorphic Wetlands Mapped adjacent to the Site

UFI	Wetland Name	Current Management Category	Location in relation to the Site
8021	Nowergup Lake	CCW	200 m west
8017	Unknown	REW	310 m south
8009	Carabooda Lake	REW	320 m west
8020	Unknown	REW	500 m west
8018	Unknown	MUW	730 m south
7938	Camel Swamp	REW	1.1 km east
8019	Neerabup Lake	REW	1.4 km south

5.3.4 Public Drinking Water Source Areas

Public Drinking Water Source Areas (PDWSA) are surface water catchments or groundwater aquifers that supply drinking water to towns and cities in Western Australia. In the Metropolitan Area, they are constituted under the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* and the *Country Areas Water Supply Act 1947* (CAWS Act).

As shown on Figure 9, the Site does not intersect any mapped PDWSAs (DWER-033). A Priority 3 PDWSA is located approximately 670 m to the west, and a Priority 1 area is located approximately 750 m to the east.

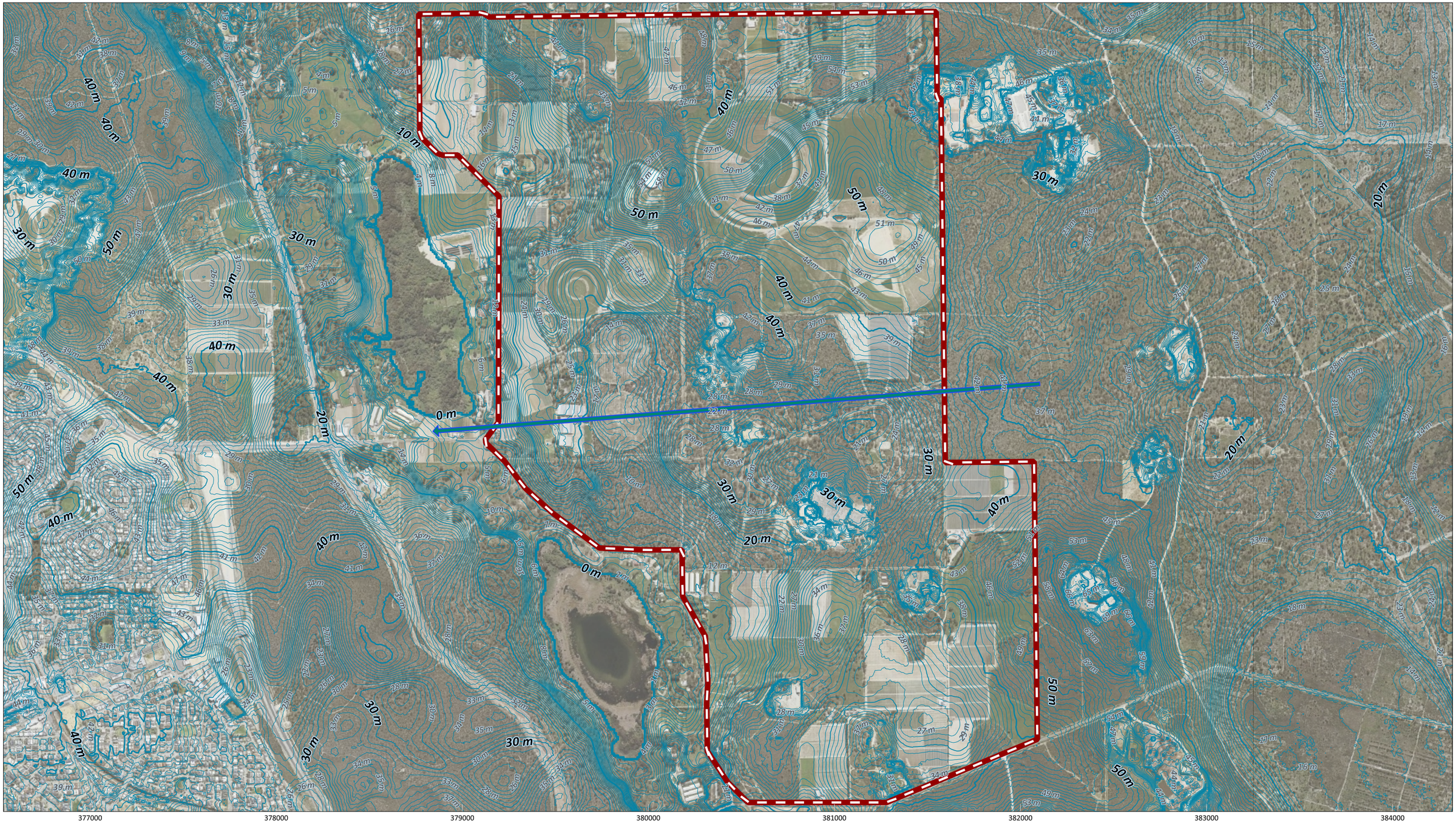


Figure 7: Groundwater Contours

N

0 0.5 1 km

SCALE: 1:20,000	SHEET SIZE: A3 COLOUR
COORDINATE REFERENCE SYSTEM: GDA2020 / MGA zone 50	
DATA SOURCE: LANDGATE AERIAL IMAGERY NOW	

PROJECT/REPORT NAME
Carabooda Urban Precinct District Structure Plan
Multiple lots, Carabooda and Nowergup, WA

CLIENT: Acumen Development Solutions

PROJECT NUMBER	VERSION
A24.019	0
DRAWN BY / REVIEWED BY: JP / HS	DATE: 15/1/2025

Legend

- The Site
- Inferred Regional Groundwater Direction
- Gnangara Jandakot Depth to Groundwater (Contours) – 2019 Min (DWER-095)

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A	Original issue	JP	HS	15/1/2025

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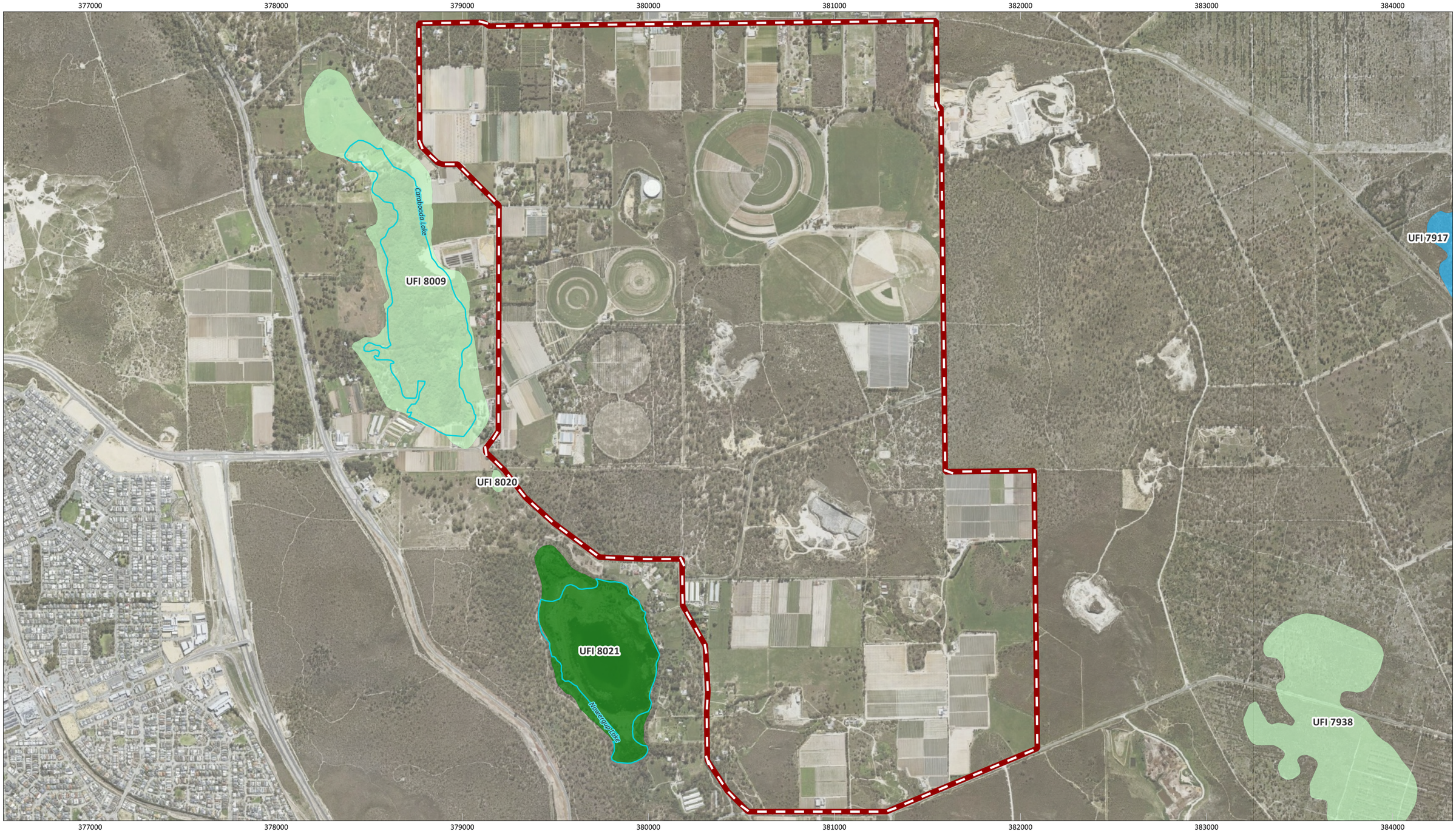


Figure 8: Surface Water Features and Geomorphic Wetlands

N

0 0.5 1 km

SCALE	1:20,000
SHEET SIZE	A3 COLOUR
COORDINATE REFERENCE SYSTEM	GDA2020 / MGA zone 50
DATA SOURCE	LANDGATE AERIAL IMAGERY NOW

PROJECT/REPORT NAME	Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA
CLIENT	Acumen Development Solutions
PROJECT NUMBER	A24.019
VERSION	0
DRAWN BY / REVIEWED BY	JP / HS
DATE	15/1/2025

Legend

- The Site

Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)

- Conservation
- Multiple Use
- Resource Enhancement

Hydrography Linear (Hierarchy) (DWER-031)

- Major Trib

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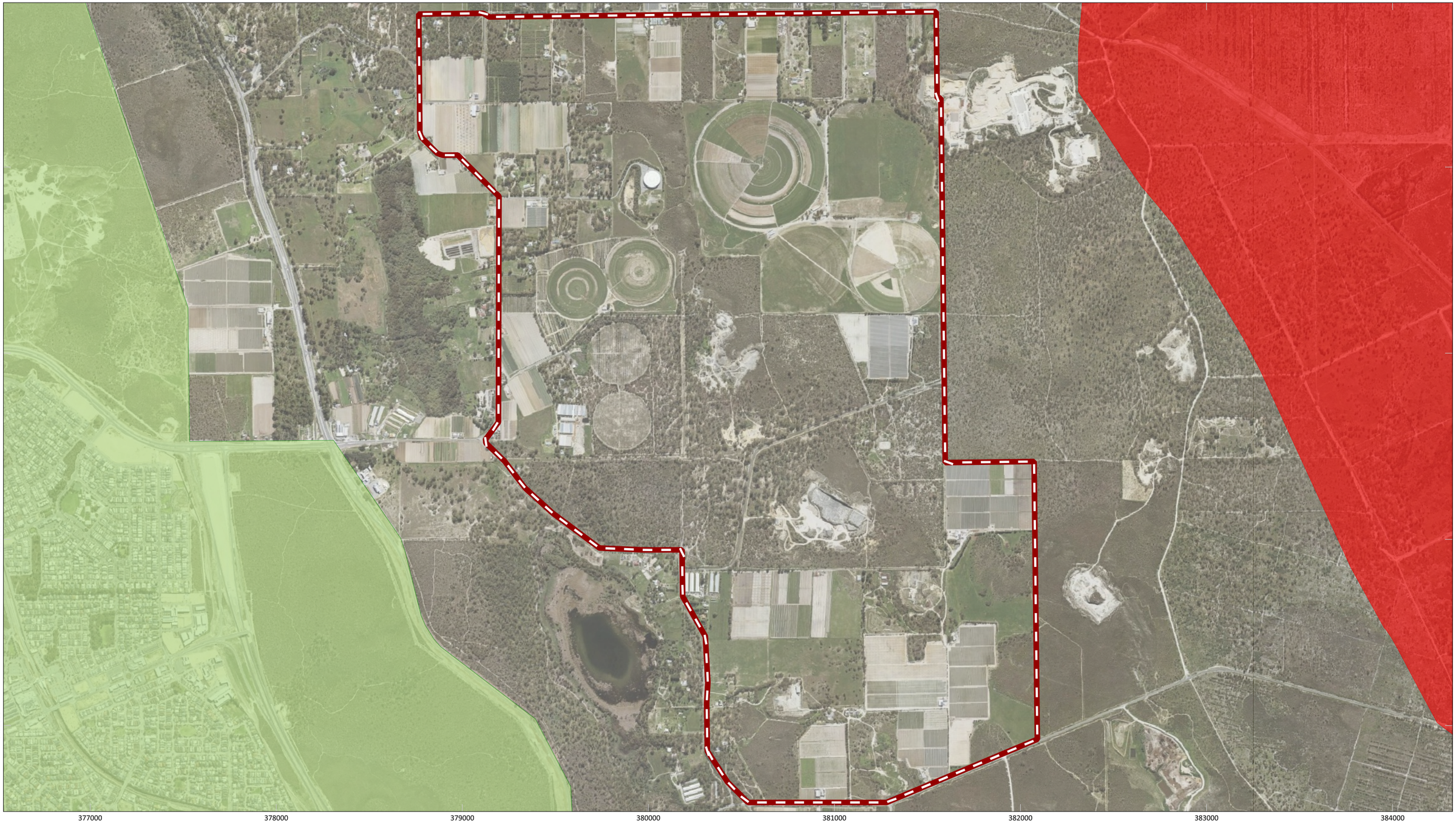


Figure 9: Public Drinking Water Source Areas

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SCALE: 1:20,000	SHEET SIZE: A3 COLOUR	CLIENT: Acumen Development Solutions	
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DATA SOURCE: LANDGATE AERIAL IMAGERY NOW		DRAWN BY / REVIEWED BY: JP / HS	DATE: 15/1/2025

Legend

- The Site
- Public Drinking Water Source Areas (DWER-033)
  - Protection Area-P1
  - Protection Area-P3

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5.4 Flora and Vegetation

5.4.1 Desktop Assessment

Vegetation Associations

State-wide vegetation association mapping at a scale of 1:250,000 in the south west and at a scale of 1:1,000,000 in less-developed areas is maintained in digital form by DPIRD (DPIRD-006). The extents are updated periodically by DBCA, with the last update in 2018 (GoWA, 2018). Three pre-European vegetation associations are mapped within the Site (DPIRD-006) as detailed in Table 9 and shown on Figure 10.

PGV (2024) mapped 333.78 ha of native vegetation within the Site. Of that, 207.57 ha (62.2%) is within the Spearwood 949 association, 121.72 ha (36.5%) is within the Spearwood 998 association, 1.70 ha (0.5%) is within the Spearwood 51 association, and 2.79 ha (0.8%) is within the Spearwood 6 association.

Table 9. Pre-European Vegetation Associations within the Site

Scale	Pre-European Extent (ha)	Current Extent (ha)	Proportion Remaining (%)
Spearwood 949			
State	13,221.96	6,797.43	51.4%
IBRA Region	13,221.96	6,797.43	51.4%
IBRA Subregion	13,221.96	6,797.43	51.4%
LGA	11,385.81	6,224.92	54.7%
Spearwood 998			
State	48,441.77	17,667.16	36.5%
IBRA Region	48,293.94	17,666.85	36.6%
IBRA Subregion	48,293.94	17,666.85	36.6%
LGA	4,635.30	2,787.40	60.1%
Spearwood 6			
State	54,427.13	13,287.64	24.4%
IBRA Region	54,427.13	13,287.64	24.4%
IBRA Subregion	54,427.13	13,287.64	24.4%
LGA	12,662.10	2,777.67	21.9%

Vegetation Complexes

Vegetation complex mapping based on soil, landform, and floristics is managed electronically by DBCA (DBCA-046).

The majority of the Site is mapped as Cottesloe Complex - Central and South, and a small portion in the southwest is mapped as Herdsman Complex (DBCA-046) as shown in Figure 10. PGV (2024) mapped

333.78 ha of native vegetation within the Site. Of that, 317.58 ha (95.1%) is within the Cottesloe Complex - Central and South and 16.2 ha (4.9%) is within the Herdsman Complex.

The estimated pre-European and current extent of each vegetation complex within the Site is provided in Table 10, together with the percentage remaining within conservation reserves and within the City of Wanneroo.

Table 10. Current Extent of Vegetation Complexes within the Site

Scale	Pre-European Extent (ha)	Current Extent (ha)	Proportion Remaining (%)	Proportion Remaining within Conservation Areas (%)
Cottesloe Complex - Central and South				
IBRA Region	45,299.61	14,567.87	32.2%	9.5%
LGA	13,313.58	5,545.39	41.7%	N/A
Herdsman Complex				
IBRA Region	9,665.15	3,103.70	32.1%	10.8%
LGA	1,759.2	843.62	47.95%	N/A

As shown in Table 10, both vegetation complexes are relatively unconstrained at the IBRA scale, with 32.2% and 32.1% remaining for Cottesloe Complex - Central and South and Herdsman Complex, respectively.

Cottesloe Complex Central and South and Herdsman Complex are also well-represented at the local scale, with 41.7% and 47.95% remaining within the City of Wanneroo, respectively. However, both vegetation complexes are under-represented in conservation reserves, with 9.5% and 10.8%, respectively. The complexes and conservation are discussed further in Section 6.

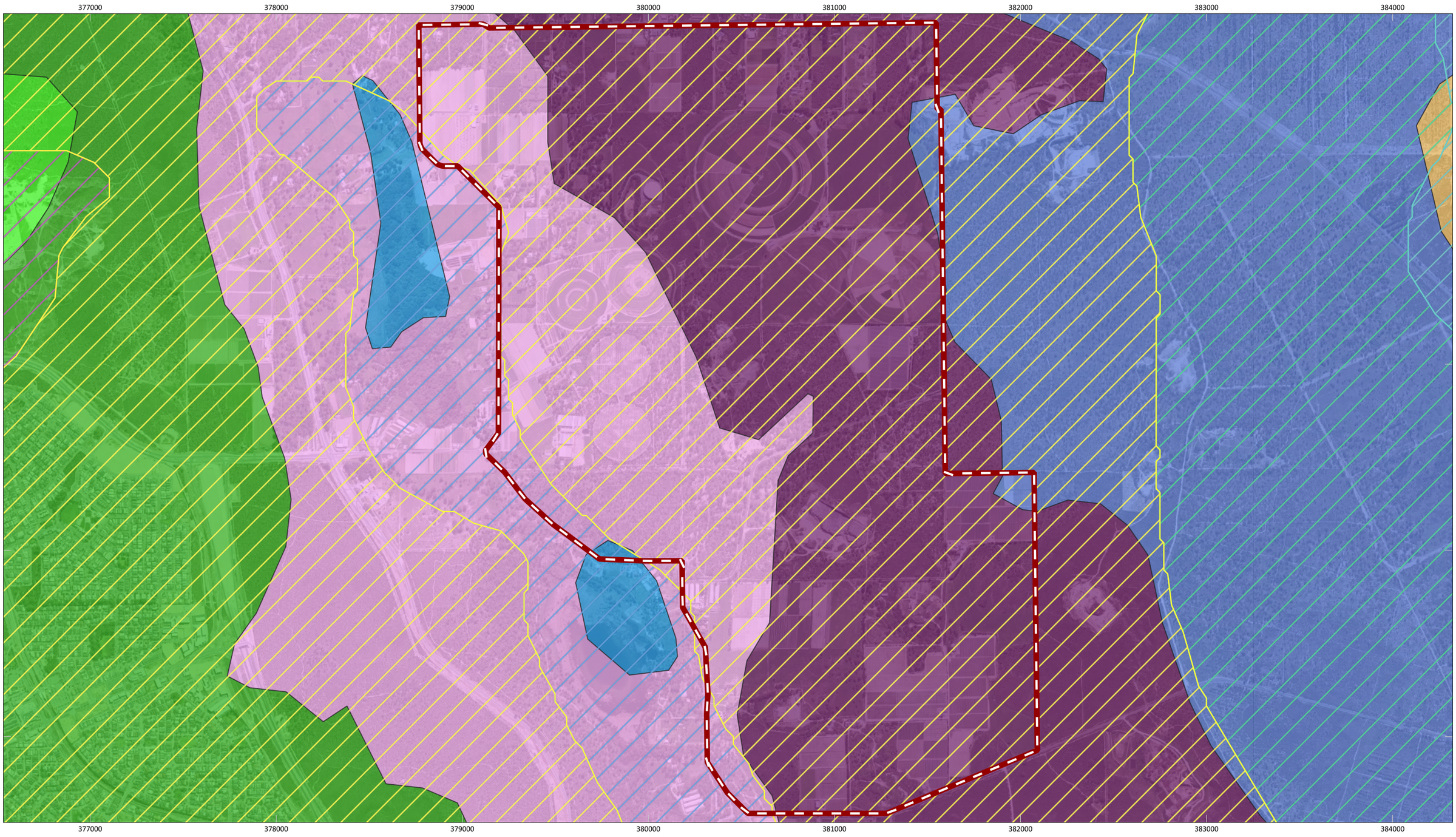


Figure 10: Regional Vegetation Associations and Complexes

N

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SCALE 1:20,000	SHEET SIZE A3 COLOUR	
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50	PROJECT NUMBER A24.019	VERSION 0
DATA SOURCE LANDGATE AERIAL IMAGERY NOW	DRAWN BY / REVIEWED BY JP / HS	DATE 15/1/2025

PROJECT/REPORT NAME
Carabooda Urban Precinct District Structure Plan
Multiple lots, Carabooda and Nowergup, WA

CLIENT
Acumen Development Solutions

Legend

- The Site
- Vegetation Complexes - Swan Coastal Plain (DBCA-046)
  - Cottesloe Complex-Central and South
  - Herdsman Complex
  - Karrakatta Complex-Central and South
  - Pinjar Complex
  - Quindalup Complex
- Pre-European Vegetation (DPIRD-006)
  - BASSENDEAN_51
  - GUILDERTON_1007
  - GUILDERTON_949
  - SPEARWOOD_51
  - SPEARWOOD_6
  - SPEARWOOD_949
  - SPEARWOOD_998

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	15/1/2025

NOTES:

Cadastral boundary from LANDGATE 2022. UFID stands for Unique Identifier

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Conservation Significant Flora

PGV (2024) obtained known records of Threatened and Priority flora species from DBCA for a 10 km radius of the Site, and assessed the likelihood of each occurring within the Site prior to the survey. This search identified 41 flora species, of which 14 are listed as Threatened and 27 as Priority species. Records of two conservation significant flora species occur within the Site itself:

- *Eucalyptus argutifolia* (Vulnerable): six individuals.
- *Stylidium maritimum* (Priority 3): 35 individuals.

Table 11 provides details of conservation significant flora species that were assessed (prior to field surveys) as having the potential to occur within the Site. The table identifies those with a likelihood of at least 'Possible'. The complete assessment is provided in PGV (2024).

Table 11. Threatened and Priority Flora with the Potential to Occur within the Site (PGV,2024)

Species	Common Name	Conservation Status		Habitat Description[2]	Pre-Survey Likelihood of Occurrence
		State	Commonwealth		
***Melaleuca* sp. Wanneroo (G.J. Keighery 16705)**	-	EN	EN	*Melaleuca sp.* Wanneroo occurs in very shallow soil over limestone 'caprock' on ridges.	Possible – potential habitat occurs on the site
Eucalyptus argutifolia	Yanchep Mallee, Wabling Hill Mallee	VU	VU	The Yanchep Mallee occurs in shallow soils over limestone on slopes or gullies of limestone ridges, outcrops.	Highly Likely – habitat occurs on the site and has been previously recorded
***Baeckea* sp. Limestone (N. Gibson & M.N. Lyons 1425)**	-	P1		*Baeckea sp*. Limestone is recorded from limestone outcrop/ridge in yellow sand derived from Tamala Limestone - Spearwood Dune System in bushland burnt 5+ years (Western Australian Herbarium, 2012).	Possible – habitat may occur on the site
Pimelea calcicola	-	P3		*Pimelea calcicola* occurs in sand on coastal limestone ridges.	Possible – habitat likely to occur on the site
Stylidium maritimum	-	P3		*Stylidium maritimum* occurs in sand over limestone on dune slopes and flats in coastal heath and shrubland, open Banksia woodland.	Highly Likely - habitat occurs on the site and has been

[2] Sourced from Florabase as well as DBCA database searches, unless otherwise denoted (PGV, 2024).

Species	Common Name	Conservation Status		Habitat Description[2]	Pre-Survey Likelihood of Occurrence
		State	Commonwealth		
					previously recorded
Jacksonia sericea	Waldjumi	P4		Waldjumi grows in calcareous and sandy soils.	Possible – habitat may occur on the site

Conservation Significant Ecological Communities

PGV (2024) obtained known records of Threatened and Priority ecological communities from DBCA for a 10 km radius of the Site, and assessed the likelihood of each occurring within the Site prior to the survey. This search identified five Threatened Ecological Communities (TECs) and seven Priority Ecological Communities (PECs) listed at State level under the BC Act and by DBCA, respectively. The search returned occurrences of six TECs listed at Commonwealth level under the EPBC Act.

Table 12 provides details of conservation significant ecological communities that have been recorded within 10 km of the Site, together with the distance from the Site to the closest known occurrence.

Table 12. Threatened and Priority Ecological Communities identified within 10 km of the Site (PGV, 2024)

Ecological Community (State)	Conservation Status (State)	Ecological Community (Commonwealth)	Conservation Status (Commonwealth)	Proximity to Site
Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain	Critically Endangered	Aquatic Root Mat Community in Caves of the Swan Coastal Plain	Endangered	5 km buffer of a known occurrence intersects the Site.
Woodlands over sedgelands in Holocene dune swales of the southern Swan Coastal Plain (floristic community type 19 as originally described in Gibson et al. 1994)	Critically Endangered	Sedgelands in Holocene dune swales of the southern Swan Coastal Plain (Endangered)	Endangered	Known occurrence (edge of 2 km buffer) is 2.7 km from Site.
Shrublands on dry clay flats (floristic community type 10a as originally described in Gibson et al. 1994)	Endangered	Component of 'Clay Pans of the Swan Coastal Plain' (Critically endangered)	Critically Endangered	Known occurrence (edge of 500 m buffer) is 4 km from Site.
***Melaleuca huegelii* – *M. systena* shrublands of limestone ridges (floristic community type 26a as originally**	Critically Endangered	Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain (Critically Endangered, different to the State	Critically Endangered	500 m buffer of a known occurrence intersects the Site.

Ecological Community (State)	Conservation Status (State)	Ecological Community (Commonwealth)	Conservation Status (Commonwealth)	Proximity to Site
described in Gibson et al. 1994)		listing in terms of TEC composition)		
***Banksia attenuata* woodlands over species rich dense shrublands (floristic community type 20a as originally described in Gibson et al. 1994)**	Critically Endangered	Commonly a component of 'Banksia Woodlands of the Swan Coastal Plain ecological community' (Endangered)	Endangered as part of the Banksia WL SCP	Known occurrence (edge of 500 m buffer) is 5 km from Site.
***Banksia ilicifolia* woodlands, southern Swan Coastal Plain ('floristic community type 22')**	Priority 3	Commonly a component of 'Banksia Woodlands of the Swan Coastal Plain ecological community' (Endangered)	Endangered as part of the Banksia WL SCP	Known occurrence (edge of 200 m buffer) is 5 km from Site.
Swan Coastal Plain *Banksia attenuata* - *Banksia menziesii* woodlands ('floristic community type 23b')	Priority 3	Commonly a component of 'Banksia Woodlands of the Swan Coastal Plain ecological community' (Endangered)	Endangered	Known occurrence (edge of 500 m buffer) is 4 km from Site.
Northern Spearwood shrublands and woodlands ('floristic community type 24')	Priority 3	Commonly a component of 'Banksia Woodlands of the Swan Coastal Plain ecological community' (Endangered)	Endangered	500 m buffer of a known occurrence intersects the Site.
Quindalup *Eucalyptus gomphocephala* and / or *Agonis flexuosa* woodlands ('floristic community type 30b')	Priority 3	Can form a component of the Tuart woodlands and forests of the Swan Coastal Plain EPBC listed TEC	Critically Endangered	Known occurrence (edge of 500 m buffer) is 4 km from Site.
Acacia shrublands on taller dunes, southern Swan Coastal Plain ('floristic community type 29b')	Priority 3	N/A	N/A	Known occurrence (edge of 500 m buffer) is 6.5 km from Site.
Banksia Woodlands of the Swan Coastal Plain	Priority 3	Banksia Woodlands of the Swan Coastal Plain	Endangered	Known occurrence (edge of 200 m buffer) is 500 m from Site.
Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain)	Priority 3	Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain)	Critically Endangered	500 m buffer of a known occurrence intersects the Site.

5.4.2 Site Surveys

Survey Details

A number of ecological surveys have been undertaken within the Site, as detailed in Table 13.

Table 13. Description of Flora and Vegetation Surveys undertaken within the Site

Survey Title	Survey Type	Survey Area Coverage
Level 1 Fauna and Targeted Black-Cockatoo Assessment, Carabooda 'Urban Investigation Boundary' (Bamford Consulting Ecologists, 2024)	Black-cockatoo habitat assessment and Basic fauna assessment.	DSP boundary.
Carabooda Rezoning Project: Flora and Vegetation Survey - Version 3 (PGV Environmental, 2024)	Detailed flora and vegetation survey	DSP boundary.
The Carabooda Rezoning Project: Flora and Vegetation Survey (PGV Environmental, 2023)	Detailed flora and vegetation survey	Carabooda Landholders Group (659 ha)
Nowergup Strawberry Farm McLennan Drive Nowergup (MBS Environmental, 2017)	Detailed flora and vegetation survey	Strawberry farm at 235 McLennan Drive, Nowergup.
Flora and Vegetation Survey - Lot 105 & 107 McLennan Drive, Nowergup (PGV Environmental, 2014)	Detailed flora and vegetation survey	Lot 105 & 107 McLennan Drive.
Preliminary Environmental Assessment (EnviroWorks, 2014)	Environmental Assessment	Lots 105 & 107 McLennan Drive

Vegetation Units

There is approximately 333.78 ha of remnant native vegetation within the Site. PGV (2024) identified 13 discrete vegetation units within the Site, as detailed in Table 14 and shown in Figure 11. The complete survey report is provided as Appendix B.

Table 14 Vegetation Types Described within the Site

Vegetation Type	Description	Area (ha)	% of Site	% of native vegetation
MhMs	This vegetation type occurs on the top of several limestone ridges in the northern half of the site. Melaleuca huegelii and M. systena are dense and around 2-2.5m high. Common understorey species include Grevillea preissii, Austrostipa flavescens, Banksia dallanneyi, Trymalium ledifolium, Diplopeltis huegelii and Desmocladus flexuosus. The soils are shallow orange-brown sand with extensive outcropping limestone.	12.09	1.2	3.6
MhBs	Similar to the MhMs vegetation type but with Banksia sessilis (Parrot Bush) common. Occurs at the eastern end of the quarry on Lot 104 McLennan Drive and a small area on Lot 13 Wesco Road. Typical understorey species include Lepidosperma calcicola, Hakea lissocarpha, Hakea trifurcata, Trymalium ledifolium, Grevillea preissii and Desmocladus flexuosus. The soils are orange-brown sand with abundant surface limestone.	2.37	0.2	0.7
Bs	The most common vegetation type on the site, occurring on the lower to mid-slopes of limestone ridges where the depth of sand is deeper than in the MhMs and MhBs units. Banksia sessilis is 1-2m high and sparse to moderately dense at 5-25% cover. Common species include Hibbertia hypericoides, Xanthorrhoea preissii, Templetonia retusa, Melaleuca systena, Calothamnus quadrifidus, Petrophile serruriae, Mesomelaena pseudostygia and Homalosciadium homalocarpum. The soils are orange-brown sand with some surface limestone.	70.56	7.2	21.1
EdBs	Very similar to the Bs vegetation type but with Eucalyptus gomphocephala (Tuart) present as a tree up to 15m high and relatively low density. Common understorey species include Banksia sessilis, Acacia pulchella, Hakea trifurcata, Mesomelaena pseudostygia and Hibbertia hypericoides. The soils are orange-brown sand with some surface limestone.	24.45	2.5	7.3
EgBs	Very similar to the Bs vegetation type but with Eucalyptus gomphocephala (Tuart) present as a tree up to 15m high and relatively low density. Common understorey species include Banksia sessilis, Acacia pulchella, Hakea trifurcata, Mesomelaena pseudostygia and Hibbertia hypericoides. The soils are orange-brown sand with some surface limestone.	30.09	3.1	9.0
AfBs	One stand of this vegetation type occurs at the northwestern end of the site. It is the only area where	1.22	0.1	0.4

Vegetation Type	Description	Area (ha)	% of Site	% of native vegetation
	Allocasuarina fraseriana (Sheoak) occurs with few other tree species. Jacksonia sternbergiana is a common tall shrub species which indicates some disturbance in the past. Other common species include Xanthorrhoea preissii, Banksia sessilis, Hibbertia hypericoides and a variety of weed species. The soils are yellow-grey sand			
Et	This vegetation type occurs at the southern end of the site on Lot 11 Wesco Road and occurs in a disturbed area that has been partially cleared. Eucalyptus todtiana and Nuytsia floribunda (WA Christmas Tree) are 5-6m high and 5-10% cover. Most of the understorey consists of weeds but Hibbertia hypericoides and Xanthorrhoea preissii are reasonably common. The soils are yellow-brown sand.	5.22	0.5	1.6
EtBaBm	This vegetation type occurs on deep sand and in large patches in the central part of the site. Eucalyptus todtiana is the main tree species present, up to 4m high. Banksia attenuata and B. menziesii are co-dominant with around 5-10% cover. Common understorey species include Xanthorrhoea preissii, Hibbertia hypericoides, Daviesia divaricata, Eremaea pauciflora, Mesomelaena pseudostygia, Bossiaea eriocarpa and Burchardia congesta. The soils are yellow-brown sand.	36.66	3.7	11.0
BaBmEt	Similar to the EtBaBm vegetation type but with fewer E. todtiana trees. The understorey is also slightly different with Allocasuarina humilis a common species as well as Hibbertia hypericoides, Calothamnus quadrifidus and Mesomelaena pseudostygia. Occurs in the central and northeastern parts of the site on deep sands. The soils are light orange-brown sand.	17.38	1.8	5.2
Em	Occurs on lower areas in the central part of the site. Most of the areas mapped have a very weedy understorey. The Eucalyptus marginata (Jarrah) trees have mostly been coppiced with few to no old, mature single stem trees. Xanthorrhoea preissii and Hibbertia hypericoides are the most common native understorey species while the most common weed species is Perennial Veldtgrass (Ehrharta calycina). The soils are dark brown sand.	23.15	2.4	6.9
Eg	Occurs on the lower slopes, mostly in the central part of the site. Eucalyptus gomphocephala (Tuart) is up to 25m high and moderately dense (15-25% cover). Typical understorey species include Xanthorrhoea preissii, Mesomelaena pseudostygia, Phyllanthus calycinus, Hakea lissocarpha and Desmocladus flexuosus. The soils are orange-brown sand with some surface limestone.	21.42	2.2	6.4

Vegetation Type	Description	Area (ha)	% of Site	% of native vegetation
EgEm	This is an extensive vegetation type that occurs on the western side of the site on lower elevation land. The condition of the understorey ranges from Degraded to very Good. Perennial Veldtgrass the dominant weed species. Xanthorrhoea preissii and Hibbertia hypericoides are the main native species. The soils are orange-brown sand.	64.93	6.6	19.5
CcEm	Two areas containing Marri (Corymbia calophylla) mixed with Jarrah were recorded on the site, in the central western area. The vegetation ranges from Degraded to Completely Degraded condition up to Very Good on Lot 201. Perennial Veldtgrass dominates the Degraded and Completely Degraded areas. Xanthorrhoea preissii, Hibbertia hypericoides and Mesomelaena pseudostygia are the common native species. The soils are dark brown sand.	24.25	2.5	7.3
Total native vegetation		333.78	34.1	100.0
Unmapped (primarily road reserves)[3]		19.83	2.0	
Cleared		625.38	63.9	-
Grand total		979	100.0	-

[3] No flora, vegetation or fauna habitat assessments have been undertaken for 19.83 ha of the Site. These areas are associated with road reserves necessary to access the DSP. It is assumed that no vegetation clearing will be undertaken within these areas.

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Figure 11: Vegetation Units

N

0 200 400 m

PROJECT/REPORT NAME: Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA		
SCALE: 1:13,000	SHEET SIZE: A3 COLOUR	CLIENT: Acumen Development Solutions
COORDINATE REFERENCE SYSTEM: GDA2020 / MGA zone 50	PROJECT NUMBER: A24.019	VERSION: 0
DATA SOURCE: LANDGATE AERIAL IMAGERY NOW	DRAWN BY / REVIEWED BY: JP / HS	DATE: 21/7/2026

Legend

The Site

Vegetation
- AfBs
- BaBmEt
- Bs
- CcEm
- cleared
- EdBs
- Eg
- EgBs
- EgEm
- Em
- Et
- EtBaBm
- MhBs
- MhMs

Proposed District Structure Plan
- Residential
- Centre
- Water Authority of WA
- School Site
- Conservation
- Potential Clearing Permit and BRM Extraction
- Integrator A / Integrator B / Neighbourhood Connector A
- Local Open Space for Conservation
- District Open Space

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	21/7/2026

NOTES:

Cadastral boundary (LGATE-002). Label corresponds to the vegetation association number.

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Vegetation Condition

Native vegetation condition within the Site ranges from Completely Degraded to Excellent. The majority (65.2%) of the Site is in a cleared state (includes some parkland cleared vegetation in a completely degraded state). The majority of mapped native vegetation (217.94 ha; 65.3%) is in Good or better condition. This includes 14.40 ha reported to be in Good to Degraded condition.

A breakdown of vegetation condition within the Site is provided in Table 15, and shown on Figure 12.

Table 15 Vegetation Condition within the Site

Vegetation Condition	Description	Area (ha)	% of Site	% of native vegetation
Native vegetation				
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.	46.97	4.8	14.1
Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	112.85	11.5	33.8
Good to Very Good	-	13.69	1.4	4.1
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate to it.	30.12	3.1	9.0
Degraded to Good	-	14.41	1.5	4.3
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.	79.35	8.1	23.8
Completely Degraded	The structure of the vegetation is no longer intact, and the area is completely or almost completely without native species. These are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.	36.53	3.7	10.9
Total native vegetation		333.78[4]	34.1	100

[4] This is the total mapped area of native vegetation. There is a minor discrepancy between this value and the sum of native vegetation categories shown in the table due to rounding of values presented in the table.

Vegetation Condition	Description	Area (ha)	% of Site	% of native vegetation
Unmapped (primarily road reserves)[5]		19.83	2.0	
Cleared areas				
Cleared		625.38	63.9%	N/A
Grand total		979	100%	N/A

[5] 'No flora, vegetation or fauna habitat assessments have been undertaken for 19.83 ha of the Site. These areas are associated with road reserves necessary to access the DSP. It is assumed that no vegetation clearing will be undertaken within these areas.

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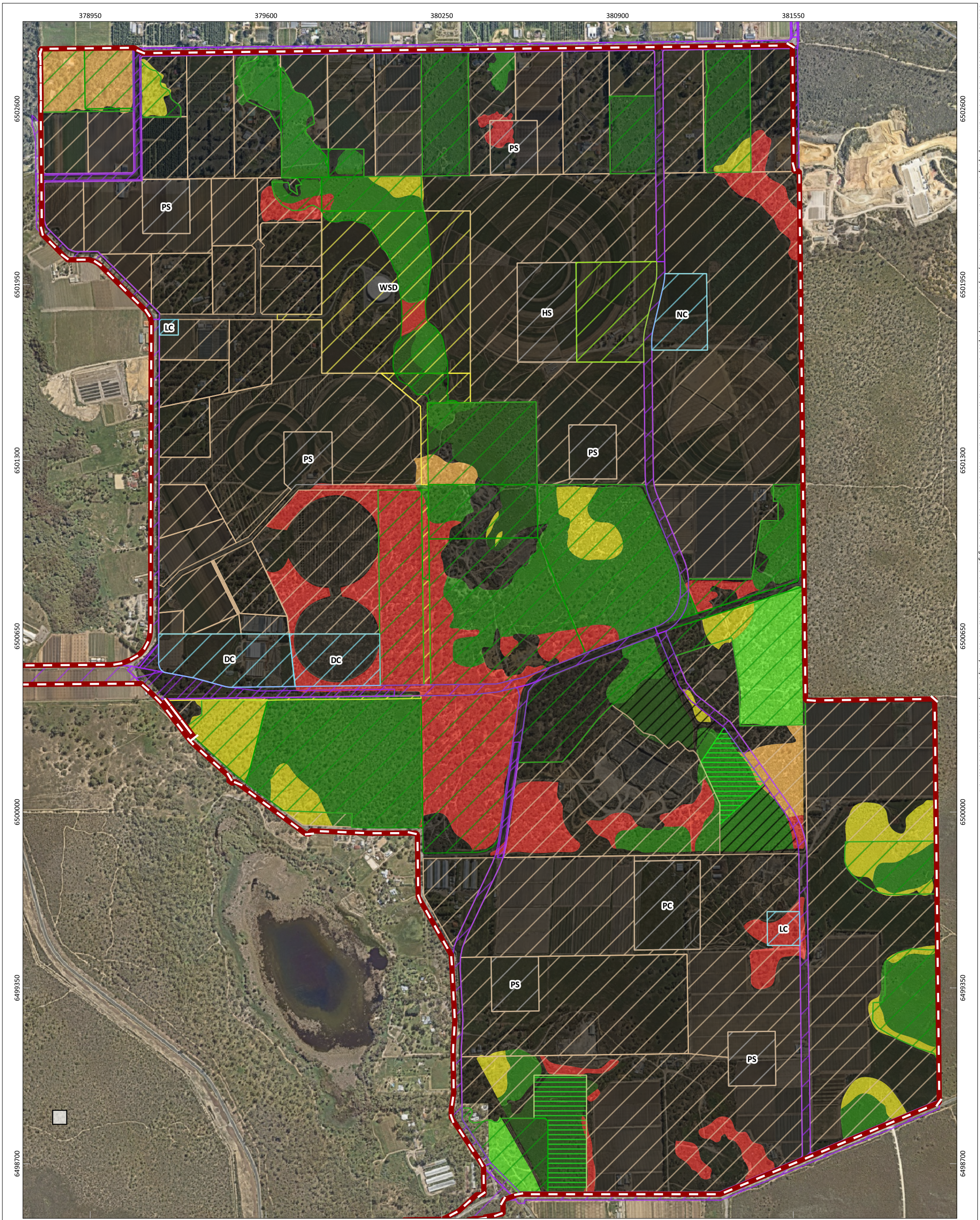


Figure 12: Vegetation Condition

N

0 200 400 m

SCALE 1:13,000	SHEET SIZE A3 COLOUR	CLIENT Acumen Development Solutions	
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50		PROJECT A24.019	VERSION 0
DATA SOURCE LANDGATE AERIAL IMAGERY NOW		DRAWN BY / REVIEWED BY JP / HS	DATE 21/7/2026

PROJECT/REPORT NAME

Carabooda Urban Precinct District Structure Plan
Multiple lots, Carabooda and Nowergup, WA

Legend

The Site

Vegetation Condition
- Excellent
- Very Good
- Good-Very Good
- Good
- Good-Degraded
- Degraded
- Completely Degraded

Proposed District Structure Plan
- Residential
- Centre
- Water Authority of WA
- School Site
- Conservation
- Potential Clearing Permit and BRM Extraction
- Integrator A / Integrator B / Neighbourhood Connector A
- Roads
- Local Open Space for Conservation
- District Open Space

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	21/7/2026

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Conservation Significant Flora

A total of 230 plant species were recorded during the flora survey, of which 175 were native and 55 were introduced species. As identified in the previous section, *Eucalyptus argutifolia* (Vulnerable) and *Stylidium maritimum* (Priority 3) were already known to occur within the Site, within Lot 50 Greenlees Way and Lot 121 Carabooda Road, respectively. Records of conservation significant flora identified during the survey, including those populations already known to DBCA, are detailed in Table 16.

Table 16. Records of Threatened and Priority Flora within the Site

Species	Conservation Status		Number and Location
	Commonwealth	State	
Eucalyptus argutifolia	Vulnerable	Vulnerable	Six plants (Lot 50 Greenlees Way) - previously known population.
Pimelea calcicola	N/A	Priority 3	Two small populations (Lot 104 McLennan Drive and Lot 121 Carabooda Road).
Stylidum maritimum	N/A	Priority 3	One population (Lot 121 Carabooda Road) - previously known population.
Eucalyptus foecunda* subsp. *foecunda	N/A	Priority 3	Two plants (Lot 104 McLennan Drive).

Locations of conservation significant flora within the Site are shown in Figure 13.

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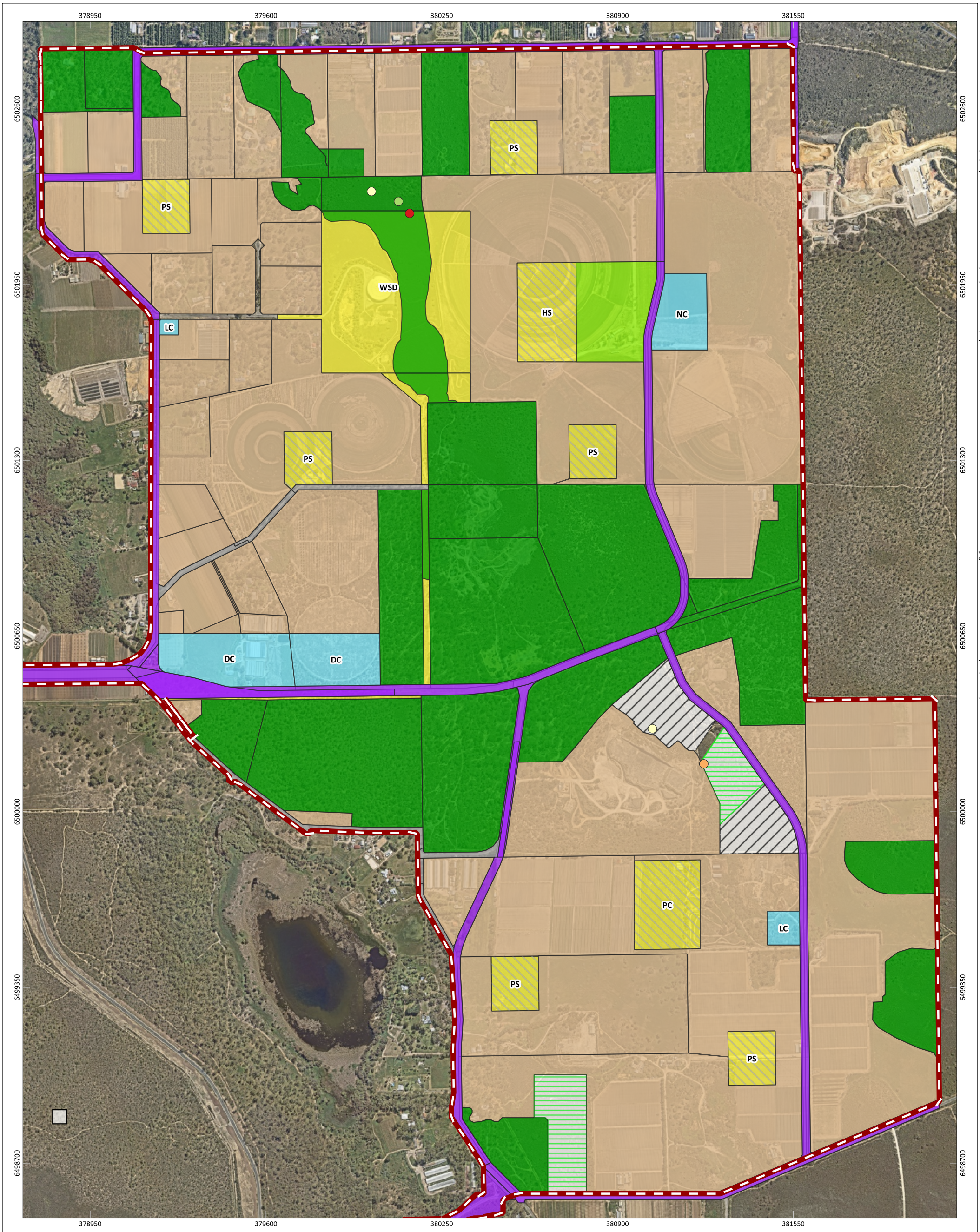


Figure 13: Conservation Significant Flora within the Site

0 200 400 m

N

SCALE 1:13,000	SHEET SIZE A3 COLOUR	CLIENT Acumen Development Solutions	
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50		PROJECT A24.019	VERSION 0
DATA SOURCE LANDGATE AERIAL IMAGERY NOW		DRAWN BY / REVIEWED BY JP / HS	DATE 21/7/2026

PROJECT/REPORT NAME

Carabooda Urban Precinct District Structure Plan
Multiple lots, Carabooda and Nowergup, WA

Legend

- The Site

Proposed District Structure Plan

- Residential
- Centre
- Water Authority of WA
- School Site
- Conservation
- Potential Clearing Permit and BRM Extraction
- Integrator A / Integrator B / Neighbourhood Connector A
- Roads
- Local Open Space for Conservation
- District Open Space

Conservation Significant Flora

- Eucalyptus argutifolia (T)
- Eucalyptus foecunda subsp. foecunda (P4)
- Pimelea calcicola (P3)
- Stylidium maritimum (P3)

No	Description	Drawn	Approved	Date
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NOTES:

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Conservation Significant Ecological Communities

Floristic Community Types

Plantecology were comissioned by PGV (2024) to undertake statistical analyses to determine whether any Floristic Community Types (FCT) occur within the Site. The analysis included quadrats containing vegetation in Excellent and Very Good condition.

The analysis indicated that the vegetation types that occur on shallow sand over limestone soils are FCT 24, vegetation on deeper sands is more typical of FCT 28, and that vegetation containing *Melaleuca huegelii* is most likely FCT 26a. A summary of FCTs considered to occur within the Site is presented in Table 17, and further information is available in section 4.3.3 of Appendix D. Table 17 also identifies any relationships between FCTs within the Site and TEC or PECs.

Table 17. Floristic Community Types Identified within the Site

FCT	Description	Vegetation Types and Quadrats	Relationship to Threatened or Priority Ecological Communities
FCT 24	Northern Spearwood shrublands and woodlands	MhBs (CB44, C13) Bs (C15) EdBs (C1, CB45) Eg (C22)	FCT 24 is a PEC at State level, listed as Priority 3 by DBCA. FCT 24 also has a relationship with the Banksia Woodlands of the Swan Coastal Plain ecological community which is listed as Endangered at Commonwealth level and Priority 3 by DBCA.
FCT 28	Spearwood Banksia attenuata or Banksia attenuata - Eucalyptus woodlands	BaBmEt (C25, C31)	FCT 28 has a relationship with the Banksia Woodlands of the Swan Coastal Plain ecological community, listed as Priority 3 by DBCA and as Endangered under the EPBC Act.
FCT 26a	Melaleuca huegelii - Melaleuca systena shrublands on limestone ridges	MhMs (C30, C33)	FCT 26a is a Critically Endangered TEC listed under BC Act. FCT 26a also meets the definition of Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion, which is a Critically Endangered TEC at Commonwealth level.

Threatened and Priority Ecological Communities

PGV (2024) recorded three TEC/PECs within the Site, which are:

- Banksia woodlands of the Swan Coastal Plain ecological community (Commonwealth-listed Endangered TEC; State-listed Priority 3 PEC) (hereafter referred to as 'Banksia TEC/PEC').
- Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain ecological community (Commonwealth-listed Critically Endangered TEC; State-listed Priority 3 PEC) (hereafter referred to as 'Tuart TEC/PEC').
- Honeymyrtle shrublands on limestone ridges of the Swan Coastal Plain ecological community (Commonwealth-listed Critically Endangered TEC) which is identified as *Melaleuca huegelii* -

Melaleuca systena shrublands on limestone ridges (FCT 26a) (State-listed Critically Endangered) (hereafter collectively referred to as 'Honeymyrtle shrubland TEC').

The extent of each TEC/PEC recorded within the Site is provided in Table 18. Retention and impacts to each community are discussed in Section 6.

Table 18. Extent of Threatened Ecological Communities within the Site

Threatened Ecological Community	Area (ha)
Banksia TEC/PEC	45.01
Tuart TEC/PEC	112.85
Honeymyrtle Shrubland TEC	12.09

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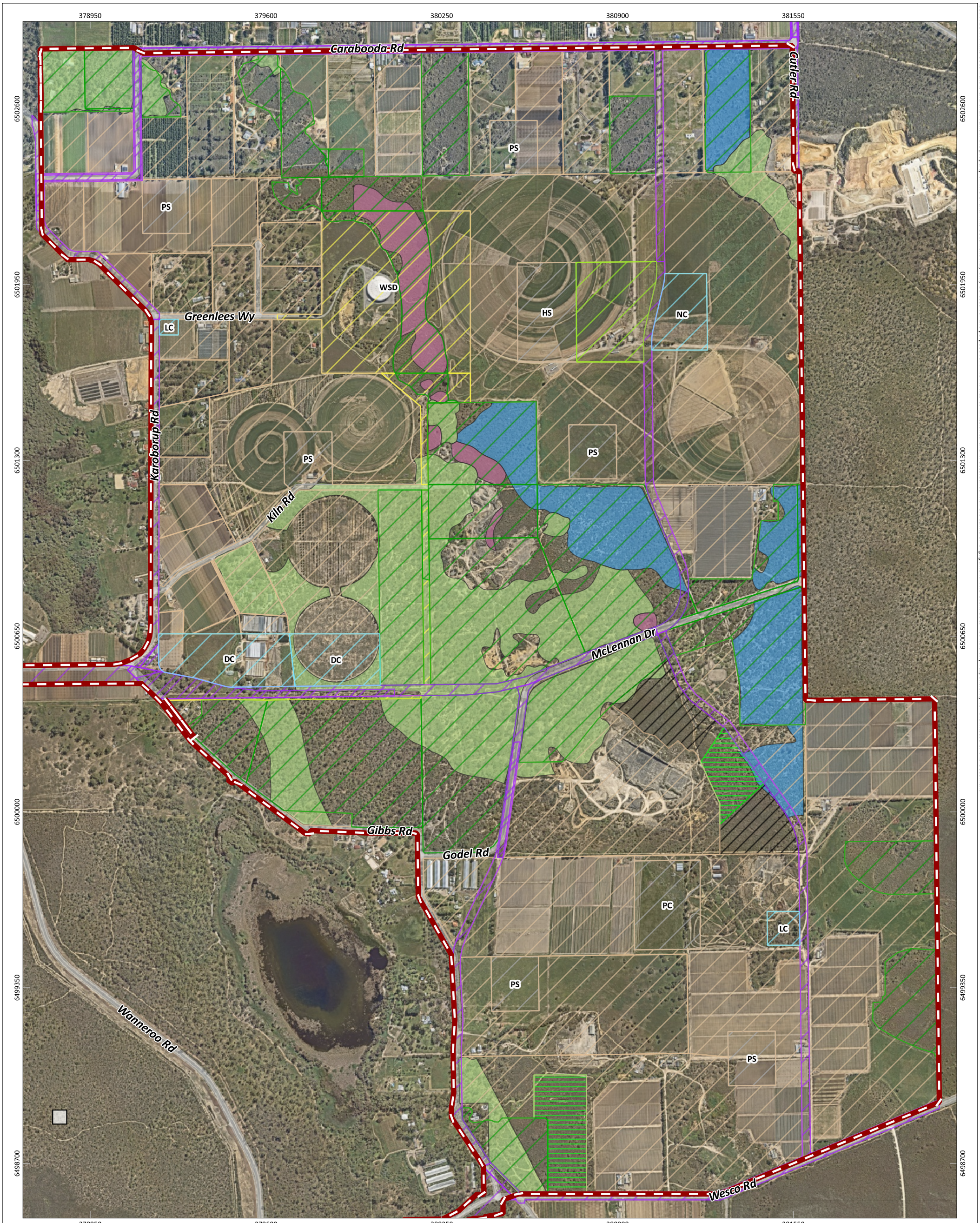


Figure 14: Conservation Significant Ecological Communities within the Site

N

0 200 400 m

SCALE 1:13,000	SHEET SIZE A3 COLOUR	
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50	PROJECT A24.019	VERSION 0
DATA SOURCE LANDGATE AERIAL IMAGERY NOW	DRAWN BY / REVIEWED BY JP / HS	DATE

PROJECT/REPORT NAME

Carabooda Urban Precinct District Structure Plan
Multiple lots, Carabooda and Nowergup, WA

CLIENT

Acumen Development Solutions

Legend

- The Site

Proposed District Structure Plan

- Residential
- Centre
- Water Authority of WA
- School Site
- Conservation
- Potential Clearing Permit & BRM Extraction
- Integrator A, B, Nbhd Connector A
- Roads
- Local Open Space for Conservation
- District Open Space

Conservation Significant Ecological Communities

- Banksia woodlands of the Swan Coastal Plain (Cwlth TEC: EN; State PEC: P3)
- Tuart woodlands and forests of the Swan Coastal Plain (Cwlth TEC: CR; State PEC: P3)
- Honeymyrtle shrublands on limestone ridges of the Swan Coastal Plain (Cwlth TEC: CR); Melaleuca huegelii – M. systena shrublands on limestone ridges (FCT 26a) (State TEC: CR)

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	21/7/2026

NOTES:

Cadastral boundary (LGATE-002). Label corresponds to the vegetation association number.

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5.5 Terrestrial Fauna

5.5.1 Desktop Assessment

A desktop assessment undertaken by BCE (2024) identified 222 vertebrate fauna species as potentially occurring within the Site, including nine frogs, 52 reptiles, 139 birds, 17 native mammals, and five introduced mammals.

Table 19 identifies fauna species with the potential to utilise the Site that are of conservation significance, as assessed by BCE (2024). The complete assessment is provided in Appendix C.

Table 19. Conservation Significant Fauna Species Expected to Occur within the Site

Latin Name	Common Name	Expected Occurrence	Conservation Status	
			State	Commonwealth
REPTILES				
Ctenotus gemmula	Jewelled Sandplain Ctenotus	Resident	Priority 3	-
Neelaps calonotos	Black-striped Burrowing Snake	Resident	Priority 3	-
BIRDS				
Apus pacificus	Fork-tailed Swift	Irregular visitor	Migratory	Migratory
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo, Karrak	Regular visitor	Vulnerable	Vulnerable
Falco peregrinus	Peregrine Falcon	Regular visitor	Other Specially Protected	-
Plegadis falcinellus	Glossy Ibis	Vagrant	Migratory	Migratory
Tyto novaehollandiae novaehollandiae	Southern Masked Owl	Vagrant	Priority 3	-
Zanda baudinii	Baudin's Black-Cockatoo	Vagrant	Endangered	Endangered
Zanda latirostris	Carnaby's Black-Cockatoo	Regular visitor	Endangered	Endangered
MAMMALS				
Dasyurus geoffroii	Chuditch	Vagrant	Vulnerable	Vulnerable
Hydromys chrysogaster	Water-rat, Rakali	Irregular visitor	Priority 4	-
Isoodon fusciventer	Quenda	Resident	Priority 4	-
Notamacropus irma	Brush Wallaby	Regular visitor	Priority 4	-
Phascogale tapoatafa wambenger	South-western Brush-tailed Phascogale	Irregular visitor	Conservation Dependent	-

5.5.2 Site Surveys

Survey Details

Fauna surveys undertaken within the Site are detailed in Table 20.

Table 20. Fauna Surveys Undertaken within the Site

Survey Title	Survey Type	Survey Area Coverage
Level 1 Fauna and Targeted Black-Cockatoo Assessment, Carabooda 'Urban Investigation Boundary' (2024)	Black-cockatoo habitat assessment and Basic fauna assessment	DSP area.

Vegetation Substrate Associations

Seven vegetation and substrate associations (VSAs) were identified by Bamford Consulting Ecologists during a Level 1 fauna survey (BCE, 2024) as shown on Figure 15. The complete survey report is provided as Appendix C. A description of each VSA is provided in Table 21, together with the extent each occupies within the Site.

Table 21. Vegetation Substrate Associations within the Site (BCE, 2024)

Vegetation Substrate Association	Description	Area (ha) within Site	% of Site
VSA 1: Tuart Open Woodland.	Open eucalypt woodland of tuart and jarrah. Occasional grass trees and thickets of *Acacia pulchella* and *Banksia sessilis*, over mostly veldt grass ground cover on orange-brown sands. Heavily disturbed in some areas. Consistent with VTs Eg, EgBs, and EgEm (PGV, 2024).	116.44	11.9
VSA 2. Banksia Woodland	Open woodland dominated by *B. sessilis* and *B. attenuata* with some *Dwutta (Eucalyptus todtiana), Sheoak (Allocasuarina fraseriana), Moodjar (Nuytsia floribunda)* and/or *Melaleuca sp.* over shrub layer and mostly native ground cover, on yellow-brown sands. Some degraded areas. In Lot 11 Wesco Rd, there is a small area classified as VSA 2 where the banksia trees have been removed, leaving only *Dwutta* and *Moodjar*. Consistent with VTs BaBmEt, EtBaBm, and Et (PGV, 2024).	59.26	6.1
VSA 3. Banksia Thicket.	Closed shrubland of *Banksia sessilis* with grass trees on orange-brown sands and surface limestone. In one small area in the north of the project area, this VSA contains *Sheoak (Allocasuarina fraseriana)* and	74.15	7.6

Vegetation Substrate Association	Description	Area (ha) within Site	% of Site
	appears to have been subject to historical disturbance (PGV, 2023). Consistent with VTs AfBs, Bs, and MhBs (PGV, 2024).		
VSA 4. Jarrah Woodland.	Closed woodland/forest of immature jarrah, with some areas including marri as co-dominant, over *Balga* and *Veldt Grass* on brown sands. Most of the understorey and ground cover is degraded. Consistent with VTs CcEm and Em (PGV, 2024).	47.40	4.8
VSA 5. Melaleuca Heath and Scrub.	Dense *Melaleuca scrub* with occasional *Banksia dallanneyi* on orange-brown sands and limestone outcropping. Consistent with VT MhMs (PGV, 2024).	12.09	1.2
VSA 6. Redheart Woodland.	Occasional redheart/limestone marlock (*Eucalyptus decipiens*) over understorey of *Banksia sessilis* and *Balga* over brown sands and limestone outcropping. Consistent with VT EdBs (PGV, 2024).	24.45	2.5
VSA 7. Parkland Cleared	Consists of parkland-cleared land where understorey and midstorey are absent but substantial numbers of large trees remain (e.g. gardens along the northern boundary and in the north-eastern portion of the Site). Tree species vary and may be remnant or planted, but include native eucalypts ad important foraging species such as Pine (e.g. along northern boundary).	73.46	7.5
VSA 7. Cleared/Disturbed Land.	Heavily disturbed or cleared/developed areas, sometimes with isolated trees or patches of planted trees or shrubs. Approximately 100 ha of this VSA consists of parkland-cleared land where understorey and midstorey are absent but substantial numbers of large trees remain (e.g. gardens along the northern boundary and in the north-eastern portion of the Site). Consistent with cleared areas (PGV, 2024).	553.33	56.5
Unmapped (primarily road reserves)[6]		19.83	2.0
Total[7]		979	**100**

[6] No flora, vegetation or fauna habitat assessments have been undertaken for 19.83 ha of the Site. These areas are associated with road reserves necessary to access the DSP. It is assumed that no vegetation clearing will be undertaken within these areas.

[7] This is the total mapped area of the Site. There is a minor discrepancy between this value and the sum areas shown in the table. This is due to rounding of values presented in the table.

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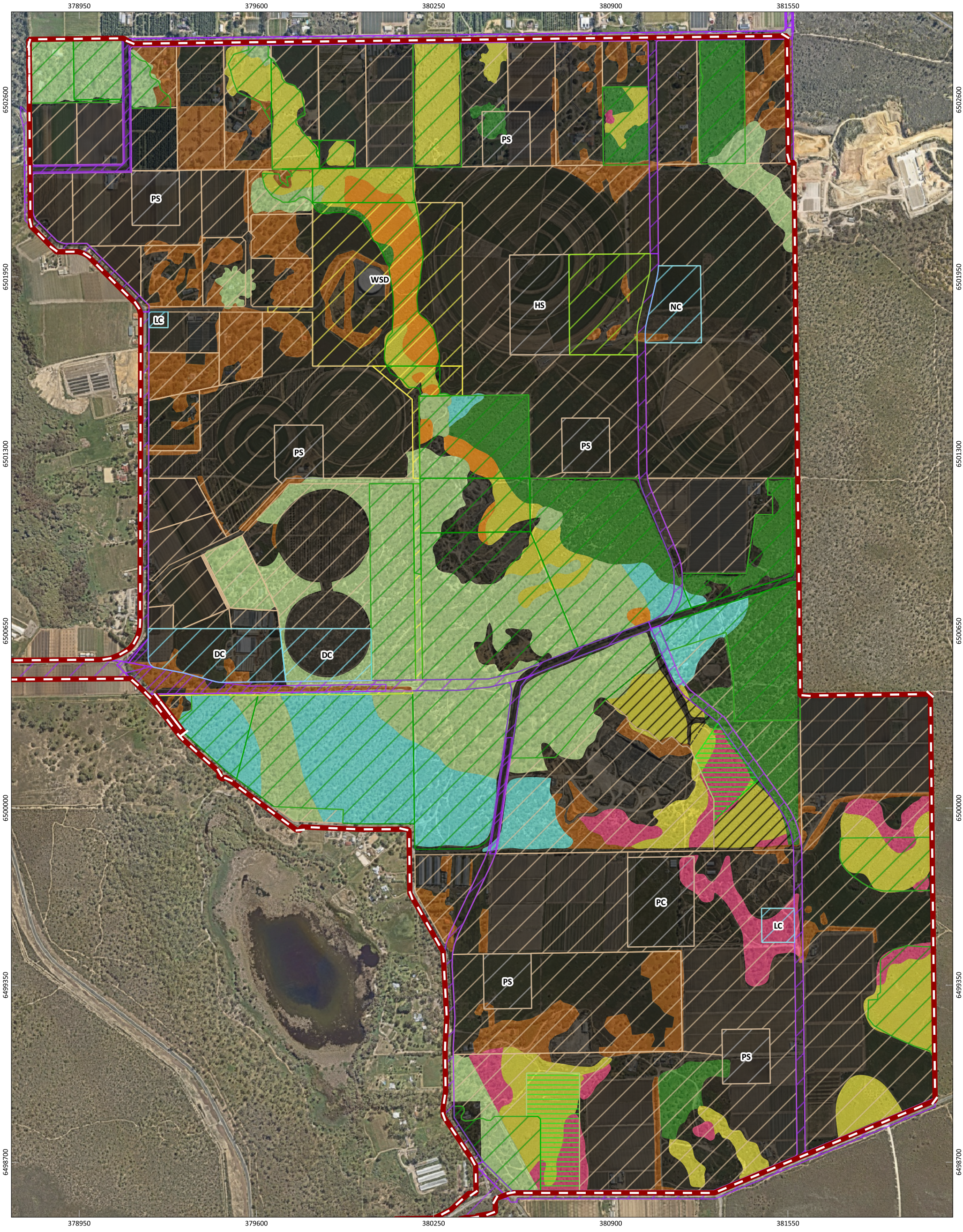


Figure 15: Vegetation Substrate Associations

N

0 200 400 m

PROJECT/REPORT NAME	Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA
SCALE: 1:13,000	SHEET SIZE: A3 COLOUR
CLIENT	Acumen Development Solutions
COORDINATE REFERENCE SYSTEM	GDA2020 / MGA zone 50
PROJECT	A24.019
VERSION	0
DATA SOURCE	LANDGATE AERIAL IMAGERY NOW
DRAWN BY / REVIEWED BY	JP / HS
DATE	21/7/2026

Legend

The Site

Vegetation Substrate Associations
- VSA 1 Tuart Open Woodland
- VSA 2 Banksia Woodland
- VSA 3 Banksia Thicket
- VSA 4 Jarrah Woodland
- VSA 5 Melaleuca Heath and Scrub
- VSA 6 Redheart Woodland
- VSA 7 Parkland Cleared
- VSA 8 Cleared

Proposed District Structure Plan
- Residential
- Centre
- Water Authority of WA
- School Site
- Conservation
- Potential Clearing Permit and BRM Extraction
- Integrator A / Integrator B / Neighbourhood Connector A
- Roads
- Local Open Space for Conservation
- District Open Space

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	21/7/2026

NOTES:

Cadastral boundary (LGATE-002). Label corresponds to the vegetation association number.

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Fauna Species of Conservation Significance

Fork-tailed Swift (*Apus pacificus*)

Fork-tailed swift is a largely aerial species of unpredictable occurrence in WA. The species is listed as migratory under the EPBC Act and Schedule 1 Division 2 (Migratory) under the BC Act. Being aerial, it is effectively independent of terrestrial ecosystems when in Australia. There are six records in the DBCA database within 14 km of the Site. This species is considered an 'irregular visitor' to the Site, as it may occasionally fly over but is unlikely to utilise the Site in any significant manner.

Glossy ibis (*Plegadis falcinellus*)

Glossy ibis is listed as Migratory under the EPBC Act and Schedule 1 Division 2 (Migratory) under the BC Act. The species is most abundant on wet grasslands across northern Australia, but occasionally appears from the Pilbara and south. There are a few locations in the Perth region where it is seen regularly on damp grasslands, such as at Herdsman Lake. The species is considered an 'irregular visitor' to the Site. There are 33 records in the DBCA database within 20 km of the Site, most of which are associated with wetlands or lakes in the region. The closest record is approximately 2 km from the Site, and suitable habitat is limited to agricultural landscapes within VSA 7 (such as the turf farm).

Peregrine falcon (*Falco peregrinus*)

Peregrine falcon is listed under Schedule 1 Division 3 of the BC Act (Other Specially Protected). This species occurs in a variety of habitats but is usually reliant on cliff faces or tall trees for nesting (Debus, 2019). The species is considered to be a 'regular visitor' to the Site. Peregrine falcon is known from the general region, and there are 16 records in the DBCA database within 20 km of the Site. The Site is likely to be within the home range of a pair, and contains tall trees that would be suitable nesting sites.

Forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*)

Forest red-tailed black cockatoo is listed as Vulnerable under the EPBC and and Schedule 2 Division 3 (Vulnerable) under the BC Act. The species is endemic to the deeper south-west of Western Australia, from around Gingin in the north, east to Mount Helena, North Bannister and Mount Saddleback, and south to around Albany (Johnstone and Storr 1998). In recent years there appears to have been a distinct expansion of the range of this species on to the Swan Coastal Plain, including many suburbs within the Perth metropolitan area. The species is generally restricted to areas of Jarrah-Marri forest, farmlands with remnant trees and urban landscapes. Forest red-tailed black cockatoo is considered a 'regular visitor' to the Site. The Site is close to the northern extent of the distribution of this species. There are 17 records in the DBCA database within 20 km of the Site, and all are in the southern half of the study area. The Site contains suitable habitat for roosting and breeding but lower foraging value for this species.

Baudin's black cockatoo (*Zanda baudinii*)

Baudin's black cockatoo is listed as Endangered under the EPBC Act and Schedule 2 Division 2 (Endangered) under the BC Act. The species is Endemic to the south-west of Western Australia, from around Perth to around Albany. In recent years there appears to have been a distinct expansion of the range of this species on to the Swan Coastal Plain, including many suburbs within the Perth metropolitan area. The species is

generally restricted to areas of Jarrah-Marri forest and farmlands with remnant trees or pine plantations. The species is considered a 'vagrant' to the Site.

The Site is outside of the current distribution of this species (which lies to the east of the Site), but it has been included as a vagrant due to recent reports of this species towards the west of the present distribution. There are four records in the DBCA database within 17 km of the Site; all of which are from 2002-2009. The Site supports little suitable foraging habitat and this species is not known to breed on the Swan Coastal Plain. It is therefore not expected to be regularly present but may occasionally occur in the Site.

Carnaby's black cockatoo (*Zanda latirostris*)

Carnaby's black cockatoo is listed as Endangered under the EPBC Act and Schedule 2 Division 2 (Endangered) under the BC Act. The species is endemic to south-western Western Australia, from Kalbarri in the north, east to Merredin and Ravensthorpe, and then further east along the south coast to the Esperance area (DCCEEW, 2024d; Johnstone & Storr, 1998). The species breeds (July to December) predominantly in the east of its range with a migration to coastal areas in the non-breeding period. In recent years, however, the species has expanded its breeding range westward and south into the Jarrah-Marri forests of the Darling Scarp and into the Tuart forests of the Swan Coastal Plain (DCCEEW, 2024d). The species is heavily reliant on areas of Banksia woodland and proteaceous shrubland/heath for foraging (DCCEEW, 2024d; Johnstone & Storr, 1998). Carnaby's black cockatoo is considered a 'regular visitor' to the Site. The species is known from the general region and was observed within or flying over the Site during the majority of visits by BCE (2024). There are approximately 1,400 records in the DBCA database within 20 km of the Site, with the most recent from 2022 and the closest records being within the Site. The Site provides potential roosting sites and nesting trees, and suitable foraging habitat.

Chuditch (*Dasyurus geoffroii*)

Chuditch is listed as Vulnerable under the EPBC Act and Schedule 2 Division 3 (Vulnerable) under the BC Act. The species is a wide-ranging resident in Marri-Jarrah forest of the south-west of Western Australia and also in heaths and eucalypt woodlands of the eastern wheatbelt and goldfields (Van Dyck & Strahan, 2008). The species is considered a 'vagrant' to the Site. There are two records in the DBCA database within 5 km of the Site; one of which is historical and one is from 1972. The species is not expected to be present regularly, but may move through the Site very occasionally (particularly during juvenile dispersal).

South-western brush-tailed phascogale (*Phascogale tapoatafa wambenger*)

The South western brush tailed phascogale is listed under Schedule 6 (Conservation Dependent) under the BC Act. The species is a wide-ranging but low-density resident in dry sclerophyll forests and open woodlands where there are hollow-bearing trees (DEC, 2012). These hollows are used for shelter and nesting. The species is considered an 'irregular visitor' to the Site. There are no records in the DBCA database within 20 km of the Site, and the closest is 27 km away (ALA, 2024). Site is within the range of the species, and may persist in larger swathes of native vegetation in the area.

Carnaby's Cockatoo, Baudin's Cockatoo, and Forest Red-tailed Black Cockatoo

Description of Habitat

Carnaby's black cockatoo (*Zanda latirostris*) forage primarily on the flowers and nectar of proteaceous flora species including *Banksia* spp., *Hakea* spp., and *Grevillea* spp (DAWE, 2022). The species also feeds on the fruit and seeds of many native eucalypt species, most importantly marri (*Corymbia calophylla*), jarrah (*Eucalyptus marginata*), pricklybark (*E. todtiana*), flooded gum (*E. rudis*) and wandoo (*E. wandoo*). The species roosts generally in or near riparian environments near to permanent water sources within tall eucalypt trees. The species breeds in natural and artificial hollows within eucalypt trees of a suitable size and species to develop nesting hollows, including salmon gum, wandoo, tuart, jarrah, flooded gum, York gum, powderbark, karri, and marri (DAWE, 2022).

Baudin's cockatoo (*Zanda baudinii*) forage primarily on the seeds of marri, sometimes jarrah, as well as on the seeds of native proteaceous flora species such as *Banksia* spp. and *Hakea* spp (DAWE, 2022). The species roosts generally in or near riparian environments near to permanent water sources within tall eucalypt trees. The species breeds in natural and artificial hollows within eucalypt trees of a suitable size and species to develop nesting hollows, particularly karri, marri, jarrah, wandoo, bullich, and tuart (DAWE, 2022). Baudin's black cockatoo is considered a vagrant to the Site only. Therefore, this report includes limited discussion of the Site's habitat value for the species.

Forest red-tailed black cockatoo (*Calyptorhynchus* banksii *naso*) forage primarily on the seeds of marri and jarrah, as well as on wandoo, blackbutt, and *Allocasuarina fraseriana* cones (DAWE, 2022). The species roosts generally in or near riparian environments near to permanent water sources within tall eucalypt trees. The species breeds in natural and artificial hollows within eucalypt trees of a suitable size and species to develop nesting hollows, particularly salmon gum, wandoo, tuart, jarrah, flooded gum, York gum, powderbark, karri, and marri (DAWE, 2022).

Type and Extent of Habitat within the Site

The types and extent of suitable habitat for black cockatoos (focussing on Carnaby's black cockatoo and Forest red-tailed black cockatoo) is provided in the following subsections.

Foraging

Foraging habitat for Carnaby's black cockatoo is present throughout the Site in varying quality. BCE (2024) undertook a foraging habitat assessment which identified that the quality of foraging habitat ranged from 1/10 to 7/10, with the weighted Site average quality being 3/10 (described as low). This is due to the majority (56.5%) of foraging habitat having a score of 1/10 (negligible) comprised of cleared or heavily disturbed land. Areas with more suitable foraging habitat, such as those containing higher densities of Banksia spp., are less prevalent across the Site. Areas with a high density of Banksia spp. (VSA 2 and 3) and jarrah (VSA 4) scored more highly, whilst areas identified by PGV (2024) as cleared or parkland cleared with scattered trees scored less highly. A breakdown of foraging habitat quality and extent for Carnaby's black cockatoo is provided in Table 22.

Table 22. Quality and Extent of Foraging Habitat for Carnaby's Black Cockatoo within the Site

Quality (score out of 10)	Area (ha)	% of Total
1	553.33	56.5
3	73.46	7.5
4	152.97	15.6
5	47.40	4.8
6	74.16	7.6
7	59.26	6.1
Unmapped (primarily road reserves)[8]	19.83	2.0
Total[9]	**979**	**100**

Foraging habitat for Forest red-tailed black cockatoo is present throughout the Site in varying quality. BCE (2024) undertook a foraging habitat assessment which identified that foraging habitat quality ranged from 1/10 to 5/10, with the weighted Site average quality being 2/10 (described as low). Higher quality habitat was identified within VSA 4 (jarrah woodland) where marri was co-dominant in some areas (BCE, 2024). A breakdown of foraging habitat quality and extent for Forest red-tailed black cockatoo is provided in Table 23.

Table 23. Quality and Extent of Foraging Habitat for Forest Red-tailed Black Cockatoo within the Site

Quality (score out of 10)	Area (ha)	% of Total
1	639.58	65.3
2	24.45	2.5
3	73.46	7.5
4	175.70	17.9
5	47.40	4.8
Unmapped (primarily road reserves)[8]	19.83	2.0
Total[9]	**979**	**100**

[8] No flora, vegetation or fauna habitat assessments have been undertaken for 19.83 ha of the Site. These areas are associated with road reserves necessary to access the DSP. It is assumed that no vegetation clearing will be undertaken within these areas.

[9] This is the total mapped area of the Site. There is a minor discrepancy between this value and the sum areas shown in the table. This is due to rounding of values presented in the table.

It is important to note that the habitat quality scores of 1 for both species of black cockatoo, are associated with cleared areas with very scattered trees. The actual extent of foraging habitat within these areas (i.e. canopy cover) is significantly less than the areas quoted in BCE (2024) and the tables above.

Roosting

Black cockatoo species utilise tall eucalypt trees (> 10 m) for night roosting, and will typically utilise the tallest trees in the landscape (DAWE, 2022). Roosting sites are commonly within 2 km of natural or artificial watering points (DAWE, 2022). BCE (2024) did not identify any signs of night roosting activity during the field investigations, however there are abundant tall trees present that would be suitable for roosting. BCE (2024) recorded 1,598 large trees within the Site that have the potential to provide roosting habitat for black cockatoos.

As noted above, the presence of a nearby water source is an important feature of a night roosting Site (DAWE, 2022) and is also associated with successful breeding (BCE, 2024). Black cockatoos have been reported to drink from artificial water sources (horse troughs) within the Site (BCE, 2024).

Breeding

All three black cockatoo species breed in deep hollows with a large entry diameter, within eucalypt species of a suitable size and species to form such hollows. Eucalypt trees with the capacity to develop suitable hollows are generally have a diameter at breast height (DBH) of at least 50 cm.

Within the Site, BCE (2024) recorded 1,589 trees with a DBH ≥ 50 cm that are of a suitable size and species to develop hollows suitable for black cockatoo nesting. These are herein referred to as 'potential nesting trees'. Most of these are tuart (1,113 trees), jarrah (300 trees) and marri (65 trees)[10]. BCE (2024) categorised these trees according to the presence and suitability of hollows (if any) in accordance with Table 24.

Table 24. Potential Nesting Tree Class

Rank	Description of tree and hollows/activity
1	Activity at hollow observed; adult (or immature) bird seen entering or emerging from hollow. Can also be used for a known nest tree active in the previous 12 months (although this should be noted in the description). Note that activity at a hollow does not absolutely mean that breeding is occurring unless a young bird in hollow is observed.
2	Hollow of suitable size visible with chew marks around entrance. Record if chew-marks are recent or old.
3	Potentially suitable hollow visible but no chew marks present at entrance; or potentially suitable hollow suspected to be present - as suggested by structure of tree, such as large, vertical trunk broken off at a height of >8m; but note that hollow height is contextual. Carnaby's Black-Cockatoo will nest in hollows <5m so in a Wheatbelt breeding site a lower criterion may be more appropriate.
4	Tree with large hollows or broken branches that might contain large hollows, but hollows or potential hollows (nest chamber) are not vertical or near-vertical; thus a tree with or likely to have hollows of

[10] The remaining 111 trees are not considered to be species suitable for black cockatoo breeding, however were recorded for thoroughness due to their size.

Rank	Description of tree and hollows/activity
	sufficient size but not to have hollows of the angle preferred by Black-Cockatoos. Trees with low but otherwise suitable hollows can also be assigned a rank or 4, depending on the species of black-cockatoo likely to be present.
5	Tree lacking large hollows or broken branches that might have large hollows; a tree with more or less intact branches and a spreading crown.

A breakdown of tree species and class for all potential nesting trees within the Site, is provided in Table 25.

Table 25. Species and Class of Potential Nesting Trees within the Site

Species Name	Common Name	Tree Class					Grand Total
		1	2	3	4	5	
Eucalyptus gomphocephala	Tuart	0	12	65	136	900	**1,113**
Eucalyptus marginata	Jarrah	0	2	21	49	228	**300**
Corymbia calophylla	Marri	0	0	8	6	51	**65**
Eucalyptus todtiana	Dwutta	0	0	0	0	47	**47**
Eucalyptus sp.	Ornamental or unknown Eucalypt	0	0	5	2	39	**46**
Eucalyptus wandoo	Wandoo	0	0	0	0	14	**14**
Eucalyptus decipiens	Redheart	0	0	0	0	2	**2**
Eucalyptus rudis	Flooded Gum	0	0	0	0	2	**2**
Grand Total		**0**	**14**	**99**	**193**	**1,283**	**1,589**

As shown in Table 25, the significant majority of trees are Class 5 (1,292 trees; 81.3%) and show no signs of hollow development. A total of 14 trees contain hollows that are a suitable size and orientation to support black cockatoo nesting, and chew marks are visible indicating previous use or investigation by individuals. Assessment of the age of chew marks was unable to be made. A further 99 trees contain hollows of suitable size and orientation to support black cockatoo nesting, however no chew marks were observed.

BCE (2024) did not record any confirmed black cockatoo nesting hollows (Class 1).

Regional Context

There is approximately 33,991 ha of remnant native vegetation within 15 km of the Site. Remnant native vegetation within the Site therefore represents approximately 1% of native vegetation in the local area.

According to records held by DBCA, there are 11 confirmed and 12 potential white-tailed black-cockatoo breeding sites within 20 km of the Site. It should be noted that no distinction is made in this dataset for Carnaby's black cockatoo or Baudin's black cockatoo. Both species are collectively recorded as 'white-tailed black cockatoos'. It is assumed that, given the location of the Site, records relate to Carnaby's black cockatoo. Of the confirmed breeding sites, one is a natural hollow and the remaining 10 are artificial hollows. Publicly

available records from DBCA (2024b) indicate that the Site is within a known breeding area for Carnaby's black cockatoo (defined by a 12 km buffer around a point where successful breeding has been confirmed or strongly suspected (Glossop et al., 2011) which suggests there is a known breeding site approximately 12 km of the Site that is not included in the DBCA threatened and priority fauna database (BCE, 2024) (Figure 20).

There are no known breeding sites for the Forest red-tailed black cockatoo within 20 km of the Site.

According to records held by Birdlife Australia, there are 39 confirmed roost sites within 20 km of the Site (BirdLife Australia, 2024). Of these, two are Forest red-tailed black cockatoo sites, 28 are white-tailed black-cockatoo sites, and nine are joint sites. Eleven of these roosts are within 6 km of the Site. Of these eleven confirmed roost sites within 6 km, one is a joint site (last used by Forest red-tailed black cockatoos in 2024 and white-tailed black-cockatoos in 2024), and ten have been confirmed used by white-tailed black-cockatoos (five confirmed uses since 2021).

The closest known roost site is on the boundary of the Site and is a joint site where both species have been recorded. There are also several buffers associated with unconfirmed roost sites that intersect the Site as depicted on Figure 20.

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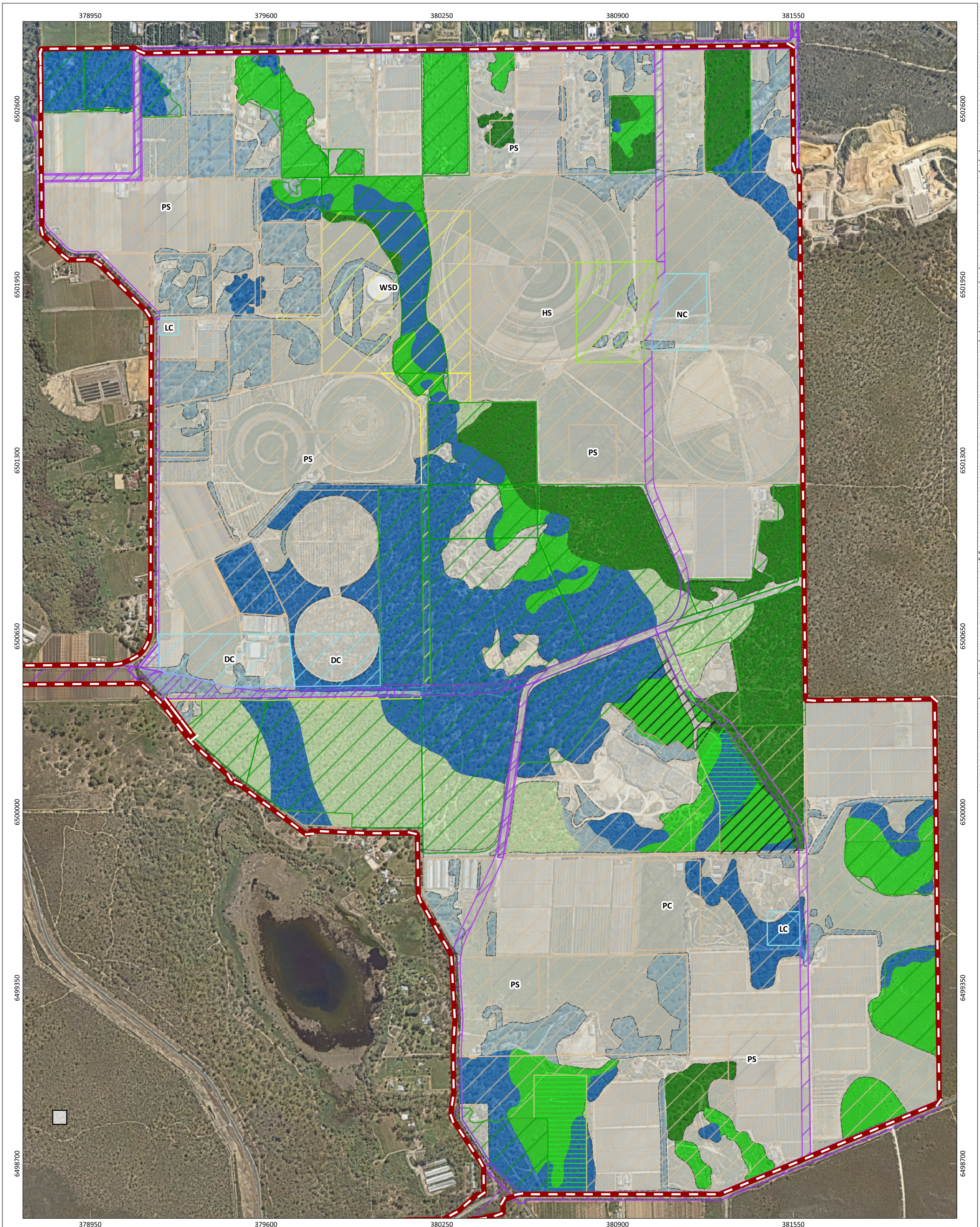


Figure 16: Carnaby's Black Cockatoo Foraging Habitat within the Site

N

0 200 400 m

SCALE 1:13,000	SHEET SIZE A3 COLOUR	
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50	PROJECT A24.019	VERSION 0
DATA SOURCE LANDGATE AERIAL IMAGERY NOW	DRAWN BY / REVIEWED BY JP / HS	DATE 21/7/2026

PROJECT/REPORT NAME

Carabooda Urban Precinct District Structure Plan
Multiple lots, Carabooda and Nowergup, WA

CLIENT

Acumen Development Solutions

Legend

The Site

Carnaby's Black Cockatoo Foraging Habitat Quality Score
- 1/10
- 3/10
- 4/10
- 5/10
- 6/10
- 7/10

Proposed District Structure Plan
- Residential
- Centre
- Water Authority of WA
- School Site
- Conservation
- Potential Clearing Permit and BRM Extraction
- Integrator A / Integrator B / Neighbourhood Connector A
- Roads
- Local Open Space for Conservation
- District Open Space

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	21/7/2026

NOTES:

Cadastral boundary (LGATE-002). Label corresponds to the vegetation association number.

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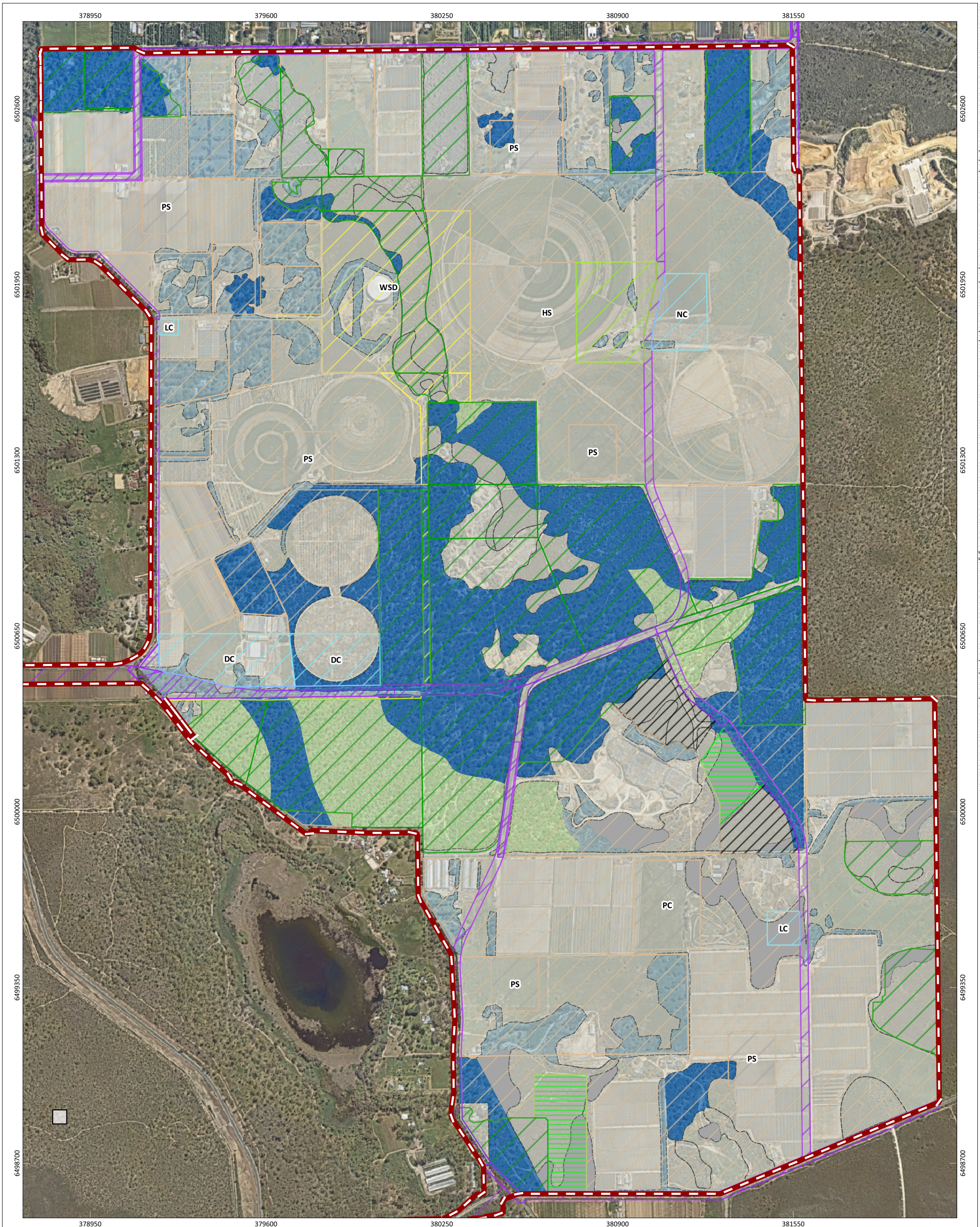


Figure 17: Forest Red-tailed Black Cockatoo Foraging Habitat within the Site

N

0 200 400 m

SCALE 1:13,000	SHEET SIZE A3 COLOUR	
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50	PROJECT A24.019	VERSION 0
DATA SOURCE LANDGATE AERIAL IMAGERY NOW	DRAWN BY / REVIEWED BY JP / HS	DATE 21/7/2026

PROJECT/REPORT NAME

Carabooda Urban Precinct District Structure Plan
Multiple lots, Carabooda and Nowergup, WA

CLIENT

Acumen Development Solutions

Legend

The Site

Forest Red-tailed Black Cockatoo Foraging Habitat Quality Score
- 1/10
- 2/10
- 3/10
- 4/10
- 5/10

Proposed District Structure Plan
- Residential
- Centre
- Water Authority of WA
- School Site
- Conservation
- Potential Clearing Permit and BRM Extraction
- Integrator A / Integrator B / Neighbourhood Connector A
- Roads
- Local Open Space for Conservation
- District Open Space

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	21/7/2026

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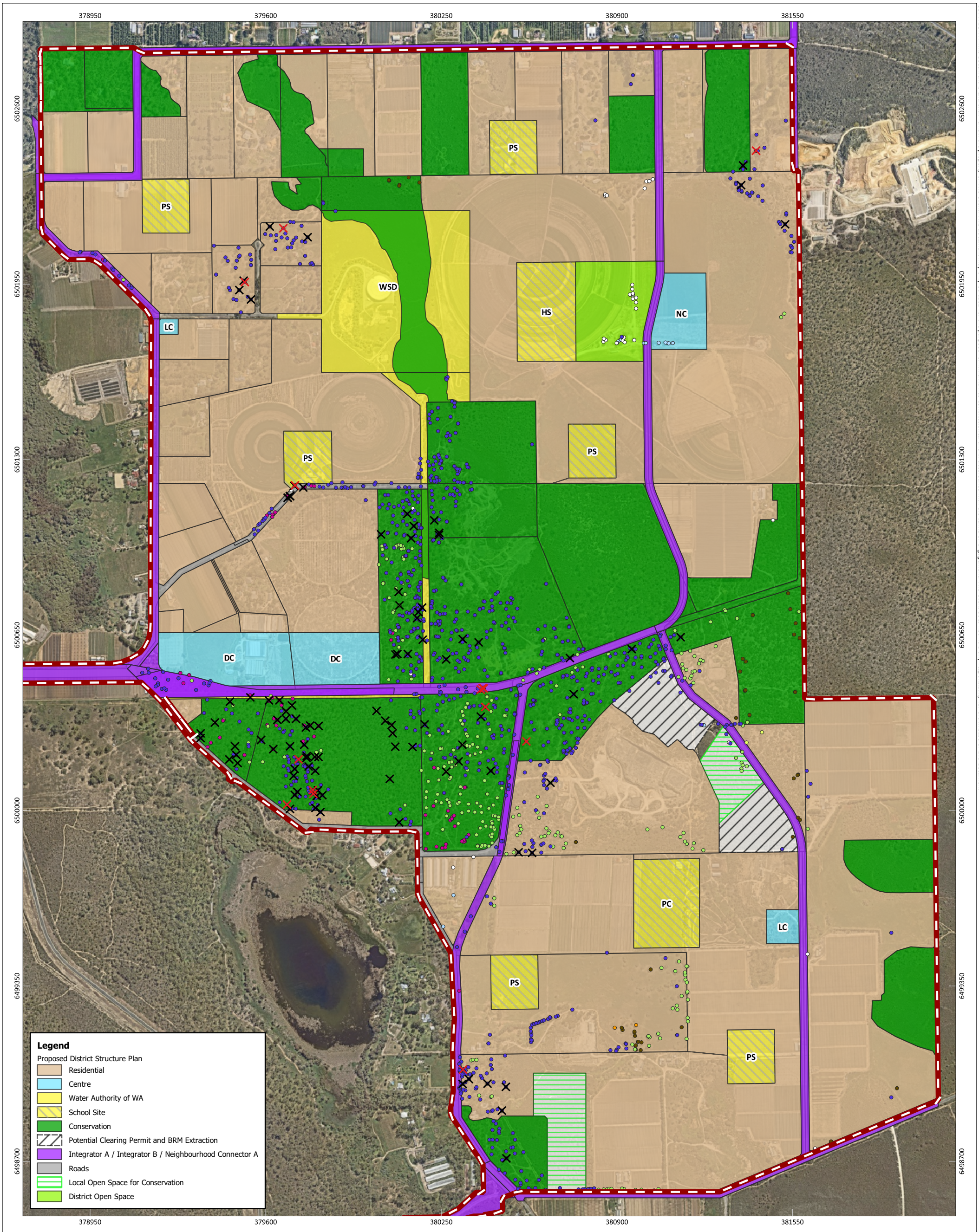


Figure 18: Black Cockatoo Potential Nesting Trees within the Site

N

0 200 400 m

SCALE 1:13,000	SHEET SIZE A3 COLOUR	CLIENT Acumen Development Solutions	
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50		PROJECT A24.019	VERSION 0
DATA SOURCE LANDGATE AERIAL IMAGERY NOW		DRAWN BY / REVIEWED BY JP / HS	DATE 21/7/2026

PROJECT/REPORT NAME

Carabooda Urban Precinct District Structure Plan
Multiple lots, Carabooda and Nowergup, WA

Legend

The Site

Potential Nesting Trees (Class 2 and 3)
- 2
- 3
- 4
- 5

Potential Nesting Tree Species (DBH ≥ 50 cm)
- Corymbia calophylla
- Eucalyptus decipiens
- Eucalyptus gomphocephala
- Eucalyptus marginata
- Eucalyptus rudis
- Eucalyptus sp
- Eucalyptus todtiana
- Eucalyptus wandoo

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	21/7/2026

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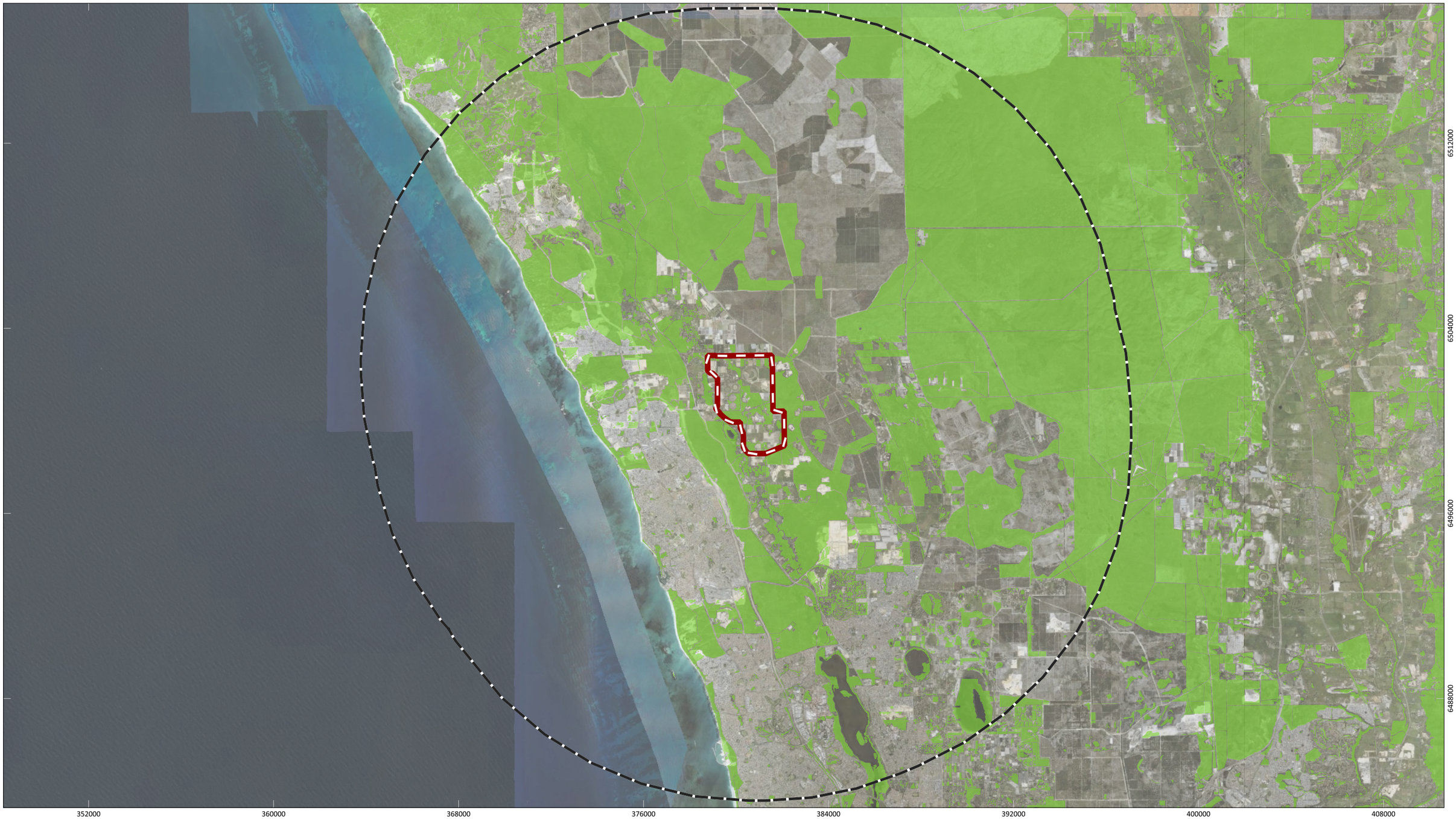


Figure 19: Remnant Native Vegetation within 15 km of the Site

N

0 2.5 5 km

PROJECT/REPORT NAME	Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA
SCALE: 1:160,000	SHEET SIZE: A3 COLOUR
CLIENT	Acumen Development Solutions
COORDINATE REFERENCE SYSTEM	GDA2020 / MGA zone 50
PROJECT NUMBER	A24.019
VERSION	0
DATA SOURCE	LANDGATE AERIAL IMAGERY NOW
DRAWN BY / REVIEWED BY	JP / HS
DATE	16/1/2025

Legend

- The Site
- 15 km Buffer
- Native Vegetation Extent (DPIRD-005)

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	05/06/2023
B	Revision			16/1/2025

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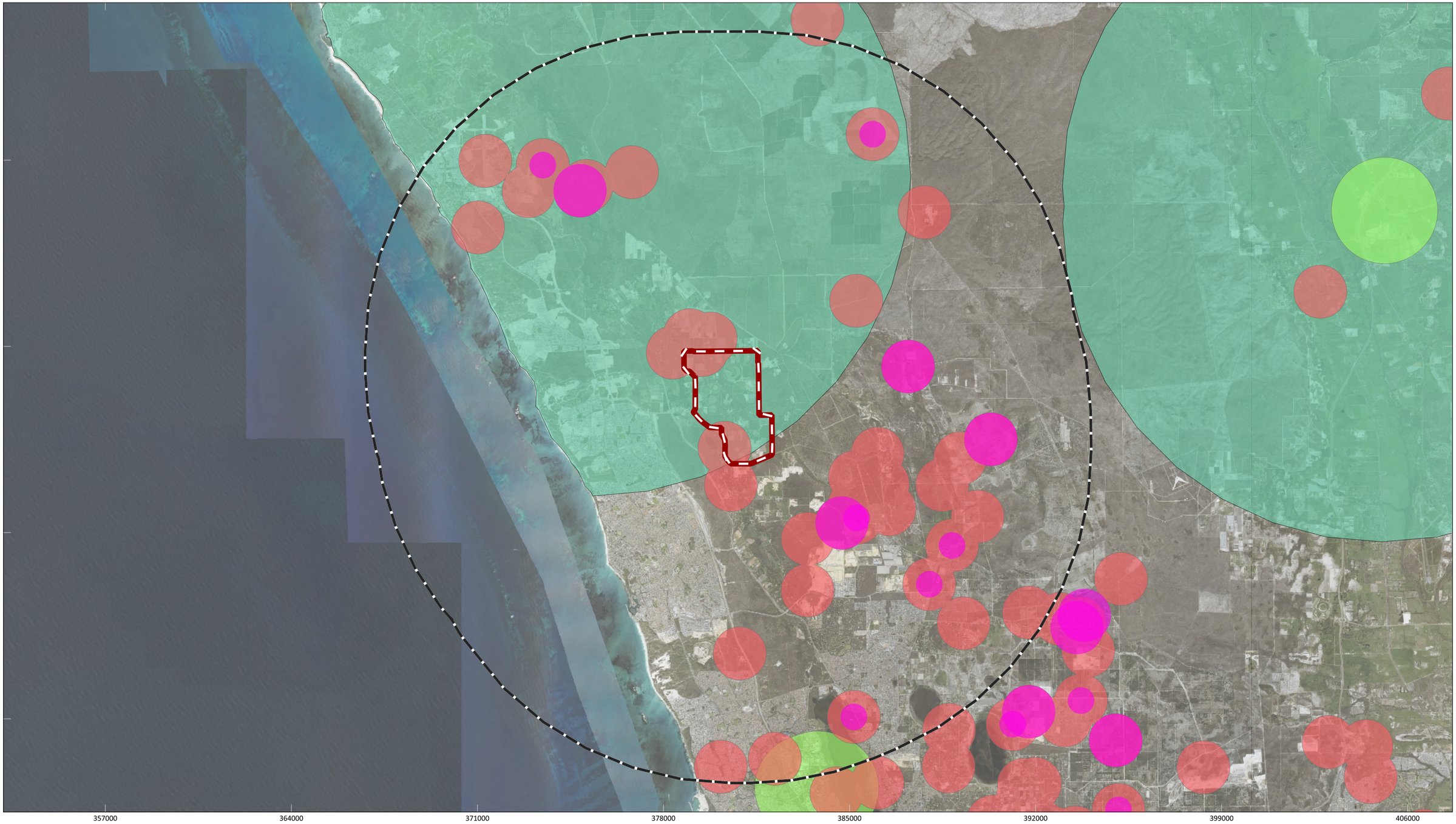


Figure 20: Regional Black Cockatoo Roosting and Breeding Habitat

N

0 2.5 5 km

PROJECT/REPORT NAME Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA		
SCALE 1:140,000	SHEET SIZE A3 COLOUR	CLIENT Acumen Development Solutions
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50	PROJECT NUMBER A24.019	VERSION 0
DATA SOURCE LANDGATE AERIAL IMAGERY NOW	DRAWN BY / REVIEWED BY JP/HS	DATE 16/1/2025

Legend

- The Site
- 12 km Buffer
- Carnabys Cockatoo Confirmed Roost Sites (DBCA-050)
- Black Cockatoo Roosting Sites - Buffered (DBCA-064)
- Black Cockatoo Breeding Sites - Buffered (DBCA-063)
- Carnabys Cockatoo Confirmed Breeding Areas within the Swan Coastal Plain and Jarrah Forest IBRA Regions (DBCA-054)

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	16/1/2025

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5.6 Ecological Linkages

The Site intersects one mapped regional ecological linkage (Link ID 8) (WALGA, 2008) which runs from east to west across the centre of the Site (Figure 21). This linkage traverses vegetation that is a mixture of cleared agricultural land and areas that are comprised of Very good and Excellent condition native vegetation (PGV, 2023). The mapped linkage connects State Forest associated with Bush Forever site 290 (Hopkins Road Bushland) to the east of the Site with Bush Forever site 383 (Neerabup National Park, Lake Gnowerup Nature Reserve and adjacent bushland) to the southeast of the Site.

This ecological linkage will be preserved through the proposed DSP, with conservation areas located across the centre of the Site maintaining linkage from east to west (Figure 21).

5.7 Conservation Areas

The Site does not intersect any conservation areas managed by DBCA (DBCA-011). Nowergup Nature Reserve is situated immediately adjacent to the Site, with the nearest point immediately east of Gibbs Road (Figure 21) Neerabup National Park is located approximately 1.2 km to the west.

SPP 2.8 aims to provide a policy and implementation framework that ensures bushland protection and management issues throughout the Perth Metropolitan Region are adequately addressed and integrated with broader land use planning and decision-making (WAPC, 2021). The policy predominantly deals with two distinct subjects, Bush Forever areas and local bushland areas. In accordance with SPP 2.8, proposals must recognise regionally significant bushland and outline methods by which it will avoid, minimise, and offset any likely adverse impacts. Two Bush Forever (BF) sites are located in close proximity to the Site. BF Site 290 (Hopkins Road Bushland) is immediately east of the Site while BF 383 (Neerabup National Park, Lake Gnowerup Nature Reserve, and adjacent bushland) is 175 m west of the Site.

Connectivity between conservation areas to the east and west of the Site will be maintained by the proposed DSP, through the location of conservation areas in the centre of the Site (Figure 21).

5.8 Environmentally Sensitive Areas

One mapped Environmentally Sensitive Area (ESA) intersects the northwest portion of the Site (DWER-046), which is associated with the buffer of a TEC (Figure 21). This ESA overlaps the Site by 169.72 ha. A second ESA intersects the southwestern portion of the Site which is associated with the buffer of a CCW. This ESA overlaps the Site by 0.33 ha.

ESAs are gazetted under *Environmental Protection Notice 2005*, Government Gazette No. 55. Under this designation, exemptions for clearing of native vegetation under the *Environmental Protection (Clearing of Native vegetation) Regulations 2004* do not apply. Further ESAs located adjacent to the site are associated with Bush Forever sites 290 and 383 to the east and southwest. A review of aerial imagery found that a

portion of the Site to the northwest which is marked as an ESA has been historically cleared for agricultural purposes.

5.9 Bushfire Risk

The majority of the Site is mapped as a Bushfire Prone Area (OBRM-023) as shown on Figure 22. This mapping was updated in 2024. Given the Site is within a Bushfire Prone Area, SPP 3.7 will apply. A Bushfire Management Plan has been prepared and forms part of the DSP documentation (WEPL, 2024).

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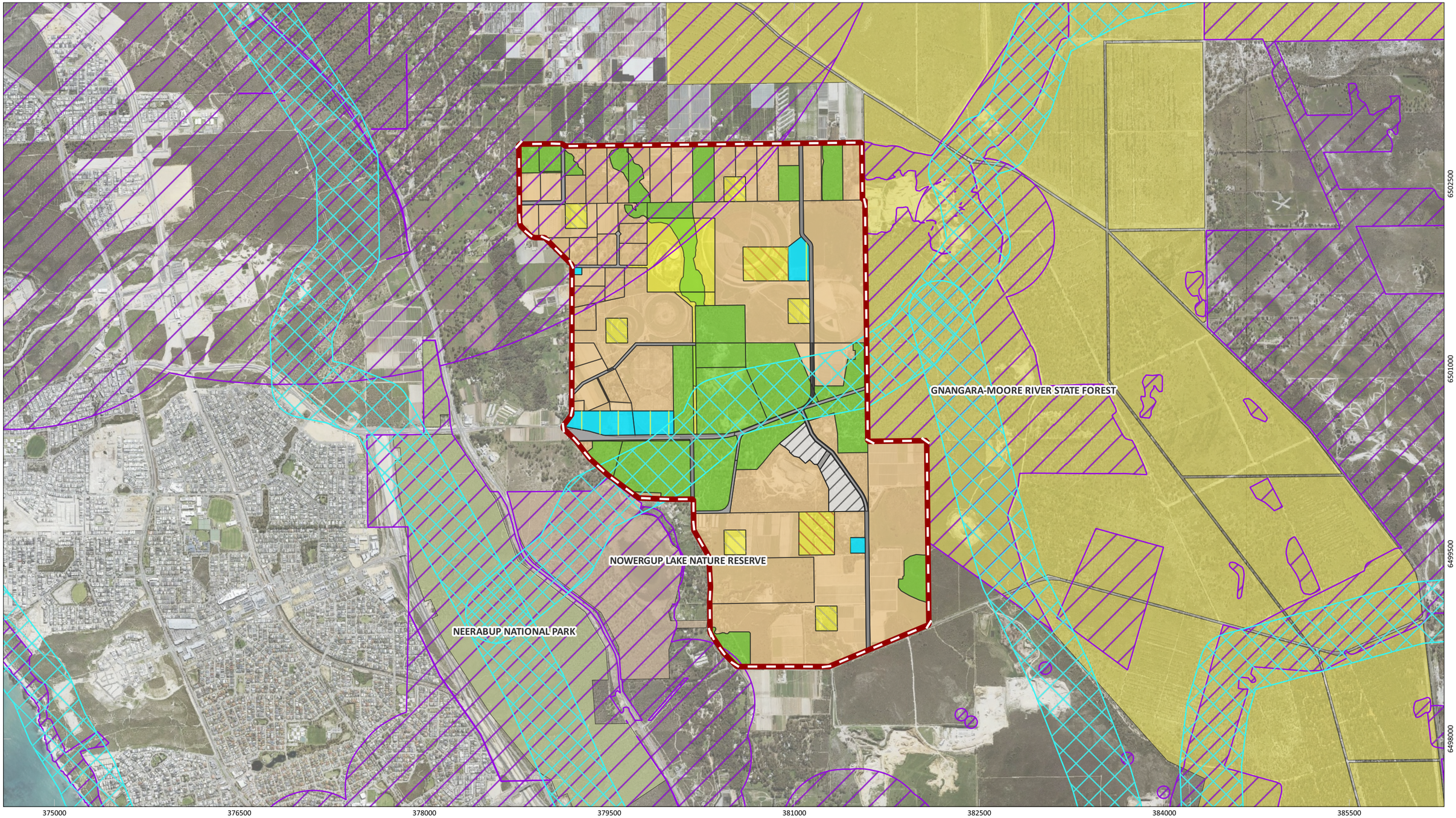


Figure 21: Ecological Linkages, Conservation Areas, and Environmentally Sensitive Areas

N

0 0.5 1 km

PROJECT/REPORT NAME	Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA
SCALE: 1:30,000	SHEET SIZE: A3 COLOUR
CLIENT	Acumen Development Solutions
COORDINATE REFERENCE SYSTEM: GDA2020 / MGA zone 50	PROJECT NUMBER: A24.019 / VERSION: 0
DATA SOURCE: LANDGATE AERIAL IMAGERY NOW	DRAWN BY / REVIEWED BY: JP/HS / DATE: 23/1/2025

Legend

- The Site
- Regional Ecological Linkages
- Environmentally Sensitive Areas (DWER-046)

DBCA - Legislated Lands and Waters (DBCA-011)
- National Park
- Nature Reserve
- State Forest

Proposed District Structure Plan
- Potential clearing permit and BRM extraction
- Centre
- Conservation
- High School
- Primary School
- Private College
- Roads
- Urban
- Water Authority of WA

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	23/1/2025

NOTES:

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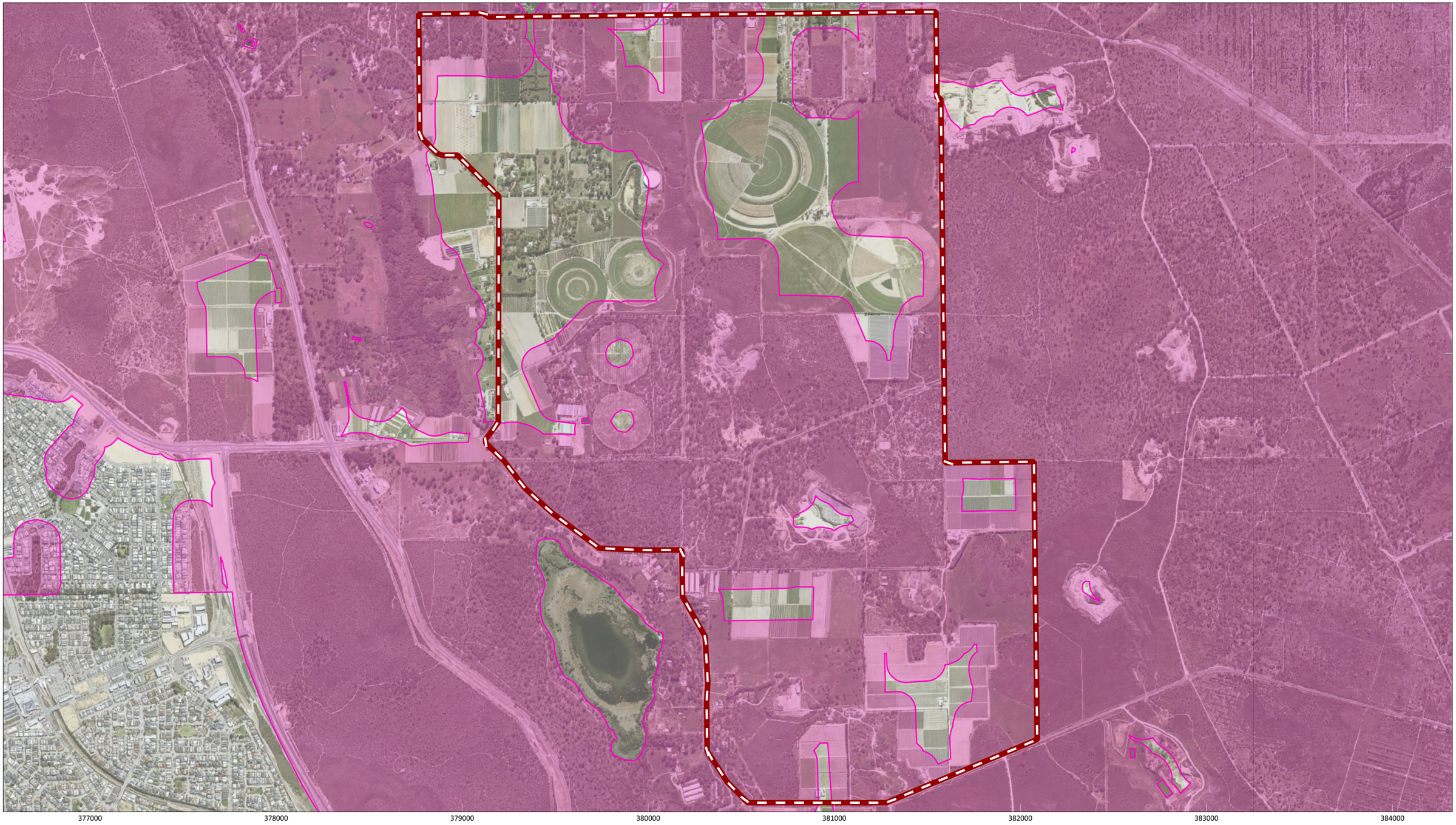


Figure 22: Bush Fire Prone Areas

N; 0 – 0.5 – 1 km		PROJECT/REPORT NAME: Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA	
SCALE: 1:20,000	SHEET SIZE: A3 COLOUR	CLIENT: Acumen Development Solutions	
COORDINATE REFERENCE SYSTEM: GDA2020 / MGA zone 50		PROJECT NUMBER: A24.019	VERSION: 0
DATA SOURCE: LANDGATE AERIAL IMAGERY NOW		DRAWN BY / REVIEWED BY: JP / HS	DATE: 16/1/2025

Legend

The Site

Bush Fire Prone Area Planning (OBRM-023)

Bushfire Prone Area

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	16/1/2025

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5.10 Contaminated Sites

The *Contaminated Sites Act 2003* (CS Act) defines contamination as having a substance present in land or water above background concentrations that presents a risk of harm to human health or the environment. The CS Act also provides for the identification, recording, management, and remediation of contaminated sites.

Contamination commonly occurs through accidental leakage and spillage, or poor site management practices. A search was conducted for contaminated sites within 2 km of the site boundary via the Contaminated Sites Register that is managed by DWER (DWER-059). One registered contaminated site was identified: the Nowergup Biosolids Facility. The facility is situated 360 m to the southeast of the Site, and is now closed and classified as Remediated for Restricted Use (Figure 23).

There is no evidence of potentially contaminating industries other than the lime kilns (shown in Figure 3) that could have contributed to contamination. This investigation has not identified any records to indicate any large spills or other contamination events at the site. There are reports of rubbish dumping (i.e. car bodies) in various locations. Given the age of site structures, there is the potential for asbestos-containing material to be present, associated with old rural buildings and sheds across the site. With past agricultural and horticultural land uses there is a possibility of contamination from fertiliser, residual pesticides and herbicides use. It is recommended that preliminary site investigation for contamination be conducted as part of early works for development.

5.11 Heritage

5.11.1 Native Title Agreement

The Site is located on Whadjuk Noongar Country. The Site forms part of the South West Native Title Settlement, within the Whadjuk Indigenous Land Use Agreement area.

5.11.2 Indigenous Heritage Places

The amended *Aboriginal Heritage Act 1972* (AHA Act) came into effect on 15 November 2023 and aims to protect Aboriginal heritage by registering Aboriginal sites (places and/or objects) that are of cultural importance to Aboriginal people. Any proposal to use or alter an area of land, for purposes such as research or development, must first determine if Aboriginal sites occur within the proposed area. If an Aboriginal site is found to occur, consent must be sought from the Minister for Aboriginal Affairs before that land can be used or altered in any way.

The Department of Planning, Lands and Heritage (DPLH) Aboriginal Cultural Heritage Register (DPLH-099) does not identify any registered Aboriginal heritage sites within the Site.

As shown in Figure 24, there is one registered Aboriginal heritage site located approximately 200 to the west of the Site, associated with Nowergup Lake (Place ID 17450). This Site is of mythological significance. One

other registered Aboriginal heritage site is within 2 km of the Site, which is associated with Lake Neerabup (Place ID 3315) located 700 m to the south. This site incorporates Orchestra Shell Cave (Place ID 4404) containing artifacts.

Future development of the site will have to follow the Aboriginal Heritage Due Diligence Guidelines (DPLH and DPC 2013).

5.11.3 European Heritage Places

The State Register of Heritage Agreements and Municipal Inventory was assessed to identify whether any other heritage places are located within the site. There are no heritage places mapped within 2 km of the Site (DPLH 2021). However, under the City of Wanneroo's Local Heritage Survey there are historic lime kilns located within and just outside the site to the southwest.

The Lime Kilns – Spiers (Place no. 14299), located at 115 Kiln Road, Carabooda are registered as a Category 2 site under the City's Heritage List, thus providing a high level of protection through the local planning scheme. Another Lime Kiln site, Wanneroo (Place no. 18338) is located adjacent to the site boundary at Nowergup Lake, however these are not on any local heritage listings.

The Lime Kilns - Spiers (Place no. 14299) heritage site will be retained within the proposed conservation area in the centre of the Site (Figure 24).

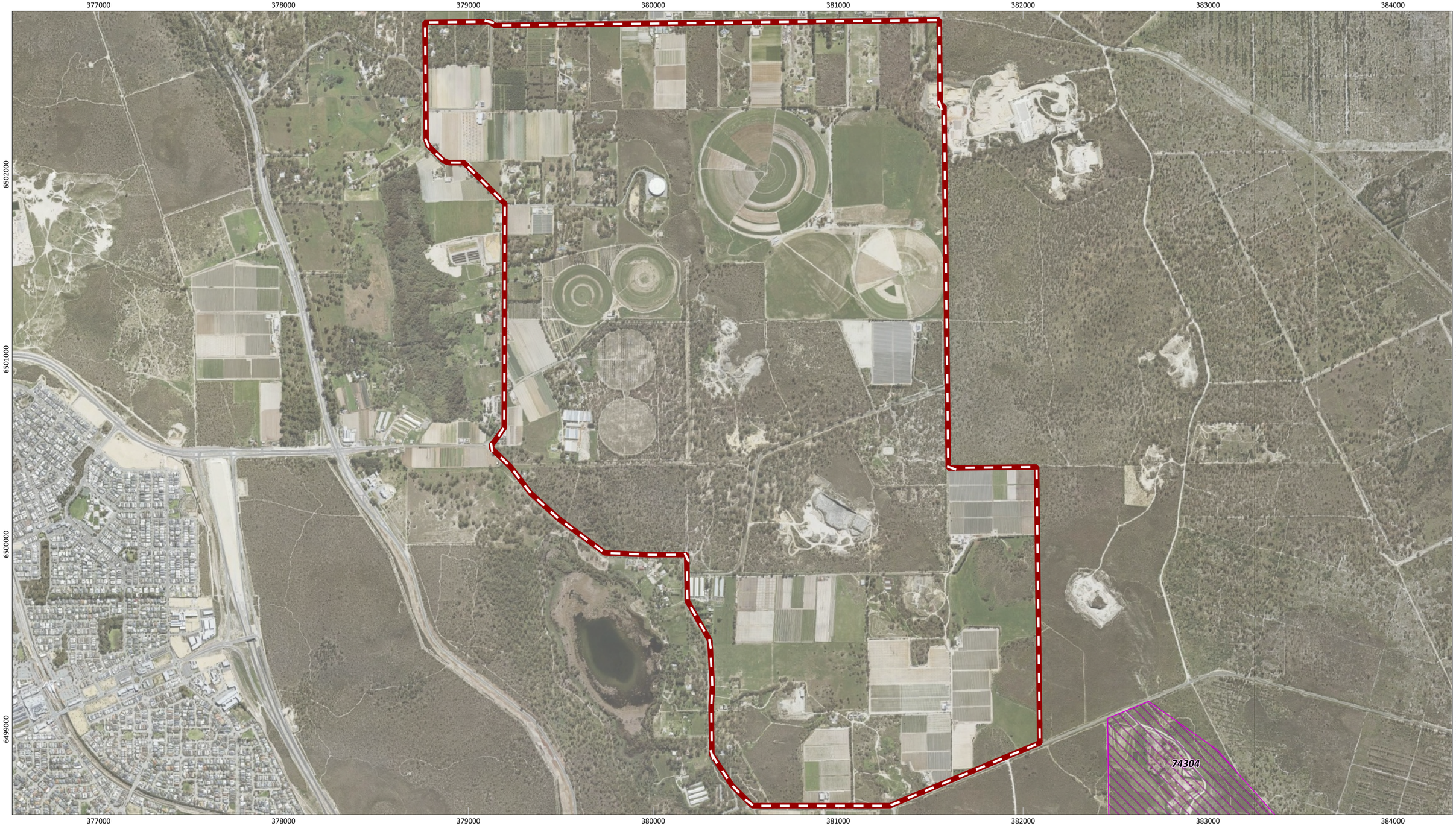


Figure 23: Contaminated Sites

N 0 0.5 1 km		PROJECT/REPORT NAME Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA	
SCALE 1:20,000	SHEET SIZE A3 COLOUR	CLIENT Acumen Development Solutions	
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50		PROJECT NUMBER A24.019	VERSION 0
DATA SOURCE LANDGATE AERIAL IMAGERY NOW		DRAWN BY / REVIEWED BY JP / HS	DATE 16/1/2025

Legend

The Site

Contaminated Sites Database (DWER-059)

Remediated for restricted use

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	16/1/2025

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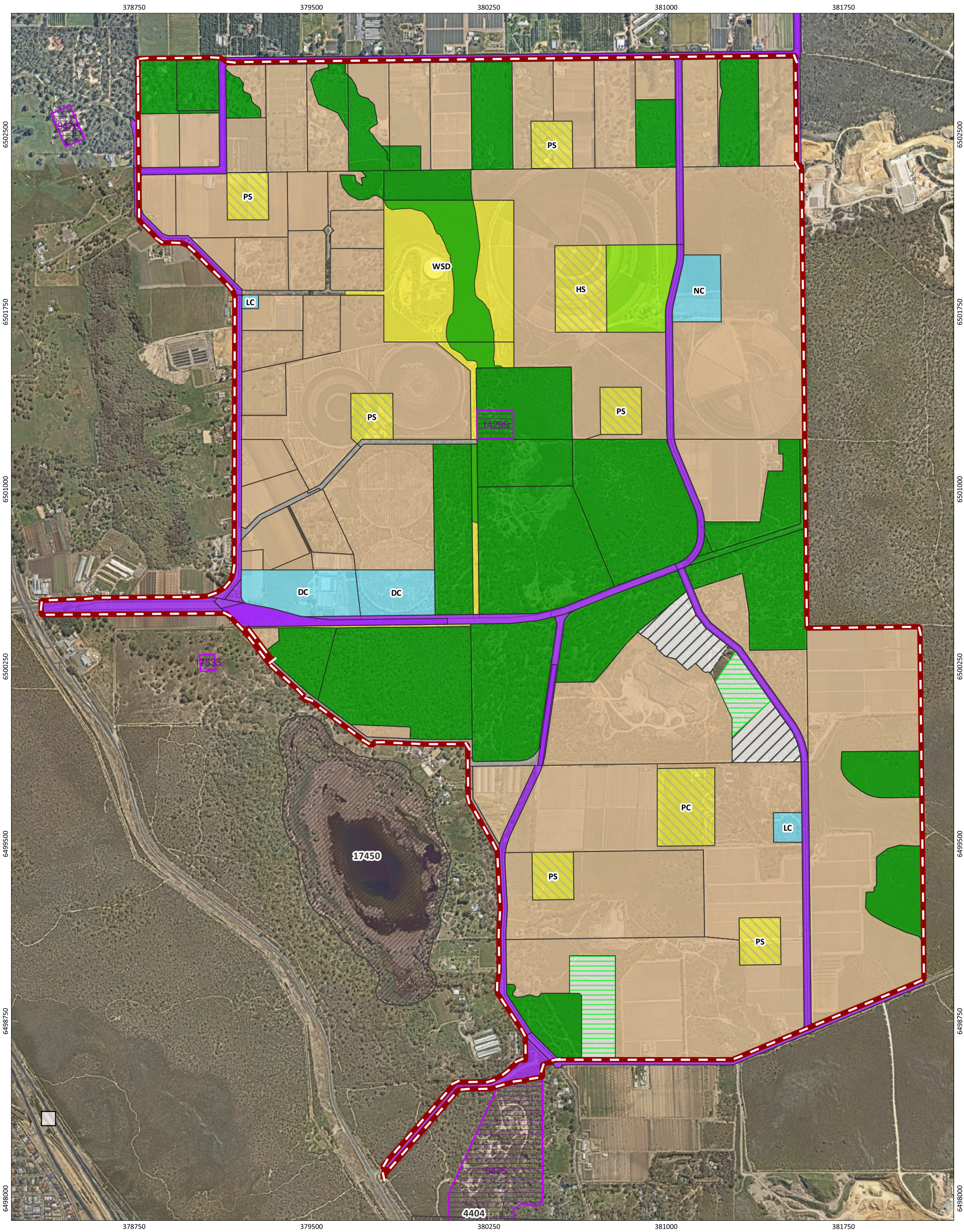


Figure 24: Heritage

N; 0 200 400 m		PROJECT/REPORT NAME Carabooda Urban Precinct District Structure Plan Multiple lots, Carabooda and Nowergup, WA	
SCALE 1:15,000	SHEET SIZE A3 COLOUR	CLIENT Acumen Development Solutions	
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50		PROJECT A24.019	VERSION 0
DATA SOURCE LANDGATE AERIAL IMAGERY NOW		DRAWN BY / REVIEWED BY JP / HS	DATE 21/7/2026

Legend

- The Site
- Aboriginal Cultural Heritage - Register (DPLH-099)
- Heritage List (DPLH-090)

Proposed District Structure Plan
- Residential
- Centre
- Water Authority of WA
- School Site
- Conservation
- Potential Clearing Permit and BRM Extraction
- Integrator A / Integrator B / Neighbourhood Connector A
- Roads
- Local Open Space for Conservation
- District Open Space

No	Description	Drawn	Approved	Date
A	Original issue	JP	HS	21/7/2026

NOTES:

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6. Assessment of Proposed Impacts and Mitigation

In accordance with Section 38 of the PD Act, all proposed Schemes and amendments are to be referred to EPA for assessment against their Environmental Principles, Factors and Objectives. This section details the environmental impacts that may result from future development of the Site under the DSP and future Scheme amendments. This section also discusses measures that have and will be taken to avoid, mitigate, and manage environmental impacts.

6.1 Proposed DSP

As illustrated in Figure 4, the DSP proposes the following land uses:

- Urban
- Centre
- Water Authority of WA
- Primary School
- High School
- Private College
- Conservation
- Local Open Space (LOS) for Conservation
- BRM extraction

6.1.1 Proposed Conservation Areas

Large, consolidated areas have been designated for conservation in the centre of the Site, with smaller conservation areas proposed in the north, southeast, and southwest of the Site (see Figure 4). Approximately 24.7% of the Site (241.60 ha) has been designated for conservation under the DSP. Of that, 165.47ha (68.5%) is connected to other conservation areas as well as vegetation outside of the Site.

The DSP will enhance conservation efforts for two key vegetation complexes: the Cottesloe Complex - Central and South and the Herdsman Complex. The Cottesloe Complex, which has 32.2% of its original extent remaining, will see additional areas designated for protection within public open spaces. Similarly, the Herdsman Complex, with 32.1% of its original extent remaining, will also benefit from expanded conservation areas through the DSP. These measures will help preserve the ecological integrity of both complexes for future generations.

Values to be retained within the proposed conservation area are detailed in Table 26.

6.1.2 Proposed LOS for Conservation Areas

In addition to the proposed Conservation Areas, the DSP also identifies 11.0 ha as LOS for Conservation. These areas were identified through consultation with the project team, to preserve additional environmental values, such as black cockatoo foraging habitat, outside of formal conservation areas. Significant values within these areas are reflected in Table 26.

6.1.3 Management of Interface between Conservation Areas and Road Reserves

The DSP has attempted to minimise the number of road reserves intersecting areas of Conservation, however in order to provide safe and efficient passage through the DSP area, some roads were unavoidable. In line with advice received by the EPA, measures to reduce potential impacts to fauna resulting from roads intersecting conservation areas will be considered and addressed at subsequent stages of planning, informed by fauna surveys. Measures are likely to include fencing, fauna overpasses or underpasses, signage, speed limits, and the consideration of artificial lighting necessity, type, and placement.

Table 26. Proposed Conservation Area - Retention of Environmental Values

Environmental Value		Proposed Conservation[11]		Proposed LOS for Conservation		Proposed Urban		Proposed BRM	
		Area (ha)	% of Total	Area (ha)	% of Total	Area (ha)	% of Total	Area (ha)	% of Total
Vegetation in Good or Better Condition[12]		168.71	77.4%	10.54	4.8%	28.73	13.2%	9.96	4.6%
Banksia Woodlands of the Swan Coastal Plain		**39.26**	**87.2%**	**0.18**	**0.4%**	**5.49**	**12.2%**	**0.08**	**0.2%**
Very Good and Excellent Condition		24.47	95.7%	0.00	0.0%	1.11	4.3%	0	0.0%
Tuart Woodlands and Forests of the Swan Coastal Plain		**84.34**	**74.7%**	**0.00**	**0.0%**	**28.03**	**24.8%**	**0.48**	**0.4%**
Good or better condition		34.49	93.2%	0.00	0.0%	2.03	5.5%	0.48	1.3%
Honeymyrtle Shrublands on Limestone Ridges of the Swan Coastal Plain		**12.09[13]**	**100.0**	**0**	**0**	**0**	**0**	**0**	**0**
Foraging Habitat for Carnaby's Black Cockatoo - Total		241.46	25.1%	11.00	1.1%	708.12	73.7%	0	0.0%
Foraging Habitat Quality	1[14]	18.24	3.3%	0.06	0.0%	533.98	96.5%	1.05	0.2%
	3	0.99	1.3%	0.00	0.0%	72.21	98.3%	0.27	0.4%
	4	99.24	64.9%	5.35	3.5%	47.45	31.0%	0.93	0.6%
	5	37.56	79.2%	0.00	0.0%	9.82	20.7%	0.02	0.0%
	6	41.49	55.9%	5.30	7.1%	18.43	24.9%	8.94	12.1%
	7	43.94	74.2%	0.29	0.5%	14.74	24.9%	0.28	0.5%

[12] Includes vegetation determined to be in 'Degraded to Good' condition by PGV (2024).

[13] 0.25 ha of this TEC occurs within the Water Corporation owned land, outside of conservation areas. This is a result of mapping inaccuracies, and the entirety of this TEC will be included within conservation areas.

[14] This habitat quality score is associated with cleared areas with very scattered trees. The actual extent of foraging habitat within these areas (i.e. canopy cover) is significantly less than the areas quoted in BCE (2024).

Environmental Value		Proposed Conservation[11]		Proposed LOS for Conservation		Proposed Urban		Proposed BRM	
		Area (ha)	% of Total	Area (ha)	% of Total	Area (ha)	% of Total	Area (ha)	% of Total
Foraging Habitat for Forest Red-tailed Black Cockatoo - Total		**241.46**	**25.1%**	**11.00**	**1.1%**	**696.63**	**72.5%**	**11.49**	**1.2%**
Foraging Habitat Quality	1	71.75	11.2%	5.36	0.8%	552.48	86.4%	9.99	1.6%
	2	2.12	8.7%	5.35	21.9%	16.51	67.5%	0.46	1.9%
	3	0.99	1.4%	0.00	0.0%	72.21	98.3%	0.27	0.4%
	4	129.04	73.4%	0.29	0.2%	45.61	26.0%	0.76	0.4%
	5	37.56	79.2%	0.00	0.0%	9.82	20.7%	0.02	0.0%
Black Cockatoo Potential Nesting Trees - Total		**999**	**62.5%**	**13**	**0.8%**	**570**	**35.7%**	**16**	**1.0%**
Tree Class	Class 2 (suitable hollow, chew marks)	6	42.9%	0	0.0%	8	57.1%	0	0.0%
	Class 3 (suitable hollow, no chew marks)	75	75.8%	0	0.0%	24	24.2%	0	0.0%
	Class 4 (some hollow development, unsuitable for nesting)	123	63.7%	0	0.0%	69	35.8%	1	0.5%
	Class 5 (no hollow development)	780	60.4%	13	1.0%	484	37.5%	15	1.2%

Total retention of environmental values through the allocation of 252.60 ha of land for Conservation and LOS for Conservation is provided in Table 27.

Table 27. Total Retention of Environmental Values - Conservation Areas and LOS for Conservation

Environmental Asset	Extent within DSP	Extent to be Retained within Conservation and LOS for Conservation	
		Extent to be Retained	Proportion of that within DSP
Remnant Vegetation	333.78 ha	233.17 ha	69.9%
Remnant Vegetation in Good or Better Condition	217.94 ha	179.25 ha	82.2%
Banksia Woodlands of the Swan Coastal Plain	45.01 ha	39.44 ha	87.6%
Tuart Woodlands and Forests of the Swan Coastal Plain	112.85 ha	84.35 ha	74.8%
Honeymyrtle Shrublands on Limestone Ridges of the Swan Coastal Plain	12.09 ha	12.02 ha	99.4%
Carnaby's Black Cockatoo Foraging Habitat (Higher Quality)	180.81 ha	128.58 ha	71.1%
5	47.40 ha	37.56 ha	79.2%
6	74.16 ha	46.79 ha	63.1%
7	59.25 ha	44.23 ha	74.7%
Forest Red-tailed Black Cockatoo	223.09 ha	166.88 ha	75.3%
4	175.69 ha	129.33 ha	73.6%
5	47.40 ha	37.56 ha	79.2%
Black Cockatoo Potential Nesting Trees	1,598	1,012	63.3%
Black Cockatoo Potential Nesting Trees with Suitable Hollows (Class 2 and 3)	113	81	71.7%

6.2 Preliminary Assessment Against the EPA Environmental Factors

A preliminary assessment against the EPA's Environmental Factors and Objectives was undertaken, as detailed in Table 28. The 'Marine' Theme has been excluded as none of the applicable Factors are relevant to the DSP.

Based on this assessment, the following EPA Factors are identified as relevant to the proposed DSP:

- Flora and vegetation.
- Terrestrial fauna.
- Subterranean fauna.
- Social surroundings.

Table 28. EPA Environmental Factors - Preliminary Assessment

Theme	Factor	Objective	Description within Site	Proposed Impact and Preliminary Assessment
Land	Flora and vegetation	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.	• The Site contains 333.78 ha of remnant native vegetation that supports the following values: ○ 217.94 ha remnant native vegetation in Good or better condition[15]. ○ 112.85 ha of Tuart Woodlands and Forests of the Swan Coastal Plain TEC. ○ 45.01 ha of Banksia Woodlands of the Swan Coastal Plain TEC. ○ 12.09 ha of Honeymyrtle Shrubland on Limestone Ridges of the Swan Coastal Plain TEC. ○ Individuals or populations of four species of conservation significance: ○ *Eucalyptus argutifolia* (six plants) (VU). ○ *Pimelea calcicola* (two small populations) (P3). ○ *Stylidum maritimum* (one population) (P3). ○ *Eucalyptus foecunda subsp. foecunda* (two plants) (P4).	The proposed DSP may result in the following impacts to flora and vegetation: • Clearing of 100.61 ha (30.1%) of remnant native vegetation that supports the following values: ○ 38.69 ha (17.8%) of remnant vegetation in Good or better condition. ○ 28.51 ha (25.3%) of Tuart Woodlands and Forests of the Swan Coastal Plain TEC. ○ 5.57 ha (12.4%) of Banksia Woodlands of the Swan Coastal Plain TEC. ○ *Pimelea calcicola* (one small population) (P3). ○ *Eucalyptus foecunda* subsp. *foecunda* (two plants) (P4). Conservation areas have been identified within the DSP to retain and protect areas of remnant native vegetation, prioritising areas with consolidated high-quality environmental values. This presents an outcome that balances environmental impacts with proposed urban development, resulting in 25% of Tuart Woodlands and Forests of the Swan Coastal Plain and less than 13% of Banksia Woodlands of the Swan Coastal Plain being impacted. Impacts to Honeymyrtle Shrubland on Limestone Ridges of the Swan Coastal Plain have been entirely avoided[16]. The proposed DSP also avoids any impact to rare flora, retaining six plants of *Eucalyptus argutifolia* (Vulnerable) within a conservation area. Impacts to *Stylidium maritimum* (P3) and one population of *Pimelea calcicola* (P3) will also be avoided by the proposed DSP.

[15] Includes vegetation categorised by PGV (2024) as 'Good to Degraded' condition.

[16] 0.25 ha of this TEC occurs within the Water Corporation owned land, outside of conservation areas. This is the result of misaligned mapping rather than actual impact, and the entirety of this TEC will be included within conservation areas.

Theme	Factor	Objective	Description within Site	Proposed Impact and Preliminary Assessment
				A comprehensive restorative planting program within the site will also be undertaken; funded by the mechanisms detailed in Section 2.3. This, along with further opportunities to avoid, mitigate, manage and offset impacts to flora and vegetation will be explored through subsequent stages of planning. It is considered that impacts to flora and vegetation can be managed effectively to meet the EPA's objective for this factor.
	Landforms	To maintain the variety and integrity of distinctive physical landforms so that environmental values are protected.	No significant landforms present within the Site.	No significant impacts to landforms will result from the proposed DSP, given the absence of significant landforms from the Site.
	Subterranean fauna	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.	Subterranean fauna may occur within the Site, given that it is located in a high-risk area for karst limestone (CoW, 2022b).	There is potential of subterranean fauna occurring within the site, given that it is located in an area of high risk of karst limestone (CoW 2022b). As detailed in the City of Wanneroo (2022) LPP 4.13 *Caves and Karstic Features*, a desktop karst survey will be prepared for each Local Structure Plan. Based on the nature of urban development, any potential impacts are likely to be localised and able to be readily avoided or mitigated if identified, due to the required management of geotechnical risks for other reasons.
	Terrestrial environmental quality	To maintain the quality of land and soils so that environmental values are protected.	A large proportion of the Site (65.2%) has already been cleared, irrigated, and/or used for agricultural purposes. Whilst the majority of the Site is mapped as having a low risk of ASS occurring, there is a small pocket of land with a high to moderate risk of ASS occurring within 3 m of the natural soil surface in the northern portion of the Site, affecting approximately 2.15 ha. The Site does not show evidence of heavy industry (other than the lime kilns) that are likely to have resulted in contamination, and no registered contaminated sites are located within the Site. There are no records to indicate any large spills or other contamination events have occurred at the Site, however there are reports of rubbish dumping (car bodies) in various locations and the	No significant impacts expected, given large areas of the Site are currently cleared, irrigated, and used for agricultural purposes. There are minimal impacts expected from ASS, and no waste storage structures are planned for the Site. It is recommended that preliminary site investigation for contamination be conducted as part of early works for development.

Theme	Factor	Objective	Description within Site	Proposed Impact and Preliminary Assessment
			age of structures mean there is potential for asbestos-containing material to be present.	
	Terrestrial fauna	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	The Site provides the following significant fauna habitat values: • 959.16 ha of foraging habitat for Carnaby's black cockatoo with a weighted average quality of 3 (out of 10) described as low to moderate quality (BCE, 2024). The majority (553.33 ha; 57.6%) of habitat is of negligible quality (1/10). • 133.42 ha of foraging habitat for Carnaby's black cockatoo with foraging quality score of at least 6/10. • 959.16 ha of foraging habitat for Forest red-tailed black cockatoo with a weighted average quality of 2 (out of 10) described as low quality (BCE, 2024). The majority (664.02 ha; 69.2%) is of negligible to low quality (score of 2/10 or lower). • No foraging habitat for Forest red-tailed black cockatoo with foraging quality score of at least 6/10. • 1,598 potential nesting trees with DBH ≥ 50 cm, of which: ○ 14 are Class 2 (suitable hollows, chew marks). ○ 99 are Class 3 (suitable hollows, no chew marks). ○ 193 are Class 4 (unsuitable hollows). • 1,292 are Class 5 (no hollow development). It is important to note that the habitat quality scores of 1 for both species of black cockatoo, are associated with cleared areas with very scattered trees. The actual extent of foraging habitat within these areas (i.e. canopy cover) is significantly less than the areas quoted in BCE (2024) and above.	Future development in accordance with the proposed DSP would result in the following impacts: • Clearing of 173.09 ha of foraging habitat for Carnaby's black cockatoo with a quality score of at least 3/10. • Of that, 42.39 ha has a foraging quality score of at least 6/10. • Clearing of 128.69 ha of foraging habitat for Forest red-tailed black cockatoo with a quality score of at least 3/10. • Of that, 56.21 ha has a foraging quality score of 4/10 or 5/10 (highest quality habitat present within DSP). • 586 potential nesting trees with DBH ≥ 50 cm, of which: ○ 8 are Class 2 (suitable hollows, chew marks). ○ 24 are Class 3 (suitable hollows, no chew marks). ○ 70 are Class 4 (unsuitable hollows). ○ 499 are Class 5 (no hollow development). Conservation areas have been identified within the DSP to retain and protect areas of remnant native vegetation, prioritising areas with consolidated high-quality environmental values. This presents an outcome that balances environmental impacts with proposed urban development. Within conservation areas, 71.1% of the higher quality habitat for Carnaby's black cockatoo (score of 5/10 or higher) will be retained. Similarly, 75.3% of the higher quality habitat for Forest red-tailed black cockatoo (score of 4/10 or 5/10) will be retained within conservation areas. Approximately 63.3% of potential nesting trees (DBH ≥ 50 cm) will be retained within conservation areas. Further, 71.7% of Class 2 and 3 trees (i.e. those with suitable nesting hollows) will be retained. Further opportunities to avoid, mitigate, manage and offset impacts to terrestrial fauna will be explored through subsequent stages of planning. Specifically: • Measures to reduce potential impacts to fauna resulting from roads intersecting conservation areas, such as fencing, fauna

Theme	Factor	Objective	Description within Site	Proposed Impact and Preliminary Assessment
				overpasses or underpasses, signage, speed limits, and the consideration of artificial lighting necessity, type, and placement. • Prioritising the retention of existing trees. • Undertaking additional planting within development areas to provide black cockatoo foraging habitat. • Establishment of canopy corridors to facilitate flight paths between foraging habitats and roost sites within and outside of the DSP area. It is considered that impacts to terrestrial fauna can be managed effectively to meet the EPA's objective for this factor.
Water	Inland waters	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.	Minimum depth to groundwater ranges across the Site from 10 m below ground level (m bgl) in the west to 50 m bgl in the west. No surface water features or geomorphic wetlands occur within the Site.	Hydrological regimes and quality of groundwater and surface water will be further managed through the development and implementation of a District Water Management Strategy (DWMS), Local Water Management Strategy (LWMS) and Urban Water Management Plan (UWMP) at the appropriate stage in the development process. Management measures associated with Inland Waters are discussed in the Integrated Water Management Framework prepared by Pentium Water (2023).
Air	Air quality	To maintain air quality and minimise emissions so that environmental values are protected.	There is potential for dust emissions during construction phase, as well as from nearby land uses (e.g. quarries).	A CEMP will be prepared with provisions for dust management throughout the vegetation clearing and construction phase of future development. Reduced impacts are anticipated post-development with a likely drop in airborne dust typically associated with the current activities on-site (i.e. from non- vegetated soil after crop harvesting and establishment of a new crop. Impacts of dust and noise from nearby quarries should also be considered through subsequent stages of planning and development.
	Greenhouse gas emissions	To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable.	Future development of the Site, facilitated by the proposed scheme amendment, will result in scope 1, 2 and 3 emissions (during construction and operation).	It is recommended that potential Scope 1 and 2 emissions associated with future development under the DSP are assessed concurrently with the MRS amendment. The assessment should identify opportunities to reduce and/or minimise GHG emissions from future urban development.

Theme	Factor	Objective	Description within Site	Proposed Impact and Preliminary Assessment
People	Social surroundings	To protect social surroundings from significant harm.	The Site does not contain any registered sites of Aboriginal heritage value. There is a historic lime kiln located within the Site which is identified under the City of Wanneroo's Local Heritage Survey. There are three poultry farms in proximity to the Site which are expected to remain operational. Odour, dust, and noise emissions from these farms may impact sensitive land uses.	The historic lime kiln identified under the City of Wanneroo Local Heritage Survey will be retained and protected within a conservation area. The social surrounds will be altered with the eventual increase in the population as a result of the change to an urban land use. An indicative buffer of 500 m has been applied, consistent with the EPA's guideline for assigning buffers to industrial land uses, to mitigate impacts of odour, dust, and noise. However, it is expected that these buffers may be able to be reduced to 300 m, as informed by site-specific conditions. An assessment of these conditions will be undertaken to inform local structure planning. It is recommended that a social impact study be considered to ensure no significant impacts will result from future development consistent with the DSP.
	Human health	To protect human health from significant harm.	N/A	No significant impacts to human health are expected to result from future development consistent with the DSP.

6.3 Residual Impacts

The proposed DSP is likely to result in residual impacts to:

- Banksia woodlands of the Swan Coastal Plain.
- Tuart woodlands and forests of the Swan Coastal Plain.
- Carnaby's black cockatoo.
- Baudin's black cockatoo.

As detailed in Table 28, these residual impacts have been minimised as far as reasonably practicable. To contribute to the compensation for these impacts, the Proponent will undertake restorative plantings within conservation areas where Degraded and Completely Degraded vegetation and agricultural land exists. These plantings (encompassing approximately 30 ha - to be refined at future planning stages) will be documented within a restoration plan which will be developed under the guidance and advice of Vern Newton of Heidelberg Materials, who is recognised as an industry leader in this field.

7. Other Environmental Issues

7.1 Cumulative Impact Assessment

Discussion with DWER EPA Services during project development highlighted the need to consider cumulative impacts to the conservation significant ecological communities (namely Banksia Woodlands of the Swan Coastal Plain and Tuart Woodlands and Forests of the Swan Coastal Plain Threatened Ecological Communities) from the DSP as well as surrounding major projects. Following consultation with DWER EPA Services and a process of project identification and refinement, the East Wanneroo District Structure Plan (EWDSP; located 18 km from the Site) was considered to be the major project with impacts that should be considered in this cumulative impact assessment.

Table 29 summarises the extent of each TEC within the Site, and the quantum of impact and conservation associated with the DSP.

Table 29: Summary of TECs within the DSP

Threatened Ecological Community	Total (ha)	Proposed to be Impacted (ha)	Proposed for Conservation (ha)
Banksia Woodlands of the Swan Coastal Plain	45.01	5.75	39.26
Tuart Woodlands and Forests of the Swan Coastal Plain	112.85	28.51	84.35
Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion	12.09	0	12.09[17]

7.2 Conservation Outcomes

This analysis has been undertaken to demonstrate the significant representation of Banksia Woodlands of the Swan Coastal Plain and Tuart Woodlands and Forests of the Swan Coastal Plain TECs in the surrounding conservation estate and DBCA managed land.

The DSP has been designed to ensure that there are no impacts to Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion TEC[17], therefore the TEC is excluded from further discussion.

The impact of the DSP on Banksia Woodland TEC and Tuart Forests and Woodlands TEC is extremely low. Through strategic and environmentally conscious design, impacts have been reduced to 5.57 ha of Banksia Woodland TEC and 28.51 ha of Tuart Forests and Woodlands TEC. Impacts are largely limited to the most degraded representations of these TECs within the Site. Further, significant commitment to

[17] 0.07 ha of this TEC occurs within the Water Corporation owned land, outside of conservation areas. This is a result of misaligned mapping, rather than an actual impact, and the entirety of this TEC will ultimately be included within conservation areas.

preservation of these TECs is demonstrated by the DSP - a total of 39.26 ha (87.3% of mapped extent within the Site) of Banksia Woodland TEC and 84.34 ha (74.8% of mapped extent within the Site) of Tuart Forests and Woodlands TEC will be captured within conservation areas.

These impacts are of even lower significance when considered in the context of the surrounding area. A limited assessment was undertaken to understand the representation of TECs within 18 km of the Site (i.e. the radius in which a database search was undertaken using data purchased from DBCA). The assessment is limited in that the data which is available does not differentiate between how much of a mapped TEC is the TEC itself, and how much is a buffer which has been applied.

Notwithstanding these constraints, this preliminary assessment identified approximately 6,186 ha of Banksia Woodland TEC and Tuart Forests and Woodlands TEC in conservation estate (i.e. conservation reserves, Bush Forever, National Parks etc.) within 18 km of the Site. There is an estimated additional 12,175 ha of these TECs in State Forest within this radius. A breakdown of these figures by TEC is provided in Table 30.

This assessment demonstrates that the proposed clearing of Banksia Woodland TEC and Tuart Forests and Woodlands TEC for the Carabooda DSP amounts to a very small percentage of the extent of these TECs in the conservation estate and DBCA-managed land within 18 km.

Table 30: Regional Conservation Analysis

Threatened Ecological Community	Conservation reserves, National Parks and DBCA managed crown land	State Forest
Banksia Woodlands of the Swan Coastal Plain	2,964 ha	10,089 ha
Tuart Woodlands and Forests of the Swan Coastal Plain	3,222 ha	2,086 ha
TOTAL	**6,186 ha**	**12,175 ha**

In accordance with the advice of EPA Services, a cumulative impact assessment was undertaken that combines impacts of the DSP with those expected from the EWDSP, using information obtained from Table 2 in Emerge (2019). Impacts were calculated by subtracting the area within Draft EWDSP protection areas from the area within the site. Table 31 provides a summary of the proposed conservation outcomes and demonstrates:

- The quantum of impacts to Banksia Woodland TEC and Tuart Forests and Woodlands TEC associated with the DSP are extremely low when compared to those associated with the EWDSP (5.57 ha vs. 255 ha and 28.51 ha vs. 33 ha respectively).
- The overall impact to Banksia Woodland TEC and Tuart Forests and Woodlands TEC from both urban development proposals is low, in the context of the surrounding area and quantum of each TEC within conservation reserves, Bush Forever, National Parks, and State Forest within 18 km of the DSP.

Table 31: Cumulative Impact Assessment (Carabooda and East Wanneroo DSPs)

Threatened Ecological Community	Mapped Extent	Impact
Banksia Woodlands of the Swan Coastal Plain		
Carabooda DSP	45.01 ha	5.57 ha
East Wanneroo DSP	1,167.00 ha	255.00 ha
TOTAL	**1,212.01 ha**	**260.57 ha**
Tuart Woodlands and Forests of the Swan Coastal Plain		
Carabooda DSP	112.85 ha	28.51 ha
East Wanneroo DSP	53.00 ha	33.00 ha
TOTAL	**165.85 ha**	**61.50 ha**

7.3 Bushfire Management

As a result of the bushfire prone status of the site, a Bushfire Management Plan (BMP) is required to accompany the scheme amendment application to address the following requirements of *State Planning Policy 3.7 Planning in Bushfire prone areas* (SPP 3.7):

- A Bushfire Hazard Level (BHL) assessment or, where lot layout is known, a Bushfire Attack Level (BAL) contour assessment to determine the indicative acceptable BAL ratings across the Site.
- Identification of any bushfire hazard issues arising from the above assessment.
- Assessment against the bushfire protection criteria requirements contained within the Guidelines demonstrating compliance can be achieved in subsequent planning stages.

A BMP has been prepared to support future the DSP (WEPL, 2024) and does not rely on clearing of vegetation within the proposed conservation areas to achieve compliance with SPP 3.7.

8. Conclusion

The proposed DSP has been designed to retain significant environmental and heritage features, as well as preserve ecological linkages, through thoughtful designation of conservation areas. High quality vegetation are preserved within 241.60 ha of conservation areas which are representative of conservation significant ecological communities, contain Threatened and Priority flora, and provide habitat for conservation significant fauna. The Proponent has recognised these values early in the design process, and seeks to enhance and protect these values through future urban development including a comprehensive restorative planting plan, developed and conducted under the guidance and advice of Vern Newton of Hanson Construction Materials, who is recognised as an industry leader in this field. In addition, environmental values will be retained within 11.0 ha of land which is designated as LOS for Conservation.

The DSP will provide for ongoing funding for designated Conservation Areas, which will be delivered through an innovative Conservation Management Fund (CMF), managed by the City of Wanneroo or an identified authority or agency. This will result in:

- Establishing seed funding of $8,500,000 over the development of the Carabooda DSP through the contribution of $1,000 per lot into a CMF.
- Ensuring the management of the significant conservation areas are permanently funded and protected in the future by establishing a Specific Area Rating system (SAR) that provides an ongoing annual contribution to the CMF through the annual collection of SAR from every residential lot created in the DSP, contributing $2.76M annually into the CMF.
- Protecting and enhancing that the significant regional ecological linkage which runs from east to west across the centre of the Site through the establishment and management of the significant conservation areas in the DSP.

The Environmental Factors of Flora and Vegetation, Terrestrial Fauna, Subterranean Fauna, Inland Waters and Social Surroundings have been the focus of this report.

As detailed in section 5.4.2, three TECs (Banksia Woodland, Tuart Woodland and Forests, and Honeymyrtle Shrubland) are identified within the DSP Site. The proposed DSP will retain 87.6% of Banksia Woodland, 74.8% of Tuart Woodlands and Forests, and 100% of Honeymyrtle Shrubland[18]. Further, the DSP prioritises the retention of higher quality TEC.

[18] 0.25 ha of this TEC occurs within the Water Corporation owned land, outside of conservation areas. This is the result of mapping inaccuracies rather than an actual impact, and the entirety of this TEC will be included within conservation areas.

As detailed in section 5.4.2, one Threatened and three Priority flora species have been identified within the DSP Site, namely *Eucalyptus argutifolia* (VU), *Pimelea calcicola* (P3), *Stylidium maritimum* (Priority 3), and *Eucalyptus foecunda subsp. foecunda* (P3). The proposed DSP will retain all individuals of *E. argutifolia* and *S. maritimum*, and limits impact to one population of *P. calcicola*.

As detailed in section 5.5.2, the Site provides foraging, roosting, and breeding habitat for Carnaby's black cockatoo and Forest red-tailed black cockatoo. Foraging habitat for Carnaby's black cockatoo has a weighted average quality of 3/10, and foraging habitat for Forest red-tailed black cockatoo has a weighted average quality of 2/10. The proposed DSP will retain 252.46 ha of foraging habitat for Carnaby's black cockatoo with a weighted average quality of 5/10, and 252.46 ha of foraging habitat for Forest red-tailed black cockatoo with a weighted average quality of 3/10. As such, the DSP retains higher quality habitat for both species within areas of conservation.

The proposed DSP will also retain 63.3% of potential black cockatoo nesting trees within conservation areas and LOS for Conservation, including 71.7% of Class 2 and 3 trees (which contain suitable hollows).

As detailed in section 5.6, a mapped regional ecological linkage traverses the centre of the Site, running east to west. The DSP will ensure this ecological linkage is preserved through conservation areas, that will maintain connectivity between State Forest associated with Bush Forever site 290 (Hopkins Road Bushland) to the east and Bush Forever site 383 (Neerabup National Park, Lake Gnowerup Nature Reserve and adjacent bushland) to the west.

The area is identified as ‘high risk’ for caves/karst limestone across the north of the Site. It is therefore possible that subterranean fauna could exist in these areas. Alongside the geotechnical risk that these areas pose, further assessment is required on the likelihood of subterranean fauna existing on the Site. Desktop karst surveys will be undertaken for each Local Structure Plan in accordance with LPP 4.13.

The hydrology of the site will likely be impacted with a change in land use and water regimes (i.e. irrigation). There are identified geomorphic wetlands adjacent to the Site which in turn could be impacted by the proposed DSP. Increased water runoff from roads and sealed areas and a likely increase in groundwater levels from the cessation of irrigation is a positive for wetlands in the area.

There are no registered Aboriginal Heritage sites within the Site. Historic lime kilns in the centre of the Site will be preserved within a conservation area. Further, the EPA's Social Surroundings Environmental Factor includes amenity and the economy. The Proponent has commenced studies in this area and should continue to further understand the impact of the proposed DSP.

The impact from existing quarrying activities on the site should be considered during subsequent planning stages. Potential noise and dust impacts from these activities can be managed through consultation with quarry managers and staging development works.

There is no evidence of heavy industry and associated contamination at the Site. The age of assorted structures across the site highlights the potential for asbestos-containing material to be present at various locations. Past agricultural and horticultural land use raises the possibility of contamination from fertiliser, pesticide and herbicide use. It is recommended that a preliminary site investigation for contamination be conducted as part of early works for the Site's development.

A cumulative impact assessment undertaken to consider proposed impacts and retention of TECs in the context of the local area (18 km radius) indicates that 0.5% of Banksia Woodlands and 17.2% of Tuart Woodlands and Forests mapped within the Carabooda and East Wanneroo District Structure Plans may be impacted by the DSP. The impacts are also low when considered in conjunction with those of the East Wanneroo District Structure Plan, with combined impacts to 21.5% of Banksia Woodlands and 37.1% of Tuart Woodlands and Forests mapped within both District Structure Plans.

In summary, this environmental assessment, in the context of DSP lodgement, highlights strong retention of ecological values and raises the need for further investigation at relevant stages of planning. a number of environmental values that need to be further investigated. As the Proposal develops the additional information on environmental aspects will offer an opportunity to refine the design to ensure that Proposal can be undertaken in a sustainable manner.

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Appendix A
Lots included in the DSP and Proposed MRS Amendment

Lot on Plan/Diagram	Area (ha)	Site Address
Lot 121 on D072877	141.21	288 Carabooda Road, Carabooda
Lot 69 on P057248	5.01	113 Kiln Road, Carabooda
Lot 67 on P057248	29.45	99 Kiln Road, Carabooda
Lot 68 on P057248	39.29	60 Kiln Road, Nowergup
Lot 8038 on P206216	12.24	115 Kiln Road, Carabooda
Lot 5466 on P206216	8.00	116 Kiln Road, Nowergup
Lot 106 on P014371	26.11	149 McLennan Drive, Nowergup
Lot 105 on P014371	25.26	193 McLennan Drive, Nowergup
Lot 100 on P014371	20.18	235 McLennan Drive, Nowergup
Lot 101 on P014371	21.12	210 McLennan Drive, Nowergup
Lot 102 on P014371	20.00	198 McLennan Drive, Nowergup
Lot 104 on P014371	22.54	170 McLennan Drive, Nowergup
Lot 103 on P014371	23.80	44 Godel Road, Nowergup
Lot 107 on P014371	18.84	59 Godel Road, Nowergup
Lot 13 on D039500	75.98	135 Wesco Road, Nowergup
Lot 12 on D039500	68.10	348 Gibbs Road, Nowergup
Lot 1 on D027699	31.12	288 Gibbs Road, Nowergup
Lot 11 on D039500	59.80	53 Wesco Road, Nowergup

Appendix B
Carabooda Rezoning Project - Flora and Vegetation Survey (PGV, 2024)

CARABOODA REZONING PROJECT

FLORA AND VEGETATION SURVEY

Prepared for:	Carabooda Landowners Pty Ltd
Report Date:	16 January 2025
Version:	4
Report No.	2023-784

pgv ENVIRONMENTAL

CONTENTS

Contents i

List of Tables and Plates iii

List of Attachments iv

1 INTRODUCTION 1

1.1 Background 1

1.2 Scope of Works 1

2 EXISTING ENVIRONMENT 2

2.1 Historic Land Use 2

2.2 Topography 3

2.3 Geology and Soils 3

2.3.1 Geology 3

2.3.2 Soils 3

2.4 Hydrology 4

3 METHODOLOGY 5

3.1 Database Searches 5

3.2 Detailed Survey 5

3.3 Survey Conditions 5

4 RESULTS 7

4.1 Desktop Studies 7

4.1.1 Flora Database Searches 7

4.1.2 TEC/PEC Database Searches 13

4.2 Flora 14

4.3 Vegetation 17

4.3.1 Vegetation Complexes 17

4.3.2 Vegetation Types 17

4.3.3 Floristic Community Types 25

4.3.4 Vegetation Condition 26

4.4 Conservation Significance of Flora and Vegetation 27

4.4.1 Flora 27

4.4.2 Vegetation Complexes 27

4.4.3 Threatened and Priority Ecological Communities 28

5 SUMMARY 37

6 REFERENCES 39

LIST OF TABLES AND PLATES

Tables

Table 1: Statement of Botanical Survey Conditions

Table 2: Identified Significant Flora Species and Likelihood of Occurring on the Site

Table 3: TEC and PECs Identified in Database Searches

Table 4: Vegetation Types on the Site

Table 5: FCT Analysis

Table 6: Vegetation Condition Rating Scale

Table 7: Vegetation Association Statistics

Table 8: Tuart TEC Condition Categories and Thresholds

Table 9: Tuart Woodland TEC Step 1 Diagnostics

Table 10: Tuart Woodland TEC Step 2 Diagnostics

Plates

Plate 1: Aerial Photograph from 1965 (Landgate, 2023)

Plate 2: Aerial Photograph from 1979 (Landgate, 2023)

Plate 3: Eucalyptus argutifolia on the Site

Plate 4: *Pimelea calcicola* Recorded on the Site

Plate 5: *Stylidium maritimum* Recorded on the Site

Plate 6: *Eucalyptus foecunda subsp. foecunda* Recorded on the Site

Plate 7: Tuart TEC Patch Boundaries

Plate 8: Variation Within a Patch

LIST OF ATTACHMENTS

Figures

Figure 1: Site Location

Figure 2: Site Boundary and Topography

Figure 3: Vegetation Types

Figure 4: Vegetation Condition

Figure 5: Threatened Ecological Communities

Appendices

Appendix 1: Track Logs

Appendix 2: DBCA Flora Database Searches

Appendix 3: Atlas of Living Australia Database Search

Appendix 4: Protected Matters Search Tool Report

Appendix 5: Conservation Codes

Appendix 6: DBCA TEC/PEC Database Search

Appendix 7: Flora Species List

Appendix 8: Quadrat Data

Appendix 9: Plantecology FCT Analyses

1 INTRODUCTION

1.1 Background

The Carabooda Rezoning Project (the site) is located in the City of Wanneroo, approximately 38km north-north-west of the Perth Central Business District (Figure 1). The site is approximately 660ha in size and is used for a variety of purposes including market gardens, turf farms, sand and limestone mining (past, present and possible future), rural retreats and undeveloped bushland (Figure 2).

Carabooda Landowners Pty Ltd is investigating the future urban development potential of the site.

This Flora and Vegetation Survey was commissioned by Carabooda Landowners Pty Ltd to assess the flora and vegetation values of the site.

1.2 Scope of Works

A Detailed Flora and Vegetation Survey was undertaken in accordance with the *EPA Technical Guidance: Flora and Vegetation Surveys* (EPA, 2016). The survey included the following:

- Desktop search and review of the Department of Biodiversity, Conservation and Attractions (DBCA) Threatened and Priority flora database;
- A search of Atlas of Living Australia for records pf Threatened or Priority species;
- A search of the Commonwealth Government's Protected Matters Search Tool to identify species potentially occurring within the area that are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- Examination of historic and recent aerial photography and contour and soil maps to provisionally identify vegetation types and condition;
- Field survey using quadrats to record native and introduced species as well as a thorough site walkover of any areas of native vegetation;
- Analysis of quadrat data to ascertain the conservation significance of the vegetation;
- Recording of any significant plant species using a hand-held GPS;
- Description and mapping of vegetation types and vegetation condition; and
- Compilation of a flora list.

2 EXISTING ENVIRONMENT

2.1 Historic Land Use

Historical aerial photography shows that in 1965 (the oldest historical aerial photography available on-line) the northern third of the site (highlighted in red) was mostly native vegetation while the southern two-thirds was a mix of cleared areas and remnant vegetation (Plate 1).

Plate 1: Aerial Photograph from 1965 (Landgate, 2023)



The 1979 aerial photograph shows the vegetated part of the northern area has by then been cleared (Plate 2).

Plate 2: Aerial Photograph from 1979(Landgate, 2023)



2.2 Topography

The site is undulating with an elevation range from 24m Australian Height Datum (AHD) to 74mAHD (Figure 2).

2.3 Geology and Soils

2.3.1 Geology

The site is mapped as part of the Spearwood System which has the highest relief of the dune systems on the Swan Coastal Plain (Bolland, 1998). The Spearwood system consists of slightly calcareous Aeolian sand remnant from leaching of the underlying Pleistocene Tamala limestone (Davidson, 1995).

2.3.2 Soils

The soil units located on the site are described by the Department of Primary Industries and Regional Development (DPIRD) (2023) as:

- Karrakatta shallow soils Phase (211Sp_Kls) which are on low hills and ridges with bare limestone or shallow siliceous or calcareous sand over limestone.

- Karrakatta Sand Yellow Phase (211Sp_Ky) which are undulating dunes on Aeolian sand over limestone in the Swan Coastal Plain between Wanneroo and Lancelin and are yellow deep sands.
- Spearwood Sand Phase (211Sp_Sp) which are undulating dunes with rocky crests on aeolian sand over limestone in the Swan Coastal Plain between Wanneroo and Moore River. These soils are brown deep sands and yellow deep sands (DPIRD, 2023).

2.4 Hydrology

Maximum groundwater under the site is at approximately 16m to 20 AHD which is 10 to 50 m below the surface level. Groundwater generally flows to the west (DWER, 2023). There are no wetlands or watercourses on the site.

3 METHODOLOGY

3.1 Database Searches

Searches of the following databases were undertaken prior to the site survey:

- DBCA Threatened and Priority Flora Databases including the WA Herbarium database (WAHerb) and Threatened (Declared Rare) and Priority Flora Species List (TFPL) (Appendix 2) for a radius of 10 km that provides a list of Threatened and Priority species recorded in the area;
- Atlas of Living Australia (ALA, 2022) (Appendix 3) which shows all species that have been recorded within a 10km radius of the site.
- The EPBC Act Protected Matters Search Tool (DCCEEW, 2022) (Appendix 4) which identifies species that are listed as Endangered, Threatened or Priority under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) could potentially have habitat within a 5km radius of the site.

3.2 Detailed Survey

The Detailed Flora and Vegetation Survey was undertaken over a two-year period on the following dates:

- 14 September – 17 October 2023 on 7 separate field days
- 10 September – 24 September 2024 on 5 separate field days

Due to the large size of the site and difficult terrain for walking in areas of outcropping limestone, sampling in closely spaced transects was not considered feasible. The survey included sampling from 64 permanently marked 10m x 10m quadrats as well as sampling from outside of the quadrats within the different vegetation types on the site. Quadrats in Very Good to Excellent condition were scored twice, once in September and a second time in mid-October. The track logs are shown in Appendix 1.

Information on flora composition and vegetation structure was recorded in the quadrats.

Most plant species were identified in the field. Some specimens were photographed or taken for identification at the Perth Reference Herbarium or office using standard reference guides.

3.3 Survey Conditions

The conditions that the survey was undertaken in are presented in Table 1 in order to assess the adequacy of the survey. Rainfall for Perth in 2023 (Measured at Wanneroo, Site Number 009105) was above average in June and below average in July being 199.4mm and 66.4mm compared to an average of 160.9mm and 160.6mm (BOM, 2023). Rainfall in August and September in 2023 was below average with 98.3mm and 73.5mm compared to 123.5 and 82.6mm (BoM, 2023). The below average rainfall for most of 2023 was not sufficient to be considered a constraint on the survey.

Rainfall for Perth in 2024 (Measured at Wanneroo, Site Number 009105) was below average in June and slightly above average in July being 141.2mm and 166mm compared to an average of 160.6mm and 160.7mm (BOM, 2024) – note averages have changed due to an additional year of statistics.

Rainfall in August was above average with 150.8mm compared to 123.9mm and September was dry with an average rainfall of 22.8 compared to an average of 81.9mm (BoM, 2024). The below average rainfall for September was not sufficient to be considered a constraint on the survey

Table 1: Statement of Botanical Survey Conditions

Issue	Constraints (Y/N)*	Comment
Competency/experience of the consultant conducting the survey	No	Dr Paul van der Moezel has extensive botanical survey experience on the Swan Coastal Plain, including the Wanneroo area.
Proportion of the flora identified^	Moderate	The timing of the survey in September-October of both years was optimal to identify most flora species on the site including all potential Threatened and Priority Flora. Due to the large size of the site and difficult terrain for walking in areas of outcropping limestone, sampling in closely spaced transects was not considered feasible. Therefore, some plant species may have not been recorded.
Sources of information (historic/recent or new data)	No	The flora of the Swan Coastal Plain is well documented.
Proportion of the task achieved and further work that may need to be undertaken	No	More detailed survey of outcropping limestone areas may increase the number of Priority plants recorded on the site. However, no Threatened species are expected to occur which would warrant additional detailed surveys.
Timing/weather/season/cycle	No	The spring survey was optimal for most flora species. 2023 was a good year for ephemeral species, although the season finished early due to the small amount of rainfall in September. 2024 was a better year for ephemeral species but some species appear to have been impacted by the 8 month drought from Sept 2023 to May 2024.
Disturbances (Fire)	No	The site has not been recently burnt.
Intensity of survey (e.g. In retrospect was the intensity adequate)	No	The time spent on site, 13 man days, was considered adequate to sample a high proportion of the flora.
Completeness (e.g. was relevant area fully surveyed)	No	
Resources (e.g. degree of expertise available for plant identification)	No	Experienced botanist undertook most plant identifications on site.
Remoteness and/or access problems	No	Easily accessible site in the Perth Metropolitan Region.
Availability of contextual (e.g. bioregional) information for the study area.	No	WALGA statistics on remnant bushland

*Constraints have been rated as Significant, Moderate or No constraints

^Fungi and nonvascular flora (e.g. algae, mosses and liverworts) were not specifically surveyed for during the survey.

4 RESULTS

4.1 Desktop Studies

4.1.1 Flora Database Searches

The results from the database searches are shown in Table 2. A total of 41 species were identified in the database searches, including 14 Threatened and 27 Priority species. There were two Threatened species and one Priority species identified that are errors within the databases and do not grow in the Perth region. Table 2 lists the likelihood that any of the conservation significant species identified in the database searches could occur on the site based on the soil types and vegetation condition.

Two conservation significant species have been recorded in the northern part of the site on Lot 121 Carabooda Road as follows:

- *Eucalyptus argutifolia* (Endangered); and
- *Stylidium maritimum* (Priority 3).

Conservation codes are in Appendix 5.

Table 2: Identified Significant Flora Species and Likelihood of Occurring on the Site

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act	Habitat*	Likelihood to occur on the site
Caladenia huegelii	King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid	Critically Endangered	Endangered	The Grand Spider-orchid prefers deep grey-white sand usually associated with the Bassendean sand-dune system, however, rare plants have been known to extend into the Spearwood system (in which calcareous yellow sands dominate) in some areas (DEC, 2009). This species generally does not survive in disturbed areas.	Unlikely – the location is further north of known populations
Drakaea elastica	Glossy-leafed Hammer Orchid	Critically Endangered	Endangered	The Glossy-leafed Hammer Orchid prefers low-lying situations adjoining winter-wet swamps and grows on bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps, typically in banksia (*Banksia menziesii*, *B. attenuata* and *B. ilicifolia*) woodland or spearwood (*Kunzea glabrescens*) thicket vegetation (DEC, 2009).	Highly Unlikely – not suitable habitat
Diuris purdiei	Purdie's Donkey-orchid	Endangered	Endangered	Purdie's Donkey Orchid occurs in grey-black sand in moist winter-wet swamps with winter inundation in dense heath with scattered trees and amongst native sedges and dense heath with scattered emergent *Melaleuca preissiana*, *Eucalyptus calophylla*, *E. marginata* and *Nuytsia floribunda*.	Highly Unlikely – not winter-wet habitat
Drakaea micrantha	Dwarf Hammer-orchid	Endangered	Vulnerable	Dwarf Hammer-orchid usually occurs on cleared fire breaks or open sandy patches in Banksia, Jarrah and Sheoak woodlands or forest and often found under Spearwood thickets.	Highly Unlikely – not suitable habitat and not recorded north of the Swan River
Macarthuria keigheryi	Keighery's Macarthuria	Endangered	Endangered	Keighery's Macarthuria prefers white or grey sand on low-lying winter-wet damp sands growing among heathland, Jarrah and Sheoak/Banksia woodland and Banksia/Eucalypt Woodland (DEC, 2008).	Highly Unlikely – not suitable habitat

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act	Habitat*	Likelihood to occur on the site
Marianthus paralius		Endangered	Endangered	*Marianthus paralius* occurs in white sand and brown loam amongst heath on coastal limestone cliffs (DEC, 2009).	Highly Unlikely – not suitable habitat
Melaleuca sp. Wanneroo (G.J. Keighery 16705)		Endangered	Endangered	*Melaleuca* sp. Wanneroo occurs in very shallow soils over limestone 'caprock' on ridges.	Possible – potential habitat occurs on the site
Andersonia gracilis	Slender Andersonia	Vulnerable	Endangered	Slender Andersonia occurs in white/grey sand, sandy clay, gravelly loam in winter-wet areas, near swamps. Vegetation type is low open heath with shrubs over sedges (DEC, 2006).	No – outside of species range, record is in error
Anigozanthos viridis subsp. *terraspectans*	Dwarf Green Kangaroo Paw	Vulnerable	Vulnerable	The Dwarf Green Kangaroo Paw occurs on grey sand, clay loam in winter-wet depressions.	Highly Unlikely – not suitable habitat
Banksia mimica	Summer Honeypot	Vulnerable	Endangered	Summer Honeypot prefers white or grey sand over laterite, sandy loam.	Highly Unlikely – not suitable habitat and not recorded in the vicinity of the site
Diuris micrantha	Dwarf Bee-orchid	Vulnerable	Vulnerable	The Dwarf Bee-orchid is usually found on brown loamy clay in winter-wet swamps, in shallow water.	Highly Unlikely – not suitable habitat
Eleocharis keigheryi	Keighery's Eleocharis	Vulnerable	Vulnerable	Keighery's Eleocharis occurs in clay, sandy loam and is emergent in freshwater: creeks, claypans.	Highly Unlikely – not suitable habitat
Eucalyptus argutifolia	Yanchep Mallee, Wabling Hill Mallee	Vulnerable	Vulnerable	The Yanchep Mallee occurs in shallow soils over limestone on slopes or gullies of limestone ridges, outcrops.	Highly Likely – habitat occurs on the site and has been previously recorded
Paracaleana dixonii	Sandplain Duck Orchid	Vulnerable	Endangered	Sandplain Duck Orchid occurs in grey sand over granite.	No – outside of species range, record is in error

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act	Habitat*	Likelihood to occur on the site
Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)		Priority 1		*Baeckea* sp. Limestone is recorded from limestone outcrop/ridge in yellow sand derived from Tamala Limestone - Spearwood Dune System in bushland burnt 5+ years (Western Australian Herbarium, 2012).	Possible – habitat may occur on the site
Drosera paleacea	Dwarf Sundew	Priority 1		Dwarf Sundew occurs in white sand, sandy clay.	Unlikely – not typical habitat
Leucopogon maritimus		Priority 1		*Leucopogon maritimus* occurs in Quindalup deep, calcareous sands, on the mid to upper slopes of dunes or in shallow sand over limestone, but avoiding the thicker vegetation of the swale (Hislop, 2011)	Highly Unlikely – not Quindalup habitat
Acacia benthamii		Priority 2		*Acacia benthamii* grows on sand, typically on limestone breakaways	Highly Unlikely – not limestone breakaway habitat
Adiantum capillus-veneris	Maidenhair	Priority 2		Maidenhair grows in moist, sheltered sites in gorges and on cliff walls.	No – outside of species range, record is in error
Fabronia hampeana		Priority 2		*Fabronia hampeana* occurs on sheltered wet trunk of *Macrozamia dyeri* in shrub layer (Western Australian Herbarium, 2005).	Highly Unlikely – host plant not recorded from the site
Netrostylis sp. Chandala (G.J. Keighery 17055)		Priority 2		*Netrostylis* sp. Chandala occurs in peaty sand on swamp edges.	Highly Unlikely – not suitable habitat
Adenanthos cygnorum subsp. *chamaephyton*		Priority 3		*Adenanthos cygnorum* subsp. *chamaephyton* occurs in grey sand, lateritic gravel.	Highly Unlikely – not suitable habitat
Conostylis bracteata		Priority 3		*Conostylis bracteata* occurs in sand, limestone on consolidated sand dunes.	Unlikely – not typical habitat

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act	Habitat*	Likelihood to occur on the site
Hibbertia leptotheca		Priority 3		*Hibbertia leptotheca* grows near-coastal limestone ridges, outcrops and cliffs in coastal heaths and thickets usually dominated by species of *Melaleuca* and *Acacia* (Thiele, 2019).	Highly Unlikely – not suitable habitat
Jacksonia gracillima		Priority 3		*Jacksonia gracillima* occurs in grey and brown well-drained sand.	Unlikely – not typical habitat
Lasiopetalum membranaceum		Priority 3		*Lasiopetalum membranaceum* grows in sand over limestone.	Unlikely – not typical habitat
Leucopogon sp. Yanchep (M. Hislop 1986)		Priority 3		*Leucopogon* sp. Yanchep occurs in light grey-yellow sand, brown loam, limestone, laterite, granite on coastal plain, breakaways, valley slopes, low hills.	Unlikely – not typical habitat
Pimelea calcicola		Priority 3		*Pimelea calcicola* occurs in sand on coastal limestone ridges.	Possible – habitat likely to occur on the site
Pithocarpa corymbulosa		Priority 3		*Pithocarpa corymbulosa* occurs in gravelly or sandy loam amongst granite outcrops.	Highly Unlikely – not suitable habitat
Sarcozona bicarinata	Ridged Noon-flower	Priority 3		Ridged Noon-flower is found in white sand in coastal areas.	Highly Unlikely – not suitable habitat
Sphaerolobium calcicola		Priority 3		*Sphaerolobium calcicola* grows in white-grey-brown sand, sandy clay over limestone, black peaty sandy clay on tall dunes, winter-wet flats, interdunal swamps, low-lying areas.	Highly Unlikely – not suitable habitat
Stylidium maritimum		Priority 3		*Stylidium maritimum* occurs in sand over limestone on dune slopes and flats in coastal heath and shrubland, open Banksia woodland.	Highly Likely – habitat occurs on the site and has been previously recorded
Styphelia filifolia		Priority 3		*Styphelia filifolia* occurs in sandy soils of the coastal plain (with one known occurrence from the northern Darling Scarp), usually in Banksia or Jarrah woodland and in low-lying situations (Hislop and Lelièvre, 2017).	Highly Unlikely – not suitable habitat

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act	Habitat*	Likelihood to occur on the site
Conostylis pauciflora subsp. *euryrhipis*		Priority 4		*Conostylis pauciflora* subsp. *euryrhipis* occurs in white, grey or yellow sand on consolidated dunes in coastal areas.	Highly Unlikely – not suitable habitat
Conostylis pauciflora subsp. *pauciflora*		Priority 4		*Conostylis pauciflora* subsp. *pauciflora* occurs in grey sand, limestone on hillslopes, consolidated dunes in coastal areas.	Unlikely – not typical habitat
Eucalyptus foecunda subsp. *foecunda*	Fremantle Mallee	Priority 4		Fremantle Mallee grows on yellowish coastal sands overlying limestone, often on limestony hills and dunes, in shrubland or very open woodland (Nicolle and French, 2021).	Unlikely – not typical habitat
Jacksonia sericea	Waldjumi	Priority 4		Waldjumi grows in calcareous and sandy soils.	Possible – habitat may occur on the site
Lepidium pseudotasmanicum		Priority 4		*Lepidium pseudotasmanicum* occurs in loam, sand associated with granite.	Highly Unlikely – not suitable habitat
Stylidium longitubum	Jumping Jacks	Priority 4		Jumping Jacks prefer sandy clay, clay in seasonal wetlands.	Highly Unlikely – not suitable habitat
Stylidium striatum	Fan-leaved Triggerplant	Priority 4		The Fan-leaved Triggerplant grows in brown clay loam over laterite on hillslopes in Jarrah/Marri forest, Wandoo woodland.	Highly Unlikely – not suitable habitat
Tripterococcus sp. *Brachylobus* (A.S. George 14234)		Priority 4		*Tripterococcus* sp. Brachylobus occurs in grey, black or peaty sand winter-wet flats.	Highly Unlikely – not suitable habitat

* sourced from Florabase as well as the DBCA database searches unless otherwise denoted

4.1.2 TEC/PEC Database Searches

A search of DBCA's Threatened (TEC) and Priority Ecological Communities (PEC) database was conducted within a radius of 10 km around the site (10-0822EC) (Appendix 6). Five TECs and seven PECs were identified. One TEC and three of the PECs are part of a Federally listed TEC. The communities identified in the database searches are outlined in Table 3.

Table 3: TEC and PECs Identified in Database Searches

Number	Description	Conservation Status in Western Australia	Status under the EPBC Act
CAVES SCP01	Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain	Critically Endangered	Endangered
SCP19b	Woodlands over Sedgelands in Holocene dune swales of the southern Swan Coastal Plain (floristic community type 19 as originally described in Gibson et al. 1994)	Critically Endangered	Endangered
SCP10a	Shrublands on dry clay flats (floristic community type 10a as originally described in Gibson *et al.* (1994))	Endangered	Critically Endangered
SCP26a	*Melaleuca huegelii - Melaleuca systena* shrublands on limestone ridges (floristic community type 26a as originally described in Gibson *et al*. (1994))	Endangered	Pending Critically Endangered
SCP20a	*Banksia attenuata* woodlands over species rich dense shrublands (floristic community type 20a as originally described in Gibson et al. (1994))	Endangered	Endangered as part of the Banksia WL SCP
SCP22	*Banksia ilicifolia* woodlands	Priority 3	Endangered as part of the Banksia WL SCP
SCP23b	Swan Coastal Plain *Banksia attenuata - Banksia menziesii* woodlands	Priority 3	Endangered as part of the Banksia WL SCP
SCP24	Northern Spearwood shrublands and woodlands	Priority 3	
SCP30b	Quindalup *Eucalyptus gomphocephala* and/or *Agonis flexuosa* woodlands	Priority 3	Critically Endangered as part of the Tuart Woodlands
SCP29b	*Acacia* shrublands on taller dunes	Priority 3	
Banksia WL SCP	Banksia Woodlands of the Swan Coastal Plain ecological community	Priority 3	Endangered
Tuart woodlands	Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain	Priority 3	Critically Endangered

Of the TECs and PECs identified in the database search the following communities are mapped as occurring on the site:

- Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain;
- SCP24 Northern Spearwood shrublands and woodlands;
- Banksia Woodlands of the Swan Coastal Plain ecological community; and
- Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain.

Based on the preliminary assessment of vegetation types on the site the following additional FCTs are considered to potentially occur on the site:

- SCP20a *Banksia attenuata* woodlands over species rich dense shrublands
- SCP23b Swan Coastal Plain *Banksia attenuata* - *Banksia menziesii* woodlands
- SCP26a *Melaleuca huegelii* - *Melaleuca systena* shrublands on limestone ridges

4.2 Flora

A total of 230 plant species were recorded during the flora survey (Appendix 7). The total consisted of 175 native species and 55 (23.9%) introduced species. The number of native species is considered moderate for the amount of native vegetation on the site.

The plant Families with the highest representation of species were the Fabaceae (Wattle and Pea family – 22 species, 19 native and 3 introduced), Asteraceae (Daisy family – 19 species, 11 native, 8 introduced), Proteaceae (Banksia family – 18 species, all native), Poaceae (Grass family – 17 species, 5 native, 12 introduced), Myrtaceae (Myrtle family – 16 species, 15 native and 1 introduced), Orchidaceae (Orchid family – 13 species, 12 native, 1 introduced) and Asparagaceae (Asparagus family - 10 species, 9 native and 1 introduced).

Six plants of the Threatened species, *Eucalyptus argutifolia*, were recorded on the site at a previously known location on the Water Corporation site on Lot 50 Greenlees Way (Plate 3). The plants occur at the base of a limestone ridge (Figure 3).

Two small populations of the Priority 3 species *Pimelea calcicola* were recorded (Plate 4) on the site, both in areas of outcropping limestone, one on Lot 104 McLennan Drive and the other on Lot 121 Carabooda Road (Figure 3).

One population of the Priority 3 species *Stylidium maritimum* Plate 5) was recorded at the base of the limestone ridge on Lot 121 Carabooda Road (Figure 3).

Two plants of the Priority 4 species *Eucalyptus foecunda* subsp. *foecunda* were recorded on disturbed limestone soils at the eastern end of the quarry on Lot 104 McLennan Drive (Figure 3).

The plants mentioned above were all recorded during the 2023 survey. It was the intention in 2024 to do more extensive surveys of areas of outcropping limestone to identify further populations of *Pimelea calcicola* and *Stylidium maritimum*. However, both species appear to have been adversely affected by the long 8 month absence of rain on the Swan Coastal Plain from mid-September 2023 to early May 2024. The locations recorded in 2023 were visited in late September 2024 and no *Stylidium maritimum* plants were observed. PGV Environmental's broader observations during the 2024 spring

flora survey season was a large drop in numbers for many species in the genus *Stylidium*. Similarly, of the *Pimelea calcicola* plants recorded in 2023 only one non-flowering individual was observed. Therefore, further detailed surveying in areas of outcropping limestone in 2024 were not undertaken.

Plate 3: *Eucalyptus argutifolia* Recorded on the Site



Plate 4: *Pimelea calcicola* Recorded on the Site



Plate 5: *Stylidium maritimum* Recorded on the Site



Plate 6: *Eucalyptus foecunda* subsp. *foecunda* Recorded on the Site



Species richness in the 39 quadrats ranged from 6-48 with a range of 4-38 native species, averaging 30.0 native species. The average number of weed species was 9.9 (33.0%).

4.3 Vegetation

4.3.1 Vegetation Complexes

Vegetation complexes are a very broad mapping unit based on landform and soils type (Heddle *et al.*, 1980). Almost all of the site is mapped as the Cottesloe Complex-Central and South. There is a very small area in the southwestern part of the site that is mapped as the Herdsman Complex. The Herdsman Complex is associated with wetlands and includes Sedgelands and fringing woodlands of Flooded Gum. As these do not occur in the south-west corner of the site, the mapping of the Herdsman Complex on the site is considered an error.

The Cottesloe Complex-Central and South is described as:

> – Mosaic of woodland of *Eucalyptus gomphocephala* (Tuart) and open forest of *E. gomphocephala* – *E. marginata* (Jarrah) – *Corymbia calophylla* (Marri), closed heath on the limestone outcrops' (Heddle *et al.,* 1980).

4.3.2 Vegetation Types

Vegetation types are a finer level of vegetation description and mapping used for small scale sites, such as the survey area. Vegetation types are described based on the structure of the vegetation (eg. woodland, heath) and the dominant species in each structure.

Thirteen vegetation types were described and mapped on the site (Figure 3). The vegetation types are described in Table 4. Quadrat Data are in Appendix 8.

Native vegetation was mapped over 333.78ha of the 959ha site.

Table 4: Vegetation Types on the Site

Vegetation Type	Description	Photograph
MhMs *Melaleuca huegelii/M. systena* Closed Heath	This vegetation type occurs on the top of several limestone ridges in the northern half of the site. *Melaleuca huegelii* and *M. systena* are dense and around 2-2.5m high. Common understorey species include *Grevillea preissii, Austrostipa flavescens, Banksia dallanneyi, Trymalium ledifolium, Diplopeltis huegelii* and *Desmocladus flexuosus.* The soils are shallow orange-brown sand with extensive outcropping limestone. Quadrats C21, C30, C33, C36, CB55, CB61, CB62 and CB64 are representative of this vegetation type. The total area of this vegetation type is 12.086ha.	
MhBs *Melaleuca huegelii/Banksia sessilis* Closed Tall Scrub over *Melaleuca systena/Hibbertia hypericoides* Open Low Heath	Similar to the MhMs vegetation type but with *Banksia sessilis* (Parrot Bush) common. Occurs at the eastern end of the quarry on Lot 104 McLennan Drive and a small area on Lot 13 Wesco Road. Typical understorey species include *Lepidosperma calcicola, Hakea lissocarpha, Hakea trifurcata, Trymalium ledifolium, Grevillea preissii* and *Desmocladus flexuosus.* The soils are orange-brown sand with abundant surface limestone. Quadrats C6, C13, C39 and CB44 are representative of this vegetation type. The total area of this vegetation type is 2.37ha.	

Vegetation Type		Description	Photograph
Bs	*Banksia sessilis/Calothamnus quadrifidus* Open Heath over *Hibbertia hypericoides* Open to Closed Low Heath	The most common vegetation type on the site, occurring on the lower to mid-slopes of limestone ridges where the depth of sand is deeper than in the MhMs and MhBs units. *Banksia sessilis* is 1-2m high and sparse to moderately dense at 5-25% cover. Common species include *Hibbertia hypericoides, Xanthorrhoea preissii, Templetonia retusa, Melaleuca systena, Calothamnus quadrifidus, Petrophile serruriae, Mesomelaena pseudostygia* and *Homalosciadium homalocarpum.* The soils are orange-brown sand with some surface limestone. Quadrats C2, C4, C5, C15, C24, C38 and CB60 are representative of this vegetation type. The total area of this vegetation type is 70.56ha.	
EdBs	*Eucalyptus decipiens* Low Open Woodland over *Banksia sessilis* Tall Open Shrubland over *Melaleuca systena/Hibbertia hypericoides* Closed Low Heath	Occurs mostly in the southern end of the site on the lower slopes of limestone hills. *Eucalyptus decipiens* is 5-12m high and sparse to moderate at 2-25% cover. The understorey commonly includes *Banksia sessilis, Calothamnus quadrifidus, Xanthorrhoea preissii, Hibbertia hypericoides, Dianella revoluta* var. *divaricata* and *Conostylis aculeata.* The soils are orange-brown sand with some surface limestone. Quadrats C1, C7, C14, CB40, CB41, CB43 and CB45 are representative of this vegetation type. The total area of this vegetation type is 24.45ha.	

Vegetation Type		Description	Photograph
EgBs	*Eucalyptus gomphocephala* Woodland over *Banksia sessilis/Calothamnus quadrifidus* Open Heath over *Hibbertia hypericoides* Closed Low Heath	Very similar to the Bs vegetation type but with *Eucalyptus gomphocephala* (Tuart) present as a tree up to 15m high and relatively low density. Common understorey species include *Banksia sessilis, Acacia pulchella, Hakea trifurcata, Mesomelaena pseudostygia* and *Hibbertia hypericoides.* The soils are orange-brown sand with some surface limestone. Quadrats C3, C23, C35 and CB57 are representative of this vegetation type. The total area of this vegetation type is 30.09ha.	
AfBs	*Allocasuarina fraseriana* Low Open Woodland over *Banksia sessilis/ Xanthorrhoea preissii/ Hibbertia hypericoides* Open Low Heath	One stand of this vegetation type occurs at the northwestern end of the site. It is the only area where *Allocasuarina fraseriana* (Sheoak) occurs with few other tree species. *Jacksonia sternbergiana* is a common tall shrub species which indicates some disturbance in the past. Other common species include *Xanthorrhoea preissii, Banksia sessilis, Hibbertia hypericoides* and a variety of weed species. The soils are yellow-grey sand. Quadrat C34 is representative of this vegetation type. The total area of this vegetation type is 1.22ha.	

Vegetation Type	Description	Photograph
Et *Eucalyptus todtiana* Low Open Woodland over weeds	This vegetation type occurs at the southern end of the site on Lot 11 Wesco Road and occurs in a disturbed area that has been partially cleared. *Eucalyptus todtiana* and *Nuytsia floribunda* (WA Christmas Tree) are 5-6m high and 5-10% cover. Most of the understorey consists of weeds but *Hibbertia hypericoides* and *Xanthorrhoea preissii* are reasonably common. The soils are yellow-brown sand. Quadrat C8 and CB42 are representative of this vegetation type. The total area of this vegetation type is 5.22ha.	
EtBaBm *Eucalyptus todtiana/ Banksia attenuata/B. menziesii* Low Open Woodland over *Xanthorrhoea preissii/ Daviesia divaricata* Tall Shrubland over *Eremaea pauciflora/Hibbertia hypericoides* Open Low Heath	This vegetation type occurs on deep sand and in large patches in the central part of the site. *Eucalyptus todtiana* is the main tree species present, up to 4m high. *Banksia attenuata* and *B. menziesii* are co-dominant with around 5-10% cover. Common understorey species include *Xanthorrhoea preissii, Hibbertia hypericoides, Daviesia divaricata, Eremaea pauciflora, Mesomelaena pseudostygia, Bossiaea eriocarpa* and *Burchardia congesta.* The soils are yellow-brown sand. Quadrats C9, C10, C26 and C37 are representative of this vegetation type. The total area of this vegetation type is 36.66ha.	

Vegetation Type	Description	Photograph
BaBmEt *Banksia attenuata/Banksia menziesii/Eucalyptus todtiana* Low Woodland over *Allocasuarina humilis/ Calothamnus quadrifidus/ Hibbertia hypericoides* Closed Heath	Similar to the EtBaBm vegetation type but with fewer *E. todtiana* trees. The understorey is also slightly different with *Allocasuarina humilis* a common species as well as *Hibbertia hypericoides, Calothamnus quadrifidus* and *Mesomelaena pseudostygia.* Occurs in the central and northeastern parts of the site on deep sands. The soils are light orange-brown sand. Quadrats C25, C31, CB56, CB58 and CB59 are representative of this vegetation type. The total area of this vegetation type is 17.38ha.	
Em *Eucalyptus marginata* Low Woodland over *Xanthorrhoea preissii* Tall Shrubland	Occurs on lower areas in the central part of the site. Most of the areas mapped have a very weedy understorey. The *Eucalyptus marginata* (Jarrah) trees have mostly been coppiced with few to no old, mature single stem trees. *Xanthorrhoea preissii* and *Hibbertia hypericoides* are the most common native understorey species while the most common weed species is Perennial Veldtgrass (*Ehrharta calycina*). The soils are dark brown sand. Quadrats C11, C19, C28, C32 and CB52 are representative of this vegetation type. The total area of this vegetation type is 23.15ha.	

Vegetation Type		Description	Photograph
Eg	*Eucalyptus gomphocephala* Woodland over *Xanthorrhoea preissii* Shrubland over *Mesomelaena pseudostygia/Phyllanthus calycinus* Open Low Heath	Occurs on the lower slopes, mostly in the central part of the site. *Eucalyptus gomphocephala* (Tuart) is up to 25m high and moderately dense (15-25% cover). Typical understorey species include *Xanthorrhoea preissii, Mesomelaena pseudostygia, Phyllanthus calycinus, Hakea lissocarpha* and *Desmocladus flexuosus.* The soils are orange-brown sand with some surface limestone. Quadrats C12, C17, C22, C27, C29, CB46 and CB47 are representative of this vegetation type. The total area of this vegetation type is 21.42ha.	
EgEm	*Eucalyptus gomphocephala/E. marginata* Woodland over **Ehrharta calycina* Closed Grassland	This is an extensive vegetation type that occurs on the western side of the site on lower elevation land. The condition of the understorey ranges from Degraded to very Good. Perennial Veldtgrass the dominant weed species. *Xanthorrhoea preissii* and *Hibbertia hypericoides* are the main native species. The soils are orange-brown sand. Quadrats C16, C20, CB48, CB49, CB50, CB51, CB52 and CB54 are representative of this vegetation type. The total area of this vegetation type is 64.93ha.	

Vegetation Type		Description	Photograph
CcEm	*Corymbia calophylla/ Eucalyptus marginata* Low Woodland over *Xanthorrhoea preissii* Shrubland	Two areas containing Marri (*Corymbia calophylla*) mixed with Jarrah were recorded on the site, in the central western area. The vegetation ranges from Degraded to Completely Degraded condition up to Very Good on Lot 201. Perennial Veldtgrass dominates the Degraded and Completely Degraded areas. *Xanthorrhoea preissii, Hibbertia hypericoides* and *Mesomelaena pseudostygia* are the common native species. The soils are dark brown sand. Quadrat C18 and CB53 is representative of this vegetation type. The total area of this vegetation type is 24.25ha.	

4.3.3 Floristic Community Types

Floristic Community Types (FCT) are based on the whole floristic composition of the vegetation (trees, shrubs, herbs, sedges etc) rather than being determined by soil type and geomorphology (Vegetation Complex) or the nature of the dominant species (Vegetation Types). Many of the Threatened and Priority Ecological Communities on the Swan Coastal Plain are based on the FCT level of vegetation description.

The FCTs of the southern Swan Coastal Plain were initially identified in a study undertaken by the (then) Department of Conservation and Land Management and the Conservation Council of Western Australia (Gibson *et al.* 1994). The study analysed the floristic composition of 509 10m x 10m quadrats by computer programmes. The analysis resulted in the definition of 43 community types and sub-types.

The database searches identified four FCTs that could potentially occur on the site, including one that has been mapped on the site:

- SCP24 Northern Spearwood shrublands and woodlands (mapped on the site)
- SCP20a *Banksia attenuata* woodlands over species rich dense shrublands
- SCP23b Swan Coastal Plain *Banksia attenuata - Banksia menziesii* woodlands
- SCP26a *Melaleuca huegelii - Melaleuca systena* shrublands on limestone ridges

To determine whether any of these FCTs occur on the site, quadrat data were analysed using the PATN computer programme. Computer analysis of FCTs requires high quality quadrat data to achieve meaningful results. Therefore, only 10 of the 64 quadrats were used in the analyses. The 10 quadrats had vegetation condition in Excellent and Very Good condition. The results of the analyses, undertaken by Plantecology are provided in Appendix 9.

The results of the numerical analysis indicate that the vegetation types that occur on shallow sand over limestone soils are FCT 24 'Northern Spearwood shrublands and woodlands'. The vegetation on deeper sands is more typical of FCT 28 'Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands' (Table 5). As mentioned in the Plantecology report, the presence of Tuart (*Eucalyptus gomphocephala*) could indicate the occurrence of one of the Tuart-dominated woodlands, eg. FCT 25 and 30b, however the data do not support this. Tuart was recorded from 24% of the FCT 24 quadrats sampled by Gibson *et al.* (1994). Therefore, the conclusion that the Tuart Woodland vegetation type is FCT24 (represented by quadrat C22) is not an unexpected result.

The numerical analysis discusses the potential for the vegetation containing *Melaleuca huegelii* to be representative of FCT 26a '*Melaleuca huegelii-M. systena* shrublands of limestone ridges'. However, none of the five quadrats analysed that contained *Melaleuca huegelii* as a common species showed any similarity to FCT 26a. Two of the quadrats sampled from the MhMs vegetation type (C30 and C33) resulted in an FCT analysis as ?29a 'Coastal shrublands on shallow sands'. Plantecology commented that the FCT29a result was anomalous given that FCT 29a is found on coastal dunes on the Quindalup Dune System, which does not occur on the Carabooda site. Plantecology identified a number of statistical reasons why the MhMs quadrats resulted in FCT 29a rather than the expected 26a and concluded that the possibility that Plot C30 belongs to FCT 26b and Plot C33 to FCT 26a cannot be excluded. Gibson *et al*. (1994) describe FCT 26a as occurring on skeletal soils on limestone ridge slopes and ridge tops while FCT 26b occurs on the lower slopes or in pockets with deeper soil which allow

overstorey trees to develop. The two MhMs quadrats (C30 and C33) were recorded from the top of hills with shallow skeletal sand and abundant surface limestone. PGV Environmental considers the most likely FCT for the MhMs vegetation type is FCT 26a.

The two MhBs vegetation types analysed (C13 and CB44) were analysed from the same stand, approximately 100m apart with C13 at the lower end of the slope and CB44 at the upper end. Both quadrats were analysed clearly as FCT24.

Table 5: FCT Analysis

Quadrat	Vegetation Type	Description	Likely FCT
C30	**MhMs**	*Melaleuca huegelii/M. systena* Closed Heath	26a
C33	**MhMs**	*Melaleuca huegelii/M. systena* Closed Heath	26a
CB44	**MhBs**	*Melaleuca huegelii/M. systena* Closed Heath	24
C13	**MhBs**	*Melaleuca huegelii/Banksia sessilis* Closed Tall Scrub over *Melaleuca systena/Hibbertia hypericoides* Open Low Heath	24
C15	**Bs**	*Banksia sessilis/Calothamnus quadrifidus* Open Heath over *Hibbertia hypericoides* Open to Closed Low Heath	24
C1	**EdBs**	*Eucalyptus decipiens* Low Open Woodland over *Banksia sessilis* Tall Open Shrubland over *Melaleuca systena/Hibbertia hypericoides* Closed Low Heath	24
CB45	**EdBs**	*Eucalyptus decipiens* Low Open Woodland over *Banksia sessilis* Tall Open Shrubland over *Melaleuca systena/Hibbertia hypericoides* Closed Low Heath	24
C22	**Eg**	*Eucalyptus gomphocephala* Woodland over *Xanthorrhoea preissii* Shrubland over *Mesomelaena pseudostygia/Phyllanthus calycinus* Open Low Heath	24
C25	**BaBmEt**	*Banksia attenuata/Banksia menziesii/Eucalyptus todtiana* Low Woodland over *Allocasuarina humilis/Calothamnus quadrifidus/Hibbertia hypericoides* Closed Heath	28
C31	**BaBmEt**	*Banksia attenuata/Banksia menziesii/Eucalyptus todtiana* Low Woodland over *Allocasuarina humilis/Calothamnus quadrifidus/Hibbertia hypericoides* Closed Heath	28

4.3.4 Vegetation Condition

The condition of the vegetation was assessed according to the system devised by Keighery and described in Bush Forever (Government of Western Australia, 2000) (Table 6).

Table 6: Vegetation Condition Rating Scale.

Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

Condition	Description
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Source: Government of Western Australia, 2000.

The vegetation condition ranged from Excellent to Completely Degraded (Figure 4). Generally, the areas with the best quality vegetation were the areas of outcropping and shallow sand over limestone. The areas of deeper sand over limestone contained more weeds, with Perennial Veldtgrass the most common weed species. Areas of Banksia and *Eucalyptus todtiana* vegetation in Very Good to Excellent condition were recorded in the central part of the site on Lots 105 McLennan Drive, 116 Kiln Road and 115 Kiln Road. These areas are all contiguous.

4.4 Conservation Significance of Flora and Vegetation

4.4.1 Flora

One Threatened species was recorded on the site being the Yanchep mallee (Eucalyptus argutifolia). The Yanchep Mallee is protected under the *Biodiversity Conservation Act 2016* (BC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

One plant of the Priority 3 species, *Pimelea calcicola*, was recorded on the site. *Pimelea calcicola* is normally found on coastal limestone ridges but has been recorded further inland including in the Joondalup area. The Priority 3 species *Stylidium maritimum* was also recorded on the site.

Priority 3 plant species are poorly known species that are either known from several locations but are not under imminent threat, or are known from few but widespread locations not under imminent threat. Priority species are not protected by environmental legislation at State or Commonwealth level.

4.4.2 Vegetation Complexes

The percentage retention and reservation of the vegetation complexes mapped on the site are outlined in Table 7.

Table 7: Vegetation Association Statistics

Vegetation Complex	Pre-European Extent	Remaining on Swan Coastal Plain		Remaining in Secure Tenure	
	Area (ha)	Area (ha)	%	Area (ha)	%
Cottesloe Complex-Central and South	45,299	14,567	32.16	2,053	9.51

The percentage remaining is above EPA's 10% minimum criteria for vegetation complexes in the Perth and Peel Region Constrained Areas.

4.4.3 Threatened and Priority Ecological Communities

Two Floristic Community Types were analysed as definitely occurring on the site, FCT 24 and 28 with FCT 26a most likely. FCT 24 is a Priority 3 Ecological Community at State level. Both FCT24 and 28 are part of the State and Federally listed Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community. Further analysis of each vegetation type with respect to the Banksia Woodland TEC criteria is provided in the following section.

FCT 26a is a Threatened Ecological Community (Critically Endangered) at State and at Federal level is recognised as the 'Honeymyrtle Shrubland on Limestone Ridges of the Swan Coastal Plain Bioregion' ecological community which was listed under the EPBC Act on 15 November 2023.

4.4.3.1 Banksia Woodland TEC Assessment

The Banksia Woodlands of the Swan Coastal Plain ecological community was listed as an Endangered community under the Commonwealth EPBC Act on 16 September 2016. The Banksia Woodland ecological community is listed as a Priority Ecological Community at State level.

The *Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community* (Commonwealth of Australia, 2016) (Conservation Advice) describes the Banksia Woodland TEC as:

> *The ecological community is a woodland associated with the Swan Coastal Plain of southwest Western Australia. A key diagnostic feature is a prominent tree layer of Banksia, with scattered eucalypts and other tree species often present among or emerging above the Banksia canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range* (Commonwealth of Australia, 2016).

The Banksia Woodland TEC is most commonly dominated by *Banksia attenuata* and/or *B. menziesii* and in some examples *B. prionotes* or *B. ilicifolia.*

Two vegetation types on the site (EtBaBm and BaBmEt) contain a prominent layer of *Banksia attenuata* and *B. menziesii* co-dominant with *Eucalyptus todtiana*. The other vegetation types either have no Banksia trees or a very sparse cover and are therefore considered not a part of the Banksia Woodland TEC.

For an area of Banksia woodland to meet the criteria of the Banksia Woodland TEC it needs to be in at least Good condition and meet a minimum patch size depending on the condition of the vegetation. The areas mapped as EtBaBm and BaBmEt in Good condition or better are much larger than the

minimum 2ha size requirement to be the Banksia Woodland TEC. These areas are therefore considered a part of the Banksia Woodland TEC.

The location of vegetation considered to meet the definition of the Banksia Woodland TEC is shown in Figure 5. The total area of Banksia Woodland TEC is 44.99ha.

4.4.3.2 Tuart Woodland Assessment

Description

The Tuart Woodlands and Forests of the Swan Coastal Plain was listed as a Threatened Ecological Community (TEC) with a rating of Critically Endangered under the Commonwealth EPBC Act on 4 July 2019 (for brevity the community will be called the Tuart Woodland TEC in this report). The Tuart Woodland ecological community is listed as a Priority Ecological Community at State level.

A description of the Tuart Woodland TEC is contained in the *Approved Conservation Advice (incorporating listing advice) for the Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain ecological community* (Commonwealth of Australia, 2019). According to the Conservation Advice the diagnostic characteristics of the TEC are:

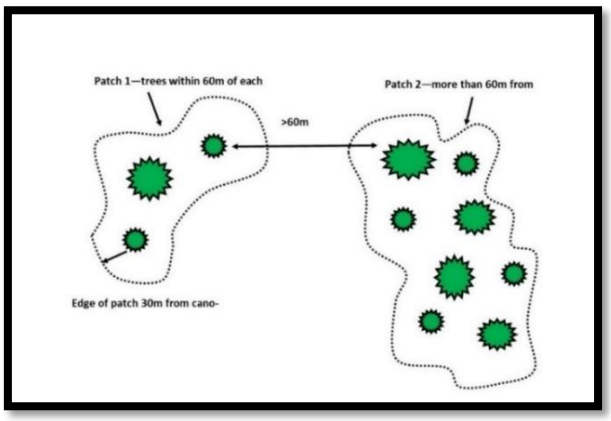
Key diagnosis characteristics

- The ecological community is limited to patches of vegetation (with their associated biota) that meet all of the following key diagnostic characteristics:
- Occurs in the Swan Coastal Plain Bioregion, Western Australia (IBRA v7. Department of the Environment 2012).
- Primarily occurs on the Spearwood and Quindalup dune systems but can also occur on the Bassendean dunes and Pinjarra Plain. It can occur on the banks of rivers and wetlands.
- The primary defining feature is the presence of at least two living established *Eucalyptus gomphocephala* (Tuart) trees in the uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent Tuart trees. These trees may occur either as single stemmed trees or as a mallee growth form.
- Most often occurs as a woodland but can occur in other structural forms, For example, forest, open forest, woodland, open woodland, and various mallee forms.
- Other tree species may be present in the canopy or sub-canopy. They commonly include: *Agonis flexuosa* (Peppermint) and *Banksia grandis* (Bull Banksia) (both in the southern part of the range), *Banksia attenuata* (Candlestick Banksia), *Eucalyptus marginata* (Jarrah); and less commonly, *Corymbia calophylla* (Marri), *Banksia menziesii* (Firewood Banksia) and *Banksia prionotes* (Acorn Banksia).
- An understorey of native plants is typically present, which may include grasses, herbs and shrubs, although this is often modified by disturbance. Some understorey plant species that are most commonly present are listed in Section 2.3.3 of the Conservation Advice.
- Native fauna species that are most commonly present are noted in Section 2.4 of the Conservation Advice (Commonwealth of Australia, 2019).

Defining a patch of the ecological community

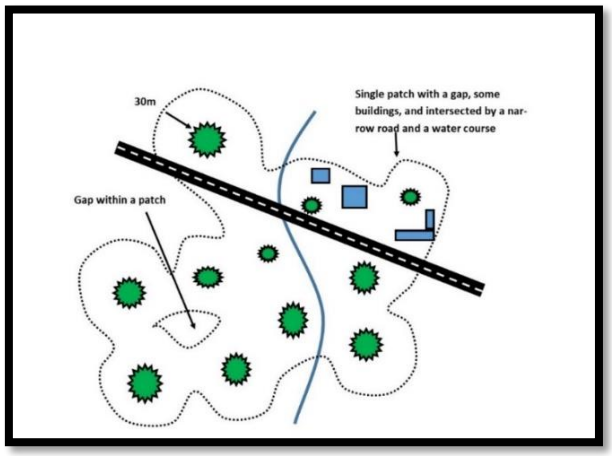
- A patch of the ecological community is a discrete and mostly continuous area of vegetation that meets the key diagnostic characteristics.
- Boundaries for a patch can extend beyond a site or property boundary, or potential area of impact for a proposed action.
- The patch boundary is 30 m beyond the outer canopy of the established Tuart trees (≥15 cm diameter at breast height (DBH)), including dead Tuart trees (stags). See Plate 6
- Where a dead Tuart tree (stag) is being considered for inclusion in a patch of the ecological community, the vertical projection of its outermost remaining branches is used to define the edge of its canopy. If the species of a stag tree is unclear, if the edge of its canopy is within 60 m of an identified Tuart tree the stag is presumed to be a Tuart.
- Patches of Tuart woodlands and forests may contain areas that vary in structural or biological complexity. One part of a patch may have a larger number of mature trees and more ecological diversity, whereas another part of the same patch may demonstrate fewer mature trees and less groundcover. Areas with soil exposed and/or plant litter can also be expected within this ecological community.
- Variation in quality or condition of vegetation across a patch should not necessarily be considered to be evidence of multiple patches. Patches of the ecological community can be spatially variable and are often characterised by one or more areas within a patch that meet higher condition thresholds amongst areas of lower condition.
- If an area meets the key diagnostic characteristics but the average condition across that area falls below the minimum condition thresholds, the largest area or areas of at least 0.5 ha that meet minimum condition thresholds on average, should be specified as the patch or patches of the nationally listed ecological community. This may result in multiple patches of the ecological community being identified within the overall area first identified as meeting the key diagnostics.
- A patch may include small areas without understorey vegetation, such as bare ground, as well as waterbodies or hardscape (e.g. roads, paths, car parks, or buildings) that do not significantly alter the overall function of the ecological community. These small areas do not break up a patch, or divide a patch into multiple patches, as long as there are some parts of the canopy within 60 m of the outer edges of the canopies of adjacent Tuart trees (as per Plate 6). However, existing buildings and other human-made structures and gardens are not part of the nationally protected ecological community and should be excluded from the calculation of patch size and condition. See Plate 7 (Commonwealth of Australia, 2019).

Plate 8: Tuart TEC Patch Boundaries



Source: Commonwealth of Australia, 2019

Plate 9: Variation Within a Patch*



* including small areas without understorey vegetation, and a small gap within a patch due to part of the Tuart canopy being >60 m apart

Source: Commonwealth of Australia, 2019

Condition thresholds and categories

For confirmed patches of the ecological community, following the key diagnostic characteristics and patch definition above (Step 1), determine the following requirements for information on condition to indicate if they are part of the nationally protected ecological community:

- If the patch is smaller than 0.5 ha it is **not** part of the nationally protected ecological community.
- If **the patch is at least 0.5 ha and up to 5 ha** in size, conduct on ground surveys. Patches in this size range are presumed to be part of the nationally protected ecological community unless surveys indicate they do not meet the minimum condition required for national protection. For patches in this size range inclusion in the nationally protected ecological community is determined by surveyed characteristics such as native plant species richness and contribution to cover, habitat values, evidence of regeneration and landscape characteristics.

- **All patches of 5 ha or greater** that meet the key diagnostic characteristics **are part of the nationally protected ecological community**. It is not necessary to conduct additional surveys to confirm that they meet biotic condition thresholds (Table 8) and that they are protected.

Table 8: Tuart TEC Condition Categories and Thresholds

All patches ≥5 ha is part of the nationally protected ecological community, regardless of their understorey condition. That is, thresholds in this table do not apply to patches ≥5 ha, but the key diagnostic characteristics and patch definition must be met.

Patch size Biotic thresholds	≥2 ha <5 ha	≥0.5 ha <2 ha
Very high condition ≥80 % of all understorey^ vegetation cover is native# Or At least 12 native understorey^ species per 0.01 ha (10 m x 10 m plot or equivalent sample unit)	Medium sized patches with very high condition understorey. PART OF THE PROTECTED ECOLOGICAL COMMUNITY	Smaller patches with very high condition understorey. PART OF THE PROTECTED ECOLOGICAL COMMUNITY
High condition ≥60 % of all understorey^ vegetation cover is native# Or At least 8 native understorey^ species per 0.01 ha (10 m x 10 m plot or equivalent sample unit)	Medium sized patches with high condition understorey. PART OF THE PROTECTED ECOLOGICAL COMMUNITY	Smaller patches with high condition understorey. **AND** That either: have an important landscape role (≤100 m to native vegetation)* OR have a habitat role (≥2 very large trees per 0.5 ha)* OR show regeneration (≥15 seedlings and/or saplings per 0.5 ha)* PART OF THE PROTECTED ECOLOGICAL COMMUNITY
Moderate condition ≥50 % of all understorey^ vegetation cover is native# Or At least 4 native understorey^ species per 0.01 ha (10 m x 10 m plot or equivalent sample unit)	Medium sized patches with moderate condition understorey. **AND** That either: have an important landscape role (≤100 m to native vegetation)* OR have a habitat role (≥2 very large trees per 0.5 ha)* OR show regeneration (≥15 seedlings and/or saplings per 0.5 ha)* PART OF THE PROTECTED ECOLOGICAL COMMUNITY	NOT PART OF THE PROTECTED ECOLOGICAL COMMUNITY (but may be a focus for local protection or restoration)

Patch size Biotic thresholds	≥2 ha <5 ha	≥0.5 ha <2 ha
Poor Has minimal or no native cover and species richness. That is: <50 % of all understorey^ vegetation cover is native# And Less than 4 native understorey^ species per 0.01 ha (10 m x 10 m plot or equivalent sample unit)	NOT PART OF THE PROTECTED ECOLOGICAL COMMUNITY (but may be a focus for local protection or restoration)	NOT PART OF THE PROTECTED ECOLOGICAL COMMUNITY (but may be a focus for local protection or restoration)

Tuart Woodland TEC Assessment

Three vegetation types on the site contain Tuart trees as the dominant component of the tree canopy – Eg, EgEm and EgBs. The presence of Tuart trees does not automatically mean that the Tuart Woodland TEC occurs on site. The Conservation Advice contains the following step-wise approach in determining if the TEC occurs on a site:

- Step 1: Is the Tuart Woodlands and Forests ecological community in your proposed project site? Is it in other adjacent or off-site areas that may be impacted (for example, by introducing weeds)?
- Step 2: What is the patch size and condition category of the Tuart Woodlands and Forests in the proposed project site and in the surrounding area?

The assessment of the Tuart Woodland TEC on the site is outlined in Table 9 and Table 10.

In summary, most of the areas mapped as Eg, EgEm and EgBs are large enough or in good enough condition to be assessed as patches of the Tuart Woodland TEC. The location of the Tuart Woodland TEC is shown on Figure 5. Where areas of Tuart woodland with a Poor condition class due to low numbers of native understorey species and high proportion of weed species are in a contiguous patch that is well over 5ha in size, these areas were also included as part of the Tuart Woodland TEC.

Two areas on Lot 8 Greenlees Way and Lot 61 Tifway Place contain about 2ha of Eg and EgBs vegetation type in Poor condition and were assessed as being too small (ie. <5ha) to be the Tuart Woodland TEC.

The total area of Tuart Woodland TEC is 112.8ha

Step 1: Is the Tuart Woodlands and Forests ecological community in your proposed project site? Is it in other adjacent or off-site areas that may be impacted (for example, by introducing weeds)?

Table 9: Tuart Woodland TEC Step 1 Diagnostics

Key diagnostic characteristics♦	**Information**	**Key diagnostic questions*** (Refer to Section 3.2 of the Approved Conservation Advice for a complete explanation of these diagnostic features – other sections of the Approved Conservation Advice are referenced where relevant)	**Response (yes/no/possibly) and detailed comments. Use as much space as you need to fully answer the question#**
Location and physical environment	Bioregion	Is the proposal site within the Swan Coastal Plain IBRA bioregion?	Yes
Soils and Landform	Soil type	Is the soil type consistent with where the Tuart Woodlands and Forests may occur? (see Section 2.2.1♦)	Yes, Spearwood Dune soil type
	Location in the landscape, topography	Is the topography/physical environment consistent with where the Tuart Woodlands and Forests may occur? Is the site associated with any hydrology (groundwater/surface water)?	Yes, Tuarts commonly found in the Wanneroo area. Not associated with any wetlands
Structure	Presence of Tuart trees	How many Tuart trees are present and are they consistent with the characteristics set out in the Approved Conservation Advice? **Note:** Please present this information in terms of total number of trees (dead, established, seedlings etc.) and trees per hectare of the footprint. Diagrams/maps should also be provided.	The site is too large to count all Tuart trees with a DBH equal to or greater than 30cm and a concise count is not considered necessary as there would be hundreds of Tuart trees that meet this criterion.
	Structural form	What structural form is the vegetation?	Low Open Woodland to Woodland
Composition	Dominant tree species, emergent tree layer, understory	Is the composition of the community consistent with the characteristics set out in the Approved Conservation Advice? What other tree species are present? How many native understorey species are present and what is the number of weedy species/proportion of weeds?	Tuarts occur in many areas as the sole tree species and in other areas co-dominant with Jarrah trees. Native understorey species ranges from 0-34 in 17 quadrats. Number of weed species ranges from 4-13. Proportion of weeds to native understorey species ranges from 21-100%. Refer to quadrat data in Appendix 7.

Key diagnostic characteristics♦	Information	Key diagnostic questions* (Refer to Section 3.2 of the Approved Conservation Advice for a complete explanation of these diagnostic features – other sections of the Approved Conservation Advice are referenced where relevant)	Response (yes/no/possibly) and detailed comments. Use as much space as you need to fully answer the question#
Defining a patch of Tuart Woodlands and Forests	Patch definition	What is the extent of the patch? **Note:** Descriptions of patch extent must include analysis of canopy extent and associated understorey vegetation (see Section 3.2.2♦). Patches may extend beyond the project area or include areas of infrastructure (i.e. road, powerline). The referral should make clear how, and how much of the patch will be directly or indirectly impacted.	Each Tuart tree was not mapped on the site as there are several hundred Tuarts present. Therefore, a 30m perimeter around Tuart tree canopies was not able to be mapped. However, based on site investigations the density of Tuarts on the site is highly likely that the 30m perimeter around the Tuart canopies overlaps in all areas mapped as Eg, EgEm and EgBs.
Relationship with other ecological communities	Other vegetation communities	Are other vegetation communities present? What are they and how do they intergrade and/or interact with the Tuart Woodlands and Forests TEC? (see Section 3.2.3♦)	The site contains other dryland woodland vegetation that does not contain Tuart trees as well as wetland vegetation in the south-east corner.

The complete key diagnostic characteristics are provided in the Approved Conservation Advice.

* The Tuart Woodlands and Forests may include restored, planted or revegetated flora. Do not exclude vegetation from being classed as the Tuart Woodlands and Forests because it is a planted, restoration or revegetation site (unless it is a garden).

Comments should include references to appropriate supporting information and data.

Step 2: What is the patch size and condition category of the Tuart Woodlands and Forests in the proposed project site and in the surrounding area?

Table 10: Tuart Woodland TEC Step 2 Diagnostics

Size and condition♦	**Information**	**Relevant content to be discussed in the referral** (Refer to Section 3.3 of the Approved Conservation Advice for a complete explanation of these diagnostic features)	**Detailed comments.** **Use as much space as you need to fully answer the question#**
Patch Size	Patch size in hectares	Is the patch size large enough to meet the minimum patch size in this section? (Section 3.3♦) **Note:** Patch boundaries are not limited to the proposal site. You must make clear that the patch boundary is consistent with Section 3.2.2♦.	The areas mapped with Tuart trees are mostly well above the minimum 5ha to meet the criteria for the TEC regardless of understorey condition. Two areas mapped as Degraded and Completely Degraded are rated as being in Poor condition and are both around 2ha and are therefore too small to be the TEC. The smaller areas have a High species richness and are above the 2ha minimum size to be the TEC.
Patch condition	Condition thresholds	Using the condition categories in this section, what is the patch condition? (Section 3.3.1♦) What is the quality and size (hectares) of the vegetation community in and around the site where the proposed action will occur? Is the patch expected to improve in condition (e.g. after appropriate fire management) or is there a threatening process underway that will reduce the current size and/or condition? **Note:** Refer to Section 3.4 – Step 3 – Further information to assist in identifying patches of the protected ecological community and avoiding significant adverse impacts. If patch quality varies over the site; characterisation of the variation should be provided. Patch condition includes consideration of thresholds for characteristics such as plant species richness, landscape features, Tuart tree age and size and other habitat roles of the vegetation. Other vegetation condition measures (e.g. Keighery scale) do not necessary reflect the condition thresholds and both should be provided, where relevant. Where threats are identified (i.e. those listed in Appendix C of the Approved Conservation Advice) please provide further information on what these are and how they have impacted the condition.	The 17 quadrats assessed have 0-34 native understorey species per 0.1ha. Ten of the quadrats have 12 or more native understorey species which gives the quadrats a Very High rating. Four have less than 4 which gives those quadrats a Poor rating. The four quadrats with a Poor rating are within a patch of Tuart woodland that is larger than 5ha and is therefore automatically part of the Tuart Woodland TEC regardless of the Poor rating.

♦ Further information on the key diagnostic characteristics is provided in the Approved Conservation Advice..

5 SUMMARY

The Flora and Vegetation survey of the Carabooda Rezoning Project resulted in the following:

1. Native vegetation occurs on 333.78ha of the 959ha;

2. Thirteen vegetation types were recorded and mapped on the site. The different types were related to the variation in depth of sand over limestone and the associated position of the vegetation in the landscape, eg. top of a limestone ridge or on lower land;

3. The condition of the vegetation ranged from Excellent to Completely Degraded. The vegetation on shallow sand or outcropping limestone were in the best condition. Areas of Banksia/*Eucalyptus todtiana* vegetation in Very Good to Excellent condition occurred in the central part of the site in one contiguous area.;

4. A total of 230 plant species were recorded on the site. The total consisted of 172 native species and 55 (23.9%) introduced species. The number of native species is considered moderate for the size of the site;

5. One Threatened plant species, *Eucalyptus argutifolia,* was recorded from a known population at the northern end of the site;

6. Three Priority species, *Pimelea calcicola, Stylidium maritimum* and *Eucalyptus foecunda* subsp. *foecunda* were recorded in low numbers on the site, all associated with outcropping limestone areas;

7. Three Floristic Community Types were analysed as occurring on the site. The vegetation types on areas of shallow sand over limestone were assessed as FCT 24 'Northern Spearwood shrublands and woodlands'. The vegetation types occurring on deeper sand were assessed as FCT 28 'Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands'. The FCT analysis result for the vegetation type MhMs that occurs on the top of limestone hills was anomalous due to low species richness in the quadrats. The most likely result is for MhMs to be either FCT 26a '*Melaleuca huegelii-M. systena* shrublands of limestone ridges' or FCT 24. FCT 26a is a Threatened Ecological Community at State and Commonwealth level. FCT 24 is a Priority 3 Ecological Community at State level;

8. The areas of EtBaBm and BaBmEt vegetation type in Good condition or better were assessed as being part of the Banksia Woodlands of the Swan Coastal Plain ecological community which is a TEC at State and Commonwealth level. A total of 44.99ha of the Banksia Woodland TEC occurs on the site; and

9. The three vegetation types containing Tuart trees were all considered to be representative of the Tuart Woodlands and Forests of the Swan Coastal Plain ecological community which is a

TEC at Commonwealth level and State level. A total of 112.8ha of the Tuart Woodland TEC occurs on the site.

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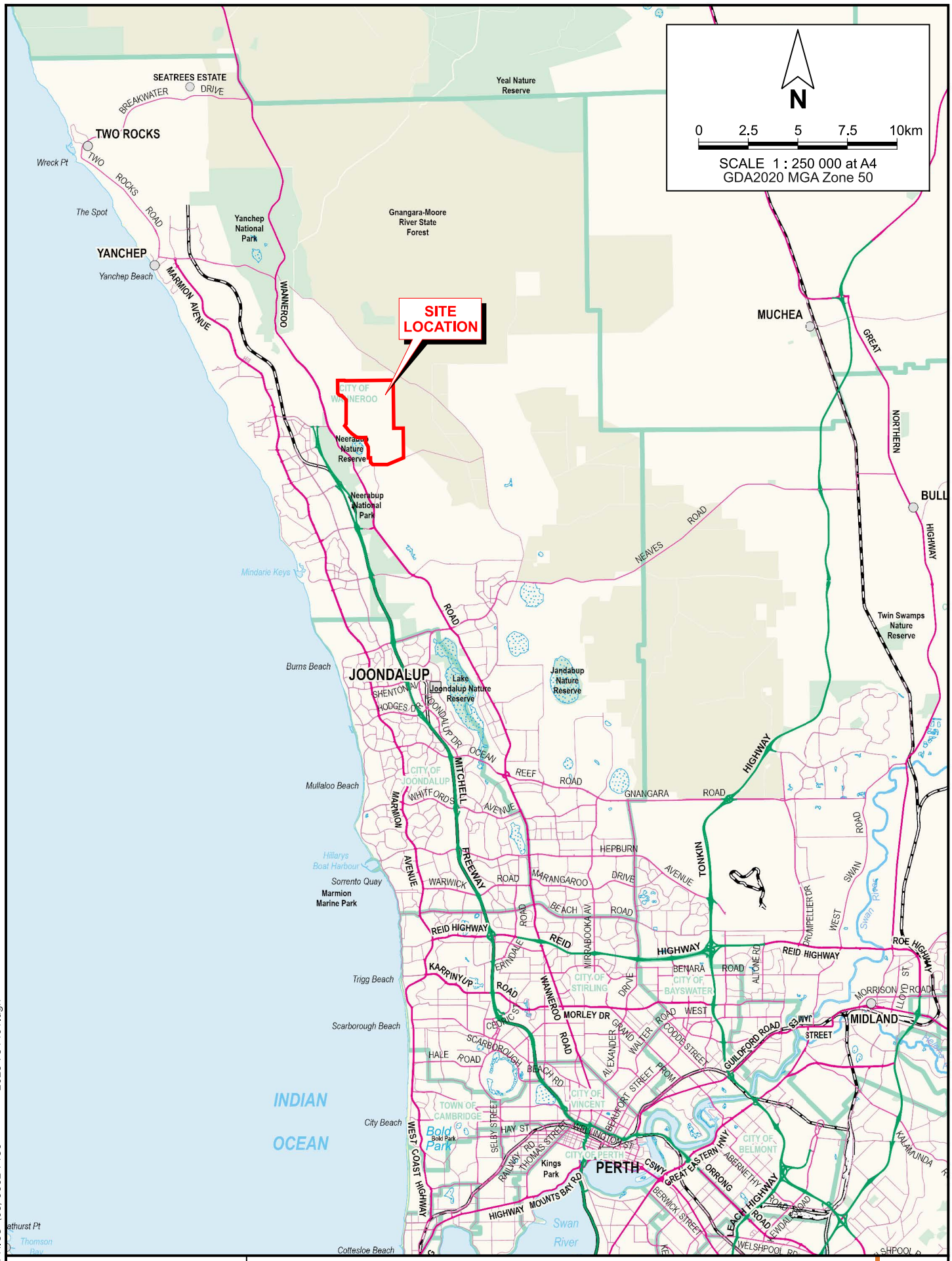
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FIGURES



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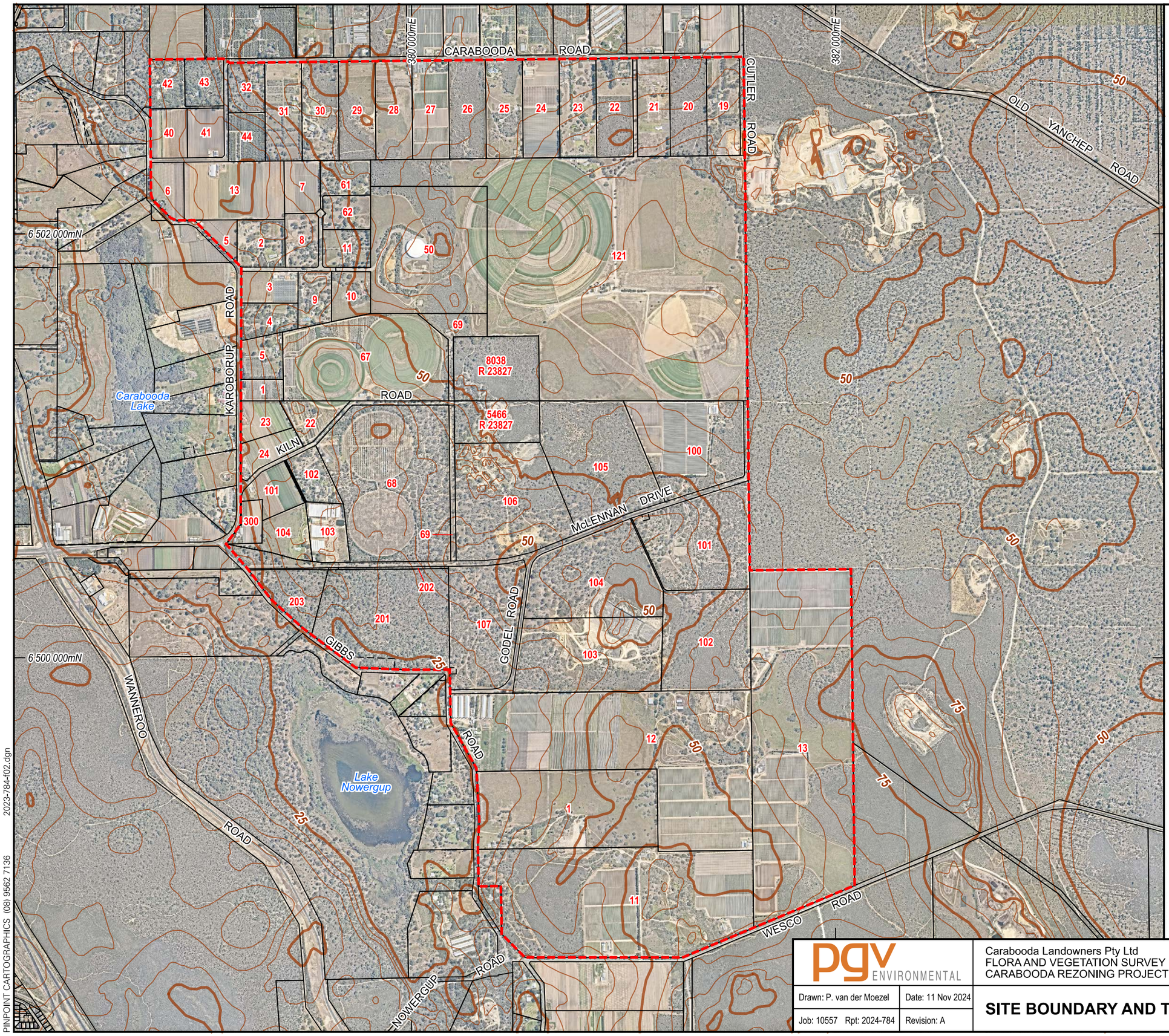
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Carabooda Landowners Pty Ltd
FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel	Date: 11 Nov 2024
Job: 10557 Rpt: 2023-784	Revision: A

SITE LOCATION

Figure 1



N

0 200 400 600 800 1000m

SCALE 1 : 17 500 at A3
GDA2020 MGA Zone 50

Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Topographic Contour

CADASTRAL SOURCE: Landgate, September 2024.
CONTOUR SOURCE: Landgate, 1:50,000 Topographic Mapping.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown October 2024.

pgv ENVIRONMENTAL

Carabooda Landowners Pty Ltd
FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel	Date: 11 Nov 2024
Job: 10557 Rpt: 2024-784	Revision: A

SITE BOUNDARY AND TOPOGRAPHY

Figure 2

PINPOINT CARTOGRAPHICS (08) 9562 7136 2023-784-f02.dgn

N

0 100 200 300 400 500m

SCALE 1 : 10 000 at A3
GDA2020 MGA Zone 50

380 000mE

381 000mE

6 502 000mN

6 501 000mN

CARABOODA ROAD

CUTLER ROAD

ROAD

KILN ROAD

KAROBORUP ROAD

McLENNAN DRIVE

EgBs

Bs

EgEm

Cl

CB60

AfBs

C34

C35

C36

2 plants

3 plants

6 plants

CB64

BaBmEt

CB63

MhMs

Eg

CB62

CB61

CB55

Em

C32

EgEm

C31

C33

CB50

CB49

C30

C25

C26

C37

EtBaBm

C24

C23

C20

C21

C22

C11

C10

CB48

C29

CB47

CB46

CB56

CB59

EdBs

CB58

CB57

Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Quadrat Location
- Quadrat Location (2024)
- Vegetation Type Boundary
- Bs — Vegetation Type

Threatened and Priority Plant Locations

- *Eucalyptus argutifolia* (Threatened)
- *Pimelea calcicola* (P3)
- *Stylidium maritimum* (P3)
- *Eucalyptus foecunda* subsp. *foecunda* (P4)
- 3 — Number of plants

Vegetation Types

MhMs
Melaleuca huegelii/M. systena Closed Heath

MhBs
Melaleuca huegelii/Banksia sessilis Closed Tall Scrub over *Melaleuca systena/Hibbertia hypericoides* Open Low Heath

Bs
Banksia sessilis/Calothamnus quadrifidus Open Heath over *Hibbertia hypericoides* Open to Closed Low Heath

EdBs
Eucalyptus decipiens Low Open Woodland over *Banksia sessilis* Tall Open Shrubland over *Melaleuca systena/ Hibbertia hypericoides* Closed Low Heath

EgBs
Eucalyptus gomphocephala Woodland over *Banksia sessilis/ Calothamnus quadrifidus* Open Heath over *Hibbertia hypericoides* Closed Low Heath

AfBs
Allocasuarina fraseriana Low Open Woodland over *Banksia sessilis/Xanthorrhoea preissii/Hibbertia hypericoides* Open Low Heath

Et
Eucalyptus todtiana Low Open Woodland over weeds

EtBaBm
Eucalyptus todtiana/Banksia attenuata/B. menziesii Low Open Woodland over *Xanthorrhoea preissii/Daviesia divaricata* Tall Shrubland over *Eremaea pauciflora/ Hibbertia hypericoides* Open Low Heath

BaBmEt
Banksia attenuata/Banksia menziesii/Eucalyptus todtiana Low Woodland over *Allocasuarina humilis/Calothamnus quadrifidus/ Hibbertia hypericoides* Closed Heath

Em
Eucalyptus marginata Low Woodland over *Xanthorrhoea preissii* Tall Shrubland

Eg
Eucalyptus gomphocephala Woodland over *Xanthorrhoea preissii* Shrubland over *Mesomelaena pseudostygia/ Phyllanthus calycinus* Open Low Heath

EgEm
Eucalyptus gomphocephala/E. marginata Woodland over **Ehrharta calycina* Closed Grassland

CcEm
Corymbia calophylla/Eucalyptus marginata Low Woodland over *Xanthorrhoea preissii* Shrubland

Cl
Cleared

CADASTRAL SOURCE: Landgate, September 2024.
AERIAL PHOTOGRAPHY SOURCE: NearMap, flown October 2024.

2023-784-f03a.dgn

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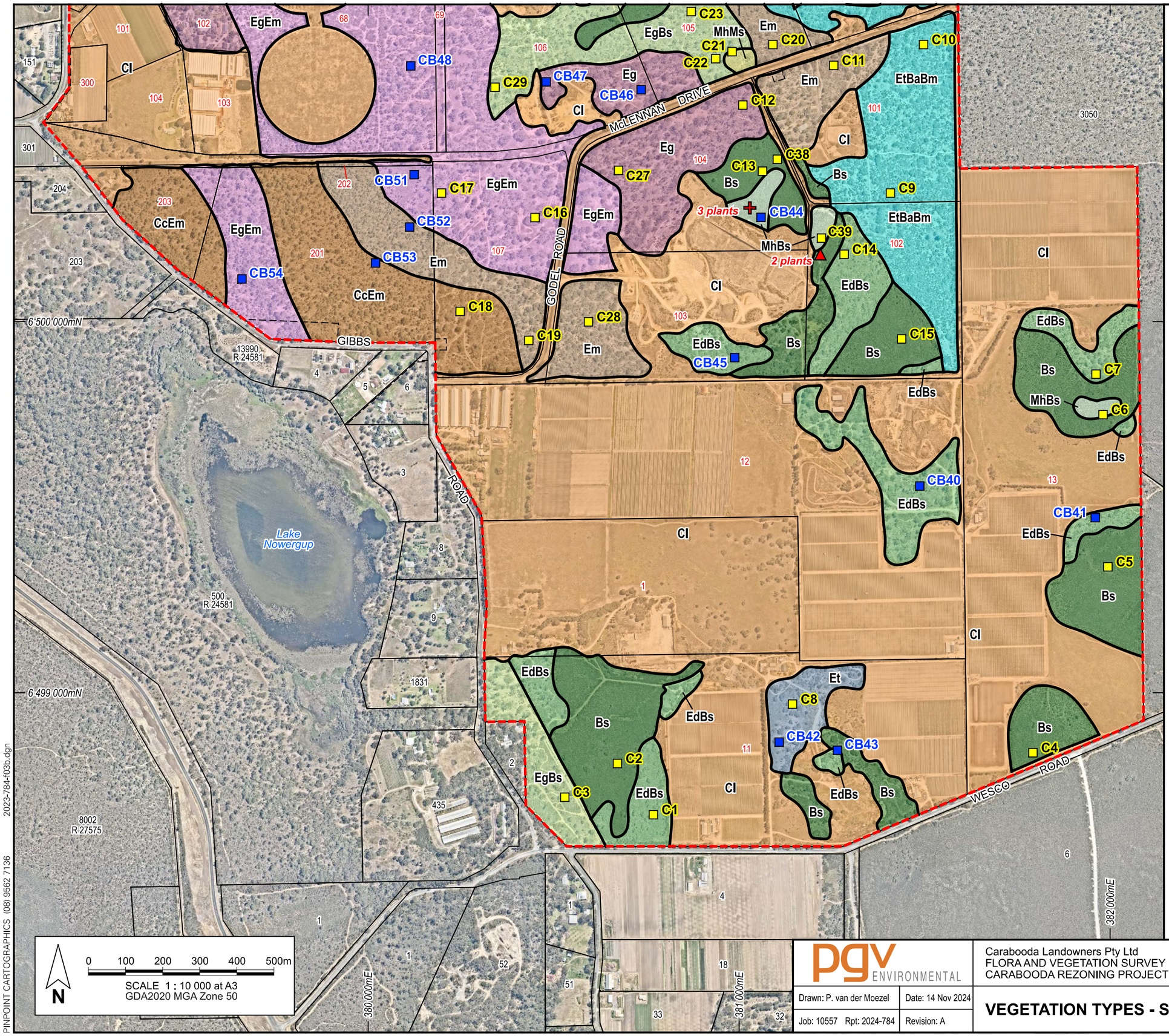
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Carabooda Landowners Pty Ltd
FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel | Date: 13 Nov 2024
Job: 10557 Rpt: 2024-784 | Revision: A

VEGETATION TYPES - NORTH

Figure 3a



Site Boundary
Cadastral Boundary
Easement Boundary
Quadrat Location
Quadrat Location (2024)
Vegetation Type Boundary
Bs Vegetation Type

Threatened and Priority Plant Locations

- *Eucalyptus argutifolia* (Threatened)
- *Pimelea calcicola* (P3)
- *Stylidium maritimum* (P3)
- *Eucalyptus foecunda* subsp. *foecunda* (P4)
- 3 Number of plants

Vegetation Types

MhMs
Melaleuca huegelii/M. systena Closed Heath

MhBs
Melaleuca huegelii/Banksia sessilis Closed Tall Scrub over *Melaleuca systena/Hibbertia hypericoides* Open Low Heath

Bs
Banksia sessilis/Calothamnus quadrifidus Open Heath over *Hibbertia hypericoides* Open to Closed Low Heath

EdBs
Eucalyptus decipiens Low Open Woodland over *Banksia sessilis* Tall Open Shrubland over *Melaleuca systena/ Hibbertia hypericoides* Closed Low Heath

EgBs
Eucalyptus gomphocephala Woodland over *Banksia sessilis/ Calothamnus quadrifidus* Open Heath over *Hibbertia hypericoides* Closed Low Heath

AfBs
Allocasuarina fraseriana Low Open Woodland over *Banksia sessilis/Xanthorrhoea preissii/Hibbertia hypericoides* Open Low Heath

Et
Eucalyptus todtiana Low Open Woodland over weeds

EtBaBm
Eucalyptus todtiana/Banksia attenuata/B. menziesii Low Open Woodland over *Xanthorrhoea preissii/Daviesia divaricata* Tall Shrubland over *Eremaea pauciflora/ Hibbertia hypericoides* Open Low Heath

BaBmEt
Banksia attenuata/Banksia menziesii/Eucalyptus todtiana Low Woodland over *Allocasuarina humilis/Calothamnus quadrifidus/ Hibbertia hypericoides* Closed Heath

Em
Eucalyptus marginata Low Woodland over *Xanthorrhoea preissii* Tall Shrubland

Eg
Eucalyptus gomphocephala Woodland over *Xanthorrhoea preissii* Shrubland over *Mesomelaena pseudostygia/ Phyllanthus calycinus* Open Low Heath

EgEm
Eucalyptus gomphocephala/E. marginata Woodland over **Ehrharta calycina* Closed Grassland

CcEm
Corymbia calophylla/Eucalyptus marginata Low Woodland over *Xanthorrhoea preissii* Shrubland

Cl
Cleared

CADASTRAL SOURCE: Landgate, September 2024.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown October 2024.

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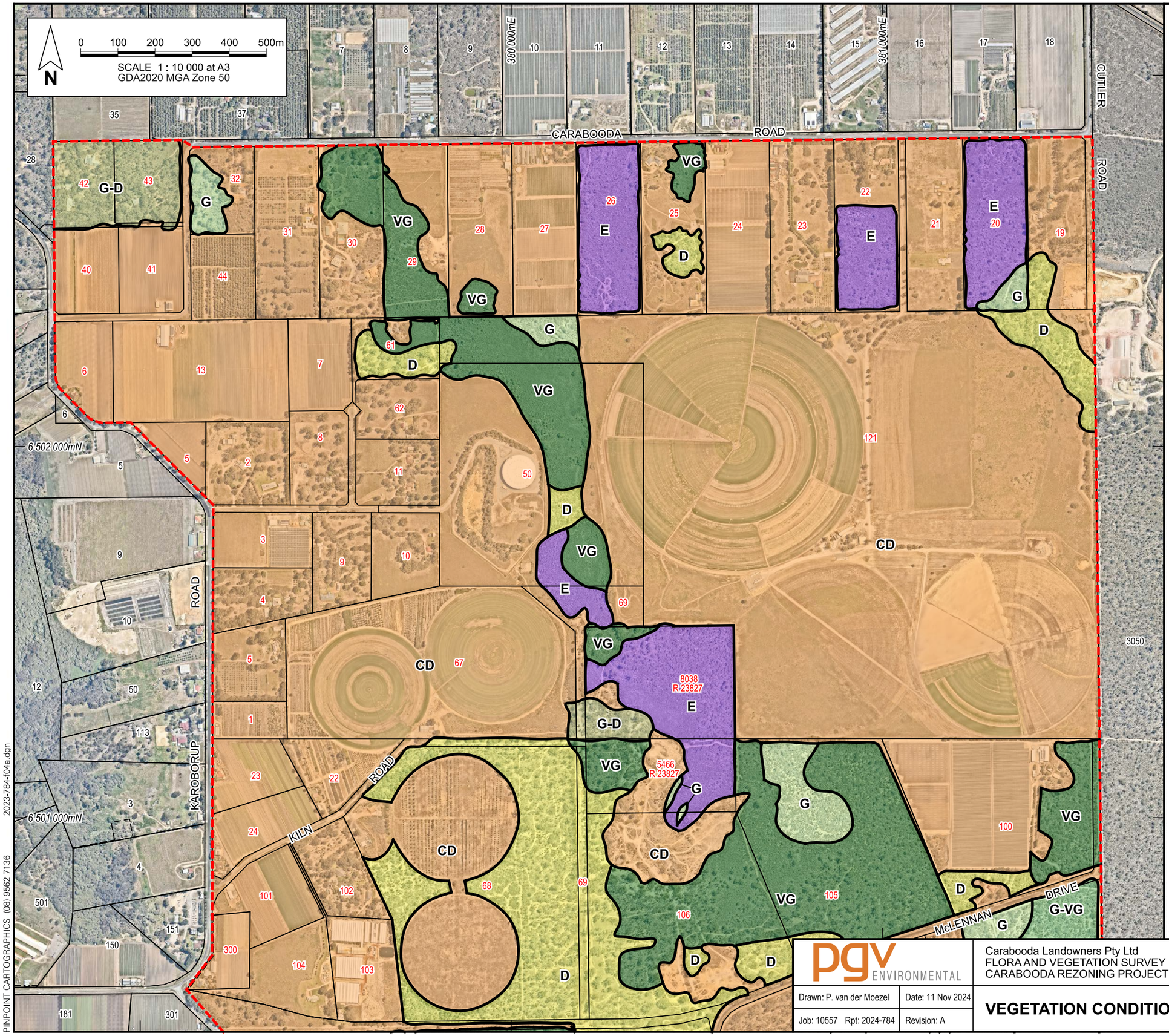
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Carabooda Landowners Pty Ltd
FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel | Date: 14 Nov 2024
Job: 10557 Rpt: 2024-784 | Revision: A

VEGETATION TYPES - SOUTH

Figure 3b



Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Vegetation Condition Boundary
- VG Vegetation Condition

Vegetation Condition

- Excellent
- Very Good
- Good to Very Good
- Good
- Good to Degraded
- Degraded
- Completely Degraded

Vegetation Condition
(SOURCE: Bush Forever, Govt. of W.A., 2000)

P - Pristine
Pristine or nearly so, no obvious signs of disturbance.

Ex - Excellent
Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species.

VG - Very Good
Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

G - Good
Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

D - Degraded
Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

CD - Completely Degraded
The structure of the vegetation is no longer intact and the areas is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.

CI - Cleared
No native vegetation remaining.

CADASTRAL SOURCE: Landgate, September 2024.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown October 2024.

PINPOINT CARTOGRAPHICS (08) 9562 7136 2023-784-f04a.dgn

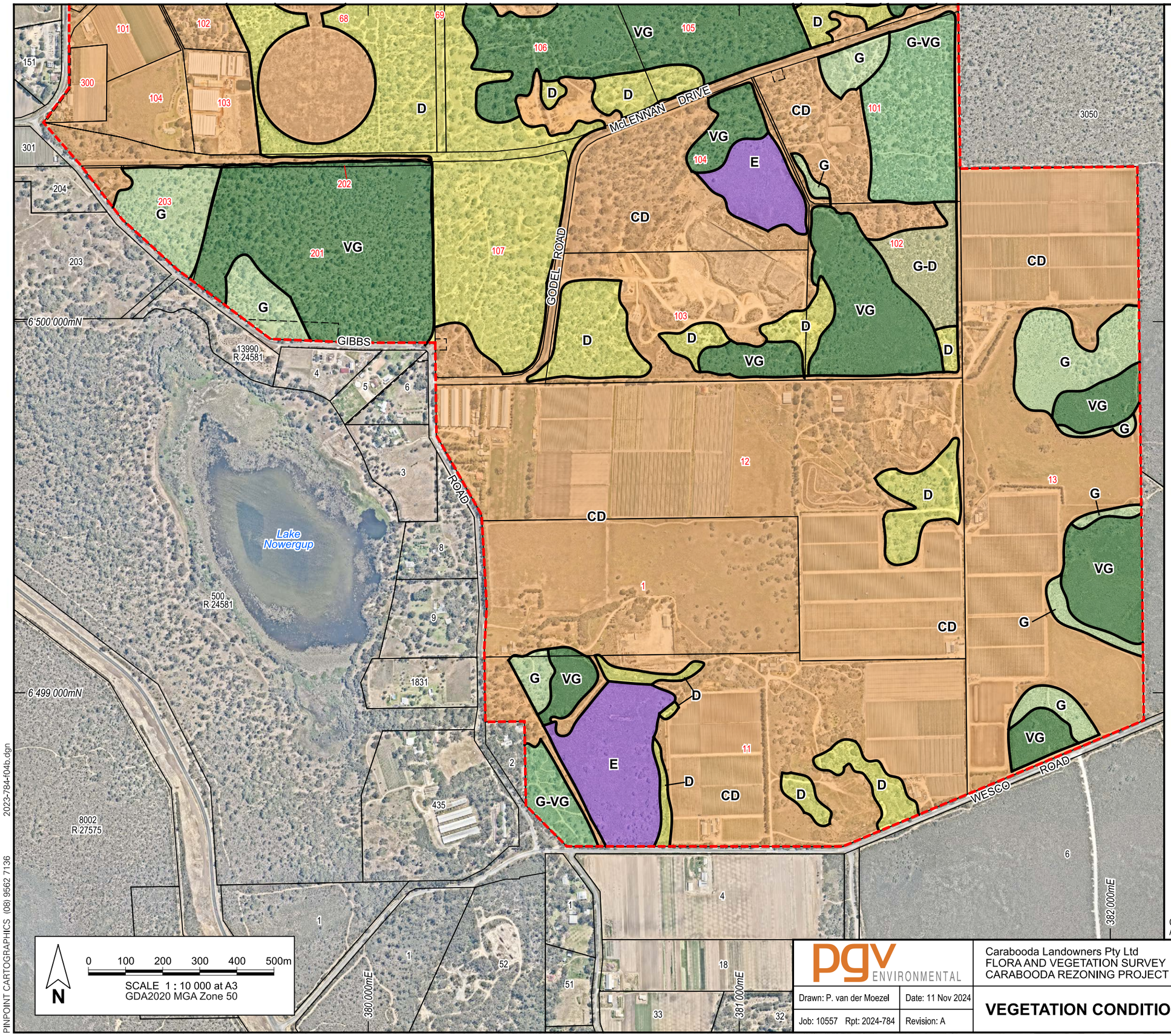
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Carabooda Landowners Pty Ltd
FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel | Date: 11 Nov 2024
Job: 10557 Rpt: 2024-784 | Revision: A

VEGETATION CONDITION - NORTH

Figure 4a



Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Vegetation Condition Boundary
- VG — Vegetation Condition

Vegetation Condition

- Excellent
- Very Good
- Good to Very Good
- Good
- Good to Degraded
- Degraded
- Completely Degraded

Vegetation Condition
(SOURCE: Bush Forever, Govt. of W.A., 2000)

P - Pristine
Pristine or nearly so, no obvious signs of disturbance.

Ex - Excellent
Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species.

VG - Very Good
Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

G - Good
Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

D - Degraded
Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

CD - Completely Degraded
The structure of the vegetation is no longer intact and the areas is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.

CI - Cleared
No native vegetation remaining.

CADASTRAL SOURCE: Landgate, September 2024.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown October 2024.

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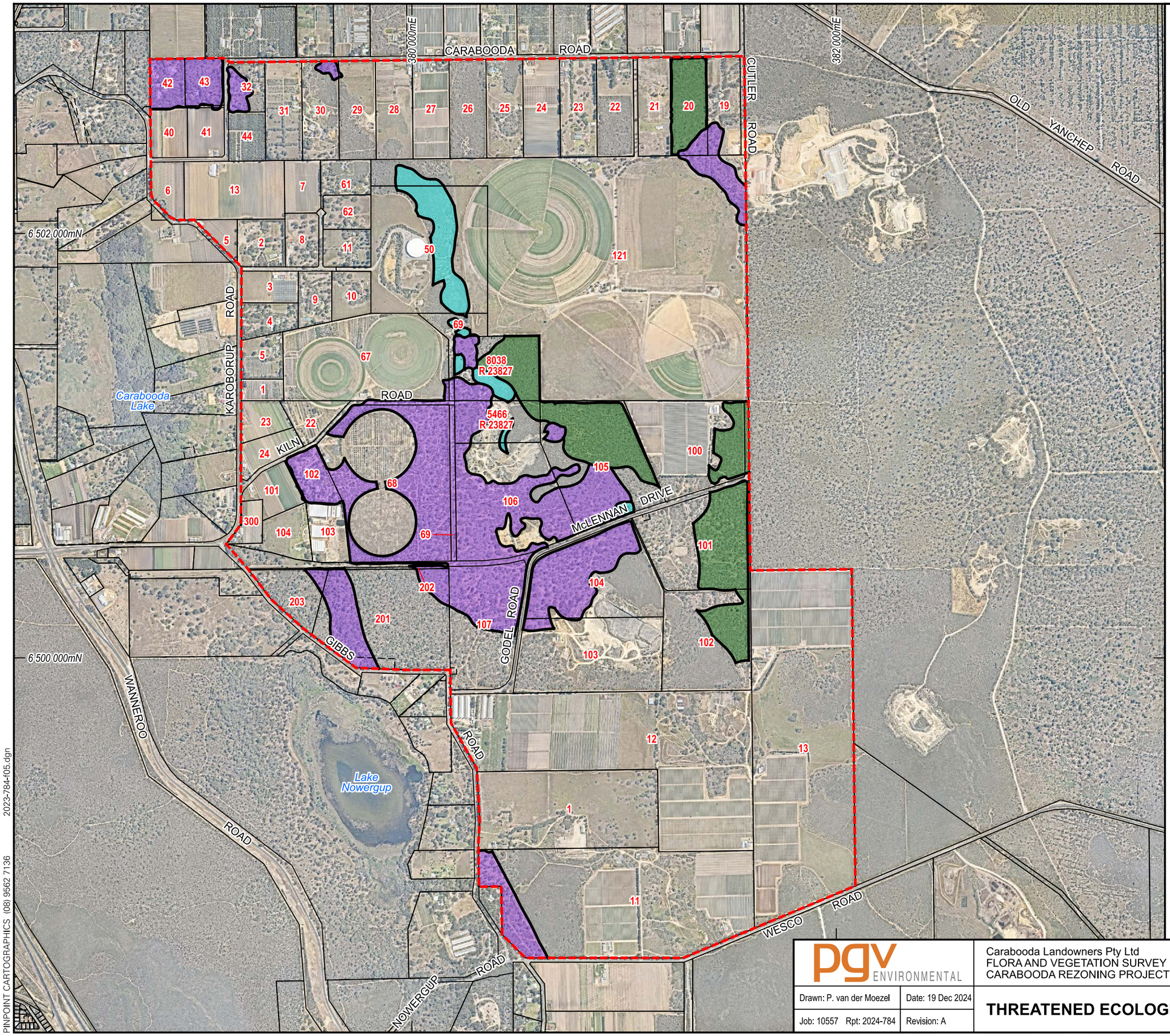
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FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel | Date: 11 Nov 2024
Job: 10557 Rpt: 2024-784 | Revision: A

VEGETATION CONDITION - SOUTH

Figure 4b



N

0 200 400 600 800 1000m

SCALE 1 : 17 500 at A3
GDA2020 MGA Zone 50

Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary

Threatened Ecological Communities

- Banksia Woodland
- Tuart Woodland
- Honeymyrtle Shrubland

CADASTRAL SOURCE: Landgate, September 2024.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown October 2024.

PINPOINT CARTOGRAPHICS (08) 9562 7136 2023-784-f05.dgn

pgv ENVIRONMENTAL

Carabooda Landowners Pty Ltd
FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel | Date: 19 Dec 2024
Job: 10557 Rpt: 2024-784 | Revision: A

THREATENED ECOLOGICAL COMMUNITIES

Figure 5

APPENDIX 1

Track Logs

Track Log 14 and 15 September 2023



Track Log 16 September 2023



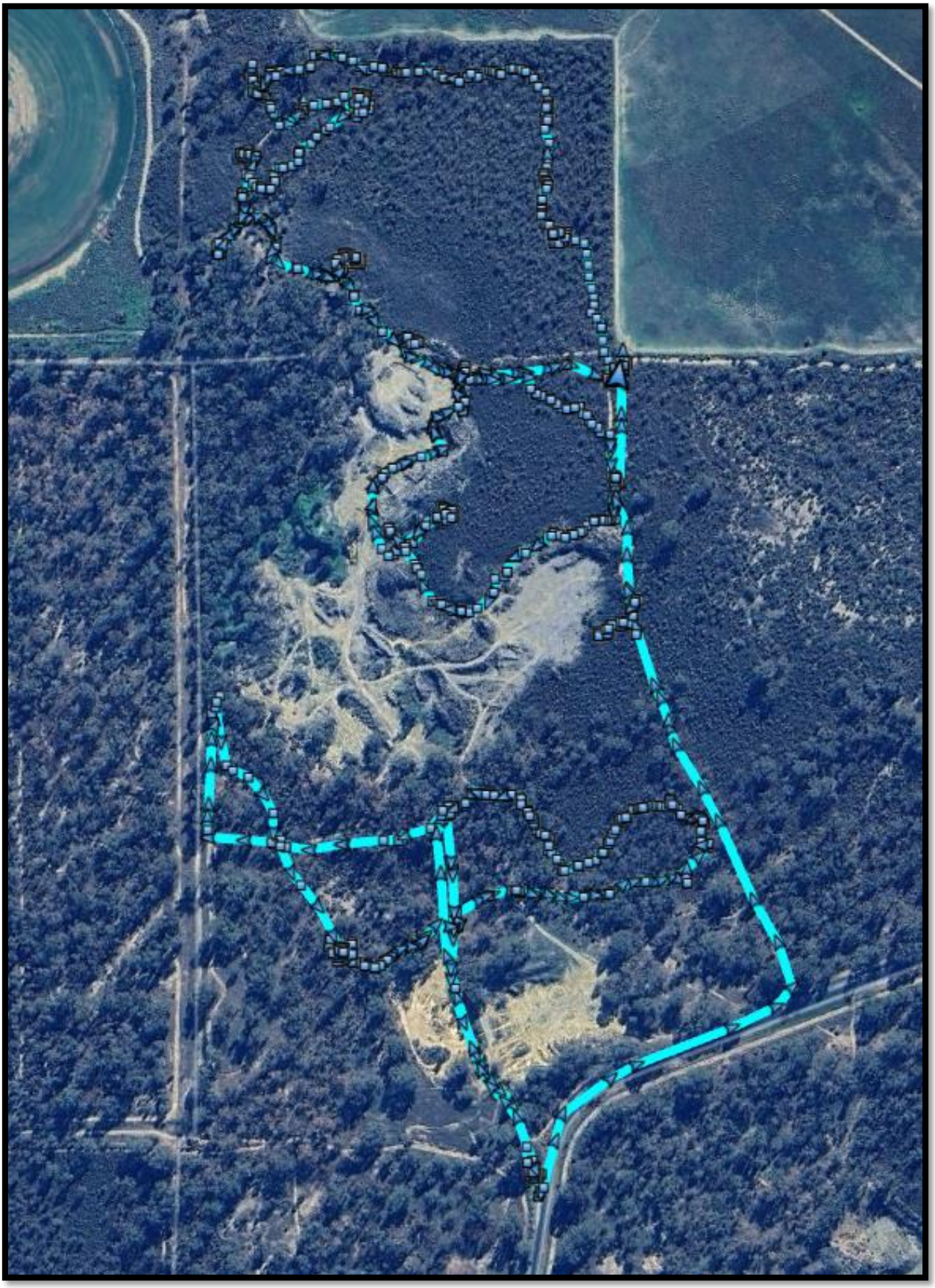
Track Log 25 September 2023



Track Log 27 September 2023



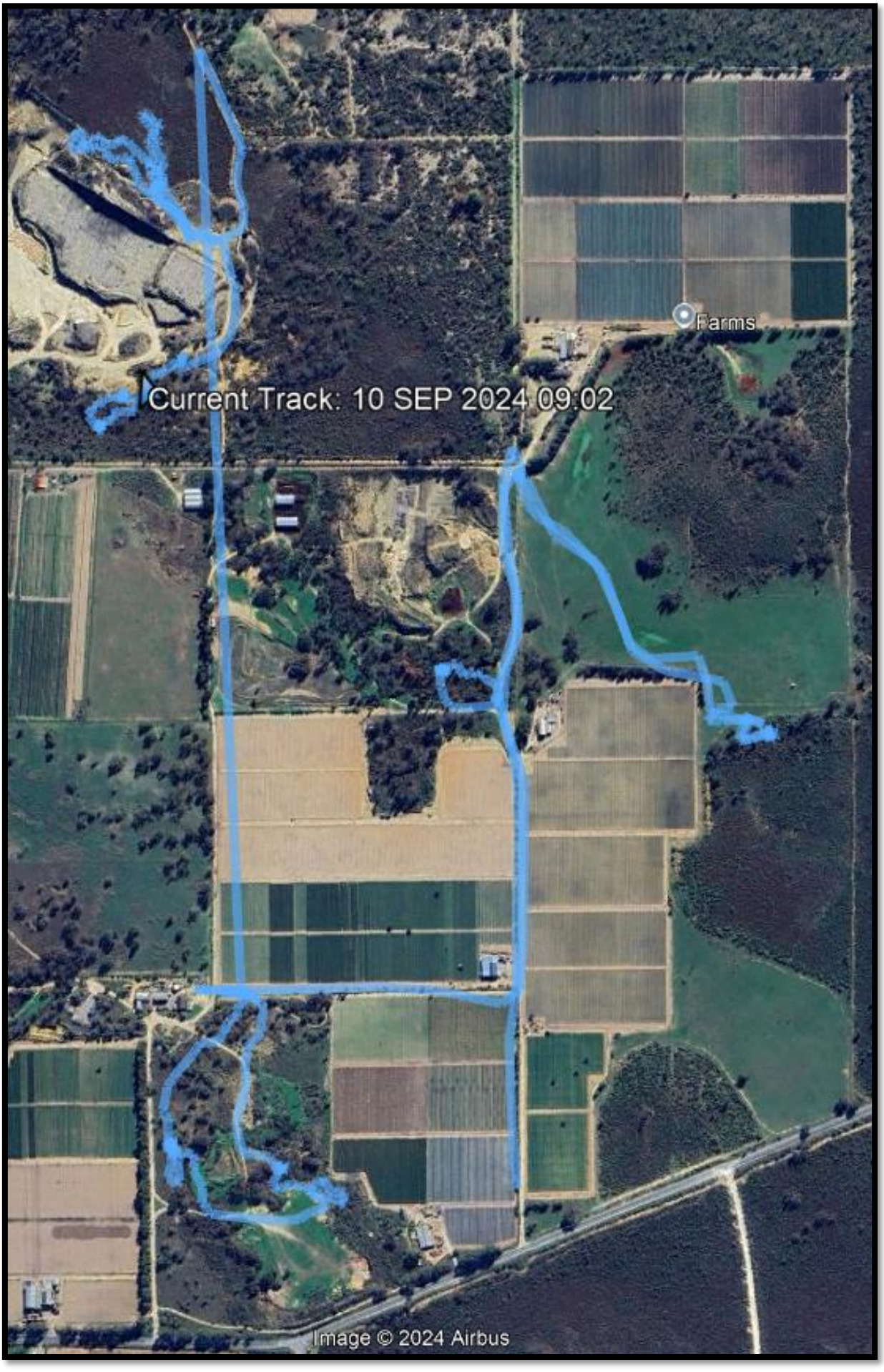
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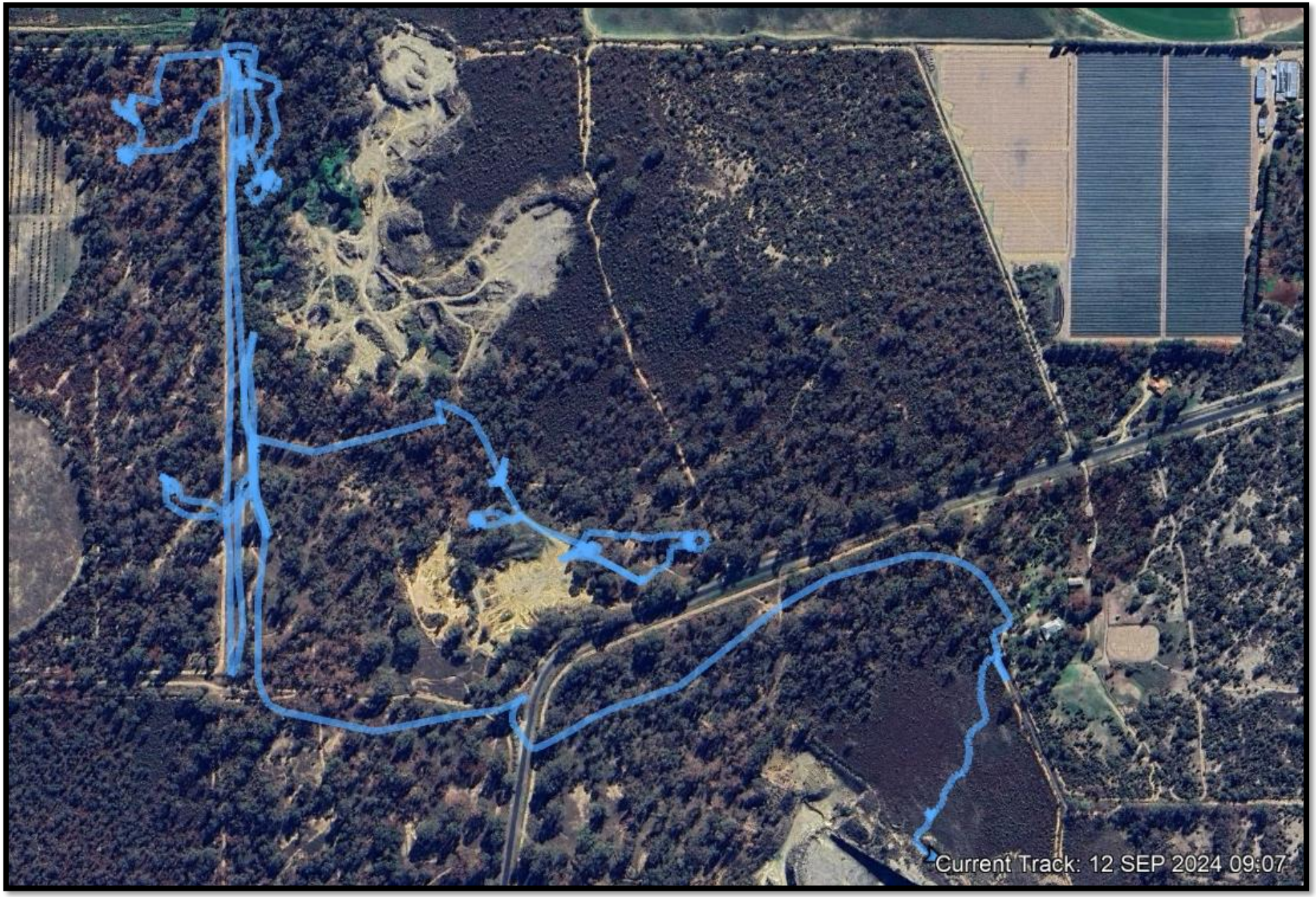
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Track Log 10 September 2024



Track Log 12 September 2024



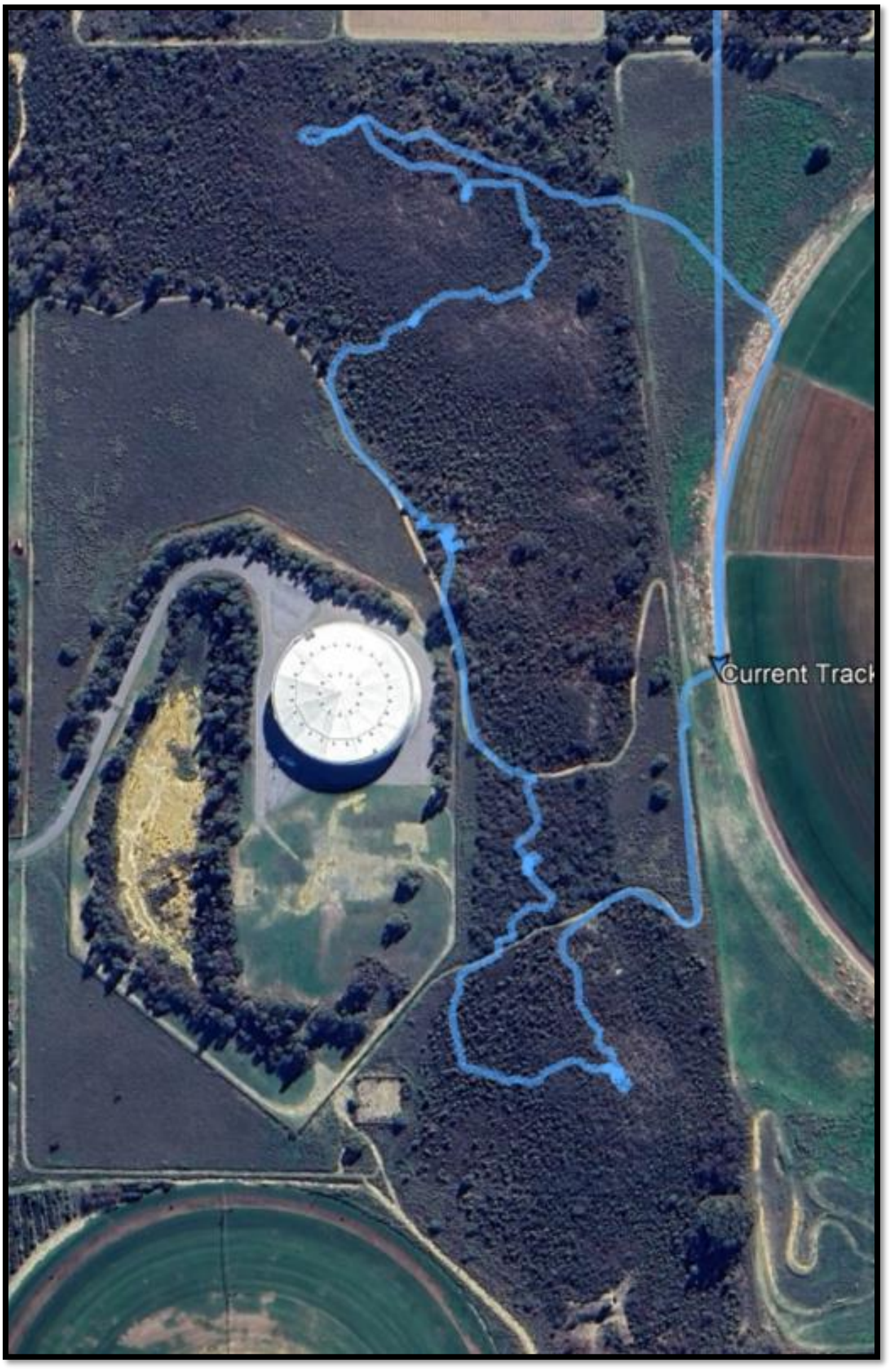
Track Log 13 September 2024



Track Log 23 September 2024



Track Log 24 September 2024



APPENDIX 2

DBCA Flora Database Searches

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Site	Vegetation	Frequency	Notes
749	1218697	3237	Acacia benthamii	2					
770	8982627	3237	Acacia benthamii	2	Shrub, 1.3 m high.	Flat. Yellow brown sand.	Low open forest of Allocasuarina fraseriana, Banksia attenuata and B. menziesii over tall open shrubland of Xanthorrhoea preissii over low open heath of Hibbertia hypericoides and Acacia humilis over very open grassland/sedgeland of Mesomelaena pseudosty		
5072	1014773	11336	Adenanthos cygnorum subsp. chamaephyton	3	Prostrate mat like shrub.	Lateritic sandy loam. Roadside.		common, ca 10 plants.	
8365	3416119	34161	Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)	1	Shrub 1.8-2 m high, flowers white.	Limestone.			
8370	7404808	34161	Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)	1		Limestone ridges SCP26a.			FCT26a Hadrell road. Transect road myhad 02, 10 m transect ID JP05, preburn plot.
8374	9139532	34161	Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)	1	Upright shrub to 2.5 m. White flowers.	Moderate east-facing slope. Yellow grey sand.		120+ plants.	
16366	8755388	1425	Conostylis bracteata	3	Tufted herb to 20 cm tall. Flowers yellow. Plants flowering at the time of collection. Leaves arranged into flattened, broadly fan-like clusters. The leaf margins glabrescent.	Grey sand, on mid-slope.	Acacia rostellifera and Melaleuca systena mid shrubland. Lomandra maritima low open herbs.	1 mature plant.	Project: 3536.
16534	9208054	11388	Conostylis pauciflora subsp. euryrhipis	4	Stoloniferous herb, 20 cm high.	Interdunal flat or swale. White calcareous sand. > 7 years since fire.	Allocasuarina lehmanniana subsp. lehmanniana high open shrubland over Spyridium globulosum, Olearia axillaris, Acacia cyclops high shrubland over Melaleuca systena, Rhagodia baccata low open shrubland over Desmocladus asper, Lepidosperma pubisquameum ver		
16537	5982138	11388	Conostylis pauciflora subsp. euryrhipis	4		S slope, on sand dunes; dry white sand; long unburnt.	Low heath 0.3 m tall, 30-70% cover.	c. 20 mature plants in a 5 x 20 m area.	
16539	7836457	11388	Conostylis pauciflora subsp. euryrhipis	4		Yellow-brown sand over limestone, slope, private lease. NW aspect.	Acacia rosterllifera and Spyridium globulosum Tall Open Scrub over Melaleuca systena Low Open Shrubland over mixed Herbland-Grassland.		Healthy population with flowers. Potential threat from clearing.
16540	7858833	11388	Conostylis pauciflora subsp. euryrhipis	4	Tufted perennial.	Sand, secondary dunes.	Scaevola crassifolia, Lomandra maritima, Rhagodia baccata, Hardenbergia comptoniana, Threlkeldia diffusa, Hemiandra pungens, Acanthocarpus preissii.		
16545	9039023	11388	Conostylis pauciflora subsp. euryrhipis	4	Herb.	Dunes.	Acacia cochlearis and Melaleuca systena low open shrubland.		
16550	4059034	11388	Conostylis pauciflora subsp. euryrhipis	4	Tufted perennial herb, flowers yellow.	On grey calcareous sand.			
16567	7836449	11657	Conostylis pauciflora subsp. pauciflora	4		Grey sand over limestone, slope private lease, W aspect.	Melaleuca systena and Scaevola globulifera Open Low Heath over Austrostipa flavescens, Lolium perenne and Bromus diandrus Grassland.		Healthy population with flowers. Potential threat from clearing.

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Site	Vegetation	Frequency	Notes
22919	1123661	13091	Eucalyptus argutifolia	T		ESE aspect. Lower ridgetop slope. Sheet sand/brown boulder. Completely open to treeless site.	Melaleuca huegelii, Xanthorrhoea preissii, Dryandra sessilis/nivea, Hakea trifurcata, Hibbertia hypericoides, Native wisteria.		
22934	9139524	13091	Eucalyptus argutifolia	T	Mallee to 2 m high.	At the base of a limestone ridge. Grey sand.		ca. 6 plants.	
22936	2160765	13091	Eucalyptus argutifolia	T		Slight gully situation nestles between two limestone ridges. Sand/boulder/brown/ yellow/dry/limestone.	Completely open and treeless with dense scrubland. Dryandra's nivea/ sessilus, Hakea trifurcata, Melaleuca huegelii, Blackboys (Xanthorrhoea preissii), Templetonia retusa.	32 clumps.	
22937	2117223	13091	Eucalyptus argutifolia	T		Slight gully situation nestled between two limestone ridges. Limestone/boulder/ sand/brown/yellow/dry.	Completely open & treeless with dense scrubland. Dryandra's nivea/ sessilus, Hakea trifurcata, Melaleuca huegelii, Blackboys (Xanthorrhoea preissii), Templetonia retusa.	32 clumps, undisturbed.	
22946	8153302	13091	Eucalyptus argutifolia	T	Mallee to 2.5 m. Flowers white.	Slight slope/ridge. Grey/white sand over limestone.	With Acacia cyclops, Hakea prostrata, Lomandra maritima, rhagodia baccata, Spyridium globulosum.		
22947	8153310	13091	Eucalyptus argutifolia	T	Mallee to 2.5 m. Flowers white.	Slight slope/ridge. Grey/white sand over limestone.	With Acacia cyclops, Hakea prostrata, Lomandra maritima, rhagodia baccata, Spyridium globulosum.		
22953	9482083	13091	Eucalyptus argutifolia	T	Mallee, 1 - 2.5 m high by 1 - 3.5 m wide.	Hill top, with exposed limestone outcropping, moist brown sand. Site was burnt approx. 2002-2003.			Population 7B. Access is through the quarry.
22954	9487921	13091	Eucalyptus argutifolia	T	Mallee to 3 m high. Buds, white flowers and fruit present.	Mid-slope, brown sand over limestone.	Associated species: Banksia sessilis, Xanthorrhoea preissii, Melaleuca huegelii, Hibbertia hypericoides.	25 mature and 2 juvenile plants.	Plants are in two clumps. The southern clump is close to a limestone quarry.
24451	1176412	50737	Eucalyptus foecunda subsp. foecunda	4	Mallee to 5 m tall, bark rough, flowers white.	Slopes of hill high in the landscape.	Limestone heath with Eucalyptus falcata and E. decipiens at foot of N side of hill.		
24457	1153900	50737	Eucalyptus foecunda subsp. foecunda	4	Mallee to < 3 m, grey bark rough at base, smooth above. Buds and branchlets yellow-orange.	On limestone/sand,	Dryandra sessilis, Grevillea thelemanniana, Hakea trifurcata.		
24458	1153919	50737	Eucalyptus foecunda subsp. foecunda	4	Mallee to < 3 m, grey bark rough at base, smooth above. Buds and branchlets yellow-orange.	On limestone/sand,	Dryandra sessilis, Grevillea thelemanniana, Hakea trifurcata.		
24466	1192558	50737	Eucalyptus foecunda subsp. foecunda	4	Smooth barked mallee to 2 m x 2 m.	Grey sand over limestone, hilltop.	Low limestone heath.	rare.	
24472	1144987	50737	Eucalyptus foecunda subsp. foecunda	4		Limestone soil.			
24476	1155458	50737	Eucalyptus foecunda subsp. foecunda	4		In limestone soil.			
24503	1144235	50737	Eucalyptus foecunda subsp. foecunda	4		Sand over limestone.	In shrubland with E. petrensis.		
24511	6985165	50737	Eucalyptus foecunda subsp. foecunda	4	Mallee. 2 m high x 2 m wide. Flowers white; in flower and bud.	Limestone hill. White sand.	Eucalyptus foecunda mallee heath.	>100 plants over 0.25 ha.	
27340	8076626	20162	Fabronia hampeana	2		Private property in depression between limestone outcrops with yellow sand. Potential threat by urban development. Last burnt summer 2001.	Banksia low open woodland with occasional Eucalyptus decipiens, Macrozamia riedlei, Acacia rostellifera and Hypocalymma angustifolium.		Condition of population: Healthy.
27341	9248811	20162	Fabronia hampeana	2	Moss on Macrozamia riedlei trunks.	Lower dune. Dry pale grey sand.	Woodland of Banksia attenuata with Xanthorrhoea preissii, Mesomelaena pseudostygia, Hakea trifurcata and occasional Macrozamia.		The stems of Macrozamia needed to be well developed and the fronds large to provide shade.
34558	2625598	49637	Hibbertia leptotheca	3		Limestone.	Heath.		

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Site	Vegetation	Frequency	Notes
34572	7520859	49637	Hibbertia leptotheca	3		Outcrop, slope. Dry, red-brown-white, limestone.	Mixed low scrub. Melaleuca cardiophylla, Mel. huegelii, Diplopeltis huegelii, Grevillea preissii, Trymalium ledifolium.	> 100 plants.	
34582	9208046	49637	Hibbertia leptotheca	3	Low shrub, 30 cm high.	WSW-facing upper to mid slope of dune. White calcareous sand. 1.5 to 2.5 years since fire.	Allocasuarina lehmanniana subsp. lehmanniana, high open shrubland over Acacia rostellifera shrubland over Melaleuca systena, Phyllanthus calycinus, Olearia axillaris, Gastrolobium linearifolium low shrubland over Lepidosperma pubisquameum scattered sedge		
34583	9039058	49637	Hibbertia leptotheca	3	Low shrub.	Dunes.	Xanthorrhoea preissii mid open shrubland over Melaleuca systena low open shrubland.	5 plants.	
36574	8755396	20462	Jacksonia gracillima	3	Perennial tufted herb with narrow leaves 10-40 cm long, with rose pink flowers.	Grey sand, on mid-slope with exposed limestone. Fire > 5 years.	Low open forest of Eucalyptus rudis and Melaleuca preissiana. Banksia attenuata shrubs. Tall shrubland of Gastrolobium ebracteolatum and Kunzea glabrescens. Sedgeland of Baumea preisii subsp. laxa.	1 mature plant.	Project: 3516.
36729	6410731	4027	Jacksonia sericea	4		Slope/flat. Dry grey sand over limestone.	Eucalyptus marginata, Banksia attenuata, B. menziesii Woodland. Associated species: Banksia attenuata, B. grandis, Allocasuarina fraseriana, Dryandra sessilis, Calothamnus sp.		Condition of population: healthy.
36734	7400160	4027	Jacksonia sericea	4	Low shrub.				
36751	8982643	4027	Jacksonia sericea	4	Shrub, 0.5 m high.	Gentle slope, slight ridge. Yellow brown loamy sand.	Tall open shrubland of Acacia rostellifera to 3 m over closed tall scrub of Banksia sessilis to 2.4 m over open shrubland of Xanthorrhoea preissii, Melaleuca systena and Hakea trifurcata to 2 m over low shrubland of Jacksonia sericea and Hibbertia hyperi	> 700 plants.	
38359	1421468	3042	Lepidium pseudotasmanicum	4					
39370	5456169	40801	Leucopogon maritimus	1		On stable dune.	Coastal heath.		
39371	7835213	40801	Leucopogon maritimus	1		White sand, sand dune, slope, private property.	Melaleuca systena, Lomandria maritima Low Open Heath Melaleuca systena, Scaevola thesioides, Acacia rosterllifera and Herbland of Lomandra martima.		Healthy population with potential threat from clearing.
39378	5536359	40801	Leucopogon maritimus	1	Low spreading shrub, 20 cm high x 20 cm wide. Flowers white, single stemmed at ground level. Ovary 3 celled glabrous.	Near coastal dunes ca 600 m from beach. Bare yellow sand over limestone.	Low Heath D (Muir 1977) with Acacia truncata, Melaleuca systena and Acanthocarpus preissii.	locally common.	
39383	5127742	40801	Leucopogon maritimus	1	Erect to spreading shrub to 30 cm tall. Corolla white, flowers just beginning.	In sand among limestone rocks on small hill.	In low kwongan, Scaevola, Pimelea, Acacia.		
39384	9208038	40801	Leucopogon maritimus	1	Low shrub, 35 cm high.	Gentle, NW-facing lower slope of lower ridge. Grey calcareous sands. > 5 - 7 years since fire.	Melaleuca huegelii, M. cardiophylla, Acacia truncata closed low heath over Thomasia triphylla, Leucopogon insularis, Melaleuca systena, Lysinema ciliatum low shrubland over Desmocladus asper, Lepidosperma pubisquameum very open sedgeland with Lomandra ma		
39599	8262926	19460	Leucopogon sp. Yanchep (M. Hislop 1986)	3					
39600	8262934	19460	Leucopogon sp. Yanchep (M. Hislop 1986)	3					

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Site	Vegetation	Frequency	Notes
39603	3509311	19460	Leucopogon sp. Yanchep (M. Hislop 1986)	3	Dwarf shrub 40 cm high, flowers white, mucronate leaves.	Undulating, grey sand over limestone.	Woodland, Banksia.	frequent.	
39604	1147773	19460	Leucopogon sp. Yanchep (M. Hislop 1986)	3	Low twiggy woody shrub, 15-20 cm, flowers white, sweet honey scent.	Low hill, grey sand over limestone.	Limestone heath.	scattered in area.	
39617	7293178	19460	Leucopogon sp. Yanchep (M. Hislop 1986)	3	Erect shrub to 60 cm high x 60 cm wide. Flowers white, strictly pendulous.	Coastal plain. Dry, yellow sand over limestone.	Heath (mostly 1-2 m). Dryandra sessilis, Jacksonia calcicola, Conostephium stoechadis.	locally common.	
41047	9196951	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	Slender erect open shrub, 2-3 m high x 1 m wide. In fruit, not in flower.	Limestone hill. Skeletal white loam over limestone.	Banksia sessilis / Melaleuca tall shrubland.	locally common.	Co-occurring with Melaleuca systena which is in full flower.
41048	8815224	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	Erect to spreading shrub to 1.5 m with yellow flowers.	Limestone ridge remnant within a mine pit.	Remnant.	occasional.	
41049	8816476	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	Erect shrub 1 - 2.5 m x 2 m.	On fine sand to sandy loam soils with 30-70% outcropping limestone.	Closed tall scrub of Melaleuca systena, M. sp. Wanneroo, M. sp. Wanneroo x systena and M. huegelii, over low shrubland of Calothamnus quadrifidus, Banksia sessilis var. cygnorum, Leucopogon parviflorus and Templetonia retusa.	locally common.	Co-occurs with Melaleuca systena and M. systena x M. sp. Wanneroo. Population 1.
41050	8816522	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	Erect shrub 1-2.5 m x 2 m. Flowers yellow.	On well drained grey sand with 30-70% outcropping limestone.	Tall open scrub of Melaleuca huegelii, M. sp. Wanneroo with occasional Eucalyptus petrensis and Melaleuca systena, over open low heath of Acacia alata var. tetrantha, Thomasia triphylla over open sedgeland/herbland.	locally common.	
41051	9137459	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	Tall shrub to 2 m tall. Yellow flowers.	Hilltop and upper slopes. Soil: shallow brown sand.	Shrubland. Associated species: Thomasia sp., sedges, Hakea trifurcata, Grevillea preissii, Melaleuca systena, Banksia sessilis.	>1000.	
41052	8997675	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T		Hill slope. Yellow/brown sand.	Melaleuca shrubland. Associated species: Acacia alata var. tetrantha, Banksia sessilis, Melaleuca huegelii and M. systena.	1000+.	
41053	9041443	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	Shrub to 2 m tall. Yellow flowers.	NE face of limestone hill. Soil: shallow yellow/brown sand.	Dense shrubland to 2 m. Associated species: Calothamnus sp., Hakea trifurcata, Grevillea preissii and Banksia sessilis.	>1000.	
41054	6972942	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	Slender erect single 2-3 m high and 1-2 m wide. Flowers pale yellow; in full flower.	Rugged limestone ridge. Mossy black sand.	Melaleuca cardiophylla, M. sp., M. systena tall closed shrubland.	dominant locally.	
41057	8982635	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	Shrub, 2.5 m high. Flowers yellow.	Limestone ridge. Brown loamy sand.	Tall open scrub of Melaleuca huegelii and M. sp. Wanneroo (G.J. Keighery 16705) over open shrubland to 1.5 m of Melaleuca systena, Xanthorrhoea preissii and Acacia lasiocarpa over low open shrubland to 0.4 m of Grevillea preissii and Banksia nivea over v	40 plants.	

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41058	9446958	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	Many branched shrub to 1.3 m tall x 0.8 m wide. Leaves are linear to 20 mm long x 3-5 mm wide, hairy and bright green on young plants. Early fruits present towards stem ends, with new growth of shorter recurved leaves continuing.	Grey fine sand on limestone outcropping up to 70%. Upper slopes to ridge.	Very Open Shrub Mallee of Eucalyptus argutifolia over Closed to Open Heath of Melaleuca sp. Wanneroo (G.J. Keighery 16705), Grevillea preissii, Templetonia retusa, Melaleuca huegelii, Acacia lasiocarpa, A. alata subsp. tetranthera, Opercularia vaginata,	6250 plants extrapolated within a mapped population boundary.	The majority of plants had recruited after a wildfire 6 years previously. The habitat is between a water corporation facility and a mine-pit.
41059	9446966	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	Many branched shrub to 1.3 m tall x 0.8 m wide. Leaves are linear to 20 mm long x 3-5 mm wide, hairy and bright green on young plants. Early fruits present towards stem ends, with new growth of shorter recurved leaves continuing.	Grey fine sand on limestone outcropping up to 70%. Upper slopes to ridge.	Very Open Shrub Mallee of Eucalyptus argutifolia over Closed to Open Heath of Melaleuca sp. Wanneroo (G.J. Keighery 16705), Grevillea preissii, Templetonia retusa, Melaleuca huegelii, Acacia lasiocarpa, A. alata subsp. tetranthera, Opercularia vaginata,	6250 plants extrapolated within a mapped population boundary.	The majority of plants had recruited after a wildfire 6 years previously. The habitat is between a water corporation facility and a mine-pit.
42409	8755442	50567	Netrostylis sp. Chandala (G.J. Keighery 17055)	2	Sedge c. 50 cm tall with very narrow leaves and culms. Inflorescence loose and branched, with dark brown florets.	Grey brown peaty soil in a swamp.	Low open forest of Eucalyptus rudis and Melaleuca preissiana. Tall open shrubland of Astartea fascicularis and Kunzea glabrescens. Pteridium esculentum mid ferns. Sedgeland of Lepidosperma.	100 mature plants.	Project: 3516.
44256	9136924	5237	Pimelea calcicola	3		Brown sandy loam soil on plain over limestone.	Isolated low Banksia attenuata trees over tall closed Banksia sessilis, Hakea trifurcata and Leptospermum laevigatum shrubland over low open Hibbertia hypericoides and Xanthorrhoea preissii shrubland.	1 mature plant.	
44267	3409368	5237	Pimelea calcicola	3	Shrub, erect 3 ft. Reddish pink flowers.				
44269	4948874	5237	Pimelea calcicola	3	Erect single stemmed shrub 1 m high x 1 m wide. Flowers grading from white through to pink.	Dry brown clayey sand over limestone.	Dense Low Forest A, Open Scrub, Heath A, Heath B, Low Heath C, Low Heath D, Very Open Herbs, Open Hummock Grass. Eucalyptus gomphocephala, Dryandra sessilis, Scaevola sp, purple Hemiandra and yellow flowered Melaleuca, Xanthorrhoea preissii.	frequent.	
44274	9220828	5237	Pimelea calcicola	3	1.5 m high.	Undulating plain. Brown sandy loam over limestone.	Isolated low Banksia attenuata trees over tall closed Banksia sessilis, Hakea trifurcata and Leptospermum laevigatum shrubland over low open Hibbertia hypericoides and Xanthorrhoea preissii shrubland.		
44419	6209874	8163	Pithocarpa corymbulosa	3					Field No. Y 64.
46763	8039364	17543	Sarcozona bicarinata	3		Private property; limestone outcrops with dry white sand. Potential threat by urban development. Last burnt summer 2001.	Open Banksia sessilis heathland. Banksia sessilis, Opercularia vaginata, Scaevola crassifolia and Desmocladus flexuosus.	5 mature plants over 5 m squared.	Condition of population: Healthy.
48266	6233090	20348	Sphaerolobium calcicola	3	Standard yellow, red around yellow eye. Red wings. Keel yellow with few red spots near apex. Ca 1 m tall.	Grey brown sand over limestone. Seasonally wet, fairly low lying area.	Shrubland with understorey of sedgeland. Associated species: Nuytsia and Acacia with Viminaria, Xanthorrhoea, Comesperma and Lepidospermum.	occasional.	
49717	6511546	7756	Stylidium longitubum	4	Flowers pink.	Seasonal Wetland, flat ground. Dark brown clay loam some peat, over ?clay. Poor drainage, wet during winter/spring.	Open Low Scrub A. Associated species: Astartea fascicularis.		

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Site	Vegetation	Frequency	Notes
49775	4430921	13127	Stylidium maritimum	3	Flowers pink-mauve, throat white, outer petal surface white to pale pink, upper winged throat appendages pink, lower throat appendages white-red tipped, leaves 3 per papery sheath.	On limestone outcrops in crater-like depressions filled with black sandy soil.	Area surrounded by low coastal heath and open Banksia menziesii woodland.		
49786	9139559	13127	Stylidium maritimum	3	Sedge-like herb to 0.4 m high. In fruit.	Limestone ridge with outcropping. Sandy soil.	Melaleuca huegelii and Melaleuca systena TEC.	ca. 35 plants.	
49790	7520840	13127	Stylidium maritimum	3		Side of dune. Dry, white-grey sand.	Low heath. Lomandra maritima, Leptorhynchos scabrus, Melaleuca huegelii.	> 200 plants.	
49791	5982103	13127	Stylidium maritimum	3		Slope; on stable sand dunes; dry white sand; long unburnt.	Low heath 0.5 m tall, 70-100 % cover.	c. 10 mature plants in a 5 x 5 m area.	
49796	7836384	13127	Stylidium maritimum	3		Grey sand-loam, slope, ridge, limestone, private property.	Closed Tall Scrub of Melaleuca huegelii, Dryandra sessilis with occasional Spyridium globulosum.		Healthy population, in flower. Potential threat from clearing and weeds.
49798	7836430	13127	Stylidium maritimum	3		Brown sand-loam over limestone, slope, private property.	Acacia rosteliifera Open Low Heath with Melaleuca huegelii, Acacia truncata and Melaleuca systena.		Healthy population with flowers. Potential threat from clearing and weeds.
49800	8755361	13127	Stylidium maritimum	3	Perennial tufted herb with narrow leaves 10-40 cm long, with rose pink flowers.	Grey sand, on mid-slope with exposed limestone.		1 mature plant.	Project: 3536.
49806	9039066	13127	Stylidium maritimum	3	Herb.	Dune swale.	Banksia sessilis low open shrubland.	10 plants.	
49808	8982600	13127	Stylidium maritimum	3	Herb, 0.8 m high.	Limestone ridge. Brown loamy sand over limestone.	Tall shrubland of Melaleuca systena over open shrubland of Melaleuca huegelii and Acacia lasiocarpa over very open herbland of Desmocladus flexuosus. Associated species: Grevillea preissii.	15 plants.	
49809	9207996	13127	Stylidium maritimum	3	Caespitose, perennial herb, 40 cm high. Flowers white/purple.	S-facing, midslope of low dune (ridge). Brown sand.	Olearia axillaris, Stylidium globulosum scattered shrubs over Melaleuca systena, Leucopogon parviflorus, Trymalium ledifolium var. ledifolium low shrubland over Austrostipa flavescens, Poa poiformis, Lomandra maritima herbland/grassland/sedgeland.		
49816	9556192	13127	Stylidium maritimum	3	Perrenial herb. Leaves smooth, 3 leaves sometimes 2 per scale leaf sheath. Flowers pink, calyx lobes bent at an angle away from the ovary centre line.	Grows in small pockets, filled with soil in very weathered and eroded limestone (cap-rock) outcrops.			
49818	9565078	13127	Stylidium maritimum	3	Flowers pink-mauve, throat white, outer petal surface white to pale pink, upper winged throat appendages pink, lower throat appendages white-red tipped, leaves 3 per papery-sheath.	On limestone outcrops in crater-like depressions filled with black sandy soil.	Area surrounded by low coastal heath and open Banksia menziesii woodland.		
49819	9565116	13127	Stylidium maritimum	3	Flowers pink-mauve, throat white, outer petal surface white to pale pink, upper winged throat appendages pink, lower throat appendages white-red tipped, leaves 3 per papery sheath.	On limestone outcrops in crater-like depressions filled with black sandy soil.	Area surrounded by low coastal heath and open Banksia menziesii woodland.		
50489	9573445	7803	Stylidium striatum	4	Corolla pink.	Grows in sand over limestone in Banksia woodlands.			
55374	6427405	44444	Tripterococcus sp. Brachylobus (A.S. George 14234)	4	Flowers yellow.	Seasonal Wetland, flat ground, black fine peaty clay loam sand, poor drainage, wet during winter/spring.	Open Herbs. Associated species: Lepyrodia muirii, Baumea articulata, Baumea vaginalis.		

FID	PopId	Nameid	Taxon	ConsStatus	WARank	PopNumber	SubPopCode	District	Vesting	Purpose1	Purpose2	CountDate	Method	HabNotes	SoilCondit	Landform	RockType	Gravel	SoilType	SoilColor	Drainage
352	86278	3237	Acacia benthamii	2		4		SWAN COASTAL	MRD	VER		5/06/2000	ESTMT	VegClas: Open B.menziessii woodland over shrubland	MOIST	FLAT	LIMESTN		SAND	YELLOW	
1684	89656	11336	Adenanthos cygnorum subsp. chamaephyton	3		16		SWAN COASTAL	LGA	VER	FOR	13/11/1981	UNKNOWN				LATERITE		LOAM_SND		
2856	118771	34161	Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)	1		3		SWAN COASTAL	MRD	VER		9/11/2017	ESTMT	No sign of fire	DRY	SLOPE		GRVL_30	SAND	GREY	WLL_DRND
2857	118772	34161	Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)	1		4		SWAN COASTAL	CC	FOR		14/09/2020	ACT_IND	Heath of Melaleuca huegelii, Banksia sessilis var. cygnorum, Xanthorrhoea preissii, Calothamnus quadrifidus, Baeckea sp. Limestone over Open Low Shrubland of Melaleuca systena, Hibbertia hypericoides, Banksia dallanneyi subsp. dallanneyi, Leucopogon parv	MOIST	SL_UP_ST	LIMESTN	GRVL_30	SAND	YEL_ORNG	WLL_DRND
6555	89775	11657	Conostylis pauciflora subsp. pauciflora	4		7		SWAN COASTAL	PRI			19/10/2007		Dom sp: Bromus diandrus. OPen low heath over grassland.		SLOPE	LIMESTN		SAND	GREY	
8894	101587	13091	Eucalyptus argutifolia	T	VU	7	A	SWAN COASTAL	CC	FOR		6/12/2013	ACT_CLMP	QUARRY Despite being surrounded by a limestone mine this elevated and isolated remnant of vegetation on the top of the ridge is in very good to excellent condition.	DRY	OUTCROP	LIMESTN	GRVL_30	SAND	BROWN	
8895	101588	13091	Eucalyptus argutifolia	T	VU	7	B	SWAN COASTAL	CC	FOR	MIN	6/12/2013	ACT_CLMP	Heath of Banksia sessilis var. cygnorum, Acacia lasiocarpa, Melaleuca huegelii, Melaleuca systena, Xanthorrhoea preissii, Acacia ?stenoptera, Hemiandra pungens, Trymalium ledifolium var. ledifolium with occasional Hakea prostrata, Cassytha ?racemosa, Tem	MOIST	SLOPE	LIMESTN		SAND	BROWN	
8898	90756	13091	Eucalyptus argutifolia	T	VU	10		SWAN COASTAL	WAT	WAT		15/05/2018	ACT_CLMP	Regenerating community: Very Open Shrub Mallee of Eucalyptus argutifolia over Tall Open Scrub of Banksia sessilis var. cygnorum, Xanthorrhoea preissii, Melaleuca systena, M. sp. Wanneroo (T), M. huegelii, Hakea prostrata, Acacia saligna over Open Low Hea	MOIST	SLOPE	LIMESTN		SAND	BROWN	WLL_DRND
8901	90759	13091	Eucalyptus argutifolia	T	VU	13		SWAN COASTAL	LGA	REC		5/12/2017	ACT_CLMP	HABITAT CONDITION: Good-degraded. Two bushland remnants still exist, but the degraded areas are reducing. 1. Low Open Woodland of Eucalyptus argutifolia over Tall Shrubland of Acacia rostellifera and Spyridium globulosum. 2. The second remnant is domina	MOIST	SL_MI_GE	LIMESTN		SAND	GREY	WLL_DRND
8902	101581	13091	Eucalyptus argutifolia	T	VU	14	A	SWAN COASTAL	NON	UCL		13/12/2013	ACT_IND		MOIST	SL_UP_ST	LIMESTN	GRVL_10	SAND	BROWN	
8903	101582	13091	Eucalyptus argutifolia	T	VU	14	B	SWAN COASTAL	NON	UCL		13/12/2013	ACT_IND		MOIST	RIDGE	LIMESTN		SAND	BROWN	
8904	90760	13091	Eucalyptus argutifolia	T	VU	15		SWAN COASTAL	LGA	REC		6/04/2021		A small amount of rubbish within population. Shrub Malle of Eucalyptus argutifolia over Shrubland Melaleuca huegelii, Melaleuca systena, Acacia rostellifera, Spyridium globulosum, Hakea trifurcata, over Hardenbergia comptoniana, Opercularia vaginata, Le	DRY	SL_UP_GE	LIMESTN		SAND	WHITE	
8906	101584	13091	Eucalyptus argutifolia	T	VU	17		SWAN COASTAL	PRI			3/08/2006	ACT_IND		MOIST	RIDGE	LIMESTN		SAND	BROWN	
8911	120029	13091	Eucalyptus argutifolia	T	VU	20		SWAN COASTAL	WAT	OTH		7/11/2017	ESTMT		DRY	SLOPE	LIMESTN	GRVL_10	SAND	GREY	WLL_DRND
10043	104267	20162	Fabronia hampeana	2		4	B	SWAN COASTAL	PRI			12/01/2009		Dom sp: Macrozamia sp. & Banksia sp. Woodland.					SAND	YELLOW	
10044	104268	20162	Fabronia hampeana	2		4	C	SWAN COASTAL	PRI			12/01/2009		Banksia low open woodland. Dom sp: Acacia cyclops, Hibbertai hypericoides, Desmocladus flexuosus			LIMESTN		SAND	YELLOW	
12418	100798	49637	Hibbertia leptotheca	3		9	A	SWAN COASTAL	PRI			14/10/2004	ESTMT		DRY	OUTCROP	LIMESTN		SAND	GREY	
12419	100799	49637	Hibbertia leptotheca	3		9	B	SWAN COASTAL	PRI			14/10/2005	UNKNOWN		DRY	OUTCROP	LIMESTN			WHITE	

FID	PopId	Nameid	Taxon	ConsStatus	WARank	PopNumber	SubPopCode	District	Vesting	Purpose1	Purpose2	CountDate	Method	HabNotes	SoilCondit	Landform	RockType	Gravel	SoilType	SoilColor	Drainage
13226	87329	5038	Lasiopetalum membranaceum	3		11		SWAN COASTAL	CC	NPK		4/11/1987		Growing under a jarrah tree in open woodland. On a flat - gently undulating slope. Occasional in area.		FLAT	LIMESTN		SAND	GREY	
14062	107424	25819	Marianthus paralius	T	EN	3		SWAN COASTAL	LGA	REC		18/09/2013	ACT_IND	1) Acacia xanthina, Templetonia retusa Open Heath over Spyridium globulosum, Grevillea preissii, Allocasuarina lehmanniana, Melaleuca cardiophylla, Phyllanthus calycinus, Hibbertia hypericoides, Scaevola crassifolia, Lomandra maritima Low Shrubland. *Ehr	MOIST	SL_UP_GE	LIMESTN	GRVL_10	SAND	GREY	WLL_DRND
14197	110769	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	EN	1		SWAN COASTAL	LGA	GVT		8/07/2014	PART_CNT	Almost on the top of the ridge, slightly SW - W aspect.	MOIST	RIDGE	LIMESTN		FSA_LOAM		WLL_DRND
14198	110770	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	EN	2		SWAN COASTAL	PRI	UNKNOWN		7/04/2008	ESTMT			OU_SLOPE	LIMESTN		SAND	BLACK	
14199	110789	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	EN	3	A	SWAN COASTAL	PRI			10/05/2017	ESTMT	Hilltop and upper slopes. Soil: shallow brown sand.		CR_HILL	LIMESTN		SAND	BROWN	
14200	111492	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	EN	3	B	SWAN COASTAL	RDL	MIN		27/11/2013	ACT_IND	NOTE - Fire information was taken from Corporate Mapping Data. Not confirmed in the field			LIMESTN				
14201	111509	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	EN	3	C	SWAN COASTAL	RDL	MIN		30/09/2009	PART_CNT				LIMESTN				
14202	120789	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	EN	3	D	SWAN COASTAL	WAT	GVT		15/05/2018	EXT_GRQD	Occasional Eucalyptus argutifolia and Eucalyptus petrensis to 1.5m over Closed Heath of Melaleuca sp. Wanneroo, Melaleuca huegelii, Grevillea preissii, Templetonia retusa, Scaevola crassifolia, Acacia lasiocarpa, Acacia alata var. tetrantha, Opercularia	MOIST	RIDGE	LIMESTN		SAND	GREY	WLL_DRND
14203	110790	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	EN	4	A	SWAN COASTAL	CC	FOR		26/11/2013	PART_CNT	NOTE - Fire information was taken from Corporate Mapping Data. Not confirmed in the field			LIMESTN				
14204	111490	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	EN	4	B	SWAN COASTAL	CC	FOR		6/12/2013	ESTMT		DRY	RIDGE	LIMESTN		SAND		WLL_DRND
14205	120790	33022	Melaleuca sp. Wanneroo (G.J. Keighery 16705)	T	EN	4	C	SWAN COASTAL	CC	FOR		17/01/2019	PART_CNT	Tall Open Scrub of Melaleuca systena, M. sp. Wanneroo, Banksia sessilis ssp. cygnorum, M. huegelii over Open Heath of Grevillea preissii, Hibbertia hypericoides, Conostylis candicans, Cryptandra mutila, Acacia pulchella, Desmocladus flexuosa.	DRY	SL_MI_ST	LIMESTN		SAND	GREY	WLL_DRND
16741	89298	7756	Stylidium longitubum	4		16		SWAN COASTAL	SPC			10/11/1994				FL_PALU			CLA_LOAM	BROWN	SEASINUN
16766	90804	13127	Stylidium maritimum	3		13		SWAN COASTAL	PRI			9/10/2004	ESTMT	more illegible DomSp on RFRF	DRY	CREST	LIMESTN		SAND	GREY	
16767	90805	13127	Stylidium maritimum	3		14		SWAN COASTAL	PRI			12/10/2005	UNKNOWN		DRY	RI_DUNE			SAND	WHITE	
18032	93721	44444	Tripterococcus sp. Brachylobus (A.S. George 14234)	4		17		SWAN COASTAL	PRI			10/11/1994		VegClass:Open Herbs		FL_PALU			CLA_LOAM	BLACK	SEASINUN

APPENDIX 3

Atlas of Living Australia Database Search

APPENDIX 4

Protected Matters Search Tool Report

APPENDIX 5

Conservation Codes

Conservation Codes for Western Australian Flora and Fauna

Threatened, Extinct and Specially Protected fauna or flora are species which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

The lists of Threatened, Extinct and Specially Protected species are listed under Part 2 of the Biodiversity Conservation Act 2016.

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T Threatened species

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

> ***Threatened fauna*** is the species of fauna that are listed as critically endangered, endangered or vulnerable threatened species.
>
> ***Threatened flora*** is the species of flora that are listed as critically endangered, endangered or vulnerable threatened species.

The assessment of the conservation status of threatened species is in accordance with the BC Act listing criteria and the requirements of Ministerial Guideline (Number 1) and Ministerial Guideline (Number 2) that adopts the use of the International Union for Conservation of Nature (IUCN) Red List of Threatened Species Categories and Criteria 4, and is based on the national distribution of the species.

CR Critically endangered species

> Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".
>
> Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines.

EN Endangered species

> Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".
>
> Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines.

VU Vulnerable species

> Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines.

Extinct Species

EX Presumed extinct species

Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

EW Extinct in the wild species

Species that "*is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory species

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

CD Species of special conservation interest (conservation dependent fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Currently only fauna are listed as species of special conservation interest.

OS Other specially protected species

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Currently only fauna are listed as species otherwise in need of special protection.

P Priority species

Priority is not a listing category under the BC Act.

All fauna and flora are protected in WA following the provisions in Part 10 of the BC Act. The protection applies even when a species is not listed as threatened or specially protected, and regardless of land tenure (State managed land (Crown land), private land, or Commonwealth land).

Species that may possibly be threatened species that do not meet the criteria for listing under the BC Act because of insufficient survey or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of prioritisation for survey and evaluation of conservation status so that consideration can be given to potential listing as threatened.

Species that are adequately known, meet criteria for near threatened, or are rare but not threatened, or that have been recently removed from the threatened species list or conservation dependent or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of priority status is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, for example, agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation.

Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements for threatened listing and appear to be under immediate threat from known threatening processes. These species are in urgent need of further survey.

Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, for example, national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation.

Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements for threatened listing and appear to be under threat from known threatening processes. These species are in urgent need of further survey.

Priority 3: Poorly-known species

Species that are known from several locations and the species does not appear to be under imminent threat or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat.

Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. These species need further survey.

Priority 4: 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 are close to qualifying for vulnerable but are not listed as a conservation dependent specially protected species.

(c) Species that have been removed from the list of threatened species or lists of conservation dependent or other specially protected species, during the past five years for reasons other than taxonomy.

(d) Other species in need of monitoring.

Western Australian Ecological Communities

<u>Threatened Ecological Communities</u>

The BC Act provides for the statutory listing of threatened ecological communities (TECs) by the Minister.

Presumed Totally Destroyed (PD)

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.

Critically Endangered (CR)

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.

Endangered (EN)

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.

Vulnerable (VU)

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.

Priority Ecological Communities

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community List under priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities

Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha).

Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities

Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:

(ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or;

(iii) munities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category.

(iii) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Commonwealth of Australia Conservation Codes

Threatened Flora and Fauna

Threatened fauna and flora may be listed under Section 178 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in any one of the following six categories:

Extinct

A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.

Extinct in the wild

A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time:

a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or
b) 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.

Critically endangered

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the five criteria for the category identified in Part 7.01 of the EPBC Regulations, and it is therefore considered to be facing an extremely high risk of extinction in the wild.

Endangered

A taxon is Endangered when the best available evidence indicates that it meets any of the five criteria for the category identified in Part 7.01 of the EPBC Regulations, and it is therefore considered to be facing a very high risk of extinction in the wild.

Vulnerable

A taxon is Vulnerable when the best available evidence indicates that it meets any of the five criteria for the category identified in Part 7.01 of the EPBC Regulations, and it is therefore considered to be facing a high risk of extinction in the wild.

Conservation dependent

A native species is eligible to be included in the conservation dependent category at a particular time if, at that time:

a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or
b) the following subparagraphs are satisfied:
    i. the species is a species of fish;

ii. the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised;
iii. the plan of management is in force under a law of the Commonwealth or of a State or Territory;
iv. cessation of the plan of management would adversely affect the conservation status of the species.

The EPBC Act does not provide for listing in a data deficient category. Where sufficient data (evidence) is unavailable to allow assessment by the Threatened Species Scientific Committee against the criteria for listing, the species are found to be ineligible. A recommendation is made to the Minister to not include the species in any category under the EPBC Act. For reasons of transparency and to inform future research, the Threatened Species Scientific Committee publishes the names of those species found to be data deficient. As data deficient is not a listing category under the EPBC Act, this has no statutory implications and the species is not considered to be listed under the EPBC Act.

Threatened Ecological Communities

Threatened Ecological communities under the EPBC Act are listed in three categories.

Critically endangered

If, at that time, an ecological community is facing an extremely high risk of extinction in the wild in the immediate future (indicative timeframe being the next 10 years).

Endangered

If, at that time, an ecological community is not critically endangered but is facing a very high risk of extinction in the wild in the near future (indicative timeframe being the next 20 years).

Vulnerable

If, at that time, an ecological community is not critically endangered or endangered, but is facing a high risk of extinction in the wild in the medium–term future (indicative timeframe being the next 50 years).

APPENDIX 6

DBCA TEC/PEC Database Search

APPENDIX 7

Flora Species List

SPECIES LIST – Carabooda

GYMNOSPERMS

ZAMIACEAE
Macrozamia riedlei

MONOCOTYLEDONS

ANARTHRIACEAE
Lyginia barbata

ASPHODELACEAE
**Asphodelus fistulosus*

ASPARAGACEAE
Acanthocarpus preissii
**Asparagus asparagoides*
Lomandra caespitosa
Lomandra hermaphrodita
Lomandra maritima
Lomandra preissii
Sowerbaea laxiflora
Thysanotus arenarius
Thysanotus patersonii
Thysanotus sparteus

COLCHICACEAE
Burchardia congesta
Wurmbea dioica

CYPERACEAE
Chaetospora grandiflora
Isolepis marginata
Lepidosperma calcicola
Lepidosperma leptostachyum
Lepidosperma scabrum
Lepidosperma pubisquameum
Mesomelaena pseudostygia
Morelotia octandra
Schoenus clandestinus

HAEMODORACEAE
Anigozanthos humilis
Anigozanthos manglesii
Conostylis aculeata
Conostylis pauciflora
Conostylis setigera subsp. *setigera*
Haemodorum paniculatum
Haemodorum spicatum

HEMEROCALLIDACEAE
Dianella revoluta var. *divaricata*
Tricoryne elatior

IRIDACEAE
**Gladiolus caryophyllaceus*
**Moraea flaccida*
Orthrosanthus laxus
Patersonia occidentalis
**Romulea rosea*

ORCHIDACEAE
Caladenia arenicola
Caladenia flava
Caladenia georgei
Caladenia latifolia
Caladenia longicauda
**Disa bracteata*
Diuris corymbosa
Elythranthera brunonis
Leptoceras menziesii
Microtis media
Thelymitra macrophylla
Pterostylis vittata
Pyrorchis nigricans

POACEAE
**Aira caryophyllea*
Austrostipa compressa
Austrostipa elegantissima
Austrostipa flavescens
**Avena fatua*
**Briza maxima*
**Bromus diandrus*
**Ehrharta calycina*
**Ehrharta longiflora*
**Eragrostis curvula*
Lachnagrostis filiformis

**Lagurus ovatus*
**Lolium perenne*
Neurachne alopecuroidea
**Pentameris airoides*
Rytidosperma occidentale
**Vulpia myuros*

RESTIONACEAE
Alexgeorgea nitens
Desmocladus flexuosus
Hypolaena exsulca
Restionaceae sp

XANTHORRHOEACEAE
Xanthorrhoea brunonis
Xanthorrhoea preissii

DICOTYLEDONS

AIZOACEAE
**Carpobrotus edulis*

AMARANTHACEAE
Ptilotus polystachyus

APIACEAE
Homalosciadium homalocarpum
Xanthosia huegelii

ARALIACEAE
Hydrocotyle intertexta
Trachymene pilosa

ASTERACEAE
**Arctotheca calendula*
Hyalosperma cotula
**Hypochaeris glabra*
**Hypochaeris radicata*
Lagenophora huegelii
Millotia myosotidifolia
Olearia axillaris
Olearia rudis
**Osteospermum ecklonis*
Podolepis gracilis
Podotheca angustifolia
Podotheca chrysantha
Podotheca gnaphalioides
Quinetia urvillei
**Senecio condylus*
Siloxerus humifusus
**Sonchus oleraceus*
**Taraxacum officinale*
**Urospermum picroides*
**Ursinia anthemoides*

BRASSICACEAE
**Heliophila pusilla*
**Raphanus raphanistrum*

CAMPANULACEAE
**Wahlenbergia capensis*

CARYOPHYLLACEAE
**Minuartia mediterranea*
**Petrorhagia dubia*
**Silene gallica*
**Stellaria media*

CASUARINACEAE
Allocasuarina fraseriana
Allocasuarina humilis

CELASTRACEAE
Tripterococcus brunonis

CONVOLVULACEAE
**Cuscuta epithymum*

CRASSULACEAE
Crassula colorata
**Crassula glomerata*

DILLENIACEAE
Hibbertia hypericoides
Hibbertia subvaginata

DROSERACEAE
Drosera erythrorhiza
Drosera pallida

ERICACEAE
Andersonia heterophylla
Conostephium pendulum
Conostephium preissii
Leucopogon squarrosus
Leucopogon parviflorus
Styphelia polymorpha
Styphelia pallida
Styphelia propinqua
Styphelia racemulosa

EUPHORBIACEAE
**Euphorbia peplus*
**Euphorbia terracina*

FABACEAE
Acacia applanata
Acacia huegelii
Acacia lasiocarpa
Acacia littorea
Acacia pulchella
Acacia rostellifera
Acacia saligna
Bossiaea eriocarpa
Daviesia decurrens
Daviesia divaricata
Gompholobium tomentosum
Hardenbergia comptoniana
Hovea trisperma var. *trisperma*
Isotropis cuneifolia subsp. *cuneifolia*
Jacksonia calcicola
Jacksonia sternbergiana
Kennedia prostrata
**Lupinus cosentinii*
Sphaerolobium medium
Templetonia retusa
**Trifolium arvense*
**Trifolium campestre*

GENTIANACEAE
**Centaurium erythraea*

GERANIACEAE
**Erodium botrys*
**Erodium cygnorum*
**Geranium molle*
**Pelargonium capitatum*

GOODENIACEAE
Dampiera linearis
Lechenaultia linarioides
Scaevola anchusifolia
Scaevola canescens
Scaevola thesioides

GYROSTEMONACEAE
Tersonia cyathiflora

LAMIACEAE
Hemiandra pungens

LAURACEAE
Cassytha racemosa

MONTIACEAE
Calandrinia granulifera

MYRTACEAE
Calothamnus quadrifidus
Calothamnus sanguineus
Calytrix fraseri
**Chamelaucium uncinatum*
Corymbia calophylla
Eremaea asterocarpa
Eremaea pauciflora
Eucalyptus argutifolia **T**
Eucalyptus decipiens
Eucalyptus foecunda
Eucalyptus gomphocephala
Eucalyptus marginata
Eucalyptus petrensis
Eucalyptus todtiana
Melaleuca huegelii
Melaleuca systena

OXALIDACEAE
**Oxalis pes-caprae*

OROBANCHACEAE
**Orobanche minor*

**Parentucellia latifolia*
**Parentucellia viscosa*

PHYLLANTHACEAE
Phyllanthus calycinus
Poranthera microphylla

PITTOSPORACEAE
Billardiera fraseri

POLYGALACEAE
Comesperma calymega
Comesperma integerrimum
Comesperma volubile

PRIMULACEAE
**Lysimachia arvensis*

PROTEACEAE
Banksia attenuata
Banksia dallanneyi
Banksia grandis
Banksia ilicifolia
Banksia menziesii
Banksia sessilis
Grevillea crithmifolia
Grevillea preissii
Hakea costata
Hakea lissocarpha
Hakea prostrata
Hakea ruscifolia
Hakea trifurcata
Persoonia saccata
Petrophile linearis
Petrophile macrostachya
Petrophile serruriae
Stirlingia latifolia

RHAMNACEAE
Trymalium ledifolium
Spyridium globulosum

RUBIACEAE
**Galium murale*
Opercularia hispidula
Opercularia vaginata

RUTACEAE
Diplolaena angustifolia
Philotheca spicata

SAPINDACEAE
Diplopeltis huegelii

SCROPHULARIACEAE
**Dischisma arenarium*

SOLANACEAE
**Solanum linnaeanum*

STYLIDIACEAE
Stylidium brunonianum
Stylidium calcaratum
Stylidium dichotomum
Stylidium hesperium
Stylidium maritimum **P3**
Stylidium piliferum

THYMELEACEAE
Pimelea calcicola **P3**
Pimelea ferruginea
Pimelea rosea

VIOLACEAE
Pigea calycina

APPENDIX 8

Quadrat Data

APPENDIX 9

Plantecology FCT Analyses

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24 November 2024

Paul van der Moezel
Managing Director
PGV Environmental
Suite 3, 67 Howe St
Osborne Park Western Australia 6017

Dear Paul,

Plantecology Consulting was commissioned to undertake the numerical analysis and assignment of plot data to existing Floristic Community Types of the Swan Coastal Plain for a site at Carabooda. The methods and results outlined below are based on the data as supplied on the 15th November 2023.

1 Introduction

The remnant vegetation of the southern Swan Coastal Plain (SCP) was surveyed by Gibson et al. (1994) to provide an understanding of the major floristic gradients across the region. The major plant communities (or FCTs) were defined by classifying the data according to the similarities in species composition between plots. When determining the FCT of a new record, a floristic analysis of species composition provides the most robust method that is consistent with the original classification. Presently, a single consistent method for the determination of FCTs for vegetation data in the Swan Coastal Plain is not available. Therefore, it is preferable to use multiple methods and compare the output for the most likely result. All analyses described below were undertaken using R packages Cluster (Maechler et al 2019), Vegclust (De Cáceres et al. 2010), indicspecies (De Cáceres and Legendre 2009), optpart (Roberts 2020) and Vegan (Oksanen et al. 2020).

2 Methods

2.1. Hierarchical Clustering Assignments

Hierarchical agglomerative clustering is the usual first stage in classifying vegetation data into community types. This involves calculating the similarity (or more often, the dissimilarity) between plots within the dataset and then sequentially fusing the plots into groups according to their similarity. This type of method was used in the analysis of the original Swan Coastal Plain dataset (Gibson et al. 1994) and to determine the conservation status of additional plots, data is often added to the original dataset and the analysis re-run (Environmental Protection Authority 2016). The direct use of the original dataset as the basis for assigning new plot data to the regional classification has some drawbacks, however. Firstly, a hierarchical clustering only applies to the relationships between plots, and the relative distances between them, within that particular dataset. The addition of new data often alters the relative cophenetic distances and disrupts the clustering output. Secondly, as an unsupervised method, hierarchical clustering does not define rules for the membership of the defined groups, and so the addition of new plots requires the rebuilding of the entire hierarchy (De Cáceres and Wiser 2012).

The data for the Swan Coastal Plain regional survey (Gibson et al. 1994) was downloaded from the NatureMap website. This is largely similar to the original survey except for one site (OATES-1), which

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has now been excluded, resulting in a dataset of 508 plots. The species nomenclature of the original dataset was updated to be consistent with current usage. Where original names could not be matched clearly to the updated usage, those taxa were removed from the analysis.

The new data from the Carabooda survey was added to the Swan Coastal Plain dataset and the new dataset was then analysed calculating the Bray-Curtis distance coefficient (or resemblance measure) and the flexible beta linkage method (beta = -0.1). Assignment of the Carabooda plots was to the nearest distinct group by inspection of the resulting dendrogram. To remove any effect of spatial correlation between the new plots, data was also added to the matrix one plot a time and the analysis re-run.

In practice, there is often less similarity between new plots and the plots of the original group to which it is assigned than between the original plots themselves. That is, new plots are usually most similar to fringing members of the original group.

2.2. Rarefaction

Distance measures such as Bray-Curtis are sensitive to differences in species richness between samples. For vegetation in a natural state this is desirable as these differences will reflect true variation between community types. Where there are differences in species richness resulting from extrinsic factors such seasonality or disturbance, then dissimilarity measures may not be a reliable indicator of the natural relationship between samples. To remove the influence of disturbance from the analysis, the data were first rarefied before again conducting a hierarchical clustering.

Rarefaction is a method that randomly samples a subset of species from each plot, computes the dissimilarity matrix of the dataset, and then averages the results of numerous iterations. While this method compensates for differences in species richness between plots, it can introduce a degree of homogeneity to the dataset.

To minimise disruption to the original classification, the Swan Coastal Plain dataset was subsetted to include only those major groups that were indicated from the hierarchical clustering results i.e. the *Banksia* woodlands FCTs. As introduced (weed) taxa are an indication of disturbance, they were removed from both the Carabooda and subsetted datasets, leaving only the native components of each.

The Carabooda plots were added to the subsetted dataset using the same procedure above, the seed set to 42 for reproducibility, the target sample size was set to the minimum species richness of 16, and the mean dissimilarities from 1 000 iterations used in the cluster analysis.

2.3. Non-hierarchical Clustering Assignments

Non-hierarchical clustering methods often allow new plot data to be added to previous classifications because they are based on the concept that each group or cluster is represented by a prototype i.e. either a centroid or a medoid (a 'type' plot) (De Cáceres and Wiser 2012). Therefore, new observations can be assigned to an existing classification by calculating the distance to the nearest prototype (which may be considered a membership criterion). This approach is conceptually preferable to the hierarchical reconstruction approach because it defines numerical rules that can be consistently applied. However, it also means the original classification needs to be re-analysed using a different method, which can be problematic because not all sites from the original classification may be diagnostic for their respective clusters.

For the analysis of the Carabooda data, an updated SCP dataset of core diagnostic plots was used as for the non-hierarchical clustering analysis. The dataset was then analysed using Fuzzy C-Means clustering in the R package Vegclust (De Cáceres et al. 2010). A fuzziness coefficient of 1.1 was chosen to minimise influence from noisy data points. FCTs with too few plots to reliably define or determine a prototype (e.g. FCT 14 with two plots) were removed from the analysis. Similarly, some plots that

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were regularly being misclassified (such as those from clusters with large internal heterogeneity) were also removed. The final dataset consisted of 344 plots with 1316 taxa representing 38 FCTs. Each site of the Carabooda data was then assigned a FCT using function 'vegclass' in the Vegclust (De Cáceres et al. 2010) package.

It should be noted the non-hierarchical clustering approach can provide excellent results when the new plot data is in a near natural state i.e. in 'Excellent' or better condition with an alpha diversity near to that of the Swan Coastal Plain dataset. When the subject vegetation has been disturbed or when there is a high proportion of weed species in the data, non-hierarchical clustering results are often less reliable than those of hierarchical clustering.

3 Results

The FCT analysis of the Carabooda plots indicates that at least three FCTs are present. FCT 24 'Northern Spearwood shrublands and woodlands' is indicated by Plots C13, C15 and C22; FCT 28 'Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands' is indicated by Plots C1, C25 and C3; and FCT 29a is indicated by Plots C30 and C33.

Hierarchical clustering assignments (see Figures 1:8) for Plots C13, C15 and C22 were definitive in the assignment to FCT 24. All plots fused low in their dendrograms with no disruption to the nearest group caused by the addition of new data. The clustering was equally as definitive for Plots C1, C25 and C31 in their assignment to FCT 28. The hierarchical clustering for Plots C30 and C33 shows a disruption to the grouping of FCTs 29a 'Coastal shrublands on shallow sands' and 29b '*Acacia* shrublands on taller dunes'. This result may depend on a plot's similarity to TRIG-1 from the Swan Coastal Plain dataset, which is a transitional plot between the two types.

The results for Plots C30 and C33 in the non-hierarchical clustering were more definitive, with both strongly assigned to the FCT 29a/30a group and only a 7% – 8% probability of being part of FCT 29b (table 1). The non-hierarchical clustering results for the other plots were less definitive. Apart from Plot C15, the strongest assignment was still to the same FCT as in the hierarchical clustering, although the strengths of memberships were not significantly higher than to the second and third nearest groups.

The use of the rarefaction method was able to confirm assignments for the FCT 28 plots, but were less clear for the others. Where the results from the other analyses were clear, the output from the rarefaction analysis showed a considerable disruption to the original groups, often showing an affinity to FCT 25. This may be due to the presence of *Eucalyptus gomphocephala* in some plots, but FCT 25 only occurs south of Perth. The results from the rarefaction analysis is therefore considered unreliable.

Table 1: Results of non - hierarchical analysis for plots from the Carabooda survey (Strength of membership shown in brackets).

Plot	FCT of nearest group	FCT of 2nd nearest group	FCT of 3rd nearest group
C1	28 (19.2%)	6 (17.7%)	24 (16.9%)
C13	24 (22.0%)	29a/30a (17.1%)	29b (0.1%)
C15	5 (12.7%)	6 (11.0%)	29a/30a (10.6%)
C22	24 (28.1%)	28 (16.0%)	29b (10.5%)
C25	28 (20.0%)	5 (18.8%)	6 (15.9%)
C30	29a/30a (49.3%)	13, 15, 16, 17 (11.4%)	24 (10.6%)
C31	28 (38.0%)	21c (19.7%)	6 (9.4%)

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C33	29a/30a (48.4%)	24 (12.3%)	13, 15, 16, 17 (12.0%)

Table 2: Assignment of plots to the most likely FCT.

Plot	Assignment from hierarchical clustering	Assignment from non-hierarchical clustering	Assignment from rarefaction	Likely FCT
C1	28	28	28	28
C13	24	24	24/25/28	24
C15	24	5	28	24
C22	24	24	24/25/28	24
C25	28	28	28	28
C30	29a	29a	24/25	?29a
C31	28	28	28	28
C33	29b	29a	24/25	?29a

4 Discussion

The results of the numerical analysis indicate that the Carabooda site supports stands of FCT 24 'Northern Spearwood shrublands and woodlands', FCT 28 'Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands' and FCT 29a 'Coastal shrublands on shallow sands'. The species inventory within the respective plots support these results with many typical species for each FCT recorded within the site. Both FCT 24 and FCT 29a are listed as Priority Ecological Communities, with a rank of Priority 3. The presence of *Eucalyptus gomphocephala* may have suggested the presence of tuart-dominated woodlands within the site, but these are mostly found south of Perth and *Eucalyptus gomphocephala* occurs within all the FCTs listed above.

The occurrence of limestone outcropping north of Perth also has the possibility of supporting the Threatened Ecological Community FCT 26a '*Melaleuca huegelii* – *Melaleuca systena* shrublands of limestone ridges'. None of the results from the numerical analyses showed any indication that FCT 26a occurs within the site. However, FCT 29a is known from coastal environments on the Quindalup Dune System and the Carabooda site is located on the Spearwood Dune System, and the assignment of C30 and C33 to this FCT is anomalous. Both FCT 29a and 26a occur in similar environments on shallow sands over limestone, although FCT 29a would experience more maritime influences and is less species rich (approximately 40 taxa per plot versus approximately 50 taxa per plot for FCT 26a). The assignment of Plots C30 and C33 with around 30 taxa each to FCT 29a is most likely due to there being fewer absent species compared to FCT 29a than that compared to FCT 26a.

As well as the differences in species richness, *Xanthorrhoea preissii* and *Hibbertia hypericoides* were recorded in Plot C30 and neither occur in 29a or 29b, but are typical species in FCT 26b 'Woodlands and mallees on limestone'. It is possible that the assignment to FCT 29a is being influenced by those species adapted to the shallow soil over limestone environment whilst being hindered by a relatively low species richness. The possibility that Plot C30 belongs to FCT 26b and Plot C33 to FCT 26a cannot be excluded. The result of the rarefaction analysis for these plots caused too much disruption to the original classification, and the assignments to FCT 24 or 25 is not considered reliable.

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5 Conclusion

In summary, the results of numerical analysis indicate that FCT 24 'Northern Spearwood shrublands and woodlands' and FCT 28 'Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands' are likely to be present within the site at Carabooda. FCT 24 is listed as a Priority 3 Ecological Community.

Despite the strength of the assignment of Plots C30 and C33 to FCT 29a 'Coastal shrublands on shallow sands', there are contra indicators to this result, including the locality and the presence of *Xanthorrhoea preissii* and *Hibbertia hypericoides*. The possibility that these latter plots are part of FCT 26a (or 26b) cannot be excluded.

Should you require any further information or have any other queries, please feel free to contact me.

Sincerely yours,



Dr. Shane Chalwell

Plantecology Consulting

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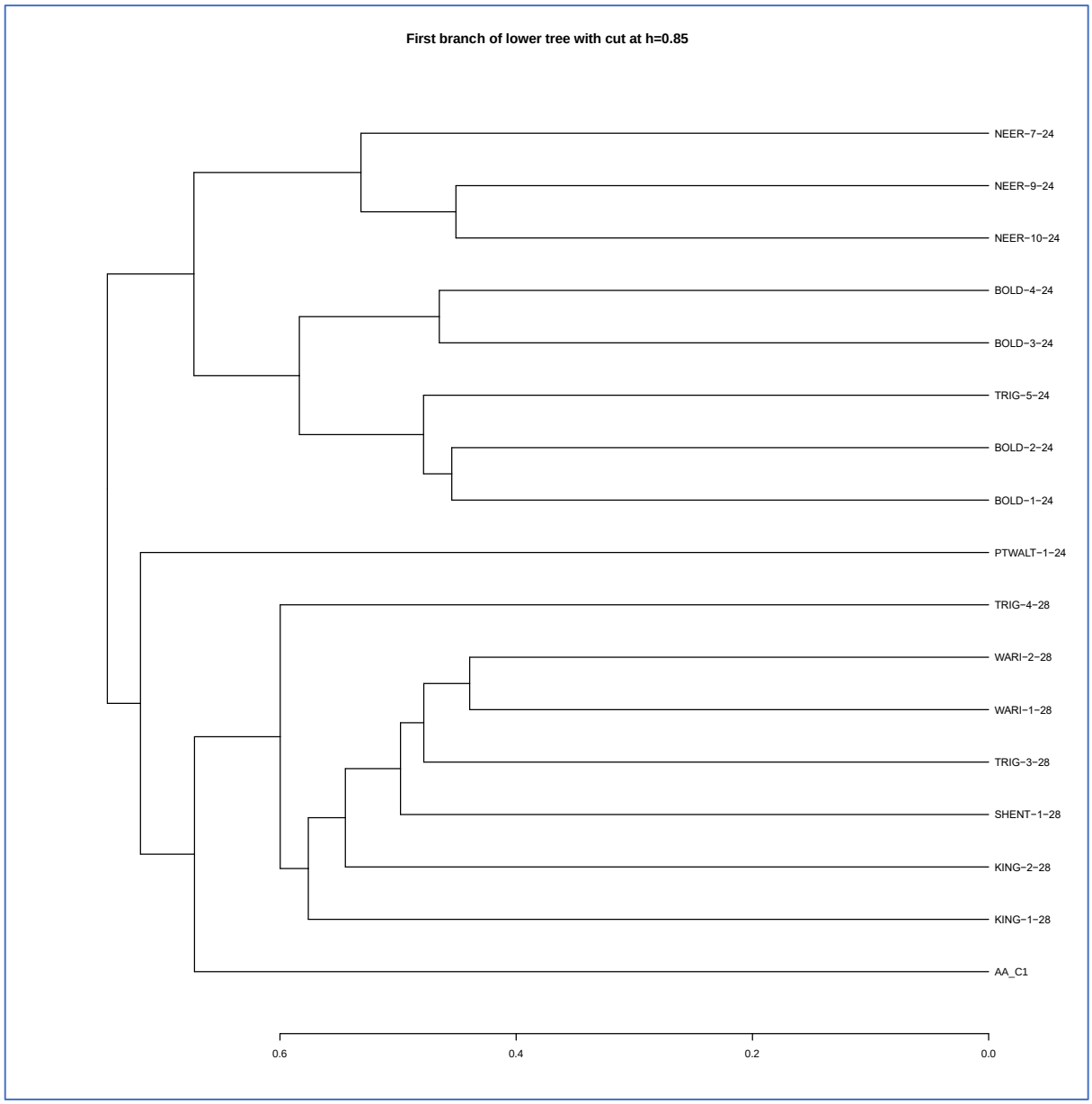


Figure 1: Partial dendrogram for the assignment of Plot C1 to Swan Coastal Plain floristic community types.

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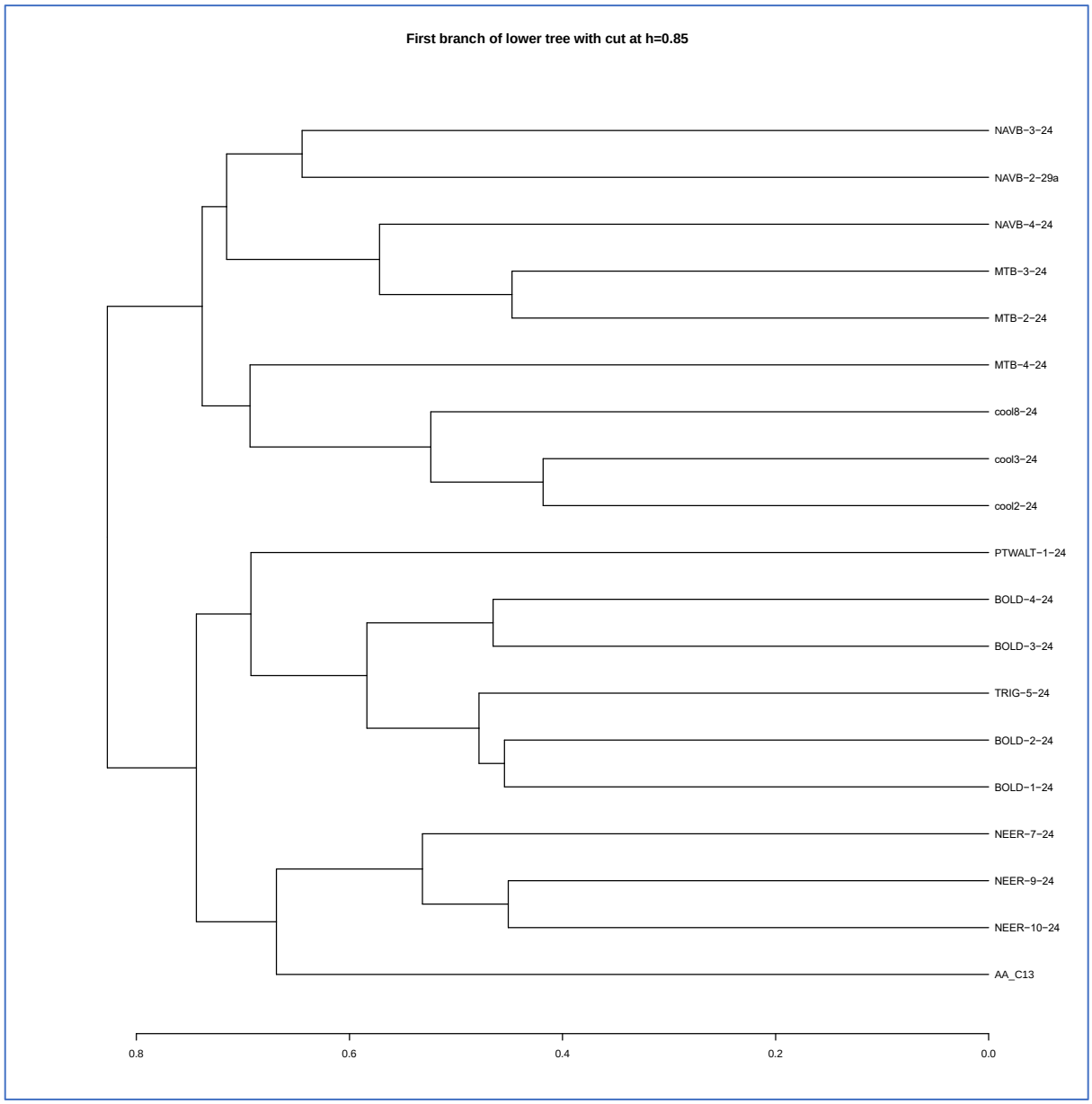


Figure 2: Partial dendrogram for the assignment of Plot C13 to Swan Coastal Plain floristic community types.

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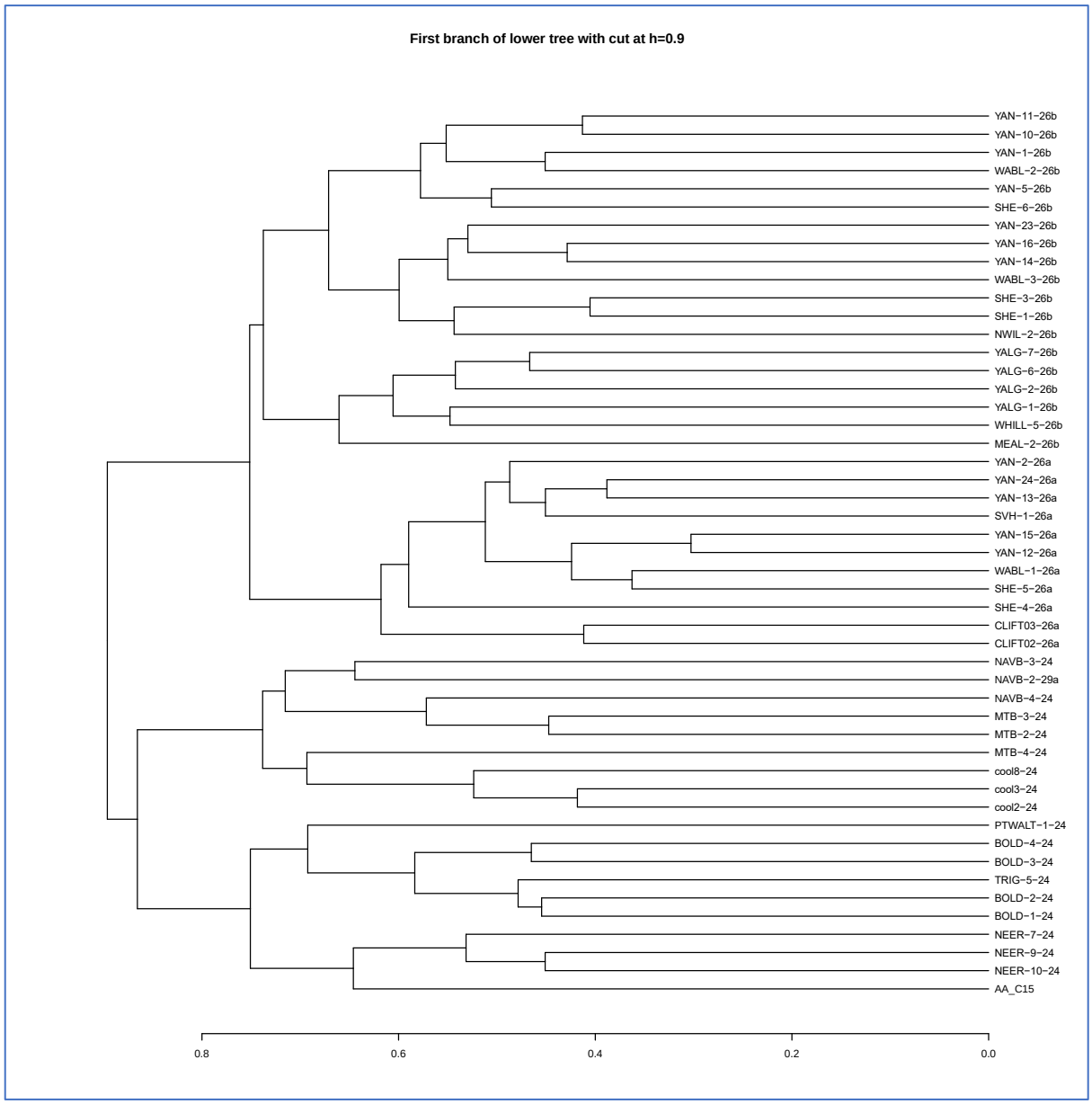


Figure 3: Partial dendrogram for the assignment of Plot C15 to Swan Coastal Plain floristic community types.

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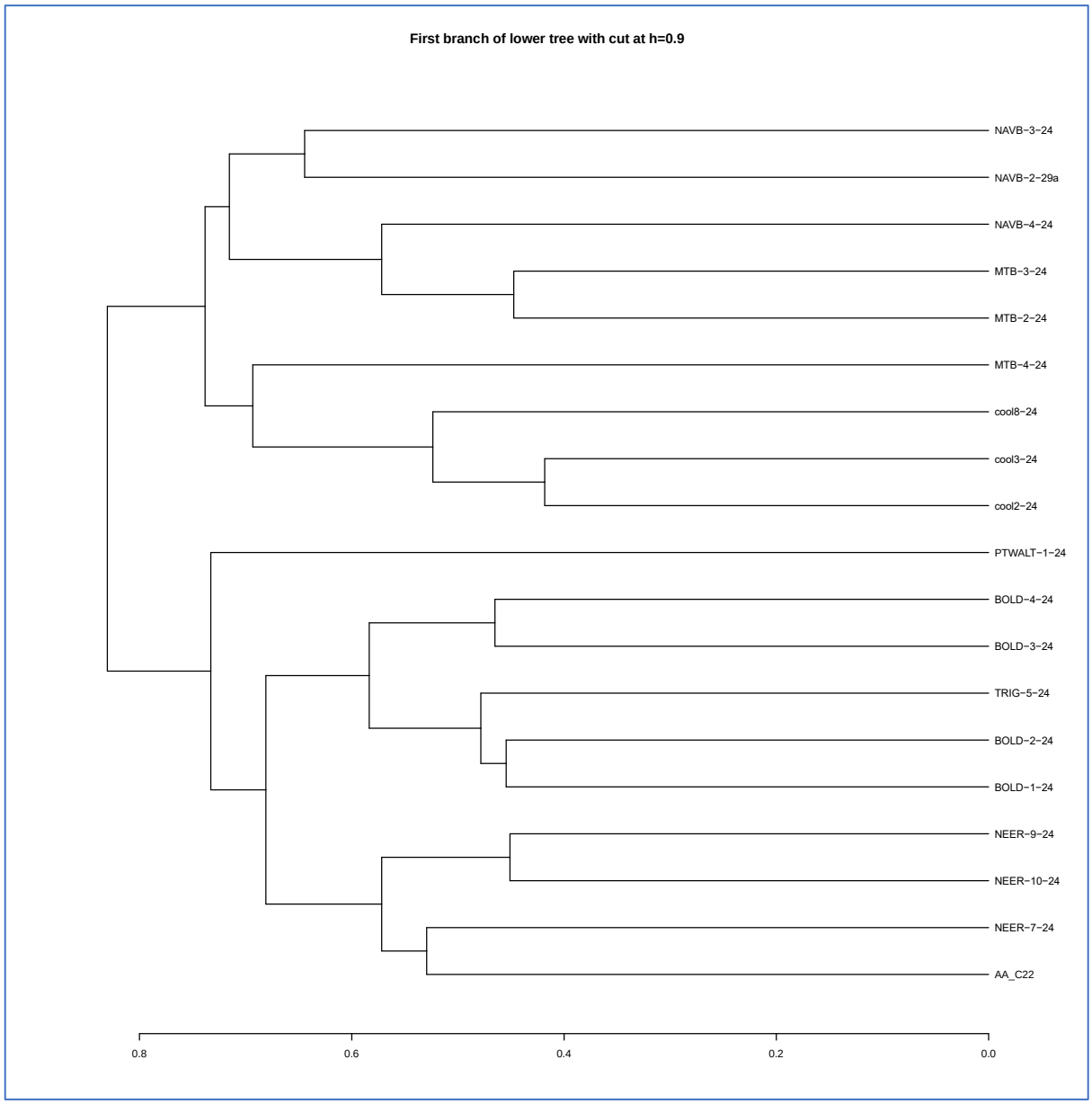


Figure 4: Partial dendrogram for the assignment of Plot C22 to Swan Coastal Plain floristic community types.

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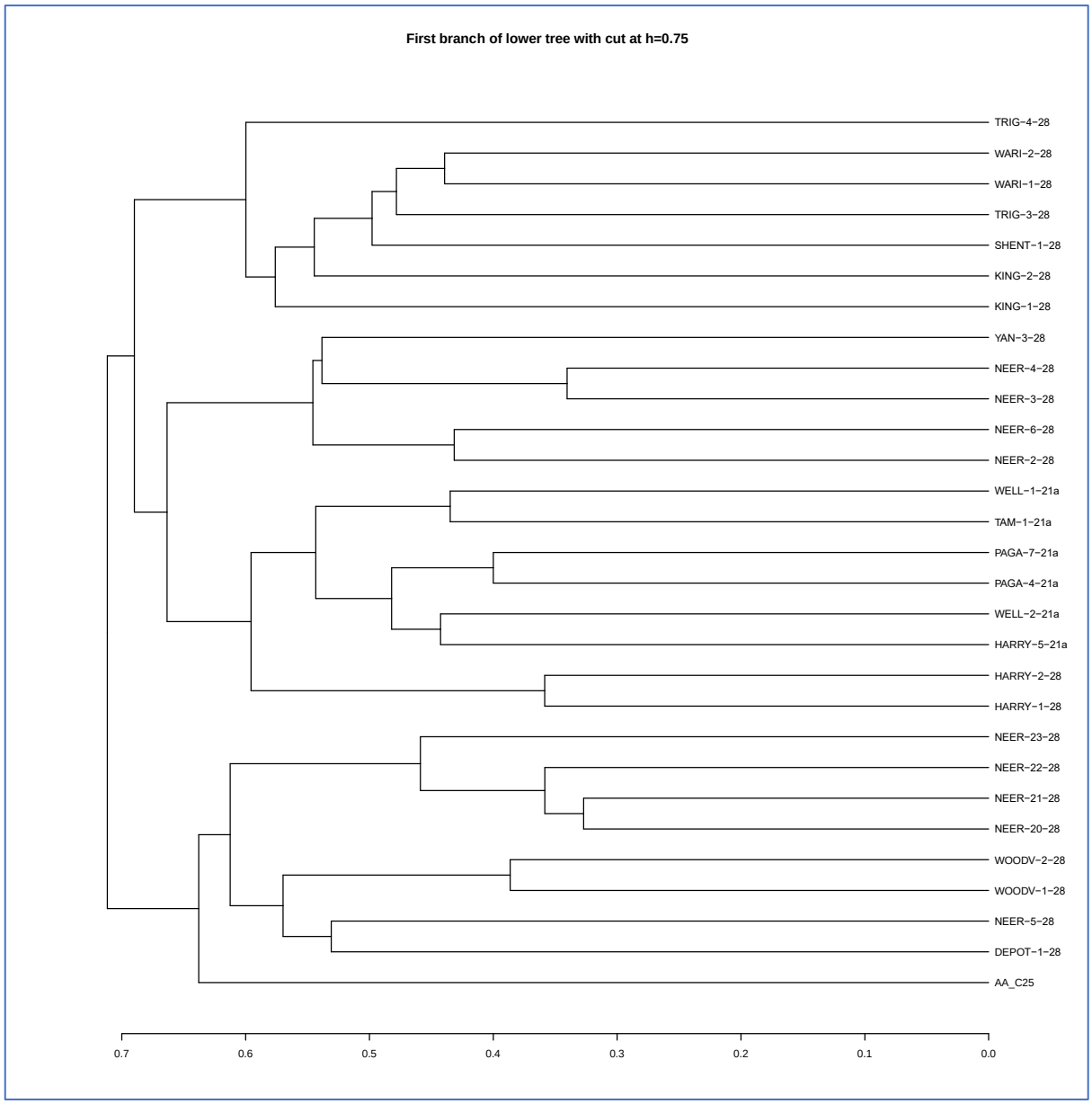


Figure 5: Partial dendrogram for the assignment of Plot C25 to Swan Coastal Plain floristic community types.

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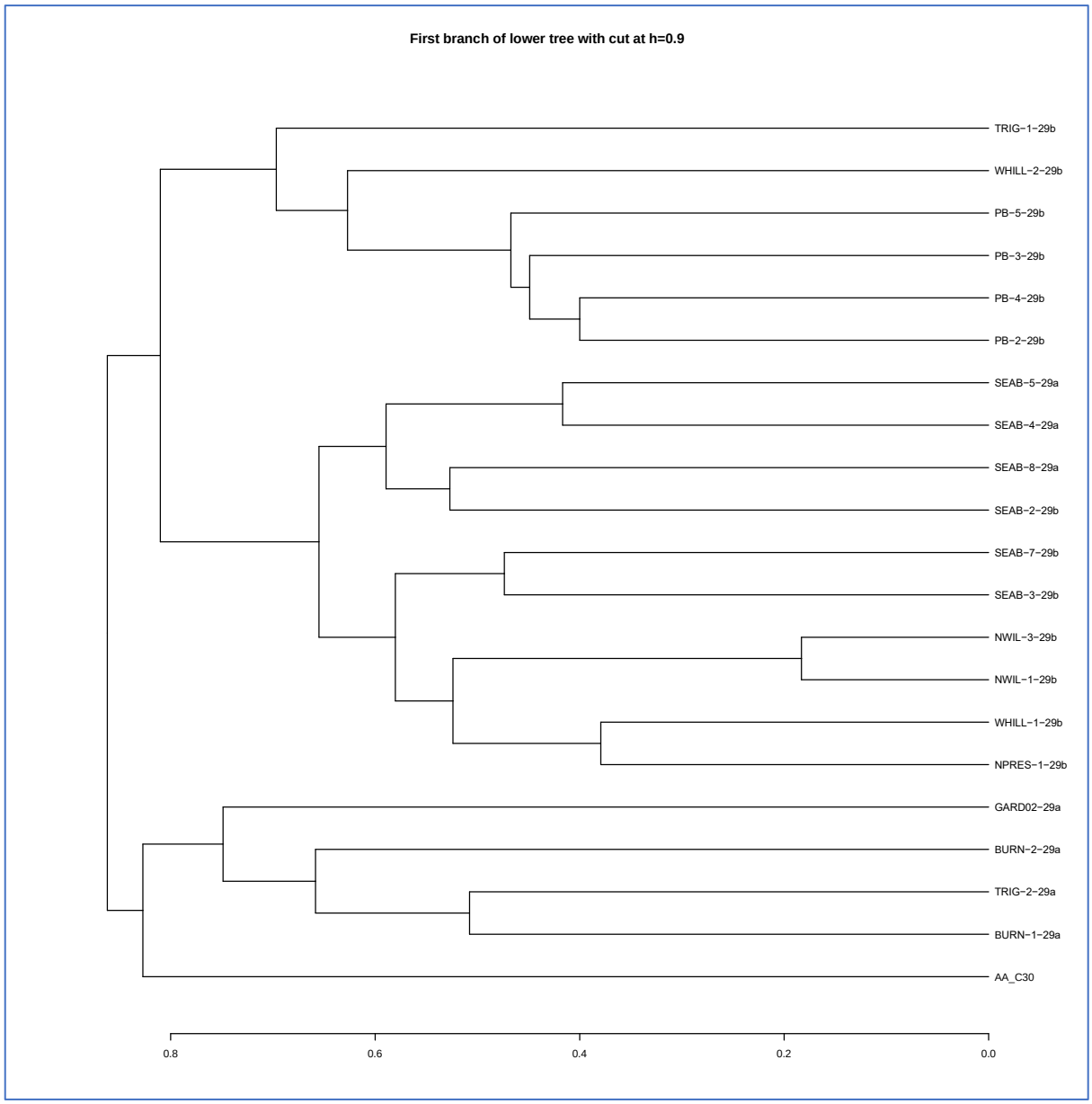


Figure 6: Partial dendrogram for the assignment of Plot C30 to Swan Coastal Plain floristic community types.

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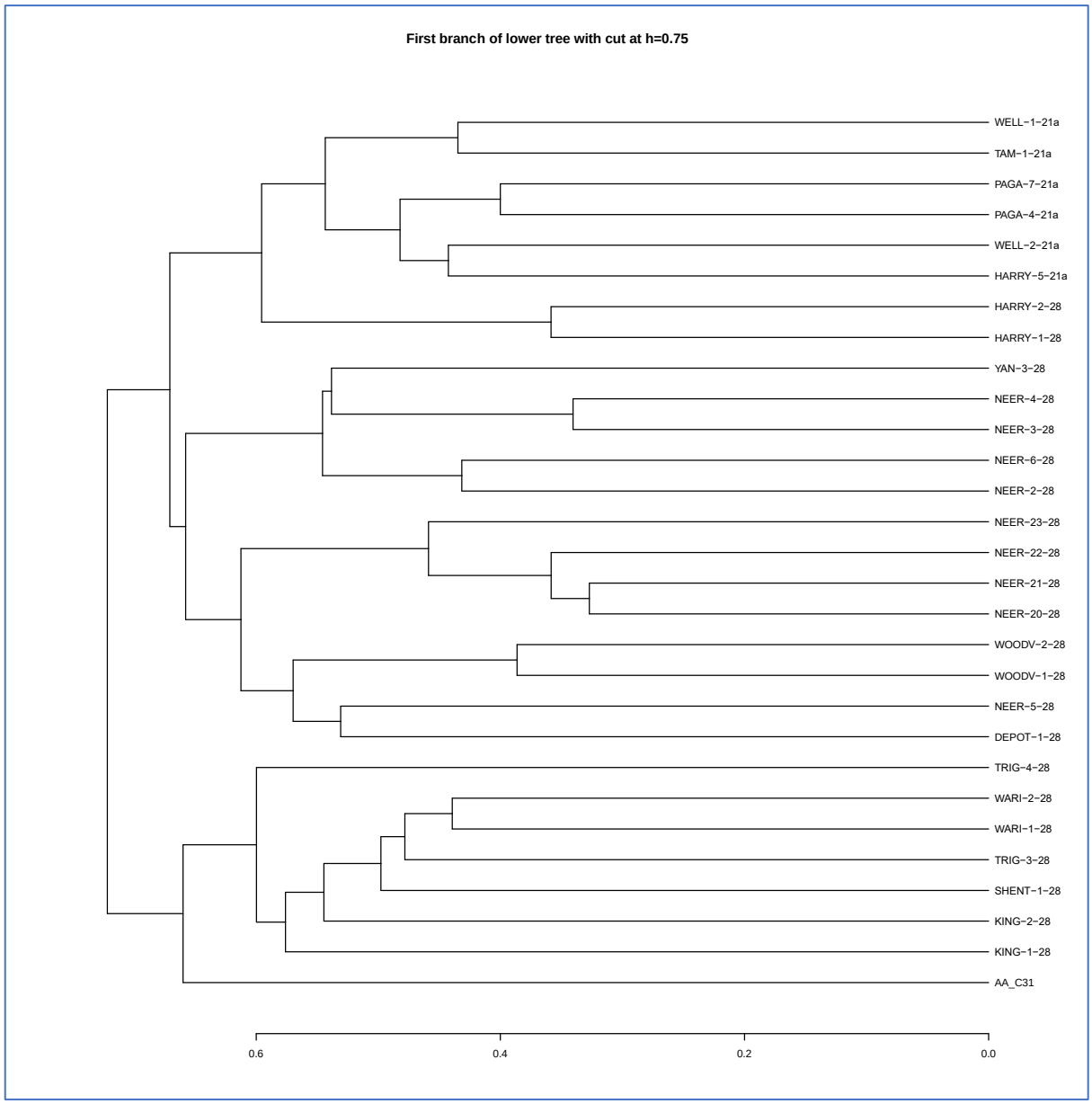


Figure 7: Partial dendrogram for the assignment of Plot C31 to Swan Coastal Plain floristic community types.

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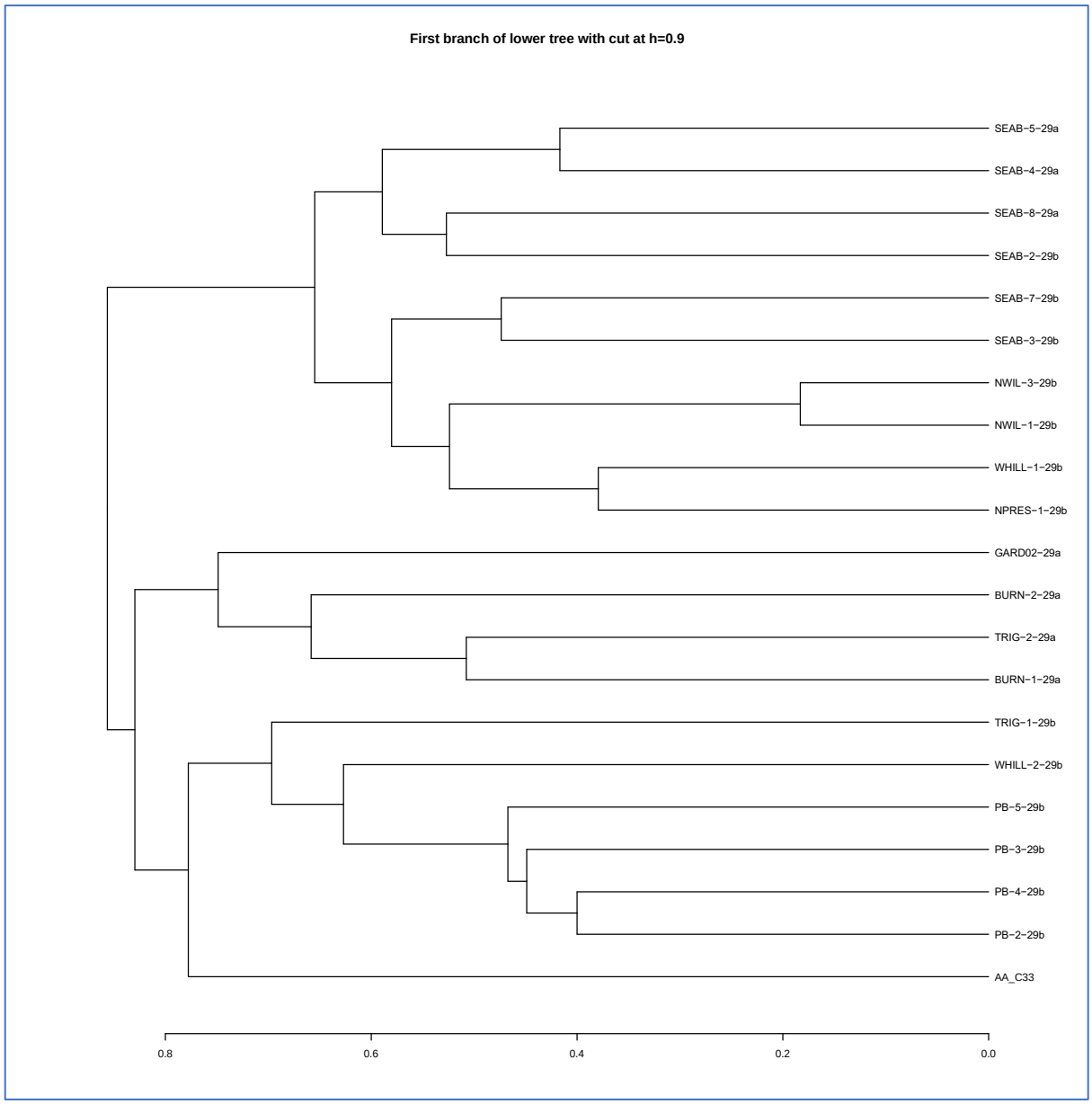


Figure 8: Partial dendrogram for the assignment of Plot C33 to Swan Coastal Plain floristic community types.

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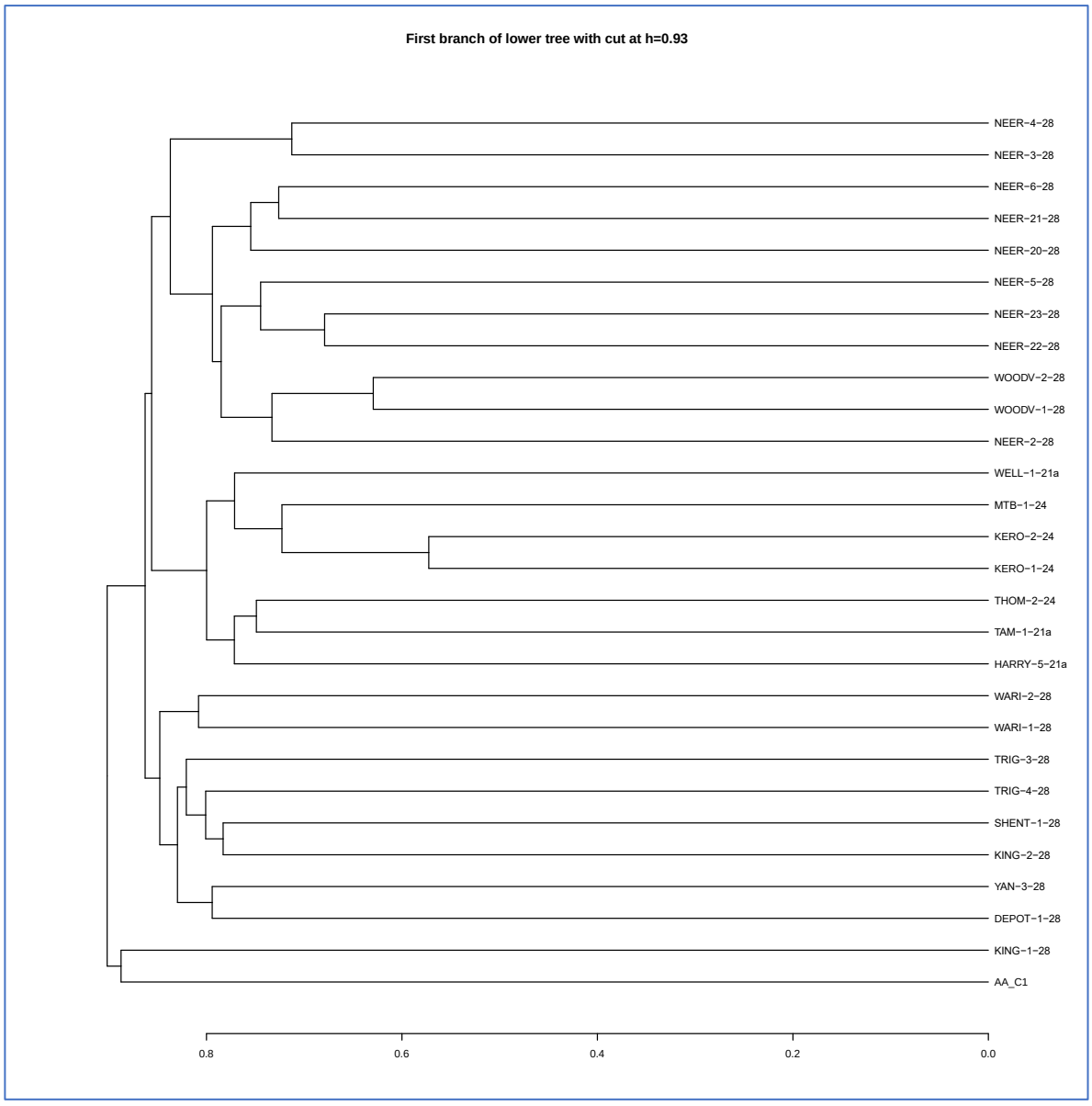


Figure 9: Partial dendrogram for the assignment from the rarefaction approach of Plot C1 to Swan Coastal Plain floristic community types.

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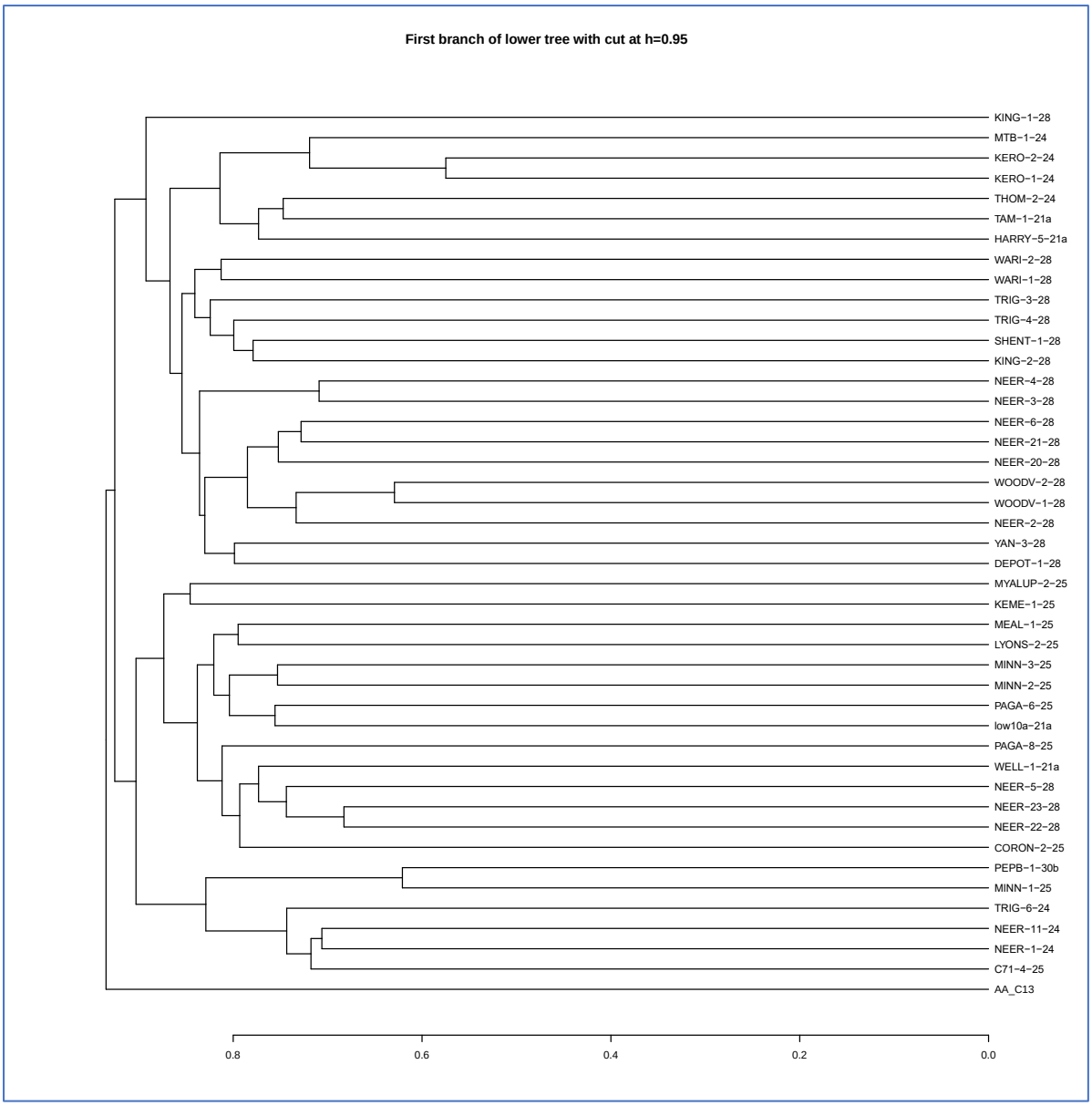


Figure 10: Partial dendrogram for the assignment from the rarefaction approach of Plot C13 to Swan Coastal Plain floristic community types.

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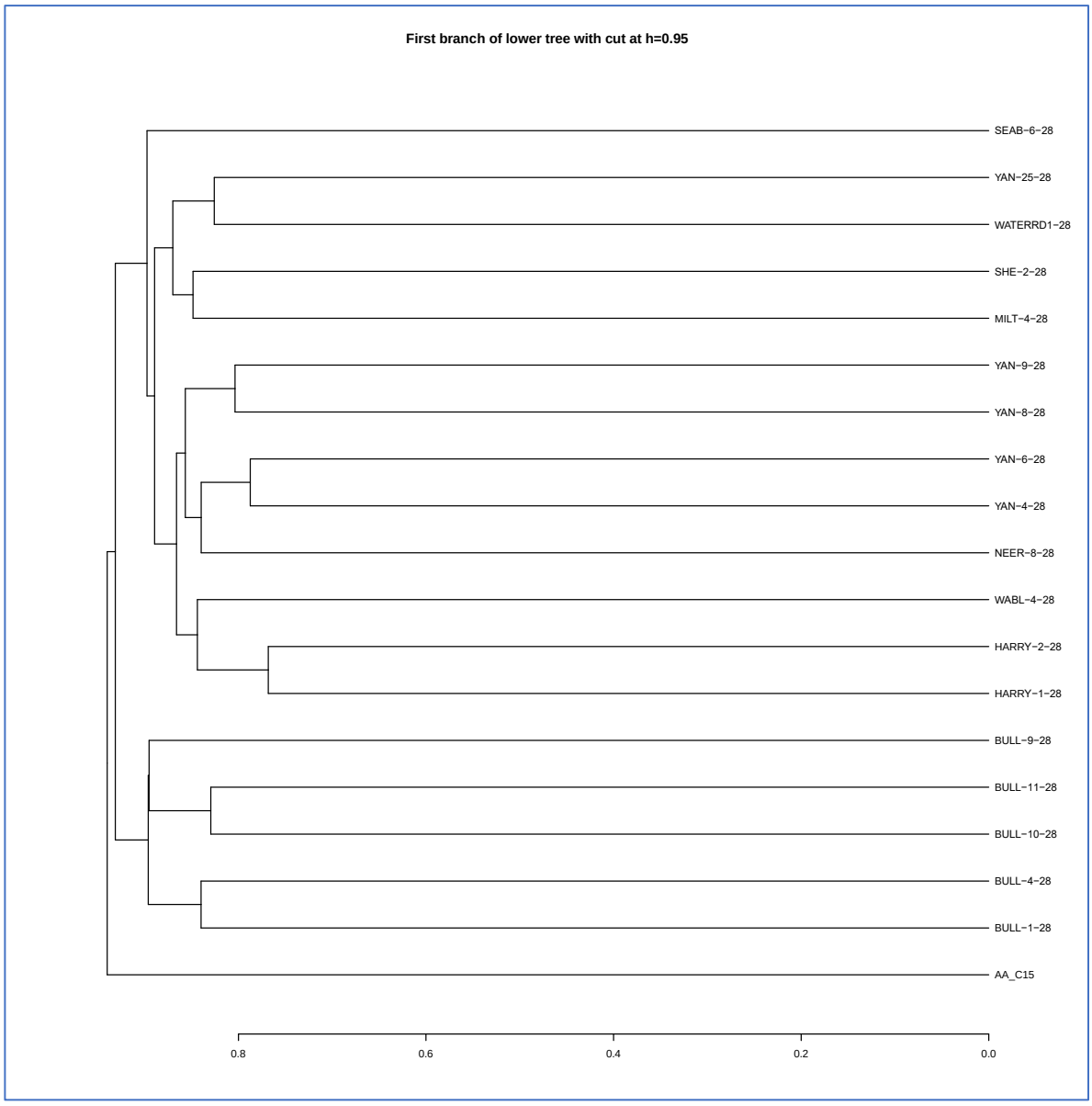


Figure 11: Partial dendrogram for the assignment from the rarefaction approach of Plot C15 to Swan Coastal Plain floristic community types.

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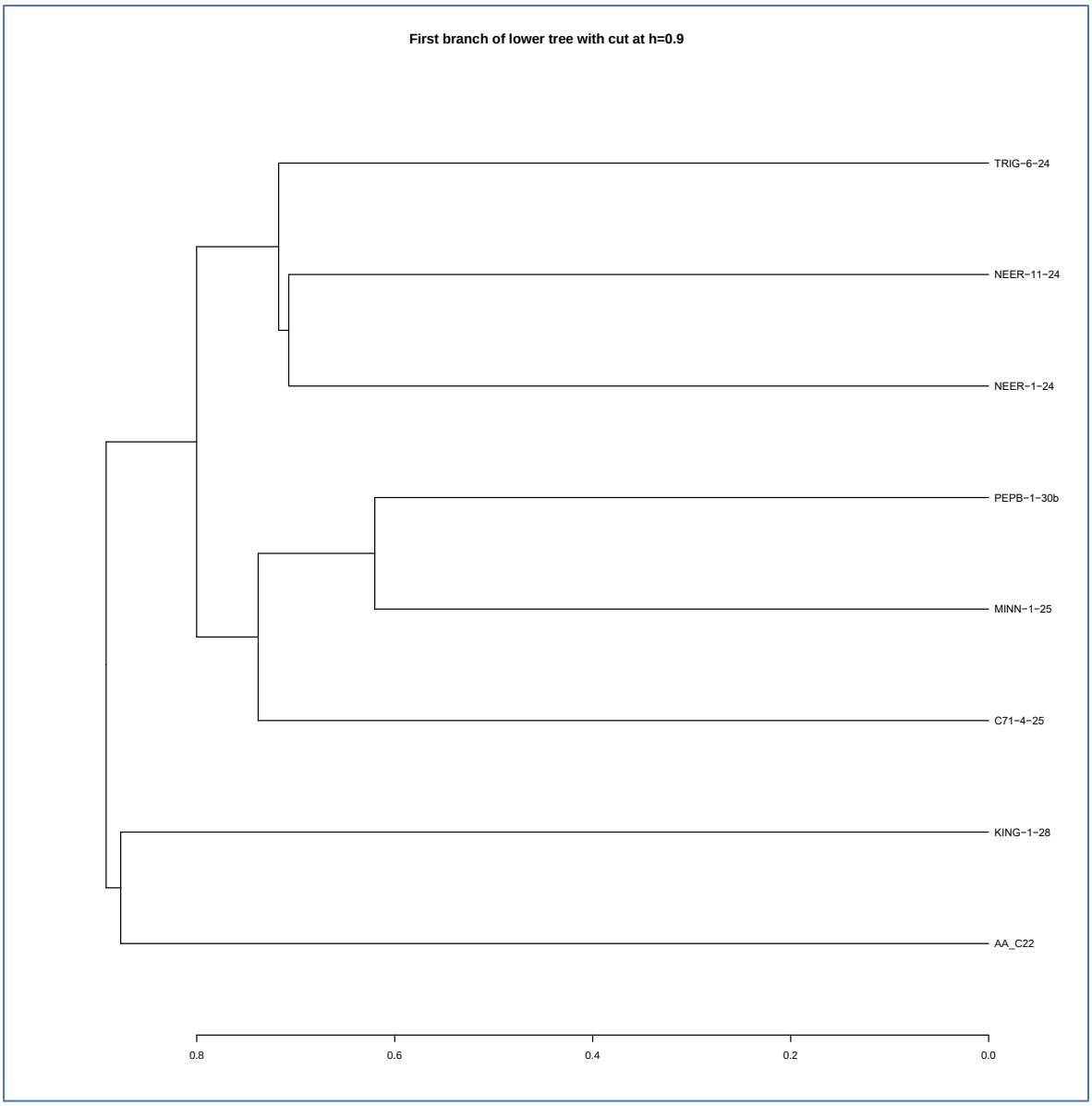


Figure 12: Partial dendrogram for the assignment from the rarefaction approach of Plot C22 to Swan Coastal Plain floristic community types.

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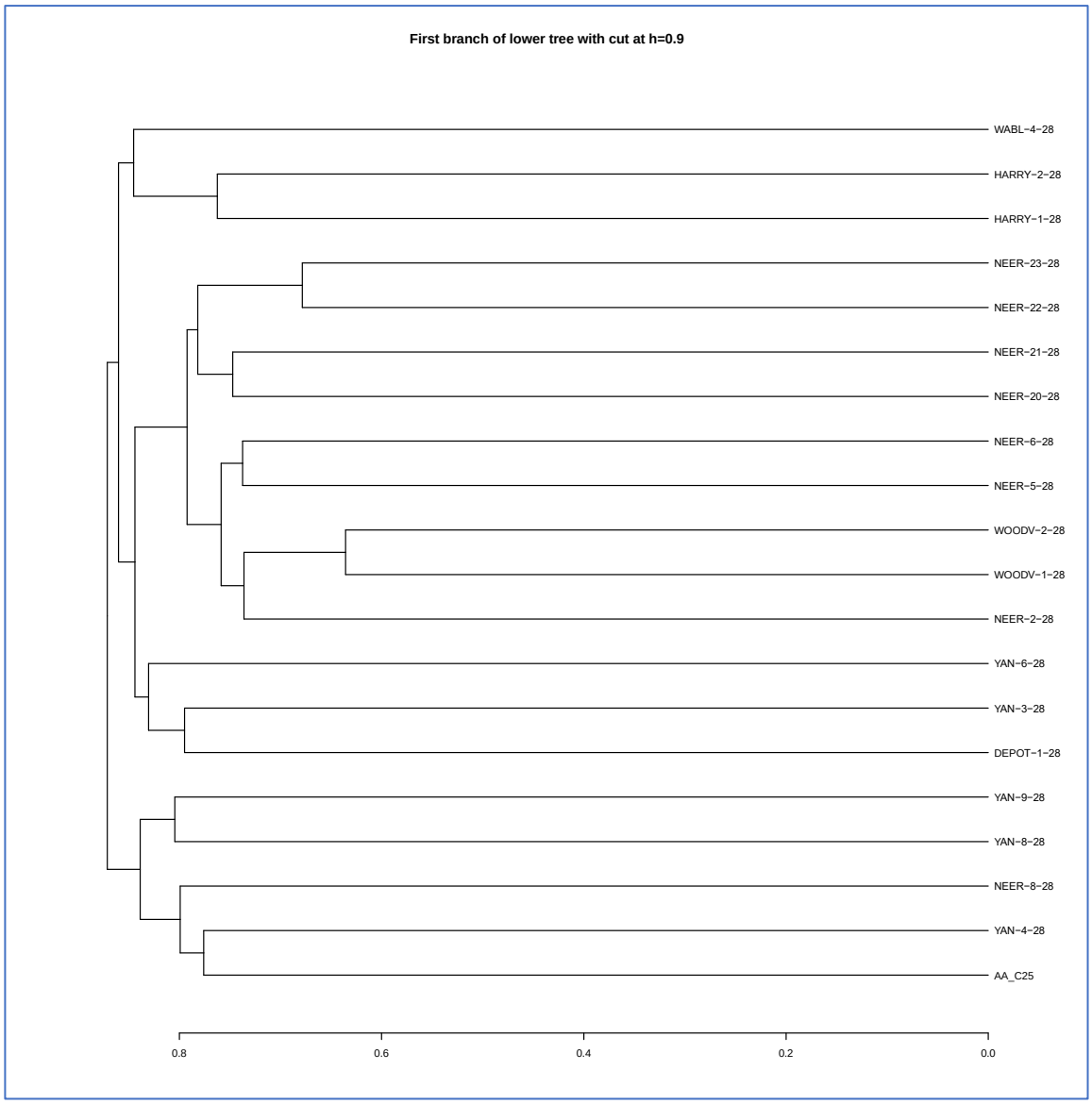


Figure 13: Partial dendrogram for the assignment from the rarefaction approach of Plot C25 to Swan Coastal Plain floristic community types.

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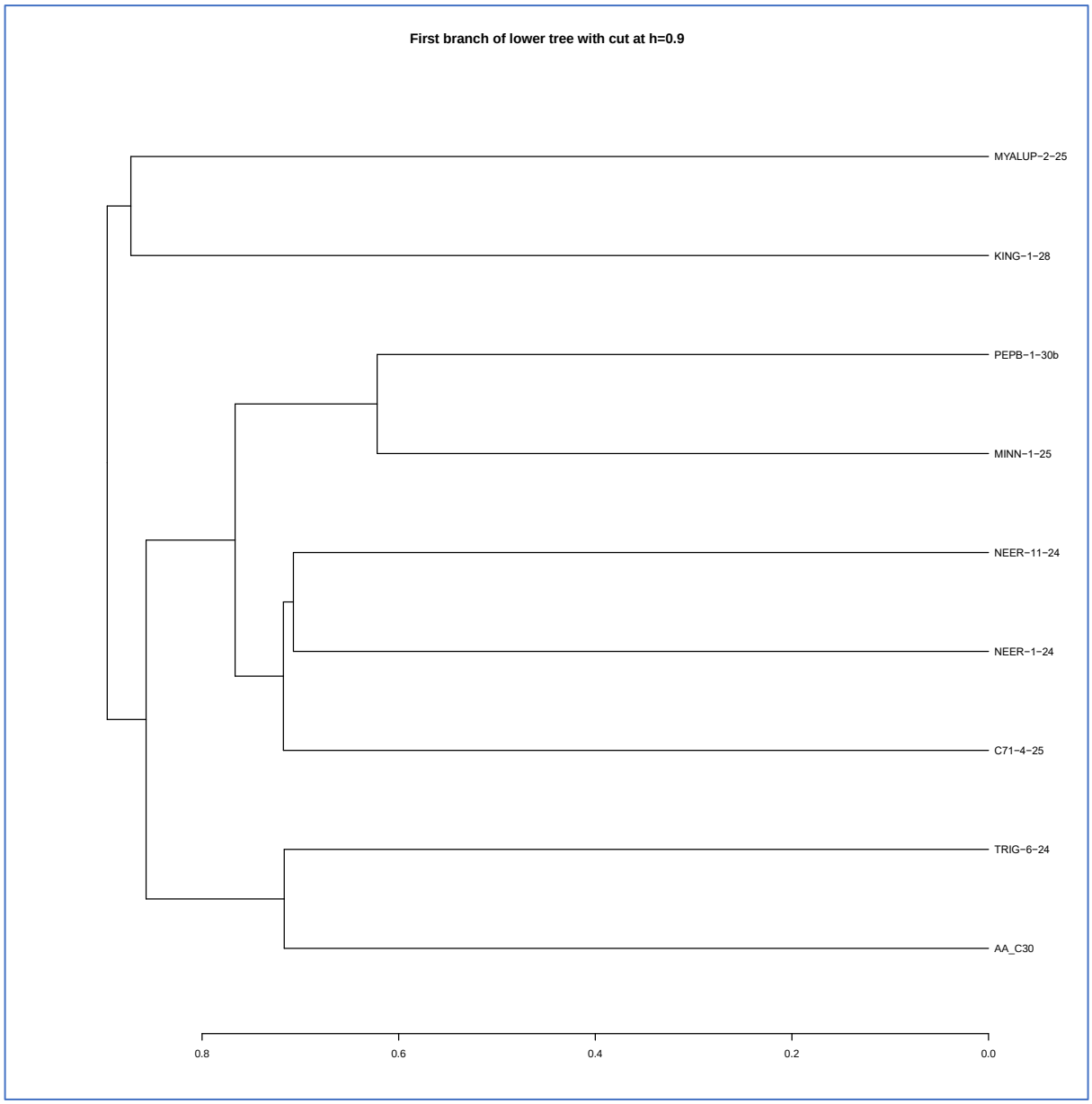


Figure 14: Partial dendrogram for the assignment from the rarefaction approach of Plot C30 to Swan Coastal Plain floristic community types.

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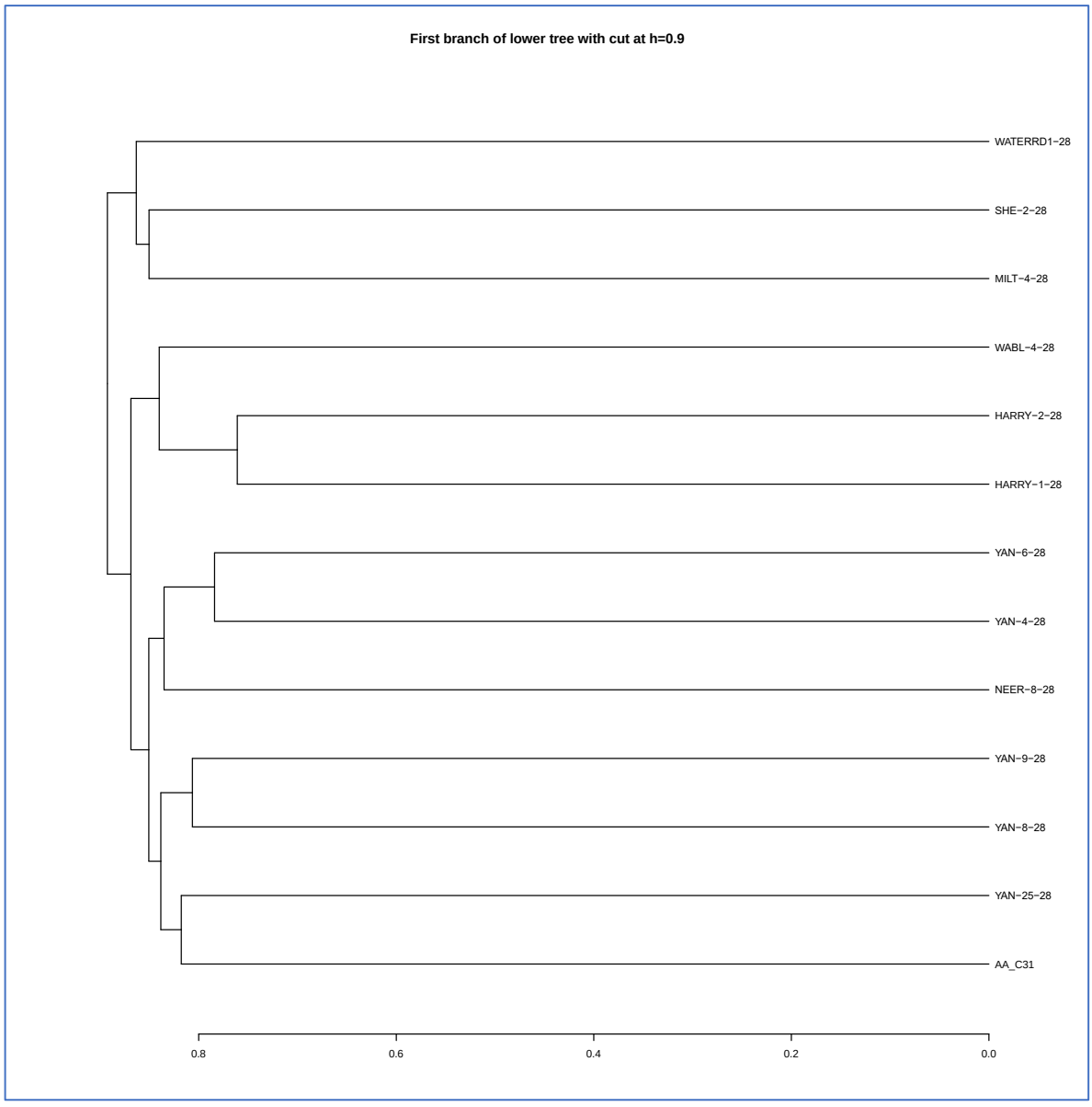


Figure 15: Partial dendrogram for the assignment from the rarefaction approach of Plot C31 to Swan Coastal Plain floristic community types.

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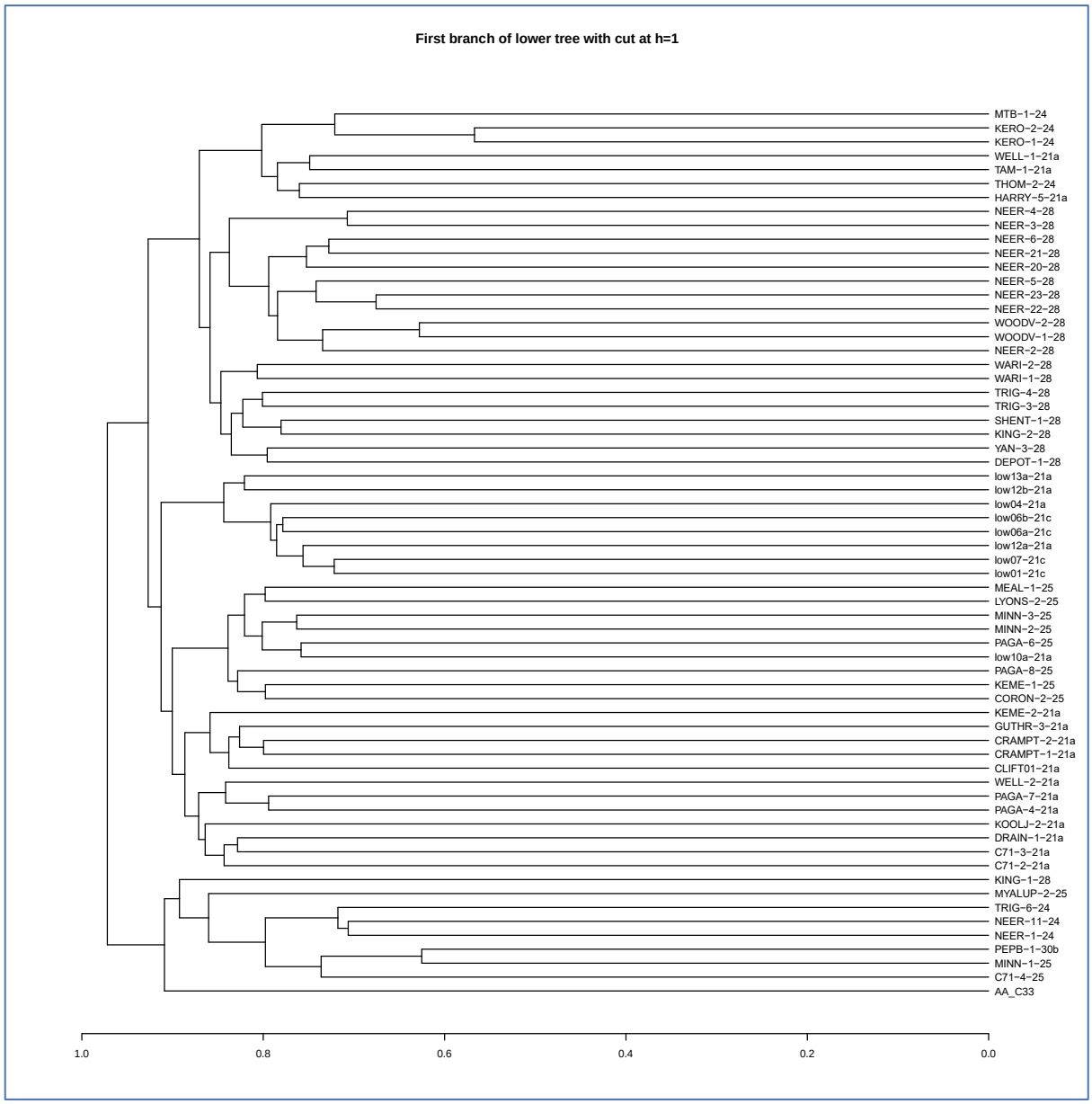


Figure 16: Partial dendrogram for the assignment from the rarefaction approach of Plot C33 to Swan Coastal Plain floristic community types.

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27 September 2024

Paul van der Moezel
Managing Director
PGV Environmental
Suite 3, 67 Howe St
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Dear Paul,

Plantecology Consulting was commissioned to undertake the numerical analysis and assignment of plot data to existing Floristic Community Types of the Swan Coastal Plain for a site at Carabooda. The methods and results outlined below are based on the data as supplied on the 25th September 2024.

1 Introduction

The remnant vegetation of the southern Swan Coastal Plain (SCP) was surveyed by Gibson et al. (1994) to provide an understanding of the major floristic gradients across the region. The major plant communities (or FCTs) were defined by classifying the data according to the similarities in species composition between plots. When determining the FCT of a new record, a floristic analysis of species composition provides the most robust method that is consistent with the original classification. Presently, a single consistent method for the determination of FCTs for vegetation data in the Swan Coastal Plain is not available. Therefore, it is preferable to use multiple methods and compare the output for the most likely result. The methods used are those outlined in *Methods for Survey and Identification of Western Australian Threatened Ecological Communities* (DBCA 2024) being FCT assignment using the Gibson et al. (1994) and Keighery et al. (2012) datasets, and assignment by the minimum dissimilarity between the Carabooda plots and plots from the two regional datasets (nearest neighbour). All analyses described below were undertaken using R packages Cluster (Maechler et al 2019), Vegclust (De Cáceres et al. 2010), optpart (Roberts 2020) and Vegan (Oksanen et al. 2020).

2 Methods

2.1. Hierarchical Clustering Assignments

Hierarchical agglomerative clustering is the usual first stage in classifying vegetation data into community types. This involves calculating the similarity (or more often, the dissimilarity) between plots within the dataset and then sequentially fusing the plots into groups according to their similarity. This type of method was used in the analysis of the original Swan Coastal Plain dataset (Gibson et al. 1994) and to determine the conservation status of additional plots, data is often added to the original dataset and the analysis re-run (Environmental Protection Authority 2016). The direct use of the original dataset as the basis for assigning new plot data to the regional classification has some drawbacks, however. First, a hierarchical clustering only applies to the relationships between plots, and the relative distances between them, within that particular dataset. The addition of new data often alters the relative cophenetic distances and disrupts the clustering output. Second, as an unsupervised method, hierarchical clustering does not define rules for the membership of the defined groups, and

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so the addition of new plots requires the rebuilding of the entire hierarchy (De Cáceres and Wiser 2012).

The data for the Swan Coastal Plain regional survey (Gibson et al. 1994) and that of Keighery et al. (2012) was downloaded from the NatureMap website. The current Gibson et al. (1994) dataset has been modified from that of the original survey with the removal of one site (OATES-1), resulting in a dataset of 508 plots. The Keighery et al. (2012) dataset is a compilation of data from a number of floristic studies and extended the Gibson et al. (1994) dataset. The composite dataset used in this analysis was that curated on the NatureMap website as of 2015. Notwithstanding the proviso in Keighery et al. (2012) that the composite dataset should not be used for FCT analyses, it can be useful when assigning new plot data that are potentially from FCT that were under-sampled in in the Gibson et al. (1994) survey e.g. FCT 14 and FCT 18.

The species nomenclature of the datasets was updated to be consistent with current usage. Where original names could not be matched clearly to the updated usage, those taxa were removed from the analysis. Infraspecies ranks were raised to species level when no matching rank had been used in the original datasets. Taxa that could not be identified to species level in the Carabooda dataset were removed.

The new data from the Carabooda survey was added to both Swan Coastal Plain datasets and the new dataset was then analysed using the Bray-Curtis distance coefficient (or resemblance measure) and the flexible beta linkage method (beta = -0.1). Assignment of the Carabooda plots was to the nearest distinct group by inspection of the resulting dendrogram. To examine any effect of spatial correlation between the new plots, data was also added to the matrix one plot a time and the analyses re-run.

In practice, there is often less similarity between a new plot and the plots of the FCT to which it is assigned than between the original plots themselves. That is, new plots are usually most similar to fringing members of the original group.

2.2. Nearest Neighbour

The nearest neighbour assignment method uses the minimum Bray-Curtis distance between a new plot and a plot from the original dataset. The comparison of individual samples is seldom useful as new plots are rarely similar to diagnostic plots from the original FCT classification. More often, the nearest neighbour is a fringe member of a FCT and may not be a 'near' neighbour, which regularly leads to misclassifications. Assignments to the nearest group (as in the clustering methods described above) are more robust.

2.3. Results

The cluster analysis of the Carabooda plots indicates that both are likely members of FCT 24 'Northern Spearwood shrublands and woodlands' (Figure 1). This result was repeated when assigning the plots individually to the Gibson et al. (1994) dataset (Figures 2 and 3).

Assignment to FCTs using the Keighery et al. (2012) dataset was more equivocal. The first fusion for Plot CB44 was to a plot from FCT 24 and then to a plot from FCT 27 'Species poor mallees and shrublands on limestone'. The assignments for CB45 was similar, although fusing slightly higher in the dendrogram. The assignments to FCT 24 are reasonable given the presence of species such as *Banksia sessilis, Melaleuca systena, Hardenbergia comptoniana* and *Dianella revoluta* subsp. *divaricata.*

The cross tabulation of the Bray Curtis dissimilarities between the Swan Coastal Plain and the Carabooda plots is shown on Table 1, with both plots assigned to FCT 24. In determining probable FCTs for the Carabooda plots, most weight was given to assignment to the Gibson et al. (1994) dataset, as this produced clearer and more consistent results (Table 2). Assignment to the Keighery et al. (2012) dataset was less clear, with more disruption to the original classification observed. Least

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weight was given to the nearest neighbour assignments as these were less consistent with the results of the clustering analyses, and none were less 0.5.

Table 1: Bray Curtis dissimilarity values for Carabooda and the closest Swan Coastal Plain plots

Swan Coastal Plain Plot (FCT)	CB44	CB45
NEER-10-24	0.649	0.571
NEER-9-24	0.718	0.614
NEER-7-24	0.735	0.634
BOLD-1-24	0.743	0.725
BOLD-2-24	0.772	0.730
TRIG-5-24	0.681	0.646
NAVB-3-24	0.522	0.662
Bold18-27	0.594	0.649
Buck01-24	0.577	0.677
Bold05-S11	0.667	0.724
Bold06-30a2	0.644	0.709
Bold22-27	0.673	0.695
Minimum dissimilarity	**0.522**	**0.571**

Table 2: Floristic Community Type assignment summary.

Plot	Assignment to Gibson et al. (1994)	Assignment to Keighery et al. (2012)	Nearest Neighbour	Probable FCT
CB44	24	24	24	24
CB45	24	24	24	24

3 Discussion

The results of the cluster assignments show that the Carabooda plots are most likely part of FCT 24 'Northern Spearwood shrublands and woodlands'. FCT 24 is associated with deeper soils of the Cottesloe unit of the Spearwood Dune System (Gibson et al. 1994) and is listed as a Priority Ecological Community with a rank of Priority 3. Common species include *Melaleuca systena* and *Hardenbergia comptoniana,* both of which were recorded in the Carabooda plots.

However, both CB44 and CB45 recorded a relatively high weed species richness (14 and 9, respectively) indicating that the plots are quite disturbed. As the regional datasets are based on presence/absence, the number of native taxa within a plot strongly influences the resultant assignments. Both plots showed some similarity to FCT27 'Species poor mallees and shrublands on limestone' and it is also possible that the Carabooda site was originally FCT 26a '*Melaleuca huegelii – Melaleuca systena* shrublands of limestone ridges', a TEC. FCT 24 and FCT 26a share very similar species pools, with FCT 24 less species rich (approximately 42 taxa per plot versus approximately 50

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taxa per plot for FCT 26a (Gibson et al. 1994)) and occurring on deeper soils. SCP 26a occurs on shallow soils over limestone with typical species including *Acacia lasiocarpa, Banksia sessilis, Grevillea preissii, Melaleuca huegelii* and *Melaleuca systena*, all of which were recorded in the Carabooda plots. Site disturbance and subsequent weed invasion disproportionately replaces the herbaceous species and numerical assignment methods are unlikely to ascertain the presence of FCT 26a unless the vegetation retains the native ground layer.

4 Conclusion

In summary, the results of the numerical analyses indicates that FCT 24 'Northern Spearwood shrublands and woodlands' is likely the correct FCT for the site at Carabooda. FCT 24 is listed as a Priority 3 Ecological Community. Given the proportion of weeds in the dataset, it is possible that other types such as FCT 26a or FCT 27 may have been the original community type, but it is not now possible to determine this as the ecological function of the site has been compromised by the loss of native taxa.

Should you require any further information or have any other queries, please feel free to contact me.

Sincerely yours,



Dr. Shane Chalwell

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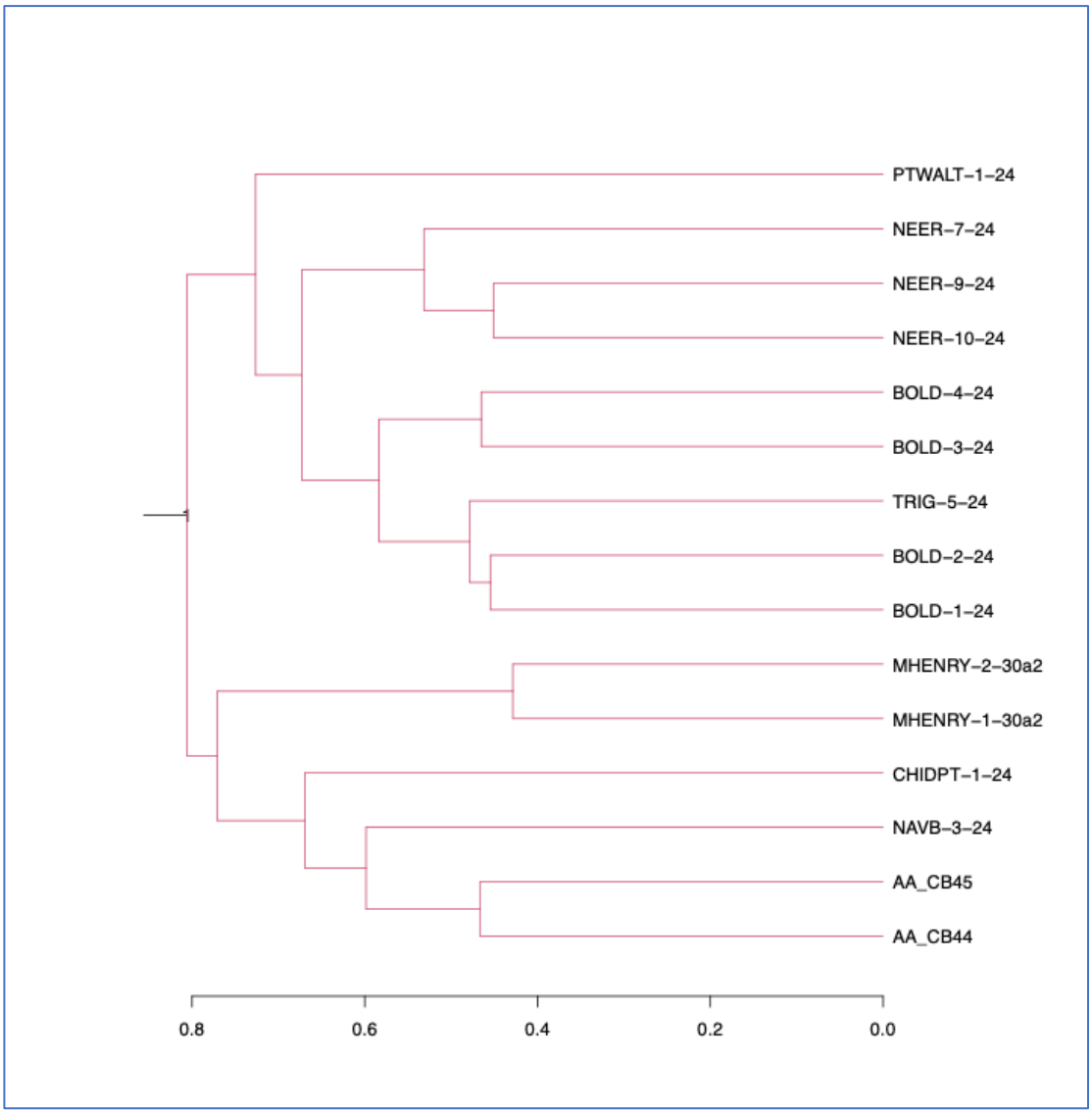


Figure 1: Partial dendrogram for the assignment of the Carabooda plots to the Swan Coastal Plain floristic community types.

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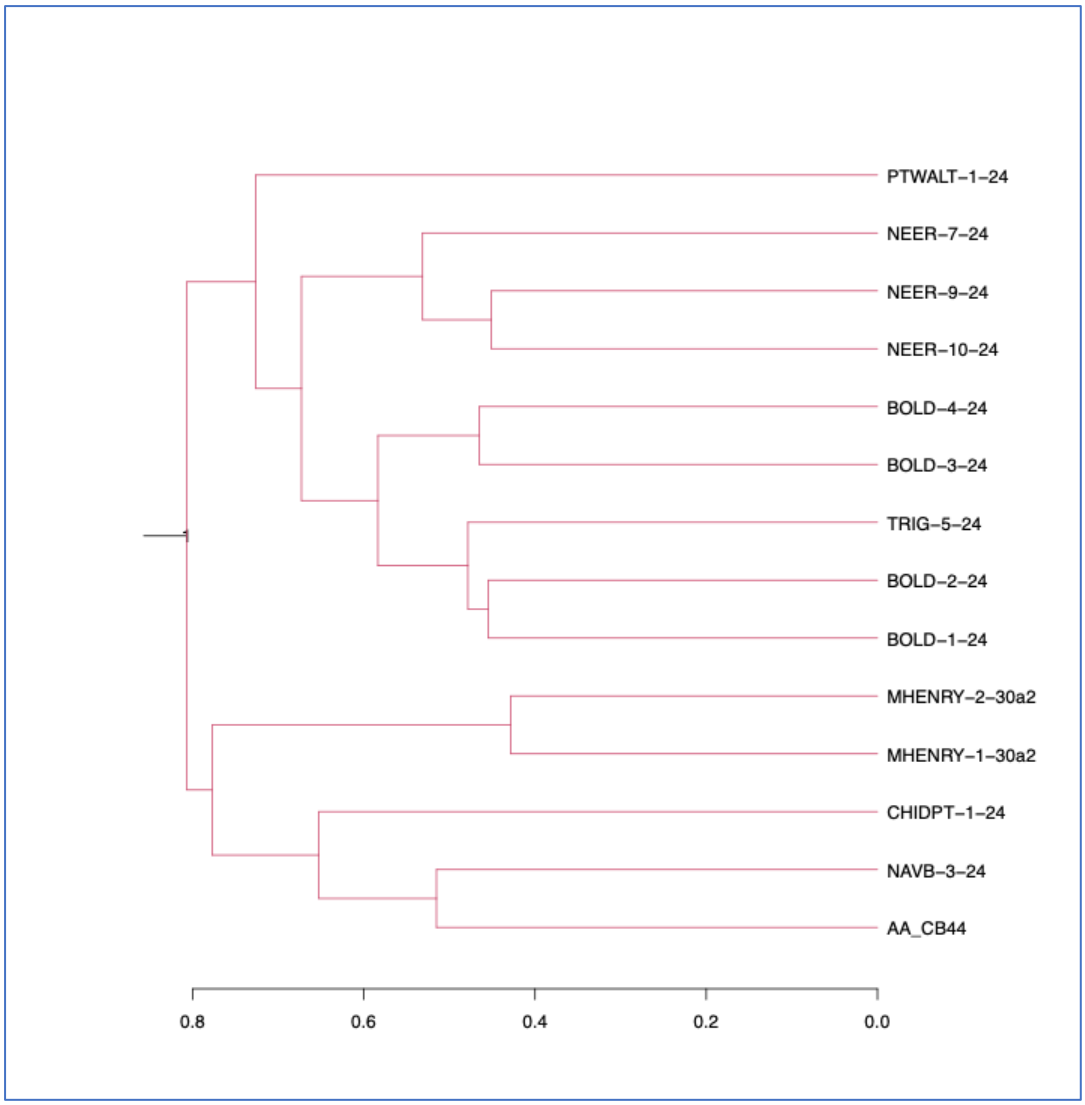


Figure 2: Partial dendrogram for the assignment of Plot CB44 to the Swan Coastal Plain floristic community types.

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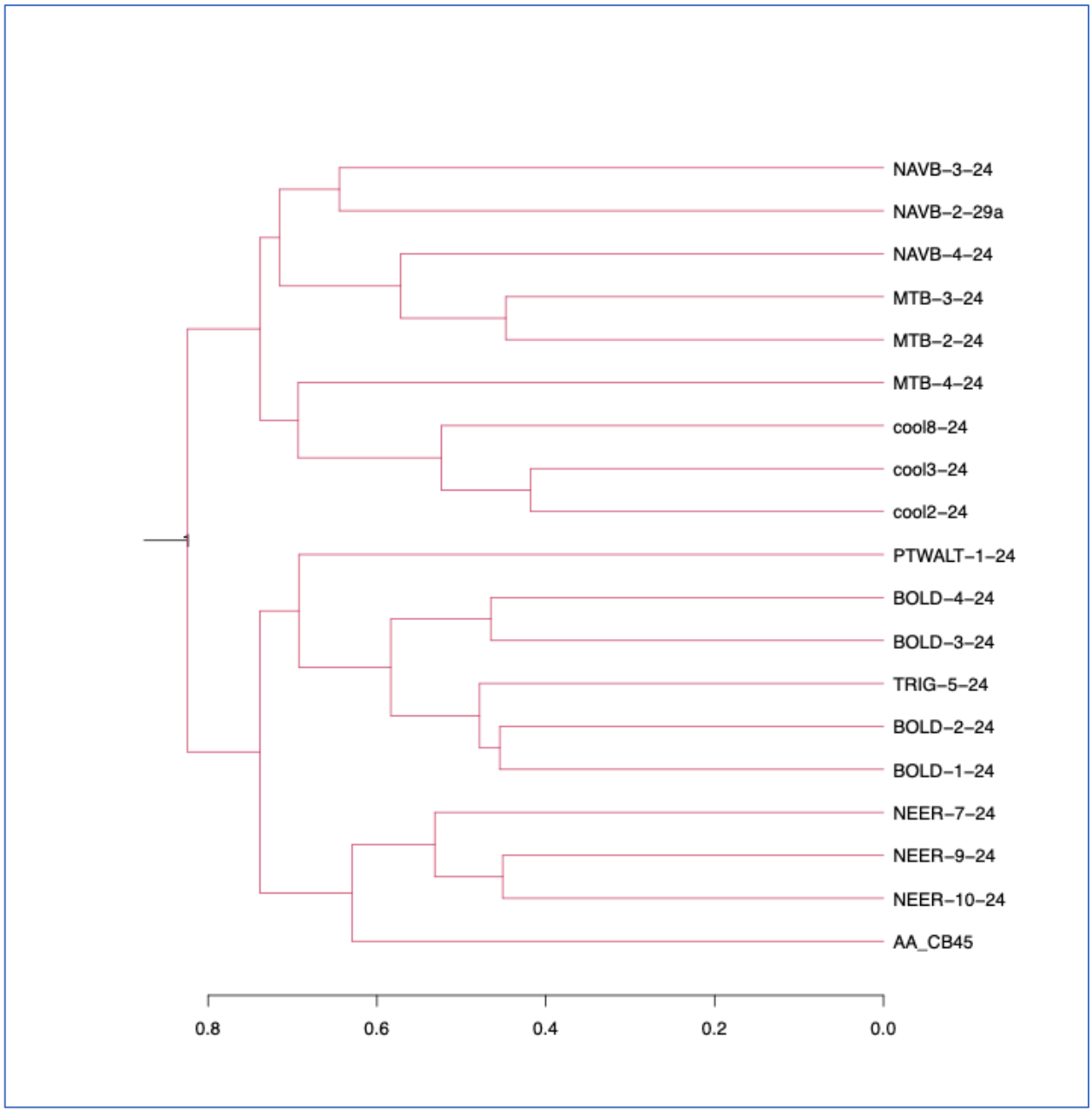


Figure 3: Partial dendrogram for the assignment of Plot CB45 to the Swan Coastal Plain floristic community types.

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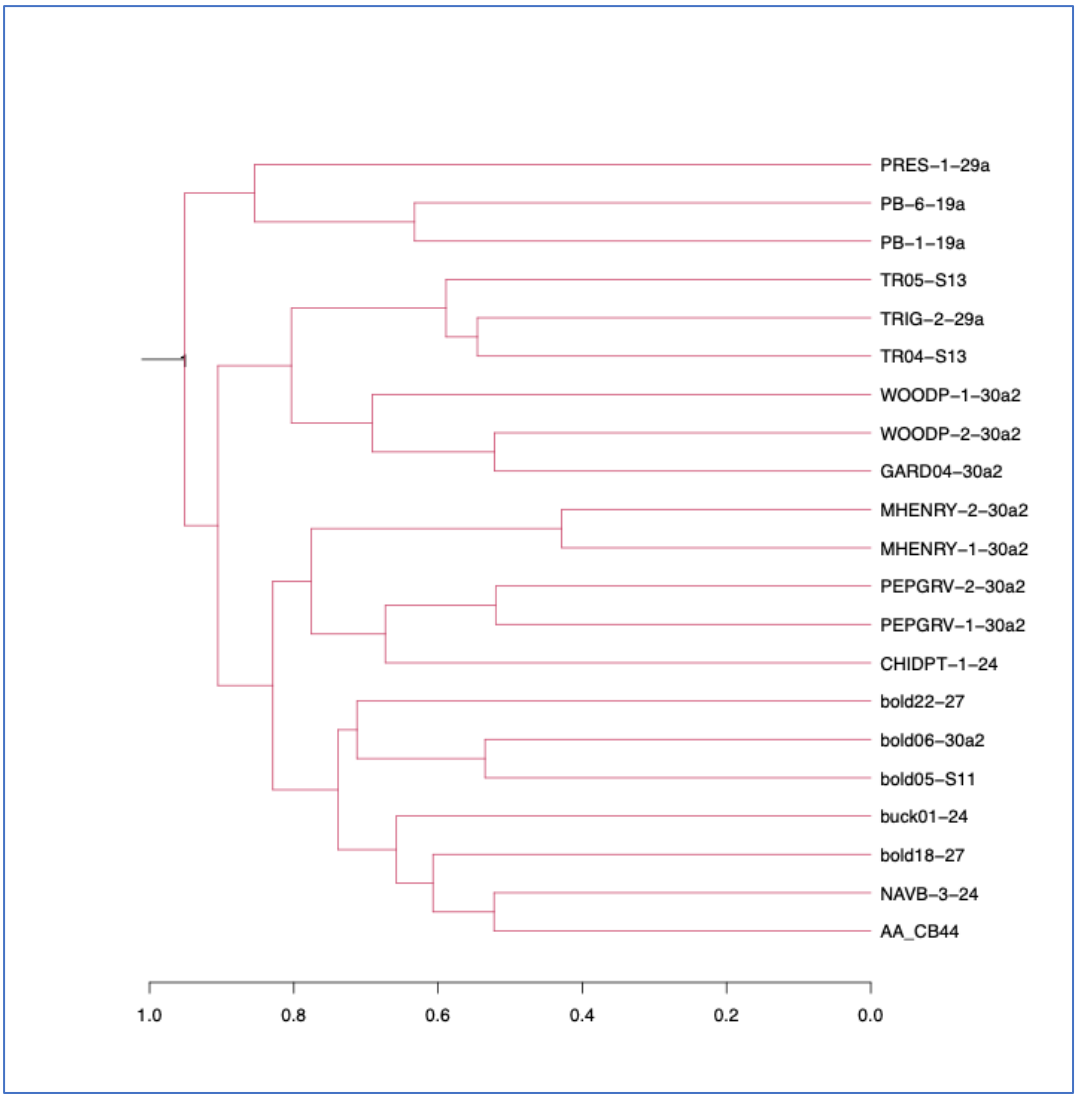


Figure 4: Partial dendrogram for the assignment of Plot CB44 to the Keighery et al. (2012) floristic community types.

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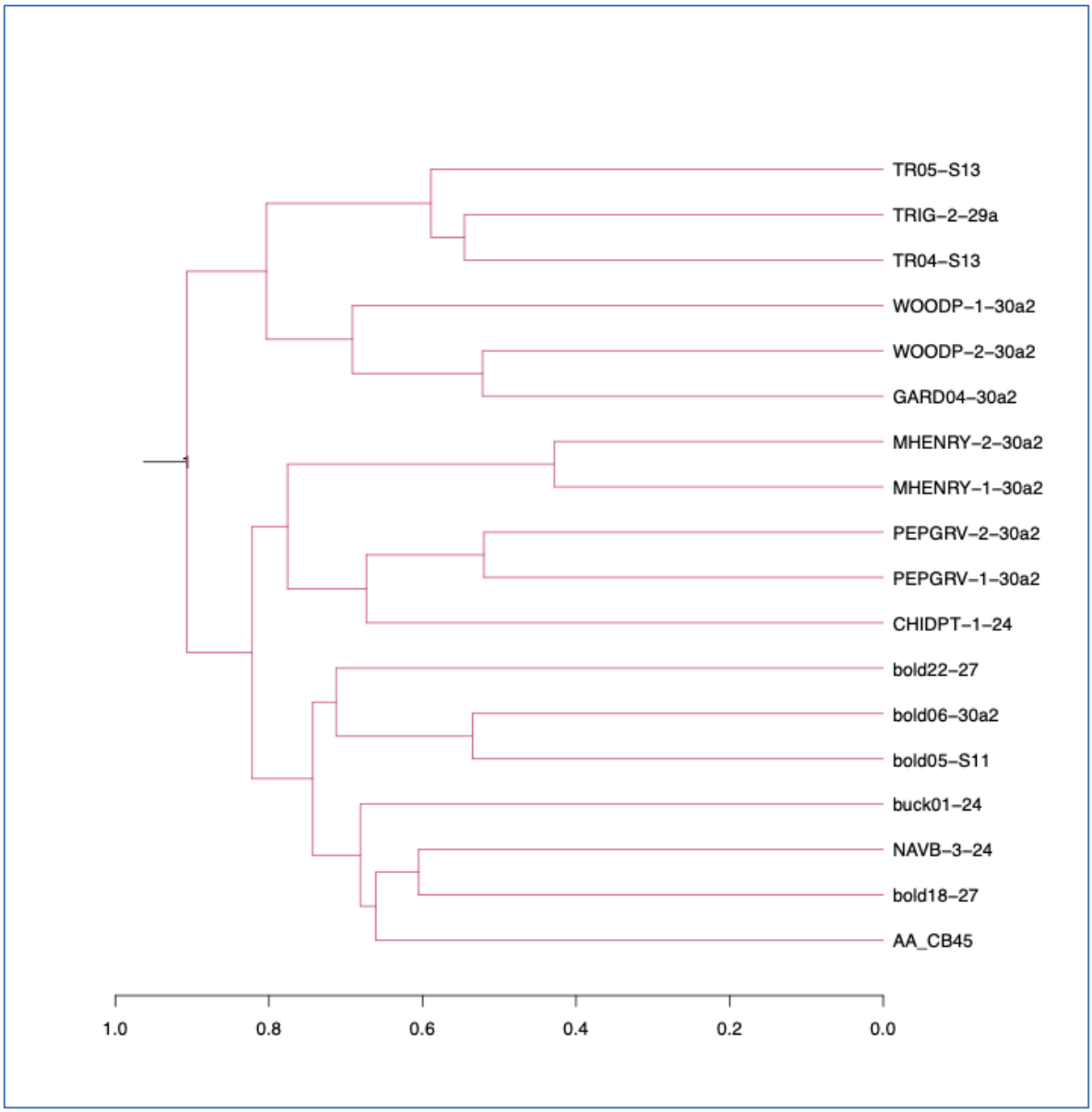


Figure 5: Partial dendrogram for the assignment of Plot CB45 to the Keighery et al. (2012) floristic community types.

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Appendix C
Level 1 Fauna and Targeted Black Cockatoo Assessment, Carabooda 'Urban Investigation Boundary' (BCE, 2024)

Level 1 Fauna and Targeted Black-Cockatoo Assessment, Carabooda 'Urban Investigation Boundary'



Banksia sessilis Thicket (VSA 3) with Eucalypt Woodland (VSA 6) in background (N. Ducker)

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21st January 2025

Executive Summary

Introduction

Bamford Consulting Ecologists (BCE) was commissioned by Carabooda Landowners Pty Ltd. to conduct a black-cockatoo habitat assessment and Basic fauna assessment of five parcels of land (the project area) in Carabooda, Western Australia. This report presents the results of the desktop review, site inspection and targeted black-cockatoo assessment for the project area. The project area was visited on multiple occasions from May to October 2024.

A Basic fauna assessment relies on information on the fauna assemblage and its environment, and BCE uses an approach with the following components:

- The identification of **fauna values:**
  - Assemblage characteristics: uniqueness, completeness and richness;
  - Species of conservation significance;
  - Recognition of ecotypes or vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
  - Patterns of biodiversity across the landscape; and
  - Ecological processes upon which the fauna depend.

The targeted black-cockatoo habitat assessment involves assessing foraging, breeding and roosting habitat for black-cockatoos, based on methodology developed by BCE and guided by federal guidelines.

Project area description

The project area is located in the northern half of Western Australia's Swan region, approximately 40 km north of Perth. The project area, comprised of 63 parcels of land, is approximately 960 ha in size and consists of remnant native vegetation and areas cleared for limestone quarries and residential purposes. The surrounding area is comprised of native vegetation (often isolated and fragmented), cleared land associated with agriculture or mining (quarries), and residential development. Within 15 km of the project area there are several recognized sensitive sites including state-listed Threatened Ecological Communities, Environmentally Sensitive Areas, Important Wetlands, protected terrestrial reserves, and a Key Biodiversity Area – the Northern Swan Coastal Plain KBA (important for Carnaby's Black-Cockatoo and other bird species).

Key fauna values

Vegetation and Substrate Associations (VSAs). The project area encompasses seven VSAs: VSA 1 (Tuart Open Woodland), VSA 2 (*Banksia* Woodland), VSA 3 (*Banksia* Thicket), VSA 4 (Jarrah Woodland), VSA 5 (Melaleuca Heath and Scrub), VSA 6 (Redheart Open Woodland) and VSA 7 (Cleared/Disturbed land).

Fauna assemblage. The desktop assessment identified 222 vertebrate fauna species as potentially occurring in the project area: nine frogs, 52 reptiles, 139 birds, 17 native and 5 introduced mammals.

Nine vertebrate species that would historically have been present in the project area have been omitted from the expected species list because they are extinct or considered locally extinct (two birds and seven mammals). Overall, the assemblage of vertebrate fauna expected in the project area is typical of remnant vegetation in the region and is likely to be represented elsewhere. However, the fauna assemblage associated with Banksia woodland has a restricted distribution due to high levels of loss and fragmentation of this ecological community on the Swan Coastal Plain.

Species of conservation significance. Three broad levels of conservation significance are used in this report:

- Conservation Significance 1 (CS1) – species listed under State or Commonwealth Acts.
- Conservation Significance 2 (CS2) – species listed as Priority by DBCA but not listed under State or Commonwealth Acts.
- Conservation Significance 3 (CS3) – species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

Species of conservation significance. There are 68 vertebrate species of conservation significance expected to occur in the project area: eight CS1, six CS2 and 54 CS3. An additional eight species (two birds and six mammals) would be considered of conservation significance (CS1, CS2 or CS3) if they were not locally extinct in the area.

It is expected that five invertebrate species of listed conservation significance are likely to be present in the project area: the Spiny Katydid (Swan Coastal Plain) (*Austrosaga spinifer*), Douglas' Broad-headed Bee (*Hesperocolletes douglasi*), Woollybush Bee (*Hylaeus globuliferus*), Swan Coastal Plain Shield-backed Trapdoor Spider (*Idiosoma sigillatum*) and Graceful Sun Moth *(Synemon gratiosa*). It is also expected that the karst landscape of the project area will support short-range endemic (SRE) invertebrates including stygofauna.

Black-cockatoo Assessment. The project area is out of range for Baudin's Black-Cockatoo (although it may occur as a vagrant). The Forest Red-tailed Black-Cockatoo and Carnaby's Black-Cockatoo are both expected as regular visitors. Both species were regularly observed in the project area during field investigations, and foraging evidence from both species was recorded.

Foraging value – overall the project area is of low to moderate foraging value for Carnaby's Black-Cockatoo, primarily due to the presence of *Banksia* spp. in several VSAs, with the overall value affected by extensive areas of VSA 7 (Cleared/Disturbed land) which provided low foraging value. The project area is of low foraging value for the Forest Red-tailed Black-Cockatoo, due to the presence of preferred food plants at low density.

Breeding value – 1598 trees met the criteria to be assessed as potential nesting trees for black-cockatoos. Of these, 113 contained hollows suitable for black-cockatoo breeding (99 Rank 3 trees and 14 Rank 2 trees). The closest confirmed breeding sites for Carnaby's Black-Cockatoo are c. 10 km from the project area.

Roosting value – Abundant tall trees within the project area would provide suitable roosting sites for black-cockatoos. Residents within the project area reported Carnaby's Black-Cockatoo drinking from

horse troughs on the property. Other artificial water sources are likely to exist in the surrounding landscape. The closest confirmed roost site (confirmed used by both red-tailed and white-tailed black-cockatoos) is on the boundary of the project area.

Patterns of biodiversity. The vegetation within the project area ranged from completely degraded (VSA 7) to relatively intact native vegetation in 'very good' and 'excellent' condition (VSAs 2, 3, 5 and 6). Large trees in VSA 1 and parts of VSA 7 provide habitat features such as hollows (large and small), crevices in tree bark, sites for nest building, and fallen limbs that all provide important fauna habitat. The relatively open understorey of VSA 1 and degraded and open nature of VSA 7 will limit the abundance and diversity of fauna species supported by these VSAs. VSAs 2, 3, and 5 contain a complex and dense vegetation structure in the understorey and/or midstorey which is likely to support a large variety and high abundance of vertebrate fauna. Several conservation significant species are likely to use these VSAs, such as the Quenda, Jewelled Sandplain Ctenotus, Black-striped Burrowing Snake, Brush Wallaby and Rakali.

The Banksia woodland of VSA 2 may support conservation significant insects including the Spiny Katydid (Swan Coastal Plain) (*Austrosaga spinifer*), Douglas' Broad-headed Bee (*Hesperocolletes douglasi*) and Woollybush Bee (*Hylaeus globuliferus*). The relatively undisturbed understorey of VSAs 2, 3, 5 and 6 is expected to provide a suitable environment for the Graceful Sun Moth and the Swan Coastal Plain Shield-backed Trapdoor Spider.

Key ecological processes. The ecological processes that are expected to influence the fauna assemblage include existing habitat loss, the presence and abundance of feral species, and landscape connectivity. The project area contains no wetlands, but elements of the native vegetation are likely to have some reliance on groundwater. The limestone topography suggests that a subterranean fauna assemblage is present, and this may include species that occur in the groundwater (Stygofauna). It is not expected that fire is currently having a significant impact on the fauna assemblage, but changes to natural fire regimes have the potential to negatively affect the fauna assemblage.

Contents

Executive Summary i
Contents iv
List of Tables vi
List of Figures vi
List of Plates vii
List of Appendices vii
1 Introduction 1
1.1 Background information 1
1.2 Black-cockatoos 1
1.3 Scope 1
1.4 Description of project area and background environmental information 2
1.4.1 Overview 2
1.4.2 Interim Biogeographic Regionalisation of Australia (IBRA) and landscape characteristics 4
1.4.3 Pre-European Vegetation and Soil-Landscape Mapping 5
1.4.4 Land use and tenure 9
1.4.5 Recognised sensitive sites 9
1.4.6 Regional development and extent of native vegetation 12
2 Methods 14
2.1 Overview 14
2.2 Identification of vegetation and substrate associations (VSAs) 15
2.3 Desktop assessment of expected species 16
2.3.1 Sources of information 16
2.3.2 Previous fauna surveys 17
2.3.3 Nomenclature and taxonomy 17
2.3.4 Interpretation of species lists 18
2.4 Field investigations 19
2.4.1 Overview 19
2.4.2 Black-cockatoo habitat analysis 23
2.5 Survey limitations 25
3 Fauna values 28
3.1 Vegetation and substrate associations (VSAs) [‘Habitat assessment‘] 28
3.2 Fauna assemblage 37

3.2.1 Overview of vertebrate fauna assemblage 37
3.2.2 Expected vertebrate fauna 38
3.2.3 Locally extinct vertebrate fauna 39
3.2.4 Conservation significant fauna 39
3.2.5 Conservation significant species accounts 49
3.3 Black-cockatoo habitat analysis 59
3.3.1 Black-cockatoo presence 59
3.3.2 Black-cockatoo breeding habitat 59
3.3.3 Black-cockatoo foraging habitat 64
3.3.4 Black-cockatoo night roosting habitat 73
3.3.5 Black-cockatoo watering points 73
3.4 Patterns of biodiversity 75
3.5 Ecological processes 76
3.6 Summary of fauna values 78
4 References 81
5 Appendices 94
Appendix 1. Explanation of fauna values. 94
Appendix 2. Categories used in the assessment of conservation status. 98
Appendix 3. Explanation of threatening processes. 99
Appendix 4. Ecological and threatening processes identified under legislation and in the literature. 102
Appendix 5. Scoring system for black-cockatoo foraging value. 104
Appendix 6. The foraging quality scoring tool template from DAWE (2022). 114
Appendix 7. Draft DCCEEW Habitat Scoring System. 115
Appendix 8. Expected fauna assemblage of the project area. 119
Appendix 9. Vertebrate species returned from the literature review and database search that have been omitted from the expected species list because they are extinct or considered locally extinct. 132
Appendix 10. Species returned from the literature review that have been omitted from the expected species list because of habitat or range limitations, or because they are domesticated species. 133
Appendix 11. Conservation significant invertebrate fauna species potentially present in the project area. 144
Appendix 12. Fauna observed during field investigations. 146
Appendix 14. Map showing access restrictions. 158

List of Tables

Table 2-1. Databases searched for the desktop review; accessed May 2024. 16
Table 2-2. Sources of information used for general patterns of fauna distribution. 17
Table 2-4. Personnel involved in the field investigations and report preparation. 20
Table 2-5. Ranking system for the assessment of potential nest-trees for black-cockatoos (revised 08/01/2021). 24
Table 2-6. Survey limitations as outlined by EPA (2020). 27
Table 3-1. Composition of expected vertebrate fauna assemblage of the project area. 37
Table 3-2. The number of conservation significant species in each vertebrate class expected to occur within the project area. 40
Table 3-3. Conservation significant fauna species expected to occur within the project area, including TABLE A) CS1 and CS2 species (listed under state or federal legislation) and TABLE B) CS3 species (locally significant). 40
Table 3-4. Summary of potential nest trees within the project area. 59
Table 3-5. Carnaby's Black-Cockatoo foraging scores for each VSA. Note that Site Context and Species Stocking scores have been moderated based on the condition of the vegetation. 65
Table 3-6. Forest Red-tailed Black-Cockatoo foraging scores for each VSA. 69
Table 3-7. DCCEEW foraging quality scoring tool calculations for the project area. 72
Table 3-8. Draft DCCEEW habitat scoring system calculations for the project area. 73

List of Figures

Figure 1-1. Locations of the project area and the study area (used for database searches). 3
Figure 1-2. Location of project area within the Interim Biogeographic Regionalisation for Australia (IBRA) subregions. 4
Figure 1-3. Soil-landscape mapping (DPIRD, 2024c) within 15km of the project area boundary. 7
Figure 1-4. Pre-European vegetation types (DPIRD, 2024b) within 15km of the project area. 8
Figure 1-5. Environmentally Sensitive Areas (DWER, 2023a) and Bush Forever Areas (DPLH, 2019) within 15 km of the project area. 10
Figure 1-6. State-listed Threatened Ecological Communities (DBCA, 2023e) and Important Wetlands (DBCA, 2023b) within 15 km of the project area. 11
Figure 1-7. Estimated existing development within the region. Native vegetation extent is from DPIRD (2024a). 13
Figure 2-1. GPS tracks of BCE personnel during the field investigations. Map 1 of 2. 21
Figure 2-2. GPS tracks of BCE personnel during the field investigations. Map 2 of 2. 22
Figure 3-1. The distribution of VSAs in the northern half of the project area. 35
Figure 3-2. The distribution of VSAs in the southern half of the project area. 36
Figure 3-3. Locations of records of black-cockatoos within 20 km of the project area. Records are from DBCA (2024f). 43
Figure 3-4. Locations of records of expected conservation significant vertebrates within 20 km of the project area. Records are from DBCA (2024f). 44
Figure 3-5. Records of listed conservation invertebrates (does not include potential SRE species) from the DBCA threatened and priority fauna database. 48

Figure 3-6. Locations of potential black-cockatoo nesting trees within the project area. Map 1 of 2. 61
Figure 3-7. Locations of potential black-cockatoo nesting trees within the project area. Map 2 of 2. 62
Figure 3-8. Known black-cockatoo breeding sites in the region. 63
Figure 3-9. Distribution of Carnaby's Black-Cockatoo foraging scores across the project area. Map 1 of 2. 66
Figure 3-10. Distribution of Carnaby's Black-Cockatoo foraging scores across the project area. Map 2 of 2. 67
Figure 3-11. Distribution of Forest Red-tailed Black-Cockatoo foraging habitat in the project area. Map 1 of 2. 70
Figure 3-12. Distribution of Forest Red-tailed Black-Cockatoo foraging habitat in the project area. Map 2 of 2. 71
Figure 3-13. Known black-cockatoo roost locations within 20 km. 74
Figure 5-1. Lots highlighted in red represent areas that were not surveyed directly, mostly due to lack of landowner permission. The majority were able to be assessed from the boundary to inform VSA mapping and to assess foraging value. Large trees within these areas were not assessed for black-cockatoo hollows. 158

List of Plates

Plate 1. VSA 1: Tuart Open Woodland. 30
Plate 2. VSA 2: Banksia Woodland (see also cover photo). 31
Plate 3. VSA 3: Banksia Thicket. 31
Plate 4. VSA 4: Jarrah Woodland. 32
Plate 5. VSA 5: Melaleuca Heath and Scrub. 32
Plate 6. VSA 6: Redheart Woodland. 33
Plate 7. VSA 7: Cleared/Disturbed Land. 33

List of Appendices

Appendix 1. Explanation of fauna values. 94
Appendix 2. Categories used in the assessment of conservation status. 98
Appendix 3. Explanation of threatening processes. 99
Appendix 4. Ecological and threatening processes identified under legislation and in the literature. 102
Appendix 5. Scoring system for black-cockatoo foraging value. 104
Appendix 6. The foraging quality scoring tool template from DAWE (2022). 114
Appendix 7. Draft DCCEEW Habitat Scoring System. 115
Appendix 8. Expected fauna assemblage of the project area. 119
Appendix 9. Vertebrate species returned from the literature review and database search that have been omitted from the expected species list because they are extinct or considered locally extinct. 132
Appendix 10. Species returned from the literature review that have been omitted from the expected species list because of habitat or range limitations, or because they are domesticated species. 133

Appendix 11. Conservation significant invertebrate fauna species potentially present in the project area. 144
Appendix 12. Fauna observed during field investigations. 146
Appendix 14. Map showing access restrictions. 158

1 Introduction

Bamford Consulting Ecologists (BCE) was commissioned by Carabooda Landowners Pty Ltd. to conduct a black-cockatoo habitat assessment and Basic fauna assessment to support environmental planning associated with proposed urban development across a suite of properties in Carabooda, collectively referred to as the project area. The current report describes the methods and results for these assessments. The project area is located c. 40 km north of Perth.

1.1 Background information

A Basic fauna assessment relies on information on the fauna assemblage and its environment, and BCE uses an approach with the following components:

- The identification of **fauna values:**
  - Assemblage characteristics: uniqueness, completeness and richness;
  - Species of conservation significance;
  - Recognition of ecotypes or vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
  - Patterns of biodiversity across the landscape; and
  - Ecological processes upon which the fauna depend.

1.2 Black-cockatoos

The targeted black-cockatoo habitat assessment involves assessing foraging, breeding and roosting habitat for black-cockatoos, based on methodology developed by BCE and guided by federal guidelines.
The project area is within the range of two threatened black-cockatoos:

- **Carnaby's Black-Cockatoo** (*Zanda latirostris*), listed as Endangered under the EPBC Act and Schedule 2 Division 2 (Endangered) under the BC Act.
- **Forest Red-tailed Black-Cockatoo** (*Calyptorhynchus banksii naso*), listed as Vulnerable under the EPBC Act and Schedule 2 Division 3 (Vulnerable) of the BC Act.

The project area is outside the present distribution of Baudin's Black-Cockatoo (DCCEEW, 2024e), but this species has been included as a vagrant due to recent records towards the west of the present distribution. The black-cockatoo habitat assessment involves assessing the project area for foraging habitat, roosting habitat, and potential nesting trees (details provided in Section 2.4.2 below).

1.3 Scope

The objectives of the current assessment and report are as follows:

1. Conduct a literature review and searches of Commonwealth and State fauna databases to compile a comprehensive list of fauna expected to occur in the project area;
2. Review the list of fauna expected to occur in the project area in the light of fauna habitats present, with a focus on investigating the likelihood of significant species being present, including a targeted black-cockatoo assessment;
3. Identify significant or fragile fauna habitats within the project area;

4. Identify significant habitat for black-cockatoos within and surrounding the project area;
5. Identify general patterns of biodiversity within or adjacent to the project area; and
6. Identify any ecological processes in the project area upon which fauna may depend.

Descriptions and more background information on fauna values and ecological processes can be found in Appendices 1 to 4.

1.4 Description of project area and background environmental information

1.4.1 Overview

The project area is located in the northern half of Western Australia's Swan region (DBCA, 2024c), approximately 40 km north of Perth (Figure 1-1). The project area is approximately 960 ha in size and consists of remnant native vegetation and areas cleared for limestone quarries and residential purposes (Figure 1-1). The surrounding area is comprised of native vegetation (often isolated and fragmented), cleared land associated with agriculture or mining (quarries) and residential development.

A range of terms is used through this report to refer to the spatial environment including and around the project area; these are defined below and illustrated in Figure 1-1:

- Project area – the current project area consists of 42 parcels of land, the boundaries of which were indicated by the client. This is the area to which the results of the desktop assessment are directed and the area within which field investigations were conducted.
- Study area – the outermost boundary of the desktop assessment area that is almost always a specified buffer distance (see Section 2.3.1 below) around the *project area*. The study area thus encompasses the *project area* but includes the area from which database records are sourced for the desktop assessment. For the current report, this is a 20 km buffer around the boundary of the project area (see Figure 1-1).

Note that for the purposes of regional context and mapping, a 15 km buffer around the boundary of the project area was used; this is based upon guidance for regional context from the EPA (EPA, 2016c).

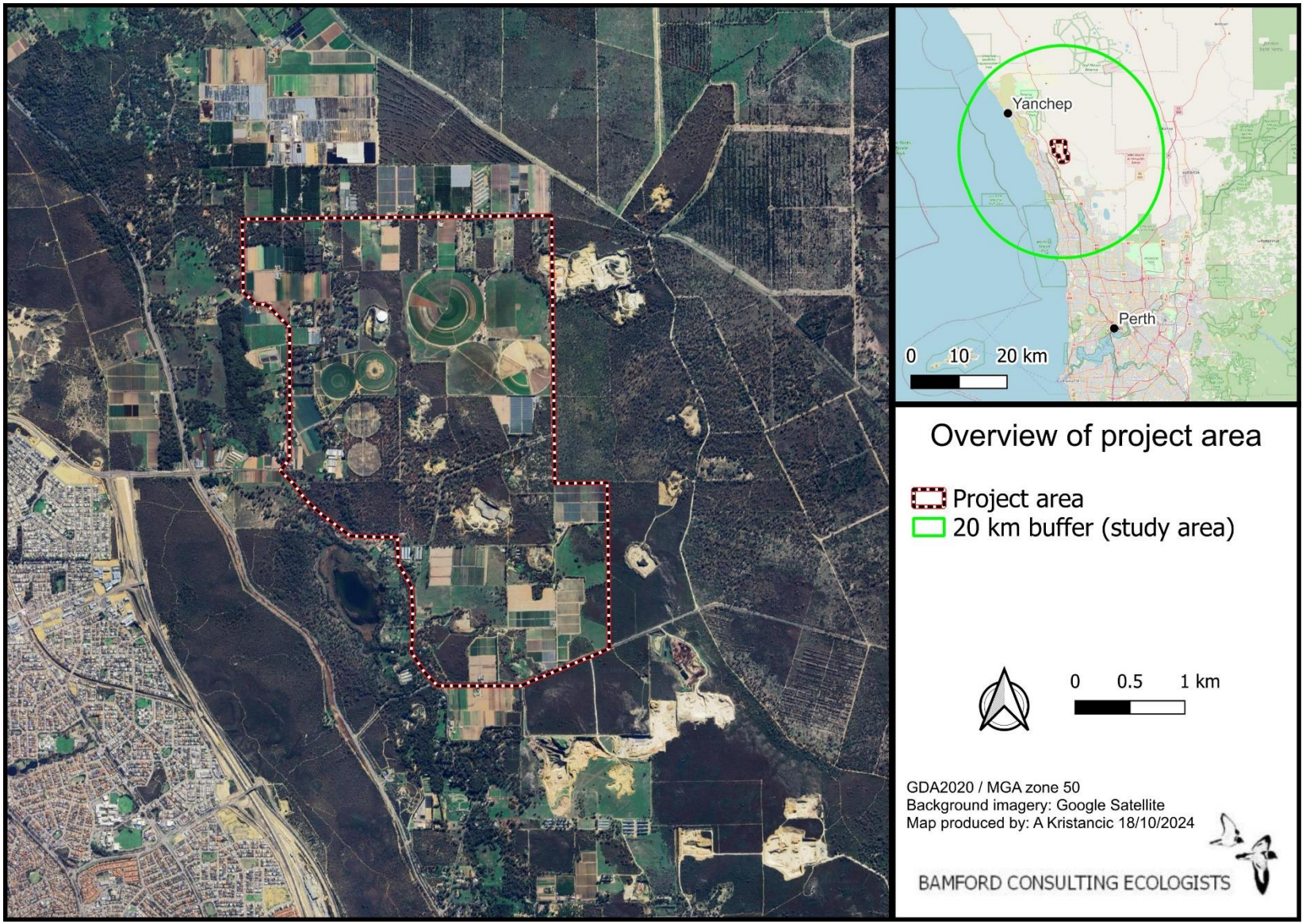


Figure 1-1. Locations of the project area and the study area (used for database searches).

1.4.2 Interim Biogeographic Regionalisation of Australia (IBRA) and landscape characteristics

The project area is in the north-west quadrant of the Swan region (DBCA, 2024e), and within the Perth subregion (SWA02) of the Swan Coastal Plain bioregion (Interim Biogeographic Regionalisation for Australia (DCCEEW, 2023b)). The most recent version, IBRA v7 (DCCEEW, 2023b), recognises 27 bioregions within Western Australia, which are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway & Cresswell, 1995). The Swan Coastal Plain bioregion is a low lying coastal plain, with woodlands the predominant vegetation type, and dominant species comprising *Banskia* or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas (Mitchell et al., 2003). The Swan Coastal Plain bioregion falls into the Southern Climatic Region (EPA, 2020) and the climate of the Perth subregion is Mediterranean (Mitchell et al., 2003). Average rainfall for the station closest to the project area is 608 mm (Station: Tamala Park (Mindarie), Number 009264, BOM, 2023).

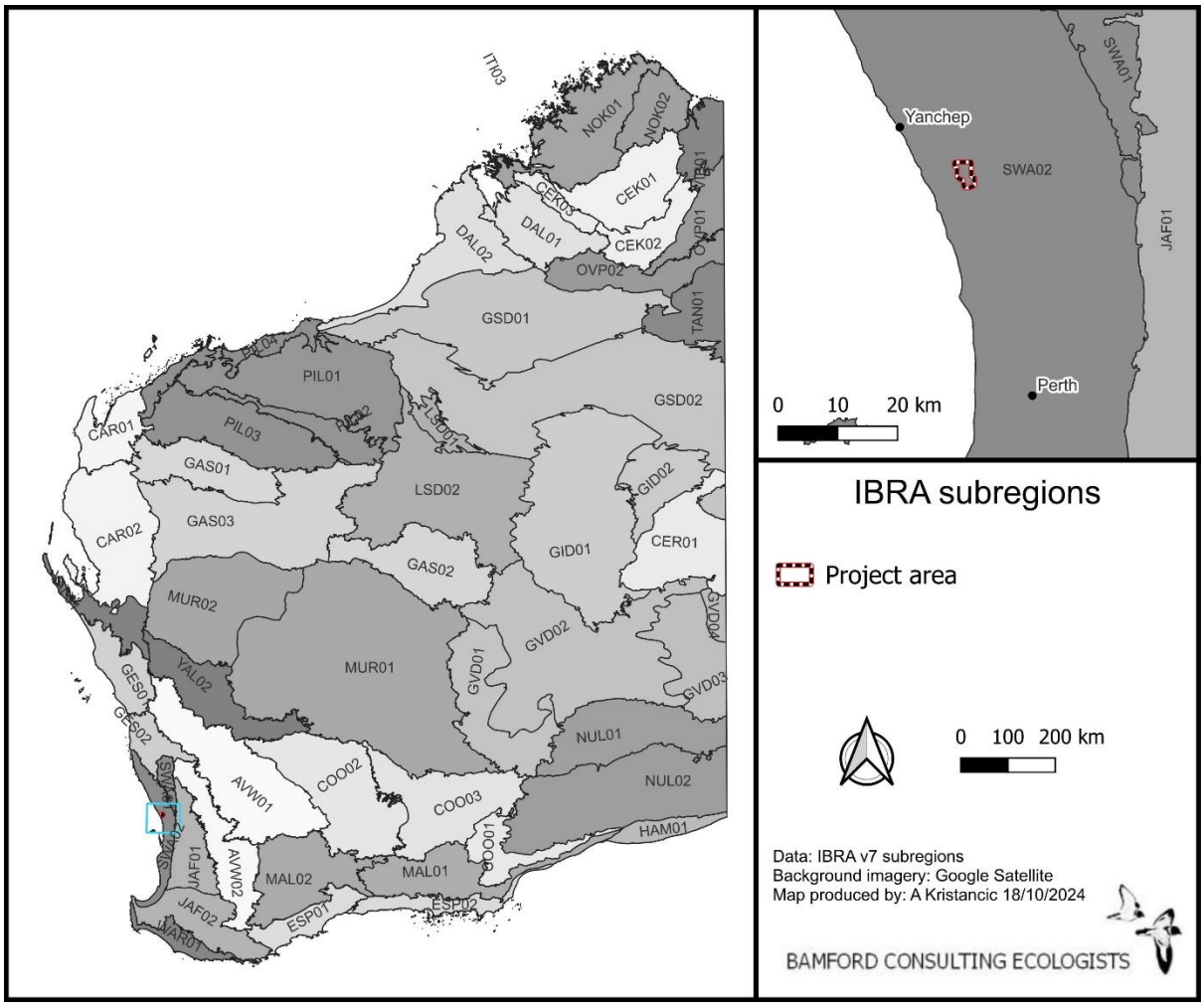


Figure 1-2. Location of project area within the Interim Biogeographic Regionalisation for Australia (IBRA) subregions.

1.4.3 Pre-European Vegetation and Soil-Landscape Mapping

Mapping of a project area in relation to broad scale datasets can provide useful context regarding the current and historical landscape of the project area and surrounds. A dataset of soil-landscape mapping across Western Australia is provided by DPIRD (2024c). Beard *et al.* (2013) have described and mapped the original vegetation presumed to have existed across Western Australia prior to European settlement and this dataset is provided by DPIRD (2024b). The project area in relation to these datasets is shown in Figure 1-3 and Figure 1-4.

The landscape within 15 km of the project area is made up of a complex mosaic of 26 phases within two zones (Perth Coastal Zone and Bassendean Zone). The project area overlaps with four of these, all of which are part of the Perth Coastal Zone (descriptions from DPIRD, 2024c):

- **Karrakatta Sand Grey phase:** Low hilly to gently undulating terrain. Iron podzols. *Banksia* spp woodland with *E. todtiana* and depauperate *E. marginata*; dense shrub layer.
- **Karakatta Sand Yellow phase:** Low hilly to gently undulating terrain. Yellow sand over limestone at 1-2 m. *Banksia* spp. woodland with scattered emergent *E. gomphocephala* and *E. marginata* and a dense shrub layer.
- **Karakatta shallow soils phase:** Low hills and ridges. Bare limestone or shallow siliceous or calcareous sand over limestone. Dense low shrub dominated by *Dryandra sessilis*, *Melaleuca huegellii* and species of *Grevillea.*
- **Spearwood Sand phase:** Irregular banks of karst depressions. Some limestone outcrop. Shallow brown sands. *Banksia* spp. woodland with emergent *E. gomphocephala* and *E. marginata*; dense shrub layer.

Within 15 km of the project area, there are six Pre-European vegetation types, dune sand, and freshwater lakes (DPIRD, 2024b). The project area overlaps with three vegetation types:

- **Vegetation type 3.** Woodland*:* Jarrah, Marri, Wandoo, Tuart, and/or Flooded Gum. Tuart occurs on calcareous Karrakatta sands such as those which occur in the project area (Beard et al., 2013).
- **Vegetation type 9.** Low woodland or open low woodland: *Acacia* spp., *Banksia* spp., *Agonis flexuosa*, *Callitris* spp., *Allocasuarina* spp., and/or *Eucalyptus loxophleba*. In the Swan Coastal Plain bioregion, these woodlands are made up primarily of *Banksia attenuata, B. menziesii and B. prionotes* over a shrub understorey (Beard et al., 2013).
- **Vegetation type 33.** Sedgeland.

This dataset can sometimes be very broad, and given the high levels of clearing and disturbance in the project area and surrounds, it is unlikely that the pre-European vegetation types mapping reflects the reality of what currently exists in the project area. Based on mapping prepared by DBCA (DBCA, 2023a), which combines several vegetation datasets into a more contemporary dataset, the project area contains several patches of vegetation that are considered likely to represent feeding habitat for Carnaby's Black-Cockatoo. These include areas of the following:

- Open Low Heath to Shrubland of *Dryandra sessilis var. cygnorum*, *Melaleuca huegelii*, *Melaleuca systena*, *Xanthorrhoea preissii* with Scrubland of *Hakea trifurcata*, *Calothamnus quadrifidus*, *Acacia lasiocarpa* and combinations of these.

- *Banksia attenuata* and *B. menziesii* dominated Low Open Forest with *Allocasuarina fraseriana* and *B. grandis* and scattered *Eucalyptus marginata* and *E. gomphocephala*
- Open Forest to Woodland of *Eucalyptus gomphocephala*, *E. marginata* and *E. calophylla* and combinations of these over *Banksia attenuata*, *Banksia menziessii* and *Allocasuarina fraseriana* Low Woodland.

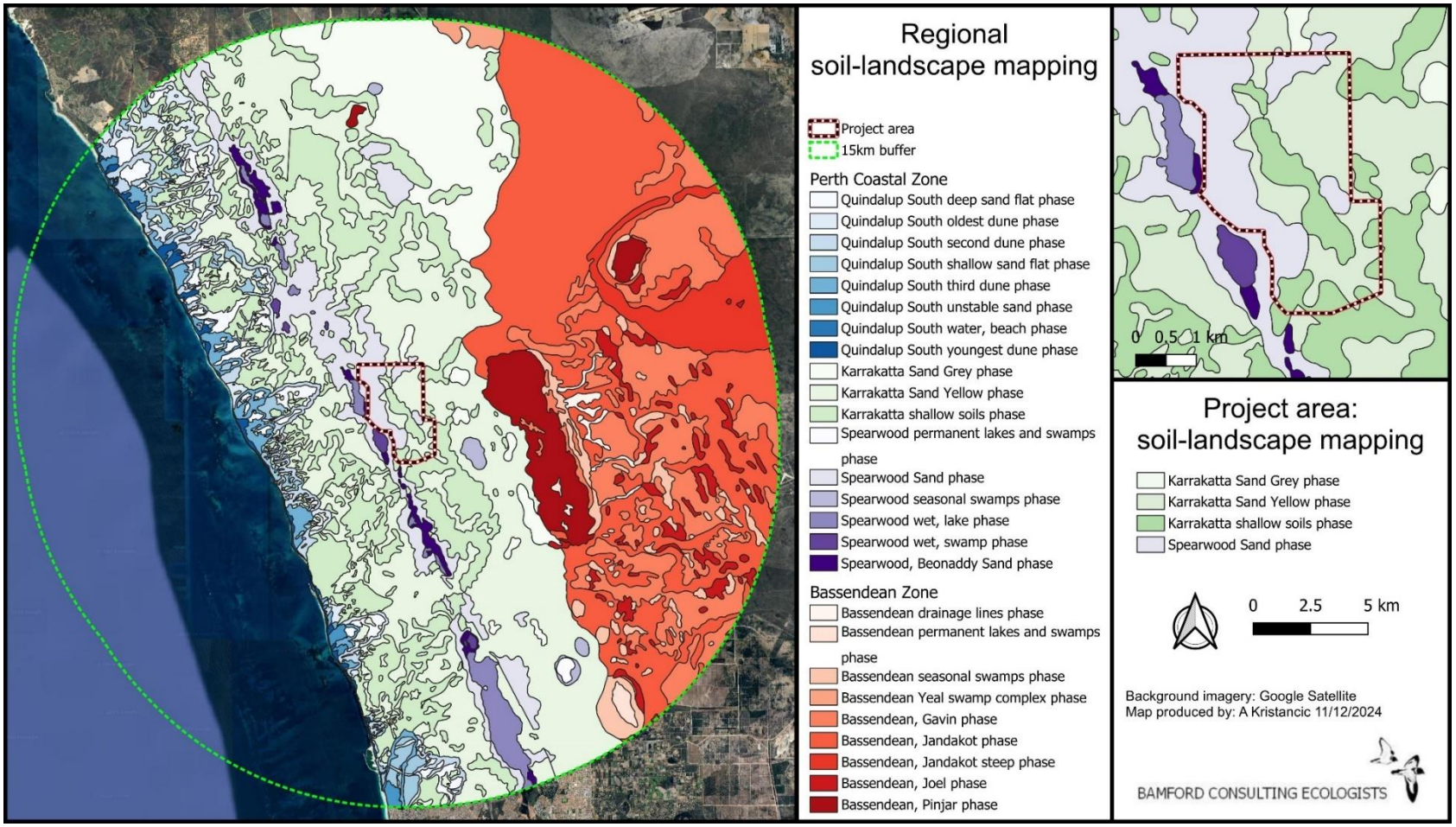


Figure 1-3. Soil-landscape mapping (DPIRD, 2024c) within 15km of the project area boundary.

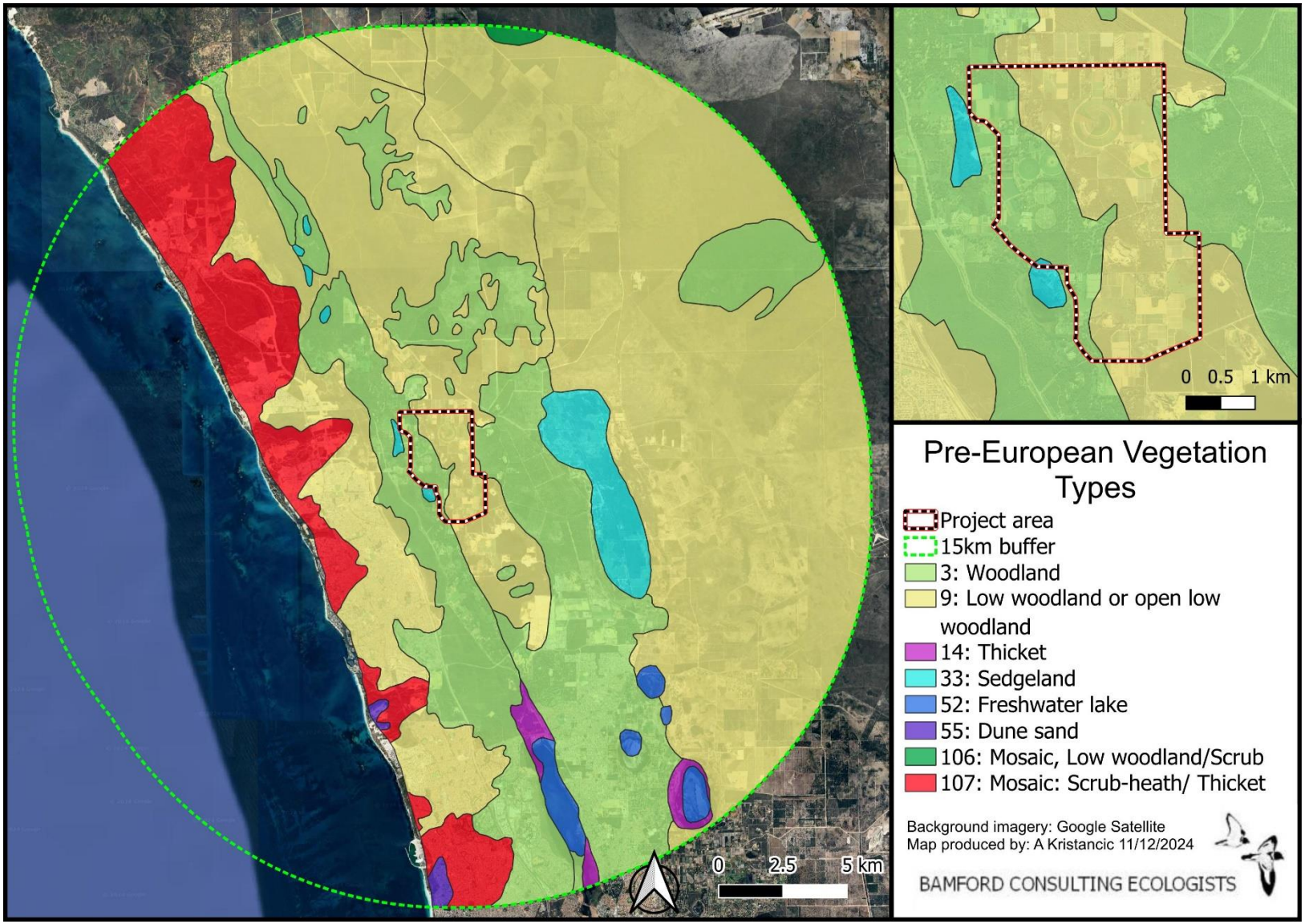


Figure 1-4. Pre-European vegetation types (DPIRD, 2024b) within 15km of the project area.

1.4.4 Land use and tenure

The dominant land uses within the Perth (SWA02) subregion are Cultivation (both dry land agriculture, and irrigated horticulture, agriculture and plantations), Conservation, UCL and Crown reserves, Urban, Rural residential, Forestry plantations, Roads and other easements and Grazing (improved pastures), with smaller areas of Mining and Defence lands (Mitchell *et al*., 2003). The project area itself consists of 42 parcels of privately owned land, some of which are subject to current or historical extractive industry.

1.4.5 Recognised sensitive sites

A number of recognised sensitive sites occur within 15 km of the project area, including state-listed Threatened and Priority Ecological Communities (TECs and PECs) (DBCA, 2023d, 2023e), Bush Forever areas (Dell & Banyard, 2000; DPLH, 2019), Important Wetlands (DBCA, 2023b) and Environmentally Sensitive Areas (ESAs) (DWER, 2023b, 2023a), some of which are also protected terrestrial reserves. Maps showing the project are in relation to these sensitive sites are provided in Figure 1-5 and Figure 1-6. There are nine protected terrestrial reserves (and one marine reserve) within 15 km of the project area (DCCEEW, 2022, 2023e). The project area lies within the Northern Swan Coastal Plain Key Biodiversity Area, which extends north from the Swan River to Gingin in the east and Guilderton in the west (KBA, 2023). This KBA is of importance for Carnaby's Black-Cockatoo as well as several other bird species (KBA, 2023). Based on the output from the Protected Matters Search Tool (DCCEEW, 2023e), along with a flora and vegetation assessment for parts of the project area (PGV Environmental, 2023), the project area overlaps with the following federally-listed Threatened Ecological Communities:

- Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological community
- Banksia Woodlands of the Swan Coastal Plain ecological community
- Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion

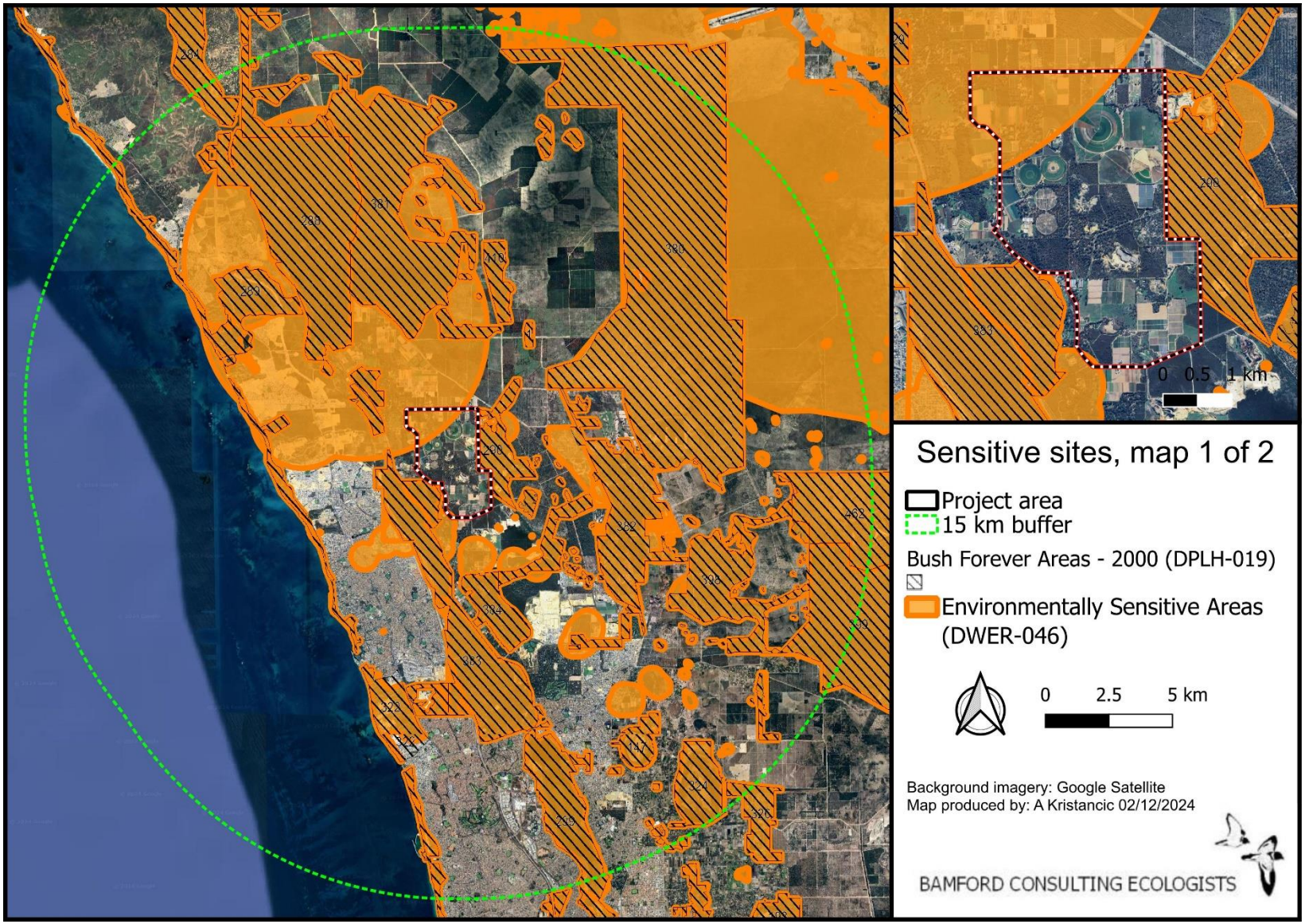


Figure 1-5. Environmentally Sensitive Areas (DWER, 2023a) and Bush Forever Areas (DPLH, 2019) within 15 km of the project area.

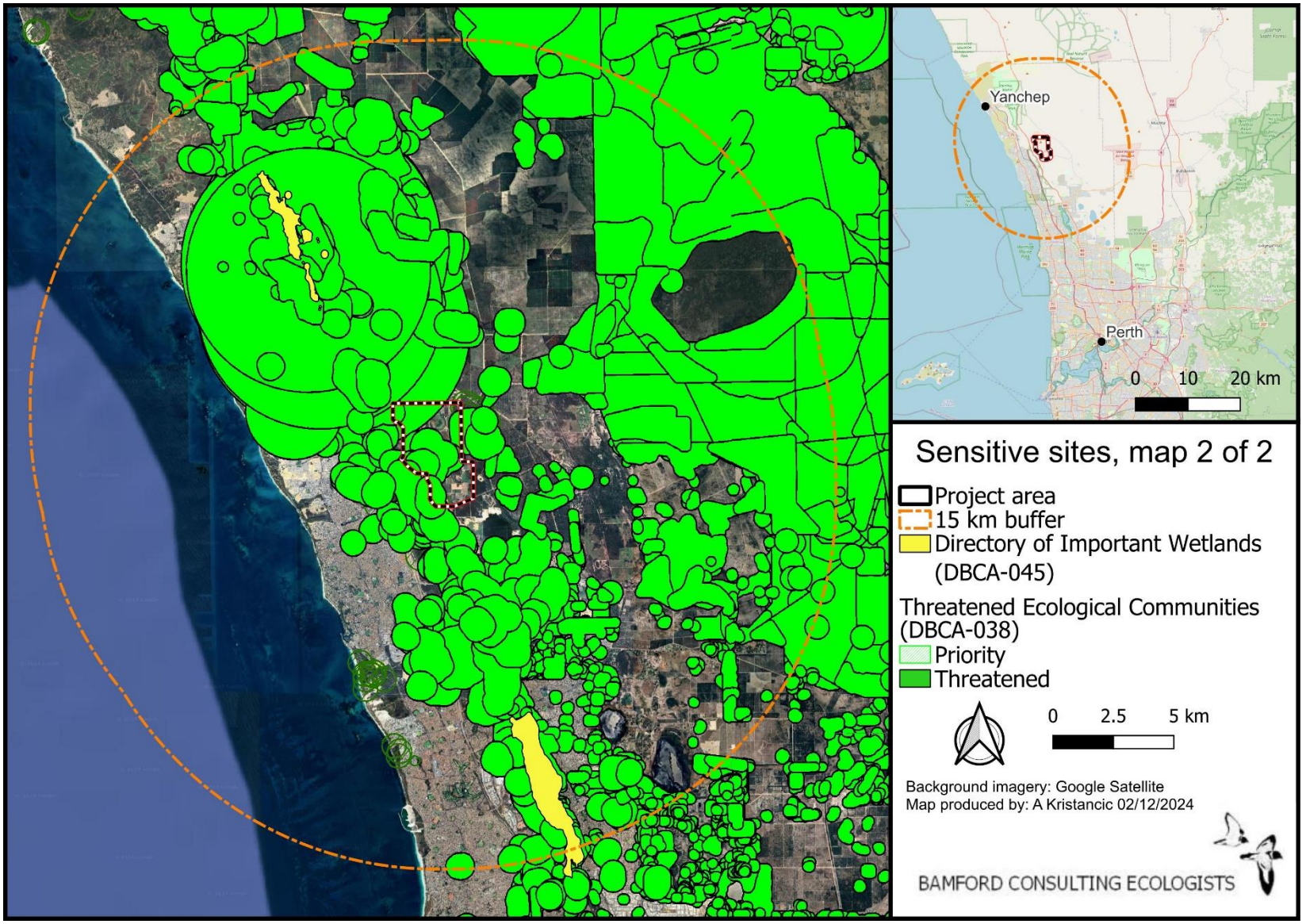


Figure 1-6. State-listed Threatened Ecological Communities (DBCA, 2023e) and Important Wetlands (DBCA, 2023b) within 15 km of the project area.

1.4.6 Regional development and extent of native vegetation

Existing development within 15 km of the boundary of the project area consists of cleared land for agriculture and residential use, a network of sealed and unsealed roads and extensive areas of pine plantations to the north. These pine plantations near Yanchep are known to be an important foraging area for Carnaby's Black-Cockatoo (DPaW, 2013). Figure 1-7 illustrates the existing extent of land clearing and development in a 15 km buffer around the project area. The land area within this buffer is c. 68,984 ha. Of this, c. 33,991 ha of native vegetation remains (DPIRD, 2024a); therefore existing land clearing or development (c. 34, 993 ha) impacts c. 51% of the total land area within 15 km. The native vegetation within the project area (as mapped by PGV Environmental, 2023) is c. 334 ha, which comprises 1% of the remaining vegetation within the 15 km buffer. It should be noted that some of the area mapped as cleared land by PGV is parkland-cleared and thus retains some value for fauna. This is discussed further in Section 3.1 (Vegetation and Substrate Associations).

The calculations above are based on the Native Vegetation Extent dataset provided by DPIRD (2024a) which gives a broad indication of vegetation remaining in the project area and surrounding landscape. To provide more detail concerning areas that provide habitats for fauna, BCE describes and provides maps of vegetation and substrate associations (VSAs) observed during site inspections, and the current report also includes a targeted assessment of black-cockatoo foraging, nesting and roosting habitats. These aspects are described in more detail in the relevant sections below.

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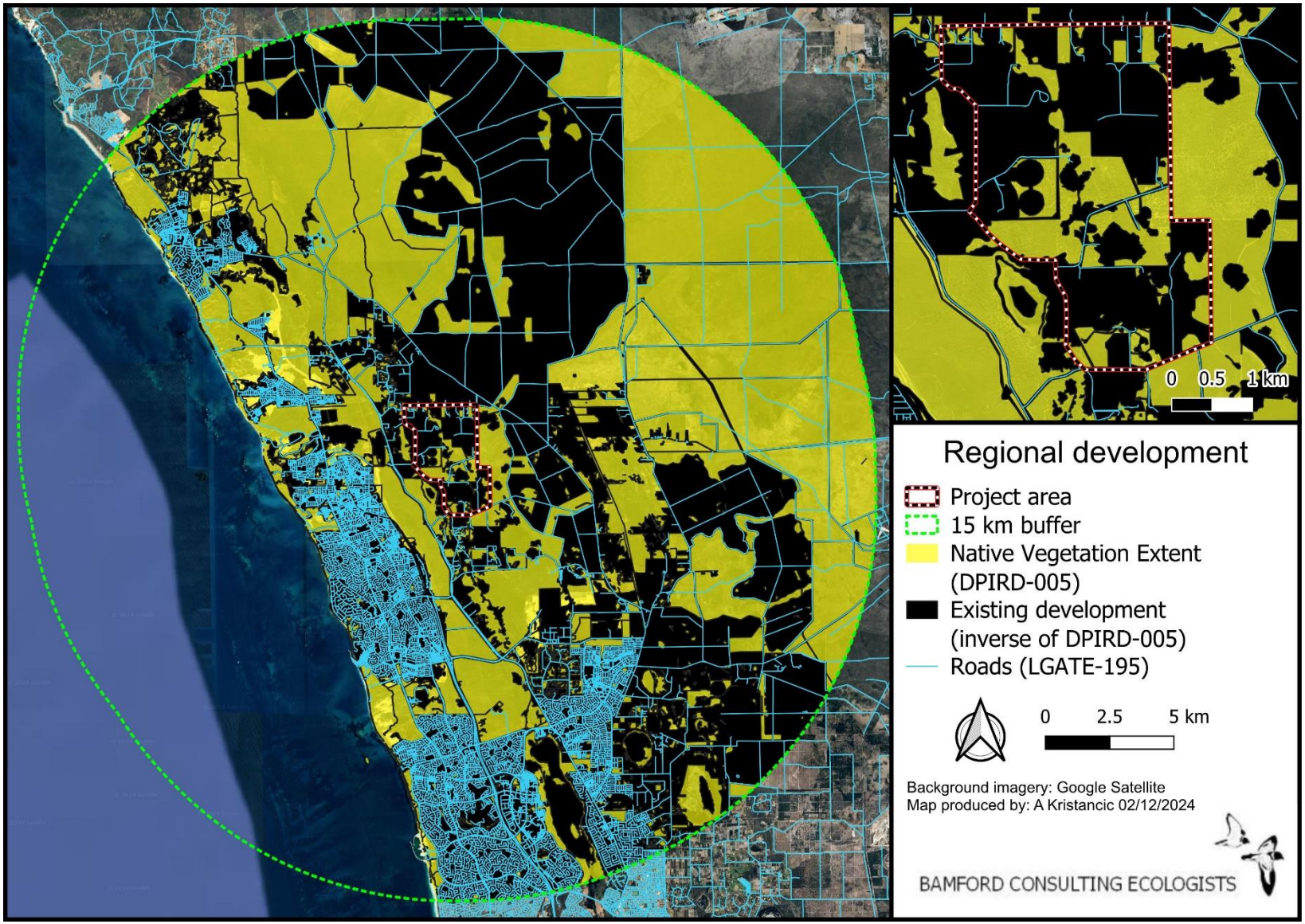


Figure 1-7. Estimated existing development within the region. Native vegetation extent is from DPIRD (2024a).

2 Methods

2.1 Overview

The BCE approach to fauna assessment has been developed with reference to guidelines and recommendations set out by the Western Australian Environmental Protection Authority (EPA) on fauna surveys and environmental protection (EPA, 2002, 2016a, 2016b, 2020), and Commonwealth biodiversity legislation (DotE, 2013; DSEWPaC, 2013). The EPA (2020) recommends three levels of investigation that differ in their approach for field investigations:

- Basic – a low-intensity survey, conducted at the local scale to gather broad fauna and habitat information (formerly referred to as 'Level 1'). The primary objectives are to verify the overall adequacy of the desktop study, and to map and describe habitats. A basic survey can also be used to identify future survey site locations and determine site logistics and access. The results from the basic survey are used to determine whether a detailed and/or targeted survey is required. During a basic survey, opportunistic fauna observations should be made and low-intensity sampling can be used to gather data on the general faunal assemblages present. While referred to as 'basic', this level of survey is involved and powerful, and should be considered the primary level of assessment. Other levels of assessment (where deemed necessary) add information to inform this primary level.
- Detailed – a detailed survey to gather quantitative data on species, assemblages and habitats in an area (formerly referred to as 'Level 2'). A detailed survey requires comprehensive survey design and should include at least two survey phases appropriate to the biogeographic region (bioregion). Surveys should be undertaken during the seasons of maximum activity of the relevant fauna and techniques should be selected to maximise the likelihood that the survey will detect most of the species that occur, and to provide data to enable some community analyses to be carried out.
- Targeted – to gather information on significant fauna and/or habitats, or to collect data where a desktop study or field survey has identified knowledge gaps. Because impacts must be placed into context, targeted surveys are not necessarily confined to potential impact areas. A targeted survey usually requires one or more site visits to detect and record significant fauna and habitats. For areas with multiple significant species there may not be a single time of year suitable to detect all species. In these cases, multiple visits, each targeting different species or groups, should be conducted.

The level of assessment recommended by the EPA (2020) is determined by geographic position, with a generic statement that detailed surveys are expected across all of the state except the south-west, but also recommending that site and project characteristics be considered, such as the survey objectives, existing available data, information required, the scale and nature of the potential impacts of the proposal and the sensitivity of the surrounding environment in which the disturbance is planned. These aspects should be considered in the context of the information acquired by the desktop study. When determining the type of survey required, the EPA (2020) suggested that the following be considered:

- level of existing regional knowledge;
- type and comprehensiveness of recent local surveys;
- degree of existing disturbance or fragmentation at the regional scale;
- extent, distribution and significance of habitats;

- significance of species likely to be present;
- sensitivity of the environment to the proposed activities; and
- scale and nature of impact.

The project area lies in a region where the fauna assemblage is well-documented, and a 'basic' level survey (desktop review, fauna habitat identification and a site inspection) with targeted investigations for relevant significant species is considered an appropriate level of investigation. Guidance for field investigation methods for vertebrate fauna is provided by the EPA (2016c, 2020) and by Bamford *et al.* (2013).

The approach and methods utilised in this report for the Basic assessment are divided into two sections, which differ in their objectives, and are used in combination to summarise the fauna values of the project area:

- **Desktop assessment.** The purpose of the desktop assessment is to produce species lists that can be considered to represent the vertebrate fauna assemblage of the project area, and the conservation significant invertebrate species likely to occur in the project area, based on unpublished and published data and using a precautionary approach.
- **Field investigations.** The purpose of the field investigations is to gather information on the vegetation and substrate associations ('VSAs') that support the fauna assemblage and place the list generated by the desktop assessment into the context of the environment of the project area. The brief field investigations that form part of a Basic assessment also allow for some fauna observations to be made and assist the consultant to develop an understanding of the ecological processes that may be operating in the project area. For the current report, the black-cockatoo habitat assessment also forms part of the field investigations.

2.2 Identification of vegetation and substrate associations (VSAs)

Vegetation and substrate associations (VSAs) combine vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna.

BCE deliberately makes the distinction between 'habitat' (a species-specific term that may encompass the whole or part of one or more VSAs and is the physical subset of an ecosystem that a given species, or species group, utilises) and 'VSA' (a general, discrete and mutually exclusive spatial division of a target area, based on soil, vegetation and topography). It is recognised, however, that, within the broader EIA literature/guidance, the former term is used more or less synonymously to indicate the latter (e.g.' habitat assessment' used by EPA, 2020). Further discussion is provided in Appendix 1.

For the current assessment, VSAs were identified based on observations made during the field investigations combined with vegetation mapping from a previous flora and vegetation assessment (PGV Environmental, 2023).

2.3 Desktop assessment of expected species

2.3.1 Sources of information

As per the recommendations of EPA (2020), information on the fauna assemblage of the project area was drawn from a range of sources including databases (as listed in Table 2-1). Information from these sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns are listed in Table 2-2.

Table 2-1. Databases searched for the desktop review; accessed May 2024.

Database	Type of records held in database	Area searched
BCE Database	Fauna recorded by BCE in the vicinity of the project area; including fauna studies along nearby Wanneroo Road and Mitchell Freeway (Main Roads WA), and fauna monitoring in the Gnangara area (Water Corporation).	Studies within 15km
Atlas of Living Australia (ALA, 2024)	Fauna records from Australian museums and conservation/research bodies.	20 km buffer around project area boundary
NatureMap (DBCA, 2023c) via request to DBCA	Records from the Western Australian Museum (WAM) and Department of Biodiversity, Conservation and Attractions (DBCA) databases, including historical data.	20 km buffer around project area boundary
DBCA Threatened and Priority Fauna (DBCA, 2024f)	Records from the DBCA Threatened and Priority species database, including black-cockatoo nesting/roosting data.	20 km buffer around project area boundary
BirdLife Australia databases (BirdLife Australia, 2023a, 2023b, 2024)	Records from Bird Life Australia, including birdata and black-cockatoo datasets	20 km buffer around project area boundary
EPBC Protected Matters Search Tool (DCCEEW, 2023e)	Records on MNES protected under the EPBC Act.	20 km buffer around project area boundary
Index of Biodiversity Surveys for Assessment (IBSA) (DWER, 2023c)	Flora and fauna data contained in EIA biodiversity survey reports.	20 km buffer around project area boundary

Table 2-2. Sources of information used for general patterns of fauna distribution.

Taxa	Sources
Fish	Morgan *et al.* (1998), Allen *et al.* (2003), Morgan *et al.* (2014), DoF (2023).
Frogs	Tyler and Doughty (2009), Anstis (2017).
Reptiles	Storr *et al*. (1983, 1990, 1999, 2002) , Bush *et al.* (2010), Wilson and Swan (2021).
Birds	Johnstone and Storr (1998, 2005), Menkhorst *et al*. (2017).
Mammals	Van Dyck and Strahan (2008), Churchill (2009), Menkhorst and Knight (2011).

2.3.1.1 Conservation significant invertebrates

A list of potentially occurring conservation significant invertebrates was compiled. This was based on the threatened and priority fauna database for the Swan region (DBCA, 2023f), DBCA threatened species search (DBCA, 2024f), Naturemap CS search (DBCA, 2023c) and PMST output (DCCEEW, 2023e) within a 20 km buffer around the project area. Species from this initial list were omitted if they were clearly out of range and any remaining species possibly within range and potentially occurring in the project area was cross-checked against ALA and Naturemap search results (within 20 km). In addition, selected genera known to contain high numbers of SRE species (e.g. *Antichiropus, Buddelundia)* were cross-checked against ALA and Naturemap invertebrate records.

2.3.2 Previous fauna surveys

The project area is within an area that has been heavily surveyed, with 29 previous fauna surveys within 10 km of the project area in the Index of Biodiversity Surveys for Assessments (IBSA) (DWER, 2023c). The fauna assemblage is therefore well understood and records of conservation significant species from these previous studies will be included in the databases searched for the desktop assessment.

2.3.3 Nomenclature and taxonomy

As per the recommendations of the EPA (2020), the nomenclature and taxonomic order presented in this report are generally based on the Western Australian Museum's (WAM) Checklist of the Fauna of Western Australia 2020. The authorities used for each vertebrate group were: fish (Morgan et al., 2014), frogs (Doughty, 2022a), reptiles (Doughty, 2022b), birds (F. Gill et al., 2023), and mammals (Travouillon, 2022). In some cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place (e.g. the BirdLife Australia working list of names for Australian Birds (BirdLife Australia, 2022), and the International Ornithological Congress' 'World Bird List'). Similarly, the group name 'black-cockatoo' is consistently used for all three taxa in the South-West. English common names of species, where available, are used throughout the text; Latin names are presented with corresponding English names in tables in the appendices. The use of subspecies is limited to situations where there is an

important (and relevant) geographically distinct population, or where the taxonomic distinction has direct relevance to the conservation status or listing of a taxon.

2.3.4 Interpretation of species lists

2.3.4.1 Expected occurrence

Species lists generated from the review of sources of information are generous as they include records drawn from a large region (the study area, see Figure 1-1) and possibly from environments not represented in the project area. Therefore, some species that were returned by one or more of the database searches have been excluded because their ecology, or the environment within the project area, determined that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that might occur as extremely rare vagrants at a terrestrial, inland site, but for which the site is of no importance. For the current assessment, given that there is no suitable habitat in the project area for freshwater fishes, all records of fish from databases were excluded and are not shown in any Appendix.

Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the project area at least occasionally, whether or not they were recorded during field surveys, and whether or not the project area are likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status, the expected occurrence, in the project area. For the current assessment, the species list has been interpreted for both project area combined, as they are of similar environments and the same fauna assemblage is expected at each. The status categories used are:

- **Resident:** species with a population permanently present in the project area.
- **Regular visitor:** species that occur within the project area regularly in at least moderate numbers, such as part of an annual cycle (thus includes migrants).
- **Irregular Visitor:** species that occur within the project area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the project area in at least moderate numbers and for some time.
- **Vagrant:** species that occur within the project area unpredictably, in small numbers and/or for very brief periods. Therefore, the project area is unlikely to be of importance for the species.
- **Locally extinct:** species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the project area.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which the project area is not important in a conservation sense, and species which use the project area in other ways but for which the site is important at least occasionally. This is particularly useful for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive, and further recognises that even the most detailed field survey can fail to record species which will be present at times. The status categories are assigned conservatively based on the precautionary principle. For example, a lizard known from the general area is assumed to be a resident unless there is very good evidence the project area will not support it, and even then, it may be classed as a vagrant rather than assumed to be absent if the

site might support dispersing individuals. It must be stressed that these status categories are predictions only and that often very intensive sampling would be required to confirm a species' status. It should be noted that the aim of the desktop assessment and field investigations is not to confirm the presence or absence of species in the project area. By using a precautionary approach, the expected species assemblage represents a conservative estimate of the species assemblage that may use the project area, with errors of inclusion rather than exclusion.

The results of the database searches were reviewed and interpreted, and obvious errors and out of date taxonomic names were deleted and/or amended.

2.3.4.2 Conservation significance

All expected species were assessed for conservation significance as detailed in Appendix 1. Three broad levels of conservation significance are used in this report:

- Conservation Significance 1 (CS1) – species listed under State or Commonwealth Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Biodiversity Conservation Act 2016* (BC Act);
- Conservation Significance 2 (CS2) – species listed as Priority by DBCA but not listed under State or Commonwealth Acts; and
- Conservation Significance 3 (CS3) – species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution. In suburban landscapes, a large proportion of what might otherwise be considered common species are of local significance as they are reliant on the very small areas of remnant native vegetation remaining (Dell & Banyard, 2000).

See Appendix 1 for an expanded discussion of these categories and Appendix 2 for a description of the categories used in the legislation (EPBC and BC Acts) and by the DBCA.

2.4 Field investigations

2.4.1 Overview

Field investigations were conducted across multiple site visits between 3rd May and 17th October 2024. Personnel involved in field investigations and/or report preparation are listed in Table 2-3 along with their qualifications and experience. Personnel walked transects through areas that potentially contained large trees or scattered foraging habitat. Habitat was assessed for foraging, breeding and/or roosting value as described in the relevant sections below. Areas that consisted of dense and relatively homogeneous vegetation that did not contain large trees were assessed without traversing them on foot. GPS tracks of personnel are shown in Figure 2-1 and Figure 2-2.

Table 2-3. Personnel involved in the field investigations and report preparation.

Personnel	EIA/Wildlife Survey Experience	Field Investigations	Report Preparation
Dr Mike Bamford *BSc (Biology), Hons (Biology), PhD (Biology)*	40 years	+	+
Dr Barry Shepherd *BSc Hons (Env. Biol.), PhD (Ecology)*	30 years	+	+
Nathan Ducker *B. Ed.*	5 years	+	
Sam Lostrom *BSc. (Zoology/Marine Biology), Hons. (Zoology)*	9 years	+	
Dr Amanda Kristancic *BSc (Zoology/Biochemistry), Hons (Zoology), PhD (Parasitology)*	8 years	+	+

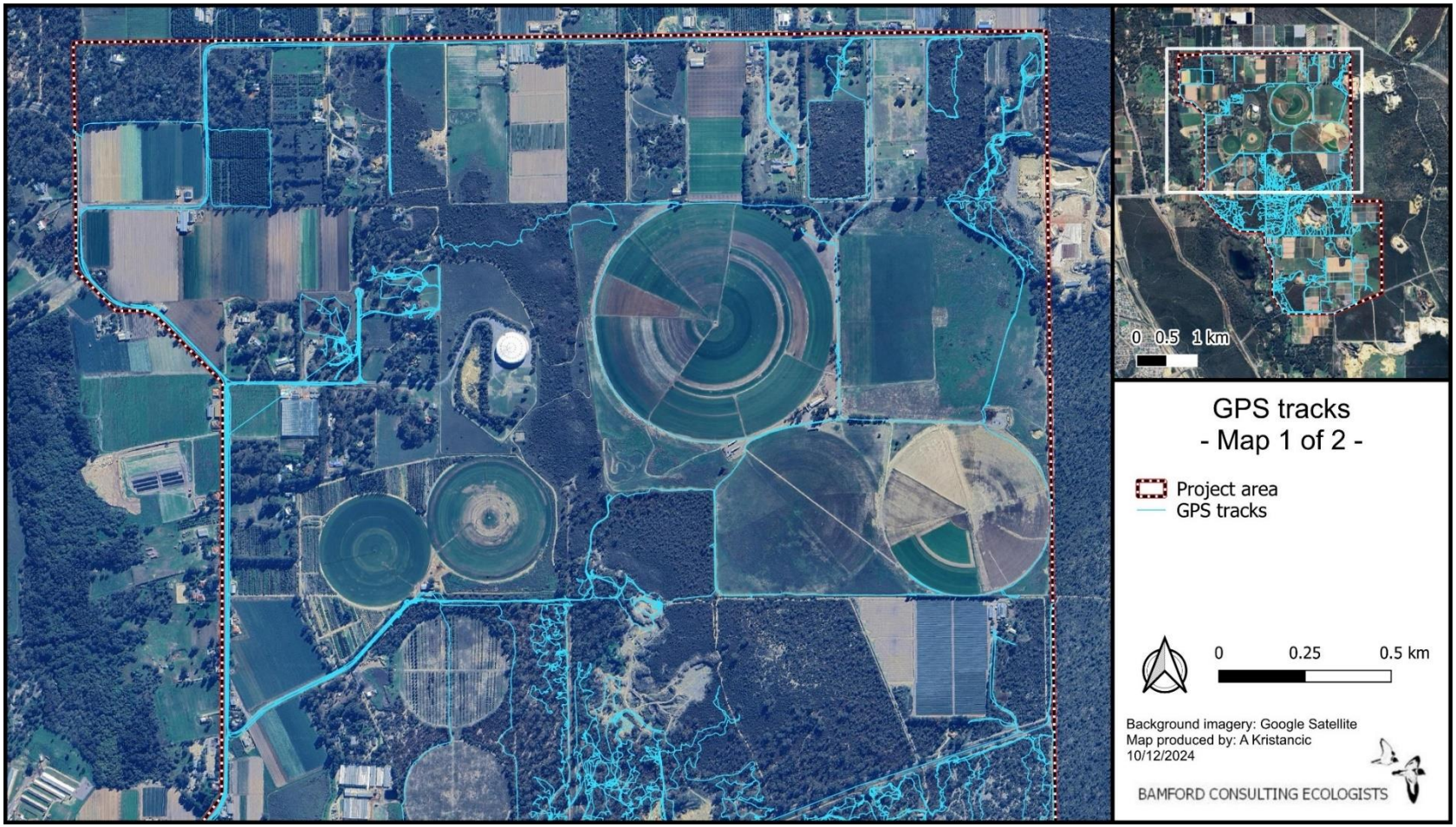


Figure 2-1. GPS tracks of BCE personnel during the field investigations. Map 1 of 2.

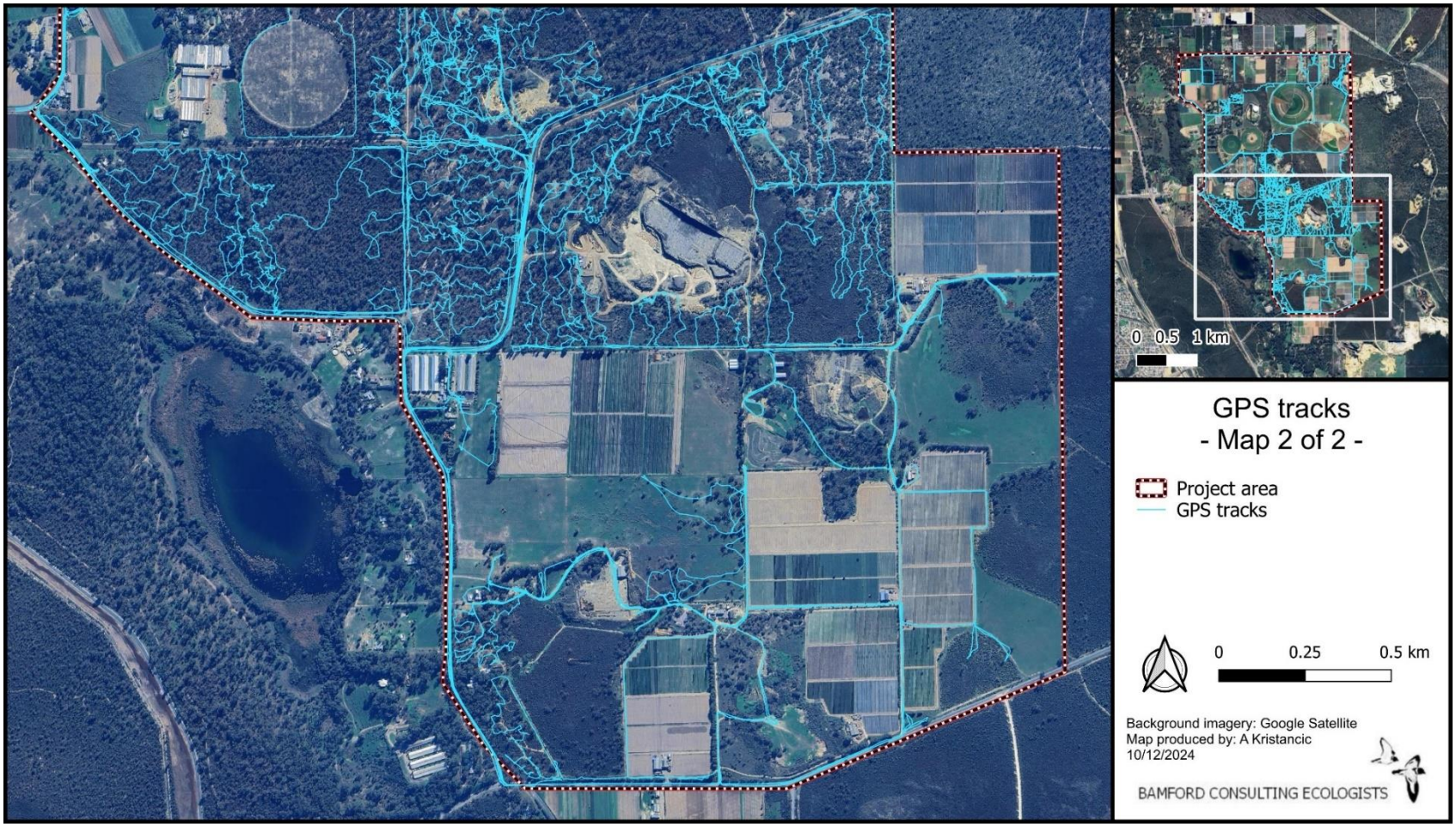


Figure 2-2. GPS tracks of BCE personnel during the field investigations. Map 2 of 2.

2.4.2 Black-cockatoo habitat analysis

2.4.2.1 Guidelines

The Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) provides guidelines for the referral of actions that may result in impact to black-cockatoos (for assessment under the EPBC Act). The survey and analysis reported here have been conducted with strong reference to both the existing guidelines (DAWE, 2022) as well as the previous guidelines (DEE, 2017a). In addition, survey methodology followed the recommendations listed on the DCCEEW's Species Profile and Threats Database (DCCEEW, 2024a, 2024e, 2024f). Ecological values for black-cockatoos within the site were based on the definitions of breeding, foraging and roosting habitat as per the EPBC Act referral guidelines for black-cockatoos (DAWE, 2022).

The DBCA has also indicated that the methodology developed and applied previously by BCE (e.g. Bancroft & Bamford, 2021), and as described below, is an acceptable approach to score nesting value and foraging habitat. In addition, survey methods were discussed with and approved by DWER EPA Services prior to commencement of field investigations.

2.4.2.2 Breeding

The aim of the breeding assessment was to record all potential hollow-bearing trees (suitable for black-cockatoo nesting) within the project area. The following information was recorded for every suitable tree[1] with a diameter at breast height (DBH) equal to or greater than 500 mm (or 300 mm for Wandoo/Salmon Gum):

- tree location;
- tree species;
- life status;
- DBH; and
- nest-tree rank: trees were assessed (initially from the ground) for the potential presence/quality of nest-hollows and allocated a nesting rank (developed by BCE) as described in Table 2-4. Hollows in trees assigned Rank 3 or better were examined with a pole camera to further investigate the presence and quality of nesting chambers, and the nesting rank was amended if required.

The DBCA database of black-cockatoo breeding sites (DBCA, 2024a) was also searched for relevant local records (see also Peck, 2019).

[1] the draft revised EPBC Act study guidelines (DEE, 2017b) stress that <u>any</u> tree species may provide suitable hollows.

Table 2-4. Ranking system for the assessment of potential nest-trees for black-cockatoos (revised 06/06/2024).

As per DCCEEW (2024f, 2024a, 2024e) guidance, a potential nest-tree is any tree with a diameter at breast height >500 mm (or >300 mm for *Eucalyptus accedens, E. salmonophloia* and *E. wandoo*). While this basic criterion is important, smaller trees could contain suitable hollows so should be checked, and trees that meet the criterion but branch close to the ground may not meet the criterion. Note that black-cockatoos favour vertical hollows for the nest chamber, but the hollow entrance may be vertical (a chimney hollow), have a side entrance or have a horizontal spout entrance. The tree may be dead or alive.

Rank	Description of tree and hollows/activity
1	Activity at hollow observed; adult (or immature) bird seen entering or emerging from hollow. Can also be used for a known nest tree active in the previous 12 months (although this should be noted in the description). Note that activity at a hollow does not absolutely mean that breeding is occurring unless a young bird in hollow is observed.
2	Hollow of suitable size visible with chew marks around entrance. Record if chew-marks are recent or old. The entrance needs to be at least 110mm in diameter.
3	Potentially suitable hollow visible but no chew marks present at entrance; or potentially suitable hollow suspected to be present - as suggested by structure of tree, such as large, vertical trunk broken off at a height of >8m; but note that hollow height is contextual. Carnaby's Black-Cockatoo will nest in hollows <5m so in a Wheatbelt breeding site a lower criterion may be more appropriate. If a rank 3 tree is especially good, make an extra note.
4	Tree with large hollows or broken branches that might contain large hollows, but hollows or potential hollows (nest chamber) are not vertical or near-vertical; thus a tree with or likely to have hollows of sufficient size but not to have hollows of the angle preferred by Black-Cockatoos. Trees with low but otherwise suitable hollows can also be assigned a rank of 4, depending on the species of black-cockatoo likely to be present.
5	Tree lacking large hollows or broken branches that might have large hollows; a tree with more or less intact branches and a spreading crown.

2.4.2.3 Foraging

The foraging value of the project area was assessed by calculating a foraging score for areas of similar vegetation type/condition, based on observations made during the field investigations. BCE uses the concept of Vegetation and Substrate Associations (VSAs) to describe these areas of similar vegetation type/condition. VSAs combine vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna.

The foraging score provides a numerical value (the Habitat Quality Score – HQS) that reflects the significance of vegetation as foraging habitat for black-cockatoos, and this numerical value is designed to provide the sort of information needed by the federal DCCEEW, the state Department of Water and Environmental Regulation (DWER) and the WA Environmental Protection Authority (EPA) to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area, and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has

three components as detailed in Appendix 5. These three components are drawn from the DCCEW offset calculator (DCCEEW, undated) but with the scoring approach developed by BCE:

- A score out of six for the vegetation composition, condition and structure.
- A score out of three for the context of the site.
- A score out of one for species density.

Foraging value can thus be assigned a score out of six, based upon site vegetation characteristics, or a score out of 10 (the HQS) if context and species density are also considered. A higher score represents better foraging value.

Black-cockatoo foraging signs were also recorded opportunistically as part of the general site inspection. When observed, the location, tree species and approximate age of the foraging evidence were recorded. Black-cockatoo foraging evidence may persist for some months or years after the foraging event. There is currently no published evidence documenting the deterioration process of forage. Factors that help to establish the time since foraging include: the colour of nuts/foliage, the degree of weathering or decay of debris, the presence of small fragments of nut debris, the position/compression of the foraging debris relative to surrounding vegetation and leaf litter, and the strength of the eucalypt smell emitted. Despite the absence of empirical data, four categories of foraging activity were recognised, based on the time since foraging:

(i) Active – where birds were observed in the act of foraging;

(ii) Recent – foraging signs (e.g. chewed nuts or vegetation) were 'fresh' (i.e. foraging was likely to have occurred within days to weeks). Recent foraging signs were typically green and/or with very little sign of weathering. Approximately less than four weeks old;

(iii) Intermediate – foraging was likely to have occurred within weeks to months previously. Approximately one to six months old; and

(iv) Old – foraging was likely to have occurred months to years previously. Approximately more than six months old.

2.4.2.4 Night roosting

As per the guidance of DAWE (2022), areas likely to be used as night roosting sites were noted based on the topographical, physical and vegetation characteristics present (such as sites adjacent to watercourses with large trees) and/or indirect evidence of roosting (e.g. guano deposits, discarded feathers).

The BirdLife Australia Great Cocky Count (GCC) database of roost sites (last updated in 2024) was searched for relevant local records (see Peck et al., 2019).

2.5 Survey limitations

The EPA Guidance Statement 56 (2004) and the EPA (2020) outline a number of limitations that may arise during field investigations for Environmental Impact Assessment. These survey limitations are discussed in the context of the BCE investigation of the project area in Table 2-5.

The lack of detailed survey (i.e. intensive sampling of the fauna assemblage) is not considered a limitation as this assemblage is well-understood in the area from previous field investigations in similar

landscapes (EPA, 2020). Furthermore, EPA guidance does not consider limitations related to the effectiveness of field sampling for fauna but appears to make an assumption that the purpose of such sampling is to confirm the fauna assemblage. This is implicit in the EPA (2020) technical guidance that does provide suggestions for sampling techniques, but the level of field investigations suggested cannot confirm the presence of an entire assemblage, or confirm the absence of a species. This requires far more work than is possible (or recommended) for studies contributing to the EIA process because fauna assemblages vary seasonally and annually, and often have high levels of variation even over short distances (Beta diversity). For example, in an intensive trapping study, How and Dell (1990) recorded in any one year only about 70% of the vertebrate species found over three years. In a study spanning over two decades, Bamford *et al.* (2010) found that the vertebrate assemblage varies over time and space, meaning that even complete sampling at a set of sites only defines the assemblage of those sites at the time of sampling. In that study, it took 24 to 26 years of annual sampling for species richness of small, terrestrial vertebrates to asymptote (M. Bamford unpubl. analysis). The limited effectiveness of short periods of fauna sampling is not a limitation for assessing the fauna values of a project area *per se*, as long as database information is interpreted effectively and field investigations are targeted appropriately. That is the approach taken by BCE.

Table 2-5. Survey limitations as outlined by EPA (2020).

EPA Survey Limitations	BCE Comment
Availability of data and information	Sufficient information from databases (see Section 2.3.1). Not a limitation.
Competency/experience of the survey team, including experience in the bioregion surveyed	The ecologists have had extensive experience in conducting desktop reviews, Basic level field investigation and site inspections and targeted black-cockatoo habitat assessments, and have undertaken a number of studies within the region. Not a limitation.
Scope of the survey (e.g. were faunal groups excluded from the survey)	The survey focused on terrestrial vertebrate fauna and fauna values. Some information on threatened invertebrates was available from databases. Not a limitation.
Timing, weather and season	Timing is not of great importance in this region for the type of field investigations covered in this report. Not a limitation.
Disturbance that may have affected results	None. Not a limitation.
The proportion of fauna identified, recorded or collected	All fauna observed were identified. Not a limitation.
Adequacy of the survey intensity and proportion of survey achieved (e.g. the extent to which the area was surveyed)	Fauna database searches covered a 20 km radius around the project area and were interpreted based on the environments present in the project area. The Basic level assessment and targeted black-cockatoo assessment were completed. Not a limitation.
Access problems	There were several areas where access was restricted due to lack of landowner permission (see Appendix 13). In addition, vegetation mapping was not available for Red Lot 20 (258 Gibbs Road, Nowergup) and this area has therefore been omitted from VSA and foraging maps and calculations. These were small areas so were not a limitation for the overall assessment.
Problems with data and analysis, including sampling biases	There were no data problems. Not a limitation.

3 Fauna values

This section presents the results of the desktop and field investigations in terms of key fauna values (described in detail in Appendix 1) and includes:

- Recognition of ecotypes or vegetation/substrate associations (VSAs);
- Assemblage characteristics (uniqueness, completeness and richness);
- Targeted black-cockatoo habitat assessment results;
- Information on species of conservation significance;
- Patterns of biodiversity across the landscape; and
- Ecological processes affecting fauna.

3.1 Vegetation and substrate associations (VSAs) ['Habitat assessment']

PGV Environmental (2023) provided a detailed assessment of the vegetation within the majority of the project area, including a list of species recorded and mapping of vegetation types across the area. From this and observations made during the field investigations, seven major vegetation and substrate associations (VSAs) were identified in relation to fauna in the project area:

- **VSA 1. Tuart Open Woodland.** Open eucalypt woodland of Tuart and Jarrah. Occasional Grass Trees and thickets of *Acacia pulchella* and *Banksia sessilis*, over mostly Veldt Grass ground cover on orange-brown sands. Heavily disturbed in some areas. This VSA covers approximately 116 ha (12 % of the project area). See Plate 1.
- **VSA 2. Banksia Woodland.** Open woodland dominated by *B. sessilis* and *B. attenuata* with some Dwutta (*Eucalyptus todtiana*), Sheoak (*Allocasuarina fraseriana*), Moodjar (*Nuytsia floribunda*) and/or *Melaleuca* sp. over shrub layer and mostly native ground cover, on yellow-brown sands. Some degraded areas. This VSA covers approximately 59 ha (6 % of the project area). See Plate 2. In Lot 11 Wesco Rd, there is a small area classified as VSA 2 where the *Banksia* trees have been removed, leaving only Dwutta and Moodjar.
- **VSA 3. Banksia Thicket.** Closed shrubland of *Banksia sessilis* with Grass Trees on orange-brown sands and surface limestone. This VSA covers approximately 74 ha (8 % of the project area). See Plate 3. In one small area in the north of the project area, this VSA contains Sheoak (*Allocasuarina fraseriana*) and appears to have been subject to historical disturbance (PGV Environmental, 2023).
- **VSA 4. Jarrah Woodland.** Closed woodland/forest of immature Jarrah, with some areas including Marri as co-dominant, over Balga and Veldt Grass on brown sands. Most of the understorey and ground cover is degraded. This VSA covers approximately 47 ha (5 % of the project area). See Plate 4.
- **VSA 5. Melaleuca Heath and Scrub.** Dense Melaleuca scrub with occasional *Banksia dallanneyi* on orange-brown sands and limestone outcropping. This VSA covers approximately 12 ha (1 % of the project area). See Plate 5.
- **VSA 6. Redheart Woodland**. Occasional Redheart/Limestone Marlock (*Eucalyptus decipiens*) over understorey of *Banksia sessilis* and Balga over brown sands and limestone outcropping. This VSA covers approximately 24 ha (3 % of the project area). See Plate 6.
- **VSA 7. Parkland-Cleared.** Consists of parkland-cleared land where understorey and midstorey are absent but substantial numbers of large trees remain (e.g. gardens along the northern boundary and in the north-eastern portion of the project area). Tree species vary

and may be remnant or planted, but include native eucalypts and important foraging species such as Pine (e.g. along northern boundary). This VSA covers approximately 73 ha (8 %) of the project area. See Plate 7.

- **VSA 8. Cleared/Disturbed Land.** Heavily disturbed or cleared/developed areas, sometimes with isolated trees or patches of planted trees or shrubs. This includes agricultural areas and plantations (e.g. avocado farm, turf farm, fields/paddocks) as well as cleared areas surrounding dwellings and within the quarries. This VSA covers approximately 553 ha (58 %) of the project area. See Plate 8.

The extent of the VSAs in the project area is mapped in Figure 3-1. Representative photos are provided in Plate 1 to Plate 8.



Plate 1. VSA 1: Tuart Open Woodland.



Plate 2. VSA 2: Banksia Woodland.



Plate 3. VSA 3: Banksia Thicket.



Plate 4. VSA 4: Jarrah Woodland.



Plate 5. VSA 5: Melaleuca Heath and Scrub.



Plate 6. VSA 6: Redheart Woodland.



Plate 7. VSA 7: Parkland Cleared. An example of Parkland Cleared land at 348 Gibbs Rd Nowergup.



Plate 8. VSA 8: Cleared/Disturbed Land.

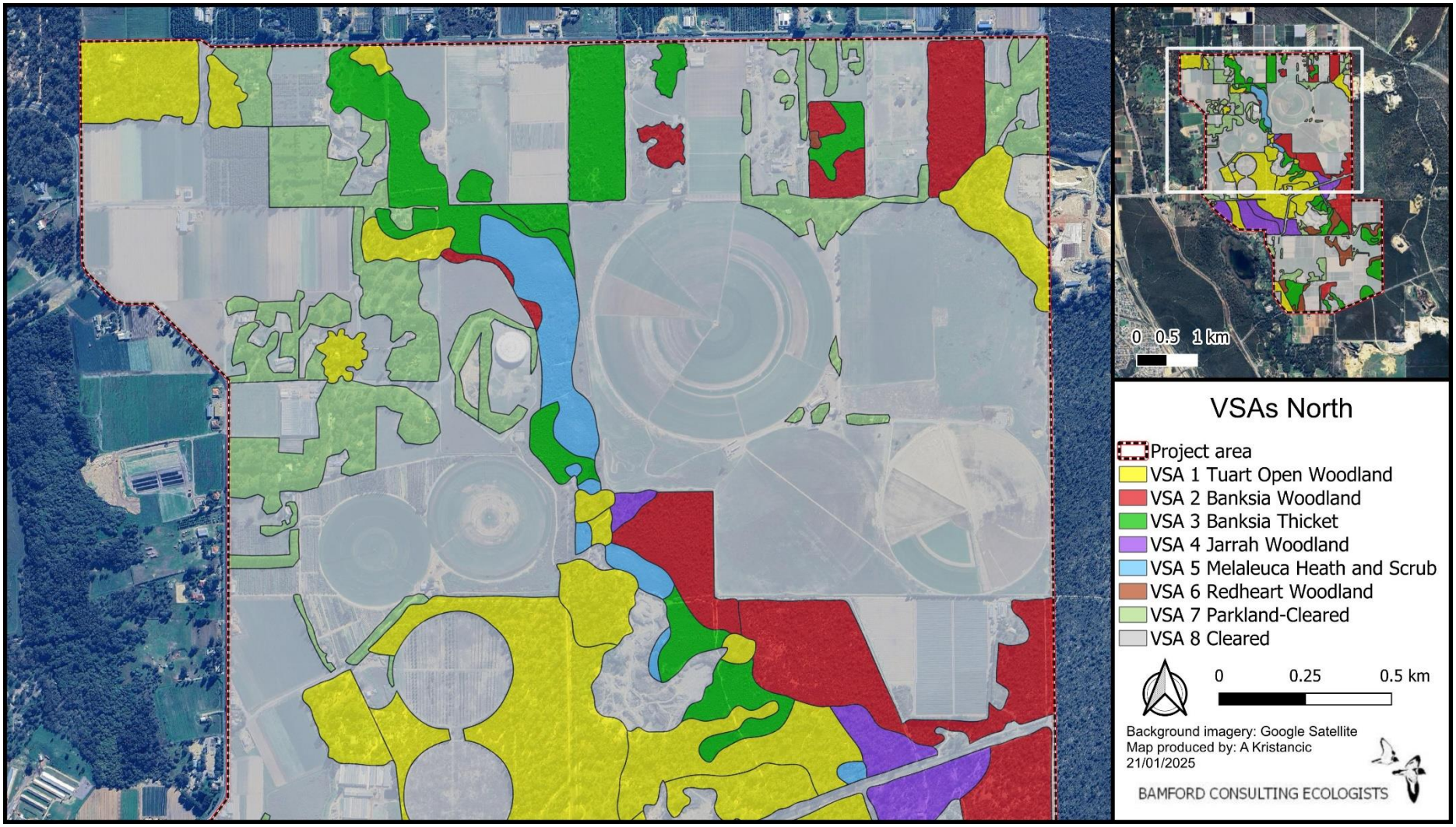


Figure 3-1. The distribution of VSAs in the northern half of the project area.

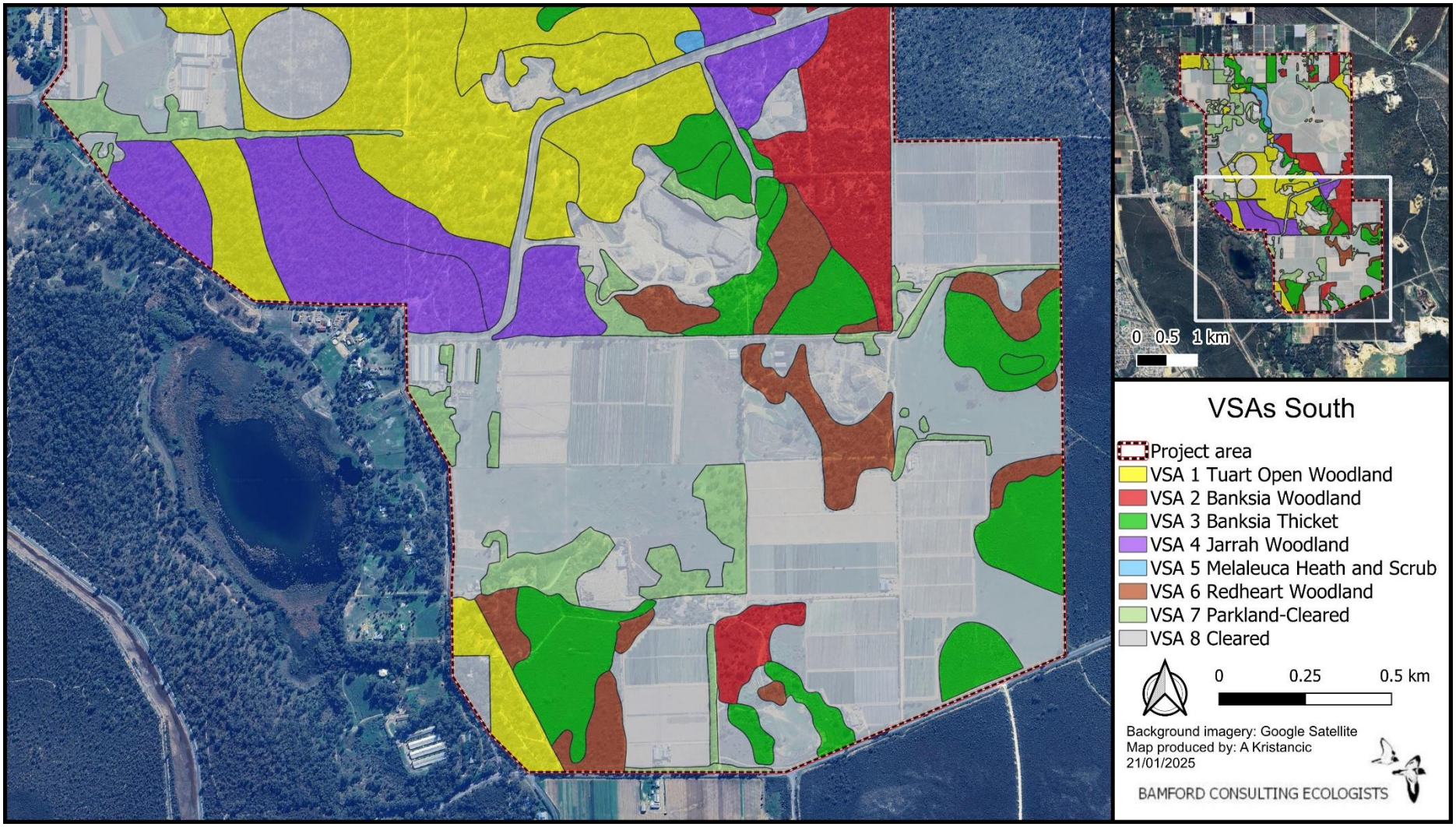


Figure 3-2. The distribution of VSAs in the southern half of the project area.

3.2 Fauna assemblage

3.2.1 Overview of vertebrate fauna assemblage

The desktop assessment identified 222 vertebrate fauna species as potentially occurring in the project area: nine frogs, 52 reptiles, 139 birds, 17 native and 5 introduced mammals. These species are listed in Appendix 8. One reptile, 35 birds and five mammals were recorded during field investigations within the five parcels of land comprising the project area; these are presented in Appendix 12 and **Error! Reference source not found.**, and indicated in Appendix 8. The composition of the expected vertebrate fauna assemblage is summarised in Table 3-1.

Nine vertebrate species that would historically have been present in the project area have been omitted from the expected species list because they are extinct or considered locally extinct; these comprise two birds and seven mammals). These species are listed in Appendix 9.

An additional 219 species were omitted due to habitat or range limitations, or because they are domesticated species. These are listed in Appendix 10. The large number of omitted species reflects differences between the environments of the project area compared with those represented in the study area from which database results were obtained. For example, the database search returned several pelagic birds, as well as marine reptiles and mammals, which are not relevant to the project area. About a third of the omitted species are waterbirds or shorebirds, some of which may use freshwater habitat nearby (e.g. Nowergup Lake), but for which there is no suitable habitat in the project area itself. These species may fly over or very occasionally visit the project area but are considered unlikely to be affected by the proposed development and have therefore been omitted on the basis of no suitable habitat.

Table 3-1. Composition of expected vertebrate fauna assemblage of the project area.

Taxon	Total	Number of species in each status category			
		Resident	Regular visitor	Irregular visitor	Vagrant
Frogs	**9**	9	0	0	0
Reptiles	**52**	51	1	0	0
Birds	**139**	47	42	33	17
Native mammals	**17**	7	5	4	1
Introduced mammals	**5**	5	0	0	0
Total	**222**	**119**	**48**	**37**	**18**

3.2.2 Expected vertebrate fauna

The expected fauna assemblage presented in the expected species list and described here is a conservative estimate of the fauna that may use the sites, taking a precautionary approach.

Frogs

The nine frog species are all expected to be resident to the project area. All frog species are terrestrial species that spend most, or all, of their life-cycle away from wetlands/damplands. One of the frog species, the Turtle Frog, is considered locally significant (CS3). It relies heavily on intact native vegetation to persist in the Perth area (M. Bamford pers. obs,).

Reptiles

The 52 reptile species consist of one tortoise, 36 lizards and 15 snakes. All are expected as residents except for the South-West Long-necked Tortoise (Regular visitor). Three of the expected reptile species are of conservation significance and are discussed in Section 3.2.5: the Jewelled Sandplain Ctenotus (CS2 (P3)), Black-striped Snake (CS2 (P3)) and Western Carpet Python (CS3).

Birds

The expected bird assemblage of 139 species is moderately rich, but only about a third of these (47 species) are expected as residents. The majority (75 species) are expected as visitors to the project area; 42 as regular visitors and 33 as irregular visitors, while 17 species are expected as vagrants. In addition to the 139 bird species expected, two species are considered locally extinct; the Malleefowl and the Barking Owl. Six bird species are introduced; five are expected as residents (Laughing Dove, Spotted Dove, Laughing Kookaburra, Long-billed Corella and Rainbow Lorikeet) and one as a regular visitor (Rock Dove). Introduced species may negatively impact native bird species via predation or competition for food and nesting resources. For example, the introduced Long-billed Corella and Rainbow Lorikeet both compete with black-cockatoos for suitable nesting hollows. Fifty-six bird species are of conservation significance: six CS1, one CS2 and 49 CS3. Eighteen of these (all CS3) are expected as residents, 22 as regular visitors (three CS1 and 19 CS3), eight as irregular visitors (one CS1 and seven CS3) and eight as a vagrants (two CS1, one CS2 and five CS3). Conservation significant birds are discussed in Section 3.2.5.

Mammals

The mammal assemblage is incomplete, with 17 native mammals expected in the project area and seven native mammals extinct or locally extinct. Less than half of the native mammal species are expected as residents (7 species), with the remainder expected as regular visitors (5 species), irregular visitors (4 species) and one expected as a vagrant. Five introduced mammal species are expected in the project area and all are expected as residents (Black Rat, House Mouse, Cat, Rabbit and Red Fox). Additional introduced mammals may be present in the project area but excluded from the expected assemblage as they are domesticated species. Nine mammals in the expected species assemblage are of conservation significance: two CS1, three CS2 and four CS3 species. Conservation significant mammals are discussed in Section 3.2.5.

Summary

The key features of the fauna assemblage expected in the project area are:

- **Uniqueness:** The assemblage is likely to be represented elsewhere within nearby native vegetation, but this assemblage has a restricted distribution in remnant patches of Banksia woodland on the already-fragmented coastal plain.
- **Completeness:** The assemblage is substantially complete for frogs and reptiles, incomplete for birds (with two species locally extinct and the majority of extant species expected only as visitors or vagrants), and incomplete for mammals (with seven species locally extinct and more than half the assemblage expected as visitors or vagrants).
- **Richness:** The assemblage is likely to be relatively rich in a regional context, particularly for reptiles, as it contains areas of relatively intact native vegetation (including Banksia woodland) within an increasingly fragmented landscape.

3.2.3 Locally extinct vertebrate fauna

There are nine vertebrate species that would be expected to be present in the project area if they were not locally extinct or extinct; this includes two birds and seven mammals. The majority of these (eight species) would be considered of conservation significance (five CS1, 1 CS2 and 2 CS3) if they were present. Locally extinct and extinct species are listed in Appendix 9. For the majority of species, the likely causes of extinction/local extinction are habitat loss and introduced predators (e.g. cats and foxes).

3.2.4 Conservation significant fauna

3.2.4.1 Vertebrate fauna of conservation significance

Of the 222 species of vertebrate fauna expected to occur in the project area, sixty-eight are considered to be of conservation significance: eight CS1, six CS2 and fifty-four CS3. A summary of the numbers in each vertebrate class is presented in Table 3-2. These species of conservation significance are indicated in the complete species list (Appendix 8) but are also listed with details of their conservation significance in Table 3-3. The CS1 species include six birds and two mammals, and none is expected as resident; three are expected as regular visitors (Carnaby's Black-Cockatoo, Forest Red-tailed Black-Cockatoo and Peregrine Falcon), two as irregular visitors (Fork-tailed Swift, South-west Brush-tailed Phascogale), and three as vagrants (Glossy Ibis, Baudin's Black-Cockatoo and Chuditch). The CS2 species consist of two reptiles, one bird and three mammals. Three are expected as resident (Jewelled Sandplain Ctenotus, Black-striped Burrowing Snake and Quenda), and one each expected as a regular visitor (Brush Wallaby), irregular visitor (Water-rat) or vagrant (Southern Masked Owl). The CS3 species consist of one reptile, forty-nine birds and four reptiles. More details regarding CS species are given under conservation significant species accounts in Section 3.2.5.

Locations of records of expected CS1 and CS2 vertebrates within 20 km of the project area (from the DBCA threatened and priority fauna database) are illustrated in Figure 3-3 (black-cockatoos) and Figure 3-4 (other birds, reptiles and mammals).

Table 3-2. The number of conservation significant species in each vertebrate class expected to occur within the project area.

See Appendix 1 for full explanation of Conservation Significance (CS) levels: CS1 = listed under WA State and/or Commonwealth legislation; CS2 = listed as Priority by DBCA; CS3 = considered locally significant. * Numbers in parentheses indicate number of extinct/locally extinct species.

		CONSERVATION SIGNIFICANCE		
CLASS	**Total**	**CS1**	**CS2**	**CS3**
Frogs	**0**	0	0	0
Reptiles	**3**	0	2	1
Birds*	**56 *(2)***	6 *(1)*	1 *(1)*	49
Mammals*	**9 *(6)***	2 *(4)*	3	4 *(2)*
Total	**68**	**8**	**6**	**54**

Table 3-3. Conservation significant fauna species expected to occur within the project area, including TABLE A) CS1 and CS2 species (listed under state or federal legislation) and TABLE B) CS3 species (locally significant).

Species are listed in taxonomic order within each table.
CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 1 for full explanation.
CS3 categories following Dell and Banyard (2000): HS = habitat specialists with a reduced distribution on the Swan Coastal Plain, WR = wide-ranging species with reduced populations on the Swan Coastal Plain.
EPBC Act listings: CR = Critically Endangered, EN = Endangered, VU = Vulnerable, MI = Migratory (see Appendix 2).
Biodiversity Conservation Act 2016 listings: S1 to S3 = Schedules 1 to 3, D1 to D3 = Divisions 1 to 3 (see Appendix 2).
DBCA Priority species: P1 to P4 = Priority 1 to 4 (see Appendix 2).

Table A

Latin Name	Common Name	Expected Occurrence	Status
REPTILES			
Ctenotus gemmula	Jewelled Sandplain Ctenotus	Resident	CS2 (P3)
Neelaps calonotos	Black-striped Burrowing Snake	Resident	CS2 (P3)
BIRDS			
Apus pacificus	Fork-tailed Swift	Irregular visitor	CS1 (MI, S1D2)
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo, Karrak	Regular visitor	CS1 (VU, S2D3)
Falco peregrinus	Peregrine Falcon	Regular visitor	CS1 (S1D3)
Plegadis falcinellus	Glossy Ibis	Vagrant	CS1 (MI, S1D2)
Tyto novaehollandiae novaehollandiae	Southern Masked Owl	Vagrant	CS2 (P3)
Zanda baudinii	Baudin's Black-Cockatoo	Vagrant	CS1 (EN, S2D2)
Zanda latirostris	Carnaby's Black-Cockatoo	Regular visitor	CS1 (EN, S2D2)
MAMMALS			
Dasyurus geoffroii	Chuditch	Vagrant	CS1 (VU, S2D3)
Hydromys chrysogaster	Water-rat, Rakali	Irregular visitor	CS2 (P4)
Isoodon fusciventer	Quenda	Resident	CS2 (P4)
Notamacropus irma	Brush Wallaby	Regular visitor	CS2 (P4)
Phascogale tapoatafa wambenger	South-western Brush-tailed Phascogale	Irregular visitor	CS1 (S1D1)

TABLE B

Latin Name	Common Name	Expected Occurrence	Status
REPTILES			
Morelia spilota imbricata	Western Carpet Python	Resident	CS3
BIRDS			
Dromaius novaehollandiae	Emu	Irregular visitor	CS3 (WR)
Aythya australis	Hardhead	Irregular visitor	CS3 (HS)
Phaps chalcoptera	Common Bronzewing	Resident	CS3 (HS)
Phaps elegans	Brush Bronzewing	Resident	CS3 (HS)
Podargus strigoides	Tawny Frogmouth	Resident	CS3
Cacomantis flabelliformis	Fan-tailed Cuckoo	Regular visitor	CS3
Chalcites basalis	Horsfield's Bronze-Cuckoo	Regular visitor	CS3
Chalcites lucidus	Shining Bronze-Cuckoo	Regular visitor	CS3
Heteroscenes pallidus	Pallid Cuckoo	Regular visitor	CS3
Ardeotis australis	Australian Bustard	Vagrant	CS3 (WR)
Nycticorax caledonicus	Nankeen Night-Heron	Regular visitor	CS3 (WR)
Turnix varius	Painted Button-quail	Resident	CS3 (WR)
Accipiter cirrocephalus	Collared Sparrowhawk	Resident	CS3 (WR)
Accipiter fasciatus	Brown Goshawk	Resident	CS3 (WR)
Aquila audax	Wedge-tailed Eagle	Regular visitor	CS3 (WR)
Haliastur sphenurus	Whistling Kite	Regular visitor	CS3 (WR)
Hieraaetus morphnoides	Little Eagle	Regular visitor	CS3 (WR)
Lophoictinia isura	Square-tailed Kite	Regular visitor	CS3 (WR)
Merops ornatus	Rainbow Bee-eater	Regular visitor	CS3
Falco berigora	Brown Falcon	Regular visitor	CS3 (WR)
Platycercus icterotis	Western Rosella	Vagrant	CS3 (WR)
Climacteris rufus	Rufous Treecreeper	Vagrant	CS3 (HS)
Malurus assimilis	Purple-backed Fairy-wren	Resident	CS3 (HS)
Malurus leucopterus	White-winged Fairy-wren	Regular visitor	CS3 (HS)
Malurus splendens	Splendid Fairy-wren	Resident	CS3 (HS)
Stipiturus malachurus	Southern Emu-wren	Regular visitor	CS3 (HS)
Anthochaera lunulata	Western Wattlebird	Resident	CS3 (WR)
Gliciphila melanops	Tawny-crowned Honeyeater	Regular visitor	CS3 (WR)
Manorina flavigula	Yellow-throated Miner	Regular visitor	CS3 (WR)
Melithreptus brevirostris	Brown-headed Honeyeater	Regular visitor	CS3
Melithreptus chloropsis	Gilbert's Honeyeater	Irregular visitor	CS3 (WR)
Phylidonyris niger	White-cheeked Honeyeater	Regular visitor	CS3 (WR)
Phylidonyris novaehollandiae	New Holland Honeyeater	Regular visitor	CS3 (WR)
Acanthiza apicalis	Inland Thornbill	Resident	CS3 (HS)
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	Resident	CS3 (HS)
Acanthiza inornata	Western Thornbill	Resident	CS3 (HS)
Sericornis maculatus	Spotted Scrubwren	Resident	CS3 (HS)
Smicrornis brevirostris	Weebill	Resident	CS3 (HS)
Daphoenositta chrysoptera	Varied Sittella	Resident	CS3 (HS)
Colluricincla harmonica	Grey Shrike-thrush	Resident	CS3 (HS)
Pachycephala occidentalis	Western Whistler	Resident	CS3 (HS)
Artamus cinereus	Black-faced Woodswallow	Regular visitor	CS3 (WR)
Artamus cyanopterus	Dusky Woodswallow	Irregular visitor	CS3 (WR)

Latin Name	Common Name	Expected Occurrence	Status
Strepera versicolor	Grey Currawong	Irregular visitor	CS3 (WR)
Myiagra inquieta	Restless Flycatcher	Vagrant	CS3 (HS)
Eopsaltria griseogularis	Western Yellow Robin	Vagrant	CS3 (HS)
Melanodryas cucullata	Hooded Robin	Irregular visitor	CS3 (HS)
Petroica boodang	Scarlet Robin	Resident	CS3 (HS)
Quoyornis georgianus	White-breasted Robin	Irregular visitor	CS3 (HS)
MAMMALS			
Tachyglossus aculeatus	Short-beaked Echidna	Resident	CS3
Sminthopsis dolichura (Swan Coastal Plain form)		Irregular visitor	CS3
Smithopsis fuliginosa		Irregular visitor	CS3
Tarsipes rostratus	Honey Possum	Regular visitor	CS3

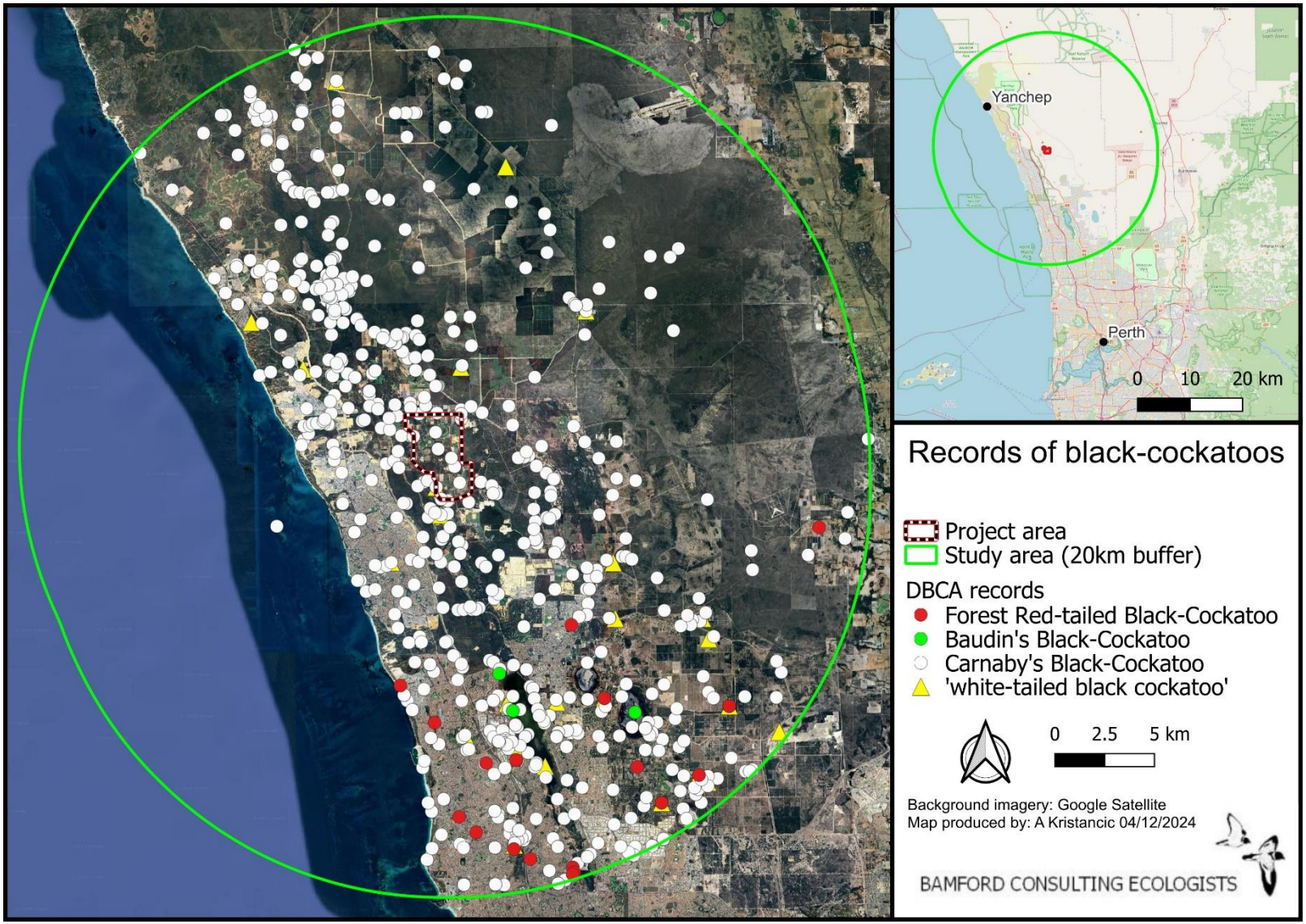


Figure 3-3. Locations of records of black-cockatoos within 20 km of the project area. Records are from DBCA (2024f).

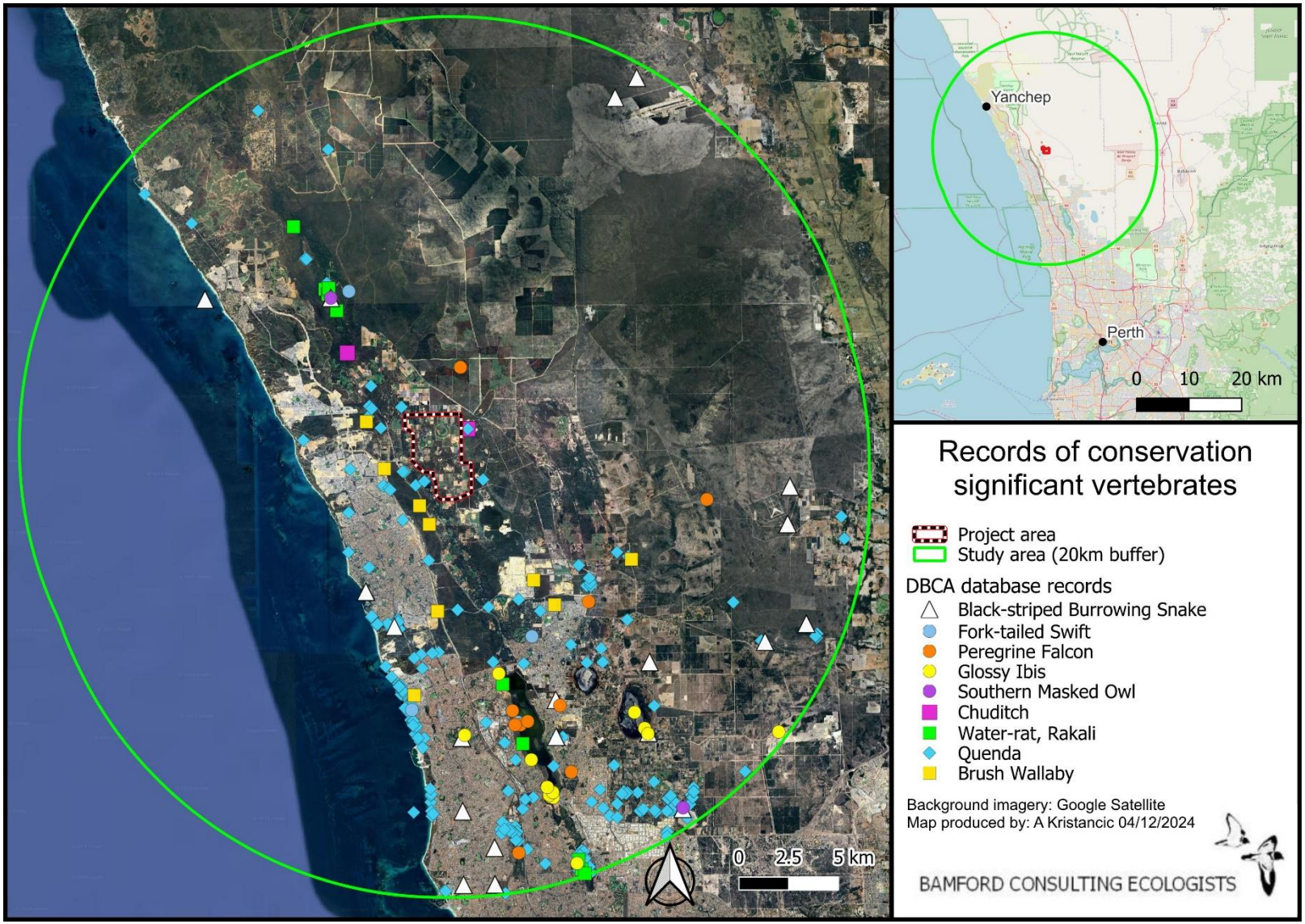


Figure 3-4. Locations of records of expected conservation significant vertebrates within 20 km of the project area. Records are from DBCA (2024f).

3.2.4.2 Invertebrate fauna of conservation significance

Invertebrate fauna of conservation significance includes listed threatened species and short-range endemic (SRE) (or potential SRE) species, although it should be noted that SRE and potential SRE species are often not well-documented. A compiled list of potential conservation significant invertebrates, along with their expected occurrence in the project area, is provided in Appendix 11.

3.2.4.2.1 Listed invertebrates

The DBCA threatened and priority fauna database contains 21 threatened invertebrates for the Swan region; 11 of these were excluded as potentially occurring in the project area due to range limitation or the species having specialised habitat requirements not provided by the project area. Of the remaining 10 species, nine were recorded in database outputs from the 20 km buffer around the project area, and five are expected to occur within the project area. Details are provided below for the 10 species not excluded on the basis of range or habitat limitations:

- *Austroconops mcmillani,* McMillan's Biting Midge (Swan Coastal Plain) – Priority 2
    - **Probably absent**. There is a cluster of records (DBCA database) within 10 km of the project area. This species is known only from small number of populations between Yanchep and Darkan where it appears to be associated with areas of damp soil or open water (Borkent & Craig, 2004). This type of habitat is not present in the project area and this species is therefore not expected to be present.
- *Austrosaga spinifer*, Spiny Katydid (Swan Coastal Plain) – CS2 (P2)
    - **Possibly present.** Records range from Cervantes to Boya (ALA, 2024) and there is one record within 6 km of the project area (DBCA, 2024f). This species is known from 'heath' habitats (Rentz, 1993); therefore suitable habitat may be present in some parts of the project area (such as VSA 3).
- *Glossurocolletes bilobatus*, a short-tongued bee (southwest) – CS2 (P2)
    - **Probably absent.** The nearest record appears to be from the Thornlie area with a specimen collected on the low shrub *Gonpholobium aristatum* (Invertebrate Solutions, 2019).
- *Hesperocolletes douglasi*, Douglas' Broad-headed Bee, Rottnest Bee – CS1 (CR, CR)
    - **Possibly present.** There are two records in the vicinity of the project area: one in the DBCA threatened fauna database and one in the Atlas of Living Australia (these records may be of the same specimen). A single female specimen was collected with a sweep net by Arnold *et al.* (2019) in a Banksia woodland remnant, c. 15km west of Muchea. This is within c. 7 km of the project area, and similar habitat occurs in the project area, in VSA 2. Therefore, this species may be present, although this VSA is degraded and in particular the understorey is in poor condition.
- *Hylaeus globuliferus*, Woollybush Bee – CS2 (P3)
    - **Possibly present.** There are nine DBCA database records of this species within 15 km of the project area. The Woollybush Bee occurs across a fairly broad region of south-western Australia, north to about Eneabba, east to the eastern edge of the wheatbelt and along the southern coast to Fitzgerald National Park near Hopetoun (ALA, 2024). Houston (2018) notes that this species is known to forage on the flowers of Woollybush (*Adenanthos cygnorum*) and Candlestick Banksia (*Banksia attenuata*) the

latter of which was confirmed to be present in the project area. Therefore, it is possible that the project area would support the Woollybush Bee, and it may be present.

- *Idiosoma nigrum*, shield-backed trapdoor spider – CS1 (VU, EN)
    - **Absent (out of range).** Database records of *Idiosoma nigrum* from this area reflect old taxonomy. The nigrum group of *Idiosoma* spiders was split into several distinct species in 2018 (Rix *et al*., 2018); records of *Idiosoma nigrum* from this area would now be classified as *I. sigillatum* (see below).
- *Idiosoma sigillatum*, Swan Coastal Plain shield-backed trapdoor spider – CS2 (P3)
    - **Likely present**. There are 28 DBCA database records of this species within 20 km of the project area. Rix *et al.* (2017) noted that this species has a "relatively widespread although strictly … substrate-specific distribution along the Swan Coastal Plain of south-western Western Australia, from Dalyellup north to at least Ledge Point (including Rottnest Island and Garden Island)". While much of its previous range has been developed (as part of the greater Perth Metropolitan area) it still persists in areas of remnant bushland with "Banksia woodland and heathland on sandy soils". These habitats are present within the project area and, therefore, it is likely that Swan Coastal Plain Shield-backed Trapdoor Spider is present.
- *Leioproctus contrarius*, a short-tongued bee – CS2 (P3)
    - **Limited data – unlikely to be present.** There is only one DBCA database record within 20 km (11 km away), from more than 40 years ago. Moulds (2019) suggested *L. contrarius* prefers areas where the plant species Scaevola repens var. repens and Leschenaultia spp. are present. These species were not noted as being present in the flora and vegetation report for the project area (PGV Environmental, 2023). The occurrence of this species is uncertain but it is considered unlikely to be present based on available information regarding habitat preference.
- Synemon gratiosa, Graceful Sunmoth – CS2 (P4)
    - **Probably present.** A number of records of this species are known from within 15 km of the project area; all are to the south. The moth is known from a series of disjunct subpopulations between Binningup and Kalbarri, a range of 625 km, where it is mainly restricted to coastal and near-coastal sand dunes but extends into Banksia woodlands near Perth (Williams *et al.* 2021). Larvae feed on two host plants*, Lomandra maritima* (on coastal dunes) and *L. hermaphrodita* (in Banksia woodlands), both of which are known from the project area (PGV Environmental, 2023). It is therefore likely that this species is present, most likely in Banksia woodland (VSA 2).

One species was not returned in database outputs (other than the DBCA threatened and priority fauna list for the entire Swan region):

- *Australotomurus morbidus*, Cemetery Springtail, Guildford Springtail – Priority 3
    - **Probably absent.** This species is only known from four locations within remnant bushland in Perth (Greenslade & Jordana, 2014), none of which is within 20 km of the project area.

Locations of listed invertebrates from the DBCA threatened and priority fauna database are shown in Figure 3-5.

3.2.4.2.2 Short range endemic (SRE) invertebrates

SRE invertebrates are significant because they have “naturally small distributions” (Harvey, 2002) and are therefore sensitive to habitat loss and degradation where they do occur. It should be noted that the ecology and distribution of short-range endemic invertebrates is often poorly understood or documented, and databases are unlikely to provide comprehensive information about these species.

The geology of the project area is primarily limestone, and some areas contain karst depressions (DPIRD, 2024c). Karst landscapes are significant for SRE invertebrates such as stygofauna, and therefore the potential exits for undetected SRE invertebrate species to be present. Limestone underlies most if not all of the area, but is closest to the surface and deepest in VSA 1 (Tuart Woodland) and VSA 5 (Heath and Scrub). It also occurs in cleared areas where limestone has been quarried (parts of VSA 7).

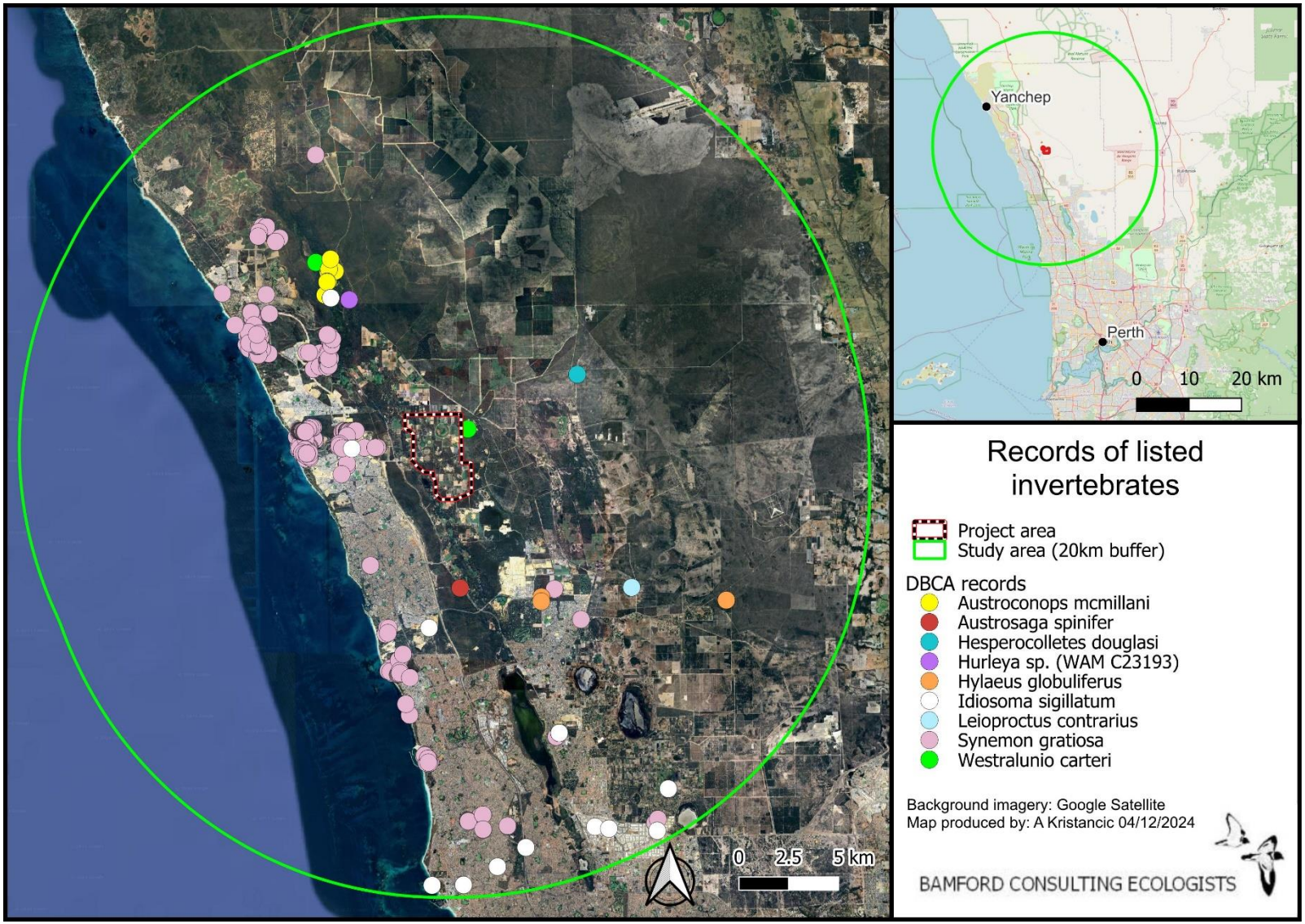


Figure 3-5. Records of listed conservation invertebrates (does not include potential SRE species) from the DBCA threatened and priority fauna database.

3.2.5 Conservation significant species accounts

A list of all conservation significant species expected within the project area is provided in Table 3-3; these comprise three reptiles, 56 birds, and nine mammals (see Section 3.2.4.1). Information on the conservation status, distribution and habitat, salient ecology and expected occurrence within the project area is provided below for all CS1 and CS2 species. A discussion regarding CS3 species is also provided below.

3.2.5.1 Conservation Significance 1

Fork-tailed Swift (*Apus pacificus*) CS1 (M, S1D2)

Conservation status:	Migratory under the EPBC Act and Schedule 1 Division 2 under the BC Act.
Distribution and habitat:	The swift is a largely aerial species of unpredictable occurrence in Western Australia. There are scattered records from the south coast, widespread in coastal and subcoastal areas between Augusta and Carnarvon, scattered along the coast from south-west Pilbara to the north and east Kimberley region. Sparsely scattered inland records, especially in the Wheatbelt, but more common in the north and north-west Gascoyne Region, north through much of the Pilbara Region, and the south and east Kimberley (DCCEEW, 2023a; Higgins, 1999). Aerial, usually flying from as low as one metre to more than 300 m above the ground.
Ecology:	A diurnal, aerial insectivore, this species often forages along the edge of low pressure systems in flocks of ten to 1000 birds (DCCEEW, 2023a; Higgins, 1999). Breeds in Siberia (April to July) and spends the non-breeding season (October to mid-April) in Australia. Being aerial, it is effectively independent of terrestrial ecosystems when in Australia.
Expected occurrence:	**Irregular visitor.** There are six records in the DBCA database within c. 14 km of the project area. This species may occasionally fly over the project area but is unlikely to utilise it in any significant manner.

Glossy Ibis *(Plegadis falcinellus)* CS1 (MI, S1D2)

Conservation status:	Migratory under the EPBC Act and Schedule 1 Division 2 under the BC Act.
Distribution and habitat:	The Glossy Ibis is most abundant on wet grasslands across northern Australia but occasionally appears from the Pilbara and south. There are a few locations in the Perth region where it is seen regularly on damp grasslands, such as at Herdsman Lake.
Ecology:	The Glossy Ibis feeds mainly on invertebrates on the margins of wetlands and on damp grassland.

Expected occurrence: **Irregular visitor.** There are 33 records in the DBCA database within 20 km of the project area. Most are associated with wetlands/lakes in the region. The closest record is c. 2 km from the project area. Suitable habitat is probably limited to agricultural landscapes within VSA 7, such as the turf farm.

Peregrine Falcon (*Falco peregrinus*) CS1 (S1D3)

Conservation status: Schedule 1 Division 3 under the BC Act.

Distribution and habitat: More or less cosmopolitan throughout Australia (Menkhorst *et al.* 2017). This species occurs in a variety of habitats but is usually reliant on cliff faces or tall trees for nesting (Debus, 2019).

Ecology: A highly adept aerial predator that predominantly forages on birds, although will also occasionally take invertebrates, fish, reptiles and mammals (Debus, 2019). Mostly diurnal or crepuscular.

Expected occurrence: **Regular visitor.** The Peregrine Falcon is known from the general region, and there are 16 records in the DBCA database within 20 km of the project area. The project area is probably within the home range of a pair and contains tall trees that would be suitable nesting sites.

Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*) CS1 (V, S2D3)

Conservation status: Vulnerable under the EBPC Act and Schedule 2 Division 3 under the BC Act.

Distribution and habitat: Endemic to the deeper south-west of Western Australia, from around Gingin in the north, east to Mount Helena, North Bannister and Mount Saddleback, and south to around Albany (Johnstone and Storr 1998). In recent years there appears to have been a distinct expansion of the range of this species on to the Swan Coastal Plain, including many suburbs within the Perth metropolitan area. Generally restricted to areas of Jarrah-Marri forest, farmlands with remnant trees and urban landscapes. Forest Red-tailed Black-Cockatoos are currently considered not to undergo regular migration (DCCEEW, 2024b). Two other sub-species occur in Western Australia: *C. b. escondidus* in the western mid-west to the Pilbara, and *C. b. macrorhynchus* in the Kimberley (Johnstone & Storr, 1998). Neither of these is of conservation significance.

Ecology: Diurnal granivore, feeding predominantly on the seeds of Jarrah and Marri (Johnstone *et al*., 2013b; Johnstone & Kirkby, 1999) but is also adapting to foraging on urban (introduced) plant species. Reliant on large tree-hollows in eucalypts (especially Marri) for breeding (DCCEEW, 2024b; Johnstone *et al.*, 2013a). Threatened by habitat loss, habitat degradation, nest hollow shortage, and competition for available nest hollows from other parrots and feral Honeybees (DCCEEW, 2024b).

Expected occurrence: **Regular visitor.** The project area is close to the northern extent of the distribution of this species. There are 17 records in the DBCA database within 20 km of the project area, and all are in the southern half of the study area. The project area contains suitable habitat for roosting and breeding, but is of low foraging value for this species. Further details are provided in Section 3.3.

Baudin's Black-Cockatoo (*Zanda baudinii*) CS1 (EN, S2D2)

Conservation status: Endangered under the EBPC Act and Schedule 2 Division 2 under the BC Act.

Distribution and habitat: Endemic to the south-west of Western Australia, from around Perth to around Albany. In recent years there appears to have been a distinct expansion of the range of this species on to the Swan Coastal Plain, including many suburbs within the Perth metropolitan area. Generally restricted to areas of Jarrah-Marri forest and farmlands with remnant trees or pine plantations.

Ecology: Diurnal. Feeds predominantly on the seeds of Jarrah and Marri, as well as other native and cultivated species (TSSC, 2018). Reliant on large tree-hollows in eucalypts (especially Marri) for breeding (DCCEEW, 2024c; TSSC, 2018). Threatened by habitat loss, habitat degradation, nest hollow shortage, and competition for available nest hollows from other parrots and feral Honeybees (DCCEEW, 2024c; TSSC, 2018).

Expected occurrence: **Vagrant.** The project area is outside of the current distribution of this species (which lies to the east of the project area), but it has been included as a vagrant due to recent reports of this species towards the west of the present distribution. There are four records in the DBCA database within 17 km of the project area; all are from between 2002-2009. The project area supports little suitable foraging habitat and this species is not known to breed on the Swan Coastal Plain. It is therefore not expected to be regularly present but may occasionally occur in the project area.

Carnaby's Black-Cockatoo (*Zanda latirostris*) CS1 (E, S2D2)

Conservation status: Endangered under the EPBC Act and Schedule 2 Division 2 under the BC Act.

Distribution and habitat: Endemic to south-western Western Australia, from Kalbarri in the north, east to Merredin and Ravensthorpe, and then further east along the south coast to the Esperance area (DCCEEW, 2024d; Johnstone & Storr, 1998). Breeds (July to December) predominantly in the east of its range with a migration to coastal areas in the non-breeding period. In recent years, however, the species has expanded its breeding range westward and south into the Jarrah-Marri forests of the Darling Scarp and into the Tuart forests of the Swan Coastal Plain (DCCEEW, 2024d). Heavily reliant on areas of Banksia woodland and proteaceous shrubland/heath for foraging (DCCEEW, 2024d; Johnstone & Storr, 1998).

Ecology: Diurnal granivore, feeding predominantly on the seeds of the Proteaceae (especially banksias) but also known to feed on a very wide variety of plants, including non-native ornamentals and plantation species such as pine (DCCEEW, 2024d; DPaW, 2013; Groom, 2011; Johnston et al., 2016; Valentine & Stock, 2008). Reliant on large tree-hollows in eucalypts (especially smooth-barked species such as Wandoo and Salmon Gum) for breeding (DCCEEW, 2024d; Johnstone & Storr, 1998; Saunders, 1974). Threatened by habitat loss, habitat degradation, nest hollow shortage, and competition for available nest hollows from other parrots and feral Honeybees, illegal shooting and illegal trade (Burbidge, 2004; DCCEEW, 2024d).

Expected occurrence: **Regular visitor.** Carnaby's Black-Cockatoo is known from the general region and was observed within or flying over the project area during the majority of site visits between May to October 2024. There are about 1400 records in the DBCA database within 20 km of the project area, with the most recent from 2022 and the closest records being within the project area. The project area provides potential roosting sites and nesting trees, and suitable foraging habitat. Further details are provided in Section 3.3.

Chuditch (*Dasyurus geoffroii*) CS1 (V, S2D3)

Conservation status: Vulnerable under the EBPC Act and Schedule 2 Division 3 under the BC Act.

Distribution and habitat: The Chuditch is a wide-ranging resident in Marri-Jarrah forest of the south-west of Western Australia and also in heaths and eucalypt woodlands of the eastern wheatbelt and goldfields (Van Dyck & Strahan, 2008). This species was formerly distributed throughout much of western and inland Australia but its range has contracted to the region approximately south-west of a line between Shark Bay and Esperance (Burbidge, 2004; DCCEEW, 2023c; Van Dyck & Strahan, 2008).

Ecology: The Chuditch is a nocturnal, terrestrial carnivore, feeding mainly on smaller vertebrates (e.g. reptiles, birds and mammals) and large invertebrates (Burbidge, 2004; Van Dyck & Strahan, 2008). During the day Chuditch shelter in dens; predominantly hollow logs and earth burrows (Van Dyck & Strahan, 2008). Chuditch have a large home range, with females in the deeper south-west occupying 55-120 ha and males ranging over 400 ha or more (Van Dyck & Strahan, 2008). Further east in a semi-arid area (Forrestania, c. 150 km north of Ravensthorpe), Rayner *et al.* (2012) found that Chuditch occurred at an average density of 0.039 individuals/km^2, with home ranges as small as 189 ha (a female) and as large as 2,125 ha (a male).

Expected occurrence: **Vagrant.** There are two records in the DBCA database within c. 5 km of the project area; one is historical and one from 1972. It is not expected that this species will be present regularly, but it is possible that individuals will move through the project area very occasionally (particularly during juvenile dispersal). For example, during a survey for Quenda, a juvenile male Chuditch was caught in the Gnangara pine plantation in 2004 (BCE database). This is <20km SSE of the project area but almost certainly represents a dispersing animal.

South-western Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*) CS1 (S6)

Conservation status: Schedule 6 under the BC Act.

Distribution and habitat: In the south-west of Western Australia, the South-western Brush-tailed Phascogale is a wide-ranging but low-density resident in dry sclerophyll forests and open woodlands where there are hollow-bearing trees (DEC, 2012). These hollows are used for shelter and nesting.

Ecology: The Brush-tailed Phascogale is a nocturnal, arboreal carnivore, feeding mainly on smaller vertebrates (e.g. reptiles, birds and mammals), larger invertebrates and nectar (DEC, 2012).

Expected occurrence: **Irregular visitor.** There are no records in the DBCA database within 20 km of the project area; the closest record according to available databases is 27 km from the project area (ALA, 2024). The project area is within the range of the species, and it possibly persists in larger swathes of native vegetation in the area.

3.2.5.2 Conservation Significance 2

Jewelled Ctenotus (Swan Coastal Plain subpopulation) (*Ctenotus gemmula*) CS2 (P3)

Conservation status: Listed as Priority 3 by DBCA.

Distribution and habitat: The Jewelled Ctenotus occurs in two isolated subpopulations in Western Australia: one on the Swan Coastal Plain from Cataby south to Perth, and another along the south coast (IUCN, 2017). The Swan Coastal Plain subpopulation is listed as Priority 3 by DBCA, and is threatened by habitat loss associated with mining and urbanisation (IUCN, 2017). Typical habitat for this species includes *Banksia* and Mallee woodlands, and heath on sandplains (Wilson & Swan, 2021).

Ecology: A fossorial skink that shelters in leaf litter (Huang, 2009).

Expected occurrence: **Resident.** There are no records in the DBCA database within 20 km of the project area, but habitat that appears suitable is present.

Black-striped Snake (*Neelaps calonotos*) CS2 (P3)

Conservation status: Listed as Priority 3 by DBCA.

Distribution and habitat: Restricted to coastal sandplains from near Dongara to Mandurah (Bush et al., 2010). Appears to be absent from the eastern coastal plain (M. Bamford pers. obs.). Within the Perth Metropolitan area this species may be restricted to large reserves (How & Shine, 1999).

Ecology: A fossorial species that preys upon small, fossorial skinks in the upper layers of loose sand (Bush et al., 2010).

Expected occurrence: **Resident.** There are 38 records in the DBCA database within c. 20 km of the project area and suitable habitat occurs within the project area.

Masked Owl (south-west) (*Tyto novaehollandiae*) CS2 (P3)

Conservation status: Listed as Priority 3 by DBCA.

Distribution and habitat: Several populations across Australia in tall forests and woodlands. The south-west population was once moderately widespread but now appears to be restricted to small areas of tall forest.

Ecology: A nocturnal predator mainly of medium-sized mammals. Roosts and nests in very large tree hollows.

Expected occurrence: **Vagrant.** There are two records in the DBCA database within c. 20 km, both from the 1970s, but the species seems now to be largely confined to the lower south-west (Collie, Bunbury to Margaret River; B. Wykes unpubl. records). The project area does provide suitable roosting and nesting habitat (large tree hollows).

Water-rat, Rakali (*Hydromys chrysogaster*) CS2 (P4)

Conservation status: Listed as Priority 4 by DBCA.

Distribution and habitat: Generally occurs in the vicinity of permanent fresh or brackish water sources (including lakes, rivers, swamps, mangroves and beaches) throughout much of Australia, with the exception of inland/central Western Australia, Northern Territory, South Australia and New South Wales (Van Dyck & Strahan, 2008). In the south of Western Australia Water-rats preferentially use wetland habitats characterised by dense, low-lying vegetation, low-density canopy cover and shallow, narrow water bodies (Speldewinde et al., 2013). Within the greater Perth area, Water-rats occurred in association with high value habitat quality characteristics such as high bank stability, habitat diversity, stream cover and foreshore vegetation (Smart et al., 2011).

Ecology: While most active around sunset (crepuscular), Water-rats are also known to forage during the day (Van Dyck & Strahan, 2008). They are generally carnivorous, feeding on aquatic invertebrates, fish and also terrestrial mammals, including birds but may also browse on plant material (Van Dyck & Strahan, 2008).

Expected occurrence: **Irregular visitor.** There are 18 records within c. 22 km in the DBCA database, all associated with lakes in the region. The species is likely to be present in the general region, but the project area does not provide preferred habitat. Individuals may pass through the project area when dispersing through the landscape.

Quenda (*Isoodon fusciventer*) CS2 (P4)

Conservation status: Listed as Priority 4 by DBCA.

Distribution and habitat: The Quenda formerly occurred across the south-west of Western Australia from Geraldton to east of Esperance, including the wheatbelt, but it now has a much-reduced range, with few records north of Yanchep/Muchea on the coastal plain, and it is more or less extinct across the Wheatbelt (Travouillon & Phillips, 2018; Van Dyck & Strahan, 2008). It persists around Perth, particularly in areas of dense vegetation around wetlands, and it remains locally common in suitable environments (Howard et al., 2014).

Ecology: Omnivorous and cathemeral (active throughout the day and night), Quenda feed on invertebrates, plant material and fungi (Van Dyck & Strahan, 2008). It is one of the few native, terrestrial mammals to persist in semi-urban landscapes in the south-west. Populations of this species have declined due to ongoing threats from feral predators and land-clearing (Howard et al., 2014; Van Dyck & Strahan, 2008).

Expected occurrence: **Resident.** There are more than 300 records in the DBCA database within 20 km of the project area boundary and more than 30 of these are within c. 2 km of the project area boundary. During field investigations, digs consistent with quenda foraging activity were observed throughout the project area.

Brush Wallaby (*Notamacropus irma*) CS2 (P4)

Conservation status: Listed as Priority 4 by DBCA.

Distribution and habitat: Endemic to the South-West more or less south of line from Geraldton to Esperance, although it has disappeared from much of the Wheatbelt due to clearing. Occurs in a wide range of vegetation types from Eucalypt Woodland to Banksia Woodland, Shrublands and Kwongan. Locally common in dry sclerophyll forest and woodland in the south-west however it has declined in recent decades due to predation and habitat destruction (Menkhorst & Knight, 2011).

Ecology: Based on detailed radio-tracking study in Banksia Woodland in Whiteman Park (Bamford & Bamford, 1999), a largely solitary species that browses on shrubs and bushes; rarely on grass. Rarely drinks free-standing water and rarely ventures from dense vegetation. Individuals occupy home ranges of up to c. 10ha; larger in males than females and those of females overlap.

Expected occurrence: **Regular visitor.** There are ten records in the DBCA database within the study area and all are within c. 10 km of the project area. The Brush Wallaby typically favours areas of dense shrubland, including where this is the understorey of low woodland. Suitable habitat for visiting individuals exists within VSAs that contain a moderately dense understorey (e.g. VSAs 2, 3 and 5) but the area is unlikely to support a resident population.

3.2.5.3 Conservation Significance 3

There are 54 species considered to be of local significance (CS3) – one reptile, 49 birds and four mammals. Further details are provided below for the reptile and mammal species.

The majority of the CS3 birds been noted by Dell and Banyard (2000) as either habitat specialists or wide ranging species with a reduced population on the Swan Coastal Plain and are, therefore, considered locally significant. These are generally species that require larger areas of intact native remnant vegetation to persist. There is a wide range of foraging strategies in this group; the majority of the species are small insectivores or honeyeaters, while others are ground-foraging granivores (e.g. Emu, bronzewings, Painted Button-quail) or carnivores (raptors).

Carpet Python (southwest) (*Morelia spilota imbricata*) CS3 (LS)

Conservation status:	This subspecies was formerly listed under the Western Australian *Wildlife Conservation Act 1950* as 'other specially protected fauna' but that status has, more recently, been removed in the WA *Biodiversity Conservation Act 2016* (DBCA, 2023f). It is likely to remain uncommon or at risk in the proximity of development.
Distribution and habitat:	Patchily distributed through south-west Western Australia in a wide range of habitats including woodlands, heaths and rock outcrops (Bush et al., 2010; Wilson & Swan, 2021). It is particularly common in areas of exposed limestone, including offshore islands (Bush et al., 2010; Wilson & Swan, 2021).
Ecology:	Predominantly a nocturnal carnivore, the Carpet Python preys mainly on birds and mammals, although reptiles are occasionally taken (Bush et al., 2010).
Expected occurrence:	**Resident**. The project area provides suitable habitat to support a resident population of this species.

Short-beaked Echidna (*Tachyglossus aculeatus*) CS3 (LS)

Conservation status:	Although widespread, the Echidna is threatened by development, predominantly via habitat loss and vehicle strike. Therefore, this species is of local significance when present.
Distribution and habitat:	Found across most of Australia in almost all terrestrial habitats (Menkhorst & Knight, 2011).
Ecology:	Eats ants, termites and other soil invertebrates (Menkhorst & Knight, 2011). Females lay eggs; young are carried in the pouch then placed in a burrow for protection (Menkhorst & Knight, 2011). Echidnas have few natural predators as their spines offer good protection, but there is some evidence they increase in abundance when the Red Fox is controlled.

Expected occurrence: **Resident.** It is expected that the project area contains sufficient vegetation and resources to allow this species to occur as a resident.

Little Long-tailed Dunnart (*Sminthopsis dolichura*) Swan Coastal Plain form
and CS3 (LS)
Sooty Dunnart (*Sminthopsis fuliginosa*)

Conservation status: Both species are considered of local significance due to severe decline seven in extensive woodland close to Perth. The Sooty Dunnart was previously considered a subspecies of the Common Dunnart (*S. murina*) and was formerly recorded as *S. griseoventer*. The Swan Coastal Plain form of the Little Long-tailed Dunnart is of interest as it is distinctive in appearance (shorter tailed than where it is found elsewhere) and appears confined to the Swan Coastal Plain (M. Bamford pers obs.).

Distribution and habitat: Both species are found in a variety of habitats including dry sclerophyll forest, semi-arid woodland, mallee and heath (Menkhorst & Knight, 2011), but on the Swan Coastal Plain appear restricted to Banksia Woodland (such as VSA 2).

Ecology: Nocturnal carnivores, these species prey on insects and spiders (Menkhorst & Knight, 2011).

Expected occurrence: **Irregular visitors**. The project area provides suitable habitat, but as they have declined more broadly across the region, they are not expected to be resident.

Honey Possum (*Tarsipes rostratus*) CS3 (LS)

Conservation status: While locally abundant in good seasons in suitable habitat, this species is struggling to persist on the Swan Coastal Plain in the vicinity of development (e.g. urban areas, agriculture, plantations etc.).

Distribution and habitat: Occurs in sandplain heaths and woodlands of south-western Australia (south-west from Kalbarri area to Esperance) and along the south-eastern coast (ALA, 2024; Van Dyck & Strahan, 2008).

Ecology: A nocturnal nectarivore, the Honey Possum is dependent on a high diversity of nectar-producing plants that can provide year-around food resources (Van Dyck & Strahan, 2008).

Expected occurrence: **Regular visitor**. Suitable habitat, with good nectar supply, exists within the project area (e.g. VSA 2). The Honey Possum persists in moderate numbers in suitable habitat on the northern margins of Perth, with records within a few kilometres of the Wanneroo City Centre (M. Bamford pers. obs.).

3.3 Black-cockatoo habitat analysis

3.3.1 Black-cockatoo presence

The project area is out of range for Baudin's Black-Cockatoo; although this species may occur as a vagrant, it is not expected to utilise the project area in a significant manner and is not considered further in the following sections. Both remaining species, the Forest Red-tailed Black-Cockatoo and Carnaby's Black-Cockatoo were regularly observed during field investigations within the project area. Foraging evidence of Carnaby's Black-Cockatoo was observed on *Banksia* cones throughout VSAs containing *Banksia* spp., as well as on Pine, Dwutta, Marri and Jarrah. Possible foraging evidence of the Forest Red-tailed Black-Cockatoo was observed on Jarrah nuts. Both the Forest Red-tailed Black-Cockatoo and Carnaby's Black-Cockatoo are expected as regular visitors in the project area, meaning they are expected within the project area regularly in at least moderate numbers.

3.3.2 Black-cockatoo breeding habitat

Within the project area, 1598 trees met the criterion to be assessed as potential nesting trees for black-cockatoos. The majority of these were Tuart (1113 trees), with other tree species including Jarrah (300 trees), Marri (65 trees), Dwutta (47 trees), ornamental or unknown *Eucalyptus* sp. (60 trees), Sheoak (7 trees), Redheart and Flooded Gum (2 trees of each), and Moodjar and Pine (1 tree of each; although these tree species almost never form hollows). Of the 1598 trees assessed, 1292 were rank 5, 193 rank 4, 99 rank 3 and 14 rank 2. No confirmed black-cockatoo nesting hollows (rank 1) were recorded. A summary of potential black-cockatoo nesting trees is provided in Table 3-4. Locations of potential nesting trees are shown on Figure 3-6 and Figure 3-7.

Table 3-4. Summary of potential nest trees within the project area.

Latin Name	Common Name	Rank					Grand Total
		1	2	3	4	5	
Eucalyptus gomphocephala	Tuart	0	12	65	136	900	1113
Eucalyptus marginata	Jarrah	0	2	21	49	228	300
Corymbia calophylla	Marri	0	0	8	6	51	65
Eucalyptus todtiana	Dwutta	0	0	0	0	47	47
Eucalyptus sp.	Ornamental or unknown Eucalypt	0	0	5	2	53	60
Allocasuarina fraseriana	Sheoak	0	0	0	0	7	7
Eucalyptus decipiens	Redheart	0	0	0	0	2	2
Eucalyptus rudis	Flooded Gum	0	0	0	0	2	2
Nuytsia floribunda	Moodjar	0	0	0	0	1	1
Pinus sp.	Pine	0	0	0	0	1	1
Grand Total		**0**	**14**	**99**	**193**	**1292**	**1598**

There are 11 confirmed and 12 potential white-tailed black-cockatoo breeding sites within the 20 km buffer used for the database search; the closest known breeding sites are c. 10 km from the project area (Figure 3-8). Of the confirmed breeding sites, one is a natural hollow and the remaining 10 are artificial hollows. Publicly available records from DBCA (2024b) indicate that the project area is within a known breeding area for Carnaby's Black-Cockatoo (defined by a 12 km buffer around a point where

successful breeding has been confirmed or strongly suspected (Glossop *et al*., 2011) which suggests there is a known breeding site c. 10 km north of the project area that is not included in the DBCA threatened and priority fauna database (see Figure 3-8). There are no known breeding sites for the Forest Red-tailed Black-Cockatoo within 20 km of the project area.

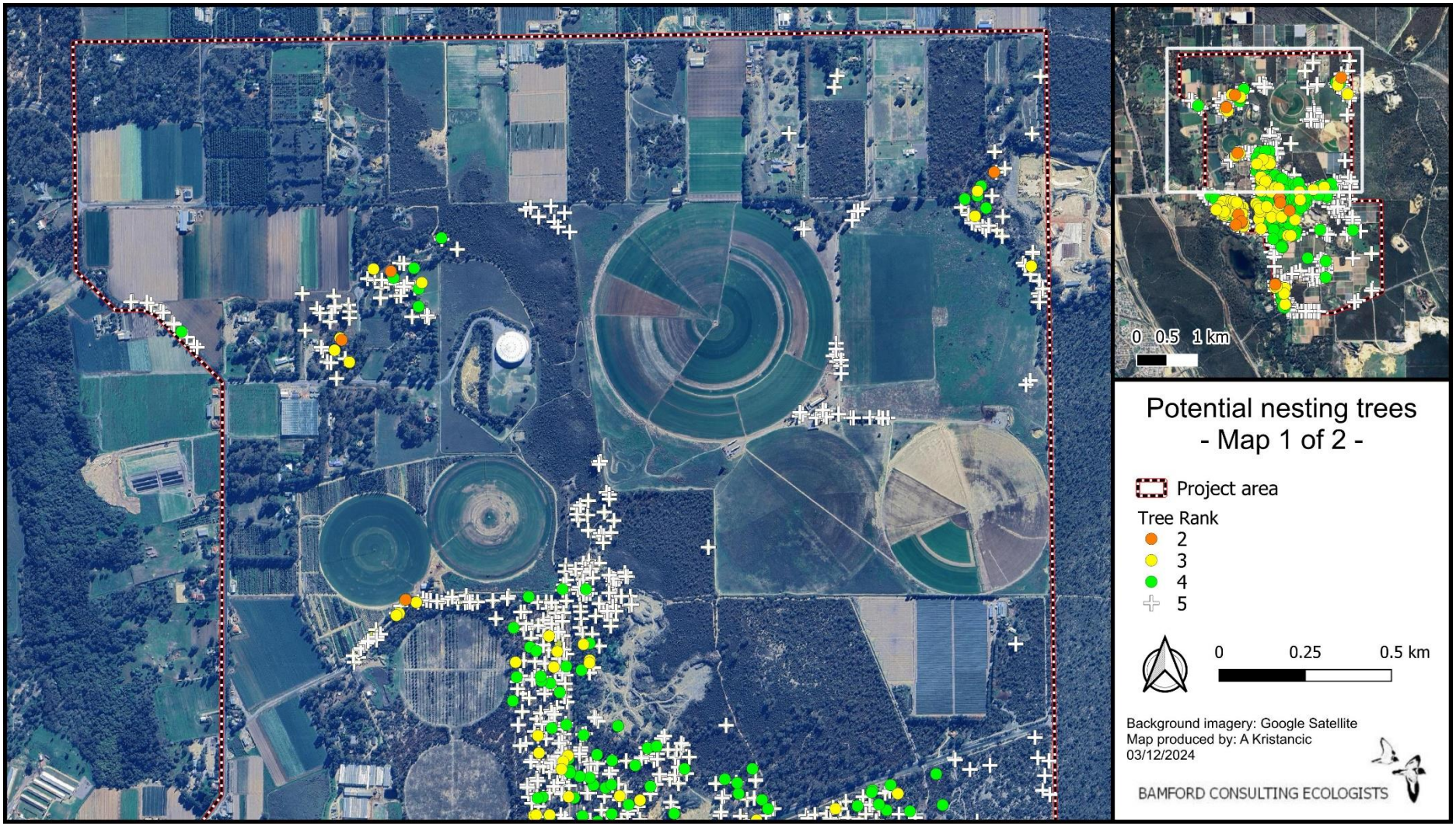


Figure 3-6. Locations of potential black-cockatoo nesting trees within the project area. Map 1 of 2.

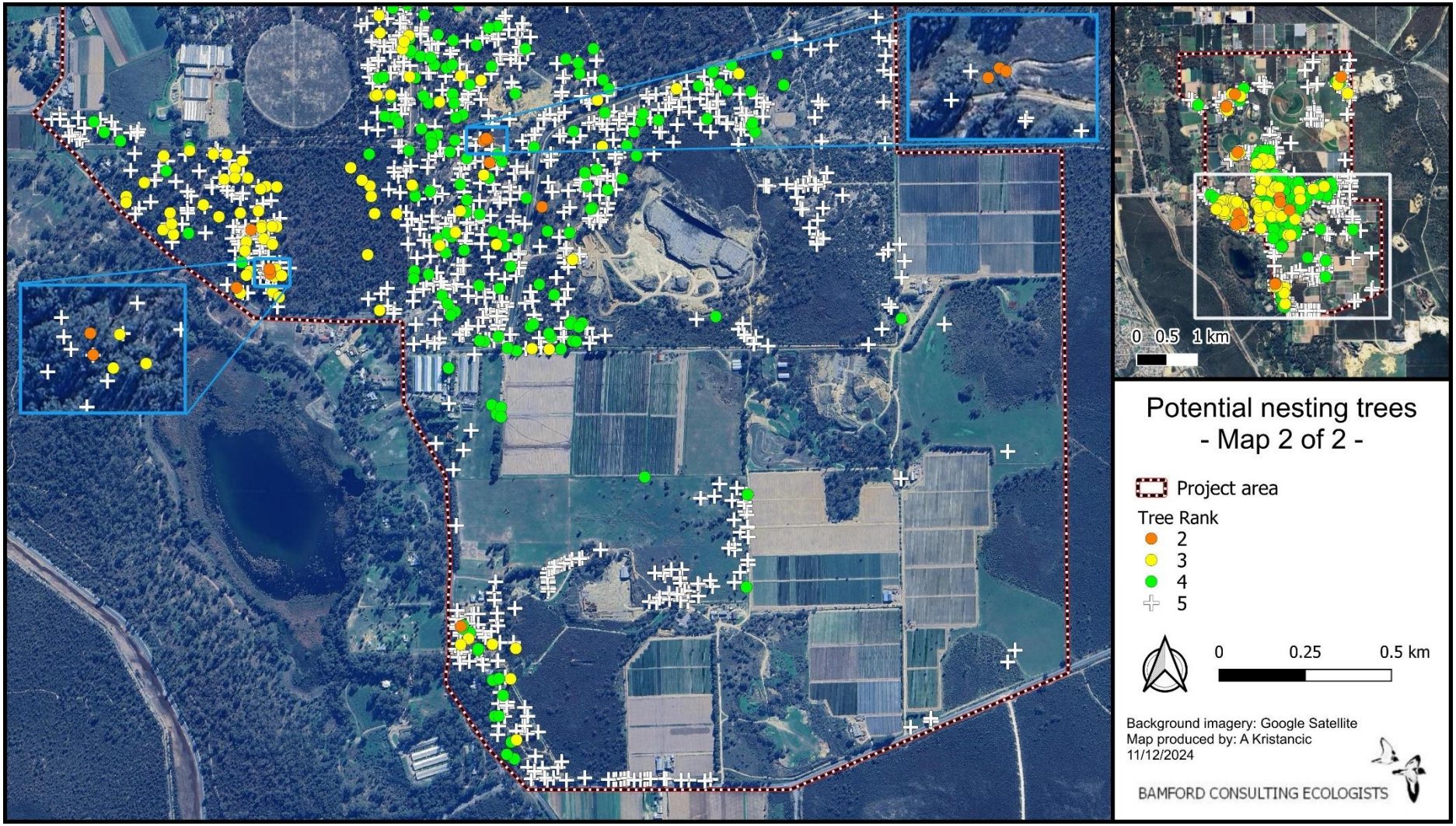


Figure 3-7. Locations of potential black-cockatoo nesting trees within the project area. Map 2 of 2.

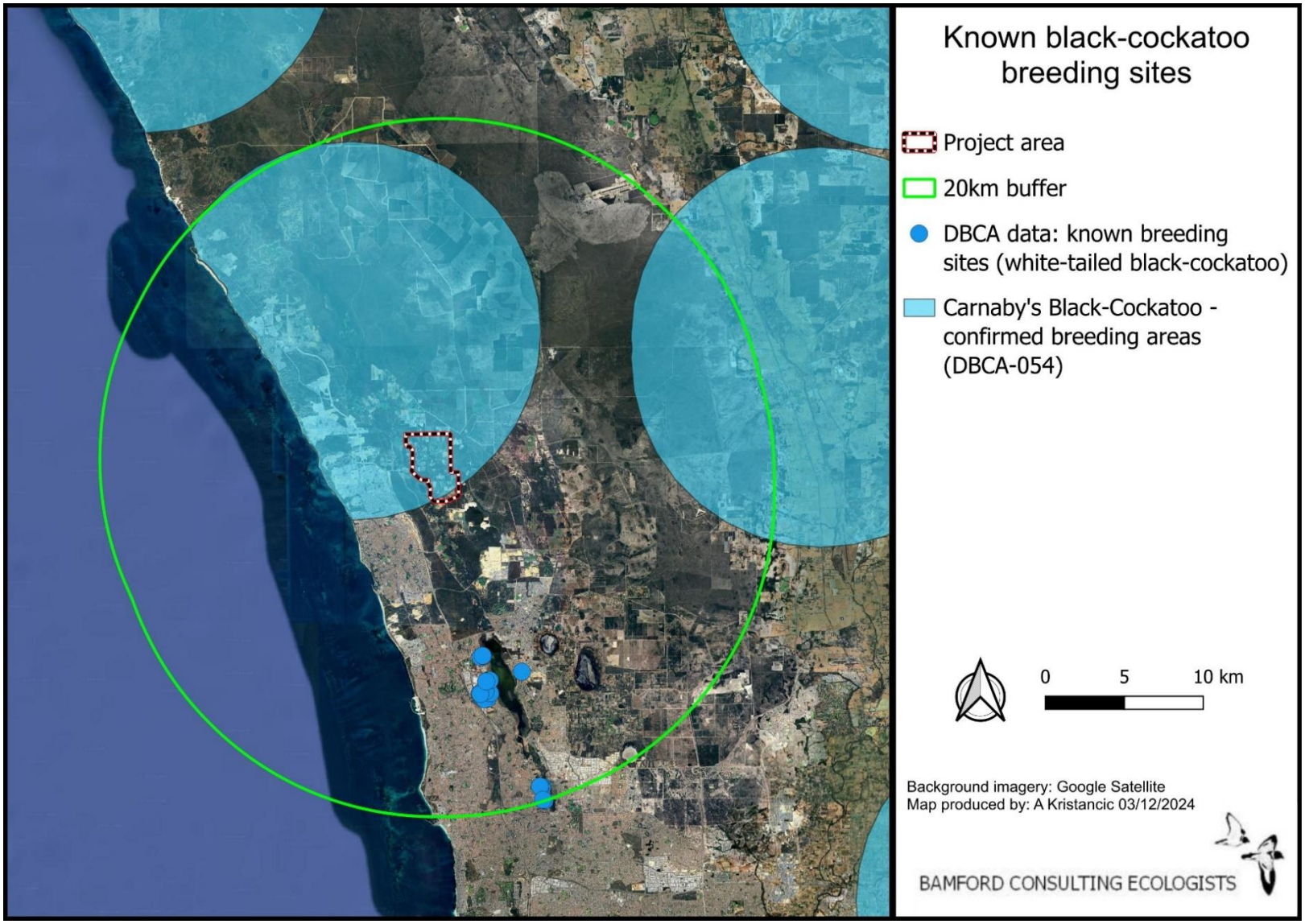


Figure 3-8. Known black-cockatoo breeding sites in the region.

3.3.3 Black-cockatoo foraging habitat

3.3.3.1 Carnaby's Black-Cockatoo

Foraging habitat for Carnaby's Black-Cockatoo was present within the project area, in the form of *Banksia attenuata*, *B. menziesii*, *B. sessilis*, Tuart (*Eucalyptus gomphocephala*), Jarrah and Dwutta (*Eucalyptus todtiana*), among other less important or frequent species, all of which provide foraging resources for the species (Groom, 2011). There was also occasional Marri (*Corymbia calophylla*) in some areas (e.g. parts of VSA 4 where Marri and Jarrah were co-dominant, and in some parts of VSA 1). *Banksia* spp. tree density was variable across the project area (ranging from patches of very high density, especially in VSA 2 and VSA 3 areas, to scattered individual trees in VSA 1). Foraging signs of Carnaby's were found throughout the project area, including areas classified as cleared (VSA 7). Marri, Jarrah, several *Banksia* spp., Dwutta and Pine were among the foodplant species for which evidence was found. Although Carnaby's Black-Cockatoos are known to utilise Tuart as a food source, there was no evidence of foraging on Tuart. The foraging scores for each VSA for Carnaby's Black-Cockatoo are described below and summarised in Table 3-5 and Figure 3-9 and Figure 3-10.

VSA 1, comprised predominantly of Tuart with very occasional *Banksia sessilis* thickets was assigned a site condition score of 2/6 to reflect the presence of small-fruited Eucalyptus trees (Tuart) and the occasional banksia. Jarrah woodland (VSA 4) was assigned a site condition score of 3/6, due to the presence of Marri as co-dominant tree species in some small areas. VSA 2 comprised key Banksia tree species of *B. attenuata* and *B. menziesii* at moderate density, as well as shrubby Banksia species (*B. sessilis*) and Dwutta which both provide additional foraging opportunities. Several pine trees were also found in a large stand of this VSA. Due to the moderate density of key species and frequency of other foraging species, this VSA was assigned a site condition score of 4/6. Although supporting many key food plant species, VSA 2 was slightly downgraded due to the level of weed invasion. VSA 3 comprised dense thickets of *B. sessilis*, a shrubby Banksia that provides very good foraging opportunities for Carnaby's Black-Cockatoo and was therefore given a site condition score of 4/6. VSA 5 was comprised of Melaleuca heath with foraging plants limited to *Banksia dallanneyi* and was scored 2/6. A small area of VSA 6 (Redheart woodland) lay in the south-east and had thickets of *B. sessilis* and *Xanthorrhoea preissii*, so was assigned a site condition score of 3/6. Parkland-Cleared areas (VSA 7) consist of parcels of land containing substantial numbers of large trees (planted and remnant, some native and some exotic species); this VSA was assigned a site condition score of 2/6 to reflect the relatively high density of foraging species (e.g. eucalypts, Sheoak, Pine) in these small patches. Cleared areas (VSA 8) contain some scattered individual *Eucalyptus* spp. trees (mostly Tuart and Jarrah but occasionally Marri), as well as extensive areas of fully cleared/modified land (such as quarries, turf farm and agricultural land); these areas were assigned a site condition score of 1/6 as the scattered native trees provide some foraging value.

The native vegetation within the project area (c. 334 ha as mapped by PGV Environmental, 2023, plus 73 ha of parkland-cleared) comprises 1.2% of the remaining vegetation within the 15 km buffer (see Section 1.4.6). Local breeding is considered likely based on available data and therefore a context score of 2/3 was indicated (see Appendix 5). This score was assigned to VSA 2 as it has a moderate condition score and is not well represented in the region due to historical habitat loss. A context score of 0/3 or 1/3 was assigned to remaining VSAs to enable slight differentiation to be provided between VSAs with similar condition scores.

Carnaby's Black-Cockatoo is expected as a regular visitor to the project area and is expected to utilise all VSAs to some extent; therefore, a stocking rate of 1/1 was assigned to all VSAs except cleared land. Overall, the project area is of low to moderate foraging value for Carnaby's Black-Cockatoo, primarily due to the presence of good quality and relatively large stands of Banksia woodland and heath (VSAs 2, 3 and 6), but affected by large areas of VSA 7 (Cleared) which has a low foraging value.

Table 3-5. Carnaby's Black-Cockatoo foraging scores for each VSA. Note that Site Context and Species Stocking scores have been moderated based on the condition of the vegetation.

VSA	VSA Name	Area (ha)	%	Site Condition (out of 6)	Site Context (out of 3)	Species Stocking Rate (0 or 1)	Total (out of 10)
1	Tuart Open Woodland	116.4	12	2	1	1	**4**
2	Banksia Woodland	59.3	6	4	2	1	**7**
3	Banksia Thicket	74.2	8	4	1	1	**6**
4	Jarrah Woodland	47.4	5	3	1	1	**5**
5	Melaleuca Heath and Scrub	12.1	1	2	1	1	**4**
6	Redheart Woodland	24.4	3	2	1	1	**4**
7	Parkland Cleared	73.5	8	2	0	1	**3**
8	Cleared	553.3	58	1	0	0	**1**
	TOTAL	959	100	**Rounded *weighted* overall site foraging score:**			**3** (out of 10)

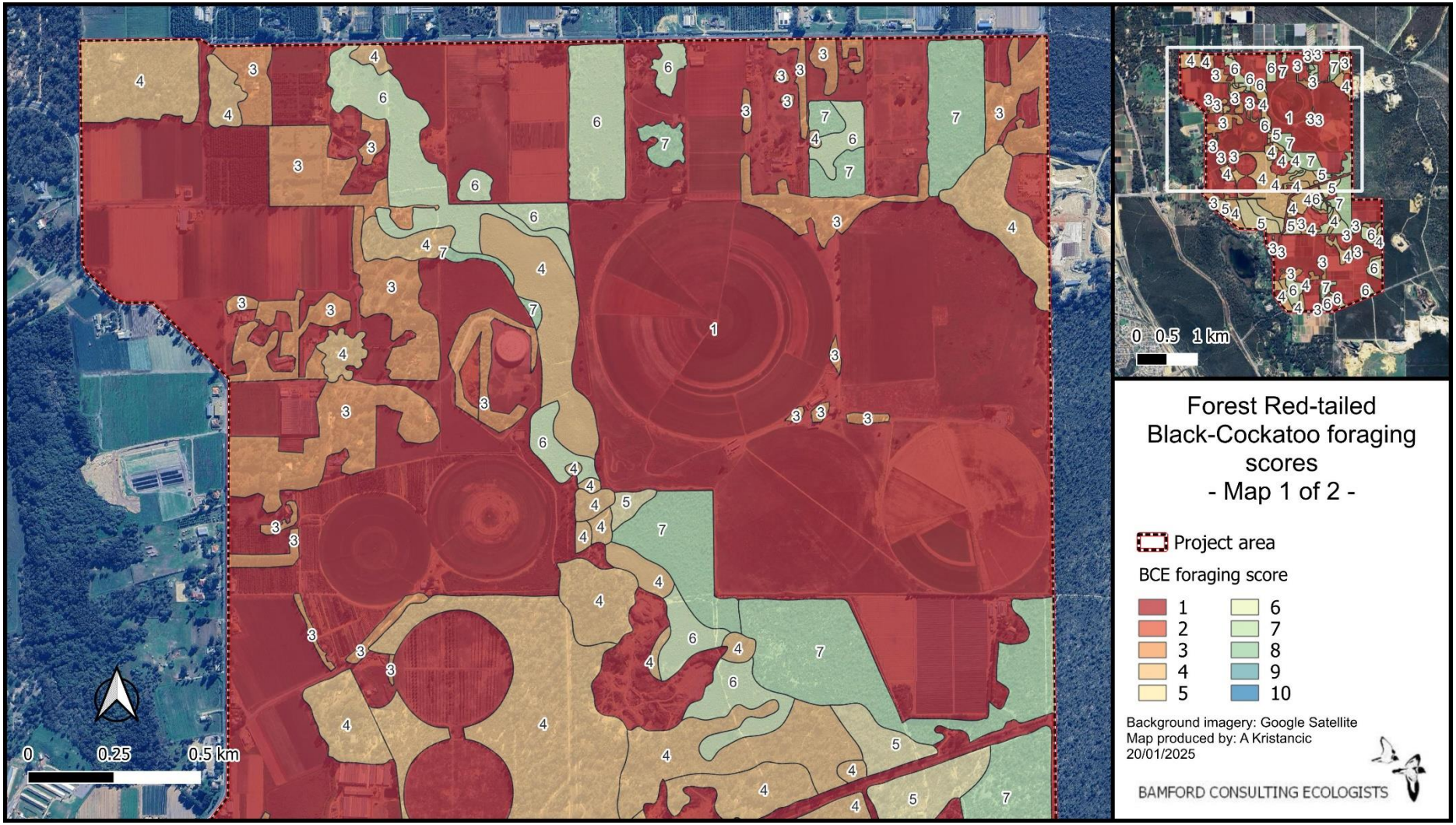


Figure 3-9. Distribution of Carnaby's Black-Cockatoo foraging scores across the project area. Map 1 of 2.

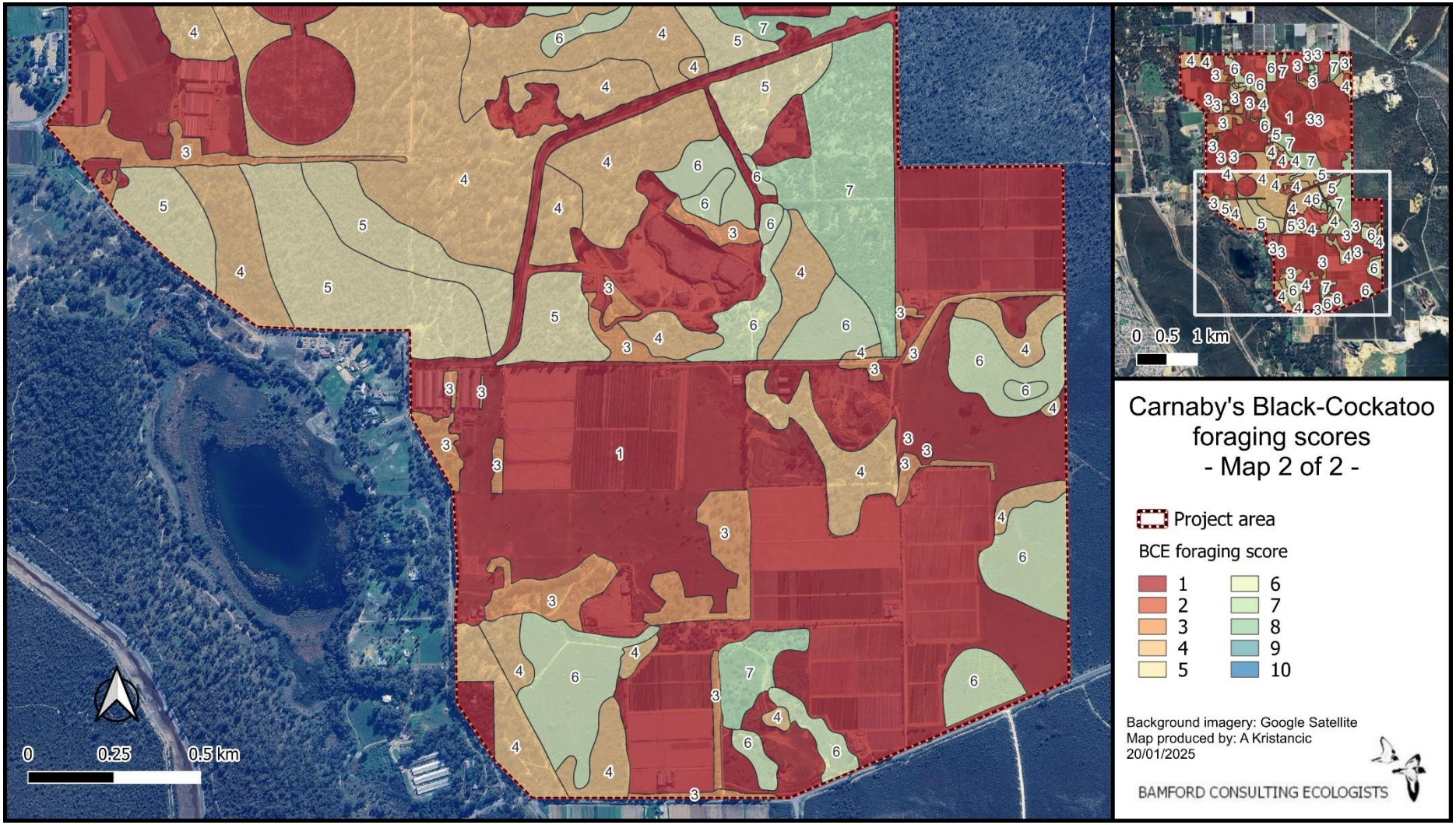


Figure 3-10. Distribution of Carnaby's Black-Cockatoo foraging scores across the project area. Map 2 of 2.

3.3.3.2 Forest Red-tailed Black-Cockatoo

Foraging habitat for the Forest Red-tailed Black-Cockatoo was present within the project area, mostly in the form of Jarrah *(E. marginata),* with occasional Marri (*C. calophylla*). Foraging signs for this species were uncommon and included possibly on Jarrah. The foraging scores for each VSA are described below and summarised in Table 3-5 and Figure 3-11 and Figure 3-12.

VSA 4 comprised regrowth Jarrah trees at moderate density, with Marri co-dominant in some areas. It was assigned a site condition score of 3/6 to reflect the moderate density of Jarrah trees and the lower density of Marri trees, and was the poor condition with the understorey degraded due to weed invasion and/or trampling by horses. VSA 2 is of low foraging value for Forest Red-tailed Black-Cockatoo but contains some scattered food plants (Dwutta and Sheoak) so was assigned a site condition score of 2/6. VSA 1 contained occasional/scattered foraging species (Jarrah and Marri) within an open woodland of Tuart, and was therefore assigned a site condition score of 2/6. VSA 3, VSA 5 and VSA 6 all contained few likely food plants but received a nominal condition score of 1/6 as birds are likely to forage in them occasionally. Parkland-Cleared areas (VSA 7) consist of parcels of land containing substantial numbers of large trees (planted and remnant, some native and some exotic species); this VSA was assigned a site condition score of 2/6 to reflect the relatively high density of foraging species (e.g. eucalypts and Sheoak) in these small patches. Cleared areas (VSA 8) contain some scattered individual *Eucalyptus* spp. trees (mostly Tuart and Jarrah but occasionally Marri), as well as extensive areas of fully cleared/modified land (such as quarries, turf farm and agricultural land); these areas were assigned a site condition score of 1/6 as the scattered native trees provide some foraging value.

The native vegetation within the project area (c. 334 ha as mapped by PGV Environmental, 2023, plus 73 ha of parkland cleared) comprises 1.2% of the remaining vegetation within the 15 km buffer (see Section 1.4.6). There are no known breeding sites for the Forest Red-tailed Black-Cockatoo within 15 km of the project area and local breeding is therefore considered unlikely. A context score of 1/3 was assigned to those VSAs with a site condition score greater than 1, with the exception of VSA 7 (Parkland-Cleared), which needs to be differentiated from less degraded native vegetation and was thus assigned a context score of 0/3. Fully cleared areas (VSA 8) were also assigned a context score of 0/3.

The Forest Red-tailed Black-Cockatoo is expected as a regular visitor to the project area and is expected to utilise all VSAs at least occasionally. Therefore, a stocking rate of 1/1 was assigned for VSAs with a condition of at least 2/6, and was also assigned to VSA 6 to separate it from other VSAs with a very low condition score. Other VSAs were assigned a stocking rate of 0/1.

Overall, the project area is of low foraging value for the Forest Red-tailed Black-Cockatoo.

Table 3-6. Forest Red-tailed Black-Cockatoo foraging scores for each VSA.

VSA	VSA Name	Area (ha)	%	Site Condition (out of 6)	Site Context (out of 3)	Species Stocking Rate (0 or 1)	Total (out of 10)
1	Tuart Open Woodland	116.4	12	2	1	1	**4**
2	Banksia Woodland	59.3	6	2	1	1	**4**
3	Banksia Thicket	74.2	8	1	0	0	**1**
4	Jarrah Woodland	47.4	5	3	1	1	**5**
5	Melaleuca Heath and Scrub	12.1	1	1	0	0	**1**
6	Redheart Woodland	24.4	3	1	0	1	**2**
7	Parkland Cleared	73.5	8	2	0	1	**3**
8	Cleared	553.3	58	1	0	0	**1**
	TOTAL	959	100	**Rounded *weighted* overall site foraging score:**			**2** (out of 10)

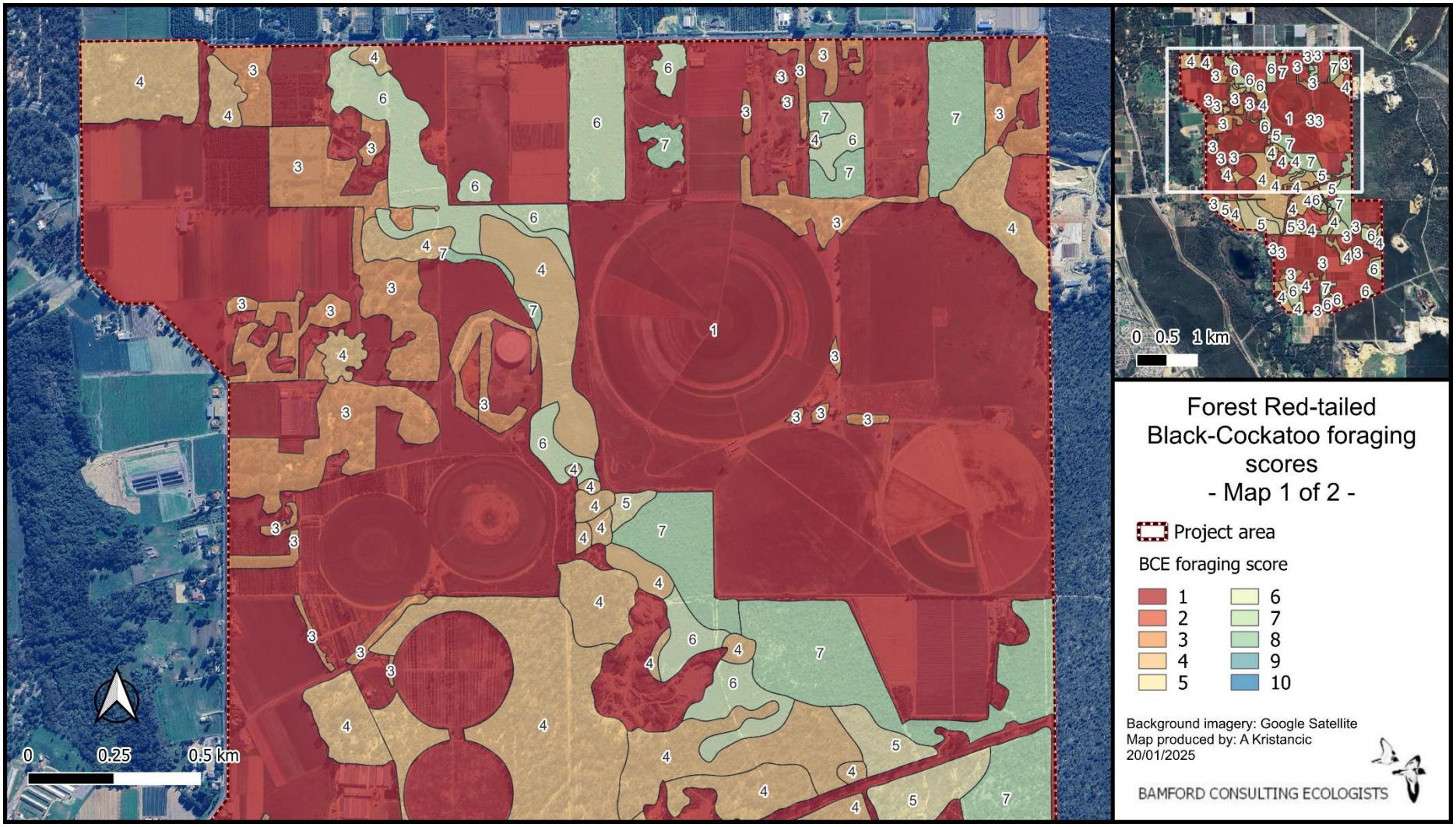


Figure 3-11. Distribution of Forest Red-tailed Black-Cockatoo foraging habitat in the project area. Map 1 of 2.

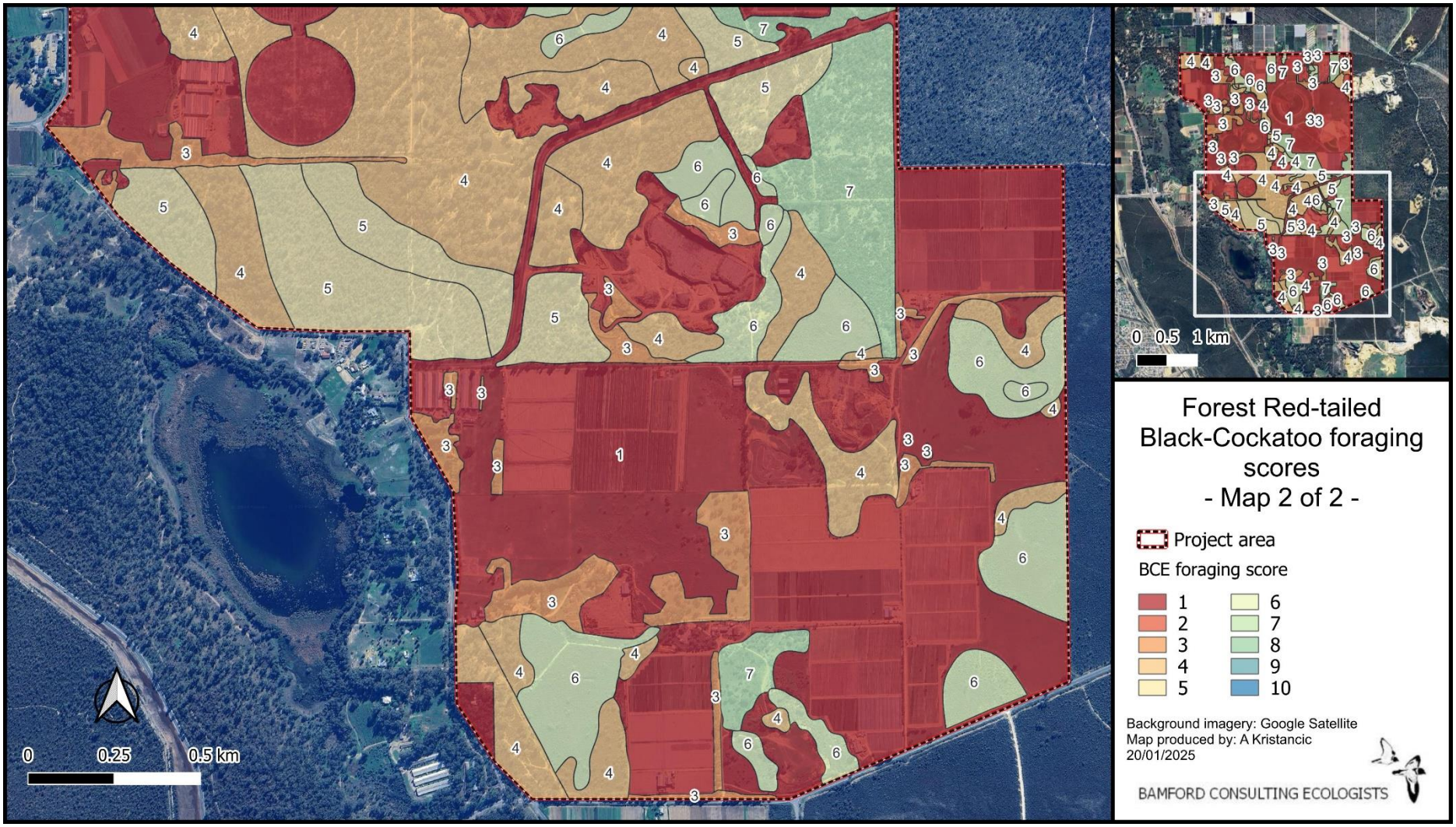


Figure 3-12. Distribution of Forest Red-tailed Black-Cockatoo foraging habitat in the project area. Map 2 of 2.

3.3.3.3 DCCEEW foraging quality scoring tool

The DCCEEW foraging quality scoring tool (provided by DAWE, 2022) and the draft foraging habitat scoring system provided by the department were both used to assess the project area as a whole (Table 3-7 and Table 3-8). Both systems gave high overall foraging scores compared with the BCE methodology detailed above.

Table 3-7. DCCEEW foraging quality scoring tool calculations for the project area.

Attribute	Carnaby's	Forest Red-tailed
Starting score	10	10
Foraging potential	0 (Foraging debris present.)	0 (Foraging debris present.)
Connectivity	0 (Foraging habitat within 12 km.)	0 (Foraging habitat within 12 km.)
Proximity to breeding	0 (Breeding habitat and confirmed breeding within 12 km.)	-1 (Breeding habitat but no confirmed breeding within 12 km.)
Proximity to roosting	0 (Known night roosting site/s within 20 km.)	0 (Known night roosting site/s within 20 km.)
Impact from significant plant disease	-1 (*Some evidence of tree decline and vegetation degraded in part*.)	-1 (*Some evidence of tree decline and vegetation degraded in part*.)
Total Score	**9**	**8**

Table 3-8. Draft DCCEEW habitat scoring system calculations for the project area.

Attribute	Carnaby's	Forest Red-tailed
SITE CONDITION: Vegetation condition and structure. (Score out of 7)	4 Moderate projected foliage cover	4 Moderate projected foliage cover
SITE CONTEXT: Proximity of the site in relation to other habitat. (Score out of 3)	2 Site is within 12 km of other foraging resources with site condition of at least '4'.	2 Site is within 12 km of other foraging resources with site condition of at least '4'.
STOCKING RATE: Confirm presence or absence of species.	Present	Present
TOTAL SCORE (out of 10)	**6**	**6**

3.3.4 Black-cockatoo night roosting habitat

No signs of night-roosting activity were noted during field investigations within the project area, but there were abundant tall trees which would be suitable for roosting.

There are 39 confirmed roost sites within 20 km of the project area (BirdLife Australia, 2024): two Forest Red-tailed Black-Cockatoo sites, 28 white-tailed black-cockatoo sites and nine joint sites. Eleven of these are within c. 6 km of the project area. Of these eleven confirmed roost sites within 6 km, one is a joint site (last used by Forest Red-tailed Black-Cockatoos in 2024 and white-tailed black-cockatoos in 2024), and ten have been confirmed used by white-tailed black-cockatoos (five confirmed used since 2021). The closest known roost site is on the boundary of the project area and is a joint site where both species have been recorded. There are also several unconfirmed roost sites that are suspected to be suitable roost sites but where black-cockatoos have not been observed roosting. Known roost locations within the region are shown on Figure 3-13.

3.3.5 Black-cockatoo watering points

The presence of a water source nearby is an important feature of a suitable roosting site (DPaW, 2013) and is also associated with successful breeding by this species. Residents at 210 McLennan Drive, Nowergup, reported seeing black-cockatoos drinking from horse troughs on the property. It is likely that additional artificial water sources are present nearby in the surrounding landscape.

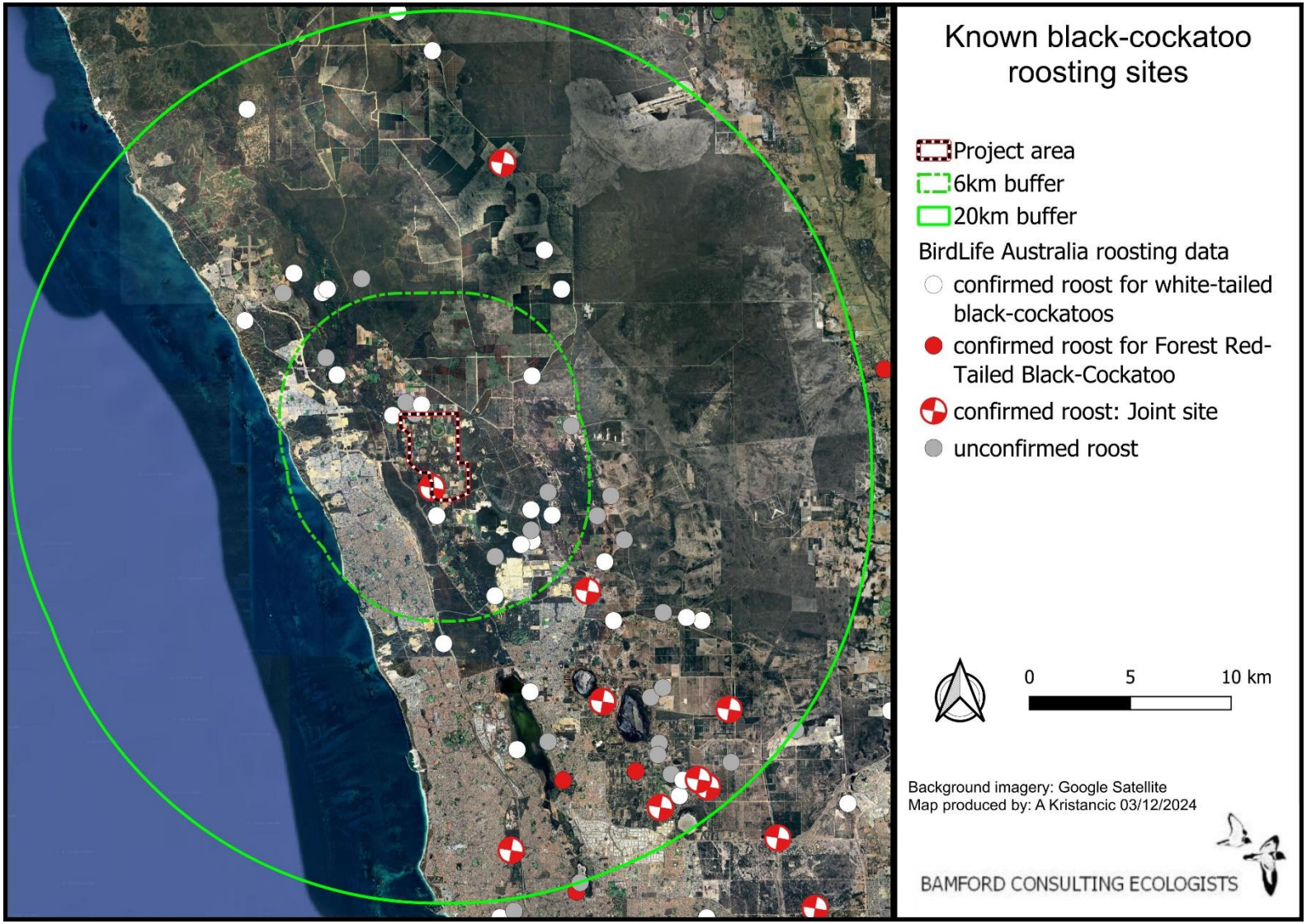


Figure 3-13. Known black-cockatoo roost locations within 20 km.

3.4 Patterns of biodiversity

Investigating patterns of biodiversity can be complex and are often beyond the scope even of detailed or targeted investigations (see Section 2.1 above), but it is possible to draw some general conclusions based upon the different VSAs in the project area.

The vegetation within the project area ranged from completely degraded (parts of VSA 7) to relatively intact native vegetation in 'very good' and 'excellent' condition (PGV Environmental, 2023) for parts of VSAs 2, 3, 5 and 6. The project area consists primarily of VSA 7 (Cleared/Disturbed land) which makes up 65% of the project area. Within this VSA there is considerable variability; some areas are completely cleared (e.g. quarries and agricultural land) while others consist of residential gardens or parkland cleared areas (where large trees are retained and the midstorey and understorey are cleared). Within some cleared areas, eucalypt trees occur as scattered individual trees or small stands of trees. These variations within VSA 7 provide variable value for fauna. Completely cleared areas provide little of value for fauna, although some agricultural areas may provide foraging opportunities for birds such as the Glossy Ibis (CS2 (P4)). The parkland cleared areas contained large trees which would be suitable for black-cockatoo roosting and some of which may contain hollows suitable for black-cockatoo nesting; the majority of these parkland cleared areas coincided with restricted areas (see Appendix 13), so large trees were not assessed for their potential value for black-cockatoo nesting. These large trees also provide habitat for a variety of other fauna such as birds (for shelter and nesting), and arboreal reptiles and mammals, but these areas are of limited value for ground dwelling mammals and shrubland birds due to the lack of shelter in the midstorey and understorey. Quenda (CS2(P4)) are known to utilise residential gardens and are likely to be present in some gardens within the project area, depending on the level of shelter and connectivity available at ground level. The next most prevalent VSA (VSA 1 - Tuart Open Woodland) contained abundant large trees, some of which contained suitable hollows for black-cockatoo breeding (Rank 3 trees, Section 3.3.2). In general, large trees such as those within VSA 1 provide valuable habitat for a variety of fauna. Important features of large trees include hollows, crevices in tree bark, sites for nest building as well as fallen limbs that provide shelter at ground level (of importance for conservation significant fauna including Chuditch and the South-western Brush-tailed Phascogale). Large trees provide suitable nesting sites for raptors, including the conservation significant Peregrine Falcon, and provide suitable roosting sites for black-cockatoos. Although the large trees of VSA 1 provide valuable fauna habitat, the relatively open understorey of VSA 1 will limit the abundance and diversity of fauna species overall.

VSAs 2, 3 and 5 have a complex vegetation structure in the understorey and midstorey which provides an environment that in general is likely to support a large number and high diversity of fauna species. This will potentially include several conservation significant species such as the Quenda, Jewelled Sandplain Ctenotus and Black-striped Burrowing Snake, and will provide suitable shelter for Brush Wallaby and Rakali that may move through the area.

Banksia trees and shrubs within VSAs 2, 3 and 5 provide foraging opportunities for nectar-dependent fauna as well as Carnaby's Black-Cockatoo.

The sandy substrates of all vegetated VSAs are likely to provide suitable habitat for a variety of fossorial (burrowing) reptiles and frogs, including the conservation significant Black-striped Snake and Jewelled Sandplain Ctenotus (both listed as P3 by DBCA).

A range of conservation significant invertebrates are likely to be present in the Banksia woodland of VSA 2, including the Spiny Katydid (Swan Coastal Plain) (*Austrosaga spinifer*), Douglas' Broad-headed Bee (*Hesperocolletes douglasi*) and Woollybush Bee (*Hylaeus globuliferus*). The Graceful Sun Moth is expected to be present throughout VSAs 2, 3, 5 and 6 and will rely in particular on areas containing *Lomandra* spp. (the host plant on which larvae feed). The Swan Coastal Plain Shield-backed Trapdoor Spider is most likely to be present in VSAs where there is sufficient vegetation cover (for shelter and to provide leaf litter) and where the understorey is not degraded. Such environments are present in VSAs 2, 3, 5 and 6.

3.5 Ecological processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see Appendix 1 for descriptions and other ecological processes). The main ecological processes which have affected and continue to affect the fauna assemblage are likely to be: (i) ongoing habitat loss; (ii) the presence and abundance of feral species, and (iii) landscape connectivity, because of the fragmented nature of vegetation in the area. These and additional ecological processes which are affecting fauna are discussed here:

Ongoing habitat loss

The project area is in a region which has experienced and continue to experience land clearing, particularly of banksia woodlands which are rich in fauna. Ultimately, removal of large amounts of fauna habitat results in mortality of fauna and the decline of local populations, and it is likely that habitat loss via clearing for agriculture, mining and residential purposes has contributed to local extinctions in the area.

Landscape connectivity

The native vegetation in the local area is highly fragmented by clearing, and remnant vegetation that remains is likely to be degraded (such as VSA 1, VSA 2 and VSA 4 in the project area). It is likely that the fragmentation and degradation of native vegetation will have impacted the persistence of some fauna in the region, and therefore in the project area. This is especially relevant to fauna species that require a large home range or to travel large distances during dispersal. In addition, although there are corridors remaining to provide connectivity between patches of vegetation, there are a number of potential issues with relatively narrow corridors (such as increased influence of edge effects), and they do not necessarily allow unimpeded movement for all fauna species. Therefore, the level of fragmentation in the surrounding landscape is likely to have contributed to the loss and decline of several fauna species. For other fauna, such as many reptiles which can persist in small remnants (Bamford & Calver, 2012), the amount of landscape connectivity remaining may be sufficient to have allowed populations to persist.

Feral species and interactions with over-abundant native species

Feral species occur throughout Western Australia and are a considerable component of the expected mammal fauna of the project area; five of the 17 mammals expected in the project area are introduced species. In addition to the introduced mammals, there are also five introduced bird species expected in the project area. Feral species are likely to have contributed to local mammal extinctions in the area and are likely to currently be affecting populations of extant species in the project area. For example, the locally significant Carpet Python is susceptible to predation by the introduced Red Fox. Grazing and trampling of vegetation by domestic livestock can have a considerable negative impact on native fauna due to habitat degradation; such degradation was observed in VSA 4 located within a paddock used to keep horses. All of the introduced mammals are expected as residents and are likely to be placing considerable pressure on the native fauna in the region - cats and foxes via predation, and rodents and rabbits via competition for resources and/or degradation of vegetation. Four of the introduced birds are expected as residents and one (Rock Dove) as a regular visitor. The doves may compete with native species for nesting and feeding resources, while the Long-billed Corella competes with native birds for nesting hollows and may be preventing black-cockatoos from breeding in the area. The Laughing Kookaburra can impact native birds via predation.

Local hydrology

The project area contains no wetlands, but elements of the native vegetation are likely to have some reliance on groundwater. For example, dead Jarrah and *Banksia* spp. were noted during field investigations and may have died as a result of extreme heat and dryness in summer 2023/2024. The limestone topography suggests that a subterranean fauna assemblage is present, and this may include species that occur in the groundwater (Stygofauna). There is no proposal to alter groundwater levels.

Fire

Native vegetation throughout the project area is subject to fire and is likely to be burnt on a regular basis. While appropriate fire regimes can benefit biodiversity, inappropriate regimes can lead to a loss of biodiversity. Part of the project area north of the main quarry was burnt in 2019 and the far north-west of the project area was burnt in 2004 (DBCA, 2024d). There is probably no actively managed fire regime.

3.6 Summary of fauna values

Vegetation and Substrate Associations (VSAs).
Overall, the project area supports seven VSAs. The majority of the project area consists of VSA 7 (Cleared and Disturbed Land, 65 %) and VSA 1 (Tuart Open Woodland, 12 %). Other VSAs include Banksia Woodland (VSA 2, 6 % of project area), Banksia Thicket (VSA 3, 8 % of project area), Jarrah Woodland (VSA 4, 5 % of project area), Melaleuca Heath and Scrub (VSA 5, 1 % of project area) and Redheart Open Woodland (VSA 6, 2.5 % of project area).

Fauna assemblage. The desktop assessment identified 222 vertebrate fauna species as potentially occurring in the project area: nine frogs, 52 reptiles, 139 birds, 17 native and 5 introduced mammals. Nine vertebrate species that would historically have been present in the project area have been omitted from the expected species list because they are extinct or considered locally extinct (two birds and seven mammals). Overall, the assemblage of vertebrate fauna expected in the project area is typical of remnant vegetation in the region and is likely to be represented elsewhere. However, the fauna assemblage associated with Banksia woodland has a restricted distribution due to high levels of loss and fragmentation of this ecological community on the Swan Coastal Plain. The expected assemblage is moderately rich in reptile species and incomplete for birds and mammals, with several species locally extinct and a large proportion of each group expected only as visitors or vagrants (not resident populations).

Species of conservation significance. Sixty-eight vertebrate species that are of conservation significance are expected to occur in the project area; eight CS1, six CS2 and fifty-four CS3 species. The CS1 species include six birds and two mammals, and none is expected as resident; three are expected as regular visitors (Carnaby's Black-Cockatoo, Forest Red-tailed Black-Cockatoo and Peregrine Falcon), two as irregular visitors (Fork-tailed Swift, South-west Brush-tailed Phascogale), and three as vagrants (Glossy Ibis, Baudin's Black-Cockatoo and Chuditch). The CS2 species consist of two reptiles, one bird and three mammals. Three are expected as resident (Jewelled Sandplain Ctenotus, Black-striped Burrowing Snake and Quenda), and one each expected as a regular visitor (Brush Wallaby), irregular visitor (Water-rat) or vagrant (Southern Masked Owl). The CS3 species are mostly considered of local significance because populations of these species are restricted or declining on the Swan Coastal Plain. CS3 species consist of one reptile, forty-nine birds and four reptiles.

It is expected that five invertebrate species of listed conservation significance are likely to be present in the project area, the Spiny Katydid (Swan Coastal Plain) (*Austrosaga spinifer*), Douglas' Broad-headed Bee (*Hesperocolletes douglasi*), Woollybush Bee (*Hylaeus globuliferus*), Swan Coastal Plain Shield-backed Trapdoor Spider (*Idiosoma sigillatum*) and Graceful Sun Moth *(Synemon gratiosa*). It is also expected that the karst landscape of the project area will support short-range endemic (SRE) invertebrates including stygofauna.

Black-cockatoo Assessment. The project area is out of range for Baudin's Black-Cockatoo (although it may occur as a vagrant). The Forest Red-tailed Black-Cockatoo and Carnaby's Black-Cockatoo are both expected as regular visitors. Both species were regularly observed in the project area during field investigations from May to October 2024, and foraging evidence from both species was recorded. The

project area contains suitable foraging habitat for Carnaby's Black-Cockatoo, mostly due to the presence of *Banksia* spp. in several VSAs, and for the Forest Red-tailed Black-Cockatoo, mostly in the form of Jarrah/Marri trees in VSA 4 and occasional, scattered Marri and Jarrah trees throughout other VSAs. Abundant large trees throughout the project area (primarily in VSA 1 and scattered in VSA 7) provide suitable roosting sites for black-cockatoos. The area in general is known to support black-cockatoo roosting, with ten confirmed roosting sites within 6 km of the project area.

Abundant suitable nesting hollows were observed during field investigations; mostly in Tuart trees but also in other eucalypts. These include 99 Rank 3 trees (containing hollows suitable for use by black-cockatoos) and 14 Rank 2 trees (containing a hollow with chew marks consistent with use by black-cockatoos). The closest known breeding sites for Carnaby's Black-Cockatoo are c. 10 km from the project area. There are no known breeding sites for the Forest Red-tailed Black-Cockatoo within 20 km of the project area.

Summary of black-cockatoo assessment

- Foraging value – overall the project area is of low to moderate foraging value for Carnaby's Black-Cockatoo. Throughout the site, foraging scores ranged from 7/10 for areas with relatively high *Banksia* spp. density (VSA 2), to 1/10 for cleared land (VSA 7). For the Forest Red-tailed Black-Cockatoo, the project area is of low foraging value. Throughout the site, foraging scores ranged from 5/10 for VSA 4, with relatively high density of immature Jarrah trees (with Marri co-dominant in some areas) with a degraded understorey, to 1/10 for Melaleuca Heath and Scrub (VSA 5), Banksia Thicket (VSA 3) and Cleared Land (VSA 7) which contained little foraging value for this species.
- Breeding value – In total, 1598 trees met the criteria to be assessed as potential nesting trees for black-cockatoos. Of these, 113 contained hollows suitable for black-cockatoo breeding (99 Rank 3 trees and 14 Rank 2 trees). The closest confirmed breeding sites for Carnaby's Black-Cockatoo are c. 10 km from the project area.
- Roosting value – Abundant tall trees within the project area would provide suitable roosting sites for black-cockatoos. Residents within the project area reported Carnaby's Black-Cockatoo drinking from horse troughs on the property. Other artificial water sources are likely to exist in the surrounding landscape. The closest confirmed roost site (confirmed used by both red-tailed and white-tailed black-cockatoos) is on the boundary of the project area.

Patterns of biodiversity. The vegetation within the project area ranged from completely degraded (parts of VSA 7) to relatively intact native vegetation in 'very good' and 'excellent' condition (VSAs 2, 3, 5 and 6). The project area consists primarily of VSA 7 (Cleared/Disturbed land) and VSA 1 (Tuart Open Woodland) which make up 65% and 12% of the project area respectively. Within VSA 7 there is considerable variability; some areas are completely cleared (e.g. quarries and agricultural land) while others are residential gardens or parkland cleared. Within some cleared areas, eucalypt trees occur as scattered individual trees or small stands of trees. These variations within VSA 7 provide variable value for fauna. The Tuart Open Woodland contained abundant large trees which provide suitable roosting sites for black-cockatoos and some of which contained suitable hollows for black-cockatoo breeding. In general, large trees provide valuable habitat for a variety of fauna in the form of hollows (large and small), crevices in tree bark, sites for nest building (including for the conservation significant Peregrine Falcon). Fallen limbs provide woody debris and shelter at ground level, of importance for

conservation significant fauna including Chuditch and the South-western Brush-tailed Phascogale. Although the large trees of VSA 1 provide valuable fauna habitat, the relatively open understorey of VSA 1 will limit the abundance and diversity of fauna species overall.

VSAs 2, 3 and 5 have a complex vegetation structure in the understorey and midstorey which provides an environment that in general is likely to support a large number and high diversity of fauna species. This will potentially include several conservation significant species such as the Quenda, Jewelled Sandplain Ctenotus and Black-striped Burrowing Snake, and will provide suitable shelter for Brush Wallaby and Rakali that may move through the area. *Banksia* trees and shrubs within VSAs 2, 3 and 5 provide foraging opportunities for nectar-dependent fauna as well as Carnaby's Black-Cockatoo.

The sandy substrates of all vegetated VSAs are likely to provide suitable habitat for a variety of fossorial (burrowing) reptiles and frogs, including the conservation significant Black-striped Snake and Jewelled Sandplain Ctenotus (both listed as P3 by DBCA).

The Banksia woodland of VSA 2 may support conservation significant insects including the Spiny Katydid (Swan Coastal Plain) (*Austrosaga spinifer*), Douglas' Broad-headed Bee (*Hesperocolletes douglasi*) and Woollybush Bee (*Hylaeus globuliferus*). The relatively undisturbed understorey of VSAs 2, 3, 5 and 6 is expected to provide a suitable environment for the Graceful Sun Moth and the Swan Coastal Plain Shield-backed Trapdoor Spider. The Graceful Sun Moth will rely on areas containing *Lomandra* spp. as this is the host plant on which its larvae feed, but adults are mobile and may therefore be present throughout the project area.

Key ecological processes. The ecological processes that are expected to influence the fauna assemblage include existing habitat loss, the presence and abundance of feral species, and landscape connectivity. The project area contains no wetlands, but elements of the native vegetation are likely to have some reliance on groundwater. The limestone topography suggests that a subterranean fauna assemblage is present, and this may include species that occur in the groundwater (Stygofauna). It is not expected that fire is currently having a significant impact on the fauna assemblage, but changes to natural fire regimes have the potential to negatively affect the fauna assemblage.

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5 Appendices

Appendix 1. Explanation of fauna values.

Fauna values are the features of a site and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but contribute to an understanding of the biodiversity of a site. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a site. For example, a site may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e. has all the species that would have been present at the time of European settlement), or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded site on the mainland).

Richness. This is a measure of the number of species at a site. At a simple level, a species rich site is more valuable than a species poor site, but value is also determined, for example, by the sorts of species present.

Vegetation and substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver et al., 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna. The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

VSA assessment was made with reference to the key attributes provided by (EPA, 2020):

- soil type and characteristics
- extent and type of ground surfaces and landforms
- height, cover and dominant flora within each vegetation stratum
- presence of specific flora or vegetation of known importance to fauna
- evidence of fire history including, where possible, estimates of time since fire
- evidence and degree of other disturbance or threats, e.g. feral species
- presence of microhabitats and significant habitat features, such as coarse woody debris, rocky
- outcrops, tree hollows, water sources and caves
- evidence of potential to support significant fauna
- function of the habitat as a fauna refuge or part of an ecological linkage.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Biodiversity Conservation Act 2016* (BC Act). In addition, the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in Appendix 2.

<u>Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts</u>.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN, 2012), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The *Biodiversity Conservation Act 2016* uses a series of divisions within three Schedules to classify conservation status that largely reflect the IUCN categories (IUCN, 2012).

Conservation Significance (CS) 2: Species listed as Priority by DBCA but not listed under State or Commonwealth Acts.

In Western Australia, DBCA has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the *Biodiversity Conservation Act 2016* but for which DBCA feels there is cause for concern.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA, 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DBCA, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (Dell & Banyard, 2000).

Marine-listed species

Some conservation significant species may also be listed as 'Marine' under the EPBC Act. This listing protects these species in 'Commonwealth areas' which include "marine areas beyond the coastal waters of each State and the Northern Territory, and includes all of Australia's Exclusive Economic Zone (EEZ)" (DEH, 2000). The EEZ extends to 200 nautical miles (approximately 350 kilometres) from the coast (DEH, 2006). This may mean that the 'Marine' listing does not apply to the project/project area (depending on its location). Therefore, when a species is otherwise protected (under the EPBC Act or BC Act) or priority-listed (by the DBCA) then the Marine listing is also noted but it does not have site-specific relevance. In cases where a species is solely Marine-listed (for a list see DEH, 2000) and a project/project area is not within a Commonwealth area then it is treated like all other fauna.

Invertebrates

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey, 2002).

Introduced species

In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes and conditions that apply to the existing environment and that affect and maintain fauna populations in an area. As such they are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a project area may be affected and effectively determined by processes such as:

- fire regime.
- landscape patterns (such as extent of existing habitat, fragmentation and/or linkage).
- the presence of feral species.
- hydrology.

Appendix 2. Categories used in the assessment of conservation status.

IUCN (International Union for the Conservation of Nature) categories, as outlined by IUCN (2012), and as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Biodiversity Conservation Act 2016*.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (Ex)	Taxa known to survive only in captivity.
Critically Endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (E)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (V)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern.	Taxa that are not Threatened.

Schedules used in the WA *Biodiversity Conservation Act 2016, updated 2023*

Schedule 1	Specially protected fauna Division 1 – Species of special conservation interest (S1D1) Division 2 – Migratory species (S1D2) Division 3 – Species otherwise in need of special protection (S1D3)
Schedule 2	Threatened species Division 1 – Critically endangered species (S2D1) Division 2 – Endangered species (S2D2) Division 3 – Vulnerable species (S2D3)
Schedule 3	Extinct species (S3)

WA DBCA Priority species (species not listed under the *WA Biodiversity Conservation Act 2016*, but for which there is some concern).

Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4. (P4)	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5 (P5)	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

Appendix 3. Explanation of threatening processes.

Potential impacts of proposed developments upon fauna values can be related to threatening processes. This is recognised in the literature and under the EPBC Act, in which threatening processes are listed (see Appendix 4). Processes that may impact fauna values are discussed below. Rather than being independent of one another, processes are complex and often interrelated. They are the mechanisms by which fauna can be affected by development. Impacts may be significant if large numbers of species or large proportions of populations are affected.

Note that the terms direct and indirect impacts are used by the DotE (2013), DSEWPaC (2013) and EPA (2016a), but there is some inconsistency in how these are defined. The federal guidance does not define direct impact but has a very broad definition of indirect, and makes the statement (DotE, 2013) '*Consideration should be given to all adverse impacts that could reasonably be predicted to follow from the action, whether these impacts are within the control of the person proposing to take the action or not. Indirect impacts will be relevant where they are sufficiently close to the proposed action to be said to be a consequence of the action, and they can reasonably be imputed to be within the contemplation of the person proposing to take the action*.' Indirect impacts therefore can even include what the DotE (2013) calls facilitated impacts, which are the result of third party actions triggered by the primary action. In contrast, the EPA (2016a) defines direct impacts to '*include the removal, fragmentation or modification of habitat, and mortality or displacement of individuals or populations.*' This document then lists as indirect impacts what in many cases are the consequences of the removal, fragmentation or modification of habitat. For example, '*disruption of the dispersal of individuals required to colonise new areas inhibiting maintenance of genetic diversity between populations'* is a consequence of habitat fragmentation. Impacts of light, noise and even roadkill are defined as indirect but they are clearly the result of the action and in control of the person taking the action. Roadkill is as direct a form of mortality as can be observed, but it is considered as an indirect impact in the context of a development presumably because it is not directly linked to land clearing. The EPA (2016a) makes a strong distinction between removal of vegetation (direct impact) and the consequences of such clearing and other aspects of a development (indirect impacts). It is not obvious how this distinction between direct and indirect impacts is helpful in the EIA process, as the key aim is to ensure that all impacts that result from a project are addressed in this assessment process. Interestingly, Gleeson and Gleeson (2012), in a major review of impacts of development on wildlife, do not use the terms direct or indirect. In the following outlines of threatening processes that can cause impacts, the emphasis is upon interpreting how a threatening process will cause an impact. For example, loss of habitat (threatening process) can lead to population decline and to population fragmentation, which are two distinct impacts, with population decline considered a direct impact and fragmentation an indirect impact by the EPA (2016a).

Loss of habitat affecting population survival

Clearing for a development can lead to habitat loss for a species with a consequent decline in population size. This may be significant if the smaller population has reduced viability. Conservation significant species or species that already occur at low densities may be particularly sensitive to habitat loss affecting population survival.

Loss of habitat leading to population fragmentation

Loss of habitat can affect population movements by limiting movement of individuals throughout the landscape as a result of fragmentation (Gleeson & Gleeson, 2012; Soule et al., 2004). Obstructions associated with the development, such as roads, pipes and drainage channels, may also affect movement of small, terrestrial species. Fragmented populations may not be sustainable and may be sensitive to effects such as reduced gene flow.

Degradation of habitat due to weed invasion leading to population decline

Weed invasion, such as through introduction by human boots or vehicle tyres, can occur as a result of development and if this alters habitat quality, can lead to effects similar to habitat loss.

Increased mortality

Increased mortality can occur during project operations; for example from roadkill, animals striking infrastructure and entrapment in trenches. Roadkill as a cause of population decline has been documented for several medium-sized mammals in eastern Australia (Dufty, 1989; Jones, 2000). Increased mortality due to roadkill is often more prevalent in habitats that have been fragmented (Clevenger & Waltho, 2000; Jackson & Griffin, 2000; Scheick & Jones, 1999).

Increased mortality of common species during development is unavoidable and may not be significant for a population. However, the cumulative impacts of increased mortality of conservation significant species or species that already occur at low densities may have a significant impact on the population.

Species interactions, including predation and competition

Changes in species interactions often occur with development. Introduced species, including the feral Cat, Red Fox and Rabbit may have adverse impacts upon native species and development can alter their abundance. In particular, some mammal species are very sensitive to introduced predators and the decline of many mammals in Australia has been linked to predation by the Red Fox, and to a lesser extent the feral Cat (Burbidge & McKenzie, 1989). Introduced grazing species, such as the Rabbit, Goat, Camel and domestic livestock, can also degrade habitats and deplete vegetation that may be a food source for other species.

Changes in the abundance of some native species at the expense of others, due to the provision of fresh watering points, can also be a concern. Harrington (2002) found the presence of artificial fresh waterpoints in the semi-arid mallee rangelands to influence the abundance and distribution of certain bird species. Common, water-dependent birds were found to out-compete some less common, water-independent species. Similarly, Read *et al.* (2015) found a decline in some bird species but an increase in others in the vicinity of active mines and concluded this was due to the mine attracting large and aggressive species that displaced other species. Over-abundant native herbivores, such as kangaroos, can also adversely affect less abundant native species through competition and displacement.

Hydroecology

Interruptions of hydroecological processes can have major effects because they underpin primary production in ecosystems and there are specific, generally rare habitats that are hydrology-dependent. Fauna may be impacted by potential changes to groundwater level and chemistry and

altered flow regime. These changes may alter vegetation across large areas and may lead to habitat degradation or loss. Impacts upon fauna can be widespread and major.

Changes to flow regime across the landscape may alter vegetation and may lead to habitat degradation or loss, affecting fauna. For example, Mulga has a shallow root system and relies on surface sheet flow during flood events. If surface sheet flow is impeded, Mulga can die (Kofoed, 1998), which may impact on a range of fauna associated with this vegetation type.

Fire

The role of fire in the Australian environment and its importance to vertebrate fauna has been widely acknowledged (Fox, 1982; A. M. Gill et al., 1981; Letnic et al., 2004). It is also one of the factors that has contributed to the decline and local extinction of some mammal and bird species (Burbidge & McKenzie, 1989). Fire is a natural feature of the environment but frequent, extensive fires may adversely impact some fauna, particularly mammals and short-range endemic species. Changes in fire regime, whether to more frequent or less frequent fires, may be significant to some fauna. Impacts of severe fire may be devastating to species already occurring at low densities or to species requiring long unburnt habitats to survive. In terms of conservation management, it is not fire *per se* but the fire regime that is important, with evidence that infrequent, extensive and intense fires adversely affect biodiversity, whereas frequent fires that cover small areas and are variable in both season and intensity can enhance biodiversity. Fire management may be considered the responsibility of managers of large tracts of land, including managers of mining tenements.

Dust, light, noise and vibration

Impacts of dust, light, noise and vibration upon fauna are difficult to predict. Some studies have demonstrated the impact of artificial night lighting on fauna, with lighting affecting fauna behaviour more than noise (Rich & Longcore, 2006). Effects can include impacts on predator-prey interactions, changes to mating and nesting behaviour, and increased competition and predation within and between invertebrates, frogs, birds and mammals.

The death of very large numbers of insects has been observed around some remote mine sites and attracts other fauna, notably native and introduced predators (M. Bamford pers. obs). The abundance of some insects can decline due to mortality around lights, although this has previously been recorded in fragmented landscapes where populations are already under stress (Rich & Longcore, 2006). Artificial night lighting may also lead to disorientation of migratory birds. Aquatic habitats and open habitats such as grasslands and dunes may be vulnerable to light spill.

Appendix 4. Ecological and threatening processes identified under legislation and in the literature.

Ecological processes are processes that maintain ecosystems and biodiversity. They are important for the assessment of impacts of development proposals, because ecological processes make ecosystems sensitive to change. The issue of ecological processes, impacts and conservation of biodiversity has an extensive literature. Following are examples of the sorts of ecological processes that need to be considered.

Ecological processes relevant to the conservation of biodiversity in Australia (Soule et al., 2004) :

- Critical species interactions (highly interactive species);
- Long distance biological movement;
- Disturbance at local and regional scales;
- Global climate change;
- Hydroecology;
- Coastal zone fluxes;
- Spatially-dependent evolutionary processes (range expansion and gene flow); and
- Geographic and temporal variation of plant productivity across Australia.

Threatening processes (EPBC Act)

Under the EPBC Act, a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 22 key threatening processes listed by the federal Department of Climate Change, Energy, the Environment, and Water (DCCEEW, 2023d) :

- Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (*Manorina melanocephala*).
- Competition and land degradation by rabbits.
- Competition and land degradation by unmanaged goats.
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*).
- Fire regimes that cause declines in biodiversity.
- Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South.
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations.
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis.
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris.
- Invasion of northern Australia by Gamba Grass and other introduced grasses.
- Land clearance.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean.
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.
- Novel biota and their impact on biodiversity.
- Predation by European red fox.
- Predation by exotic rats on Australian offshore islands of less than 1000 km^2 (100,000 ha).
- Predation by feral cats.
- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs.

- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species.
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*).
- The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta* (fire ant).

General processes that threaten biodiversity across Australia (The National Land and Water Resources Audit):

- Vegetation clearing;
- Increasing fragmentation, loss of remnants and lack of recruitment;
- Firewood collection;
- Grazing pressure;
- Feral animals;
- Exotic weeds;
- Changed fire regimes;
- Pathogens;
- Changed hydrology—dryland salinity and salt water intrusion;
- Changed hydrology— such as altered flow regimes affecting riparian vegetation; and
- Pollution.

In addition to the above processes, the federal Department of Agriculture, Water and the Environment (DAWE) produced Significant Impact Guidelines that provide criteria for the assessment of the significance of impacts. These criteria provide a framework for the assessment of significant impacts. The criteria are listed below.

- Will the proposed action lead to a long-term decrease in the size of a population?
- Will the proposed action reduce the area of occupancy of the species?
- Will the proposed action fragment an existing population?
- Will the proposed action adversely affect habitat critical to the survival of a species?
- Will the proposed action disrupt the breeding cycle of a population?
- Will the proposed action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?
- Will the proposed action result in introducing invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?
- Will the proposed action introduce disease that may cause the species to decline?
- Will the proposed action interfere with the recovery of the species?

Appendix 5. Scoring system for black-cockatoo foraging value.

Scoring system for the assessment of foraging value of vegetation for black-cockatoos.

Revised 6th February 2023

Bamford Consulting Ecologists

Introduction

Application of the Offset Assessment Guide (offsets guide) developed by the federal environment department for assessing Black-Cockatoo foraging habitat requires the calculation of a score out of 10. The following system has been developed by Bamford Consulting Ecologists (BCE) with assistance from Quessentia Consulting to provide an objective scoring system that is practical and can be used by trained field zoologists with experience in the environments frequented by the species.

The foraging value score provides a numerical value that reflects the significance of vegetation as foraging habitat for Black-Cockatoos, and this numerical value is designed to provide the information needed by the DCCEEW (formerly DAWE) to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed above. These three components are drawn from the DAWE offsets guide[2] but the scoring approach was developed by BCE and includes a fourth (moderation) component. Note that the scoring system can only be applied within the range of the species or at least where the species could reasonably be expected to occur based upon existing information.

Calculating the total score (out of 10) requires the following steps:

A. Site condition. Determining a score out of six for the vegetation composition, condition and structure; plus
B. Site context. Determining a score out of three for the context of the site; plus
C. Species stocking rate. Determining a score out of one for species density.
D. Determining the total score out of 10, which may require moderation for context and species density with respect to the site condition (vegetation) score. Moderation also includes consideration of pine plantations as a special case for foraging value.

The BCE scoring system places the greatest weight on site condition (scale of 0 to 6) because this has the highest influence on the foraging values of a site, which in turn is the fundamental driver in meeting ecological requirements for continued survival.

Site context has a lower weight (scale of 0 to 3) in recognition of the mobility of the species, which means they can access good foraging habitat even in fragmented landscapes, but allowing for recognition of the extent of available habitat in a region and context in relation to activity (such as breeding and roosting). The application of scoring site context is further discussed below.

Species stocking rate is given a low weight (0 to 1) as it is a means only of recognising that a species may or may not be abundant at a site, but that abundance is dependent upon site condition and

[2] https://www.agriculture.gov.au/sites/default/files/documents/offsets-how-use.pdf

context and is thus not an independent variable. The abundance of a species is also sensitive to sampling effort, and to seasonal and annual variation, and is therefore an unreliable indicator of actual importance of a site to a species.

Calculation of scores and the moderation process are described in detail below.

A. Site condition. Vegetation composition, condition and structure scoring

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
0	No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples: • Water bodies (e.g. salt lakes, dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits) or with vegetation of no food value, such as some suburban landscapes. • Mown grass	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).
1	Negligible to low foraging value. Examples: • Scattered specimens of known food plants but projected foliage cover of these is < 2%. This could include urban areas with scattered foraging trees; • Paddocks that are lightly vegetated with melons or other known food-source weeds (e.g. *Erodium* spp.) that represent a short-term and/or seasonal food source; • Blue Gum plantations (foraging by Carnaby's Black-Cockatoos has been reported but appears to be unusual).	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. This could include urban areas with scattered foraging trees.	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. Could include urban areas with scattered foraging trees.

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
2	Low foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, have < 10% projected foliage cover; • Woodland with tree banksias 2-5% projected foliage cover; • Eucalypt woodland/mallee of small-fruited species; • Paddocks that are densely vegetated with melons or other known food-source weeds (e.g. *Erodium* spp.) that represent a short-term and/or seasonal food source.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri and Jarrah) 1-5% projected foliage cover; • Urban areas with scattered foraging trees. • Paddocks with *Erodium* spp. and other weeds.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri, Jarrah or Sheoak) 1-5% projected foliage cover; • Urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *E. erythrocorys*. • Paddocks with *Erodium* spp. and other weeds.
3	Low to Moderate foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, have 10-20% projected foliage cover; • Woodland with tree banksias 5-20% projected foliage cover; • Eucalypt Woodland with Marri 5- 10% projected foliage cover. • Eucalypt Woodland/Forest with known food plants such as Marri 10-40% projected foliage cover but badly degraded understorey (poor long-term viability without management);	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri) 5-10% projected foliage cover; • Eucalypt Woodland/Forest with known food plants such as Marri 10-40% projected foliage cover but badly degraded understorey (poor long-term viability without management); • Managed revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability).	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri and Jarrah) 5-20% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants such as Marri 10-40% projected foliage cover but badly-degraded understorey (poor long-term viability without management); • Managed revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
4	Moderate foraging value. Examples: • Woodland/low forest with tree banksias (of key species *B. attenuata* and *B. menziesii*) 20-40% projected foliage cover; • Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have 20-40% projected foliage cover; • Eucalypt Woodland/Forest with Marri 20-60% projected foliage cover. Depending on understorey condition (and thus long-term viability) and Marri density, may downgrade to 3 or upgrade to 5.	Moderate foraging value. Examples: • Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths. • Eucalypt Woodland/Forest with diverse, healthy understorey and known food trees (especially Marri) 10-20% projected foliage cover. • Orchards with highly desirable food sources (e.g. apples, pears, some stone fruits).	Moderate foraging value. Examples: • Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with 40-60% projected foliage cover.
5	Moderate to High foraging value. Examples: • Banksia Low Forest (of key species *B. attenuata* and *B. menziesii*) with 40-60% projected foliage cover; • Banksia Low Forest (of key species *B. attenuata* and *B. menziesii*) with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Pine plantations with trees more than 10 years old (but see pine note below in moderation section).	Moderate to High foraging value. Examples: • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths.	Moderate to High foraging value. Examples: • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths. • Sheoak Forest with > 60% projected foliage cover.

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
6	High foraging value. Example: • Banksia Low Forest (of key species *B. attenuata* and *B. menziesii*) with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).	High foraging value. Example: • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).	High foraging value. Example: • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).

Vegetation structural class terminology follows Keighery (1994).

B. Site context

Site Context is a function of site size, availability of nearby habitat and the availability of nearby breeding areas. Site context includes consideration of connectivity, although Black-Cockatoos are very mobile and will fly across paddocks to access foraging sites. Based on BCE observations, Black-Cockatoos are unlikely to regularly go over open ground for a distance of more than a few kilometres and prefer to follow tree-lines.

The maximum score for site context is 3, and because it is effectively a function of presence/absence of nearby breeding and the distribution of foraging habitat across the landscape, the following table, developed by Bamford Consulting in conjunction with DEE, provides a *guide* to the assignation of site context scores. Note that 'local area' is defined as within a 15 km radius of the centre point of the study site. This is greater than the maximum distance of 12km known to be flown by Carnaby's Black-Cockatoo when feeding chicks in the nest.

Site Context Score	**Percentage of the existing native vegetation within the 'local' area that the study site represents.**	
	'Local' breeding known/likely	**'Local' breeding unlikely**
3	> 5%	> 10%
2	1 - 5%	5 - 10%
1	0.1 - 1%	1 - 5%
0	< 0.1%	< 1%

The table above provides weighting for where nearby breeding is known (or suspected) and for the proportion of foraging habitat within 15km represented by the site being assessed. Some adjustments may be needed based on the judgement of the assessor and in relation to the likely function of the site. For example, a small area of foraging habitat (eg 0.5% of such habitat within 15km) could be upgraded to a context of 2 if it formed part of a critical movement corridor. In contrast, the same sized area of habitat, of the same local proportion, could be downgraded if it were so isolated that birds could never access it. Adjustments to context score are further discussed below (moderation of scores).

C. Species density (stocking rate).

Species stocking rate is described as "the usage and/or density of a species at a particular site" in the offsets guide. The description also implies that a site supports a discrete population, which is unlikely in the case of very mobile black-cockatoos. Assignation of the species density score (0 or 1) is based upon the black-cockatoo species being either abundant or not abundant. A score of 1 is used where the species is seen or reported regularly and/or there is abundant foraging evidence. Regularly is when the species is seen at intervals of every few days or weeks for at least several months of the year. A score of 0 is used when the species is recorded or reported very infrequently and there is little or no foraging evidence. Where information on actual presence of birds is lacking, a species density score can be assigned by interpreting the landscape and the site context. For example, a site with a moderate condition score that is part of a network of such habitat where a black-cockatoo species is

known would get a species density score of 1 even without clear presence data, while a species density score of 0 can be assigned to a site where the level of usage can confidently be predicted to be low.

D. Moderation of scores for the calculation of a value out of 10.

The calculation out of 10 requires the vegetation characteristics (out of 6) to be combined with the scores given for context and species density. It is considered that the context and density scores are not independent of vegetation characteristics; otherwise habitat of absolutely no value for black-cockatoo foraging (such as concrete or a wetland) could get a foraging score out of 10 as high as 4 if it occurred in an area where the species breed (context score of 3) and are abundant (species density score of 1). Similarly, vegetation of negligible or low characteristics which could not support black-cockatoos could be assigned a score as high as 6 out of 10. In that case, the score of 6 would be more a reflection of nearby vegetation of high characteristics than of the foraging value of the negligible to low scoring vegetation. The Black-Cockatoos would only be present because of vegetation of high characteristics, so applying the context and species density scores to vegetation of low characteristics would not give a true reflection of their foraging value.

For this reason, the context and species density scores need to be moderated for the vegetation characteristic score to prevent vegetation of little or no foraging value receiving an excessive score out of 10. A simple approach is to assign a context and species density score of zero to sites with a Condition score of low (2), negligible (1) or none (0), on the basis that birds will not use such areas unless they are adjacent to at least low-moderate quality foraging habitat ($\geq$3). The approach to calculating a score out of 10 can be summarised as follows:

vegetation composition, condition and structure score (out of 6)	context score	Species density score
3-6 (low/moderate to high value)	Assessed as per B above	Assessed as per C above
0-2 (no to low value)	0	0

Note that this moderation approach may require interpretation depending on the context. For example, vegetation with a condition score of 2 could be given a context score of 1 under special circumstances; such as when very close to a major breeding area or if strategically located along a movement corridor. It could also get an elevated context score if it is the only foraging habitat in an area and birds are present, and also if it is immediately alongside at least moderately good foraging habitat, on the basis that birds are more likely to utilise it if they are nearby. Species density score might also be raised if there is a high likelihood of the birds actually being present. Context score can also be used to give a fine adjustment to the total score, such as if there are two vegetation types with the same vegetation composition score, but one may be slightly better foraging habitat and covers a larger area. Moderation is a means by which fairly subtle differences in overarching foraging value can be recognised.

Pine plantations

Pine plantations are an important foraging resource for Carnaby's Black-Cockatoo (only) but are not directly comparable with native vegetation. In comparing native vegetation with pine plantations for the purpose of calculating offsets, the following should be noted:

- Pine plantations are a commercial crop established with the intention of being harvested and thus have short-term availability (30-50 years), whereas native vegetation is available indefinitely if protected. Due to the temporary nature of pines as a food source, site condition and context differs between pines and native vegetation.
- Although pines provide a high abundance of food in the form of seeds, they are a limited food resource compared with native vegetation which provides seeds, insect larvae, flowers and nectar. The value of insect larvae in the diet of Carnaby's Black-Cockatoo has not been quantified, but in the vicinity of Perth, the birds forage very heavily on insect larvae in young cones of *Banksia attenuata* in winter, ignoring the seeds in these cones and seeds in older cones on the same trees (Scott & Black, 1981; M. Bamford pers. obs.). This suggests that insect larvae are of high nutritional importance immediately prior to the breeding season.
- Pine plantations have very little biodiversity value other than their importance as a food source for Carnaby's Black-Cockatoos. They inhibit growth of other flora. While this is not a factor for direct consideration with respect to Carnaby's Black-Cockatoo, it is a factor in regional conservation planning of which offsets for the cockatoos are a part.

Taking the above points into consideration, it is possible to assign pine plantations a foraging value as follows:

- Site condition. The actual foraging value of pines is high. Stock *et al.* (2013) report that it takes nearly twice as many seeds of *Pinus pinaster* to meet the daily energy requirements for Carnaby's Black-Cockatoo compared with Marri, and three times as many *P. pinaster* seeds compared with Slender Banksia. However, pines are planted at a high density so the food supply per hectare can be high. Taking account of the lack of variety of food from pines, this suggests a site condition score of 4 or 5 out of 6 (5 is used in Section A above). As a source of food, pines are thus comparable to the best banksia woodland. This site condition score then needs to be adjusted to take account of the short-term nature of the food supply (for pine plantations to be harvested. Where pines are 'ornamental, such as in some urban contexts, they can be treated as with other trees in urban landscapes). The foraging value of a site after pines are harvested will effectively be 0, or possibly 1 if there is some retention. It is proposed that this should approximately halve the site condition score; young pine plantations could be redacted slightly less than old plantations on the basis that a young plantation provides a slightly longer term food supply. If a maximum site condition score of 5 is given, then a young plantation (>10 but <30 years old) could be assigned a score of 3, and an old plantation (>30 years old) could be assigned a score of 2. Plantations <10 years old and thus not producing large quantities of cones could also get a score of 2, but recognising they may increase in value.
- Site context. Although a temporary food source, pines can be very important for Carnaby's Black-Cockatoo in some contexts; they could be said to carry populations in areas where there is little native vegetation. The system for assigning a context score as outlined above (Section B) also applies to pines. Thus, a context score of 3 can be given where pines are a significant proportion of foraging habitat (>5% if breeding occurs; >10% if no breeding), but where pines are a small part of the foraging landscape they will receive a context score of less than this.

- Species density. As outlined above (Section C), pines will receive a species density score of 1 where Carnaby's Black-Cockatoo are regular visitors. This is irrespective of an old plantation having a moderated condition score of 2.

Based on the above, pine plantations that represent a substantial part of the foraging landscape, such as in the region immediately north of Perth, would receive a total score (out of 10) of 6; young plantations in this area would receive a score of 7. In contrast, isolated and small plantations in rural landscapes could receive a score of just 2 if they are only a small proportion of foraging habitat and Carnaby's Black-Cockatoos are not regularly present.

Appendix 6. The foraging quality scoring tool template from DAWE (2022).

Table A1 Foraging quality scoring tool template

Starting score		Baudin's Cockatoo	Carnaby's Cockatoo	Forest Red-tailed Black-Cockatoo
10		**Start at a score of 10** if your site is native eucalypt woodlands and forest, and proteaceous woodland and heath, particularly Marri, within the range of the species, including along roadsides and parkland cleared areas. Can include planted vegetation. **This tool only applies to sites equal to or larger than 1 hectare in size.**	**Start at a score of 10** if your site is native shrubland, kwongan heathland or woodland, dominated by proteaceous plant species such as *Banksia* spp. (including *Dryandra* spp.), *Hakea* spp. and *Grevillea* spp., as well as native eucalypt woodland and forest that contains foraging species, within the range of the species, including along roadsides and parkland cleared areas. Also includes planted native vegetation. **This tool only applies to sites equal to or larger than 1 hectare in size.**	**Start at a score of 10** if your site is Jarrah or Marri woodland and/or forest, or if it is on the edge of Karri forest, or if Wandoo and Blackbutt occur on the site, within the range of the subspecies, including along roadsides and parkland cleared areas. **This tool only applies to sites equal to or larger than 1 hectare in size.**
Attribute	Sub-tractions	Context adjustor (attributes reducing functionality of foraging habitat)		
Foraging potential	-2	**Subtract 2** from your score if there is no evidence of feeding debris on your site.	**Subtract 2** from your score if there is no evidence of feeding debris on your site.	**Subtract 2** from your score if there is no evidence of feeding debris on your site.
Connectivity	-2	**Subtract 2** from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.	**Subtract 2** from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.	**Subtract 2** from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.
Proximity to breeding	-2	**Subtract 2** if you have evidence to conclude that your site is more than 12 km from breeding habitat	**Subtract 2** if you have evidence to conclude that your site is more than 12 km from breeding habitat.	**Subtract 2** if you have evidence to conclude that your site is more than 12 km from breeding habitat.
Proximity to roosting	-1	**Subtract 1** if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.	**Subtract 1** if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.	**Subtract 1** if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.
Impact from significant plant disease	-1	**Subtract 1** if your site has disease present (e.g. *Phytophthora* spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.	**Subtract 1** if your site has disease present (e.g. *Phytophthora* spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.	**Subtract 1** if your site has disease present (e.g. *Phytophthora* spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.
Total score		*Enter score*	*Enter score*	*Enter score*
Appraisal		To support your habitat score, you should provide an overall appraisal of the habitat on the impact site and within 20km of the impact area to clearly explain and justify the score. It should include discussion on the foraging habitat's proximity to other resources (e.g. exact distance to proximate resources), frequency of use of proximate sites, the degree of evidence and description of vegetation type and condition.		

Appendix 7. Draft DCCEEW Habitat Scoring System.

Habitat Scoring System for WA black cockatoo foraging habitat

This habitat scoring system describes elements indicative of suitable foraging habitat[1] for the three WA black cockatoo species (Carnaby's Black Cockatoo, Baudin's Black Cockatoo and the Forest Red-tailed Black Cockatoo) in WA. Its use must be supported by survey information and reporting, undertaken by suitably qualified and experienced ecologists.

Appropriate scores will best fit a description. Where all components of the 'detail' column description are not met, this must be specified, and justification provided for that score to be accepted by the Department.

For an offset site to be considered by the Department, the offset site must have a start score of 1 for each indicator (e.g., there must be a species stocking rate score of at least 1).

Indicator	Score	Detail		Impact site	Offset start quality	Without offset	With offset
Site Condition							
		Foraging value	Details				
Vegetation condition and structure. Habitat features	7	Very High	Carnaby's Black Cockatoo				
			Native kwongan heath and shrubland (>30% projected foliage cover), banksia and eucalypt woodlands with >50% projected foliage cover. Low percentage (< 5%) of tree deaths[2].				
			Baudin's Black Cockatoo				
			Marri-Jarrah Forest and woodlands with >50% projected foliage cover. Low percentage (< 5%) of tree deaths.				
			Forest Red-tailed Black Cockatoo				
			Marri-Jarrah-Karri Forest, other eucalypt woodlands, or allocasuarina woodlands, with >50% projected foliage cover. Low percentage (< 5%) of tree deaths.				
	6	High	Carnaby's Black Cockatoo				
			Native kwongan heath and shrubland (>25% projected foliage cover), banksia and eucalypt woodlands with >40% projected foliage cover. Low percentage (< 10%) of tree deaths.				
			Baudin's Black Cockatoo				
			Marri-Jarrah Forest and woodlands with >40% projected foliage cover. Low percentage (< 10%) of tree deaths.				
			Forest Red-tailed Black Cockatoo				
			Marri-Jarrah-Karri Forest, other eucalypt woodlands, or allocasuarina woodlands, with >40% projected foliage cover. Low percentage (< 10%) of tree deaths.				

[1] In some cases, an impact or offset site may contain or require both foraging and breeding habitat for one or more black cockatoos. Breeding habitat is species of trees known to support breeding within the range of the species which either have a suitable nest hollow or are of a suitable diameter at breast height (DBH) to develop a nest hollow. For most species of trees, suitable DBH is 500 mm. For salmon gum and wandoo, suitable DBH is 300 mm.

[2] No tree deaths indicate robustness of habitat, unlikely for the habitat to decline in the medium-term. Tree deaths may be owing to disease, water stress, fire, etc.

1

Vegetation condition and structure. Habitat features	5	Moderate to high	Carnaby's Black Cockatoo				
			Native kwongan heath and shrubland (>20% projected foliage cover), banksia and eucalypt woodlands with 30-40% projected foliage cover; OR > 60% projected foliage cover but veg. condition reduced due to tree deaths (up to 20%).				
			Baudin's Black Cockatoo				
			Marri-Jarrah Forest or woodlands with 30-40% projected foliage cover; OR > 60% projected foliage cover but veg. condition reduced due to tree deaths (up to 20%).				
			Forest Red-tailed Black Cockatoo				
			Marri-Jarrah-Karri Forest, other eucalypt woodlands, or allocasuarina woodlands, with 30-40% projected foliage cover; OR > 60% projected foliage cover but veg. condition reduced due to tree deaths (up to 20%).				
	4	Moderate	Carnaby's Black Cockatoo				
			Native kwongan heath and shrubland, banksia or eucalypt woodlands with 20-30% projected foliage cover. Moderate percentage of tree deaths (30-40%).				
			Baudin's Black Cockatoo				
			Marri-Jarrah Forest or woodlands with 20-30% projected foliage cover; OR Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to tree deaths (up to 30-40%).				
			Forest Red-tailed Black Cockatoo				
			Marri-Jarrah-Karri Forest, other eucalypt woodlands, or allocasuarina woodlands with: 20-30% projected foliage cover; OR 40-60% projected foliage cover but veg. condition reduced due to tree deaths (up to 30-40%).				
	3	Low to moderate	Carnaby's Black Cockatoo				
			Native kwongan heath and shrubland, banksia or eucalypt woodlands with 10-20% projected foliage cover.				
			Baudin's Black Cockatoo				
			Marri-Jarrah Forest or woodlands with 5-20% projected foliage cover.				
			Forest Red-tailed Black Cockatoo				
			Marri-Jarrah-Karri Forest, other eucalypt woodlands, or allocasuarina woodlands with 5-20% projected foliage cover.				
	2	Low	Carnaby's Black Cockatoo				
			Native kwongan heath and shrubland, banksia and eucalypt woodlands with <10% projected foliage cover; OR Paddocks and/or urban areas with scattered foraging trees such as banksias, marri.				
			Baudin's Black Cockatoo				
			Marri-Jarrah Forest or woodlands with 1-5% projected foliage cover; OR Paddocks and/or urban areas with scattered foraging trees such as banksia, hakea, dryandra.				

2

Vegetation condition and structure. Habitat features			Forest Red-tailed Black Cockatoo				
			Marri-Jarrah-Karri Forest, other eucalypt woodlands, or allocasuarina woodlands with 1-5% projected foliage cover; OR Paddocks and/or urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *E. erythrocorys*.				
	1	Negligible to low	All species				
			Scattered specimens of known food plants but projected foliage cover of these is <2%. May include: paddocks or urban areas with scattered foraging trees.				
	0	None	All species				
			No Proteaceae, eucalypts or other potential sources of food. May include bare ground or developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).				
			Totals				

Site Context								
Proximity of the site in relation to other habitat.	**3**	Site is within 6km of known breeding site.	or	Site is within 12km of other foraging resources with site condition of at least 3.				
	2	Site is within 12km of known breeding site.	or	Site is within 15km of other foraging resources with site condition of at least 4.				
	1	Site is within 15km of known breeding site.	or	Site is between 15km and 20km of other foraging resources with site condition of at least 5.				
	0	Site is further than 15km from known breeding site.	or	Site is further than 20km from other foraging resources.				
				Totals				

Final Totals				

Indicator		**Species Stocking Rate**[3]	**Impact Site**			**Offset Site**		
			CBC	**BBC**	**FRT**	**CBC**	**BBC**	**FRT**
Confirm presence/ absence of species.	**Yes**	Species is seen or reported regularly and/or there is abundant foraging evidence, e.g. chewed nuts can be identified as this species. Regularly is when the species is seen at intervals of every few days or weeks for at least several months of the year.						
	No	Species is recorded or reported very infrequently and there is little or no foraging evidence.						

[3] Species stocking rate is indicated by yes or no to confirm if any of the species is frequently present or not. If yes, the presence must be for the species being impacted by the proposal, not for a species that will not be impacted.

3

Legend	
	If the site scores between 0-2 (low to no value) for site condition, 0 for the site context score, or is **No** for species stocking rate, it is extremely unlikely to be considered as suitable habitat. This would not be appropriate to use as an offset site.

The metrics used to determine Site Condition, Site Context, and Species Stocking Rate were developed by the Department of Climate Change, Energy, the Environment, and Water in consultation with species experts in WA.

A standard habitat quality scoring system for a species allocates scores out of 3 for both site condition and site context, and out of 4 for species stocking rate. However, as black cockatoos are very mobile, this HQS uses a score out of 7 for site condition and a score out of 3 for site context. Site condition is considered the key factor in determining the quality of habitat for these black cockatoo species. Species stocking rate is considered only in terms of presence or absence of the species and does not add to the total score. Note that the species, or strong indicators of the species, must be present, consistent with the presence/usage description above, for an offset to be considered suitable.

4

Appendix 13. Map showing access restrictions.

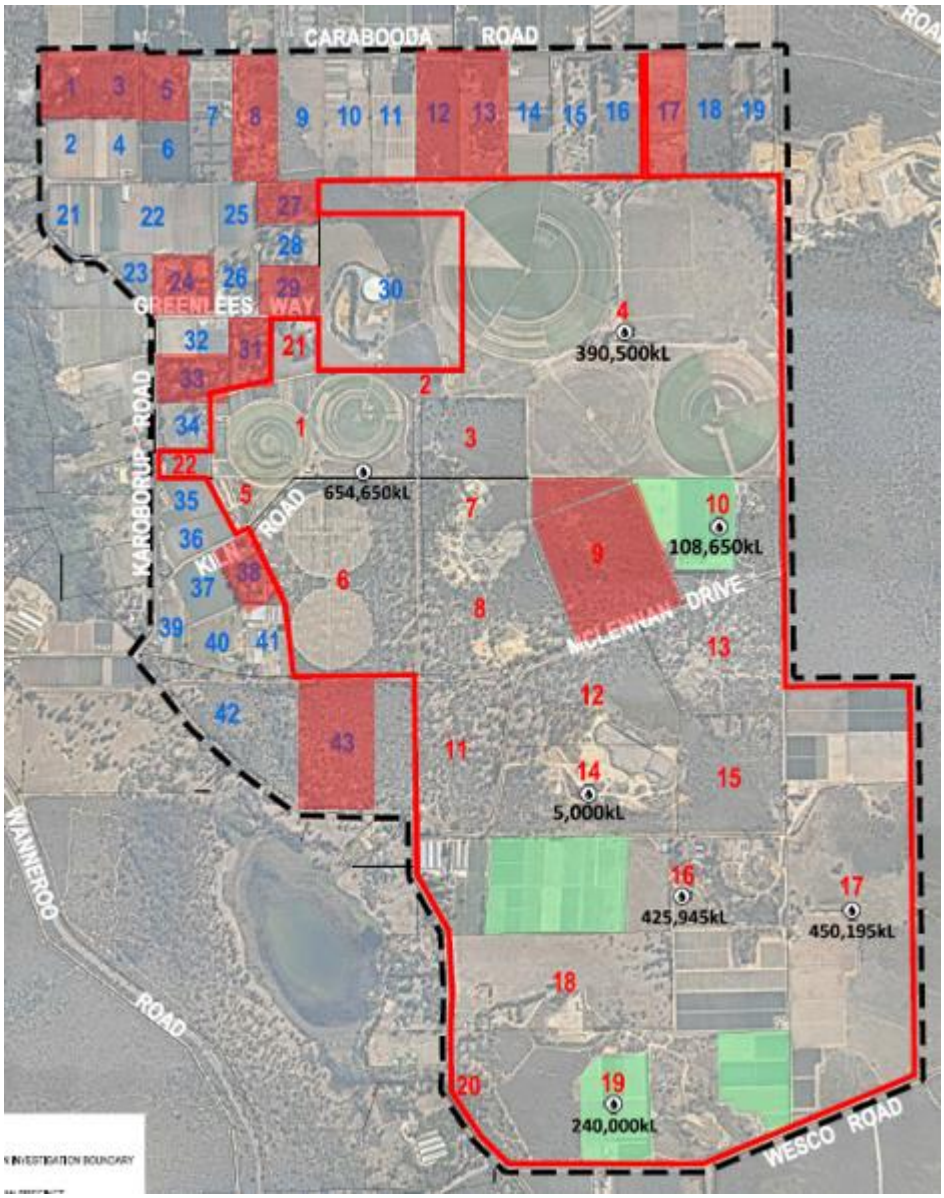


Figure 5-1. Lots highlighted in red represent areas that were not surveyed directly, mostly due to lack of landowner permission. The majority were able to be assessed from the boundary to inform VSA mapping and to assess foraging value. Large trees within these areas were not assessed for black-cockatoo hollows.

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Appendix D
The Carabooda Rezoning Project: Flora and Vegetation Survey (PGV, 2023)

CARABOODA REZONING PROJECT

FLORA AND VEGETATION SURVEY

Prepared for:	Carabooda Landowners Pty Ltd
Report Date:	6 December 2023
Version:	2
Report No.	2023-784

pgv ENVIRONMENTAL

CONTENTS

Contents i

List of Attachments ii

1 INTRODUCTION 1

1.1 Background 1

1.2 Scope of Works 1

2 EXISTING ENVIRONMENT 2

2.1 Historic Land Use 2

2.2 Topography 3

2.3 Geology and Soils 3

2.3.1 Geology 3

2.3.2 Soils 3

2.4 Hydrology 4

3 METHODOLOGY 5

3.1 Database Searches 5

3.2 Detailed Survey 5

3.3 Survey Conditions 6

4 RESULTS 8

4.1 Desktop Studies 8

4.1.1 Flora Database Searches 8

4.1.2 TEC/PEC Database Searches 14

4.2 Flora 15

4.3 Vegetation 17

4.3.1 Vegetation Complexes 17

4.3.2 Vegetation Types 17

4.3.3 Floristic Community Types 25

4.3.4 Vegetation Condition 26

4.4 Conservation Significance of Flora and Vegetation 27

4.4.1 Flora 27

4.4.2 Vegetation Complexes 27

4.4.3 Threatened and Priority Ecological Communities 28

5 SUMMARY 37

6 REFERENCES 39

LIST OF ATTACHMENTS

Tables

Table 1: Statement of Botanical Survey Conditions

Table 2: Identified Significant Flora Species and Likelihood of Occurring on the Site

Table 3: TEC and PECs Identified in Database Searches

Table 4: Vegetation Types on the Site

Table 5: FCT Analysis

Table 6: Vegetation Condition Rating Scale

Table 7: Vegetation Association Statistics

Table 8: Tuart TEC Condition Categories and Thresholds

Table 9: Tuart Woodland TEC Step 1 Diagnostics

Table 10: Tuart Woodland TEC Step 2 Diagnostics

Plates

Plate 1: Aerial Photograph from 1965 (Landgate, 2023)

Plate 2: Aerial Photograph from 1979 (Landgate, 2023)

Plate 3: Track Log

Plate 4: *Pimelea calcicola* Recorded on the Site

Plate 5: *Stylidium maritimum* Recorded on the Site

Plate 6: *Eucalyptus foecunda subsp. foecunda* Recorded on the Site

Plate 7: Tuart TEC Patch Boundaries

Plate 8: Variation Within a Patch

Figures

Figure 1: Site Location

Figure 2: Site Boundary and Topography

Figure 3: Vegetation Types

Figure 4: Vegetation Condition

Figure 5: Threatened Ecological Communities

Appendices

Appendix 1: DBCA Flora Database Searches

Appendix 2: Atlas of Living Australia Database Search

Appendix 3: Protected Matters Search Tool Report

Appendix 4: Conservation Codes

Appendix 5: DBCA TEC/PEC Database Search

Appendix 6: Flora Species List

Appendix 7: Quadrat Data

Appendix 8: Plantecology FCT Analysis

1 INTRODUCTION

1.1 Background

The Carabooda Rezoning Project (the site) is located in the City of Wanneroo, approximately 38km north-north-west of the Perth Central Business District (Figure 1). The site is approximately 660ha in size and is used for a variety of purposes including market gardens, turf farms, sand and limestone mining (past, present and possible future), rural retreats and undeveloped bushland (Figure 2).

Carabooda Landowners Pty Ltd is investigating the future urban development potential of the site.

This Flora and Vegetation Survey was commissioned by Carabooda Landowners Pty Ltd to assess the flora and vegetation values of the site.

1.2 Scope of Works

A Detailed Flora and Vegetation Survey was undertaken in accordance with the *EPA Technical Guidance: Flora and Vegetation Surveys* (EPA, 2016). The survey included the following:

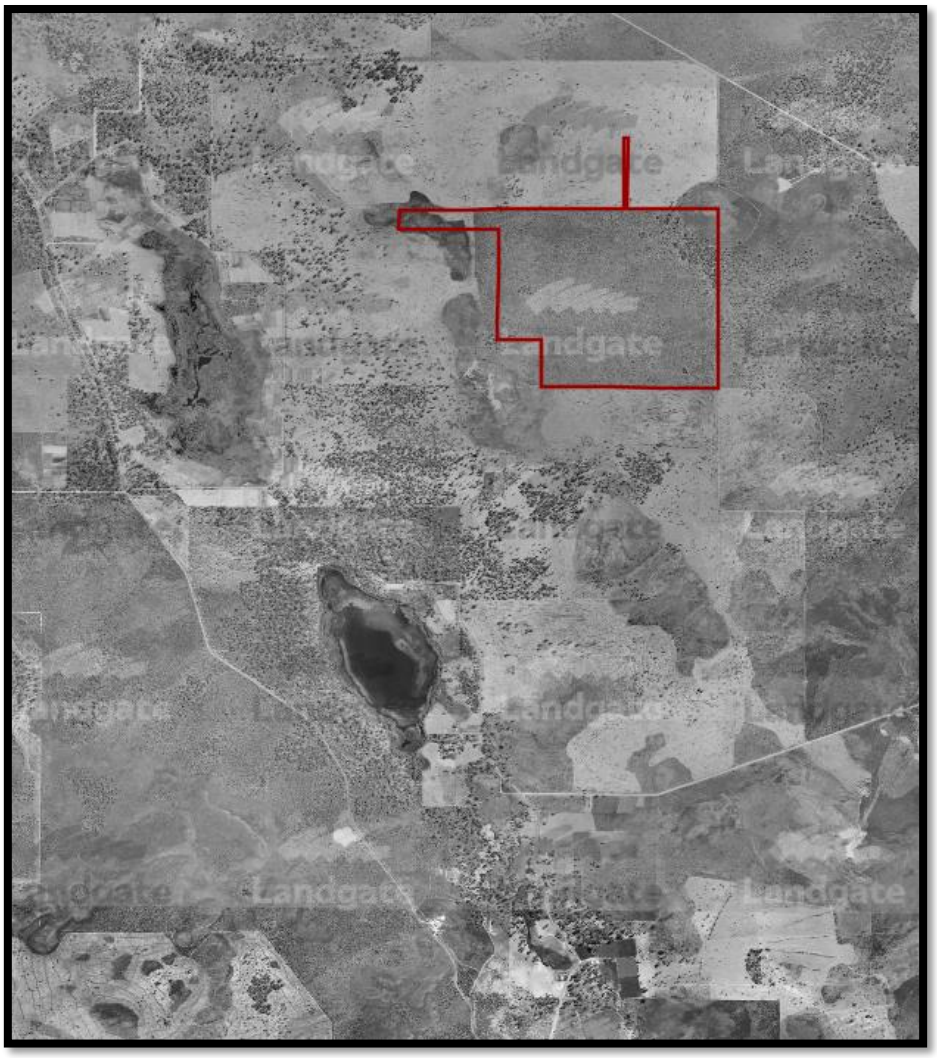
- Desktop search and review of the Department of Biodiversity, Conservation and Attractions (DBCA) Threatened and Priority flora database;
- A search of Atlas of Living Australia for records pf Threatened or Priority species;
- A search of the Commonwealth Government's Protected Matters Search Tool to identify species potentially occurring within the area that are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- Examination of historic and recent aerial photography and contour and soil maps to provisionally identify vegetation types and condition;
- Field survey using quadrats to record native and introduced species as well as a thorough site walkover of any areas of native vegetation;
- Analysis of quadrat data to ascertain the conservation significance of the vegetation;
- Recording of any significant plant species using a hand-held GPS;
- Description and mapping of vegetation types and vegetation condition; and
- Compilation of a flora list.

2 EXISTING ENVIRONMENT

2.1 Historic Land Use

Historical aerial photography shows that in 1965 (the oldest historical aerial photography available on-line) the northern third of the site (highlighted in red) was native vegetation while the southern two-thirds was a mix of cleared areas and remnant vegetation (Plate 1).

Plate 1: Aerial Photograph from 1965 (Landgate, 2023)



The 1979 aerial photograph shows the northern area has by then been cleared (Plate 2).

Plate 2: Aerial Photograph from 1979(Landgate, 2023)



2.2 Topography

The site is undulating with an elevation range from 24m Australian Height Datum (AHD) to 74mAHD (Figure 2).

2.3 Geology and Soils

2.3.1 Geology

The site is mapped as part of the Spearwood System which has the highest relief of the dune systems on the Swan Coastal Plain (Bolland, 1998). The Spearwood system consists of slightly calcareous Aeolian sand remnant from leaching of the underlying Pleistocene Tamala limestone (Davidson, 1995).

2.3.2 Soils

The soil units located on the site are described by the Department of Primary Industries and Regional Development (DPIRD) (2023) as:

- Karrakatta shallow soils Phase (211Sp_Kls) which are on low hills and ridges with bare limestone or shallow siliceous or calcareous sand over limestone.

- Karrakatta Sand Yellow Phase (211Sp_Ky) which are undulating dunes on Aeolian sand over limestone in the Swan Coastal Plain between Wanneroo and Lancelin and are yellow deep sands.
- Spearwood Sand Phase (211Sp_Sp) which are undulating dunes with rocky crests on aeolian sand over limestone in the Swan Coastal Plain between Wanneroo and Moore River. These soils are brown deep sands and yellow deep sands (DPIRD, 2023).

2.4 Hydrology

Maximum groundwater under the site is at approximately 16m to 20 AHD which is 10 to 50 m below the surface level. Groundwater generally flows to the west (DWER, 2023). There are no wetlands or watercourses mapped on the site.

3 METHODOLOGY

3.1 Database Searches

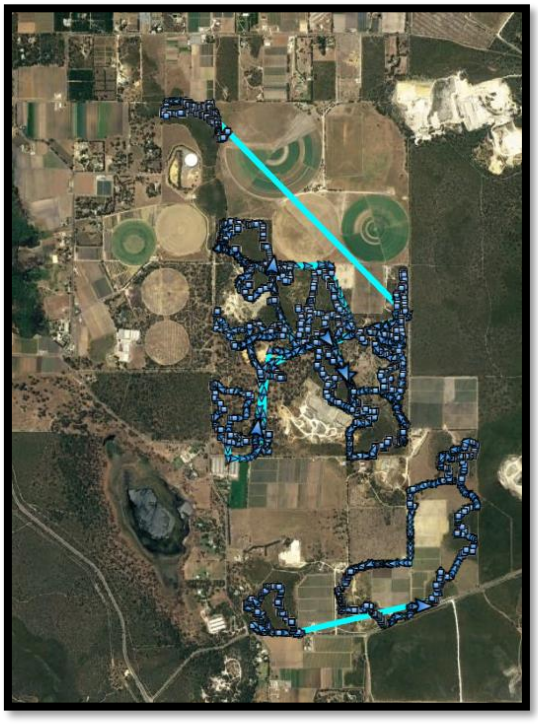
Searches of the following databases were undertaken prior to the site survey:

- DBCA Threatened and Priority Flora Databases including the WA Herbarium database (WAHerb) and Threatened (Declared Rare) and Priority Flora Species List (TFPL) (Appendix 1) for a radius of 10 km that provides a list of Threatened and Priority species recorded in the area;
- Atlas of Living Australia (ALA, 2022) (Appendix 2) which shows all species that have been recorded within a 10km radius of the site.
- The EPBC Act Protected Matters Search Tool (DCCEEW, 2022) (Appendix 3) which identifies species that are listed as Endangered, Threatened or Priority under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) could potentially have habitat within a 5km radius of the site.

3.2 Detailed Survey

The Detailed Flora and Vegetation Survey was undertaken between 14 September – 17 October 2023 on 8 separate field days. Due to the large size of the site and difficult terrain for walking in areas of outcropping limestone, sampling in closely spaced transects was not considered feasible. The survey included sampling from 39 permanently marked 10m x 10m quadrats as well as sampling from outside of the quadrats within the different vegetation types on the site. Quadrats in Very Good to Excellent condition were scored twice, once in September and a second time in mid-October. The track logs are shown in Plate 3.

Plate 3: Track Logs



Information on flora composition and vegetation structure was recorded in the quadrats.

Most plant species were identified in the field. Some specimens were photographed or taken for identification at the Perth Reference Herbarium or office using standard reference guides.

3.3 Survey Conditions

The conditions that the survey was undertaken in are presented in Table 1 in order to assess the adequacy of the survey. Rainfall for Perth (Measured at Wanneroo, Site Number 009105) above average in June and below average in July being 199.4mm and 66.4mm compared to an average of 160.9mm and 160.6mm (BOM, 2023). Rainfall in August and September was below average with 98.3mm and 73.5mm compared to 123.5 and 82.6mm (BoM, 2023). The below average rainfall in for most of the year was not sufficient to be considered a constraint on the survey.

Table 1: Statement of Botanical Survey Conditions

Issue	Constraints (Y/N)*	Comment
Competency/experience of the consultant conducting the survey	No	Dr Paul van der Moezel has extensive botanical survey experience on the Swan Coastal Plain, including the Wanneroo area.
Proportion of the flora identified^	Moderate	The timing of the survey in September-October was optimal to identify most flora species on the site including all potential Threatened and Priority Flora. Due to the large size of the site and difficult terrain for walking in areas of outcropping limestone, sampling in closely spaced transects was not considered feasible. Therefore, some plant species may have not been recorded.
Sources of information (historic/recent or new data)	No	The flora of the Swan Coastal Plain is well documented.
Proportion of the task achieved and further work that may need to be undertaken	No	More detailed survey of outcropping limestone areas may increase the number of Priority plants recorded on the site. However, no Threatened species are expected to occur which would warrant additional detailed surveys.
Timing/weather/season/cycle	No	The spring survey was optimal for most flora species. 2023 was a good year for ephemeral species, although the season finished early due to the small amount of rainfall in September.
Disturbances (Fire)	No	The site has not been recently burnt.
Intensity of survey (e.g. In retrospect was the intensity adequate)	No	The time spent on site, 8 man days, was considered adequate to sample a high proportion of the flora.
Completeness (e.g. was relevant area fully surveyed)	No	
Resources (e.g. degree of expertise available for plant identification)	No	Experienced botanist undertook most plant identifications on site.

Issue	Constraints (Y/N)*	Comment
Remoteness and/or access problems	No	Easily accessible site in the Perth Metropolitan Region.
Availability of contextual (e.g. bioregional) information for the study area.	No	WALGA statistics on remnant bushland

*Constraints have been rated as Significant, Moderate or No constraints

^Fungi and nonvascular flora (e.g. algae, mosses and liverworts) were not specifically surveyed for during the survey.

4 RESULTS

4.1 Desktop Studies

4.1.1 Flora Database Searches

The results from the database searches are shown in Table 2. A total of 41 species were identified in the database searches, including 14 Threatened and 27 Priority species. There were two Threatened species and one Priority species identified that are errors within the databases and do not grow in the Perth region. Table 2 lists the likelihood that any of the conservation significant species identified in the database searches could occur on the site based on the soil types and vegetation condition.

Two conservation significant species have been recorded in the northern part of the site on Lot 121 Carabooda Road as follows:

- *Eucalyptus argutifolia* (Endangered); and
- *Stylidium maritimum* (Priority 3).

Conservation codes are in Appendix 4

Table 2: Identified Significant Flora Species and Likelihood of Occurring on the Site

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act	Habitat*	Likelihood to occur on the site
Caladenia huegelii	King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid	Critically Endangered	Endangered	The Grand Spider-orchid prefers deep grey-white sand usually associated with the Bassendean sand-dune system, however, rare plants have been known to extend into the Spearwood system (in which calcareous yellow sands dominate) in some areas (DEC, 2009). This species generally does not survive in disturbed areas.	Unlikely – the location is further north of known populations
Drakaea elastica	Glossy-leafed Hammer Orchid	Critically Endangered	Endangered	The Glossy-leafed Hammer Orchid prefers low-lying situations adjoining winter-wet swamps and grows on bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps, typically in banksia (*Banksia menziesii*, *B. attenuata* and *B. ilicifolia*) woodland or spearwood (*Kunzea glabrescens*) thicket vegetation (DEC, 2009).	Highly Unlikely – not suitable habitat
Diuris purdiei	Purdie's Donkey-orchid	Endangered	Endangered	Purdie's Donkey Orchid occurs in grey-black sand in moist winter-wet swamps with winter inundation in dense heath with scattered trees and amongst native sedges and dense heath with scattered emergent *Melaleuca preissiana*, *Eucalyptus calophylla*, *E. marginata* and *Nuytsia floribunda*.	Highly Unlikely – not winter-wet habitat
Drakaea micrantha	Dwarf Hammer-orchid	Endangered	Vulnerable	Dwarf Hammer-orchid usually occurs on cleared fire breaks or open sandy patches in Banksia, Jarrah and Sheoak woodlands or forest and often found under Spearwood thickets.	Highly Unlikely – not suitable habitat and not recorded north of the Swan River
Macarthuria keigheryi	Keighery's Macarthuria	Endangered	Endangered	Keighery's Macarthuria prefers white or grey sand on low-lying winter-wet damp sands growing among heathland, Jarrah and Sheoak/Banksia woodland and Banksia/Eucalypt Woodland (DEC, 2008).	Highly Unlikely – not suitable habitat

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act	Habitat*	Likelihood to occur on the site
Marianthus paralius		Endangered	Endangered	*Marianthus paralius* occurs in white sand and brown loam amongst heath on coastal limestone cliffs (DEC, 2009).	Highly Unlikely – not suitable habitat
Melaleuca sp. Wanneroo (G.J. Keighery 16705)		Endangered	Endangered	*Melaleuca* sp. Wanneroo occurs in very shallow soils over limestone 'caprock' on ridges.	Possible – potential habitat occurs on the site
Andersonia gracilis	Slender Andersonia	Vulnerable	Endangered	Slender Andersonia occurs in white/grey sand, sandy clay, gravelly loam in winter-wet areas, near swamps. Vegetation type is low open heath with shrubs over sedges (DEC, 2006).	No – outside of species range, record is in error
Anigozanthos viridis subsp. *terraspectans*	Dwarf Green Kangaroo Paw	Vulnerable	Vulnerable	The Dwarf Green Kangaroo Paw occurs on grey sand, clay loam in winter-wet depressions.	Highly Unlikely – not suitable habitat
Banksia mimica	Summer Honeypot	Vulnerable	Endangered	Summer Honeypot prefers white or grey sand over laterite, sandy loam.	Highly Unlikely – not suitable habitat and not recorded in the vicinity of the site
Diuris micrantha	Dwarf Bee-orchid	Vulnerable	Vulnerable	The Dwarf Bee-orchid is usually found on brown loamy clay in winter-wet swamps, in shallow water.	Highly Unlikely – not suitable habitat
Eleocharis keigheryi	Keighery's Eleocharis	Vulnerable	Vulnerable	Keighery's Eleocharis occurs in clay, sandy loam and is emergent in freshwater: creeks, claypans.	Highly Unlikely – not suitable habitat
Eucalyptus argutifolia	Yanchep Mallee, Wabling Hill Mallee	Vulnerable	Vulnerable	The Yanchep Mallee occurs in shallow soils over limestone on slopes or gullies of limestone ridges, outcrops.	Highly Likely – habitat occurs on the site and has been previously recorded
Paracaleana dixonii	Sandplain Duck Orchid	Vulnerable	Endangered	Sandplain Duck Orchid occurs in grey sand over granite.	No – outside of species range, record is in error

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act	Habitat*	Likelihood to occur on the site
Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)		Priority 1		*Baeckea* sp. Limestone is recorded from limestone outcrop/ridge in yellow sand derived from Tamala Limestone - Spearwood Dune System in bushland burnt 5+ years (Western Australian Herbarium, 2012).	Possible – habitat may occur on the site
Drosera paleacea	Dwarf Sundew	Priority 1		Dwarf Sundew occurs in white sand, sandy clay.	Unlikely – not typical habitat
Leucopogon maritimus		Priority 1		*Leucopogon maritimus* occurs in Quindalup deep, calcareous sands, on the mid to upper slopes of dunes or in shallow sand over limestone, but avoiding the thicker vegetation of the swale (Hislop, 2011)	Highly Unlikely – not Quindalup habitat
Acacia benthamii		Priority 2		*Acacia benthamii* grows on sand, typically on limestone breakaways	Highly Unlikely – not limestone breakaway habitat
Adiantum capillus-veneris	Maidenhair	Priority 2		Maidenhair grows in moist, sheltered sites in gorges and on cliff walls.	No – outside of species range, record is in error
Fabronia hampeana		Priority 2		*Fabronia hampeana* occurs on sheltered wet trunk of *Macrozamia dyeri* in shrub layer (Western Australian Herbarium, 2005).	Highly Unlikely – host plant not recorded from the site
Netrostylis sp. Chandala (G.J. Keighery 17055)		Priority 2		*Netrostylis* sp. Chandala occurs in peaty sand on swamp edges.	Highly Unlikely – not suitable habitat
Adenanthos cygnorum subsp. *chamaephyton*		Priority 3		*Adenanthos cygnorum* subsp. *chamaephyton* occurs in grey sand, lateritic gravel.	Highly Unlikely – not suitable habitat
Conostylis bracteata		Priority 3		*Conostylis bracteata* occurs in sand, limestone on consolidated sand dunes.	Unlikely – not typical habitat

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act	Habitat*	Likelihood to occur on the site
Hibbertia leptotheca		Priority 3		*Hibbertia leptotheca* grows near-coastal limestone ridges, outcrops and cliffs in coastal heaths and thickets usually dominated by species of *Melaleuca* and *Acacia* (Thiele, 2019).	Highly Unlikely – not suitable habitat
Jacksonia gracillima		Priority 3		*Jacksonia gracillima* occurs in grey and brown well-drained sand.	Unlikely – not typical habitat
Lasiopetalum membranaceum		Priority 3		*Lasiopetalum membranaceum* grows in sand over limestone.	Unlikely – not typical habitat
Leucopogon sp. Yanchep (M. Hislop 1986)		Priority 3		*Leucopogon* sp. Yanchep occurs in light grey-yellow sand, brown loam, limestone, laterite, granite on coastal plain, breakaways, valley slopes, low hills.	Unlikely – not typical habitat
Pimelea calcicola		Priority 3		*Pimelea calcicola* occurs in sand on coastal limestone ridges.	Possible – habitat likely to occur on the site
Pithocarpa corymbulosa		Priority 3		*Pithocarpa corymbulosa* occurs in gravelly or sandy loam amongst granite outcrops.	Highly Unlikely – not suitable habitat
Sarcozona bicarinata	Ridged Noon-flower	Priority 3		Ridged Noon-flower is found in white sand in coastal areas.	Highly Unlikely – not suitable habitat
Sphaerolobium calcicola		Priority 3		*Sphaerolobium calcicola* grows in white-grey-brown sand, sandy clay over limestone, black peaty sandy clay on tall dunes, winter-wet flats, interdunal swamps, low-lying areas.	Highly Unlikely – not suitable habitat
Stylidium maritimum		Priority 3		*Stylidium maritimum* occurs in sand over limestone on dune slopes and flats in coastal heath and shrubland, open Banksia woodland.	Highly Likely – habitat occurs on the site and has been previously recorded
Styphelia filifolia		Priority 3		*Styphelia filifolia* occurs in sandy soils of the coastal plain (with one known occurrence from the northern Darling Scarp), usually in Banksia or Jarrah woodland and in low-lying situations (Hislop and Lelièvre, 2017).	Highly Unlikely – not suitable habitat

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act	Habitat*	Likelihood to occur on the site
Conostylis pauciflora subsp. *euryrhipis*		Priority 4		*Conostylis pauciflora* subsp. *euryrhipis* occurs in white, grey or yellow sand on consolidated dunes in coastal areas.	Highly Unlikely – not suitable habitat
Conostylis pauciflora subsp. *pauciflora*		Priority 4		*Conostylis pauciflora* subsp. *pauciflora* occurs in grey sand, limestone on hillslopes, consolidated dunes in coastal areas.	Unlikely – not typical habitat
Eucalyptus foecunda subsp. *foecunda*	Fremantle Mallee	Priority 4		Fremantle Mallee grows on yellowish coastal sands overlying limestone, often on limestony hills and dunes, in shrubland or very open woodland (Nicolle and French, 2021).	Unlikely – not typical habitat
Jacksonia sericea	Waldjumi	Priority 4		Waldjumi grows in calcareous and sandy soils.	Possible – habitat may occur on the site
Lepidium pseudotasmanicum		Priority 4		*Lepidium pseudotasmanicum* occurs in loam, sand associated with granite.	Highly Unlikely – not suitable habitat
Stylidium longitubum	Jumping Jacks	Priority 4		Jumping Jacks prefer sandy clay, clay in seasonal wetlands.	Highly Unlikely – not suitable habitat
Stylidium striatum	Fan-leaved Triggerplant	Priority 4		The Fan-leaved Triggerplant grows in brown clay loam over laterite on hillslopes in Jarrah/Marri forest, Wandoo woodland.	Highly Unlikely – not suitable habitat
Tripterococcus sp. *Brachylobus* (A.S. George 14234)		Priority 4		*Tripterococcus* sp. Brachylobus occurs in grey, black or peaty sand winter-wet flats.	Highly Unlikely – not suitable habitat

* sourced from Florabase as well as the DBCA database searches unless otherwise denoted

4.1.2 TEC/PEC Database Searches

A search of DBCA's Threatened (TEC) and Priority Ecological Communities (PEC) database was conducted within a radius of 10 km around the site (10-0822EC) (Appendix 5). Five TECs and seven PECs were identified. One TEC and three of the PECs are part of a Federally listed TEC. The communities identified in the database searches are outlined in Table 3.

Table 3: TEC and PECs Identified in Database Searches

Number	Description	Conservation Status in Western Australia	Status under the EPBC Act
CAVES SCP01	Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain	Critically Endangered	Endangered
SCP19b	Woodlands over Sedgelands in Holocene dune swales of the southern Swan Coastal Plain (floristic community type 19 as originally described in Gibson et al. 1994)	Critically Endangered	Endangered
SCP10a	Shrublands on dry clay flats (floristic community type 10a as originally described in Gibson *et al.* (1994))	Endangered	Critically Endangered
SCP26a	*Melaleuca huegelii - Melaleuca systena* shrublands on limestone ridges (floristic community type 26a as originally described in Gibson *et al*. (1994))	Endangered	Pending Critically Endangered
SCP20a	*Banksia attenuata* woodlands over species rich dense shrublands (floristic community type 20a as originally described in Gibson et al. (1994))	Endangered	Endangered as part of the Banksia WL SCP
SCP22	*Banksia ilicifolia* woodlands	Priority 3	Endangered as part of the Banksia WL SCP
SCP23b	Swan Coastal Plain *Banksia attenuata - Banksia menziesii* woodlands	Priority 3	Endangered as part of the Banksia WL SCP
SCP24	Northern Spearwood shrublands and woodlands	Priority 3	
SCP30b	Quindalup *Eucalyptus gomphocephala* and/or *Agonis flexuosa* woodlands	Priority 3	Critically Endangered as part of the Tuart Woodlands
SCP29b	*Acacia* shrublands on taller dunes	Priority 3	
Banksia WL SCP	Banksia Woodlands of the Swan Coastal Plain ecological community	Priority 3	Endangered
Tuart woodlands	Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain	Priority 3	Critically Endangered

Of the TECs and PECs identified in the database search the following communities are mapped as occurring on the site:

- Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain;
- SCP24 Northern Spearwood shrublands and woodlands;
- Banksia Woodlands of the Swan Coastal Plain ecological community; and
- Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain.

Based on the preliminary assessment of vegetation types on the site the following additional FCTs are considered to potentially occur on the site:

- SCP20a *Banksia attenuata* woodlands over species rich dense shrublands
- SCP23b Swan Coastal Plain *Banksia attenuata - Banksia menziesii* woodlands
- SCP26a *Melaleuca huegelii - Melaleuca systena* shrublands on limestone ridges

4.2 Flora

A total of 226 plant species were recorded during the flora survey (Appendix 6). The total consisted of 172 native species and 54 (23.9%) introduced species. The number of native species is considered moderate for a 660ha site.

The plant Families with the highest representation of species were the Fabaceae (Wattle and Pea family – 22 species, 19 native and 3 introduced), Asteraceae (Daisy family – 19 species, 11 native, 8 introduced), Proteaceae (Banksia family – 18 species, all native), Poaceae (Grass family – 17 species, 5 native, 12 introduced), Myrtaceae (Myrtle family – 16 species, 15 native and 1 introduced), Orchidaceae (Orchid family – 12 species, 11 native, 1 introduced) and Asparagaceae (Asparagus family - 10 species, 9 native and 1 introduced).

Six plants of the Threatened species, *Eucalyptus argutifolia*, was recorded on the site at a previously known location on Lot 121 Carabooda Road. The plants occur at the base of a limestone ridge (Figure 3). The plants are very close to the boundary of Lot 121 and Lot 50 to the south. As the boundary is not fenced the plants may straddle both lots.

Two small populations of the Priority 3 species *Pimelea calcicola* were recorded (Plate 4) on the site, both in areas of outcropping limestone, one on Lot 104 McLennan Drive and the other on Lot 121 Carabooda Road (Figure 3).

One population of the Priority 3 species *Stylidium maritimum* Plate 5) was recorded at the base of the limestone ridge on Lot 121 Carabooda Road (Figure 3).

Two plants of the Priority 4 species *Eucalyptus foecunda* subsp. *foecunda* was recorded on disturbed limestone soils at the eastern end of the quarry on Lot 104 McLennan Drive (Figure 3).

Plate 4: *Pimelea calcicola* Recorded on the Site



Plate 5: *Stylidium maritimum* Recorded on the Site



Plate 6: *Eucalyptus foecunda* subsp. *foecunda* Recorded on the Site



Species richness in the 39 quadrats ranged from 9-48 with a range of 4-38 native species, averaging 32 native species. The average number of weed species was 10 (34.5%).

4.3 Vegetation

4.3.1 Vegetation Complexes

Vegetation complexes are a very broad mapping unit based on landform and soils type (Heddle *et al.*, 1980). Almost all of the site is mapped as the Cottesloe Complex-Central and South. There is a very small area in the southwestern part of the site that is mapped as the Herdsman Complex. The Herdsman Complex is associated with wetlands and includes Sedgelands and fringing woodlands of Flooded Gum. As these do not occur in the south-west corner of the site, the mapping of the Herdsman Complex on the site is considered an error.

The Cottesloe Complex-Central and South is described as:

> – Mosaic of woodland of *Eucalyptus gomphocephala* (Tuart) and open forest of *E. gomphocephala* – *E. marginata* (Jarrah) – *Corymbia calophylla* (Marri), closed heath on the limestone outcrops' (Heddle *et al.,* 1980).

4.3.2 Vegetation Types

Vegetation types are a finer level of vegetation description and mapping used for small scale sites, such as the survey area. Vegetation types are described based on the structure of the vegetation (eg. woodland, heath) and the dominant species in each structure.

Thirteen vegetation types were described and mapped on the site (Figure 3). The vegetation types are described in Table 4. Quadrat Data are in Appendix 7.

Native vegetation was mapped over 237.05ha of the 660ha site.

Table 4: Vegetation Types on the Site

Vegetation Type	Description	Photograph
MhMs *Melaleuca huegelii/M. systena* Closed Heath	This vegetation type occurs on the top of several limestone ridges in the northern half of the site. *Melaleuca huegelii* and *M. systena* are dense and around 2-2.5m high. Common understorey species include *Grevillea preissii, Austrostipa flavescens, Banksia dallanneyi, Trymalium ledifolium, Diplopeltis huegelii* and *Desmocladus flexuosus.* The soils are shallow orange-brown sand with extensive outcropping limestone. Quadrats C21, C30 and C33 are representative of this vegetation type. The total area of this vegetation type is 5.31ha.	
MhBs *Melaleuca huegelii/Banksia sessilis* Closed Tall Scrub over *Melaleuca systena/Hibbertia hypericoides* Open Low Heath	Similar to the MhMs vegetation type but with *Banksia sessilis* (Parrot Bush) common. Occurs at the eastern end of the quarry on Lot 104 McLennan Drive and a small area on Lot 13 Wesco Road. Typical understorey species include *Lepidosperma calcicola, Hakea lissocarpha, Hakea trifurcata, Trymalium ledifolium, Grevillea preissii* and *Desmocladus flexuosus.* The soils are orange-brown sand with abundant surface limestone. Quadrats C6, C13, C36 and C39 are representative of this vegetation type. The total area of this vegetation type is 2.37ha.	

Vegetation Type		Description	Photograph
Bs	*Banksia sessilis/Calothamnus quadrifidus* Open Heath over *Hibbertia hypericoides* Open to Closed Low Heath	A common vegetation type on the lower to mid-slopes of limestone ridges where the depth of sand is deeper than in the MhMs and MhBs units. *Banksia sessilis* is 1-2m high and sparse to moderately dense at 5-25% cover. Common species include *Hibbertia hypericoides, Xanthorrhoea preissii, Templetonia retusa, Melaleuca systena, Calothamnus quadrifidus, Petrophile serruriae, Mesomelaena pseudostygia* and *Homalosciadium homalocarpum.* The soils are orange-brown sand with some surface limestone. Quadrats C2, C4, C5, C15, C24 and C38 are representative of this vegetation type. The total area of this vegetation type is 50.09ha.	
EdBs	*Eucalyptus decipiens* Low Open Woodland over *Banksia sessilis* Tall Open Shrubland over *Melaleuca systena/Hibbertia hypericoides* Closed Low Heath	Occurs in the southern end of the site on the lower slopes of limestone hills. *Eucalyptus decipiens* is 5-12m high and sparse to moderate at 2-25% cover. The understorey commonly includes *Banksia sessilis, Calothamnus quadrifidus, Xanthorrhoea preissii, Hibbertia hypericoides, Dianella revoluta* var. *divaricata* and *Conostylis aculeata.* The soils are orange-brown sand with some surface limestone. Quadrats C1, C7 and C14 are representative of this vegetation type. The total area of this vegetation type is 23.75ha.	

Vegetation Type		Description	Photograph
EgBs	*Eucalyptus gomphocephala* Woodland over *Banksia sessilis/Calothamnus quadrifidus* Open Heath over *Hibbertia hypericoides* Closed Low Heath	Very similar to the Bs vegetation type but with *Eucalyptus gomphocephala* (Tuart) present as a tree up to 15m high and relatively low density. Common understorey species include *Banksia sessilis, Acacia pulchella, Hakea trifurcata, Mesomelaena pseudostygia* and *Hibbertia hypericoides.* The soils are orange-brown sand with some surface limestone. Quadrats C3, C23 and C35 are representative of this vegetation type. The total area of this vegetation type is 17.65ha.	
AfBs	*Allocasuarina fraseriana* Low Open Woodland over *Banksia sessilis/Xanthorrhoea preissii/Hibbertia hypericoides* Open Low Heath	One stand of this vegetation type occurs at the northwestern end of the site. It is the only area where *Allocasuarina fraseriana* (Sheoak) occurs with few other tree species. *Jacksonia sternbergiana* is a common tall shrub species which indicates some disturbance in the past. Other common species include *Xanthorrhoea preissii, Banksia sessilis, Hibbertia hypericoides* and a variety of weed species. The soils are yellow-grey sand. Quadrat C34 is representative of this vegetation type. The total area of this vegetation type is 1.22ha.	

Vegetation Type	Description	Photograph
Et *Eucalyptus todtiana* Low Open Woodland over weeds	This vegetation type occurs at the southern end of the site on Lot 11 Wesco Road and occurs in a disturbed area that has been partially cleared. *Eucalyptus todtiana* and *Nuytsia floribunda* (WA Christmas Tree) are 5-6m high and 5-10% cover. Most of the understorey consists of weeds but *Hibbertia hypericoides* and *Xanthorrhoea preissii* are reasonably common. The soils are yellow-brown sand. Quadrat C8 is representative of this vegetation type. The total area of this vegetation type is 3.99ha.	
EtBaBm *Eucalyptus todtiana/Banksia attenuata/B. menziesii* Low Open Woodland over *Xanthorrhoea preissii/Daviesia divaricata* Tall Shrubland over *Eremaea pauciflora/Hibbertia hypericoides* Open Low Heath	This vegetation type occurs on deep sand and in large patches in the central part of the site. *Eucalyptus todtiana* is the main tree species present, up to 4m high. *Banksia attenuata* and *B. menziesii* are co-dominant with around 5-10% cover. Common understorey specie include *Xanthorrhoea preissii, Hibbertia hypericoides, Daviesia divaricata, Eremaea pauciflora, Mesomelaena pseudostygia, Bossiaea eriocarpa* and *Burchardia congesta.* The soils are yellow-brown sand. Quadrats C9, C10, C26 and C37 are representative of this vegetation type. The total area of this vegetation type is 36.66ha.	

Vegetation Type	Description	Photograph
BaBmEt *Banksia attenuata/Banksia menziesii/Eucalyptus todtiana* Low Woodland over *Allocasuarina humilis/Calothamnus quadrifidus/Hibbertia hypericoides* Closed Heath	Similar to the EtBaBm vegetation type but with fewer *E. todtiana.* The understorey is also slightly different with *Allocasuarina humilis* a common species as well as *Hibbertia hypericoides, Calothamnus quadrifidus* and *Mesomelaena pseudostygia.* Occurs in the central part of the site on deep sands. The soils are light orange-brown sand. Quadrats C25 and C31 are representative of this vegetation type. The total area of this vegetation type is 7.35ha.	
Em *Eucalyptus marginata* Low Woodland over *Xanthorrhoea preissii* Tall Shrubland	Occurs on lower areas in the central part of the site. All of the areas mapped have a very weedy understorey. The *Eucalyptus marginata* (Jarrah) trees have mostly been coppiced with few to no old, mature single stem trees. *Xanthorrhoea preissii* is the most common native understorey species while the most common weed species is Perennial Veldtgrass (*Ehrharta calycina*). The soils are dark brown sand. Quadrats C11, C19, C28 and C32 are representative of this vegetation type. The total area of this vegetation type is 18.10ha.	

Vegetation Type		Description	Photograph
Eg	*Eucalyptus gomphocephala* Woodland over *Xanthorrhoea preissii* Shrubland over *Mesomelaena pseudostygia/Phyllanthus calycinus* Open Low Heath	Occurs on the lower slopes of limestone hills, mostly in the central part of the site. *Eucalyptus gomphocephala* (Tuart) is up to 25m high and moderately dense (15-25% cover). Typical understorey species include *Xanthorrhoea preissii, Mesomelaena pseudostygia, Phyllanthus calycinus, Hakea lissocarpha* and *Desmocladus flexuosus.* The soils are orange-brown sand with some surface limestone. Quadrats C12, C17, C22, C27 and C29 are representative of this vegetation type. The total area of this vegetation type is 15.71ha.	
EgEm	*Eucalyptus gomphocephala/E. marginata* Woodland over **Ehrharta calycina* Closed Grassland	This is an extensive vegetation type that occurs on the western side of the site on lower elevation land. All of the mapped occurrences are in Degraded condition with Perennial Veldtgrass the dominant weed species. *Xanthorrhoea preissii* is the only common native species. Many of the Tuart trees are single stem, mature specimens. The soils are orange-brown sand. Quadrats C16 and C20 are representative of this vegetation type. The total area of this vegetation type is 50.05ha.	

Vegetation Type	Description	Photograph
CcEm *Corymbia calophylla/Eucalyptus marginata* Low Woodland over *Xanthorrhoea preissii* Shrubland	Only one area containing Marri (*Corymbia calophylla*) mixed with Jarrah was recorded on the site, at the southern end of Lot 107 Godel Road. The vegetation is in Degraded to Completely Degraded condition with Perennial Veldtgrass dominating the understorey. *Xanthorrhoea preissii* is the only common native species. The soils are dark brown sand. Quadrat C18 is representative of this vegetation type. The total area of this vegetation type is 4.79ha.	

4.3.3 Floristic Community Types

Floristic Community Types (FCT) are based on the whole floristic composition of the vegetation (trees, shrubs, herbs, sedges etc) rather than being determined by soil type and geomorphology (Vegetation Complex) or the nature of the dominant species (Vegetation Types). Many of the Threatened and Priority Ecological Communities on the Swan Coastal Plain are based on the FCT level of vegetation description.

The FCTs of the southern Swan Coastal Plain were initially identified in a study undertaken by the (then) Department of Conservation and Land Management and the Conservation Council of Western Australia (Gibson *et al.* 1994). The study analysed the floristic composition of 509 10m x 10m quadrats by computer programmes. The analysis resulted in the definition of 43 community types and sub-types.

The database searches identified four FCTs that could potentially occur on the site, including one that has been mapped on the site:

- SCP24 Northern Spearwood shrublands and woodlands (mapped on the site)
- SCP20a *Banksia attenuata* woodlands over species rich dense shrublands
- SCP23b Swan Coastal Plain *Banksia attenuata - Banksia menziesii* woodlands
- SCP26a *Melaleuca huegelii - Melaleuca systena* shrublands on limestone ridges

To determine whether any of these FCTs occur on the site, quadrat data were analysed using the PATN computer programme. Computer analysis of FCTs requires high quality quadrat data to achieve meaningful results. Therefore, only 8 of the 39 quadrats were used in the analysis. The 8 quadrats had vegetation condition in Excellent and Very Good condition. The results of the analysis, undertaken by Plantecology are provided in Appendix 8.

The results of the numerical analysis indicate that the vegetation types that occur on shallow sand over limestone soils are FCT 24 'Northern Spearwood shrublands and woodlands'. The vegetation on deeper sands is more typical of FCT 28 'Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands' (Table 5). As mentioned in the Plantecology report, the presence of Tuart (*Eucalyptus gomphocephala*) could indicate the occurrence of one of the Tuart-dominated woodlands, eg. FCT 25 and 30b, however the data do not support this. Tuart was recorded from 24% of the FCT 24 quadrats sampled by Gibson *et al.* (1994). Therefore, the conclusion that the Tuart Woodland vegetation type (represented by quadrat C22) is not an unexpected result.

The numerical analysis discusses the potential for the vegetation containing *Melaleuca huegelii* to be representative of FCT 26a '*Melaleuca huegelii-M. systena* shrublands of limestone ridges'. However, none of the three quadrats analysed that contained *Melaleuca huegelii* as a common species showed any similarity to FCT 26a. Two of the quadrats sampled from the MhMs vegetation type (C30 and C33) resulted in an FCT analysis as ?29a 'Coastal shrublands on shallow sands'. Plantecology commented that the result was anomalous given that FCT 29a is found on coastal dunes on the Quindalup Dune System, which does not occur on the Carabooda site. Plantecology identify a number of statistical reasons why the MhMs quadrats resulted in FCT 29a rather than the expected 26a and concluded that the possibility that Plot C30 belongs to FCT 26b and Plot C33 to FCT 26a cannot be excluded. Gibson *et al*. (1994) describe FCT 26a as occurring on skeletal soils on limestone ridge slopes and ridge tops while FCT 26b occurs on the lower slopes or in pockets with deeper soil which allow overstorey trees

to develop. Both C30 and C33 were recorded from the top of hills with shallow skeletal sand and abundant surface limestone. PGV Environmental considers the most likely FCT for the MhMs vegetation type is FCT 26a.

Table 5: FCT Analysis

Quadrat	Vegetation Type	Description	Likely FCT
C30	**MhMs**	*Melaleuca huegelii/M. systena* Closed Heath	?26a
C33	**MhMs**	*Melaleuca huegelii/M. systena* Closed Heath	?26a
C13	**MhBs**	*Melaleuca huegelii/Banksia sessilis* Closed Tall Scrub over *Melaleuca systena/Hibbertia hypericoides* Open Low Heath	24
C15	**Bs**	*Banksia sessilis/Calothamnus quadrifidus* Open Heath over *Hibbertia hypericoides* Open to Closed Low Heath	24
C1	**EdBs**	*Eucalyptus decipiens* Low Open Woodland over *Banksia sessilis* Tall Open Shrubland over *Melaleuca systena/Hibbertia hypericoides* Closed Low Heath	24
C22	**Eg**	*Eucalyptus gomphocephala* Woodland over *Xanthorrhoea preissii* Shrubland over *Mesomelaena pseudostygia/Phyllanthus calycinus* Open Low Heath	24
C25	**BaBmEt**	*Banksia attenuata/Banksia menziesii/Eucalyptus todtiana* Low Woodland over *Allocasuarina humilis/Calothamnus quadrifidus/Hibbertia hypericoides* Closed Heath	28
C31	**BaBmEt**	*Banksia attenuata/Banksia menziesii/Eucalyptus todtiana* Low Woodland over *Allocasuarina humilis/Calothamnus quadrifidus/Hibbertia hypericoides* Closed Heath	28

4.3.4 Vegetation Condition

The condition of the vegetation was assessed according to the system devised by Keighery and described in Bush Forever (Government of Western Australia, 2000) (Table 6).

Table 6: Vegetation Condition Rating Scale.

Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

Condition	Description
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Source: Government of Western Australia, 2000.

The vegetation condition ranged from Excellent to Completely Degraded (Figure 4). Generally, the areas with the best quality vegetation were the areas of outcropping and shallow limestone. The areas of deeper sand over limestone contained more weeds, with Perennial Veldtgrass the most common weed species. Areas of Banksia and *Eucalyptus todtiana* vegetation in Very Good to Excellent condition were recorded in the central part of the site on Lots 105 McLennan Drive, 116 Kiln Road and 115 Kiln Road. These areas are all contiguous.

4.4 Conservation Significance of Flora and Vegetation

4.4.1 Flora

One Threatened species was recorded on the site being the Yanchep mallee (Eucalyptus argutifolia). The Yanchep Mallee is protected under the *Biodiversity Conservation Act 2016* (BC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

One plant of the Priority 3 species, *Pimelea calcicola*, was recorded on the site. *Pimelea calcicola* is normally found on coastal limestone ridges but has been recorded further inland including in the Joondalup area. The Priority 3 species *Stylidium maritimum* was also recorded on the site.

Priority 3 plant species are poorly known species that are either known from several locations but are not under imminent threat, or are known from few but widespread locations not under imminent threat. Priority species are not protected by environmental legislation at State or Commonwealth level.

4.4.2 Vegetation Complexes

The percentage retention and reservation of the vegetation complexes mapped on the site are outlined in Table 7.

Table 7: Vegetation Association Statistics

Vegetation Complex	Pre-European Extent	Remaining on Swan Coastal Plain		Remaining in Secure Tenure	
	Area (ha)	Area (ha)	%	Area (ha)	%
Cottesloe Complex-Central and South	45,299	14,567	32.16	2,053	9.51

The percentage remaining is above EPA's 10% minimum criteria for vegetation complexes in the Perth and Peel Region Constrained Areas.

4.4.3 Threatened and Priority Ecological Communities

Two Floristic Community Types were analysed as definitely occurring on the site, FCT 24 and 28 with FCT 16a most likely. FCT 24 is a Priority 3 Ecological Community at State level. Both FCT24 and 28 are part of the State and Federally listed Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community. Further analysis of each vegetation type with respect to the Banksia Woodland TEC criteria is provided in the following section.

FCT 26a is a Threatened Ecological Community (Critically Endangered) at State and at Federal level is recognised as the 'Honeymyrtle Shrubland on Limestone Ridges of the Swan Coastal Plain Bioregion' ecological community which was listed under the EPBC Act being on 15 November 2023.

4.4.3.1 Banksia Woodland TEC Assessment

The Banksia Woodlands of the Swan Coastal Plain ecological community was listed as an Endangered community under the Commonwealth EPBC Act on 16 September 2016. The Banksia Woodland ecological community is listed as a Priority Ecological Community at State level.

The *Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community* (Commonwealth of Australia, 2016) (Conservation Advice) describes the Banksia Woodland TEC as:

> *The ecological community is a woodland associated with the Swan Coastal Plain of southwest Western Australia. A key diagnostic feature is a prominent tree layer of Banksia, with scattered eucalypts and other tree species often present among or emerging above the Banksia canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range* (Commonwealth of Australia, 2016).

The Banksia Woodland TEC is most commonly dominated by *Banksia attenuata* and/or *B. menziesii* and in some examples *B. prionotes* or *B. ilicifolia.*

Two vegetation types on the site (EtBaBm and BaBmEt) contain a prominent layer of *Banksia attenuata* and *B. menziesii* co-dominant with *Eucalyptus todtiana*. The other vegetation types either have no Banksia trees or a very sparse cover and are therefore considered not a part of the Banksia Woodland TEC.

For an area of Banksia woodland to meet the criteria of the Banksia Woodland TEC it needs to be in at least Good condition and meet a minimum patch size depending on the condition of the vegetation. The areas mapped as EtBaBm and BaBmEt in Good condition or better are much larger than the minimum 2ha size requirement to be the Banksia Woodland TEC. These areas are therefore considered a part of the Banksia Woodland TEC.

The location of vegetation considered to meet the definition of the Banksia Woodland TEC is shown in Figure 5. The total area of Banksia Woodland TEC is 38.36ha.

4.4.3.2 Tuart Woodland Assessment

Description

The Tuart Woodlands and Forests of the Swan Coastal Plain was listed as a Threatened Ecological Community (TEC) with a rating of Critically Endangered under the Commonwealth EPBC Act on 4 July 2019 (for brevity the community will be called the Tuart Woodland TEC in this report). The Tuart Woodland ecological community is listed as a Priority Ecological Community at State level.

A description of the Tuart Woodland TEC is contained in the *Approved Conservation Advice (incorporating listing advice) for the Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain ecological community* (Commonwealth of Australia, 2019). According to the Conservation Advice the diagnostic characteristics of the TEC are:

Key diagnosis characteristics

- The ecological community is limited to patches of vegetation (with their associated biota) that meet all of the following key diagnostic characteristics:
- Occurs in the Swan Coastal Plain Bioregion, Western Australia (IBRA v7. Department of the Environment 2012).
- Primarily occurs on the Spearwood and Quindalup dune systems but can also occur on the Bassendean dunes and Pinjarra Plain. It can occur on the banks of rivers and wetlands.
- The primary defining feature is the presence of at least two living established *Eucalyptus gomphocephala* (Tuart) trees in the uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent Tuart trees. These trees may occur either as single stemmed trees or as a mallee growth form.
- Most often occurs as a woodland but can occur in other structural forms, For example, forest, open forest, woodland, open woodland, and various mallee forms.
- Other tree species may be present in the canopy or sub-canopy. They commonly include: *Agonis flexuosa* (Peppermint) and *Banksia grandis* (Bull Banksia) (both in the southern part of the range), *Banksia attenuata* (Candlestick Banksia), *Eucalyptus marginata* (Jarrah); and less commonly, *Corymbia calophylla* (Marri), *Banksia menziesii* (Firewood Banksia) and *Banksia prionotes* (Acorn Banksia).
- An understorey of native plants is typically present, which may include grasses, herbs and shrubs, although this is often modified by disturbance. Some understorey plant species that are most commonly present are listed in Section 2.3.3 of the Conservation Advice.
- Native fauna species that are most commonly present are noted in Section 2.4 of the Conservation Advice (Commonwealth of Australia, 2019).

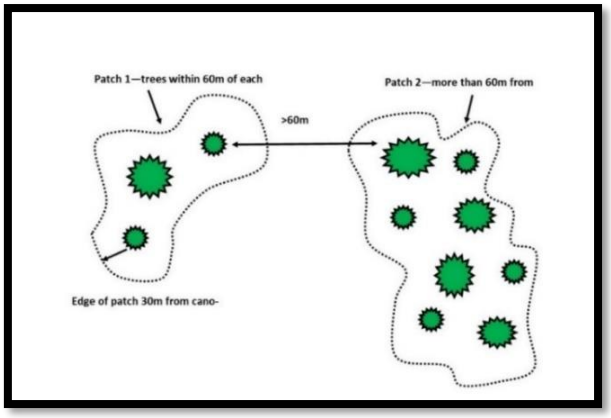
Defining a patch of the ecological community

- A patch of the ecological community is a discrete and mostly continuous area of vegetation that meets the key diagnostic characteristics.
- Boundaries for a patch can extend beyond a site or property boundary, or potential area of impact for a proposed action.
- The patch boundary is 30 m beyond the outer canopy of the established Tuart trees (≥15 cm diameter at breast height (DBH)), including dead Tuart trees (stags). See Plate 6
- Where a dead Tuart tree (stag) is being considered for inclusion in a patch of the ecological community, the vertical projection of its outermost remaining branches is used to define the

edge of its canopy. If the species of a stag tree is unclear, if the edge of its canopy is within 60 m of an identified Tuart tree the stag is presumed to be a Tuart.

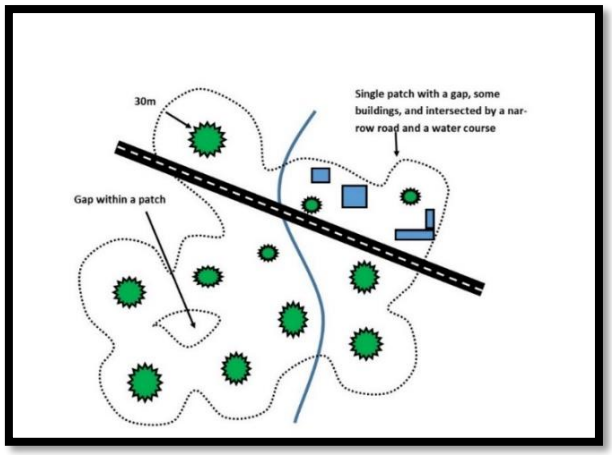
- Patches of Tuart woodlands and forests may contain areas that vary in structural or biological complexity. One part of a patch may have a larger number of mature trees and more ecological diversity, whereas another part of the same patch may demonstrate fewer mature trees and less groundcover. Areas with soil exposed and/or plant litter can also be expected within this ecological community.
- Variation in quality or condition of vegetation across a patch should not necessarily be considered to be evidence of multiple patches. Patches of the ecological community can be spatially variable and are often characterised by one or more areas within a patch that meet higher condition thresholds amongst areas of lower condition.
- If an area meets the key diagnostic characteristics but the average condition across that area falls below the minimum condition thresholds, the largest area or areas of at least 0.5 ha that meet minimum condition thresholds on average, should be specified as the patch or patches of the nationally listed ecological community. This may result in multiple patches of the ecological community being identified within the overall area first identified as meeting the key diagnostics.
- A patch may include small areas without understorey vegetation, such as bare ground, as well as waterbodies or hardscape (e.g. roads, paths, car parks, or buildings) that do not significantly alter the overall function of the ecological community. These small areas do not break up a patch, or divide a patch into multiple patches, as long as there are some parts of the canopy within 60 m of the outer edges of the canopies of adjacent Tuart trees (as per Plate 6). However, existing buildings and other human-made structures and gardens are not part of the nationally protected ecological community and should be excluded from the calculation of patch size and condition. See Plate 7 (Commonwealth of Australia, 2019).

Plate 8: Tuart TEC Patch Boundaries



Source: Commonwealth of Australia, 2019

Plate 9: Variation Within a Patch*



* including small areas without understorey vegetation, and a small gap within a patch due to part of the Tuart canopy being >60 m apart

Source: Commonwealth of Australia, 2019

Condition thresholds and categories

For confirmed patches of the ecological community, following the key diagnostic characteristics and patch definition above (Step 1), determine the following requirements for information on condition to indicate if they are part of the nationally protected ecological community:

- If the patch is smaller than 0.5 ha it is **not** part of the nationally protected ecological community.
- If **the patch is at least 0.5 ha and up to 5 ha** in size, conduct on ground surveys. Patches in this size range are presumed to be part of the nationally protected ecological community unless surveys indicate they do not meet the minimum condition required for national protection. For patches in this size range inclusion in the nationally protected ecological community is determined by surveyed characteristics such as native plant species richness and contribution to cover, habitat values, evidence of regeneration and landscape characteristics.
- **All patches of 5 ha or greater** that meet the key diagnostic characteristics **are part of the nationally protected ecological community**. It is not necessary to conduct additional surveys to confirm that they meet biotic condition thresholds (Table 8) and that they are protected.

Table 8: Tuart TEC Condition Categories and Thresholds

All patches ≥5 ha is part of the nationally protected ecological community, regardless of their understorey condition. That is, thresholds in this table do not apply to patches ≥5 ha, but the key diagnostic characteristics and patch definition must be met.

Patch size Biotic thresholds	≥2 ha <5 ha	≥0.5 ha <2 ha
Very high condition ≥80 % of all understorey^ vegetation cover is native# Or At least 12 native understorey^ species per 0.01 ha (10 m x 10 m	Medium sized patches with very high condition understorey. PART OF THE PROTECTED ECOLOGICAL COMMUNITY	Smaller patches with very high condition understorey. PART OF THE PROTECTED ECOLOGICAL COMMUNITY

Patch size Biotic thresholds	≥2 ha <5 ha	≥0.5 ha <2 ha
plot or equivalent sample unit)		
High condition ≥60 % of all understorey^ vegetation cover is native# Or At least 8 native understorey^ species per 0.01 ha (10 m x 10 m plot or equivalent sample unit)	Medium sized patches with high condition understorey. PART OF THE PROTECTED ECOLOGICAL COMMUNITY	Smaller patches with high condition understorey. **AND** That either: have an important landscape role (≤100 m to native vegetation)* OR have a habitat role (≥2 very large trees per 0.5 ha)* OR show regeneration (≥15 seedlings and/or saplings per 0.5 ha)* PART OF THE PROTECTED ECOLOGICAL COMMUNITY
Moderate condition ≥50 % of all understorey^ vegetation cover is native# Or At least 4 native understorey^ species per 0.01 ha (10 m x 10 m plot or equivalent sample unit)	Medium sized patches with moderate condition understorey. **AND** That either: have an important landscape role (≤100 m to native vegetation)* OR have a habitat role (≥2 very large trees per 0.5 ha)* OR show regeneration (≥15 seedlings and/or saplings per 0.5 ha)* PART OF THE PROTECTED ECOLOGICAL COMMUNITY	NOT PART OF THE PROTECTED ECOLOGICAL COMMUNITY (but may be a focus for local protection or restoration)
Poor Has minimal or no native cover and species richness. That is: <50 % of all understorey^ vegetation cover is native# And Less than 4 native understorey^ species per 0.01 ha (10 m x 10 m plot or equivalent sample unit)	NOT PART OF THE PROTECTED ECOLOGICAL COMMUNITY (but may be a focus for local protection or restoration)	NOT PART OF THE PROTECTED ECOLOGICAL COMMUNITY (but may be a focus for local protection or restoration)

Tuart Woodland TEC Assessment

Three vegetation types on the site contain Tuart trees as the dominant component of the tree canopy. The presence of Tuart trees does not automatically mean that the Tuart Woodland TEC occurs on site. The Conservation Advice contains the following step-wise approach in determining if the TEC occurs on a site:

- Step 1: Is the Tuart Woodlands and Forests ecological community in your proposed project site? Is it in other adjacent or off-site areas that may be impacted (for example, by introducing weeds)?
- Step 2: What is the patch size and condition category of the Tuart Woodlands and Forests in the proposed project site and in the surrounding area?

The assessment of the Tuart Woodland TEC on the site is outlined in Table 9 and Table 10.

In summary, all vegetation types containing Tuart trees are large enough or contiguous with other areas offsite that contain Tuart trees to be considered patches of the Tuart Woodland TEC. The location of the Tuart Woodland TEC is shown on Figure 5. Areas of Tuart woodland with a Poor condition class due to low numbers of native understorey species and high proportion of weed species are in a contiguous patch that is well over 5ha in size and are therefore automatically included as part of the Tuart Woodland TEC.

The total area of Tuart Woodland TEC is 82.86ha.

Step 1: Is the Tuart Woodlands and Forests ecological community in your proposed project site? Is it in other adjacent or off-site areas that may be impacted (for example, by introducing weeds)?

Table 9: Tuart Woodland TEC Step 1 Diagnostics

Key diagnostic characteristics♦	**Information**	**Key diagnostic questions*** (Refer to Section 3.2 of the Approved Conservation Advice for a complete explanation of these diagnostic features – other sections of the Approved Conservation Advice are referenced where relevant)	**Response (yes/no/possibly) and detailed comments. Use as much space as you need to fully answer the question#**
Location and physical environment	Bioregion	Is the proposal site within the Swan Coastal Plain IBRA bioregion?	Yes
Soils and Landform	Soil type	Is the soil type consistent with where the Tuart Woodlands and Forests may occur? (see Section 2.2.1♦)	Yes, Spearwood Dune soil type
	Location in the landscape, topography	Is the topography/physical environment consistent with where the Tuart Woodlands and Forests may occur? Is the site associated with any hydrology (groundwater/surface water)?	Yes, Tuarts commonly found in the Wanneroo area. Not associated with any wetlands
Structure	Presence of Tuart trees	How many Tuart trees are present and are they consistent with the characteristics set out in the Approved Conservation Advice? **Note:** Please present this information in terms of total number of trees (dead, established, seedlings etc.) and trees per hectare of the footprint. Diagrams/maps should also be provided.	The site is too large to count all Tuart trees with a DBH equal to or greater than 30cm and a concise count is not considered necessary as there would be hundreds of Tuart trees that meet this criterion.
	Structural form	What structural form is the vegetation?	Low Open Woodland to Woodland
Composition	Dominant tree species, emergent tree layer, understory	Is the composition of the community consistent with the characteristics set out in the Approved Conservation Advice? What other tree species are present? How many native understorey species are present and what is the number of weedy species/proportion of weeds?	Tuarts occur in many areas as the sole tree species and in other areas co-dominant with Jarrah trees. Native understorey species ranges from 3-34 in 9 quadrats. Number of weed species ranges from 4-13. Proportion of weeds to native understorey species ranges from 21-73%. Refer to quadrat data in Appendix 7.

Key diagnostic characteristics♦	Information	Key diagnostic questions* (Refer to Section 3.2 of the Approved Conservation Advice for a complete explanation of these diagnostic features – other sections of the Approved Conservation Advice are referenced where relevant)	Response (yes/no/possibly) and detailed comments. Use as much space as you need to fully answer the question#
Defining a patch of Tuart Woodlands and Forests	Patch definition	What is the extent of the patch? **Note:** Descriptions of patch extent must include analysis of canopy extent and associated understorey vegetation (see Section 3.2.2♦). Patches may extend beyond the project area or include areas of infrastructure (i.e. road, powerline). The referral should make clear how, and how much of the patch will be directly or indirectly impacted.	Each Tuart tree was not mapped on the site as there are hundreds of Tuarts present. Therefore a 30m perimeter around Tuart tree canopies is not able to be mapped. However, based on our site investigations the density of Tuarts on the site is highly likely that the 30m perimeter overlaps in all areas mapped with Tuart trees.
Relationship with other ecological communities	Other vegetation communities	Are other vegetation communities present? What are they and how do they intergrade and/or interact with the Tuart Woodlands and Forests TEC? (see Section 3.2.3♦)	The site contains other dryland woodland vegetation that does not contain Tuart trees as well as wetland vegetation in the south-east corner.

The complete key diagnostic characteristics are provided in the Approved Conservation Advice.

* The Tuart Woodlands and Forests may include restored, planted or revegetated flora. Do not exclude vegetation from being classed as the Tuart Woodlands and Forests because it is a planted, restoration or revegetation site (unless it is a garden).

Comments should include references to appropriate supporting information and data.

Step 2: What is the patch size and condition category of the Tuart Woodlands and Forests in the proposed project site and in the surrounding area?

Table 10: Tuart Woodland TEC Step 2 Diagnostics

Size and condition♦	**Information**	**Relevant content to be discussed in the referral** (Refer to Section 3.3 of the Approved Conservation Advice for a complete explanation of these diagnostic features)	**Detailed comments.** **Use as much space as you need to fully answer the question#**
Patch Size	Patch size in hectares	Is the patch size large enough to meet the minimum patch size in this section? (Section 3.3♦) **Note:** Patch boundaries are not limited to the proposal site. You must make clear that the patch boundary is consistent with Section 3.2.2♦.	The areas mapped with Tuart trees are mostly well above the minimum 5ha to meet the criteria for the TEC regardless of understorey condition. The smaller areas have a High species richness and only need to be 0.5ha in size to be the TEC which they are.
Patch condition	Condition thresholds	Using the condition categories in this section, what is the patch condition? (Section 3.3.1♦) What is the quality and size (hectares) of the vegetation community in and around the site where the proposed action will occur? Is the patch expected to improve in condition (e.g. after appropriate fire management) or is there a threatening process underway that will reduce the current size and/or condition? **Note:** Refer to Section 3.4 – Step 3 – Further information to assist in identifying patches of the protected ecological community and avoiding significant adverse impacts. If patch quality varies over the site; characterisation of the variation should be provided. Patch condition includes consideration of thresholds for characteristics such as plant species richness, landscape features, Tuart tree age and size and other habitat roles of the vegetation. Other vegetation condition measures (e.g. Keighery scale) do not necessary reflect the condition thresholds and both should be provided, where relevant. Where threats are identified (i.e. those listed in Appendix C of the Approved Conservation Advice) please provide further information on what these are and how they have impacted the condition.	The 9 quadrats assessed have 3-34 native understorey species per 0.1ha. 7 of the quadrats have more than 12 species which gives the quadrats a Very High rating. Two have less than 4 which gives those quadrats a Poor rating. The two quadrats with a Poor rating are within the same patch of Tuart woodland that is larger than 5ha and is therefore automatically part of the Tuart Woodland TEC regardless of the Poor rating.

♦ Further information on the key diagnostic characteristics is provided in the Approved Conservation Advice.

Comments should include references to appropriate supporting information and data. The response which includes the information does not need to be presented in table form.

5 SUMMARY

The Flora and Vegetation survey of the Carabooda Rezoning Project resulted in the following:

1. Native vegetation occurs on 237.05ha of the 660ha site;

2. Thirteen vegetation types were recorded and mapped on the site. The different types were related to the variation in depth of sand over limestone and the associated position of the vegetation in the landscape, eg. top of a limestone ridge or on lower land;

3. The condition of the vegetation ranged from Excellent to Completely Degraded. The vegetation on shallow sand or outcropping limestone were in the best condition. Areas of Banksia/*Eucalyptus todtiana* vegetation in Very Good to Excellent condition occurred in the central part of the site in one contiguous area.;

4. A total of 226 plant species were recorded on the site. The total consisted of 172 native species and 54 (23.9%) introduced species. The number of native species is considered moderate for the size of the site;

5. One Threatened plant species, *Eucalyptus argutifolia,* was recorded from a known population at the northern end of the site;

6. Three Priority species, *Pimelea calcicola, Stylidium maritimum* and *Eucalyptus foecunda* subsp. *foecunda* were recorded in low numbers on the site, all associated with outcropping limestone areas;

7. Three Floristic Community Types were analysed as occurring on the site. The vegetation types on areas of shallow sand over limestone were assessed as FCT 24 'Northern Spearwood shrublands and woodlands'. The vegetation types occurring on deeper sand were assessed as FCT 28 'Spearwood *Banksia attenuata* or *Banksia attenuata* – *Eucalyptus* woodlands'. The FCT analysis result for the vegetation type MhMs that occurs on the top of limestone hills was anomalous due to low species richness in the quadrats. The most likely result is for MhMs being FCT 26a '*Melaleuca huegelii-M. systena* shrublands of limestone ridges'. FCT 26a is a Threatened Ecological Community at State and Commonwealth level. FCT 24 is a Priority 3 Ecological Community at State level;

8. The areas of EtBaBm and BaBmEt vegetation type in Good condition or better were assessed as being part of the Banksia Woodlands of the Swan Coastal Plain ecological community which is a TEC at State and Commonwealth level. A total of 38.36ha of the Banksia Woodland TEC occurs on the site; and

9. The three vegetation types containing Tuart trees were all considered to be representative of the Tuart Woodlands and Forests of the Swan Coastal Plain ecological community which is a

TEC at Commonwealth level and State level. A total of 82.86 of the Tuart Woodland TEC occurs on the site.

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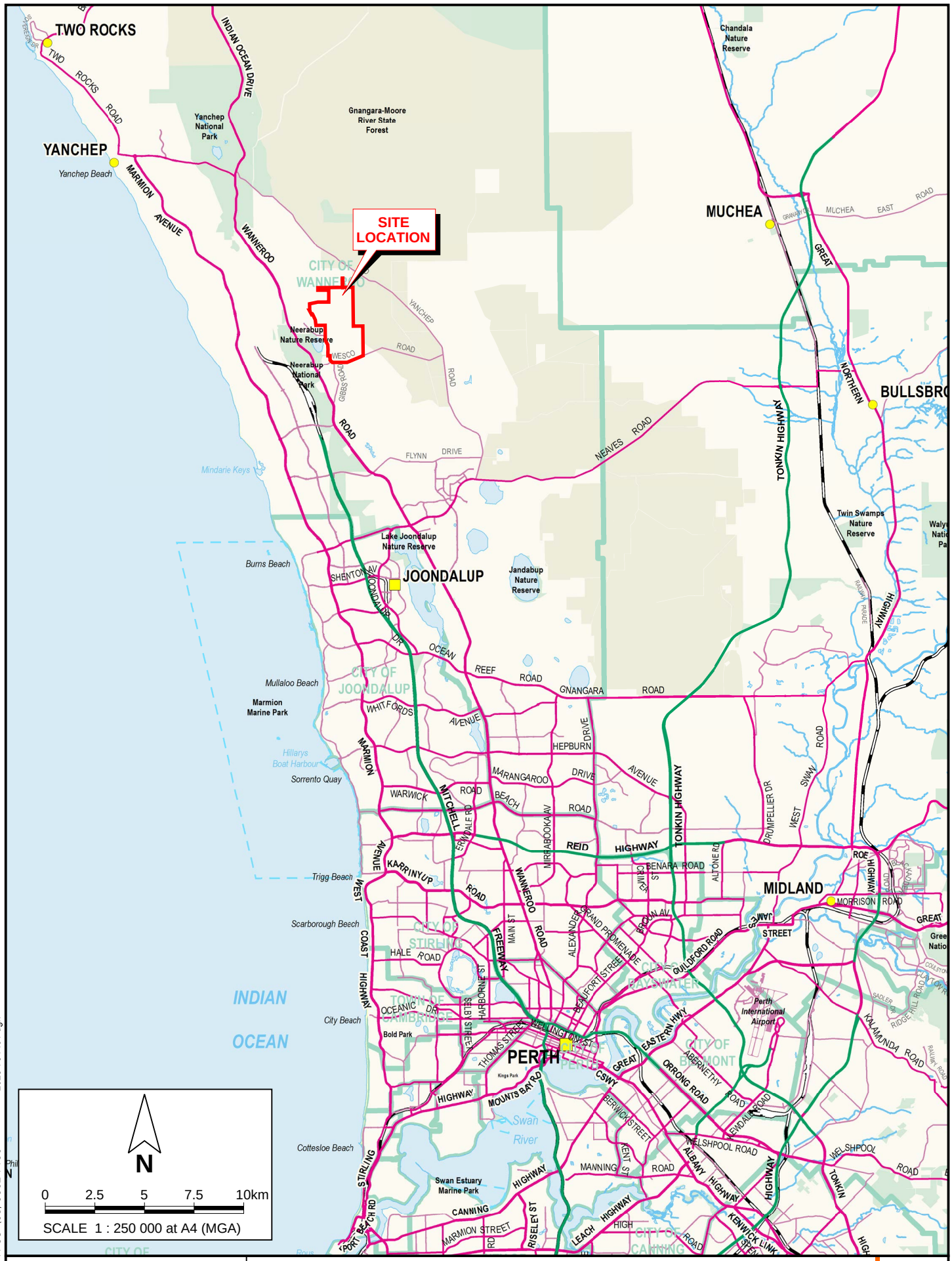
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FIGURES



PINPOINT CARTOGRAPHICS (08) 9562 7136 2023-784-f01.dgn

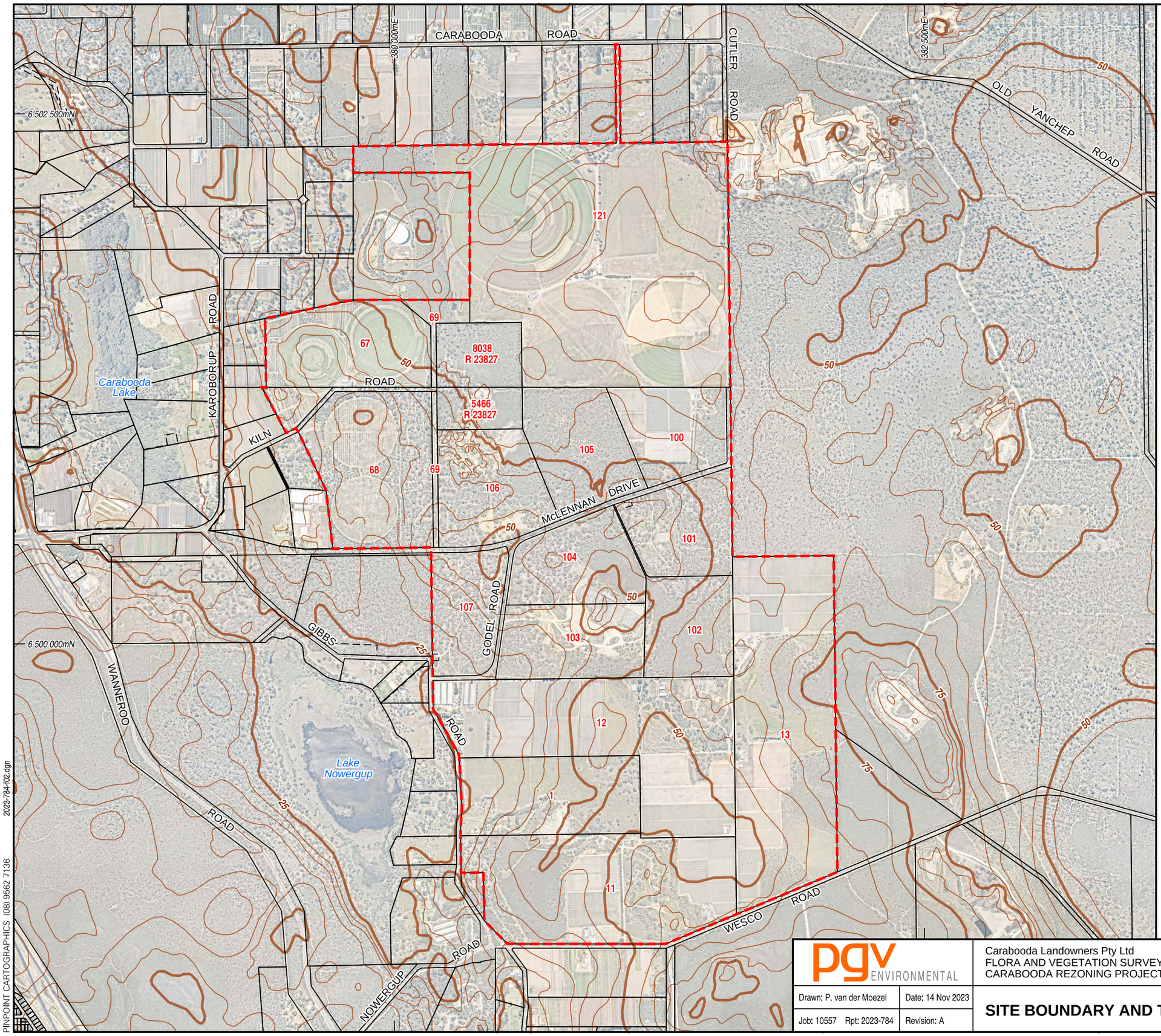
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Carabooda Landowners Pty Ltd
FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel	Date: 14 Nov 2023
Job: 10557 Rpt: 2023-784	Revision: A

SITE LOCATION

Figure 1



N

0 200 400 600 800 1000m

SCALE 1 : 17 500 at A3 (MGA)

Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Topographic Contour

CADASTRAL SOURCE: Landgate, November 2023.
CONTOUR SOURCE: Landgate, 1:50,000 Topographic Mapping.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown October 2023.

pgv ENVIRONMENTAL

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SITE BOUNDARY AND TOPOGRAPHY

Figure 2

PINPOINT CARTOGRAPHICS (08) 9562 7136 2023-784-f02.dgn

N

0 100 200 300 400 500m

SCALE 1 : 9 000 at A3 (MGA)

380 000mE

381 000mE

6 502 000mN

6 501 000mN

Bs AfBs C34 C35 C36 2 plants 3 plants MhMs EgBs 6 plants

MhMs Eg Em C32 BaBmEt EgEm C31 C33 MhMs Cl

C25 C26 C37 Bs EgBs EtBaBm MhMs Cl C24 C23 EgBs MhMs Em C20 C10 C22 C21 C11 Eg EtBaBm C29 C12 Cl Eg Bs C27 C13 EgEm

Cl EgEm

8038 R 23827

5466 R 23827

2023-784-f03a.dgn

PINPOINT CARTOGRAPHICS (08) 9562 7136

Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Quadrat Location
- Vegetation Type Boundary
- Bs Vegetation Type

Threatened and Priority Plant Locations

- *Eucalyptus argutifolia* (Threatened)
- *Pimelea calcicola* (P3)
- *Stylidium maritimum* (P3)
- *Eucalyptus foecunda* subsp. *foecunda* (P4)
- 3 Number of plants

Vegetation Types

MhMs
Melaleuca huegelii/M. systena Closed Heath

MhBs
Melaleuca huegelii/Banksia sessilis Closed Tall Scrub over *Melaleuca systena/Hibbertia hypericoides* Open Low Heath

Bs
Banksia sessilis/Calothamnus quadrifidus Open Heath over *Hibbertia hypericoides* Open to Closed Low Heath

EdBs
Eucalyptus decipiens Low Open Woodland over *Banksia sessilis* Tall Open Shrubland over *Melaleuca systena/Hibbertia hypericoides* Closed Low Heath

EgBs
Eucalyptus gomphocephala Woodland over *Banksia sessilis/ Calothamnus quadrifidus* Open Heath over *Hibbertia hypericoides* Closed Low Heath

AfBs
Allocasuarina fraseriana Low Open Woodland over *Banksia sessilis/Xanthorrhoea preissii/Hibbertia hypericoides* Open Low Heath

Et
Eucalyptus todtiana Low Open Woodland over weeds

EtBaBm
Eucalyptus todtiana/Banksia attenuata/B. menziesii Low Open Woodland over *Xanthorrhoea preissii/Daviesia divaricata* Tall Shrubland over *Eremaea pauciflora/Hibbertia hypericoides* Open Low Heath

BaBmEt
Banksia attenuata/Banksia menziesii/Eucalyptus todtiana Low Woodland over *Allocasuarina humilis/Calothamnus quadrifidus/ Hibbertia hypericoides* Closed Heath

Em
Eucalyptus marginata Low Woodland over *Xanthorrhoea preissii* Tall Shrubland

Eg
Eucalyptus gomphocephala Woodland over *Xanthorrhoea preissii* Shrubland over *Mesomelaena pseudostygia/ Phyllanthus calycinus* Open Low Heath

EgEm
Eucalyptus gomphocephala/E. marginata Woodland over **Ehrharta calycina* Closed Grassland

CcEm
Corymbia calophylla/Eucalyptus marginata Low Woodland over *Xanthorrhoea preissii* Shrubland

Cl
Cleared

CADASTRAL SOURCE: Landgate, November 2023.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown October 2023.

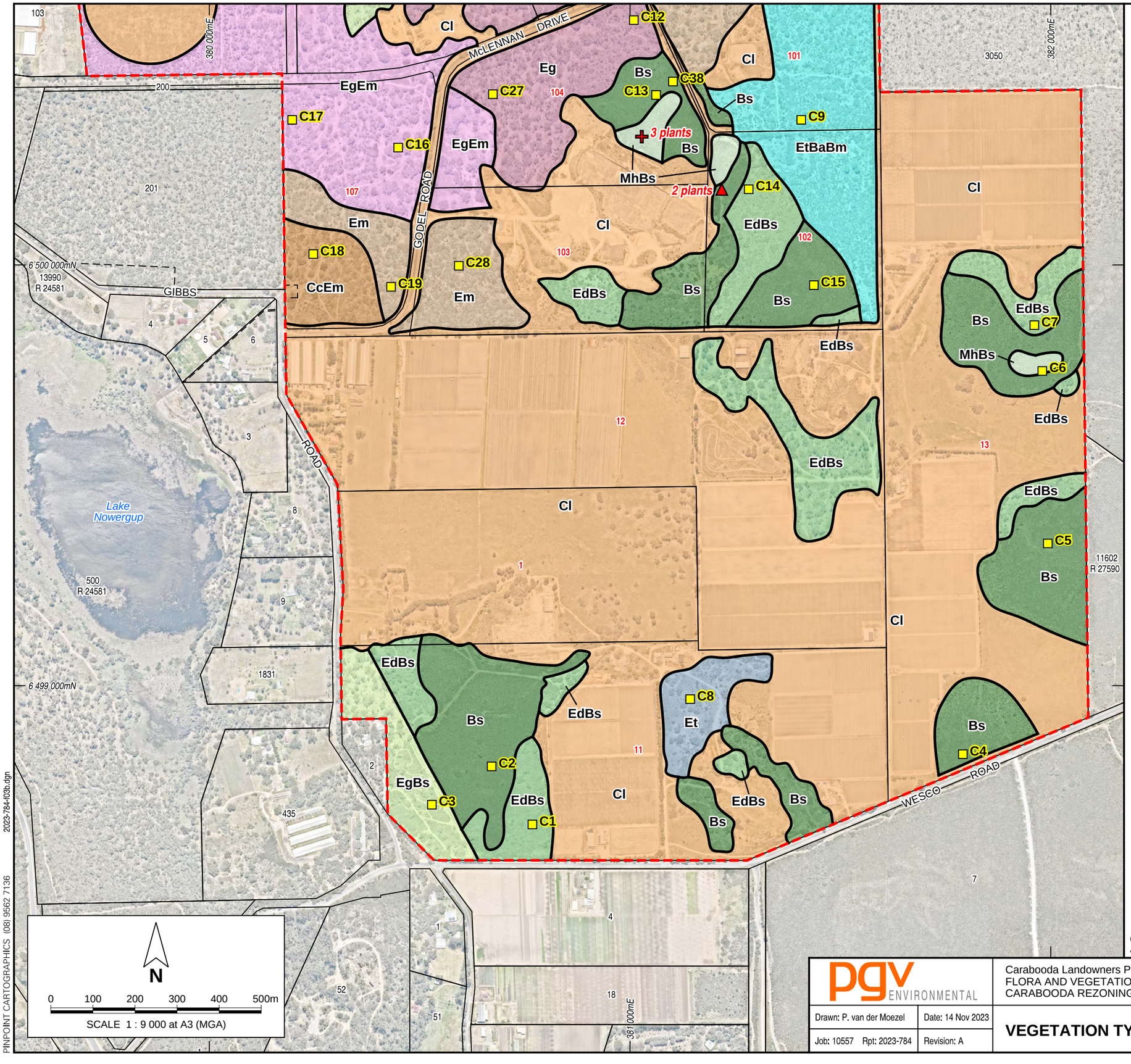
pgv ENVIRONMENTAL

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FLORA AND VEGETATION SURVEY
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Drawn: P. van der Moezel | Date: 14 Nov 2023
Job: 10557 Rpt: 2023-784 | Revision: A

VEGETATION TYPES - NORTH

Figure 3a



Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Quadrat Location
- Vegetation Type Boundary
- **Bs** Vegetation Type

Threatened and Priority Plant Locations

- *Eucalyptus argutifolia* (Threatened)
- *Pimelea calcicola* (P3)
- *Stylidium maritimum* (P3)
- *Eucalyptus foecunda* subsp. *foecunda* (P4)
- *3* Number of plants

Vegetation Types

MhMs
Melaleuca huegelii/M. systena Closed Heath

MhBs
Melaleuca huegelii/Banksia sessilis Closed Tall Scrub over *Melaleuca systena/Hibbertia hypericoides* Open Low Heath

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Eucalyptus gomphocephala Woodland over *Banksia sessilis/ Calothamnus quadrifidus* Open Heath over *Hibbertia hypericoides* Closed Low Heath

AfBs
Allocasuarina fraseriana Low Open Woodland over *Banksia sessilis/Xanthorrhoea preissii/Hibbertia hypericoides* Open Low Heath

Et
Eucalyptus todtiana Low Open Woodland over weeds

EtBaBm
Eucalyptus todtiana/Banksia attenuata/B. menziesii Low Open Woodland over *Xanthorrhoea preissii/Daviesia divaricata* Tall Shrubland over *Eremaea pauciflora/Hibbertia hypericoides* Open Low Heath

BaBmEt
Banksia attenuata/Banksia menziesii/Eucalyptus todtiana Low Woodland over *Allocasuarina humilis/Calothamnus quadrifidus/ Hibbertia hypericoides* Closed Heath

Em
Eucalyptus marginata Low Woodland over *Xanthorrhoea preissii* Tall Shrubland

Eg
Eucalyptus gomphocephala Woodland over *Xanthorrhoea preissii* Shrubland over *Mesomelaena pseudostygia/ Phyllanthus calycinus* Open Low Heath

EgEm
Eucalyptus gomphocephala/E. marginata Woodland over **Ehrharta calycina* Closed Grassland

CcEm
Corymbia calophylla/Eucalyptus marginata Low Woodland over *Xanthorrhoea preissii* Shrubland

Cl
Cleared

CADASTRAL SOURCE: Landgate, November 2023.
AERIAL PHOTOGRAPHY SOURCE: NearMap, flown October 2023.

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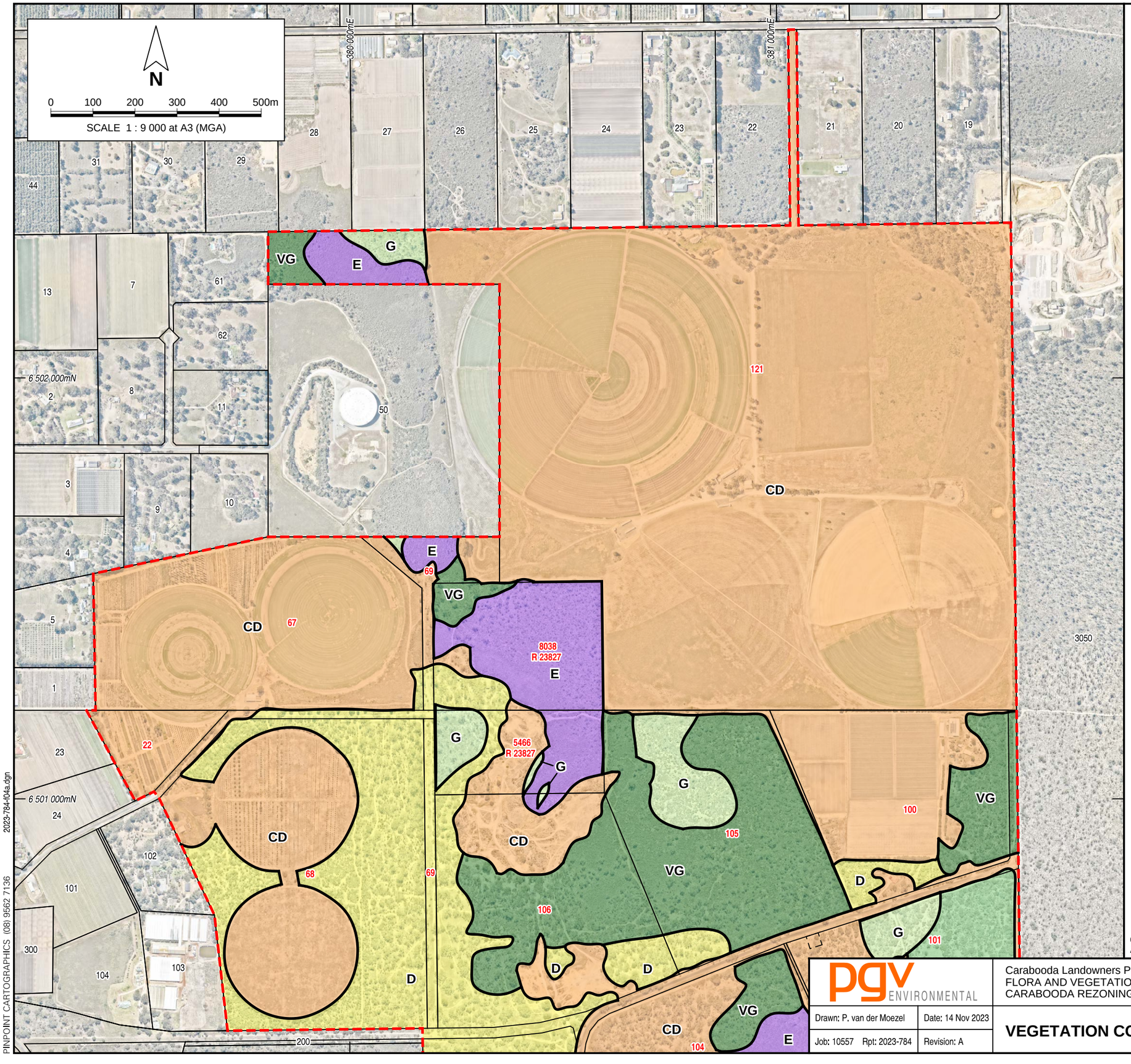
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Carabooda Landowners Pty Ltd
FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel | Date: 14 Nov 2023
Job: 10557 Rpt: 2023-784 | Revision: A

VEGETATION TYPES - SOUTH

Figure 3b



Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Vegetation Condition Boundary
- VG Vegetation Condition

Vegetation Condition

- Excellent
- Very Good
- Good to Very Good
- Good
- Good to Degraded
- Degraded
- Completely Degraded

Vegetation Condition
(SOURCE: Bush Forever, Govt. of W.A., 2000)

P - Pristine
Pristine or nearly so, no obvious signs of disturbance.

Ex - Excellent
Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species.

VG - Very Good
Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

G - Good
Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

D - Degraded
Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

CD - Completely Degraded
The structure of the vegetation is no longer intact and the areas is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.

Cl - Cleared
No native vegetation remaining.

CADASTRAL SOURCE: Landgate, November 2023.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown October 2023.

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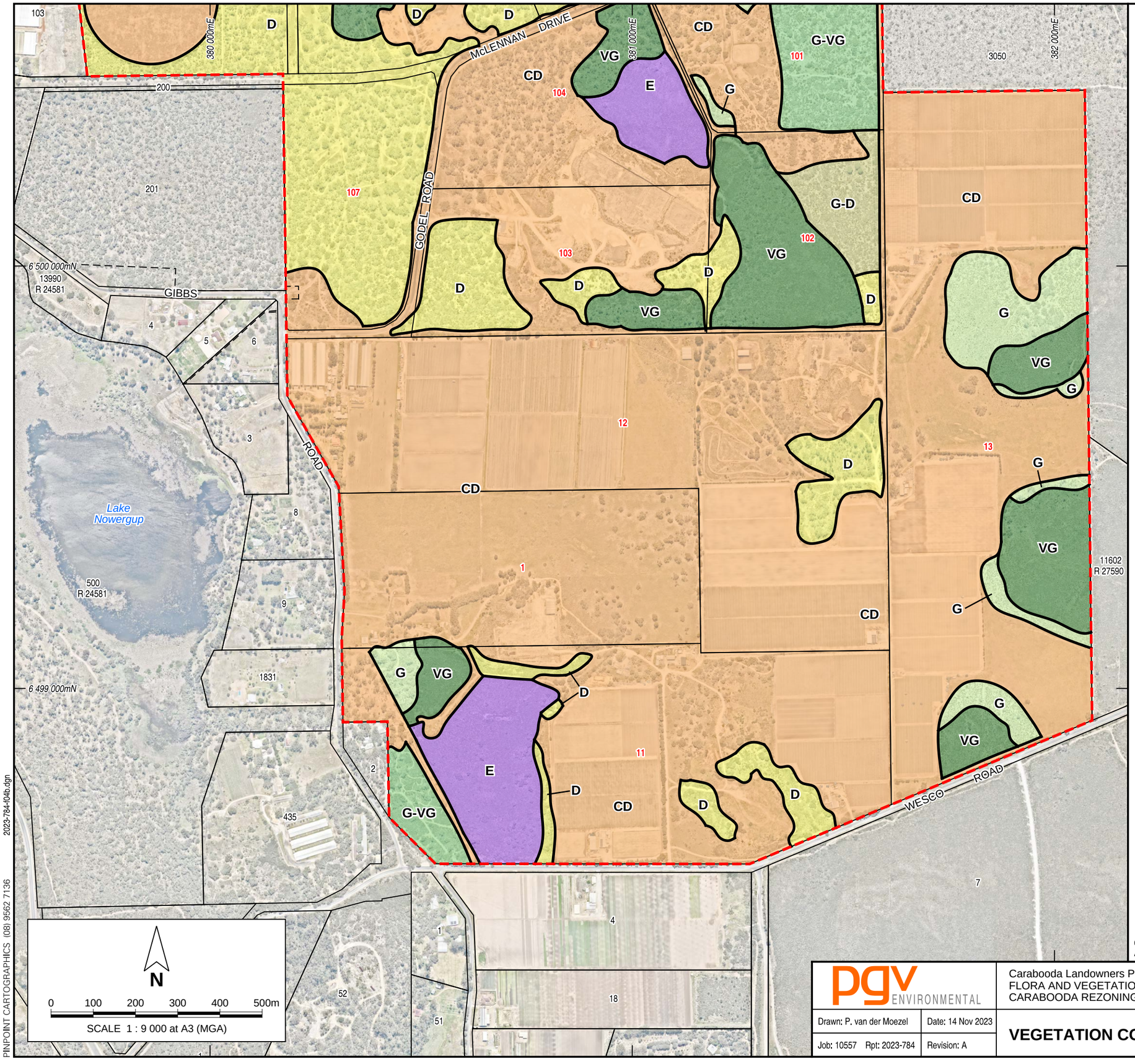
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Carabooda Landowners Pty Ltd
FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel | Date: 14 Nov 2023
Job: 10557 Rpt: 2023-784 | Revision: A

VEGETATION CONDITION - NORTH

Figure 4a



Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Vegetation Condition Boundary
- VG — Vegetation Condition

Vegetation Condition

- Excellent
- Very Good
- Good to Very Good
- Good
- Good to Degraded
- Degraded
- Completely Degraded

Vegetation Condition
(SOURCE: Bush Forever, Govt. of W.A., 2000)

P - Pristine
Pristine or nearly so, no obvious signs of disturbance.

Ex - Excellent
Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species.

VG - Very Good
Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

G - Good
Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

D - Degraded
Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

CD - Completely Degraded
The structure of the vegetation is no longer intact and the areas is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.

Cl - Cleared
No native vegetation remaining.

CADASTRAL SOURCE: Landgate, November 2023.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown October 2023.

N

0 100 200 300 400 500m

SCALE 1 : 9 000 at A3 (MGA)

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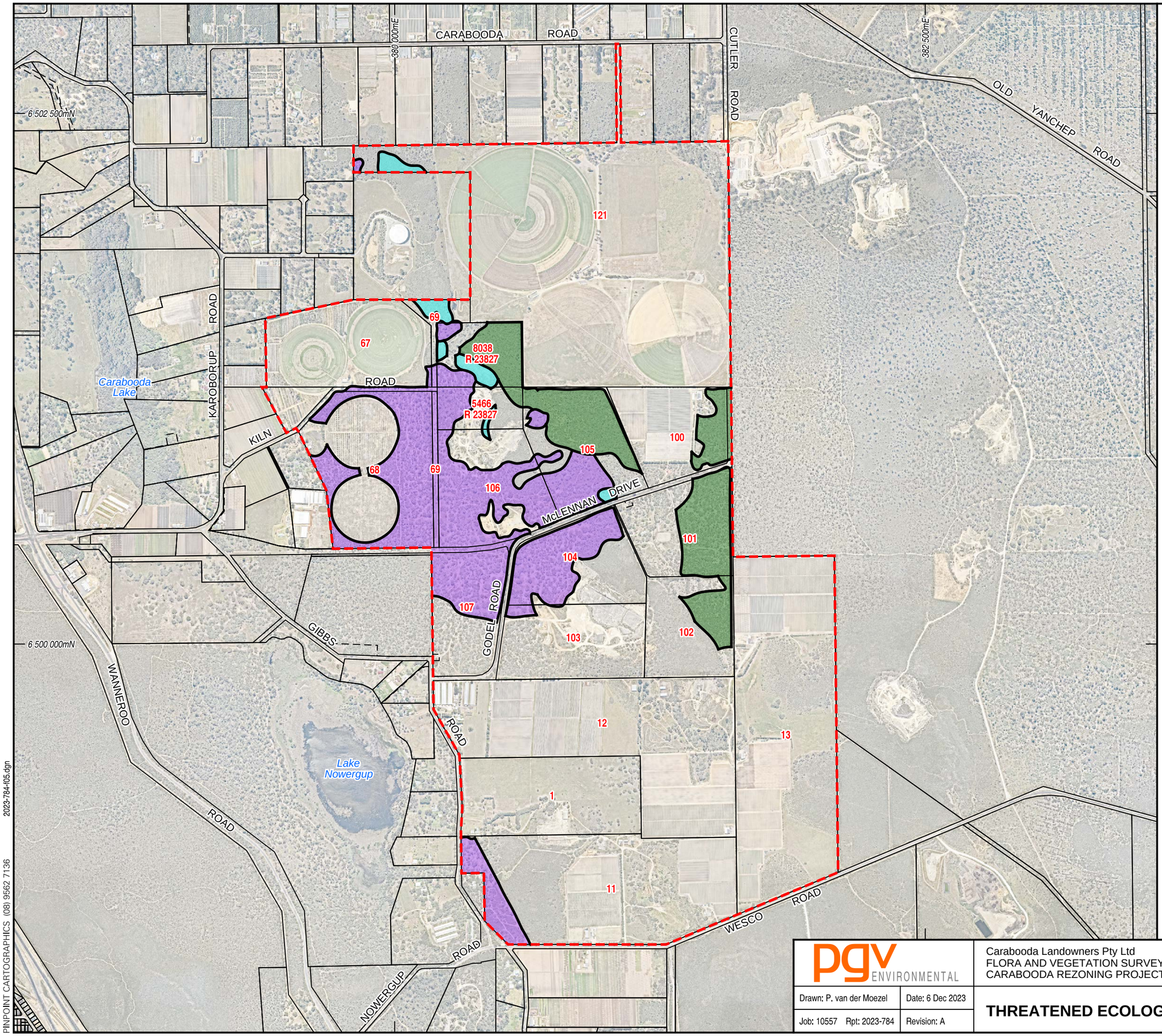
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Carabooda Landowners Pty Ltd
FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel | Date: 14 Nov 2023
Job: 10557 Rpt: 2023-784 | Revision: A

VEGETATION CONDITION - SOUTH

Figure 4b



N

0 200 400 600 800 1000m

SCALE 1 : 17 500 at A3 (MGA)

Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary

Threatened Ecological Communities

- Banksia Woodland
- Tuart Woodland
- Honeymyrtle Shrubland

CADASTRAL SOURCE: Landgate, November 2023.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown October 2023.

PINPOINT CARTOGRAPHICS (08) 9562 7136 2023-784-I05.dgn

pgv ENVIRONMENTAL

Carabooda Landowners Pty Ltd
FLORA AND VEGETATION SURVEY
CARABOODA REZONING PROJECT

Drawn: P. van der Moezel | Date: 6 Dec 2023
Job: 10557 Rpt: 2023-784 | Revision: A

THREATENED ECOLOGICAL COMMUNITIES

Figure 5

Appendix E
Environmental Advice on the Draft Carabooda District Structure Plan



GOVERNMENT OF WESTERN AUSTRALIA

Environmental advice on the draft Carabooda District Structure Plan

prepared for the Western Australian Planning Commission, under section 16 of the *Environmental Protection Act 1986*

Environmental Protection Authority

April 2025

Environmental Protection Authority, 2025, *Environmental advice on the draft Carabooda District Structure Plan* , EPA, Western Australia.

This document is available in alternative formats upon request.

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TTY: 133 677

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This advice is provided to the Western Australian Planning Commission (WAPC) by the Environmental Protection Authority (EPA) under section 16 of the *Environmental Protection Act 1986* for the purpose of:

- identifying key environmental values of the draft Carabooda District Structure Plan (DSP) site
- advising what protection and enhancement of those environmental values is proposed for consistency with the EPA's objectives
- advising what additional environmental matters need to be considered at future planning stages.

This advice is intended for use by the WAPC, local government, government agencies, developers and the community to inform ongoing environmental planning for the Carabooda District Structure Plan site.



Lee McIntosh
Deputy Chair
Environmental Protection Authority

4 April 2025

Contents

Executive Summary 5
1 EPA advice: purpose, intended use and guidance for future environmental planning 8
2 Carabooda District Structure Plan: key environmental planning characteristics 10
3 Advice on key environmental values 11
4 Flora and vegetation 14
5 Terrestrial Fauna 26
6 Inland waters 35
7 Social surroundings 37
8 Subterranean fauna 38
9 Terrestrial environmental quality 39
10 References 40
11 Appendix: Background information 43

Table 1 Flora and Vegetation key environmental values, and recommendations for future environmental planning 14
Table 2 Terrestrial fauna key environmental values and recommendations for future environmental planning 26
Table 3 Inland waters key environmental values and recommendations for future environmental planning. 35
Table 4 Social surroundings key environmental values and recommendations for future environmental planning 37
Table 5 Subterranean fauna key environmental values and recommendations for future environmental planning 38
Table 6 Terrestrial environmental quality key environmental values and recommendations for future environmental planning. 39

Figure 1 Carabooda DSP location 9
Figure 2 Carabooda DSP (CLE Town Planning and Design 2025) 10
Figure 3 Remnant native vegetation condition and conservation areas 18
Figure 4 Draft DSP Conservation areas and EPA additional conservation recommendation areas 19
Figure 5 Conservation significant ecological communities within the site 20
Figure 6 Conservation significant flora within the site 21
Figure 7 Carnaby's black cockatoo foraging habitat 28
Figure 8 Forest Red-tail Black Cockatoo foraging habitat 29

Executive Summary

Proposal subject to draft DSP: The draft Carabooda District Structure Plan (DSP) includes approximately 960 hectares (ha) of land bounded by Carabooda Road, Bush Forever Site (BFS) No 290/State Forest 65, Wesco, Karoborup and Gibbs Roads. The draft DSP proposes to provide approximately 9,200 residential dwellings accommodating a population of 23,000 people with district neighbourhood and local centres, high school and primary school sites and a conservation estate.

Purpose of EPA advice on draft DSP: The draft DSP has been proposed by Acumen Development Solutions (Acumen), acting for the Carabooda Landowners Group (CLG), and will now be considered for advertising by the Western Australian Planning Commission (WAPC).

The EPA has agreed to prepare environmental advice on the draft DSP at this early, formative stage of environmental planning in order to provide independent guidance on key site and cumulative environmental issues, and environmental protection needs.

Key environmental values of draft DSP site: The key values of the draft DSP site include[1]:

- 334 ha of remnant vegetation, with 218 ha in good or better condition and 47 ha in excellent condition.
- 334 ha of moderate to high black cockatoo foraging habitat.
- 3 priority/threatened ecological communities (TECs): 45 ha Banksia Woodlands of the Swan Coastal Plain (SCP); 112 ha Tuart woodlands and forests of the SCP, and 12 ha Honeymyrtle shrublands on limestone ridges of the SCP.
- East-west ecological linkage comprised of primarily continuous vegetation with Bush Forever and national park areas, connected to a northern north-south ecological linkage.
- Patches of remnant native vegetation, that provide fauna habitat and 'stepping stones' for alternative pathways to habitat in adjacent areas (Bush Forever and national park).
- Occurrences of 5 conservation significant flora, and areas of regionally significant vegetation.
- Areas able to be restored and enhanced to improve the ecological functioning.
- No known cockatoo roosting sites or nesting trees[2], but potential for black cockatoo roosting and nesting habitat, with 11 confirmed roost sites in 6km of the DSP site and estimated 1,600 potential nesting trees on the site.

Proposed protection within/related to the draft District Structure Plan: The draft DSP (Figure 1) proposes the retention of approximately 234 ha remnant native vegetation within conservation estate areas, to retain significant flora and vegetation and fauna habitat environmental values. The conservation estate areas protect a significant proportion of the remnant native vegetation (70%), including some of the most significant elements of the key environmental values on the site.

Retention of most of the remnant native vegetation in an east-west ecological linkage is proposed to be included as part of the conservation estate through the centre of the DSP area linking BFS 290 to the east and BFS 383 to the west.

[1] Note all areas are approximate.
[2] Note there are survey limitations.

Enhancement of 30 ha degraded vegetation (12%) in the conservation estate is proposed to increase the ecological viability and environmental value of the conservation area(s).

A Conservation Management Fund established from seed capital from developers and sustained by ongoing ratepayer contributions is proposed to enable the conservation of remnant native vegetation and ongoing management of the conservation estate.

The conservation estate is proposed to be additional to the usual 10% contribution made to local Public Open Space (POS). The location of this POS will be identified at the Local Structure Plan stage and include land for active and passive open space.

Additional environmental protection recommended: The strategic planning stage for the Carabooda area affords an important opportunity for the environmental planning system to facilitate key housing and infrastructure needs at the same time as ensuring environmental protection. Planning considerations to provide a mix of built form and density can be used in response to environmental protections whilst ensuring population and housing projections are maintained.

The protections and enhancements within and related to the DSP as proposed by Acumen and the CLG, have significantly reduced the potential impact of the draft DSP on the environment, both on site and in a cumulative context. The EPA commends this approach.

Additional protections could be included which would further reduce the significance of impacts; the EPA recommends these protections be considered now and implemented in future stages of planning.

The EPA considers that the draft DSP and its implementation at future stages of planning should consider and incorporate environmental planning to incorporate the protection already proposed, and prioritise additional protection aligned with the following advice:

- Protection of Areas H, I, J (noting J proposed for Basic Raw Materials (BRM)), K, L and M on Figure 4. These are not currently proposed for retention but meet EPA criteria for regional significance. The EPA considers that these areas should be prioritised for retention as they provide very good and excellent quality vegetation and threatened fauna habitat.
- Additional protection of cockatoo foraging habitat. For Carnaby's cockatoo, there is 334 ha of moderate or better-quality foraging habitat on site; and although 217 ha (64%) is proposed to be retained,118 ha (36%) remains proposed to be cleared. For Forest red-tailed black cockatoo, there is 223 ha of moderate or better-quality foraging habitat; 56 ha (25%) is proposed to be cleared. The amount of clearing is a likely to be a significant environmental impact, and as detailed in the *Referral guideline for 3 WA threatened black cockatoo species* (DAWE 2022) likely to require referral to the Commonwealth. Additional areas protected on site should be considered, particularly where areas are aligned with roosting, nesting, quality foraging habitat or other environmental values.
- For counter-balancing significant residual impacts, see EPA advice below on consideration of environmental offsets through a lens of prioritising on site protection, and enabling restoration and enhancement opportunities.
- Protection of any cockatoo roosting sites, and potential nesting trees with suitable hollows, found during on ground surveys.
- Maintaining ecological linkages through protection of consolidated areas of vegetation and viable ecological stepping stones (in addition to the proposed maintenance of the east-west ecological linkage).

- Inclusion of buffer areas to avoid and minimise adverse impacts to conservation estate areas and any key values retained in POS.
- Consider whether infrastructure (road) alignments can be located to reduce impacts to environmental values of conservation areas and black cockatoo habitat.
- Continuation of a holistic protection focus – prioritisation of identification and protection of areas which contain multiple key values.
- Protection of any additional key environmental values in conservation estate areas, where practicable, or otherwise in POS.

The EPA considers that, once additional protections are addressed through the draft DSP and future planning processes, development under the draft DSP is likely to be consistent with the EPA's environmental objectives.

Environmental offsets: The EPA advises that if the significance of residual impacts is reduced on site through the application of the mitigation hierarchy, this is likely to be preferable to provision of off-site offsets.

The EPA considers that, for environmental planning purposes:

> a) if on-site protection measures such as avoidance, management, restoration and enhancement are consistent with the quality and quantity of off-site offset requirements that would normally be determined through an offsets calculator, and
>
> b) if the on-site protection measures are consistent with the EPA's advice on offsets at regional scale (EPA 2024a),

this will likely be adequate to counter-balance residual on-site impacts.

Any off-site offsets which are proposed at future stage of planning should also consider the EPA's advice on offsets at regional scale.

Implementation of offsets through future planning processes is recommended, so the EPA can take the likely outcome and security of offsets into account in any future decision-making processes.

1 EPA advice: purpose, intended use and guidance for future environmental planning

Purpose: This advice is provided to the WAPC by the EPA under section 16 of the *Environmental Protection Act 1986* for the purpose of:

- Identifying key environmental values of the draft Carabooda District Structure Plan (DSP) site.
- Advising what protection and enhancement of those environmental values is proposed for consistency with the EPA's objectives.
- Advising what additional environmental matters need to be considered at future planning stages.

This advice is intended for use by the WAPC, local government, government agencies, developers and the community to inform ongoing environmental planning for the Carabooda DSP site.

Intended use: This advice is being provided at a preliminary planning stage outside of a formal statutory EPA process, to provide independent environmental guidance on key site environmental issues at an early formative stage in environmental planning. The EPA expects this advice to increase the certainty, efficiency and achievement of good environmental outcomes from the environmental planning process.

Proactive approach commended: The EPA acknowledges and commends the proactive approach taken by Acumen and the CLG to provide detailed and site-specific information on environmental values within the DSP site, including areas of priority and threatened ecological communities and habitat for species of black cockatoo. The provision of this detailed information early has facilitated an efficient review and assisted with providing EPA advice on specific environmental matters.

Advice on draft District Structure Plans: The EPA acknowledges that the level of environmental information provided for the draft Carabooda DSP may not be available for future draft DSPs; the EPA still intends to provide advice on those DSPs where practicable but notes the specificity of advice will be influenced by the information it has available.

Strategic environmental protection on the Swan Coastal Plain: The EPA's Strategic Plan 2023-26 includes development of an environmental protection framework for significant environmental assets such as the Swan Coastal Plain (SCP). The EPA considers that providing advice on draft DSPs on the SCP is consistent with this strategic plan objective, through enabling a focus on sub-regional areas within the SCP. The EPA expects DSP advice will be a key tool to ensure environmental protection in the SCP is comprehensive, adequate, and representative.

The EPA also notes achievement of this strategic plan objective will require identification of opportunities for enhancement of degraded areas, to enable restoration of areas with holistic environmental values. An offsets framework for the SCP which is consistent with the EPA's advice on offsets at a regional scale (2024a) would be an important policy mechanism to support this.

EPA guidance for future environmental planning on the Swan Coastal Plain: Outside of providing environmental advice on subregional areas of the SCP through section 16 advice,

and decision-making on schemes and scheme amendments, the EPA recommends the following be considered in preliminary planning stage outside of a formal statutory EPA process.

The EPA expects early consideration of this advice to increase the certainty, efficiency and achievement of good environmental outcomes from the environmental planning process:

- Guidance for planning and development: Protection of naturally vegetated areas in urban and peri-urban areas (EPA 2021b)
- EPA Submission into DPLH Urban Greening Strategy (EPA 2024b)
- Considering environmental offsets at a regional scale (EPA 2024a)
- Carnaby's Cockatoo in Environmental Impact Assessment in the Perth and Peel Region (EPA 2019)
- Interim strategic advice - Perth and Peel @ 3.5 million: Environmental impacts, risks and remedies (EPA 215)
- Guidance Statement No. 33: Environmental Guidance for Planning and Development (EPA 2008)
- Guidance Statement No. 3: Separation Distances Between Industrial and Sensitive Land Uses (EPA 2005).

2 Carabooda District Structure Plan: key environmental planning characteristics

The Carabooda DSP site comprises approximately 960 ha across 65 lots within the City of Wanneroo. It is located in the North-West corridor approximately 35 km north of Perth Central Business District (Figure 1). Most of the site is currently zoned 'Rural' under the Metropolitan Region Scheme (MRS) and 'Rural Resource' under the City of Wanneroo District Planning Scheme (DPS) No. 2. Two Water Corporation sites with the site are reserved for 'Public Purposes'.

The February 2025 draft DSP proposes to provide approximately 9,200 new dwellings to house approximately 23,000 people with services including district neighbourhood and local centres, high school and primary school sites and areas of open space.

The draft DSP (Figure 2) proposes the retention of approximately 234 ha (24% of the DSP area) of remnant native vegetation as conservation open space, mostly as an east-west corridor, to retain significant flora and vegetation, and fauna habitat environmental values. The proposed retention area includes approximately 9.5 ha of native vegetation on the Water Corporation sites.

The East-West corridor is part of an ecological linkage (Del Marco et al 2004) that runs through the centre of the DSP area linking Bush Forever Site (BFS) Site No.290 located to the east, within State Forest 65, and BFS No.383 to the west, within the Nowergup Nature Reserve and Nowergup National Park.

A Conservation Management Fund established from seed capital from developers and sustained by ongoing ratepayer contributions is proposed to enable the conservation of remnant native vegetation and ongoing management of the conservation estate.

The conservation estate is proposed to be additional to the usual 10% contribution made to local Public Open Space. The location of this POS will be confirmed at the local structure plan stage and include land for active and passive open space. Areas of remnant native vegetation and fauna habitat may also be retained in POS areas.

3 Advice on key environmental values

The EPA provides the following advice on:

- Identifying key environmental values of the Carabooda DSP site.
- Advising what protection and enhancement of those environmental values is proposed for consistency with the EPA's objectives.
- Advising what additional environmental matters need to be considered at future planning stages.

The EPA advice is structured on the basis of the environmental factors it usually considers for environmental impact assessment.

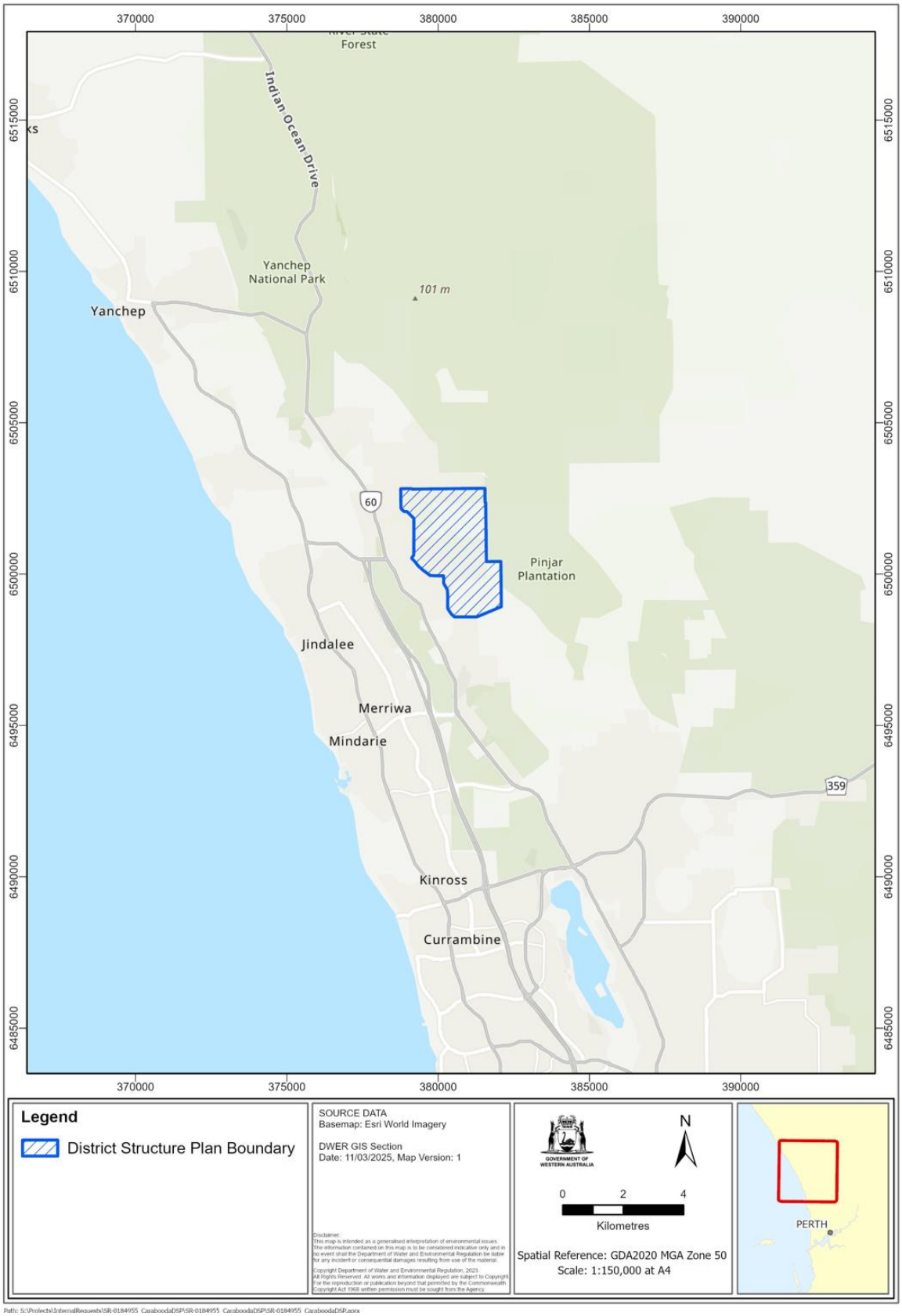


Figure 1 Carabooda DSP location

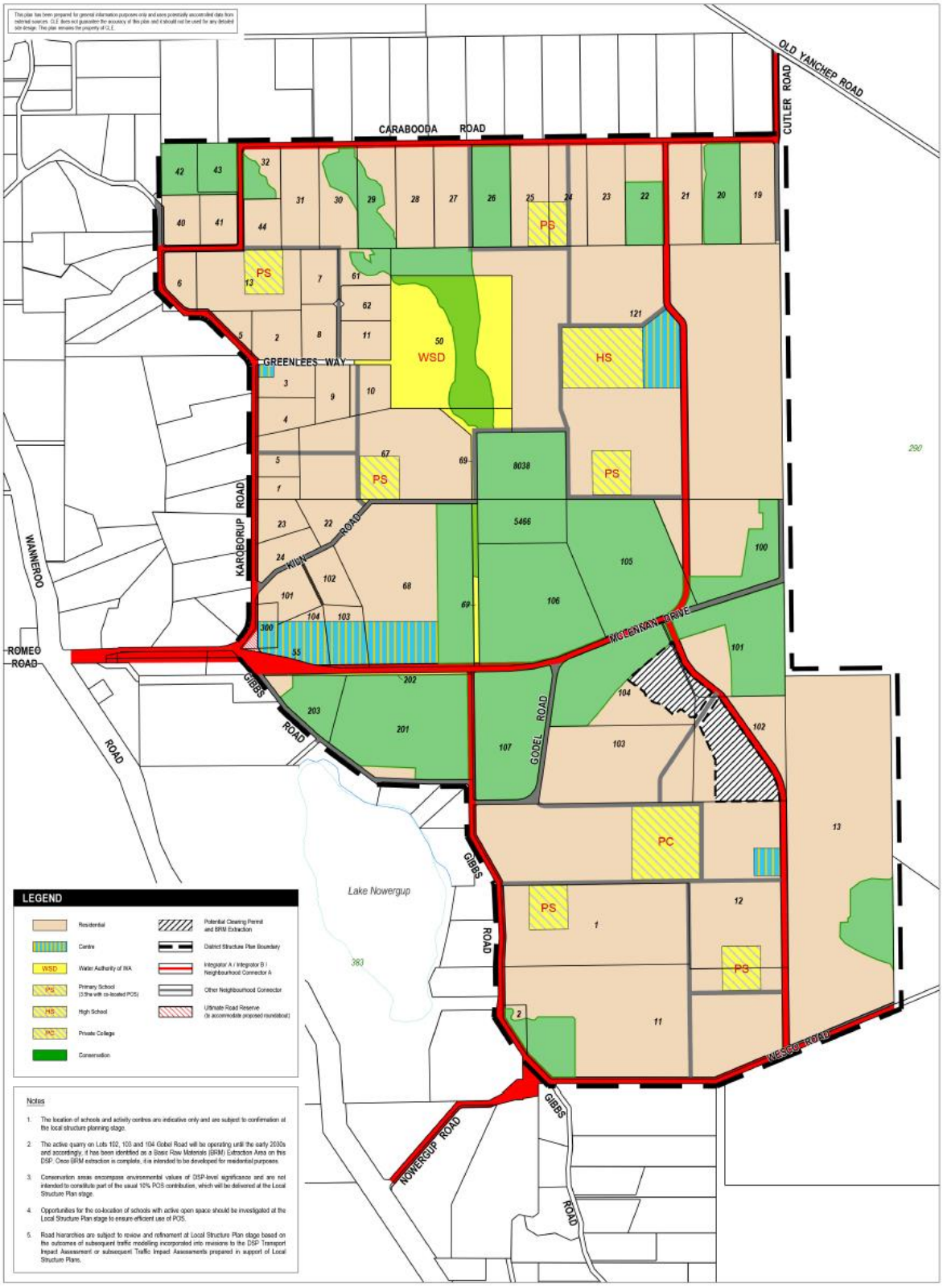


Figure 2 Carabooda DSP (CLE Town Planning and Design 2025)

4 Flora and vegetation

The EPA environmental objective for flora and vegetation is *to protect flora and vegetation so that biological diversity and ecological integrity are maintained* (EPA 2016a).

Table 1 Flora and Vegetation key environmental values, and recommendations for future environmental planning[3]

Key environmental values	Protection and enhancement currently proposed in draft DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
Remnant vegetation and conservation areas **Key values**: • 334 ha of remnant native vegetation. • 218 ha remnant native vegetation is in 'Good' or better condition. • Vegetation of regional significance, based on meeting two or three of the EPA's six criteria for regional significance. The draft DSP proposes retention of: • 234 ha (70%) of remnant native vegetation retained in conservation areas. • 162 ha (69%) of remnant native vegetation in 'Good' or better condition in conservation areas • Areas A, B, C, D, E and F (Figure 4) are regionally significant and are proposed to be retained in the conservation estate. The draft DSP proposes remnant vegetation and rehabilitated vegetation to be retained for conservation in a future Parks and Recreation reserve under the MRS.		118 ha (35%) remnant native vegetation is proposed to be cleared, including 60 ha (27%) of vegetation in good or better quality. Priority has been given to retention, protection and enhancement of key vegetation values, which the EPA considers appropriate and should continue. Priority has been given to location of development on cleared and degraded land, which the EPA considers appropriate and should continue. The EPA has considered the remnant native vegetation within the DSP area in the context of regional significance. All areas of remnant native vegetation meet two or three of the EPA's six criteria for regional significance. Remnant native vegetation has been mapped, based broadly on vegetation condition, as 'Areas', as displayed in Figure 4. Several areas are proposed to be retained; and specific advice on areas not proposed for retention in the draft DSP, is provided below. The extent and quality of vegetation which is proposed to be retained and enhanced on site is likely to be consistent with achievement of

[3] Areas of vegetation are approximate and include vegetation on Water Corporation sites. Areas of vegetation clearing are for proposed urban and basic raw material extraction areas.

Key environmental values	Protection and enhancement currently proposed in draft DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
Ongoing management and enhancement: At future stages of planning, there is proposed preparation of: • vegetation management plan to guide retention, protection and rehabilitation • conservation management plan for Threatened Ecological Communities (TEC) • restoration plan for restorative planting of approximately 30 ha on areas which are degraded within the 234 ha conservation estate. See Figures 3 and 4 for remnant native vegetation condition and draft DSP conservation areas and recommendation areas respectively.		comprehensive, adequate and representative native vegetation protection in DSP site. However, the EPA considers this is the maximum likely to be able to be cleared on-site and still be consistent with EPA objectives, and further conservation areas should be identified, with priority given to retention of the key values identified in this advice. This will ensure cumulative impacts and effects such as climate change and a drying climate, and other potential development in the region do not undermine the environmental protection on site. The EPA notes the draft DSP will facilitate a new urban precinct providing residential land in the North-West corridor and create a new community that will benefit from the environmental values being retained. Strategic planning provides the opportunity for urban development; residential, commercial/community services and infrastructure needs, to be considered holistically with protection of environmental values. It is at this strategic planning stage that planning considerations can provide a mix of built form and density to ensure population and housing projections are maintained whilst protecting significant environmental values in situ. Local Planning Scheme amendments/structure plans should include requirements for retention of proposed and additional remnant native vegetation and, preparation and implementation of management plans.
Excellent condition vegetation **Key value**: 47 ha of remnant native vegetation in 'Excellent' condition (Figure 3). 35 ha (74%) proposed for retention in conservation areas.		Approximately 12 ha (26%) of excellent condition vegetation is proposed to be cleared. The EPA considers this is the maximum likely to be able to be cleared on-site and still be consistent with EPA objectives, and recommends retention of all additional excellent condition vegetation that remains in

Key environmental values	Protection and enhancement currently proposed in draft DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
See Figures 3 and 4 for remnant native vegetation condition and draft DSP conservation areas and EPA additional conservation recommendation areas respectively.		viable patches, with adequate buffer areas provided to minimise indirect impacts. The EPA provides the following advice for consideration of additional retention and conservation areas in future planning: • Small and isolated areas (not in close proximity to other conservation areas) are less likely to be sustainable. Priority should be given to larger areas and areas that are located near to other conservation areas. There is no "minimum" area that needs protection, but all other things being equal, larger areas are usually preferred to smaller areas. • Areas which are irregularly shaped or have longer boundaries are difficult to successfully manage for conservation purposes. Priority should be given to regular shaped areas, and areas which minimise boundary effects. Areas which are part of ecological linkages are more likely to support ecological functioning. Priority should be given to ensuring a north-south vegetation corridor, and enhancing the east-west vegetation linkage.
Three Priority/Threatened Ecological (PEC/TEC) Communities **Key values**: Banksia Woodland of the SCP, Tuart Woodlands and Forests of SCP, Honeymyrtle shrublands on limestone ridges of the SCP Retention of: • 39 ha (87%) of Banksia Woodland of the SCP (Banksia Woodlands) with 24 ha in 'Very Good' to 'Excellent' Condition.		The area of Banksia Woodlands proposed for clearing is 6 ha (13%). The area of Tuart Woodlands proposed for clearing is 28 ha (26%). No clearing of Honey-myrtle is proposed. The EPA notes this includes occurrences of the TEC on the Water Corporation sites. Protection of all or significant proportions of key values as proposed is consistent with EPA objectives.

Key environmental values	Protection and enhancement currently proposed in draft DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
• 84 ha (74%) of Tuart Woodlands and Forests of SCP (Tuart Woodlands) with 34 ha in 'Good' or Better Condition. • 12.09 ha (100%) of Honeymyrtle shrublands on limestone ridges of the SCP (FCT 26a). See Figure 5: Conservation significant ecological communities within the site.		The amount of clearing of Banksia and Tuart Woodlands is likely significant and meet Commonwealth referral condition thresholds (DOEE 2016, 2019). Additional protection, particularly of Tuart and Banksia Woodlands is recommended where consistent with EPA's advice on other key values, such as protecting more excellent quality vegetation, creating more ecological linkages, or protecting more areas of regional environmental significance. Future planning processes should ensure that ongoing protection of these communities on site is enabled by ensuring they are protected in viable patches and have ongoing and appropriate protection and management i.e. fencing, buffers, hard edges.
Conservation significant flora species **Key values**: 5 conservation significant flora species present in DSP area: • *Eucalyptus argutifolia* • *Pimelea calcicola* • *Stylidum maritimum* • *Eucalyptus foecunda* subsp. *Foecunda* • *Melaleuca* sp. Wanneroo (presence in DSP site confirmed by WA Herbarium) The draft DSP includes retention of: • All 6 individuals of Yanchep mallee (*Eucalyptus argutifolia*) protected within the conservation estate area. • 1 of 2 identified populations of *Pimelea calcicole* protected in conservation estate. • The population of *Stylidium maritimum* protected in conservation estate. See Figure 6 for Conservation significant flora within the site.		There are likely to be impacts to identified priority flora species within potential BRM extraction area: • population of *Pimelea calcicola* (P3). • plants *Eucalyptus foecunda* subsp. *foecunda* (P4). The EPA considers these may be the maximum likely to be able to be cleared on-site and still be consistent with EPA objectives. Additional protection is recommended where consistent with EPA's advice on other key values, such as protecting more excellent quality vegetation, creating more ecological linkages, or protecting more areas of regional environmental significance. Noting occurrences of *Melaleuca* sp. Wanneroo within the DSP site is not yet available on public datasets and was not identified through survey for DSP, retention of and/or impacts to *Melaleuca* sp. Wanneroo have not been identified. The EPA consider occurrence(s) of *Melaleuca* sp. Wanneroo should be prioritised for retention, consistent with Ministerial Statement 1207.

Key environmental values	Protection and enhancement currently proposed in draft DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
Ecological linkages and stepping stones **Key value**: An east-west ecological linkage runs through the central area of the DSP site linking BFS 290 to the east, and BFS 383 to the west, which are within the Nowergup Nature Reserve and Nowergup National Park. The draft DSP includes retention of: • The east-west ecological linkage and retention of vegetation as a northern north-south link, (Area A in Figure 4) which creates a large conservation area of approximately 190 ha. • Areas B, C, D, E, F and G as conservation. See Figures 2 and 4 for draft DSP conservation areas.		Remnant vegetation within the DSP site contributes to Regional Ecological Linkage No.8 (del Marco et al.2004). The retention of the east-west ecological linkage, with proposed northern north – south corridor, as a large consolidated conservation area, and Areas B, C, D, E, F and G, which provide stepping stones, is consistent with EPA objectives. The northern north-south corridor includes vegetation on Water Corporation sites, is also important and the EPA considers additional protections should be included to ensure this corridor is retained and enhanced. The addition of Areas J, K, L and M to the conservation estate would also provide additional protections, and 'stepping stones' assisting with maintaining biological diversity and movement throughout the broader landscape. The EPA notes the conservation area will be fragmented by existing and proposed roads. The EPA advises roads in conservation areas reduces habitat connectivity and environmental values including loss of genetic diversity, long-term viability and increases edge effects (weeds, fire, human disturbance, feral animals). The EPA recommends road location be reviewed; it considers it is at this strategic level of planning where infrastructure (road) alignments can be located to reduce impacts to environmental values of conservation areas.
Potential for restoration The draft DSP proposes a restoration plan at subsequent stages of planning for restorative planting of approximately 30 ha of		Restorative planting of conservation areas provides onsite environmental benefits and is supported by the EPA where consistent with its advice on offsets at a regional scale.

Key environmental values	Protection and enhancement currently proposed in draft DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
vegetation identified as 'Degraded' and 'Completely Degraded' within conservation estate areas.		Restoration is also part of the mitigation hierarchy and can reduce the significant residual impacts on site and the need to consider off-site environmental protections in order to offset (counterbalance) on site impacts. Implementation of restoration planting should consider the timing of the environmental benefit i.e. for black cockatoo foraging, the time lag between foraging habitat clearing, planting, and maturation of foraging species. Local Planning Scheme amendments/structure plans should provide additional information on proposed restorative planting and include requirements for preparation and implementation of management plans to meet specific, time related environmental outcomes.
Area specific advice (For areas shown in Figure 4) Areas A – G are proposed for retention, the EPA advises these meet EPA criteria for regional significance and conservation of them is consistent with EPA objectives. Areas H, I, J, K, L and M, which are not proposed for retention, also meet EPA criteria for regional significance. The EPA considers that these areas should be prioritised for retention, with consideration of other key environmental values. **Area M** is connected to Area F (Area F is proposed as a conservation area and contains Tuart Woodlands in 'Good' to 'Excellent' condition). Area M contains vegetation identified as high value for Carnaby's cockatoo foraging and potential breeding habitat. Whilst not identified in the FCT analysis, the vegetation also potentially meets the Commonwealth key diagnostic criteria for the Honeymyrtle shrublands on limestone ridges of the SCP TEC. Further analysis and interpretation should be undertaken to inform TEC occurrences. The insert in Figure 4 identifies black cockatoo habitat that could also provide a minor corridor/linkage to Nowergup Lake. Retention of additional vegetation will increase the long-term viability of the conservation area and result in greater avoidance of impacts to high value Carnaby's foraging habitat and potential breeding habitat.		

Key environmental values	Protection and enhancement currently proposed in draft DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
Area H - located relatively close to Area A in the north of the DSP site, Area H contains approximately 0.7 ha of vegetation type *Banksia sessillis* in 'Very Good' condition. Area H is also identified as high value foraging habitat for Carnaby's cockatoo. The completely degraded area (lot boundary / firebreaks) between Areas A and H provides an opportunity for revegetation to further minimise the impacts of vegetation and habitat clearing in the DSP site. **Area I** – an irregular shaped remnant of approximately 1 ha in 'Very Good' condition. Area I and an adjacent remnant are located on Lot 13 and, via roadside assessment, identified as high value Carnaby's cockatoo foraging habitat; large trees were not inspected. Area I is in very close proximity to a black cockatoo roost site. Future planning should be informed by survey for black cockatoo and consider retention of black cockatoo habitat values. **Area K** – approximately 9 ha of remnant native vegetation dominated by *Banksia sessillis* in 'Good' and 'Very Good' condition. Similar to Area M, this vegetation also potentially meets the Commonwealth key diagnostic criteria for the Honeymyrtle shrublands on limestone ridges of the SCP TEC and further analysis and interpretation should be undertaken to inform TEC occurrences. Area K is also mostly high-quality foraging habitat for Carnaby's cockatoo. Retention of this habitat would provide additional avoidance and reduce the requirement for future off-site offsets. **Area L** – this remnant native vegetation of approximately 3.5 ha is also dominated by *Banksia sessillis* in 'Very Good' condition and provides high quality Carnaby's foraging habitat. A recent roadside inspection identified a Xanthorrhoea sp.; potentially an unidentified morphologically distinct taxon co-occurring with *Xanthorrhoea preissii*. The vegetation also potentially meets the Commonwealth key diagnostic criteria for the Honeymyrtle shrublands on limestone ridges of the SCP. The EPA recommends that further investigation/analysis is completed to confirm the unidentified species and potential TEC occurrence to assist in informing if Area L should be retained within the conservation estate.		

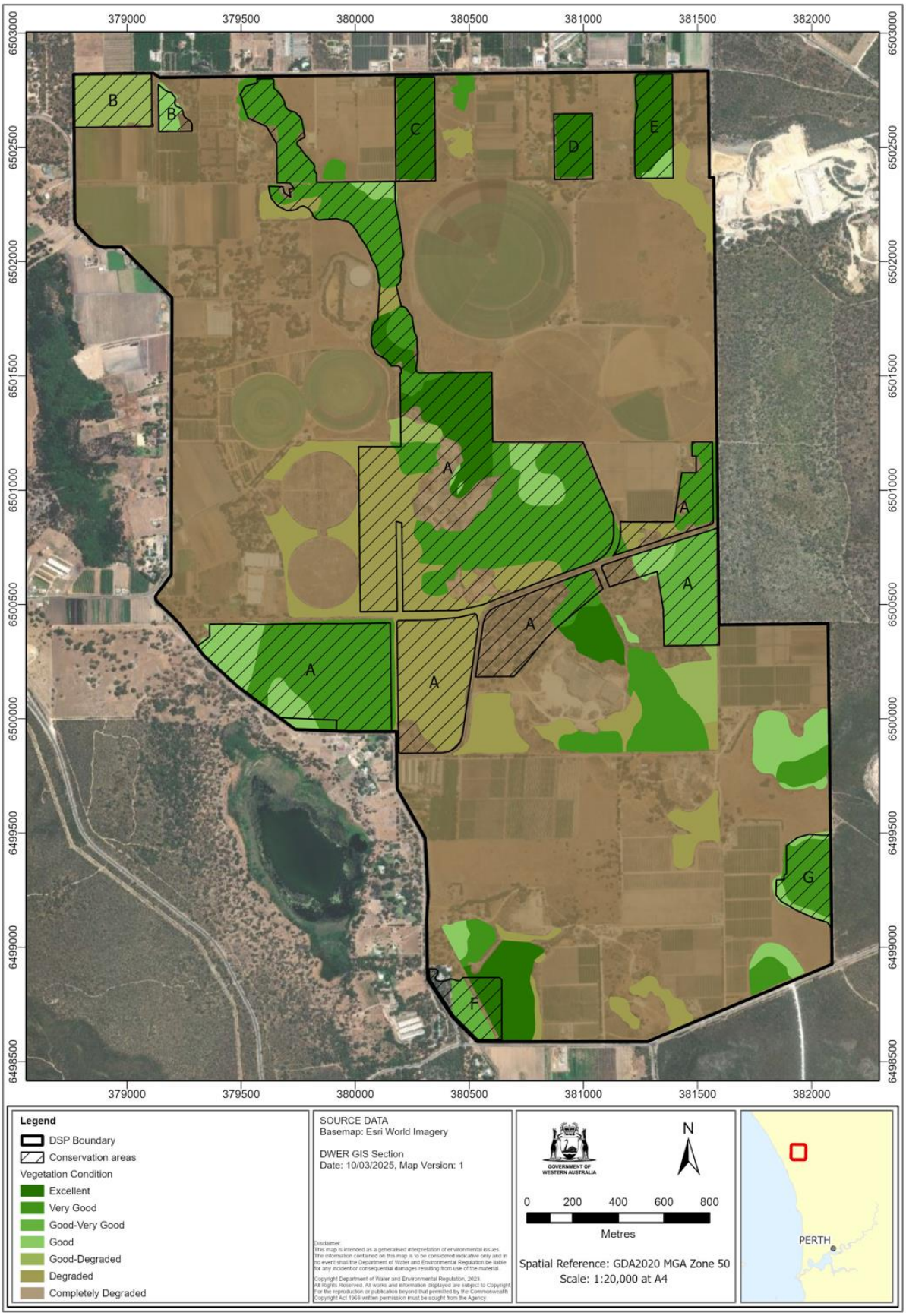


Figure 3 Remnant native vegetation condition and conservation areas

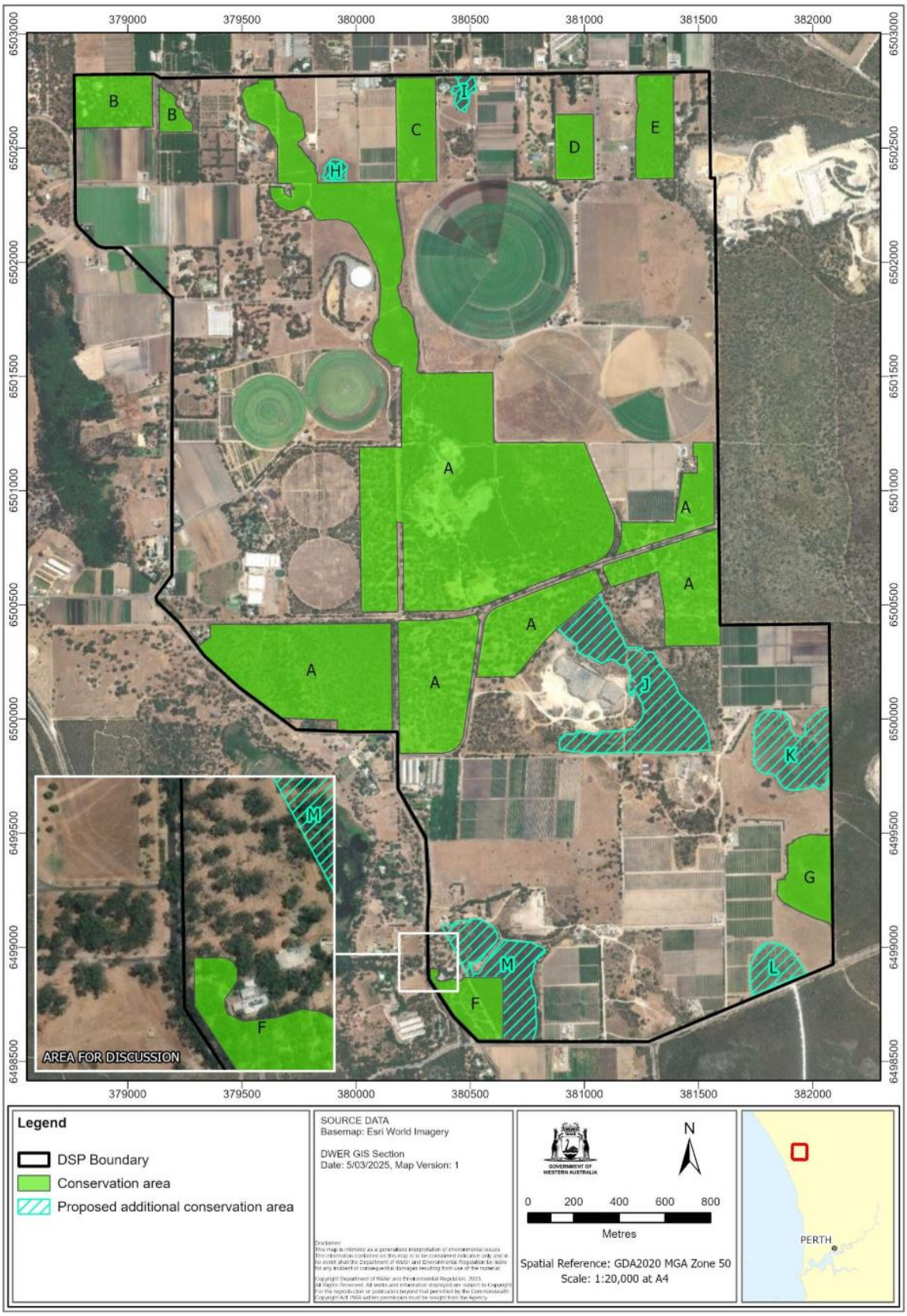


Figure 4 Draft DSP Conservation areas and EPA additional conservation recommendation areas

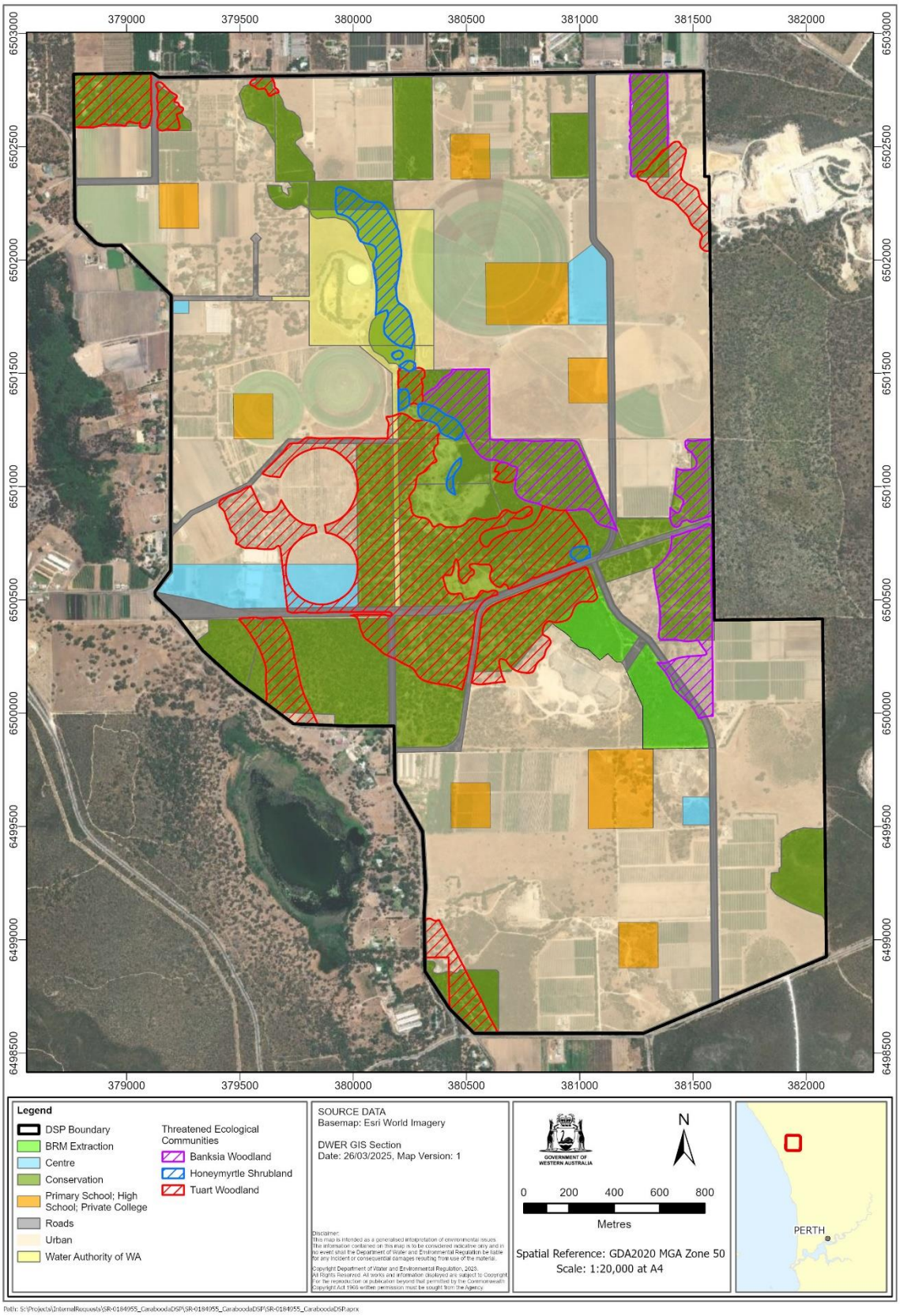


Figure 5 Conservation significant ecological communities within the site

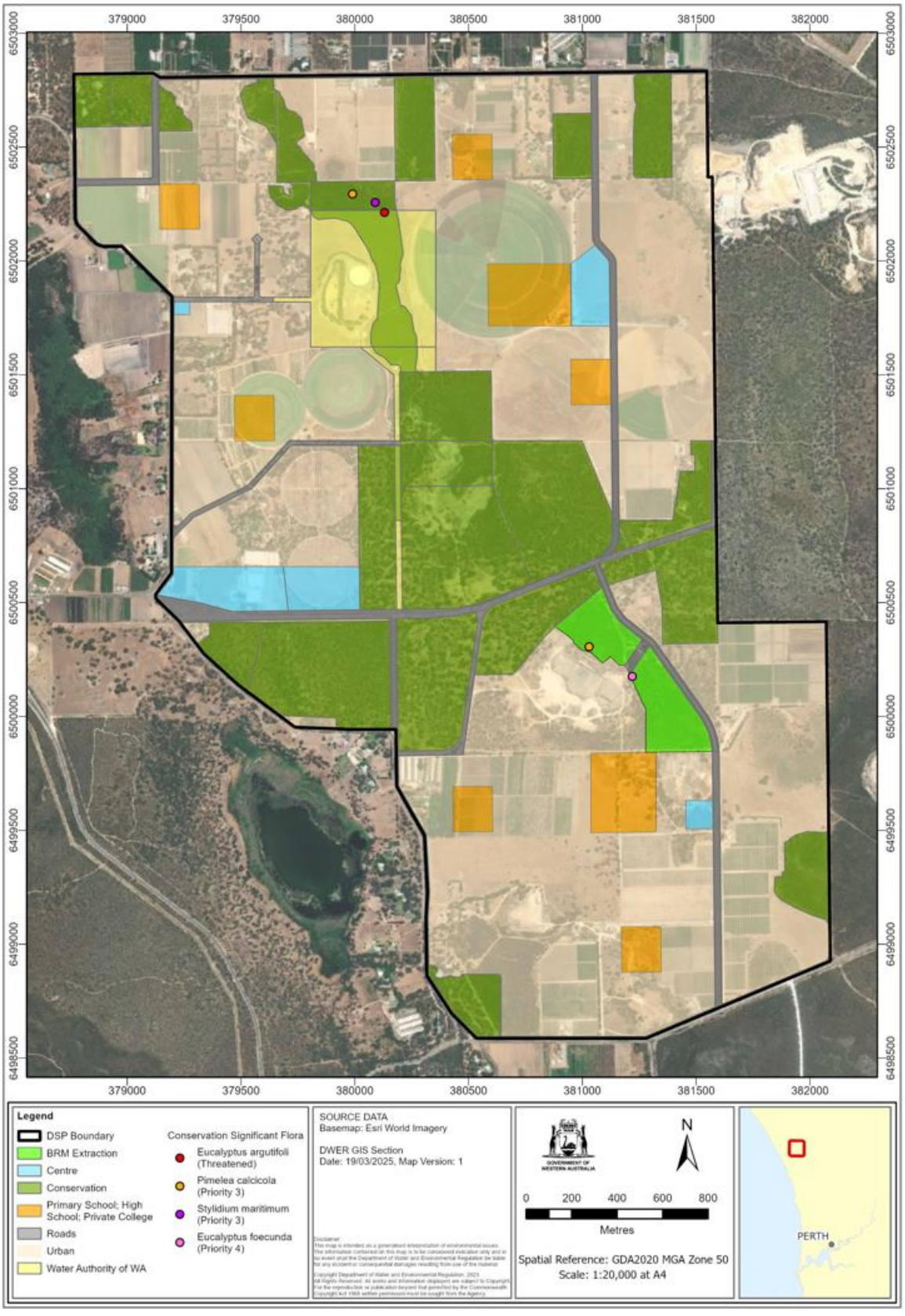


Figure 6 Conservation significant flora within the site

Cumulative and strategic environmental planning considerations: Due to the strategic nature of the draft DSP, the EPA's cumulative impact considerations is high level.

The DSP site is within the North-West Sub-regional Planning Framework corridor (WAPC 2018a). The corridor is dominated by extensive urban development with areas still to be developed for urban purposes. The existing and proposed urban development has resulted in the clearing of vegetation that would likely have been representative of Banksia Woodlands and Tuart Woodlands.

The EPA has considered clearing as a result of:

- EPBC 2017/7872 for urban development at East Eglinton: clearing of no more than 41.29 ha and retention of minimum 8 ha of Banksia Woodland clearing of up to 79 ha of cbc habitat.
- Alkimos Desalination Plant – disturbance of up to 1.7 ha of Banksia Woodlands and 1.16 ha of Tuart Woodland.
- Yanchep rail extension part 2 – Eglinton to Yanchep – clearing/disturbance of 8.8 ha of Banksia Woodlands and 56.3 ha of Carnaby's cockatoo foraging habitat.
- East Wanneroo DSP - proposes the development of more than 8000 ha of land. It will potentially impact 255 ha of Banksia Woodlands and 33 ha of Tuart Woodlands.

The EPA advises that the proposed retention of 39 ha (87%) of the mapped extent of Banksia Woodlands and 84 ha (74%) of Tuart Woodlands in proposed conservation areas in the draft DSP limits the incremental loss of these PEC/TECs.

The EPA notes impact to conservation significant flora species in the draft DSP area have been limited, and with retention of *Melaleuca* sp. Wanneroo, the cumulative impacts to significant flora are unlikely to be inconsistent with EPA's objectives.

The EPA considers that, in the context of the significance of the environmental values at risk, the impacts of the draft DSP and the proposed conservation estate area can be appropriately managed to provide for an environmental outcome that is consistent with the EPA's objective.

The EPA notes the current MRS and local scheme zoning of land in the DSP site allows land uses which, if implemented, may negatively impact environmental values i.e. BRM extraction. The EPA advises that development in proposed conservation areas of the DSP that impact environmental values may reduce consistency with the EPA's objectives.

Additional information required for future environmental planning of DSP: The EPA advises the flora and vegetation survey reports do not meet all requirements of the EPA technical guides for survey (EPA 2016b, 2016d, 2020). Consultation with DBCA regarding consistency with the technical guide for the FCT analysis and definition of threatened ecological communities is recommended. Review and additional survey and analysis may be necessary to ensure remnant native vegetation does not contain conservation significant flora or is representative of PEC/TECs. The EPA advises this should be undertaken in consultation with DWER and DBCA prior to local planning scheme amendment/local structure planning stage to inform environmental planning outcomes and the EPA's consideration of planning scheme referrals.

5 Terrestrial Fauna

The EPA environmental objective for flora and vegetation is t*o protect flora and vegetation so that biological diversity and ecological integrity are maintained* (EPA 2016c).

Table 2 Terrestrial fauna key environmental values and recommendations for future environmental planning[4].

Key environmental values	Protection and enhancement currently proposed in DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
Key value: Black cockatoo foraging habitat The entire DSP site provides black cockatoo habitat ranging from low quality; predominately cleared with scattered trees, to areas of high and higher quality foraging habitat. 334 ha is of moderate or better-quality foraging habitat for Carnaby's Cockatoo. 223 ha is of moderate or better-quality foraging habitat for Forest Red-tailed Black-cockatoo (FRTBC). The draft DSP proposes retention of: • 233 ha of black cockatoo foraging habitat (comprising cleared areas with scattered trees to higher quality) with: ○ 215 ha, being 64% of the total moderate or better quality foraging habitat for Carnaby's Black Cockatoo ○ 166 ha, being 75% of the total moderate and moderate to high quality foraging habitat for FRTBC. The draft DSP proposes at future stages of planning preparation of a restorative planting program within conservation areas of approximately 30 ha.		118 ha (35%) of Carnaby's cockatoo foraging habitat of moderate to high quality with 54 ha (40%) in higher quality to be cleared. 57 ha (25%) of FRTBC foraging habitat in moderate and moderate to high quality to be cleared. Consistent with past Ministerial decisions under the EP Act and EPBC Act, and the *Referral guideline for 3 WA threatened black cockatoo species* (DAWE 2022), the EPA considers this is likely to be a significant impact and recommends additional foraging habitat, should be prioritised for retention through DSP or, at Local Planning Scheme amendment/structure planning stage. As noted in Table 1, it is at the strategic planning stage that planning considerations can provide a mix of built form and density to ensure population and housing projections are maintained whilst protecting significant environmental values in situ. See also the cumulative and strategic environmental planning considerations below.

[4] Areas are approximate.

Key environmental values	Protection and enhancement currently proposed in DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
See Figures 7 and 8 for Black Cockatoo foraging habitat and DSP conservation areas.		Areas H, K, L and M (Figure 4) and as discussed in Table 1, provide high quality foraging habitat for Carnaby's cockatoo and additional areas of moderate to high quality FRTBC foraging habitat (Figure 8) should be prioritised for retention. Identification of additional retention areas should consider proximity to proposed retention areas, roosting and nesting sites, maintenance of any known flight paths, and other environmental values. Additional on-site protection; such as avoidance, management, restoration and enhancement, can reduce the calculation of residual impacts and the need for off-site offsets. Where onsite protection measures are consistent with the EPA's advice on offsets at a regional scale (EPA 2024a) and offsets calculator outputs, this may adequately counterbalance residual impacts onsite impacts for environmental planning purposes. Restoration and enhancement of degraded habitat, whether on site or off site, should be prioritised for protection of black cockatoos on the SCP at subregional and regional levels.
Key value: Black cockatoo roosts • No roost sites confirmed in the DSP site, but two are in very close proximity. • 11 confirmed roost sites for Carnaby's cockatoo and FRTBC (1 joint) within 6km of the DSP site. Not all landholdings were surveyed due to site access constraints.		The EPA advises the high number of roost sites within the sub-region means the foraging habitat on site is of high value. It is also possible there may be roost sites on the DSP site itself. Protection of any roost sites on site is likely needed to be consistent with EPA objectives. The EPA provides the following advice for consideration at future stages of planning:

Key environmental values	Protection and enhancement currently proposed in DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
The draft DSP proposes that at future stages of planning eucalypt trees suitable for roosting, particularly near water sources outside of the conservation areas, will be investigated for retention.		• Survey of potential black cockatoo roost sites should be of native and non-native tree species and occur prior to local structure planning. • Establish appropriate buffers and management for roost sites identified for retention outside of conservation areas. Roost site(s) within conservation areas should also have appropriate buffers to adjacent development. • Existing water sources (troughs etc) should be retained and where not possible, should be, prior to removal of existing, replaced in a nearby safe and accessible location.
Key value: Black cockatoo breeding trees • No confirmed nesting sites in DSP area. Closest confirmed nesting site approximately 10km. • 1,598 potential nesting trees identified with DBH greater than or equal to 50cm. Not all landholdings were surveyed due to site access constraints. The draft DSP proposes: • 997 potential nesting trees with DBH greater than or equal to 50cm to be retained in conservation areas; six with suitable hollows and chew marks and 75 with suitable hollows no chew marks. • Retention of additional trees with suitable hollows outside the conservation areas will be investigated for retention in future stages of planning.		Approximately 600 (37%) potential nesting trees may be impacted, noting this number may be higher as not all areas have been surveyed. Given the high number of roost sites within the sub-region, the high value of the foraging habitat, and the cumulative impacts on cockatoo species in the region, avoidance and protection of these trees should prioritised. Protection of trees with suitable hollows is likely needed to be consistent with EPA objectives. Additional on-site protection and management may reduce the calculation of residual impacts and the need for off-site offsets. Where onsite protection measures are consistent with the EPA's advice on offsets at a regional scale (EPA 2024a) and offsets calculator outputs, this may adequately counterbalance residual onsite impacts for environmental planning purposes.

Key environmental values	Protection and enhancement currently proposed in DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
		The EPA advises: • For areas not subject to survey, identify potential nesting trees prior to local structure planning. • Establish appropriate buffers for potential nesting trees identified for retention outside of conservation areas. • Potential nesting trees within conservation areas should also have appropriate buffers to adjacent development.
Conservation significant terrestrial fauna vertebrate and invertebrate fauna. **Key values**: Eight vertebrate species listed under *Biodiversity Conservation Act 2016* (BC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), six Priority species and five invertebrate species of conservation significance are likely to be present in DSP site: • Fork-tailed Swift (*Apus pacificus*) • Glossy ibis (*Plegadis falcinellus*) • Peregrine falcon (*Falco peregrinus*) • Forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*) • Baudin's black cockatoo (*Zanda baudinii*) • Carnaby's black cockatoo (*Zanda latirostris*) • Chuditch (*Dasyurus geoffroii*) • South-western brush-tailed phascogale (*Phascogale tapoatafa wambenger*). Survey for significant fauna, other than black cockatoo, was a desktop assessment and site inspection.		The presence of conservation significant terrestrial vertebrate, other than species of black cockatoo, and invertebrate species has not yet been determined. Retention of 70% of the remnant native vegetation in the DSP site with 80% of this in consolidated areas retaining and creating ecological linkages will likely contribute to terrestrial fauna values being maintained. Detailed terrestrial fauna survey is required to ensure conservation significant fauna species habitat is retained and enable appropriate management actions and planning to be undertaken at subsequent stages of planning. Protection of significant fauna habitat on site, if found during survey, is likely needed to be consistent with EPA objectives. As discussed for flora and vegetation (Table 1) terrestrial fauna diversity and abundance will likely be decreased through the existing and proposed roads within conservation areas. Species of black cockatoo are at particular risk of

Key environmental values	Protection and enhancement currently proposed in DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
The draft DSP proposes: • Retention of 234 ha of remnant native vegetation that provides habitat for terrestrial fauna species. • Retention of the east-west ecological linkage and retention of vegetation as a northern north-south linkage creates a large conservation area of approximately 190 ha shown in Figure 4.		vehicle strike as they are slow to take off. The EPA considers it is at this strategic level of planning where infrastructure (road) alignments can be located to reduce impacts to environmental values of conservation areas. Fit for purpose fauna surveys, including invertebrate fauna, are recommended to inform the appropriate placement of roads and fauna mitigation to ensure impacts are avoided where possible. The EPA also advises that where infrastructure cannot be avoided in conservation areas, fauna mitigation measures should be provided (reduced speeds, signage, fencing, and specialist fauna management i.e. fauna underpasses) in areas of high fauna values.

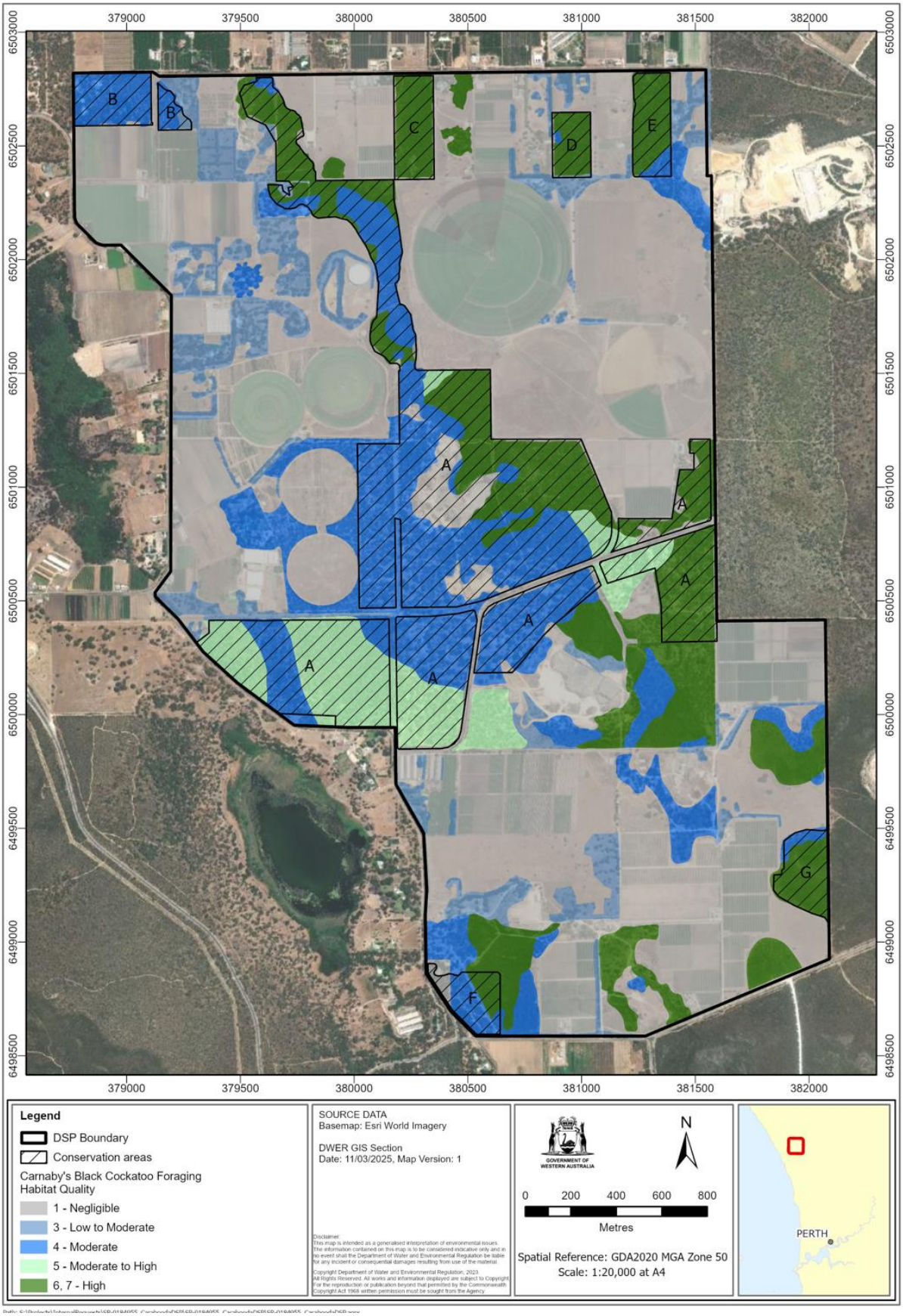


Figure 7 Carnaby's black cockatoo foraging habitat

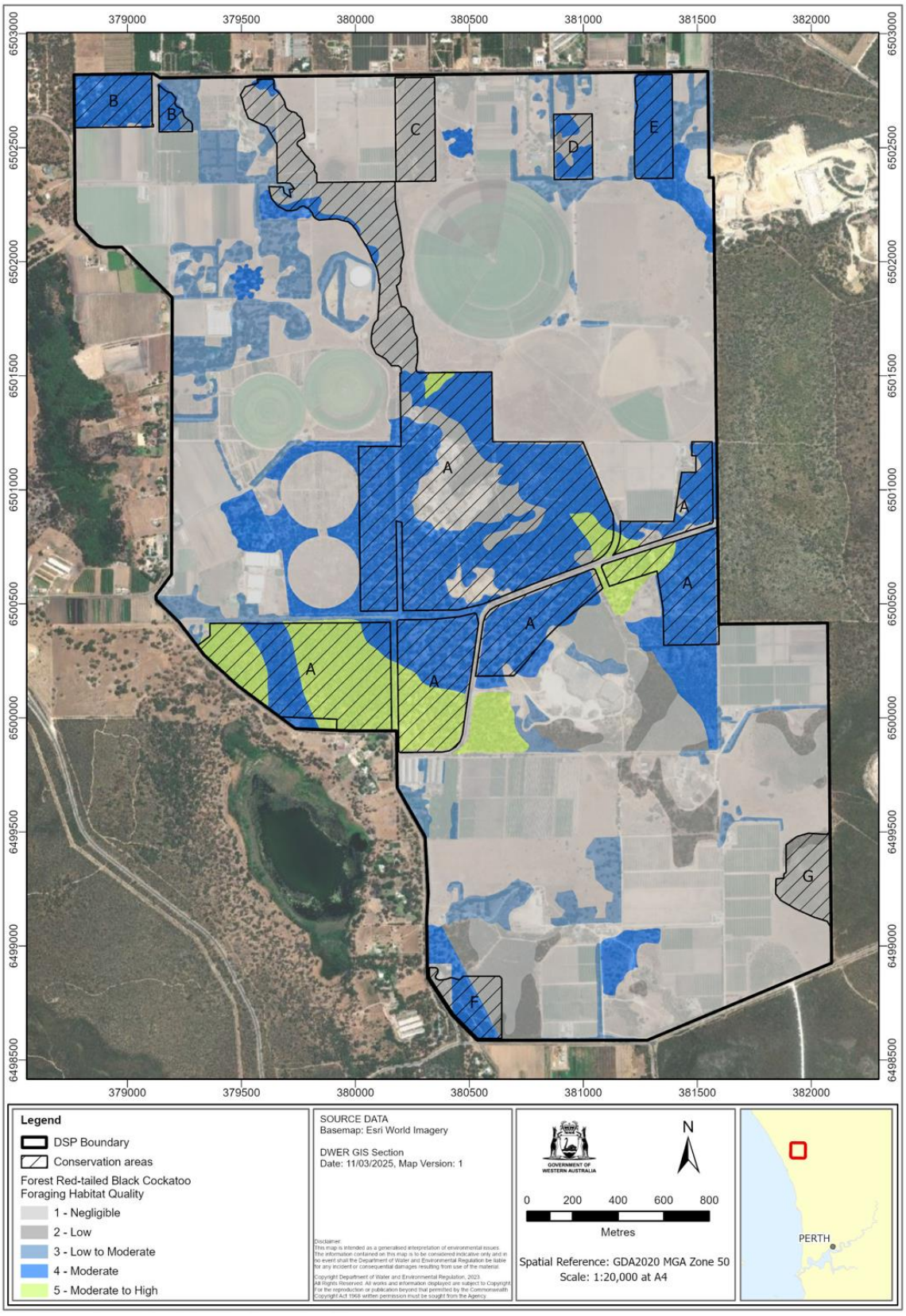


Figure 8 Forest Red-tail Black Cockatoo foraging habitat

Cumulative and strategic environmental planning considerations: Due to the strategic nature of the draft DSP, the EPA's cumulative impact considerations is high level and has focussed on Carnaby's cockatoo, noting Carnaby's cockatoo and FRTBC habitat does overlap.

The EPA considers that the continued threat to conservation significant fauna and, in particular species of black cockatoo, due to historical, present and future clearing of habitat in the Perth and Peel area of the SCP poses a significant threat to achievement of the EPA's objectives for terrestrial fauna.

The EPA notes that at this early stage of planning process detailed survey for conservation significant fauna that may inhabit the area is not available. Species such as the Chuditch and South-western brush-tailed phascogale that may be present have large home ranges and specific habitat requirements including tree hollows; clearing and habitat fragmentation are key threatening processes to these (and most) conservation significant fauna.

The DSP site is within the North-West Corridor Sub-regional Planning Framework (WAPC 2018) corridor dominated by relatively recent extensive urban development. Whilst not quantified, large areas of black cockatoo, mainly Carnaby's cockatoo habitat, has been cleared.

The EPA has considered clearing as a result of:

- EPBC 2017/7872 for urban development at East Eglinton: clearing of up to 79 ha of Carnaby's cockatoo foraging habitat.
- Alkimos Desalination Plant – clearing of up to 52 ha of high quality Carnaby's foraging habitat.
- Yanchep rail extension part 1 – Butler to Eglinton – clearing of 48.2 hectares of Carnaby's cockatoo foraging habitat.
- Yanchep rail extension part 2 – Eglinton to Yanchep – clearing of up to 56.3 ha of Carnaby's cockatoo foraging habitat.
- East Wanneroo DSP - potential impact to 285 ha of black cockatoo habitat.

Historical clearing combined with ongoing threats of further habitat clearing, disease, mortality and climate change, pose a cumulative risk to Carnaby's cockatoo. Carnaby's cockatoo utilise different habitats over a temporal and spatial scale to meet their ecological needs. Impacts to Carnaby's cockatoo should be considered in a landscape context of ecological values of the habitat, proximity to roosts, habitat connectivity, other foraging and water supplies (EPA 2019). Adding to impacts, the recent hot summers and low rainfall has resulted in reduced flowering of native plant foraging species leading to increased numbers of Carnaby's cockatoo facing starvation and reduced breeding success.

The Northern SCP is well known to support important flocks of Carnaby's cockatoo, including the largest recorded roosts at the Gnangara-Pinjar Pine Plantation area (EPA 2019). The DSP site forms part of the habitat mosaic for black cockatoo flocks in this area. Murdoch University have tracked Carnaby's cockatoo moving between large roosts at Pinjar to the Carabooda area (Murdoch University, 2018). The DSP and future planning should take into account Carnaby's cockatoo movement and ecological requirements in the Northern SCP.

The DSP site provides black cockatoo habitat ranging from low quality; predominately cleared with scattered trees, to areas of high and higher quality foraging habitat. Whilst this report has focused on the 334 ha of moderate to higher quality foraging, the EPA notes recent decisions on appeals by the Minister for Environment advising that all remaining

foraging habitat on the SCP is critical to the survival of black cockatoo species, regardless of quality.

The retention of foraging habitat has been demonstrated to be critical to support roosting and nesting sites for black cockatoos.

The EPA notes approximately two thirds of the moderate to higher quality foraging habitat (depending on the species) is proposed to be retained. The proposed clearing of one third (118 ha), including 55 ha high quality habitat in an important population area is likely to be a significant environmental impact under the EP Act. The EPA also advises the *Referral guideline for 3 WA threatened black cockatoo species* (DAWE 2022) advises the loss of greater than 1 ha of high or 10 ha of low quality foraging habitat is likely to require referral.

The EPA considers the best way to conserve Carnaby's cockatoo is to retain foraging habitat in situ. Additional areas protected on site should be considered, particularly where areas are aligned with roosting, nesting or other environmental values.

Offsets environmental planning considerations: Significant residual impacts which remain to black cockatoo habitat are usually likely to require offsets to be counterbalanced. The EPA considers environmental planning should consider environmental offsets through the following lens, rather than the strict application of a quantitative off-site environmental offsets calculator designed for individual proposal assessment.

The EPA advises that if the significance of residual impacts is reduced on site through the application of the mitigation hierarchy and protections focussing on on-site avoidance, management, restoration and enhancement, this is likely to be preferable to provision of off-site offsets.

The EPA considers that if on site protection measures such as avoidance, management, restoration and enhancement are consistent with the quality and quantity of off-site offset requirements that would normally be determined through an offsets calculator, and if the on-site protection measures are consistent with the EPA's advice on offsets at regional scale (EPA 2024a), this will likely be adequate to counter-balance residual on-site impacts.

Any off-site offsets which are proposed should also give consideration to the EPA's advice on offsets at regional scale.

The guiding values in EPA's advice on offsets at regional scale include prioritising restoration, regional scale management (beyond the site), addressing threatening processes, maintenance and creation of ecological linkages creating and managing environmental areas to be resilient, and consideration of the benefit to other values including heritage and community.

Implementation of offsets through future planning processes is recommended, so the EPA can take the likely outcome and security of offsets into account in any future decision-making processes. The EPA considers that the likely impacts of the draft DSP could be consistent with the EPA's objective if consideration is given to additional protection and offsets consistent with the advice above.

Additional information required for future environmental planning of DSP: In addition to specific protection recommendations and advice provided in Table 2, the EPA advises that future stages of planning should be informed by further information and survey for vertebrate, including species of black cockatoo, and invertebrate (SRE) fauna to ensure conservation significant species are identified so that future stages of environmental planning can respond accordingly.

6 Inland waters

The environmental objective for inland waters is *to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected* (EPA 2018).

Table 3 Inland waters key environmental values and recommendations for future environmental planning.

Key environmental values	Protection and enhancement currently proposed in DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
Key value: There are no **wetlands or water courses** within the DSP site. There are **several wetlands located outside** of the DSP site, but within 2km including Nowergup Lake (UFI 8021) a Conservation Category Wetland (CCW) located 200m to the west. Other wetlands include Resource Enhancement Wetlands Carabooda Lake (UFI 8009), UFI 8017 and 8020, Camel Swamp (UFI 2938), Neerabup Lake (UFI 8019) and Multiple Use Wetland (UFI 8018).		The EPA considers that the environmental outcome is likely to be consistent with EPA objectives. The EPA advises that the hydrogeological system is complex, however, environmental outcomes consistent with EPA objectives are likely to be able to be achieved through future environmental planning processes. Future stages of planning shall ensure there are no adverse impacts to the hydrological (water quality and quantity) and ecological functions of adjacent wetlands and include appropriate setbacks and management strategies to protect nearby wetlands, particularly Nowergup Lake. The EPA considers the requirements of *Draft State Planning Policy 2.9 Planning for Water* (WAPC 2021a) and *Better Urban Water Management* (WAPC 2018) can manage and mitigate the potential impacts to inland waters.
Depth to **groundwater** ranges from 8m in the southwest to 59m on the eastern boundary.		The EPA notes the District Water Management Strategy (DWMS) advises that based on the clearance to groundwater, it is not expected that groundwater management measures within the DSP will be needed.
A small portion of the site (0.3%) on the northern boundary is mapped as having high to moderate risk of acid sulphate soils (ASS) occurring within 3m of natural soil surface. There is a risk of mobilisation of ASS through predicted rise of groundwater levels.		Mobilisation of ASS has the potential to impact environmental values. The EPA notes that DWMS advises that ASS investigations will be undertaken to inform later stages of planning.

Additional information required for future environmental planning of DSP: The EPA advises that future stages of planning should be informed by:

- Investigation into the presence and extent of ASS should be undertaken at subsequent stages of planning and development, in accordance with *Identification and investigation of acid sulfate soils and acidic landscapes* (DER 2015a). Subsequent measures to minimise the risk of ASS disturbance should be identified in accordance with the results of the investigation and *Treatment and management of soil and water in acid sulfate soil landscapes* (DER 2015b).
- Draft *State Planning Policy 2.9 Planning for Water* (WAPC 2021a) and *Better Urban Water Management* (WAPC 2018).

7 Social surroundings

The environmental objective for social surroundings is *to protect social surrounds from significant harm* (EPA 2023b).

Table 4 Social surroundings key environmental values and recommendations for future environmental planning.

Key environmental values	Protection and enhancement currently proposed in DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
Aboriginal heritage sites There are no registered Aboriginal Heritage sites located within the DSP site. There is one registered Aboriginal heritage site of mythological significance associated with Nowergup Lake (Place ID 17450) located approximately 200m west of the DSP site. Another registered Aboriginal heritage site associated with Lake Neerabup (Place ID 3315) located 700 m to the south.		The EPA considers that the environmental outcome is likely to be consistent with EPA objectives. No impacts are likely to Aboriginal heritage.
European heritage The Lime Kilns – Spiers (Place no. 14299) is a Category 2 heritage site under the City of Wanneroo's Heritage List, and another Lime Kiln site (Wanneroo, Place no. 18338) is located adjacent to the site boundary but is not listed The draft DSP proposes that the Lime Kilns - Spiers heritage site will be retained within the proposed conservation area.		No impacts likely to listed European heritage. Potential future listings can be considered as part of future planning processes.
Dust and noise The DSP site and surrounding area is dominated by rural/horticulture and basic raw material extraction activities. The continued operation of these activities as urban development occurs in stages via subdivision is likely to occur. Future sensitive receptors may therefore be subjected to issues such as vibration, noise, odour and dust.		The EPA's *Environmental Protection Guidance Statement No.3: Separation Distances between Industrial and Sensitive Land Uses* (2005) should be considered as part of all planning decisions where existing business operations may impact proposed land uses in terms of amenity.

8 Subterranean fauna

The EPA environmental objective for subterranean fauna is *to protect subterranean fauna so that biological diversity and ecological integrity are maintained* (EPA 2016e).

Table 5 Subterranean fauna key environmental values and recommendations for future environmental planning.

Key environmental values	Protection and enhancement currently proposed in DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
High karst risk in the south-western corner and north-western covering approximately 4% of the total site area, likely abundant karst features including caves, dolines and swallows. **Medium karst risk** on the western side covering approximately 18% of the total site area. **Subterranean fauna** exists in these areas and alongside with geotechnical risk. There has been limited investigation to date and no protection has been proposed at this stage.		Environmental values for subterranean fauna that may be impacted by implementation of the draft DSP may be significant but: • are likely to be localised • are likely to be concurrent with geotechnical risks which need to be mitigated for non-environmental reasons • are likely to be able to be avoided or mitigated if found. The EPA expects future stages of environmental planning to consider avoidance and mitigation of risks to subterranean fauna.

Additional information required for future environmental planning of DSP: The EPA advises that future stages of planning should be informed by investigations and survey consistent with:

- Karst assessment and management requirements for planning proposals as outlined in *Local Planning Policy 4.13 Caves and Karstic Features* (City of Wanneroo 2022).
- *Environmental Factor Guideline – Subterranean Fauna* (EPA 2016e) and *Technical guidance – Subterranean fauna surveys for environmental impact assessment* (EPA 2021a) or any subsequent editions.

9 Terrestrial environmental quality

The environmental objective for terrestrial environmental quality is *to maintain the quality of land and soils so that environmental values are protected* (EPA 2016f).

Table 6 Terrestrial environmental quality key environmental values and recommendations for future environmental planning.

Key environmental values	Protection and enhancement currently proposed in DSP	Consistency of residual impacts with EPA objectives, and additional protection recommended for inclusion in future environmental planning
Contamination on site The Contaminated Sites register indicates there are no registered contaminated sites located within the DSP. Buildings and sheds across the site may contain asbestos material and contamination from the use and storage of fertiliser, pesticides and herbicides may have resulted in contamination.		The EPA considers that the environmental outcome is likely to be consistent with EPA objectives. Preliminary site investigation for contamination will be undertaken at the local structure planning stage. The EPA considers risks can be managed at future planning consistent with requirements of the *Contaminated Sites Act 2003* and Contaminated Sites Regulations 2006.
Groundwater flows affected by surrounding contaminated sites Immediately southeast of the DSP site there is a registered contaminated site (ID 74304), which is classified as remediated for restricted use. Groundwater beneath the site has been identified to have been historically contaminated with nutrients, metals and per- and polu-fluoroalkyl substances (PFAS) from previous use as a biosolids storage facility. As groundwater flows in a westerly direction, contamination from this site is not considered to pose a risk to the site.		Risks unlikely to be significant or inconsistent with EPA objective

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11 Appendix: Background information

Context for this EPA advice

In providing this environmental advice on the draft DSP, the EPA has relied on the DSP Part 1 and Part 2 (CLE, 2025) and technical appendices (listed in references). Key context about the information available to inform the EPA's advice is summarised below.

The EPA's environmental advice is informed by the environmental reports and surveys together with other information it has sought. Whilst the EPA has conducted some of its own investigations it has not undertaken field survey work, reviewed and analysed historical survey and database information and has not extensively consulted with technical experts.

The EPA understands the Department of Biodiversity, Conservation and Attractions and Department of Water and Environment Regulation (DWER) attended Technical Advisory Group meetings held by Department of Planning, Lands and Heritage (DPLH) and that DWER EPA Services Directorate participated in site visits and held meetings with Acumen Development Solutions and environmental consultants.

This advice is provided under section 16 of the EP Act and does not constitute a formal assessment, decision or approval by the EPA, or pre-determine any future statutory deliberations. There is no right of appeal against a section 16 advice.

Information available to inform EPA advice

Flora and Vegetation

The Carabooda District Structure Plan (DSP) was originally supported by an Environmental Assessment Report (EAR) (JBSG 2023) which included a desktop assessment to inform on the environment features of the site, outcomes of ecological site visit(s) by a senior ecologist, recommendations to address identified knowledge gaps and technical surveys. A Flora and Vegetation Survey by PVG (2023) for the core (660 ha) DSP area was also provided.

Plantecology (November 2024) undertook a statistical analysis of quadrat data to determine presence of floristic community types (FCT) that may be representative of Threatened and Priority Ecological Communities.

PVG (2025) supplemented its 2023 survey report, undertaking survey across the balance of the 960 ha DSP site.

Western Environmental (2025) also prepared an EAR to support lodgement of the DSP to the WAPC and any future MRS Amendment requests, and subsequent referrals to the EPA.

Terrestrial Fauna

The Level 1 Fauna and Targeted Black Cockatoo Assessment (Bamford Consulting Ecologist Consulting Ecologist, 2025) presents the results of the desktop review, site inspection and targeted black-cockatoo assessment for the DSP site. Most of the DSP area was visited on multiple occasions from May to October 2024. The EPA notes that potential impacts and avoidance measures for terrestrial fauna, other than species of black cockatoo, have not been discussed and quantified and some lots were not surveyed due to no site access, therefore direct observations were limited in these areas.

Appendix F
Additional Advice: Draft Carabooda District Structure Plan July 2025

GOVERNMENT OF WESTERN AUSTRALIA

Environmental Protection Authority

Ms Emma Cole
Chair
Western Australian Planning Commission
Locked Bag 2506
PERTH WA 6001

Our Ref: DWERVT18446 / ENQ-000
Enquiries: Teresa Bryant
Email: teresa.bryant@dwer.wa.gov.au

via email to: lupexecutivesupport@dplh.wa.gov.au

Dear Ms Cole

Thank you for your letter dated 7 August 2025, seeking the EPA's clarification on several matters in the EPA's section 16 Advice on the draft Carabooda District Structure Plan (s16 advice) of 4 April 2025.

The EPA's s16 advice identified key environmental values, provided advice on protection and enhancement of those values and what additional environmental values need to be considered at future stages of planning.

The additional information attached to your letter from Acumen and its environmental consultants, together with the amended DSP Concept Plan dated 7 July 2025 (amended DSP concept plan) proposing additional conservation areas has been reviewed.

In response to your specific requests for clarification the EPA now provides attachment 1 containing our additional advice.

In summary:

1. The amended DSP concept plan has appropriately responded to the EPA's 4 April 2025 advice and has prioritised the protection of the significant onsite environmental values identified by the EPA.

2. The amended DSP now proposes to protect approximately 75% of the remnant vegetation on site. This is consistent with the EPA's recommended approach to: retain good quality vegetation on sites and avoid clearing where possible in the first place (for the multiple benefits of this approach in environmental planning, see the EPA's submission to the Urban Greening Strategy July 2024).

3. The onsite retention level of native vegetation in the amended DSP is consistent with other comparative current proposals. Adoption of high levels of onsite retention of significant environmental values for the Swan Coastal Plain could

lead to significantly better environmental outcomes and efficiency of statutory processes.

4. The Conservation Management Fund represents a material step forward in environmental planning and management approaches and is commended.

5. The amended DSP has materially increased the likelihood that a future region scheme amendment will be consistent with EPA objectives and will not warrant a future EPA assessment.

6. Some environmental matters remain to be addressed in future planning processes, but the comprehensive environmental information provided has been more than usually required at this stage of planning and has enabled the EPA to provide this early advice.

7. The extent to which future planning processes can provide certainty and security of conservation areas and management (and offsets, if required), will also increase the likelihood that a future EPA assessment is not warranted.

Taken together with the EPA's 4 April 2025 advice, we trust our additional advice will assist the WAPC in the formal statutory decision-making processes which will now follow.

The EPA looks forward to continuing its collaborative work with the WAPC on strategic and district structure planning. If you have any concerns, please feel free to contact me directly. Alternatively, Teresa Bryant, Principal Advisor – Planning Projects, is available on 6364 6421 should DPLH officers have any queries.

Yours sincerely



Lee McIntosh
Deputy Chair
Environmental Protection Authority

19 September 2025

Attachment 1

Additional advice: draft Carabooda District Structure Plan July 2025

This additional advice should be considered together with the EPA's original advice of 4 April 2025.

The potential impacts of the proposed road through a conservation area and how those impacts could be managed or mitigated.

The EPA's s16 advice recommends that infrastructure (road) location be reviewed as roads in conservation areas reduce habitat connectivity and environmental values. It also recommends fauna surveys be undertaken to inform placement of roads and fauna mitigation to ensure impacts are avoided where possible.

In the event any such review concludes it is not practicable to relocate the road for non environmental reasons, we provide the following information:

Infrastructure location impacts: The location and construction of road and other infrastructure types, such as pipelines, typically impact flora and fauna during the clearing and construction phase. Impacts include habitat removal, noise, dust, light and entrapment.

Road operation impacts: Public road infrastructure has additional ongoing operational impacts (compared to non-road infrastructure). For instance, while daily vehicle movements on McLennan Drive are currently low, the proposed upgrade to an Integrator A road will increase its footprint and usage. The road reserve may expand from 20 to 45–55 metres, and the road itself will be upgraded to a four-lane divided carriageway with pedestrian and cycling path(s). Traffic volumes are expected to rise significantly as the DSP is progressively developed (estimated at 20,400vpd in PJA, 2025 Traffic Impact Assessment).

Mitigating actions: Where roads intersect conservation areas, implementing mitigation actions can reduce impacts on terrestrial fauna and risks to human safety. Mitigation actions should be informed by an understanding of local fauna and their movement patterns, particularly areas of high usage. Species particularly vulnerable to road impacts, especially collisions, include kangaroos and threatened species such as Black Cockatoos. Broader impacts may also affect the distribution and movement of other terrestrial fauna species.

Potential mitigation measures may include:

- fencing,
- fauna overpasses or underpasses,
- signage,
- speed limitations, and

- consideration of artificial lighting; its necessity, type, and placement.

These mitigation matters should be informed by fauna surveys in future planning stages so they are placed in the areas of most efficacy. These mitigating actions are well understood and so should be able to be addressed in an environmental management plan which is developed and implemented at the appropriate future stage of planning.

The potential benefits of the conservation management fund.

The potential benefit to the environment: The EPA's s16 advice acknowledged Acumen and the Carabooda Landowners Group (CLG) propose to establish a Conservation Management Fund (CMF) established from seed capital from developers, and sustained by ratepayer contributions, to enable the conservation of remnant native vegetation and ongoing management of the conservation estate.

The EPA commends the CLG for its proposal to establish a CMF, recognising it as an innovative and forward-thinking initiative. The EPA considers this model to be a significant step toward ensuring the long-term retention, protection, and active management of the proposed conservation areas. By securing dedicated funding for ongoing stewardship, the CMF demonstrates a strong commitment to delivering environmental outcomes and sets a positive precedent for future planning processes.

The potential benefit to environmental planning processes: When considering planning scheme amendment (scheme) referrals under Part IV of the EP Act , the EPA considers the mitigation hierarchy, and whether any proposed offsets will counterbalance impacts and be consistent with offsets policies.

The mitigation hierarchy is a sequence of actions to help reduce adverse environmental impacts, comprising (in order of preference): avoidance, minimisation, rehabilitation and, offset.

At this early stage in the planning process, it is not clear of the full extent to which the CMF will avoid/ reduce, minimise, rehabilitate or offset the proposal impacts. In the meantime, the EPA advises it is likely the CMF will result in good environmental outcomes and that the formal structure and final effect of the CMF should be able to be considered and embedded in future planning stages.

To assist in that consideration, the EPA provides the following early advice:

- Schemes that reserve areas with environmental values for conservation purposes clearly demonstrate avoidance.
- Where a scheme does not propose reservation, referral documentation that identifies proposed conservation areas, and proposes protection, rehabilitation, and ongoing management at future stages of planning may be considered as mitigation.

- Scheme text/provisions that secure proposed avoidance and mitigation measures at future stages of planning will enable the EPA to give them material weight in any future decision-making.
- To the extent that offsets are considered, ideally:
    - They are secured through the planning process, so the EPA can take them into account when considering future statutory referrals;
    - They prioritise the delivery of tangible environmental outcomes that are measurable (in terms of the on-ground protection, restoration etc that they result in) and are not limited to payment of funds without delivery of an environmental outcome;
    - They consider the matters in the EPA's public advice on offsets at a regional scale (EPA 2024).

For these reasons, the EPA supports the proposed CMF, and agreement between the relevant state and/or planning authorities and the CLG, being included as part of the planning process. As the CMF is a new approach, early consideration in that process is likely to be beneficial too.

The benefits of the additional conservation areas proposed by Acumen in the additional information provided

The EPA's s16 advice acknowledged and commended the approach taken by Acumen and the CLG, noting that the potential impacts of the draft DSP had been substantially mitigated through the proposed environmental protections and enhancements.

The conservation estate areas at that time protected a significant proportion of the remnant native vegetation (70%), including some of the most significant elements of the key environmental values on the site.

The EPA advised that additional protections could be incorporated to further reduce the significance of impacts. The EPA identified environmental values that should be prioritised for retention.

The EPA notes the amended DSP concept plan proposes an additional 7.44 ha for Conservation and 11 ha of conservation values to be retained in Local Open Space (LOS). This means the conservation values proposed to be protected on site are now up to approximately 75% for both native vegetation and Carnaby's black cockatoo.

The EPA also advises that:

- The proposed additional Conservation and LOS areas increase protections of vegetation mapped as Excellent and Very Good condition, and vegetation mapped as Moderate and High quality foraging habitat for Carnaby's black cockatoo.
- The additional areas increase the area of existing proposed conservation areas, and are of uniform shape and a viable size.
- They act as additional stepping stones that will contribute to improved conservation outcomes.

- Restorative planting of degraded areas is proposed which increases onsite mitigation.

Any priorities that have not been captured in the additional conservation areas proposed by Acumen.

The values identified in the EPA's s16 advice were recommended to reduce impacts to species of black cockatoo, retain vegetation in Excellent and Very Good condition and provide additional stepping stones/linkage for native flora and fauna to assist with maintenance of ecological processes and genetic diversity.

The additional Conservation/LOS areas in the amended DSP concept plan have largely addressed all these priorities.

In future planning processes, the EPA considers the ecological functionality of conservation areas for black cockatoo could be enhanced by prioritising retention of existing trees and planting suitable foraging species within development areas. The establishment of canopy corridors to facilitate flight paths between foraging habitats and roost sites within and outside of the DSP area should also be considered in future planning stages.

Do the proposed conservation areas capture a habitat mosaic for black cockatoos, such as connecting corridors or stepping stones and viable patches.

A habitat mosaic refers to variations in habitat types including vegetation types, spatial arrangement and ecological interactions. A complex mosaic supports biodiversity, strengthens ecological resilience and facilitates movement and migration.

The amended DSP concept plan improves the proposed habitat mosaic. The addition of vegetation type *Eucalyptus decipiens* Low Open Woodland over *Banksia sessilis*, results in an increased representation of the vegetation type proposed for conservation (as LOS). The additional areas also form more consolidated retention areas and contribute to viable ecological stepping stones that will support biological diversity and fauna movement within and outside of the DSP area.

Appendix G
Poultry Farm Locations

This plan has been prepared for general information purposes only and uses potentially uncontrolled data from external sources. CLE does not guarantee the accuracy of this plan and it should not be used for any detailed site design. This plan remains the property of CLE.

Carabooda Egg Farm
265 Carabooda Road

Karoborup Poultry Farmers
243 Karoborup Road

P Kyme + Co Pty Ltd
23 Karoborup Road

Nowergup Poultry Broiler Farm
348 Gibbs Road

Yaranary Farm
263 Gibbs Road

CARABOODA ROAD
OLD YANCHEP ROAD
GREENLEES WAY
KAROBORUP ROAD
KILN ROAD
MCLENNAN DRIVE
ROMEO ROAD
GODEL ROAD
WANNEROO ROAD
WESCO ROAD

PS
WSD
HS
DOS
PC

LEGEND

- District Structure Plan Boundary
- Existing Poultry Farm Buildings
- Extent of 500m Buffer
- Extent of 500m Buffer (Non-operational / to Cease Operating)

Nearmap 10.05.2025

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 km

CLE Town Planning + Design

POULTRY FARM LOCATIONS

Carabooda

plan no: 3742-115-01
date: 11 May 2026
scale: 1:15,000 @A3, 1:7,500 @A1

N